

Septic Shock Following Endoscopic Stone Surgery: Incidence, Clinical Characteristics, and Outcomes in a Retrospective Cohort Study

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Cite as: Kulturoglu G, Kucukcotur Kokurcan E. Septic Shock Following Endoscopic Stone Surgery: Incidence, Clinical Characteristics, and Outcomes in a Retrospective Cohort Study. J Cukurova Anesth Surg. 2026;9(3):1202-1211. doi: 10.36516/jocass.1965951

Received: 07.06.2026, Accepted: 24.09.2026, Published: 30.09.2026, CC BY-NC 4.0

Abstract

Aim/Objective: To evaluate the incidence, clinical characteristics, microbiological profile, and outcomes of septic shock requiring intensive care unit (ICU) admission following endoscopic stone surgery. **Methods:** Patients who underwent endoscopic stone surgery between January 2024 and January 2026 were retrospectively reviewed. Cases of septic shock requiring ICU admission within the first 7 postoperative days were identified. Demographic characteristics, comorbidities, perioperative variables, microbiological findings, APACHE II and SOFA scores at ICU admission, and 30-day mortality were analysed. **Results:** Among 3,702 patients who underwent endoscopic stone surgery, 21 developed septic shock requiring ICU admission, yielding an incidence of 0.57%. The affected patients had a mean age of 67.0 ± 11.9 years, and diabetes mellitus (57.1%) and hypertension (52.4%) were the most common comorbidities. Preoperative and postoperative urine cultures were positive in 61.9% and 71.4% of patients, respectively, with *Escherichia coli* being the predominant pathogen. The mean APACHE II and SOFA scores at ICU admission were 17.67 ± 6.82 and 7.57 ± 2.13 , respectively. Non-invasive respiratory support was required in 23.8% of patients, whereas no patient required invasive mechanical ventilation. Renal replacement therapy and multiple organ dysfunction syndrome each occurred in 19.0% of patients. The 30-day mortality rate was 14.3%. **Conclusion:** Septic shock following endoscopic stone surgery is an uncommon but clinically significant complication. Although it occurred in only 0.57% of patients, it was associated with substantial organ support requirements and a 30-day mortality rate of 14.3%. Early recognition and intensive care management may help improve outcomes in affected patients.

Keywords: Septic shock; urinary calculi; endoscopy; postoperative complications; intensive care units

1. Introduction

Urinary stone disease is one of the most common urological conditions worldwide, with a lifetime prevalence of approximately 10%.^{1,2} Advances in minimally invasive techniques over the past two decades have made endoscopic stone surgery as the primary

treatment approach. Ureteroscopy (URS), retrograde intrarenal surgery (RIRS), and percutaneous nephrolithotomy (PCNL) are now widely performed owing to their high stone-free rates, shorter hospital stays, and favourable safety profiles.³ However, these procedures carry a risk of infectious complications related to urinary tract colonisation, infected stone material, and bacterial translocation caused by increased intrarenal pressure.

Postoperative infectious complications encompass a broad clinical spectrum, ranging from uncomplicated urinary tract infections to pyelonephritis, sepsis, and septic shock. Urosepsis is one of the most serious complications of endoscopic stone surgery. It is defined as life-threatening organ dysfunction resulting from a urinary tract infection.⁴ Reported rates of sepsis following endourological procedures range from 0.5% to 11%.^{1,5,6} Several factors have been associated with the development of postoperative urosepsis, including positive preoperative urine cultures, a high stone burden, prolonged operative time, elevated irrigation pressures, preoperative ureteral stenting, diabetes mellitus, and other comorbid conditions.^{5,7}

Although the epidemiology and risk factors of infectious complications following endourological procedures have been widely studied, evidence regarding patients who develop septic shock requiring intensive care remains limited. The clinical characteristics, organ support requirements, and outcomes of this high-risk population have not been well characterised. Improved understanding of these patients may facilitate earlier recognition, risk stratification, and optimisation of perioperative management.

Accordingly, this study aimed to evaluate the incidence, clinical characteristics, microbiological profile, intensive care course, organ support requirements, and 30-day mortality of patients who developed septic shock requiring intensive care admission within the first 7 postoperative days following endoscopic stone surgery.

2. Materials and Methods

2.1. Study Design and Ethical Approval

This was a single-centre retrospective observational study. Ethical approval was obtained from the Institutional Ethics Committee of Ankara Etlik City Hospital (Approval No. AESH-BADEK2-2026-213; Date: 17.02.2026). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

2.2. Study Population and Eligibility Criteria

Adult patients who underwent endoscopic stone surgery for urinary stone disease at Ankara Etlik City Hospital between January 2024 and January 2026 were retrospectively identified from the institutional database. Patients who developed septic shock requiring ICU admission within the first 7 postoperative days were included in the study.

Exclusion criteria included documented septic shock before surgery, incomplete clinical records, and concomitant surgical procedures. Positive preoperative urine cultures were not considered an exclusion criterion.

2.3. Definitions

Urosepsis was defined according to the Sepsis-3 consensus criteria as life-threatening organ dysfunction caused by a urinary tract infection. Septic shock was defined as sepsis requiring vasopressor therapy to maintain a mean arterial pressure of ≥ 65 mmHg despite adequate fluid resuscitation, together with a serum lactate concentration > 2 mmol/L.⁴ Multiple organ dysfunction syndrome (MODS) was defined as a SOFA score ≥ 2 in at least two organ systems.⁸

2.4. Data Collection

Data were extracted from the institutional electronic medical records system. Demographic and preoperative variables included age, sex, ASA physical status, comorbidities

(diabetes mellitus, hypertension, chronic kidney disease, and immunosuppression), preoperative urine culture results, history of antimicrobial therapy, and the presence and duration of preoperative ureteral stenting.

Intraoperative data included the type of endoscopic procedure (RIRS, URS, or PCNL), anaesthetic technique, duration of anaesthesia, and perioperative antimicrobial prophylaxis.

Postoperative data included urine culture and antimicrobial susceptibility results, time to diagnosis of septic shock, laboratory findings, SOFA and APACHE II scores, requirements for mechanical ventilation, renal replacement therapy and extracorporeal cytokine adsorption therapy, development of MODS, ICU length of stay, hospital length of stay, and 30-day mortality. Laboratory analyses were based on the highest recorded values during ICU stay, whereas SOFA and APACHE II scores were calculated using data obtained on the day of ICU admission.

At our institution, preoperative urine cultures were routinely obtained from all patients undergoing endourological procedures. In emergency cases, surgery could be performed before the culture results became available. Postoperatively, urine cultures were obtained in patients with suspected urinary tract infection.

2.5. Study Outcomes

The primary outcome of this study was the incidence of septic shock requiring ICU admission within the first 7 postoperative days following endoscopic stone surgery. Secondary outcomes included the clinical characteristics, microbiological profile, organ support requirements, ICU and hospital length of stay, and 30-day mortality of the affected patients.

2.6. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean $\pm$ standard deviation (SD) or median (interquartile range [IQR]), and categorical variables as frequencies and percentages. The distribution of continuous variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests, together with visual inspection of histograms and Q–Q plots. For large samples, normality was assessed by considering the test results in conjunction with skewness, kurtosis, and graphical methods.

3. Results

3.1. Patient Flow and Overall Findings

Between January 2024 and January 2026, 3,711 consecutive adult patients underwent endoscopic stone surgery (RIRS, URS, or PCNL) at Ankara Etlik City Hospital. After excluding five patients who underwent concomitant surgical procedures and four with incomplete records, 3,702 patients remained eligible for analysis. Of these, 21 developed septic shock requiring ICU admission within the first 7 postoperative days, yielding an incidence of 0.57%. These patients constituted the study cohort (Figure 1).

3.2. Demographic and Perioperative Characteristics

The mean age was 67.0 ± 11.9 years among patients who developed septic shock and 50.8 ± 15.0 years in the overall surgical cohort. Female patients constituted the majority of both the septic shock group and the overall surgical cohort. In the septic shock group, 61.9% of patients were classified as ASA III, 33.3% as ASA II, and none as ASA I. In the overall surgical cohort, 72.5% of patients were classified as ASA II. The median duration of anaesthesia was 90 [IQR 75–117.5] minutes in the septic shock group and 70 [IQR 50–100] minutes in the overall cohort. Emergency surgery was recorded in 14.3% of patients who developed septic shock and in 2.2% of the overall surgical cohort (Table 1).

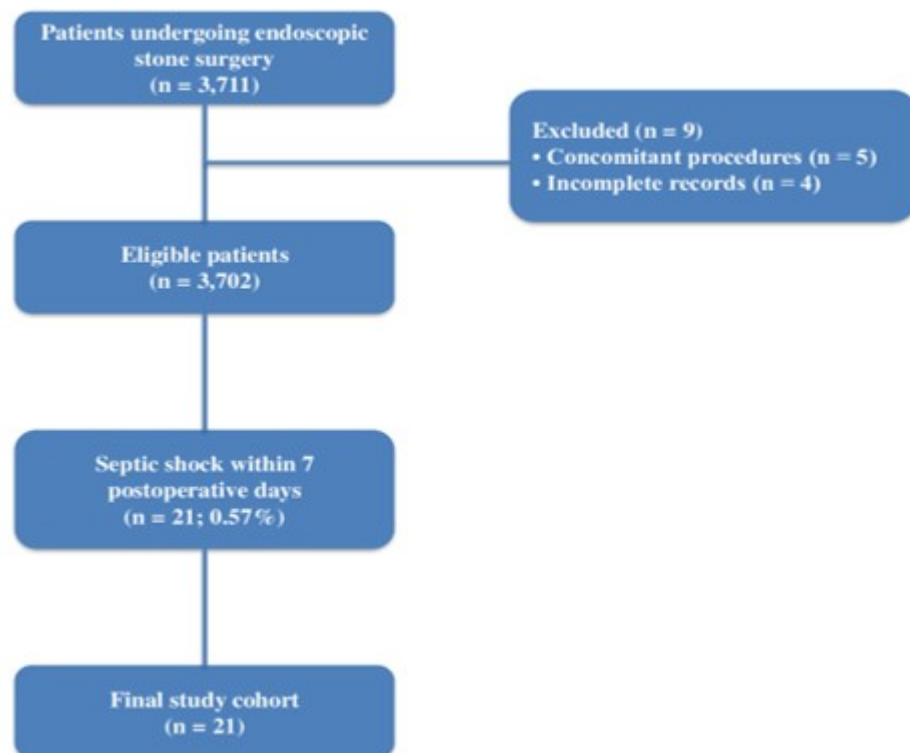


Figure 1. Flow diagram of patient selection and cohort formation. Among 3,711 patients who underwent endoscopic stone surgery, 3,702 were eligible for analysis after exclusions. Twenty-one patients developed septic shock requiring ICU admission within the first 7 postoperative days and constituted the final study cohort.

Table 1. Demographic and perioperative characteristics of the overall cohort and patients with postoperative septic shock

	Overall Cohort (n=3702)	Septic Shock Cohort (n=21)
Age, years	50.8 ± 15	67.0 ± 11.9
Sex, n (%)		
Female	2567 (69.3)	11 (52.4)
Male	1135 (30.7)	10 (47.6)
ASA-PS, n (%)		
I	267 (7.2)	0
II	2684 (72.5)	7 (33.3)
III	742 (20.0)	13 (61.9)
IV	9 (0.2)	1 (4.8)
Duration of anaesthesia, min	70 [50–100]	90 [75–117.5]
Anesthetic Technique, n (%)		
General	3565 (96.3)	21 (100)
Regional	137 (3.7)	0
Surgery type, n (%)		
Emergency	83 (2.2)	3 (14.3)
Elective	3619 (97.8)	18 (85.7)

Data are presented as mean ± SD, median [IQR], or n (%). SD: standard deviation; IQR: interquartile range; n (%): number (percentage); ASA-PS: American Society of Anesthesiologists-Physical status

Among the 21 patients with postoperative septic shock, diabetes mellitus and hypertension were present in 57.1% and 52.4% of cases, respectively. Chronic kidney disease was identified in 14.3% of patients, while 42.9% had a history of smoking. No patient had a preoperative double-J ureteral stent.

Preoperative urine cultures had been obtained from all 21 patients with postoperative septic shock. Microbial growth was detected in 13 patients (61.9%), whereas cultures were negative in eight (38.1%). *Escherichia coli* was the most frequently isolated pathogen, identified in 10 patients (47.6%). Other microorganisms included *Klebsiella* spp., *Proteus mirabilis*, and *Candida tropicalis*, each isolated in one patient (4.8%).

Preoperative antimicrobial treatment was administered to 18 patients (85.7%). Urine cultures were positive in 13 patients (61.9%), while five patients (23.8%) received empirical antimicrobial treatment despite negative urine cultures. In these five patients, treatment was initiated because of recurrent stone-associated urinary tract infection ($n=2$), the presence of a nephrostomy tube ($n=1$), or positive nitrite and leukocyte esterase results on urinalysis ($n=2$). Ceftriaxone was the most commonly used antimicrobial agent ($n=9$, 42.9%), followed by piperacillin–tazobactam ($n=4$, 19.0%) and meropenem ($n=4$, 19.0%). One patient received a combination of teicoplanin and fluconazole. The remaining three patients (14.3%) received only a single 1-g intravenous dose of ceftriaxone for surgical prophylaxis.

Among the 21 patients who developed postoperative septic shock, URS was performed in 15 patients (71.4%), RIRS in four (19.0%), and PCNL in two (9.5%). Major intraoperative bleeding and intraoperative blood transfusion were each recorded in one patient (4.8%). A postoperative double-J ureteral stent was placed in 20 patients (95.2%).

3.3. Postoperative ICU and Clinical Findings

Among the 21 patients with postoperative septic shock, 15 (71.4%) were admitted to the ICU on the day of surgery (postoperative day 0), four (19.0%) on postoperative day 1, and one patient each (4.8%) on postoperative days 3 and 5.

Fever and hypoxaemia were observed in 13 (61.9%) and 12 (57.1%) patients, respectively. Hydrocortisone therapy was administered in seven patients (33.3%). Respiratory support was required in five patients (23.8%), all of whom were successfully managed with continuous positive airway pressure (CPAP) or high-flow nasal oxygen (HFNO) without the need for invasive mechanical ventilation.

Renal replacement therapy was required in four patients (19.0%), including continuous renal replacement therapy (CRRT) in three patients and intermittent haemodialysis in one. One patient receiving CRRT underwent concomitant cytokine adsorption therapy for three consecutive days. Multiple organ dysfunction syndrome (MODS) developed in four patients (19.0%), with involvement of the haematological, hepatic, and respiratory systems.

Postoperative urine cultures yielded microbial growth in 15 patients (71.4%), whereas no growth was detected in six (28.6%). *Escherichia coli* was the most frequently isolated pathogen, identified in five patients (23.8%), followed by *Klebsiella pneumoniae* in four (19.0%). *Enterococcus faecium*, *Pseudomonas aeruginosa*, *Candida lusitanae*, and *Candida tropicalis* were each isolated in one patient (4.8%). One patient had a polymicrobial culture yielding both *Escherichia coli* and *Candida albicans*.

Laboratory parameters and clinical outcomes are summarised in Table 2. The mean APACHE II and SOFA scores were 17.67 ± 6.82 and 7.57 ± 2.13 , respectively. Median ICU and hospital lengths of stay were 3.0 [IQR 3.0–4.0] and 14.0 [IQR 11.0–22.0] days, respectively. Three patients died within 30 days, corresponding to a mortality rate of 14.3% (Table 2).

Table 2. Laboratory findings, disease severity scores, and clinical outcomes in patients with postoperative septic shock

	Septic shock cohort (n=21)
WBC ($\times 10^3/\mu\text{L}$), mean $\pm$ SD	18.17 $\pm$ 7.70
CRP (mg/L), mean $\pm$ SD	232.7 $\pm$ 104.7
Lactate (mmol/L), median [IQR]	4.24 [3.54–5.78]
Procalcitonin (ng/mL), median [IQR]	22.9 [7–98]
APACHE II score, mean $\pm$ SD	17.67 $\pm$ 6.82
SOFA score, mean $\pm$ SD	7.57 $\pm$ 2.13
ICU length of stay (days), median [IQR]	3.0 [3.0–4.0]
Hospital length of stay (days), median [IQR]	14.0 [11.0–22.0]
30-day mortality, n (%)	3 (14.3)

Data are presented as mean $\pm$ SD, median [IQR], or n (%). SD, standard deviation; IQR, interquartile range; n (%): number (percentage); WBC, white blood cell count; CRP, C-reactive protein; ICU, intensive care unit; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment. Procalcitonin values exceeding the upper measurable limit (>100 ng/mL) were recorded as 100 ng/mL.

4. Discussion

In this single-centre retrospective study, septic shock requiring ICU admission developed in 21 of 3,702 patients undergoing endoscopic stone surgery, corresponding to an incidence of 0.57%. Although uncommon, septic shock remains one of the most severe infectious complications of endourological procedures because of its association with substantial morbidity, mortality, and healthcare resource utilisation. Previous studies have reported septic shock rates of up to 1.9% following ureteroscopic procedures.⁹ The incidence observed in our cohort may be related to differences in patient selection, perioperative management strategies, and institutional practices, including routine preoperative urine culture screening and antimicrobial prophylaxis. Nevertheless, the occurrence of septic shock despite preventive measures underscores the persistent infectious risk associated with endoscopic stone surgery, particularly in the presence of infected urine, infected stone material, and increased intrarenal pressure during the procedure.¹

Patients who developed septic shock were older than the overall surgical cohort, with a mean age of 67 years compared with a mean age of 51 years in the overall population. Diabetes mellitus (57.1%) and hypertension (52.4%) were the most frequently observed comorbidities in the septic shock cohort. These findings are consistent with previous reports identifying advanced age, diabetes mellitus, and obstructive urinary tract pathology as important risk factors for urosepsis.^{5,10} In a large population-based cohort including approximately 290,000 patients, diabetes mellitus was independently associated with an increased risk of sepsis following ureteroscopy.¹¹ Collectively, these observations suggest that elderly patients and those with a substantial comorbidity burden may require closer perioperative assessment and surveillance for infectious complications.

In our cohort, 61.9% of patients who developed septic shock were classified as ASA III, and emergency surgery was more common in this group than in the overall cohort (14.3% vs. 2.2%). These findings may reflect a higher comorbidity burden and more severe underlying disease in patients who developed septic shock. Emergency surgery may also indicate active infection or obstructive urological pathology. Therefore, ASA III status and emergency surgery may be markers of disease severity rather than independent risk factors for septic shock. However, previous studies have identified emergency urinary tract interventions as an independent risk factor for urosepsis.¹²

The median duration of anaesthesia was 90 minutes in patients who developed septic shock, compared with 70 minutes in the overall surgical cohort. Although our study was not designed to identify independent risk factors, longer procedural duration has been consistently associated with an increased risk of postoperative urosepsis in previous studies.⁵ Sustained exposure to elevated intrarenal pressure and greater procedural complexity have been proposed as potential mechanisms underlying this association.

Preoperative urine cultures were positive in 61.9% of patients who subsequently developed septic shock. Although our study design does not allow assessment of independent risk factors, this observation is consistent with previous reports identifying positive preoperative urine cultures as an important predictor of postoperative infectious complications and urosepsis.¹³ Microbiological findings in our cohort were broadly consistent with the established epidemiology of urosepsis, with *Escherichia coli* representing the most frequently isolated pathogen in both preoperative and postoperative urine cultures. Previous studies have reported *E. coli* as the predominant causative organism in urosepsis, followed by other Gram-negative pathogens such as *Proteus*, *Enterobacter*, and *Klebsiella* species.¹⁴

Despite preoperative antimicrobial treatment in 85.7% of patients, septic shock still developed, highlighting the complexity of infection prevention in endoscopic stone surgery. This may partly reflect inadequate initial antimicrobial coverage, as some patients had antimicrobial-resistant organisms, while those undergoing emergency surgery received empirical treatment before culture and susceptibility results were available. Postoperative cultures showed a broad range of microorganisms, including *Klebsiella pneumoniae*, *Enterococcus faecium*, *Pseudomonas aeruginosa*, and *Candida* species, in addition to *E. coli*. The frequent use of broad-spectrum agents such as meropenem and piperacillin–tazobactam reflects the severity of these infections. These findings highlight the importance of culture-guided antimicrobial therapy and local surveillance of antimicrobial resistance patterns in the management of postoperative urosepsis.¹⁵

The observation that 71.4% of patients required ICU admission on the day of surgery suggests that septic shock most commonly manifested during the intraoperative or early postoperative period. In endourological procedures, haemodynamic instability that cannot be fully explained by anaesthetic depth, fluid status, or surgical factors should prompt consideration of an infectious aetiology, particularly in the presence of concomitant clinical and laboratory evidence of sepsis.¹² In our cohort, fever (61.9%) and hypoxaemia (57.1%) were the most frequently observed clinical findings. Acute kidney injury requiring renal replacement therapy and multiple organ dysfunction syndrome each occurred in 19.0% of patients, highlighting the potential for rapid progression from localised urinary tract infection to systemic organ dysfunction. These findings underscore the importance of maintaining a high index of suspicion for sepsis in high-risk patients and support the need for prompt recognition and timely initiation of appropriate treatment, in accordance with current sepsis management recommendations.^{16,17}

Another notable finding was that, although 23.8% of patients required non-invasive respiratory support, none required invasive mechanical ventilation. This finding differs substantially from that reported in broader septic shock cohorts. In a prospective study of 1,495 patients with septic shock, Quenot et al. reported an invasive mechanical ventilation rate of 83.9%.¹⁸ Respiratory tract infections accounted for 53.6% of cases in that cohort, whereas urinary tract infections represented only 14.1%. In contrast, our cohort consisted exclusively of patients who developed postoperative septic shock following endourological procedures, with the urinary tract being the presumed source of infection. The lower need for invasive mechanical ventilation in our cohort may therefore be related to the different infection source and the relatively limited direct pulmonary involvement in urinary-source septic shock. Differences in case mix and ICU admission practices may also

have contributed to the observed difference. Renal replacement therapy was required in 19.0% of patients, a proportion comparable to that reported in broader septic shock populations.¹⁸ Multiple organ dysfunction syndrome developed in 19.0% of patients and involved multiple organ systems, including haematological, hepatic, and respiratory dysfunction.

Disease severity scores at ICU admission were moderate, with mean APACHE II and SOFA scores of 17.67 ± 6.82 and 7.57 ± 2.13 , respectively. These values are broadly comparable to those reported in patients requiring ICU admission for urinary tract infection-related sepsis, in whom mean APACHE II and SOFA scores of 17.2 ± 9.6 and 6.6 ± 3.1 , respectively, have been described.¹⁹ In contrast, a study of surgical patients with sepsis reported higher APACHE II and SOFA scores (19.6 and 9.06, respectively) together with a markedly higher mortality rate of 87.5%.²⁰ Although direct comparisons between studies should be interpreted cautiously, these findings suggest that outcomes in septic shock may be influenced not only by illness severity scores but also by factors such as the source of infection, effectiveness of source control, comorbidity burden, and overall critical care management.

Reported mortality rates for septic shock range from 20% to 42%.¹⁰ However, mortality associated with urinary source septic shock appears to be lower, ranging from approximately 5% to 7% in general populations but reaching up to 29% in selected high-risk cohorts.^{10,21} In our study, the 30-day mortality rate was 14.3%. Differences in patient characteristics, comorbidity burden, infection severity, and treatment strategies may partly explain the variability in reported mortality rates across studies. Notably, most patients in our cohort (71.4%) were admitted to the ICU on the day of surgery and received early haemodynamic support. Although causal inferences cannot be drawn from our findings, these management practices may have contributed to the relatively favourable outcomes observed in our cohort.

This study has several limitations. First, its retrospective design and single-centre setting may limit the generalisability of the findings to other institutions and patient populations. Second, although the study was based on a large surgical cohort of 3,702 patients, only 21 patients developed septic shock, limiting the ability to perform robust multivariable analyses and identify independent predictors of this complication. Therefore, the observed associations with age, comorbidities, ASA status, culture positivity, and procedure duration should be interpreted as descriptive findings rather than as independent risk factors. Nevertheless, the study also has notable strengths. To our knowledge, few studies have provided a detailed evaluation of the perioperative characteristics, intensive care management, microbiological profile, and clinical outcomes of patients requiring ICU admission for septic shock following endoscopic stone surgery. Future multicentre prospective studies are warranted to validate these findings, improve risk stratification, and support the development of evidence-based preventive and management strategies.

5. Conclusion

Septic shock requiring ICU admission after endoscopic stone surgery was uncommon, occurring in 0.57% of patients. However, despite its low incidence, it was associated with substantial organ support requirements and a 30-day mortality rate of 14.3%. Advanced age, comorbidity burden, positive preoperative urine cultures, and emergency surgical presentation were frequently observed among affected patients. Early recognition, prompt intensive care management, and culture-guided antimicrobial therapy remain essential components of care in this high-risk population.

Author Contributions: G.K.: Conceptualization, Formal Analysis, Investigation, Methodology, Project Administration, Supervision, Validation, Writing – Original Draft, Writing – Review & Editing.

E.K.K.: Data Curation, Formal Analysis, Investigation, Resources, Validation, Writing – Review & Editing. Both authors read and approved the final version of the manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest statement: The authors declare that they have no conflict of interest.

Statement of ethics: Ethical approval was obtained from the Institutional Ethics Committee of Ankara Etlik City Hospital (Approval No. AESH-BADEK2-2026-213; Date: 17.02.2026).

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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