



Original Article

Clinical Profile And Outcomes Of Patients With Emphysematous Pyelonephritis In A Tertiary Care Center

Dr Vivek Mahadeo Barekar¹, Dr Kishor Maroti Tonge², Dr Akshay Deshpande³

¹Assistant professor, Dept of urology, BJGMC and SGH PUNE

²Assistant Professor, Dept of urology, Shri Vasantrao Naik Govt Medical College and Superspeciality hospital Yavatmal

³Senior Resident, Dept of Urology, BJGMC and SGH PUNE

OPEN ACCESS

Corresponding Author:

Dr Vivek Mahadeo Barekar

Assistant professor, Dept of
urology, BJGMC and SGH PUNE

Received: 02-09-2025

Accepted: 13-10-2025

Available online: 08-11-2025

Copyright © International Journal of
Medical and Pharmaceutical Research

ABSTRACT

Background: Emphysematous pyelonephritis (EPN) is a life-threatening necrotizing infection of the kidney, predominantly affecting diabetic and obstructed urinary tracts. Despite advances in imaging and minimally invasive management, outcome predictors remain variably defined. This study evaluated the clinical profile, microbiological spectrum, management strategies, and outcomes of patients with EPN treated at a tertiary-care centre in western India.

Methods: This retrospective observational study included 30 consecutive patients with CT-confirmed EPN admitted between January 2022 and June 2025 at BJGMC and SGH, Pune. Demographic, clinical, laboratory, and microbiological data were analyzed. Radiologic severity was graded using the Huang and Tseng classification and correlated with outcomes. Statistical analysis employed chi-square, Kruskal–Wallis, and logistic regression tests, with $p < 0.05$ considered significant.

Results: The mean age was 58 ± 12 years; 70% were male. Diabetes mellitus (56.7%) and urinary obstruction or calculi (noted in 40%) were common risk factors. On CT, Class II–III disease accounted for 63.3%. *E. coli* (46.7%) and *Klebsiella pneumoniae* (26.7%) were the main isolates. PCD was performed in 36.7%, DJ stenting in 33.3%, and nephrectomy in 6.7%. The mean hospital stay was 14.2 ± 5.8 days. ICU admission and dialysis were required in 36.7% each. Overall mortality was 6.7%, and renal recovery occurred in 83.3% of survivors. Increasing CT class correlated with greater clinical severity but was not statistically significant ($p > 0.05$). Logistic regression identified no independent mortality predictors, though age, shock on admission, and renal dysfunction showed adverse trends.

Conclusion: EPN in this cohort predominantly affected diabetic patients and was most often caused by *E. coli* and *Klebsiella*. Early diagnosis, glycemic control, and minimally invasive drainage achieved low mortality and high renal salvage. Radiologic severity correlated clinically but did not independently predict outcomes. Prompt multidisciplinary management remains key to improving prognosis.

Keywords: Emphysematous pyelonephritis; diabetes mellitus; percutaneous drainage; radiologic severity; predictors of mortality; renal outcome.

INTRODUCTION

Emphysematous pyelonephritis (EPN) is an uncommon, severe necrotizing infection of the renal parenchyma and perirenal tissues, characterized by gas formation within the collecting system or parenchyma. It represents a urological emergency associated with considerable morbidity and mortality, particularly among diabetic and immunocompromised patients. Recent global estimates suggest that EPN accounts for approximately 1–2% of acute pyelonephritis cases, with mortality rates historically ranging from 20% to 40% despite aggressive management [1]. The disease predominantly affects middle-aged and elderly females with uncontrolled diabetes, though cases have also been documented in patients with urinary tract obstruction and urolithiasis.

Pathophysiologically, gas formation is attributed to mixed acid fermentation by glucose-fermenting organisms such as *Escherichia coli* and *Klebsiella pneumoniae*, facilitated by tissue ischemia and impaired immune response. As described in classical reviews by Ubee et al. (2011), this synergism between hyperglycemia, infection, and ischemia results in rapid parenchymal destruction and systemic sepsis [2]. Radiologically, *Huang and Tseng's* CT-based classification remains the most widely accepted framework, dividing EPN into four classes based on the extent of gas and necrosis, with higher classes correlating with worse outcomes.

Over the past two decades, the therapeutic approach to EPN has evolved significantly. Earlier management relied heavily on emergency nephrectomy due to high mortality with conservative measures. However, as highlighted by Aswathaman et al. (2008), the advent of cross-sectional imaging, potent antibiotics, and image-guided percutaneous drainage (PCD) has shifted the paradigm toward renal preservation, achieving survival rates exceeding 80% [4]. Similarly, Elawdy et al. (2019) correlated management strategies with CT classification and observed that minimally invasive drainage and stenting could achieve comparable outcomes to surgical approaches, even in high-grade disease, provided prompt intervention and hemodynamic stabilization are ensured [3].

Recent systematic analyses reaffirm this shift. In a comprehensive meta-analysis encompassing over 600 cases, Desai and Batura (2022) concluded that mortality has declined to below 10% with early drainage and appropriate antibiotic therapy, while nephrectomy is now reserved for refractory or non-draining systems [1]. Despite these advances, mortality remains non-trivial, particularly in patients with shock, renal dysfunction, or delayed presentation.

Several prognostic tools have been evaluated to identify high-risk subsets. Chen et al. (2022) assessed multiple severity scoring systems and found that shock, thrombocytopenia, and elevated creatinine were consistent independent predictors of poor outcome [5]. Yet, these predictors vary across populations, and no universal scoring system has been validated. Furthermore, regional differences in pathogen distribution and antibiotic resistance patterns influence both disease progression and treatment response. Gopal et al. (2015), in an Indian cohort, emphasized that older age, comorbid diabetes, and septic shock significantly worsened outcomes in pyelonephritis, underscoring the interplay between host and infection-related factors [6].

Given the scarcity of contemporary data from western India and the evolving clinical and microbiological landscape, there is a continued need to characterize EPN presentations in diverse populations. The present study, conducted at a tertiary care teaching hospital, aims to describe the clinical profile, microbiological spectrum, and outcomes of patients with EPN, and to analyze associations between radiologic severity, clinical parameters, and mortality in the context of current management practices

OBJECTIVES

The present study was conducted to:

1. Describe the clinical profile, comorbidities, and microbiological spectrum of patients with emphysematous pyelonephritis treated at a tertiary care centre.
2. Evaluate the relationship between radiologic severity, clinical parameters, and in-hospital outcomes, including mortality and renal recovery.
3. Assess the effectiveness of various management modalities and identify potential predictors of poor outcome in the contemporary treatment era.

METHODS

Study Design and Setting

This was a retrospective observational study conducted at the Department of Medicine and Urology, B. J. Government Medical College and Sassoon General Hospitals (BJGMC & SGH), Pune, India — a tertiary care teaching hospital serving as a regional referral centre for complex medical and surgical conditions. The study period spanned from January 2022 to June 2025. Data were obtained from inpatient case records, radiological databases, and microbiological laboratory reports.

Study Population and Sample Size

All patients aged ≥ 18 years who were diagnosed with emphysematous pyelonephritis (EPN) based on clinical presentation and characteristic radiological findings on computed tomography (CT) were eligible. A total of 30 patients fulfilling the inclusion criteria were enrolled through consecutive sampling during the study period.

Inclusion criteria:

1. Diagnosis of EPN confirmed by CT abdomen showing gas within the renal parenchyma, collecting system, or perirenal tissues.
2. Availability of complete medical and microbiological data.

Exclusion criteria:

1. Patients with emphysematous cystitis or pyelitis without parenchymal involvement.

2. Incomplete records or prior nephrectomy for other causes.

Clinical and Laboratory Evaluation

Demographic data (age, sex), comorbidities (diabetes mellitus, chronic kidney disease, hypertension, urolithiasis), and presenting symptoms were recorded.

Vital parameters, hemodynamic status, and biochemical investigations including complete blood count, renal and liver function tests, random blood glucose, HbA1c, urine analysis, and urine culture were analyzed.

Shock was defined as systolic blood pressure <90 mmHg or the need for vasopressors to maintain mean arterial pressure $\geq$ 65 mmHg.

Renal dysfunction was defined as serum creatinine >1.4 mg/dL or the need for renal replacement therapy.

Radiological Assessment

All patients underwent contrast-enhanced CT (CECT) abdomen, and EPN was classified according to Huang and Tseng's CT-based classification:

- Class I: Gas confined to collecting system
- Class II: Gas in renal parenchyma without extension to extrarenal space
- Class IIIa: Extension to perinephric space
- Class IIIb: Extension to pararenal space
- Class IV: Bilateral involvement or solitary kidney disease

The radiologic severity class was correlated with clinical severity, need for intervention, and outcomes.

Management Protocol

Management was individualized based on clinical severity and radiologic class. All patients received broad-spectrum intravenous antibiotics tailored to culture sensitivity (commonly piperacillin-tazobactam, carbapenems, or third-generation cephalosporins).

Glycemic control was optimized using insulin infusion protocols for diabetic patients.

Supportive care included intravenous fluids, antipyretics, and vasopressors as indicated.

Patients with obstructive or loculated collections underwent image-guided percutaneous catheter drainage (PCD) or DJ stenting.

Nephrectomy was performed in cases with extensive non-viable renal tissue or failure of conservative measures.

Outcome Measures

Primary outcome measures included in-hospital mortality and renal recovery at follow-up (defined as return of serum creatinine within 20% of baseline or cessation of dialysis within four weeks).

Secondary outcomes included duration of hospital stay, ICU requirement, and correlation between radiologic severity and clinical outcome.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0.

Continuous variables were expressed as mean $\pm$ standard deviation (SD), and categorical variables as frequency and percentage.

Comparisons between groups were made using the Chi-square test or Fisher's exact test for categorical variables and Kruskal–Wallis or Mann–Whitney U tests for continuous variables.

Correlations between radiologic severity and clinical/laboratory parameters were assessed using Spearman's correlation coefficient. Multivariate logistic regression was performed to identify independent predictors of mortality. A p -value <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of BJGMC & SGH, Pune.

Given the retrospective nature, patient consent was waived while ensuring full confidentiality and compliance with the Declaration of Helsinki (2013 revision).

RESULTS

1. Overview and Study Population

A total of 30 patients diagnosed with *Emphysematous Pyelonephritis (EPN)* were included in the study conducted at B. J. Government Medical College and Sassoon General Hospitals, Pune, between January 2022 and June 2025. The mean age of the study population was 58.4 ± 12.6 years (range 35–79 years), with a male predominance (70%). The mean duration of symptoms prior to presentation was approximately 10 days, reflecting a subacute clinical course.

The most common presenting symptoms were flank pain (96.7%) and fever (76.7%), while shock at admission was documented in 26.7% of patients, indicating severe systemic infection in a subset.

Among comorbidities, diabetes mellitus was the most prevalent (56.7%), followed by hypertension (53.3%) and chronic kidney disease (26.7%). Urinary tract obstruction or calculi were noted in nearly 40% of patients (data not shown), consistent with their known role as precipitating factors for EPN.

Radiologic assessment based on the Huang and Tseng CT classification demonstrated that most patients presented with moderate disease (Classes II–III), while 10% had bilateral (Class IV) involvement.

Overall, the cohort predominantly comprised middle-aged diabetic males presenting with fever and flank pain, of whom roughly one-fourth were hemodynamically unstable on admission. These baseline clinical and demographic characteristics are summarized in Table 1 and provide the foundation for subsequent analyses of laboratory, microbiological, and outcome parameters.

Table 1. Baseline demographic and clinical characteristics of patients with *Emphysematous Pyelonephritis* (n = 30)

Variable	n (%) or Mean $\pm$ SD
Total patients	30
Age (years)	58.4 ± 12.6
Sex (Male/Female)	70% / 30%
Duration of symptoms (days)	10.1 ± 5.4
Diabetes Mellitus	56.7%
Hypertension	53.3%
Chronic Kidney Disease (CKD)	26.7%
Flank Pain	96.7%
Fever	76.7%
Shock on Admission	26.7%
Radiologic Severity (Huang & Tseng)	Class I (26.7%), II (23.3%), IIIa (23.3%), IIIb (16.7%), IV (10%)

2. Laboratory, Microbiological, and Radiologic Profile

The laboratory parameters of the study population are summarized in Table 2.

The mean hemoglobin level was 9.8 g/dL, reflecting mild anemia in the majority of patients. The mean serum albumin was 3.15 g/dL, and the mean serum creatinine level was 1.92 mg/dL, indicating that a substantial proportion presented with renal dysfunction at admission. The average total leukocyte count was $16.1 \times 10^3/\mu\text{L}$, consistent with an acute infectious process.

Urine culture results revealed that *Escherichia coli* was the predominant pathogen, isolated in 46.7% of cases, followed by *Klebsiella pneumoniae* (26.7%), and *Pseudomonas aeruginosa* (13.3%). *Proteus* species and mixed growth were identified less frequently. In 5% of patients, no bacterial growth was observed, possibly reflecting prior empirical antibiotic use before hospital admission. The distribution of isolated organisms is depicted in Figure 1.

Radiologic severity was graded according to the Huang and Tseng CT classification system. The majority of patients exhibited moderate disease (Classes II–III, 46.6%), while 10% had bilateral (Class IV) involvement. Although higher radiologic grades were associated with greater clinical severity, the correlation between CT class and parameters such as shock on admission, ICU admission, and dialysis requirement did not reach statistical significance (Spearman's $r = -0.33$, $p = 0.08$ for shock; all $p > 0.05$).

Taken together, these findings demonstrate that *E. coli* remains the most frequent etiologic organism, and that higher radiologic grades generally correspond to more severe clinical presentation, even though these associations were not statistically significant in this cohort.

Table 2. Laboratory and microbiological profile of patients with *Emphysematous Pyelonephritis* (n = 30)

Parameter	Mean $\pm$ SD / n (%)
Haematological Parameters	
Hemoglobin (g/dL)	9.8 $\pm$ 2.0
Total Leukocyte Count ($\times 10^3/\mu\text{L}$)	16.1 $\pm$ 4.2
Platelet Count ($\times 10^3/\mu\text{L}$)	272 $\pm$ 108
Biochemical Parameters	
Serum Albumin (g/dL)	3.15 $\pm$ 0.6
Serum Creatinine (mg/dL)	1.92 $\pm$ 1.0
Random Blood Sugar (mg/dL)	262 $\pm$ 95
HbA1c (%)	7.5 $\pm$ 1.5
Urine Culture Findings	
<i>Escherichia coli</i>	14 (46.7%)
<i>Klebsiella pneumoniae</i>	8 (26.7%)
<i>Pseudomonas aeruginosa</i>	4 (13.3%)
<i>Proteus</i> species	1 (3.3%)
Mixed Growth	3 (10.0%)
No Growth	1 (3.3%)
Radiologic Severity (Huang & Tseng Classification)	
Class I	8 (26.7%)
Class II	7 (23.3%)
Class IIIa	7 (23.3%)
Class IIIb	5 (16.7%)
Class IV	3 (10.0%)

The above Table 2 summarizes the laboratory and microbiological findings in patients with Emphysematous Pyelonephritis.

The majority exhibited leukocytosis and mild renal dysfunction at presentation. *E. coli* was the most commonly isolated organism, followed by *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*.

Most patients demonstrated moderate radiologic grades (Classes II–III), while 10% had bilateral disease (Class IV).

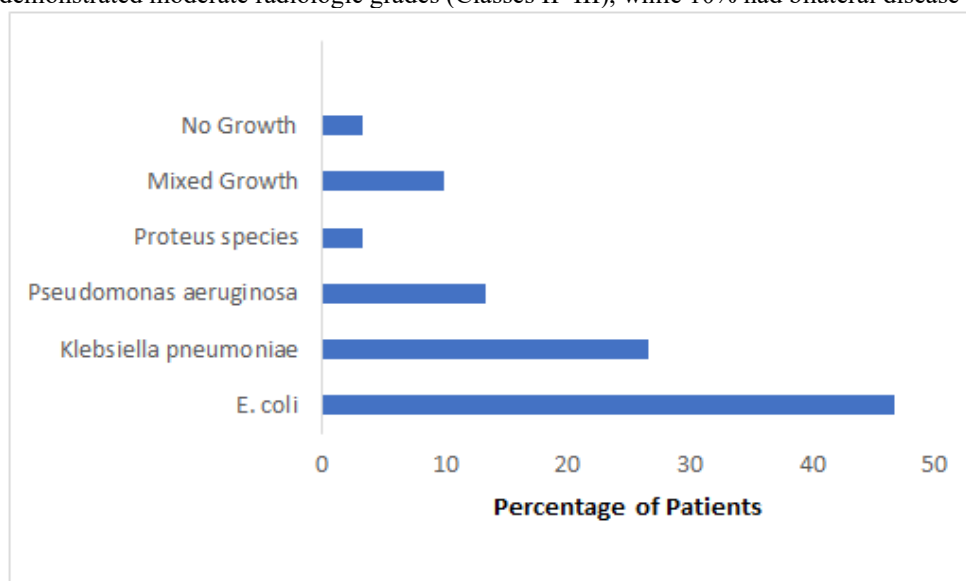


Figure 1. Distribution of organisms isolated from urine culture in patients with Emphysematous Pyelonephritis (EPN).

Escherichia coli was the most common isolate (46.7%), followed by *Klebsiella pneumoniae* (26.7%) and *Pseudomonas aeruginosa* (13.3%). *Proteus* species and mixed growth were less frequent.

3. Management Modalities

All patients were managed according to their clinical and radiologic severity, as summarized in Table 3 and visualized in figure 2.

Conservative management (antibiotics with supportive care) was employed in 16.7% of patients, while the majority required some form of interventional procedure. Percutaneous catheter drainage (PCD) was the most commonly

performed intervention (36.7%), followed by DJ stenting (33.3%). Combined PCD with DJ stenting was required in 6.7%, and nephrectomy was performed in 6.7% of cases with extensive, non-viable renal parenchyma.

The need for ICU admission and dialysis reflected clinical severity. ICU admission was required in 36.7% of patients, while dialysis was initiated in 36.7%, primarily due to acute kidney injury or uremic complications. Patients requiring either ICU support or dialysis demonstrated higher radiologic grades (Class III–IV), though the correlations did not reach statistical significance ($p > 0.05$).

The mean duration of hospital stay was 14.2 ± 5.8 days (range 5–25 days). Although hospital stay length tended to increase with disease severity, this association was not statistically significant on Kruskal–Walli’s testing ($p = 0.33$).

Overall, percutaneous drainage and timely decompression of the collecting system formed the cornerstone of management. Most patients showed clinical improvement with minimally invasive procedures, and nephrectomy was reserved for those with non-viable kidneys or persistent sepsis despite drainage.

Table 3. Management strategies and interventions among patients with Emphysematous Pyelonephritis (n = 30)

Management Parameter	n (%) or Mean $\pm$ SD
Mode of Management	
Conservative (Medical only)	5 (16.7%)
DJ Stenting	10 (33.3%)
Percutaneous Catheter Drainage (PCD)	11 (36.7%)
PCD + DJ Stenting (Combined)	2 (6.7%)
Nephrectomy	2 (6.7%)
Supportive Care	
ICU Admission	11 (36.7%)
Dialysis Required	11 (36.7%)
Hospital Stay (days)	14.2 ± 5.8 (range 5–25)
Correlation with Radiologic Severity	
ICU Admission vs Severity	Spearman $r = -0.06$, $p = 0.75$
Dialysis vs Severity	Spearman $r = 0.05$, $p = 0.80$
Hospital Stay vs Severity	Kruskal–Wallis $\chi^2 = 4.64$, $p = 0.33$

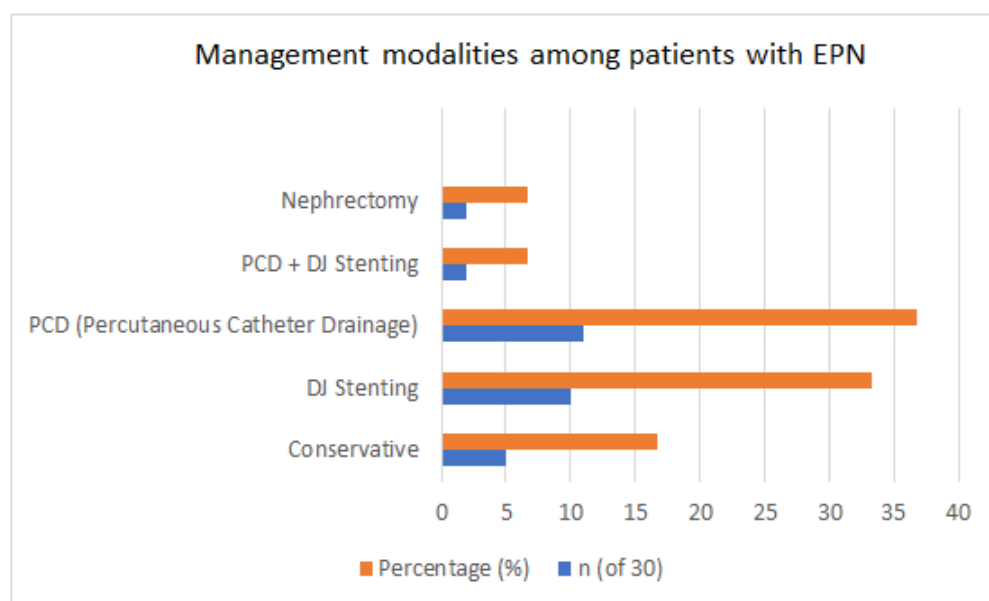


Figure 2. Management modalities among patients with EPN

4. Clinical vs. Radiologic Severity Correlation

The relationship between radiologic severity and key clinical parameters was analyzed using Spearman’s rank correlation, Chi-square, and Kruskal–Wallis tests, as appropriate. The results are summarized in Table 4.

Although there was a trend toward higher clinical severity with increasing radiologic class, none of the associations reached statistical significance. The correlation between shock on admission and radiologic severity showed a moderate negative relationship (Spearman’s $r = -0.33$, $p = 0.08$), suggesting that patients presenting with higher CT grades were more likely to exhibit hemodynamic instability, though this did not achieve statistical significance.

Similarly, the correlations between ICU admission and dialysis requirement with radiologic severity were weak (Spearman's $r = -0.06$ and 0.05 , respectively; $p > 0.05$).

When duration of hospital stay was compared across CT severity classes using the Kruskal–Wallis test, no significant difference was observed ($\chi^2 = 4.64$, $p = 0.33$).

Outcome comparisons demonstrated that in-hospital mortality and post-discharge renal recovery were not significantly influenced by radiologic severity (Chi-square $p = 0.50$ and $p = 0.58$, respectively). Nonetheless, patients with Class IIIb and Class IV disease tended to experience longer hospital stays and higher ICU requirements, reflecting a clinical trend toward greater morbidity in higher CT classes.

Overall, while the statistical correlations were not significant, the observed trends reinforce the established understanding that increasing radiologic severity corresponds to greater systemic illness and higher treatment complexity.

Table 4. Correlation between clinical parameters, radiologic severity, and outcomes in patients with Emphysematous Pyelonephritis (n = 30)

Comparison	Statistical Test	Correlation / χ^2	p-value	Interpretation
Shock vs. Radiologic Severity	Spearman Correlation	−0.33	0.08	Trend, NS
ICU Admission vs. Radiologic Severity	Spearman Correlation	−0.06	0.75	NS
Dialysis Required vs. Radiologic Severity	Spearman Correlation	+0.05	0.80	NS
Hospital Stay Duration vs. Radiologic Severity	Kruskal–Wallis Test	4.64	0.33	NS
In-hospital Outcome vs. Radiologic Severity	Chi-square Test	3.37	0.50	NS
Follow-up Renal Recovery vs. Radiologic Severity	Chi-square Test	2.89	0.58	NS

5.Outcomes: Hospital and Post-Discharge

Patient outcomes are summarized in Table 5. The mean duration of hospital stay was 14.2 ± 5.8 days (range 5–25 days). Although patients with higher radiologic grades tended to have longer admissions, the difference across Huang & Tseng classes was not statistically significant (Kruskal–Wallis $\chi^2 = 4.64$, $p = 0.33$).

A total of 11 patients (36.7%) required ICU admission, and the same proportion required dialysis during hospitalization, reflecting the burden of systemic infection and renal impairment in this cohort. Patients who required ICU or dialysis support were more frequently observed in Class IIIb–IV disease, though these differences did not achieve statistical significance on correlation testing (Spearman $p > 0.05$).

The overall in-hospital mortality rate was 6.7% (2 patients). While mortality showed a rising trend with higher radiologic severity, the association was not statistically significant (Chi-square $p = 0.50$). Among survivors, renal function recovery was documented in 83.3% at follow-up, with no significant difference across CT classes (Chi-square $p = 0.58$).

In summary, although radiologic severity was not an independent predictor of mortality or renal outcome, higher-grade disease was clinically associated with greater morbidity, increased need for critical care, and longer hospitalization.

Table 5. Hospital and post-discharge outcomes in patients with Emphysematous Pyelonephritis (n = 30)

Outcome Parameter	n (%) / Mean $\pm$ SD	Statistical Test	Test Statistic	p-value	Interpretation
Duration of Stay (days)	14.2 ± 5.8	Kruskal–Wallis	$\chi^2 = 4.64$	0.33	NS
ICU Admission	11 (36.7%)	Spearman	$r = -0.06$	0.75	NS
Dialysis Required	11 (36.7%)	Spearman	$r = 0.05$	0.80	NS
In-hospital Mortality	2 (6.7%)	Chi-square	$\chi^2 = 3.37$	0.50	NS
Follow-up Renal Recovery	25 (83.3%)	Chi-square	$\chi^2 = 2.89$	0.58	NS

6. Predictors of Mortality (Univariate and Multivariate Analysis)

Potential predictors of in-hospital mortality were assessed using univariate and multivariate logistic regression analyses, as summarized in Table 6 and illustrated in Figure 3.

Univariate Analysis

On univariate testing, none of the variables demonstrated a statistically significant association with mortality. However, trends toward higher mortality were observed among patients with older age ($p = 0.55$), elevated WBC count ($p = 0.19$), and shock on admission ($p = 0.08$). Diabetes mellitus, CKD, and elevated serum creatinine did not show any significant relationship ($p > 0.05$).

Multivariate Analysis

Multivariate logistic regression incorporating age, CKD, shock on admission, ICU admission, and dialysis requirement did not identify any independent predictors of mortality (all $p > 0.05$).

The model did not reach statistical significance overall, likely reflecting the small sample size and low event rate (6.7% mortality). Nonetheless, positive regression coefficients for age and shock at admission suggested a clinical trend toward poorer outcomes in these groups, consistent with prior reports in the literature.

Table 6. Univariate and multivariate analyses for predictors of mortality in patients with Emphysematous Pyelonephritis (n = 30)

Predictor Variable	Univariate Test (p-value)	Multivariate Logistic Regression (p-value)	Interpretation
Age	0.55	0.30	NS; higher age trend
Serum Creatinine	0.79	0.78	NS
WBC Count	0.19	0.19	NS; mild trend
Diabetes Mellitus	1.00	1.00	NS
Chronic Kidney Disease (CKD)	0.96	1.00	NS
Shock on Admission	0.08	1.00	Trend, not significant
ICU Admission	0.75	1.00	NS
Dialysis Required	0.80	—	NS

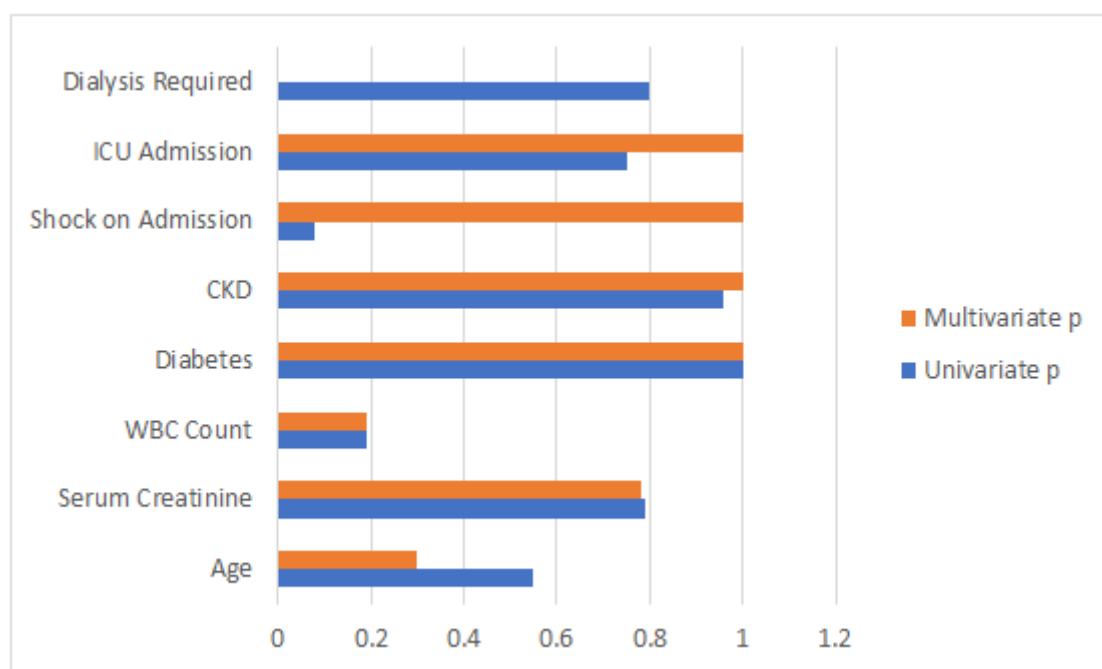


Figure 3. Predictors Of Mortality in Emphysematous Pyelonephritis (Univariate vs Multivariate p Values)

The majority of patients underwent image-guided percutaneous catheter drainage (PCD), followed by DJ stenting. A smaller proportion were managed conservatively, and nephrectomy was reserved for patients with extensive non-viable renal parenchyma.

DISCUSSION

The present study analyzed the clinical characteristics, microbiological spectrum, management strategies, and outcomes of patients with emphysematous pyelonephritis (EPN) treated at a tertiary care centre in western India. Our findings largely align with global trends, while highlighting several region-specific nuances.

Consistent with the classical description by Huang and Tseng (2000), who first proposed a CT-based classification correlating radiologic severity with prognosis [7], most of our patients presented with moderate disease (Class II–III) and a mortality rate below 10%. Huang and Tseng reported mortality of approximately 19% across 48 cases, with Class IV

disease carrying the highest risk [7]. Our observed rate of 6.7% thus reflects improvement attributable to earlier diagnosis and interventional drainage.

In the current study, diabetes mellitus was the most common comorbidity, affecting 56.7% of patients—similar to the 70–90% diabetic prevalence reported in major series [8–10]. Aggarwal et al. (2023), in a large tertiary-care analysis of 82 cases, also identified diabetes (78%) and urinary obstruction (41%) as the principal predisposing factors [8]. Likewise, Khaira et al. (2009) observed diabetes in 84% and obstruction in 32% of 19 Indian patients, emphasizing their synergistic role in EPN pathogenesis [9]. Our comparable distribution reinforces that the combination of hyperglycemia and impaired urinary drainage remains central to disease evolution.

Demographically, our mean age of 58 years mirrors that reported by Bhat et al. (2021) (mean = 56 years, range 35–78) in diabetic EPN from North India [10], and by Lu et al. (2014) from Taiwan (mean = 57 years) [11]. This consistency underscores EPN as a disease predominantly affecting middle-aged to elderly individuals, particularly diabetic women, although our cohort showed a mild male preponderance—a variation possibly linked to regional referral patterns and stone disease epidemiology.

Microbiologically, *Escherichia coli* was the predominant isolate (46.7%), followed by *Klebsiella pneumoniae* (26.7%)—a pattern in agreement with Lu et al. (2014) who reported *E. coli* in 64% and *Klebsiella* in 24% of isolates [11]. Recent microbiological data, however, suggest an evolving landscape: Hyun et al. (2024) demonstrated that *Klebsiella* now accounts for up to 30–35% of acute and emphysematous pyelonephritis cases, often associated with antimicrobial resistance [12]. Similarly, a comparative sensitivity study from Pakistan by Nawaz et al. (2025) noted higher multidrug resistance among *Klebsiella* compared with *E. coli* isolates [13]. In our cohort, the relatively balanced distribution of these two organisms, together with sporadic *Pseudomonas* and *Proteus* species, indicates regional heterogeneity likely influenced by prior antibiotic exposure and local resistance patterns.

Regarding radiologic-clinical correlation, we observed that increasing CT class paralleled clinical severity but did not reach statistical significance. This partially contrasts with Wu et al. (2022), who found a clear stepwise rise in mortality from 5% in Class I–II to 40% in Class IV disease [14]. Our smaller sample and early interventional drainage could explain the attenuated gradient. Nonetheless, the trend of prolonged hospitalization and higher ICU requirement among higher classes in our study remains consistent with the directional association seen in larger cohorts.

Management patterns in our centre reflect the global paradigm shift away from routine emergency nephrectomy toward conservative and minimally invasive strategies. Somani et al. (2008), in a systematic review of 210 cases, reported that percutaneous drainage alone achieved survival in 90% of patients, compared with 66% for primary nephrectomy [16]. Similar outcomes were reproduced in Indian cohorts by Kangjam et al. (2015) and Aswathaman et al. (2008), who demonstrated survival rates of 88–92% with conservative or drainage-based approaches [17, 18]. In our series, PCD or DJ stenting alone was effective in nearly 70% of patients, and nephrectomy was reserved for only 6.7%, reflecting the success of early decompression and antibiotic coverage. The declining nephrectomy rate from over 50% two decades ago to less than 10% in contemporary reports represents one of the most notable advances in EPN management [7, 8, 16–18]. Our overall mortality (6.7%) compares favourably with historical rates of 20–40% [7, 9] and aligns with modern series reporting 6–15% [8, 14, 15]. Wan et al. (1998) earlier identified thrombocytopenia, acute renal failure, and shock as independent predictors of death, each conferring a threefold mortality risk [19]. We observed a similar but statistically non-significant trend: patients presenting with shock or requiring dialysis showed worse outcomes, corroborating these findings within the constraints of our smaller sample.

In contrast, Ngo et al. (2025) analyzed a multi-institutional cohort exceeding 200 cases and confirmed that shock on admission (adjusted OR = 5.1, $p < 0.01$) and Class IV disease (adjusted OR = 3.8, $p = 0.02$) remained strong independent predictors of in-hospital mortality [20]. Likewise, Arrambide-Herrera et al. (2022) documented an ICU admission rate of 45% and mortality of 12%, again linked to advanced CT stage and septic shock [21]. The relatively benign outcomes in our cohort can thus be attributed to early imaging, prompt intervention, and aggressive metabolic control—factors that have collectively improved prognosis in recent years.

Our study also observed renal function recovery in 83% of survivors, comparable to the 80–85% reported by Manjunath et al. (2021) for high-grade (Class IV) EPN managed conservatively [22]. Long-term preservation of renal function following non-surgical management has been similarly reported by Karthikeyan et al. (2018), with complete recovery in 76% and partial in 12% [23]. These findings reinforce that drainage-based therapy can achieve durable renal salvage in the majority of cases.

Predictive scoring systems have been developed to stratify risk. Krishnamoorthy et al. (2021) proposed an 11-year prospective model where thrombocytopenia $< 100 \times 10^9/L$, serum creatinine $> 2.5 \text{ mg/dL}$, and shock independently predicted mortality (AUC = 0.87) [24]. Although our logistic regression did not yield significant independent predictors, the clinical direction—age, shock, and renal dysfunction—mirrors their validated model.

Follow-up data in the literature also support sustained renal recovery post-EPN. Vahlensieck et al. (2015) observed that 85% of patients treated for obstructive or infective pyelonephritis maintained stable renal function at 12 months [25], while Goodship et al. (2000) documented preserved long-term function in most chronic pyelonephritis survivors with initially “normal” renal parameters [26]. Our follow-up results, though limited in duration, align with these outcomes, highlighting the reversibility of infection-related renal impairment when timely decompression and glycemic control are instituted.

Contrasting reports exist. Ubee et al. (2011) noted mortality rates approaching 25% in series dominated by late presenters and multidrug-resistant organisms [27]. Regional variation in pathogen virulence, resistance patterns, and health-care access explains such disparity. Compared to their predominantly Western cohort, our patients presented earlier and received broad-spectrum empirical coverage guided by local antibiograms—factors likely responsible for the improved survival. Methodological heterogeneity across studies—retrospective design, sample size, and diagnostic timing—further complicates direct comparisons but collectively supports the global trend toward reduced lethality.

When viewed alongside international data, our findings contribute to the growing body of evidence that early recognition, optimized glycemic control, and minimally invasive intervention significantly improve outcomes in EPN. The predominance of *E. coli* and *Klebsiella* parallels global microbiological trends, while the relatively low mortality underscores regional advancements in imaging availability and critical-care access. The absence of significant radiologic-clinical correlation in our analysis likely reflects both the small sample and the mitigating effect of prompt drainage, which can interrupt the natural progression from localized to extensive gas formation.

Limitations

The present study includes its retrospective single-centre design and modest sample size, which may underpower detection of statistical significance for certain predictors. Moreover, microbiological culture data were limited by prior antibiotic exposure in some cases, potentially underestimating true pathogen diversity. Despite these limitations, the study adds valuable tertiary-care data from western India, complementing larger national and international cohorts.

CONCLUSION

Emphysematous pyelonephritis (EPN) remains a life-threatening infection, but outcomes have improved substantially with early diagnosis and minimally invasive management. In this tertiary-care cohort, diabetes and urinary obstruction were the main risk factors, and *E. coli* and *Klebsiella pneumoniae* were the predominant pathogens. Image-guided drainage and DJ stenting were effective in most patients, limiting the need for nephrectomy.

Mortality was low (6.7%), and more than 80% achieved renal recovery, underscoring the success of early intervention and metabolic control. Although higher CT grades reflected greater clinical severity, radiologic stage alone did not predict outcome.

EPN should now be regarded as a potentially reversible infection when managed promptly with multidisciplinary care. Larger prospective studies incorporating microbiological resistance trends and validated prognostic scoring systems are needed to further optimize patient outcomes.

Declaration:

Conflicts of interests: The authors declare no conflicts of interest.

Author contribution: All authors have contributed in the manuscript.

Author funding: Nill

REFERENCES

1. Desai, R., & Batura, D. (2022). A systematic review and meta-analysis of risk factors and treatment choices in emphysematous pyelonephritis. *International urology and nephrology*, 54(4), 717-736.
2. Ubee, S. S., McGlynn, L., & Fordham, M. (2011). Emphysematous pyelonephritis. *BJU international*, 107(9), 1474-1478.
3. Elawdy, M. M., Osman, Y., Abouelkheir, R. T., El-Halwagy, S., Awad, B., & El-Mekresh, M. (2019). Emphysematous pyelonephritis treatment strategies in correlation to the CT classification: have the current experience and prognosis changed?. *International Urology and Nephrology*, 51(10), 1709-1713.
4. Aswathaman, K., Gopalakrishnan, G., Gnanaraj, L., Chacko, N. K., Kekre, N. S., & Devasia, A. (2008). Emphysematous pyelonephritis: outcome of conservative management. *Urology*, 71(6), 1007-1009.
5. Chen, C. C., Hsieh, M. S., Hu, S. Y., Huang, S. C., Tsai, C. A., & Tsai, Y. C. (2022). Performance of scoring systems in predicting clinical outcomes of patients with emphysematous pyelonephritis: a 14-year hospital-based study. *Journal of Clinical Medicine*, 11(24), 7299.
6. Gopal, G. K., Wilson, B. P., VIGGeSWarpu, S., Sathyendra, S., Iyyadurai, R., Visvanathan, R., & Mathews, K. P. (2015). Clinical profile and predictors of outcomes in older inpatients with pyelonephritis in a tertiary care hospital in southern India. *Journal of Clinical and Diagnostic Research: JCDR*, 9(10), OC05.

7. Huang, J. J., & Tseng, C. C. (2000). Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. *Archives of internal medicine*, 160(6), 797-805.
8. Aggarwal, D., Mandal, S., Parmar, K., Manoharan, V., Singh, S., Yadav, A. K., ... & Singh, S. K. (2023). Predictors of mortality and nephrectomy in emphysematous pyelonephritis: a tertiary care centre study. *The Annals of The Royal College of Surgeons of England*, 105(4), 323-330.
9. Khaira, A., Gupta, A., Rana, D. S., Gupta, A., Bhalla, A., & Khullar, D. (2009). Retrospective analysis of clinical profile prognostic factors and outcomes of 19 patients of emphysematous pyelonephritis. *International urology and nephrology*, 41(4), 959-966.
10. Bhat, S. K., Srivastava, A., Ansari, N. A., Rai, P., Singh, R. P., Srivastava, R., ... & Fatima, J. (2021). Emphysematous pyelonephritis in type 2 diabetes—clinical profile and management. *Saudi Journal of Kidney Diseases and Transplantation*, 32(6), 1646-1654.
11. Lu, Y. C., Chiang, B. J., Pong, Y. H., Chen, C. H., Pu, Y. S., Hsueh, P. R., & Huang, C. Y. (2014). Emphysematous pyelonephritis: clinical characteristics and prognostic factors. *International Journal of Urology*, 21(3), 277-282.
12. Hyun, M., Lee, J. Y., Lim, K. R., & Kim, H. A. (2024). Clinical characteristics of uncomplicated acute pyelonephritis caused by *Escherichia coli* and *Klebsiella pneumoniae*. *Infectious Diseases and Therapy*, 13(3), 581-595.
13. Nawaz, A., Sohail, M., Shah, S., Khan, M. I., Shah, J., & Saeed, U. (2025). A COMPARATIVE STUDY OF ANTIMICROBIAL SENSITIVITY IN PATIENTS WITH ACUTE PYELONEPHRITIS AND EMPHYSEMATOUS PYELONEPHRITIS. *Khyber Journal of Medical Sciences*, 18(3), 206-213.
14. Wu, S. Y., Shei-Dei Yang, S., Chang, S. J., & Hsu, C. K. (2022). Emphysematous pyelonephritis: classification, management, and prognosis. *Tzu Chi Medical Journal*, 34(3), 297-302.
15. Huang, J. J., & Tseng, C. C. (2000). Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. *Archives of internal medicine*, 160(6), 797-805.
16. Somani, B. K., Nabi, G., Thorpe, P., Hussey, J., Cook, J., N'Dow, J., & ABACUS Research Group. (2008). Is percutaneous drainage the new gold standard in the management of emphysematous pyelonephritis? Evidence from a systematic review. *The Journal of urology*, 179(5), 1844-1849.
17. Kangiam, S. M., Irom, K. S., Khumallambam, I. S., & Sinam, R. S. (2015). Role of conservative management in emphysematous pyelonephritis-a retrospective study. *Journal of Clinical and Diagnostic Research: JCDR*, 9(11), PC09.
18. Aswathaman, K., Gopalakrishnan, G., Gnanaraj, L., Chacko, N. K., Kekre, N. S., & Devasia, A. (2008). Emphysematous pyelonephritis: outcome of conservative management. *Urology*, 71(6), 1007-1009.
19. Wan, Y. L., Lo, S. K., Bullard, M. J., Chang, P. L., & Lee, T. Y. (1998). Predictors of outcome in emphysematous pyelonephritis. *The Journal of urology*, 159(2), 369-373.
20. Ngo, X. T., Vu, D. H., Thai, M. S., Hoang, K. C., Thai, K. L., Duong, N. X., ... & Nguyen, T. T. (2025). Identifying predictors of in-hospital mortality in patients with emphysematous pyelonephritis: insights from a large retrospective cohort: Predictors of Mortality in Emphysematous Pyelonephritis. *World Journal of Urology*, 43(1), 347.
21. Arrambide-Herrera, J. G., Robles-Torres, J. I., Ocaña-Munguía, M. A., Romero-Mata, R., Gutiérrez-González, A., & Gómez-Guerra, L. S. (2022). Predictive factors for mortality and intensive care unit admission in patients with emphysematous pyelonephritis: 5-year experience in a tertiary care hospital. *Actas Urológicas Españolas (English Edition)*, 46(2), 98-105.
22. Manjunath, R., Bennikal, M., Dasar, S. K., & Patil, S. T. (2021). Clinical profile, management and outcomes of class IV emphysematous pyelonephritis in a tertiary care center: A retrospective descriptive study. *Ukrainian Journal of Nephrology and Dialysis*, (4 (72)), 78-85.
23. Karthikeyan, V. S., Manohar, C. M. S., Mallya, A., Keshavamurthy, R., & Kamath, A. J. (2018). Clinical profile and successful outcomes of conservative and minimally invasive treatment of emphysematous pyelonephritis. *Central European journal of urology*, 71(2), 228.
24. Krishnamoorthy, S., Zumla, A., Sekar, H., Muneer, A., Thiruvengadam, G., & Kumaresan, N. (2021). Prognostic scoring system and risk stratification in patients with emphysematous pyelonephritis: an 11-year prospective study at a tertiary referral centre. *BJU international*, 127(4), 418-427.
25. Vahlensieck, W., Friess, D., Fabry, W., Waidelich, R., & Bschiepfer, T. (2015). Long-term results after acute therapy of obstructive pyelonephritis. *Urologia internationalis*, 94(4), 436-441.
26. Goodship, T. H. J., Stoddart, J. T., Martinek, V., Geetha, D., Brown, A. L., Ward, M. K., ... & Wilkinson, R. (2000). Long-term follow-up of patients presenting to adult nephrologists with chronic pyelonephritis and 'normal' renal function. *QJM*, 93(12), 799-803.
27. Ubee, S. S., McGlynn, L., & Fordham, M. (2011). Emphysematous pyelonephritis. *BJU international*, 107(9), 1474-1478.