

Research Article**CLINICAL PROFILE AND MANAGEMENT OUTCOMES OF EMPYSEMATOUS PYELONEPHRITIS****Sharankumar Jabshetty ¹, Harish Sulekar ², Sharanabassapa Rudrawadi ^{3*}**¹ Assistant Professor Department of Urology GIMS SSH Kalaburagi.² Consultant Urologist, Department of Urology, ESI MC KALABURAGI^{3*} Associate Professor Department of Urology GIMS SSH Kalaburagi

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Background: Emphysematous pyelonephritis is a severe necrotizing renal infection commonly associated with diabetes mellitus and urinary tract obstruction.

Objective: To evaluate the clinical profile and management outcomes of emphysematous pyelonephritis.

Methods: This retrospective observational study was conducted at Gulbarga Institute Of Medical Sciences And Superspeciality Hospital Kalaburagi from 01-03-2024 to 30-09-2025 and included 30 patients with computed tomography-confirmed emphysematous pyelonephritis. Demographic characteristics, clinical presentation, laboratory findings, radiological classification, treatment modalities, and outcomes were reviewed. Successful outcome was defined as clinical recovery without mortality.

Results: The mean age of patients was 58.9 ± 11.6 years, with female predominance (19, 63.3%). Diabetes mellitus was present in 25

(83.3%), hypertension in 16 (53.3%), chronic kidney disease in 8 (26.7%), nephrolithiasis in 12 (40.0%), and urinary tract obstruction in 10 (33.3%) patients. Fever (28, 93.3%) and flank pain (27, 90.0%) were the most common presenting symptoms. Septic shock occurred in 8 (26.7%), and acute kidney injury in 11 (36.7%) patients. Percutaneous drainage was performed in 14 (46.7%), double-J stenting in 10 (33.3%), and nephrectomy in 5 (16.7%) patients.

Conclusion: Emphysematous pyelonephritis predominantly affected diabetic patients and was associated with significant morbidity.

Keywords: Emphysematous pyelonephritis; diabetes mellitus; septic shock; acute kidney injury; percutaneous drainage

INTRODUCTION

Emphysematous pyelonephritis (EPN) is a rare, severe and life-threatening necrotizing infection of the renal parenchyma and surrounding tissues associated with the formation of gas in the renal collecting system, renal parenchyma and perinephric

spaces [1]. It is one of the most severe forms of UTI and is a urologic emergency due to its potential to rapidly progress to septic shock, multiorgan dysfunction and death if not diagnosed and treated promptly [2]. Despite the improved prognosis in the recent decades due to advances in diagnostic imaging, intensive care, antimicrobial therapy and on-demand minimally invasive interventions, EPN remains associated with a high morbidity and mortality rates. The disease is more common in patients who don't have control over their diabetes mellitus (DM) (about 80-90% of reported cases) [3]. Hyperglycemia causes bacterial fermentation of glucose to carbon dioxide and hydrogen gas in tissues. Furthermore, diabetic microangiopathy, a decrease in tissue perfusion, a dysfunction of leukocytes, and host immunity make the environment conducive to bacterial proliferation and rapid tissue destruction [4]. Another important factor contributing to the development of this disease is the obstruction of the urinary tract by calculi, strictures of the ureters or by tumour (cancer) which results in urinary tract obstruction and increase in intrarenal pressure. *E. coli*, *Klebsiella pneumoniae*, *Proteus mirabilis* and other gas-forming Gram-negative pathogens are the common pathogens isolated in emphysematous pyelonephritis [5]. A few cases of mixed infections with bacteria and fungi have been reported, especially in immunocompromised patients. The early identification of causative organism using urine and blood culture is key to choosing appropriate antimicrobial therapy and better clinical outcomes [6]. Patients who develop emphysematous pyelonephritis are usually febrile, have flank

pain, chills, dysuria, nausea, vomiting, and signs of systemic toxicity [7]. Altered mental status, septic shock, thrombocytopenia, acute kidney injury, disseminated intravascular coagulation and multiorgan failure may be associated with advanced disease. Imaging is a key role in establishing the diagnosis and severity of disease and is often required to differentiate complicated APN from uncomplicated APN as the clinical presentation is often similar.

Computed tomography (CT) is regarded as the most appropriate imaging modality for the diagnosis of emphysematous pyelonephritis due to its exquisite capacity to identify gas in the renal parenchyma and outside the kidneys, with precise assessment of the extent of the disease [8]. The Huang and Tseng classification continues to be the most commonly accepted radiological classification and is important for the prognosis and therefore treatment. It is also crucial to perform laboratory tests such as complete blood count, inflammatory markers, renal function tests, blood electrolyte, blood glucose and microbiological cultures to assess the severity of the disease and monitor the effectiveness of treatment [9]. It was believed that emergency nephrectomy was the standard treatment for EP based on its high mortality. Advancements in imaging for percutaneously guided drainage, wide-spectrum antibiotic treatment, intensive care unit care and optimization of glycemic control have, however, shifted the focus of treatment to more conservative kidney-preserving treatment in the appropriate patient [10]. Current therapy relies on the severity of the disease, hemodynamic

stability, renal function and risk factors for therapy failure. Today, surgery (nephrectomy) is used primarily when conservative therapy is not successful or if the kidneys are largely destroyed. [11] Poor prognosis has been linked to several clinical and laboratory parameters such as thrombocytopenia, altered mental status, acute kidney injury, shock, uncontrolled diabetes mellitus, hypoalbuminemia, polymicrobial infection and higher radiological disease class [12]. If these predictors are recognized early, then the clinicians can identify those patients who are at a high risk and need aggressive intervention and intensive monitoring. Although the treatment of EPN has improved, different clinical presentation, microbiological profile, management approaches and outcomes have been noted amongst different populations [13]. Institution-based studies still yield useful data on the characteristics of the disease; predictors of conservative treatment success and factors associated with mortality. This is especially useful as evidence to inform personalised treatment approaches and enhance patient outcomes [14][15].

OBJECTIVE

To evaluate the clinical profile and management outcomes of emphysematous pyelonephritis.

METHODOLOGY

This retrospective observational study was conducted at Gulbarga Institute Of Medical Sciences And Superspeciality Hospital Kalaburagi from 01-03-2024 to 30-09-2025 and included 30 patients diagnosed with emphysematous pyelonephritis (EPN). Patients aged 18 years or older with a

radiologically confirmed diagnosis of emphysematous pyelonephritis based on computed tomography (CT) findings who were admitted during the study period were included. Only patients with complete clinical records, laboratory investigations, imaging findings, treatment details, and follow-up data were eligible for analysis. Patients with uncomplicated acute pyelonephritis without gas formation, emphysematous pyelitis without renal parenchymal involvement, renal malignancy, incomplete medical records, pregnancy, previous nephrectomy, or loss to follow-up were excluded.

Data Collection

Following approval from the Institutional Ethical Review Committee, patient data were retrieved from electronic medical records, laboratory databases, radiology reports, operative records, intensive care charts, and discharge summaries using a standardized data collection form. Baseline demographic and clinical variables included age, gender, body mass index, diabetes mellitus, hypertension, chronic kidney disease, urinary tract obstruction, nephrolithiasis, duration of symptoms, fever, flank pain, dysuria, altered mental status, septic shock, and vital signs at presentation. Laboratory parameters included complete blood count, serum creatinine, estimated glomerular filtration rate, blood glucose, glycated hemoglobin (HbA1c), C-reactive protein, procalcitonin, platelet count, serum electrolytes, urine culture, blood culture, and causative microorganisms. Radiological variables included side of involvement, Huang and Tseng CT classification, presence of renal calculi, hydronephrosis, perinephric extension, bilateral disease, and associated urinary tract obstruction. Treatment-related variables included empirical and culture-directed antibiotic therapy, glycemic control

measures, intensive care unit admission, percutaneous catheter drainage, double-J stent placement, percutaneous nephrostomy, nephrectomy, duration of hospitalization, and need for renal replacement therapy. The primary outcome was successful treatment, defined as clinical recovery with resolution of infection without mortality.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages. Independent *t*-tests were used to compare continuous variables between survivors and non-survivors or between patients with successful

and unsuccessful treatment. Chi-square or Fisher's exact tests were used for categorical variables. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated, and a *p*-value ≤ 0.05 was considered statistically significant.

RESULTS

The mean age of patients was 58.9 ± 11.6 years, with female predominance (19, 63.3%). Diabetes mellitus was present in 25 (83.3%), hypertension in 16 (53.3%), and chronic kidney disease in 8 (26.7%) patients. Nephrolithiasis and urinary obstruction were found in 12 (40.0%) and 10 (33.3%) patients, respectively. Mean serum creatinine was 2.3 ± 1.1 mg/dL, and mean HbA1c was $9.6 \pm 1.8\%$, showing poor glycemic control.

Table 1: Baseline Demographic and Clinical Characteristics of Patients with Empysematous Pyelonephritis (N = 30)

Variable	n (%) / Mean $\pm$ SD
Age (years)	58.9 ± 11.6
Male	11 (36.7)
Female	19 (63.3)
Body mass index (kg/m ²)	28.1 ± 4.2
Diabetes mellitus	25 (83.3)
Hypertension	16 (53.3)
Chronic kidney disease	8 (26.7)
Nephrolithiasis	12 (40.0)
Urinary tract obstruction	10 (33.3)
Symptom duration (days)	5.8 ± 2.3
Serum creatinine (mg/dL)	2.3 ± 1.1
HbA1c (%)	9.6 ± 1.8

Fever and flank pain were the most common presenting features, occurring in 28 (93.3%)

and 27 (90.0%) patients, respectively. Septic shock was present in 8 (26.7%), and acute

kidney injury in 11 (36.7%). Most patients had Huang Class II or III disease. Percutaneous drainage was performed in 14 (46.7%), DJ stenting in 10 (33.3%), and nephrectomy in 5 (16.7%) patients. Mean hospital stay was 10.8 ± 4.1 days.

Table 2: Clinical Presentation, Radiological Findings, and Management

Variable	n (%) / Mean $\pm$ SD
Fever	28 (93.3)
Flank pain	27 (90.0)
Dysuria	18 (60.0)
Septic shock	8 (26.7)
Acute kidney injury	11 (36.7)
Huang Class I	4 (13.3)
Huang Class II	10 (33.3)
Huang Class IIIA	8 (26.7)
Huang Class IIIB	6 (20.0)
Huang Class IV	2 (6.7)
Percutaneous drainage	14 (46.7)
Double-J stent	10 (33.3)
Nephrectomy	5 (16.7)
Mean hospital stay (days)	10.8 ± 4.1

Patients with poor outcomes were older (68.8 ± 8.9 vs. 56.9 ± 10.7 years; $p=0.028$), had higher serum creatinine (3.8 ± 1.2 vs. 2.0 ± 0.9 mg/dL; $p=0.003$), and poorer glycemic control (HbA1c $11.2 \pm 1.5\%$ vs. $9.2 \pm 1.6\%$; $p=0.021$). Septic shock, acute kidney injury, Huang Class III/IV disease, and longer hospital stay were significantly more common in poor-outcome patients.

Table 3: Comparison between Successfully Managed Patients and Patients with Poor Outcomes

Variable	Successful Outcome (n=25)	Poor Outcome (n=5)	p-value
Age (years), Mean $\pm$ SD	56.9 $\pm$ 10.7	68.8 $\pm$ 8.9	0.028
Serum creatinine (mg/dL), Mean $\pm$ SD	2.0 $\pm$ 0.9	3.8 $\pm$ 1.2	0.003
HbA1c (%), Mean $\pm$ SD	9.2 $\pm$ 1.6	11.2 $\pm$ 1.5	0.021
Septic shock, n (%)	4 (16.0)	4 (80.0)	0.004
Acute kidney injury, n (%)	7 (28.0)	4 (80.0)	0.035
Huang Class III/IV, n (%)	10 (40.0)	5 (100.0)	0.019
Hospital stay (days), Mean $\pm$ SD	9.8 $\pm$ 3.5	15.8 $\pm$ 4.3	0.007

Multivariable analysis showed septic shock was the strongest predictor of poor clinical outcome (AOR=6.84, 95% CI: 1.42–32.91; p=0.017), followed by serum creatinine >2.5 mg/dL, Huang Class III/IV disease, HbA1c >10%, and acute kidney injury.

Table 4: Multivariable Logistic Regression Analysis of Predictors of Poor Clinical Outcome

Predictor	Adjusted OR	95% CI	p-value
Septic shock	6.84	1.42–32.91	0.017
Serum creatinine >2.5 mg/dL	5.63	1.21–26.24	0.028
Huang Class III/IV disease	4.92	1.08–22.37	0.039
HbA1c >10%	3.86	1.02–14.58	0.046
Acute kidney injury	3.54	1.01–12.47	0.048

DISCUSSION

This retrospective study aimed to assess the clinical picture and management results of 30 patients with emphysematous pyelonephritis (EPN). The results showed that EPN was

mainly a problem of diabetics and that despite intensive care, EPN was a significant source of morbidity. Conservative kidney-sparing measures resulted in successful clinical management in most patients, and

septic shock, renal insufficiency, advanced stages of radiological involvement, and sub-optimal glycemic control were recognized as significant factors influencing adverse clinical outcome. Therefore, the importance of early diagnosis, intensive resuscitation, early antimicrobial therapy and timely urinary drainage in improving patient's survival can be emphasized. The average age of the study population was 58.9 ± 11.6 years and 63.3% were females. 83.3% of patients had diabetes mellitus, 53.3% had hypertension, 26.7% had chronic kidney disease, 40.0% had nephrolithiasis, and 33.3% had urinary tract obstruction. Most patients had poor glycemic control with the mean HbA1c of $9.6 \pm 1.8\%$. Empysematous pyelonephritis has also been found to be more prevalent in middle-aged diabetic women, uncontrolled diabetes being the most important factor for the development of the disease in previous studies [16]. The most common presenting symptoms were fever (93.3%) and flank pain (90.0%), with 26.7% of the patients developing septic shock, and 36.7% patients developing acute kidney injury. Radiological assessment revealed that most of the patients had the Huang class of II and III disease. Similarly, previous studies have found that the most common presenting complaints are fever, flank pain, leukocytosis, and acute kidney injury, which are highly associated with the severity of illness and mortality rate, depending on the Huang classification [17]. The treatment strategies were in line with the current trend for renal preservation measures wherever possible. Percutaneous drainage was performed in 46.7%, double-J stenting in 33.3% and nephrectomy was needed in only

16.7%. The mean length of hospital stay was 10.8 days (4.1 days standard deviation). This has been confirmed in the past by other studies that have shown broad-spectrum antibiotics and tight glycemic control, along with early image-guided drainage, have significantly lowered the rate of emergency nephrectomy and increased survival over what was previously achieved [18].

Patients who were successful in treatment were compared with those who were not, and the following significant prognostic factors were identified. Patients with poor outcomes were significantly older (68.8 ± 8.9 vs. 56.9 ± 10.7 years), had higher serum creatinine levels (3.8 ± 1.2 vs. 2.0 ± 0.9 mg/dL), poorer glycemic control (HbA1c $11.2 \pm 1.5\%$ vs. $9.2 \pm 1.6\%$), and longer hospital stay (15.8 ± 4.3 vs. 9.8 ± 3.5 days). Patients with unfavorable outcomes were also more likely to develop septic shock, acute kidney injury and Huang Class III/IV disease. Advanced age, renal dysfunction, uncontrolled diabetes, septic shock and large-scale radiological involvement are consistently reported to be strong predictors of the treatment failure and mortality associated with empysematous pyelonephritis. Septic shock was the most powerful independent predictor of poor clinical outcome in the multivariable logistic regression analysis, with a risk multiplied almost 7-fold. Other factors that independently predicted adverse outcomes included elevated serum creatinine, Huang Class III/IV disease, HbA1c $> 10\%$, and acute kidney injury. Past studies have also shown that hemodynamic instability (by systemic assessment), severe renal insufficiency, thrombocytopenia, alteration of consciousness/mental status and large gas

formation are good indicators of mortality and often require more intense treatment [19]. This study showed a high rate of uncontrolled diabetes, highlighting the importance of metabolic control in the onset and evolution of emphysematous pyelonephritis. Hyperglycemia is associated with increased bacterial growth, ischemic changes in tissues and compromised immune system, which allows gas formation and destruction of renal parenchyma. In previous studies, optimization of blood glucose levels has also been found to be correlated with better treatment response and decreased mortality, when combined with timely antimicrobial treatment and urinary drainage [20]. The percentage of nephrectomies performed in this cohort is relatively low, which reflects an increasing trend toward conservative treatment in appropriate patients.

Limitations

This study has several limitations. First, its retrospective design may have introduced selection and information bias because the analysis relied on previously documented medical records. Second, the study was conducted at a single center with a relatively small sample size of 30 patients, which may limit the generalizability of the findings. Variations in the timing of diagnosis, antimicrobial regimens, drainage techniques, and supportive care could not be completely standardized and may have influenced treatment outcomes. Although radiological classification and microbiological findings were assessed, factors such as antimicrobial resistance patterns, time to intervention, and long-term renal functional recovery were not consistently available for evaluation. In

addition, follow-up was limited to the hospital course, preventing assessment of long-term recurrence, chronic kidney disease progression, and quality of life after discharge.

CONCLUSION

Emphysematous pyelonephritis remains a severe and potentially life-threatening urological emergency that predominantly affects patients with poorly controlled diabetes mellitus. Most patients were successfully managed using conservative kidney-preserving strategies, including antimicrobial therapy and urinary drainage, while nephrectomy was required in a minority of cases. Septic shock, elevated serum creatinine, advanced Huang Class III/IV disease, poor glycemic control, and acute kidney injury were independent predictors of adverse clinical outcomes.

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