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Original Article

Evaluation of Acute Kidney Injury (AKI) due to Urosepsis in a Tertiary Care Hospital

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Abstract

Background: Urosepsis is associated with significant morbidity and mortality and remains one of the leading causes of acute kidney injury (AKI) in nephrology, urology, and intensive care unit (ICU) settings.

Aim of Study: To evaluate the clinical characteristics, microbiological profile, and severity of acute kidney injury, antimicrobial sensitivity, resistance patterns, and treatment outcomes among patients with urosepsis-associated AKI.

Methods: This prospective observational study was conducted over a three-year period from January 2023 to December 2025. Patients aged 15–80 years of both sexes attending the inpatient and outpatient departments of Nephrology were enrolled.

Result: Patients with AKI secondary to urosepsis were identified according to the kidney disease: Improving Global Outcomes (KDIGO) criteria and included in the study. A total of 200 patients were enrolled. Urosepsis was defined as the presence of acute pyelonephritis or pyonephrosis with bacterial growth in blood cultures consistent with the organism isolated from urine cultures. Among a patient with Urosepsis; Upper UTI was observed in 78% cases and lower UTI was in 22% patients. The major types of cUTI were acute pyelonephritis (56%) then acute complicated cystitis (25%), acute emphysematous pyelonephritis (3%), pyonephrosis (5%) were detected. Among the patients, 60% were mild AKI, 15% moderate AKI, 10% was severe AKI, 10% AKI on CKD, and 5% were dialysis-dependent, while the remaining patients had other grades of renal impairment. The most frequent anatomical abnormalities were posterior urethral valve (PUV), urethral stricture, vesicoureteral reflux (VUR), Autosomal Dominant Polycystic Kidney Disease (ADPKD), and pelvic kidney. Diabetes mellitus was the most common comorbidity among patients with complicated urinary tract infection (cUTI). Escherichia coli (E. coli) was the predominant pathogen, isolated in 44% of cases. Among the Gram-positive organisms, Staphylococcus aureus was the most frequently isolated, accounting for 8% of cases. The antibiogram showed that E. coli was most sensitive to colistin, meropenem, and tigecycline (88.5%). Staphylococcus aureus showed the highest sensitivity to linezolid (90%), followed by vancomycin (80%). Pseudomonas was most sensitive to imipenem (90%) and amikacin (70%). Klebsiella showed the highest sensitivity to piperacillin–tazobactam (95%), followed by meropenem (85%). Enterococcus was most sensitive to amoxicillin–clavulanic acid (80%) and levofloxacin (76%). Proteus showed 75% sensitivity to meropenem. Staphylococcus saprophyticus was most sensitive to linezolid (80%), followed by vancomycin (75%). Group B Streptococci showed the highest sensitivity to meropenem (85%) and amoxicillin–clavulanic acid (70%). Treatment response was not uniform, the study found that a 14-days antibiotic course provided better clinical outcomes compared to a 10-days treatment.Conclusion: Urosepsis-induced Acute Kidney Injury (AKI) is a severe, life-threatening complication that significantly increases short-term mortality and long-term risk of chronic kidney disease (CKD). It requires immediate source control, antibiotic therapy, and hemodynamic stabilization to prevent irreversible end-organ damage.

Keywords: Acute Kidney injury, Urosepsis, Acute Pyelonehritis, Positive Urine Culture.

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Introduction

Urosepsis is a severe and potentially life-threatening systemic infection that originates from the urinary tract

and represents one of the most common causes of sepsis worldwide. It accounts for approximately 20–30%[1] of all septic episodes and is associated with substantial morbidity, mortality, prolonged hospitalization, and increased healthcare expenditure. Studies from Germany and other European countries have reported that urosepsis accounts for approximately 9–31% of all sepsis cases, with the variation largely attributable to geographical differences and patient characteristics[2].Urosepsis commonly develops as a complication of urinary tract infections involving the kidneys, ureters, bladder, or prostate and is particularly prevalent among elderly individuals, patients with diabetes mellitus, urinary tract obstruction, nephrolithiasis, indwelling urinary catheters, and other structural abnormalities of the urinary tract[3].

The mortality rate of urosepsis is approximately 30–40%. The severity of the disease appears to be increasing and is commonly associated with acute respiratory distress syndrome (ARDS), acute kidney injury (AKI), and disseminated intravascular coagulation (DIC).Similar findings have been documented in studies from Germany, Romania, and other European countries, where urosepsis was identified as a significant contributor to sepsis-related mortality and multiorgan failure[4,5].

Gram-negative bacteria, particularly Escherichia coli and Klebsiella pneumoniae, are the predominant causative organisms, although other pathogens such as Proteus, Pseudomonas, and Enterococcus species may also be involved[6]. Early diagnosis, prompt source control, and timely administration of appropriate antimicrobial therapy are crucial for improving patient outcomes.

Despite advances in antimicrobial therapy and critical care management, urosepsis remains a major clinical challenge because of its rapid progression to septic shock and multiple organ dysfunction syndrome. Acute Kidney Injury (AKI) is one of the most frequent and serious complications of urosepsis. Urosepsis-associated AKI has been shown to significantly increase the risk of intensive care unit admission, need for renal replacement therapy, prolonged hospital stays, and mortality[7]. The development of AKI is multifactorial and results from a complex interaction of systemic inflammation, renal hypoperfusion, microvascular dysfunction, endothelial injury, and direct tubular cell damage. The reported incidence of AKI among patients with urosepsis ranges from 20% to 60%, depending on patient characteristics, severity of infection, and underlying comorbidities. Several factors, including advanced age, diabetes mellitus, hypertension, chronic kidney disease, urinary tract obstruction, delayed initiation of antibiotic therapy, and septic shock, have been identified as important predictors of AKI and adverse clinical outcomes.Although urosepsis is a common cause of sepsis-related AKI, information regarding its clinical characteristics, microbiological spectrum, and severity of renal involvement, treatment requirements, and outcomes remains limited in many tertiary care hospitals, particularly in developing countries. A better understanding of these factors may facilitate early identification of high-risk patients and improve clinical management strategies.

Operational Definitions:

SIRS (Systemic inflammatory response syndrome): is defined by the presence of any 2 of the following criteria: Body temperature >100.4 °F (38 °C) or <96.8 °F (36 °C) Heart rate >90 bpm. Respiratory rate >20 breaths/minute or PaCO2 <32 mm Hg (4.3 kPa).

Acute Kidney Injury (AKI): According to the KDIGO Guidelines, is defined as an abrupt decline in kidney function, identified by any of the following criteria:

1. Increase in Serum Creatinine: An increase in serum creatinine of ≥ 0.3 mg/dL (≥ 26.5 µmol/L) within 48 hours.

2. Percentage Increase in Serum Creatinine: An increase in serum creatinine to ≥ 1.5 times the baseline value, known or presumed to have occurred within the prior 7 days.

3. Reduced Urine Output: Urine output < 0.5 mL/kg/hour for 6 hours.

Urosepsis: Urosepsis is one of the most common causes of sepsis, accounting for up to 30% of all septic episodes originating from the urinary tract. It is a severe, life-threatening complication of urinary tract infection and constitutes a medical emergency. If left untreated, urosepsis can lead to multi organ failure, acute kidney injury (AKI), disseminated intravascular coagulation (DIC), and death.

Urosepsis-Induced AKI: Patients with documented urinary tract infection (positive urine culture and/or radiological evidence of urinary tract infection) fulfilling Sepsis-3 criteria and subsequently developing AKI according to KDIGO criteria.

Septic Shock: Requirement of vasopressor therapy to maintain mean arterial pressure ≥65 mmHg and serum lactate >2 mmol/L despite adequate fluid resuscitation.

METHODOLOGY

This prospective observational study was conducted in the Department of Nephrology, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from January 2023 to December 2025. A total of 200 consecutive patients aged 15 years and above who were admitted with Urosepsis and developed Acute Kidney Injury (AKI) were enrolled during the study period. The study was undertaken to evaluate the clinical characteristics, microbiological profile, associated risk factors, and severity of

AKI, management strategies, and outcomes of patients with Urosepsis-associated AKI. Patients were selected by purposive sampling technique after obtaining informed written consent.

Urosepsis was diagnosed in patients with culture-positive urinary tract infection and evidence of systemic infection fulfilling Sepsis-3 criteria. AKI was defined and staged according to the kidney disease: Improving Global Outcomes (KDIGO) guidelines. Adult patients of both sexes, including those with structural or functional abnormalities of the urinary tract, chronic kidney disease (CKD), renal allograft recipients, and patients on maintenance hemodialysis, were eligible for inclusion. Patients who had received antibiotic therapy before admission, had culture-negative urinary tract infection, or refused to participate were excluded from the study.

Data regarding demographic characteristics, including age and sex, were recorded. Clinical variables assessed included pre-existing renal disease, diabetes mellitus, hypertension, urinary tract instrumentation, urinary catheterization, ureteric stenting, obstructive uropathy, nephrolithiasis, hydronephrosis, hydroureteronephrosis, intensive care unit admission, requirement of renal replacement therapy, duration of hospital stay, and in-hospital mortality. Detailed clinical examination was performed, including measurement of body temperature, pulse rate, blood pressure, and assessment for suprapubic and loin tenderness.A detailed clinical history was obtained, and all relevant physical parameters were recorded. Drug history and potential complicating factors were carefully evaluated. Physical parameters, including pulse rate, blood pressure, body temperature, urine output, level of consciousness, and oxygen saturation (SpO_2), were assessed and documented.

All patients underwent laboratory investigations including complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), serum procalcitonin, D-dimer, serum creatinine, blood urea, serum electrolytes, estimated glomerular filtration rate (eGFR), urine routine and microscopic examination, urine culture and sensitivity testing (aerobic and anaerobic), fungal staining, and blood cultures whenever indicated. Serial serum creatinine measurements were performed to determine the severity and progression of AKI.Radiological evaluation included ultrasonography of the kidney, ureter, and bladder (KUB) region with assessment of the prostate, urinary bladder, and post-void residual urine volume. Additional imaging studies, including plain X-ray KUB, intravenous urography (IVU), retrograde urethrography (RGU), micturating cystourethrography (MCU), non-contrast computed tomography (CT) of KUB, and CT urography, were performed when clinically indicated to identify underlying structural abnormalities and urinary tract obstruction.

Microbiological isolates and their antimicrobial susceptibility patterns were analyzed. Patients were managed according to institutional protocols, including appropriate antimicrobial therapy, source control procedures, supportive care, and renal replacement therapy when required. Clinical outcomes including renal recovery, dialysis requirement, duration of hospitalization, and in-hospital mortality were recorded and analyzed.

Results

On evaluation of 200 patients with urosepsis-associated acute kidney injury (AKI), the following findings were observed based on manual assessment.

Table1: Clinical Presentations of Patients with Urosepsis (N = 200)

Clinical presentations	Number (n)	Percentage (%)
Nausea/Vomiting	50	25%
Hesitancy	20	10%
Flankpain/Suprapubicpain	60	30%
Dysuria	70	35%
Hematuria	40	20%
Fever	30	15%
Altered level of consciousness	10	5%
Urinaryincontinence	12	6%
Urinaryretention	04	2%

Among patients with urosepsis, nausea, vomiting, and flank pain, dysuria & Hematuria were the predominant clinical presentations, each occurring in approximately 30% of cases.

Table2: Biochemical and Microbiological Parameters of Patients with Urosepsis (n = 200).

Parameters	Frequency (n)	Percentage %
RaisedCRP	160	80%
Neutrophilicleucocytosis	144	72%
Raisedserumpro-calcitonin	22	11%
Mildtomoderateproteinuria(1+to2+)	20	10%
Thrombocytopenia	06	3%
Positivebloodculture	06	3%
Massiveproteinuria(+++)	12	6%
RaisedD-dimer	06	3%
Increase FDP	08	4%
Electrolytes imbalance	110	55%
Urineformucusthread	20	10%
Bacterialcolonycount 10^2 –		
10^3cfu/ml	14	7%
10^3-10^4cfu/ml	22	11%
>10^5cfu/ml	164	82%
Urineforpuscell 05-		
10 /HPF	84	42%
10-30 /HPF	78	39%
Plenty/HPF	30	15%

Biochemical and microbiological parameters was observed; Raised CRP (80%) and neutrophilic leucocytosis (72%) were the predominant laboratory findings among patients with urosepsis. Significant bacteriuria (>10^5 CFU/mL) was detected in 82% of cases, while electrolyte imbalance was present in 55%. Pyuria was common on urine microscopy, and positive blood cultures were identified in 3% of patients.

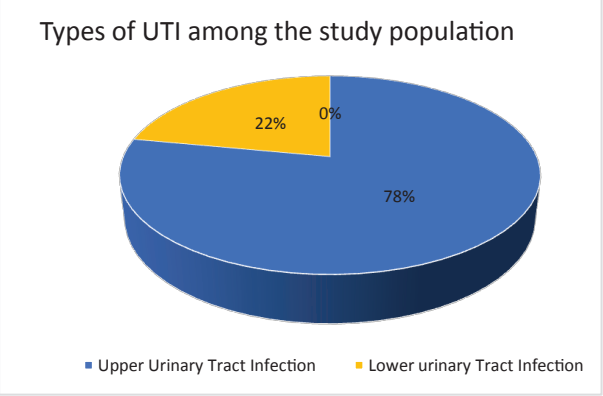

Figure-I: Types of UTIs among the study population (n=200)

Upper urinary tract infection was the predominant type of UTI among the study population, accounting for 156 (78%) cases, whereas lower urinary tract infection was observed in 44 (22%) patients.

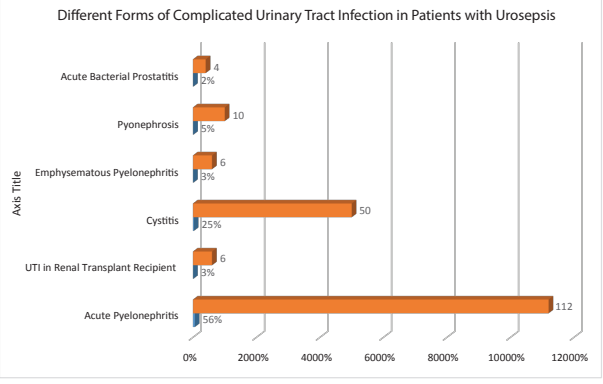

Figure-II. Distribution of different forms of urinary tract infection among patients with Urosepsis-associated acute kidney injury (AKI).

Acute pyelonephritis was the most common form of urinary tract infection, accounting for 56% of all cases, followed by cystitis (25%). Less common presentations included pyonephrosis (5%), urinary tract infection in renal transplant recipients (3%), emphysematous pyelonephritis (3%), and acute bacterial prostatitis (2%). The remaining cases comprised other less frequent forms of urinary tract infection.

Table3: Distribution of urinary tract obstructive Abnormalities among patients with Urosepsis (n = 200)

Abnormalities	Frequency (n)	Percentage (%)
Pelvi-uretericjunction(PUJ)obstruction	06	3%
ADPKD	06	3%
Strictureurethra	02	1%
Vasicouretericjunction(VUJ)obstruction	03	1.5%
Posteriorurethralvalves	03	1.5%
Bladderdiverticulum	02	1%
Renalstone	05	2.5%
Bladderneckhypertrophy	02	1%
Refluxnephropathy(unilateralorbilateral)	03	1.5%
Prolapseuterus	02	1%
Neurogenicbladder	02	1%
D-J Stent	03	1.5%

Regarding obstructive and structural abnormalities associated with urosepsis, ADPKD (3%)& PUJ obstruction (3%) was the most common abnormality. Other abnormalities included stricture urethra (3%), renal stone (2.5%), reflux nephropathy (2.5%), neurogenic bladder (2%), and VUJ obstruction (2%). Less frequent abnormalities were, posterior urethral valves, bladder diverticulum, bladder neck hypertrophy, prolapsed uterus, and D-J Stent.

Table 4: Comorbidities among patients with Urosepsis

Co-morbidities	Frequency (n=200)	Percentage(%)
Diabetesmellitus	42	21%
Pregnancy	02	1%
GN	26	13%
Immunosuppressive medication	12	6%
Steroidtherapy	08	4%
Renaltransplantrecipient	04	2%

Regarding co-morbidities, diabetes mellitus (11%) was the most common associated condition, followed by glomerulonephritis (13%), and immunosuppressive medication use (6%). Other co-morbidities were less frequent.

Table 5: OrganismsresponsibleforUrosepsis

Organisms	Frequency (%)
Grampositive bacteria	
Staphylococcussaprophyticus	4%
Staphylococcusaureus	8%
Enterococci	3%
Group-BStreptococcus	1%
Gramnegative bacteria	
E.coli	44 %
Klebsiella	5%
Proteus	12%
Actinobacteria	1.83%
Pseudomonas	14%
Other	
Candida	3.5%

Regarding the causative organisms, Gram-negative

bacteria were the predominant pathogens, with Escherichia coli (44%) being the most frequently isolated organism, followed by Pseudomonas (14%), Proteus (12%), and Klebsiella (5%). Among Gram-positive bacteria, Staphylococcus aureus (8%) was the most common isolate. Candida accounted for 3.53% of cases.

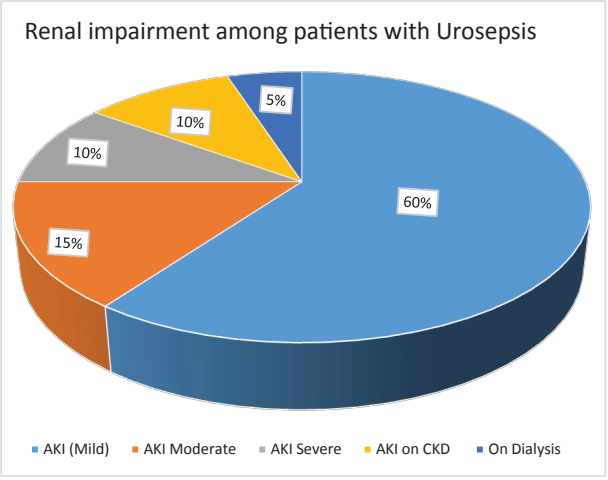

Figure-III: Patterns of renal impairment among patients with Urosepsis (n=200)

Renal impairment was common among patients with urosepsis. Mild AKI (n=120) was the most frequent presentation (60%), followed by moderate AKI (n=30) 15%, severe AKI (10% n=20, AKI on CKD (10% n=20) and dialysis-dependent kidney failure (5% n=10).

Table6:Antimicrobialagentsshowinghighbacterialsensitivity (n=200)

Bacteria	Antibiotics	Sensitive %	Resistance %
Klebsiella	Tazobactum+Piperi cillinMeropenem Tigecycline	95% 85% 80%	5% 15% 20%
Staphylococcusa ureus	Linezolid Vancomycin Tigecycline	90% 80% 75%	10% 20% 25%
E.Coli	Colistin Meropenem Tigecycline	88.5% 70% 68%	11.5% 30% 32%
Enterococci	Amoxicillin+Clavulenic Acid levofloxacin	80% 76%	20% 24%
Pseudomonas	Imipenem Amikacin Tigecycline	90% 70% 80%	10% 30% 20%
Proteus	Meropenem Amikacin levofloxacin	75% 60% 50%	25% 40% 50%
Group- BStreptococci	Meropenem Amoxicillin+Clavulenic acid	85% 70%	15% 30%
Staphylococcus Saprophyticus	Linezolid Vancomycin	80% 75%	20% 25%

Regarding antimicrobial sensitivity, most uropathogens showed high susceptibility to broad-spectrum antibiotics, particularly Meropenem, Tigecycline, Linezolid, Vancomycin, Imipenem, and Piperacillin–Tazobactam. Klebsiella demonstrated the highest sensitivity to Piperacillin–Tazobactam (95%), while E. coli was most sensitive to Colistin (88.5%). Pseudomonas showed high sensitivity to Imipenem (90%), and Staphylococcus aureus was highly sensitive to Linezolid (90%).

Table 7: Treatment responses 10 days versus 14 days

Categoryof infection	Numberof patients (n)	Numberofpatientsshowing response within 10 days	Numberofpatientsshowing response within 14 days
AcutePyelonephritis	140	60	80
EmphysematousPyelonephritis	10	04	06
Pyonephrosis	16	06	10
Cystitis	20	06	14
RecurrentAcutePyelonephritis	06	02	04
Acutebacterialprostaties	04	01	03
UTIinrenaltransplantrecipient	06	02	04

Regarding treatment response showed in patient with different UTI 14 day's treatment is superior to 10 days treatment.

DISCUSSION

Urosepsis is one of the leading causes of acute kidney injury (AKI) worldwide and represents a major complication of complicated urinary tract infections (cUTIs). Diabetes mellitus is a significant risk factor for the development of urosepsis[8], particularly among middle-aged and elderly patients. However, in children and adolescents, structural and functional abnormalities of the urinary tract are among the leading causes of urosepsis.

Among the study population, upper urinary tract infections were the most common presentation, accounting for 78% of cases, while lower urinary tract infections comprised 22%. This distribution differs from the conventional understanding that complicated UTIs primarily occur in patients with specific risk factors such as urinary tract abnormalities, immunocompromised states, or long-term catheterization9. In our cohort, acute pyelonephritis accounted for 56% of cUTI cases, followed by cystitis (25%), emphysematous pyelonephritis (3%), pyonephrosis (5%). These findings demonstrate that upper urinary tract involvement, particularly acute pyelonephritis, was the predominant clinical pattern among patients with complicated UTIs.

In the present study among the patients, 60% were mild AKI, 15% moderate AKI, 10% was severe AKI, 10% had

AKI on CKD, and 5% were dialysis-dependent, these findings indicate that most patients presented with early-stage renal dysfunction, emphasizing the importance of timely diagnosis and intervention. A multicenter study conducted in Australia and New Zealand found that 54% of patients with sepsis-associated AKI had Stage 1 AKI at diagnosis, indicating that early-stage kidney injury predominates in most cases[10]. Likewise, a large retrospective study from the United States reported that 53% of patients with sepsis-associated AKI had KDIGO Stage 1 disease, whereas Stage 2 and Stage 3 AKI accounted for 9% and 37% of cases, respectively[11]. Studies from China and Taiwan have also demonstrated that sepsis-associated AKI is frequently recognized at an early stage, although the proportion of severe AKI varies depending on patient characteristics and healthcare settings[12,13]. The predominance of mild AKI in the present study is therefore consistent with international observations and highlights the importance of early recognition and prompt management to prevent progression to severe kidney injury.

The study population exhibited a wide range of anatomical and obstructive abnormalities of the urinary tract. Autosomal Dominant Polycystic Kidney Disease (ADPKD) were among the most frequently observed structural abnormalities[14]. Other notable findings included pelvi-ureteric junction (PUJ) obstruction (3%) and posterior urethral valves (1.5%), and bladder neck hypertrophy (1%). These findings reflect the diverse congenital, structural, and acquired obstructive uropathies that predispose patients to complicated UTIs.

Diabetes mellitus (21%) was the most common comorbidity identified in the study population, followed by glomerulonephritis 13%. Significant proportions of patients were receiving immunosuppressive therapy (6%), were on long-term steroid treatment (4%). Less common but clinically important conditions included renal transplantation (2%) and pregnancy (1%) These findings highlight the important role of both systemic diseases and structural urinary tract abnormalities in predisposing patients to complicated UTIs.

Emphysematous urinary tract infections (especially emphysematous pyelonephritis) and pyonephrosis are uncommon but severe infections that occur predominantly in patients with diabetes mellitus, urinary tract obstruction, and immunocompromised states[15]. Analysis of causative organisms revealed that Gram-negative bacteria were the predominant pathogens. Escherichia coli was the most frequently isolated organism (44%), followed by Pseudomonas species (14%), Proteus species (12%), and Klebsiella species (5%). Among Gram-positive organisms, Staphylococcus aureus (8%) and Enterococcus species (3%) were the most common isolates. These findings suggest that E. coli and other Gram-negative bacteria remain the principal pathogens responsible for complicated UTIs, with occasional involvement of Gram-positive and fungal organisms. Similar findings have been reported in previous studies.

In the present study, Staphylococcus aureus demonstrated high sensitivity to Linezolid (90%) and Vancomycin (80%), findings comparable to reports from Eastern India where all S. aureus isolates were susceptible to Linezolid and approximately 88% were susceptible to Vancomycin[16]. Klebsiella species exhibited high sensitivity to Piperacillin–Tazobactam (95%), Tigecycline (80%), and Meropenem (84%). Staphylococcus saprophyticus showed 80% sensitivity to Linezolid and 75% sensitivity to Vancomycin, whereas Enterococcus species demonstrated high sensitivity to Amoxicillin–Clavulanic acid (80%) and Levofloxacin (76%).

E. coli isolates in our study remained largely susceptible to carbapenems, including Meropenem and Imipenem, as well as Amikacin, although resistance to commonly used first-line antibiotics was widespread. Most Staphylococcal isolates demonstrated good susceptibility to Linezolid, Vancomycin, and Piperacillin–Tazobactam. Linezolid and Vancomycin were highly effective against Gram-positive organisms, demonstrating sensitivity rates of 92% and 84%, respectively. Among Gram-negative bacteria, Colistin, Meropenem, and Piperacillin–Tazobactam remained effective treatment options.

Furthermore, our study demonstrated that a 14-day course of antibiotic therapy produced better clinical outcomes than a 10-day treatment regimen. This finding is supported by several clinical guidelines, which recommend prolonged treatment durations for complicated UTIs, particularly in patients with renal involvement or other complicating factors.

Limitation of study:

1. This was a single-center study, which may limit the generalizability of the findings.
2. The sample size was relatively small for subgroup analysis.
3. Long-term renal outcomes after discharge were not assessed.
4. Molecular characterization of antimicrobial resistance mechanisms was not performed.
5. Some patients had pre-existing CKD and structural urinary tract abnormalities, which may have influenced renal outcomes independently of urosepsis.

CONCLUSION

Urosepsis-induced Acute Kidney Injury (AKI) is a severe, life-threatening complication that significantly increases short-term mortality and long-term risk of chronic kidney disease (CKD). It requires immediate source control,

antibiotic therapy, and hemodynamic stabilization to prevent irreversible end-organ damage.

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