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SAFETY AND EFFICACY OF DOUBLE J STENTING IN MANAGEMENT OF GRADE 2 AND 3A EMPHYSEMATOUS PYELONEPHRITIS

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Abstract

Background:
Emphysematous pyelonephritis (EPN) is a rare, serious, and life-threatening disease that causes necrosis of renal tissue and formation of gas inside the kidney and its surrounding structures. This condition mainly occurs in diabetics and has been linked with high morbidity and mortality rates. EPN was previously treated using conservative antibiotic therapy up to nephrectomy. Currently, there is an increasing trend towards minimal invasive treatment like Double J (DJ) stenting.
Objective:
To determine the safety and efficacy of Double J stenting in the management of Grade 2 and Grade 3a Emphysematous Pyelonephritis and to assess the frequency of adverse outcomes associated with the procedure.
Methodology:
A descriptive case series study was carried out at the Department of Urology, Shaikh Zayed Hospital, Lahore, from February 04, 2026, to June 04, 2026. A total of 93 patients aged 18 to 70 years suffering from radiologically proven Grade 2 and 3a EPN were selected through a non-probability consecutive sampling technique. All patients had DJ stenting after taking informed consent. Clinical, laboratory, microbiology, and radiology findings of the patients were documented using a structured proforma. Management of patients included the use of antibiotics, glycemic control, and support, as well as hemodialysis in case of necessity. Efficacy was determined on the basis of clinical improvement, laboratory findings, radiology clearance, and further interventions. Data were analyzed using SPSS version 26.
Results:
The mean age of the patients was 51.8 ± 12.4 years, with females comprising 59.1% of the study population. Diabetes mellitus was present in 77.4% of patients, while 19.4% had chronic kidney disease. Grade 2 EPN was observed in 58.1% and Grade 3a EPN in 41.9% of patients. Radiological clearance was achieved in 76.3% of patients following DJ stenting. Hemodialysis was required in 25.8%, while nephrectomy was required in 11.8% of cases. The mortality rate was 11.8%. Univariate analysis showed significant associations of age, diabetes mellitus, hypertension, CKD, Grade 3a EPN, elevated TLC, and hemodialysis requirement with early complications. Multivariate logistic regression identified Grade 3a EPN (OR=3.8, p=0.009), CKD (OR=3.1, p=0.015), and hemodialysis requirement (OR=4.6, p=0.005) as independent predictors of complications.
Conclusion:
Double J stenting is a safe and effective minimally invasive management option for Grade 2 and Grade 3a Emphysematous Pyelonephritis, with a high radiological clearance rate and low nephrectomy requirement. However, patients with advanced disease, renal dysfunction, and associated comorbidities remain at higher risk of complications and require close monitoring.

Keywords: Emphysematous pyelonephritis, Double J stenting, Grade 2 EPN, Grade 3a EPN, nephrectomy, renal function, morbidity, mortality.

INTRODUCTION

Emphysematous Pyelonephritis [EPN] is a rare and potentially fatal necrotizing infection of the renal parenchyma and perirenal tissues characterized by gas formation within the kidney or para-renal tissue. [1] It predominantly affects people with diabetes, as hyperglycemia provides a favorable environment for the growth of nitrogen-producing bacteria, including Escherichia coli and Klebsiella pneumonia. [2] In the exceptions, a more virulent and resistant pathogen may be implicated, particularly in immunocompromised hosts; facultative anaerobes like Pseudomonas aeruginosa may be the probable cause. Overall mortality rate due to Bacterial EPN ranges from 11% to 42%. [3]

Acute kidney injury (AKI), septic shock, and multiorgan involvement, including pleural effusions and lung problems, including basal atelectasis, can exacerbate the clinical course, which may develop quickly. [4.] Because of a compromised immune system and diminutive renal reserve, chronic kidney disease (CKD) contributes to the morbidity attributed to EPN [5]

According to Huang and Tseng [6], there are different grades (I, II, IIIA, IIIB, and IV) of EPN, where Grades II and IIIa are complex with the need for intensive care. Timing is critical, as untreated EPN offers mortality rates as high as 40-70%. [7] Traditionally, the treatment of EPN has varied from a non-operative, antibiotics approach in mild cases, to an operative, nephrectomy in severe cases.

New studies have shown that percutaneous interventions such as percutaneous drainage and DJ stenting appear to be less invasive and effective in a majority of Grade 2 and 3a EPNs. DJ stenting has been advocated as a safe and effective method for relieving obstruction and encouraging drainage, hence lowering the nephrectomy rate. [8] In a systematic review of case series, wherein retrospective data highlighted minimally invasive approaches to managing EPN, outcomes demonstrate positive potential. In the study by Huang et al. in 2019, patients with Grade 2 and 3a EPN who received DJ stenting with antibiotics showed an overall success of 60% in relieving symptoms and eradicating the infections. [9] In another study by Pontin et al., they had low mortality of only 10% for the patients with EPN and diabetes who had percutaneous drainage and stenting, in contrast to the 35% mortality from nephrectomy only. [10] Such analyses indicate that DJ stenting could act as a alternate option to improve renal function and decrease the patients' morbidity and mortality.

Grade 2 and 3a EPN often requires surgical intervention when medical management alone is insufficient. DJ stenting, being minimally invasive, may help reduce morbidity and mortality, potentially eliminating the need for nephrectomy. [7] However, its role in such cases has not been conclusively established. This study aims to make this distinction by evaluating the effectiveness of DJ stenting in preventing complications and lowering mortality in patients with Grade 2 and 3a EPN [8]

DJ stenting is important for emphysematous pyelonephritis (EPN) because it provides a minimally invasive treatment that can drastically decrease mortality and the requirement for nephrectomy (kidney removal). So this study aimed to find the efficacy and frequency of adverse outcomes of DJ Stenting in the management of Grade 2 and 3a Emphysematous Pyelonephritis.

MATERIALS AND METHODS

A descriptive case series study was conducted in the Department of Urology, Shaikh Zayed Hospital, Lahore, over the period from February 04, 2026, to June 04, 2026. Patients presenting to the Emergency Room (ER) or Outpatient Department (OPD) who fulfilled the inclusion criteria were selected.

A total of 93 patients was calculated using 95% confidence level, 10% margin of error, and the efficacy of Double J Stenting as 60% [9]. Patients aged between 18 and 70 years, with radiologically proven Grade 2 or Grade 3a EPN and evidence of gas in the renal parenchyma, pelvicalyceal system, or perinephric space, were enrolled. Patients who had no prior surgical intervention for the current infection were included. Pregnant or lactating women, patients with fistula between the gut and genitourinary tract, severe bleeding disorders, immunosuppressive conditions other than diabetes mellitus, contraindications for DJ stenting, and those undergoing conservative or alternative surgical management were excluded from the study.

After obtaining informed consent, all patients underwent Double J stenting. Data regarding demographic profile, clinical history, microbiological findings, radiological examination, laboratory investigations, and treatment details were collected on a structured proforma.

All patients were managed with broad-spectrum antibiotics, glycemic control, fluid and electrolyte management, and hemodialysis where indicated. Baseline investigations, including urinalysis, complete blood count, renal function tests, and serum electrolytes, were recorded before stenting, immediately after the procedure, and at follow-up visits at two and four weeks post-operatively.

Following stent insertion, efficacy was evaluated in four phases: l) Verification of stent position via cystoscopy and contrast study to ensure unobstructed urine flow.2) Assessed functional success 24-72 hours post-insertion by monitoring relief of flank pain, fever reduction, improved urine output, decreased serum creatinine, and resolution of

leukocytosis through ultrasound and X-ray KUB. 3) Conducted four-week follow-ups to check for recurring pain, urinary obstruction symptoms, and infections using ultrasound and X-ray KUB. 4) Performed imaging before stent removal or exchange to confirm no stones or strictures and normal renal function.

The analysis of data was carried out by Statistical Package for Social Sciences (SPSS) version 26. The demographic and clinical characteristics of the patients, such as age and gender, were described by mean ± standard deviation. The frequencies and percentages of the outcome variable were calculated. Univariate analysis was done to see which factors were related to complications through chi-squared tests for categorical variables and t-test and Mann-Whitney U test for continuous variables. The multivariate analysis using logistic regression was done to identify independent predictors of complications in the form of odds ratios with 95% confidence interval, where the p-value is less than 0.05.

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of Patients (n = 93)

Variables	Frequency (n) / Mean ± SD	Percentage (%)
Age (years)	51.8 ± 12.4	—
Gender		
Male	38	40.9
Female	55	59.1
Diabetes Mellitus	72	77.4
Hypertension	31	33.3
Chronic Kidney Disease (CKD)	18	19.4
EPN Grade		
Grade 2	54	58.1
Grade 3a	39	41.9
Baseline Serum Creatinine (mg/dL)	3.1 ± 1.4	—
Baseline TLC (×10⁹/L)	17.9 ± 4.8	—
Baseline Platelet Count (×10⁹/L)	188 ± 61	—
Hospital Stay (days)	12.2 ± 5.1	—
Hemodialysis Required	24	25.8
Radiological Clearance	71	76.3
Nephrectomy Required	11	11.8
Mortality	11	11.8

A total of 93 patients with Grade 2 and Grade 3a emphysematous pyelonephritis (EPN) were included in the study. The mean age of the patients was 51.8 ± 12.4 years, indicating that EPN was more common in middle-aged and elderly individuals. Female patients (59.1%) were more frequently affected than males (40.9%). A majority of the patients (77.4%) had diabetes mellitus, highlighting its strong association with EPN. Hypertension was present in 33.3%, while chronic kidney disease (CKD) was observed in 19.4% of the patients. Regarding disease severity, 58.1% of the patients had Grade 2 EPN, whereas 41.9% had Grade 3a EPN. The mean baseline serum creatinine was 3.1 ± 1.4 mg/dL, indicating impaired renal function at presentation. Similarly, the mean total leukocyte count (TLC) was 17.9 ± 4.8 ×10⁹/L, reflecting active infection and inflammatory response. The average platelet count was 188 ± 61 ×10⁹/L, while the mean hospital stay was 12.2 ± 5.1 days. Among the total patients, 25.8% required hemodialysis, suggesting severe renal impairment in a subset of patients. Radiological clearance was achieved in 76.3%, showing good treatment response following DJ stenting. Only 11.8% required nephrectomy, and the mortality rate was also 11.8%, supporting the effectiveness of minimally invasive intervention.

Table 2: Univariate Analysis of Factors Associated with Early Complications

Variables	Early Complications Present (n=29)	Early Complications Absent (n=64)	p-value
Age (years)	56.4 ± 11.2	49.7 ± 12.6	0.016
Male	14 (48.3%)	24 (37.5%)	0.327
Female	15 (51.7%)	40 (62.5%)	
Diabetes Mellitus	25 (86.2%)	47 (73.4%)	0.032
Hypertension	14 (48.3%)	17 (26.6%)	0.040
CKD	11 (37.9%)	7 (10.9%)	0.003
Grade 3a EPN	18 (62.1%)	21 (32.8%)	<.0001
Serum Creatinine >3 mg/dL	19 (65.5%)	28 (43.8%)	0.052
TLC >15 ×10⁹/L	21 (72.4%)	26 (40.6%)	0.004
Hemodialysis Required	13 (44.8%)	11 (17.2%)	0.005

Univariate analysis demonstrated that patients who developed early complications were significantly older (56.4 ± 11.2 years) compared to those without complications (49.7 ± 12.6 years, p=0.016). Diabetes mellitus was significantly associated with early complications (p=0.032), as 86.2% of patients with complications were diabetic.

Hypertension also showed a statistically significant association (p=0.040), indicating that comorbid conditions may contribute to worse outcomes. CKD was strongly associated with complications (p=0.003), with 37.9% of complicated cases having CKD compared to 10.9% in the non-complicated group.

Patients with Grade 3a EPN were significantly more likely to develop complications compared to Grade 2 patients (p<0.0001), suggesting disease severity as an important risk factor. Elevated TLC above 15 ×10⁹/L was also significantly associated with complications (p=0.004), indicating the role of severe infection burden.

Although elevated serum creatinine (>3 mg/dL) showed borderline significance (p=0.052), it still suggested a clinical trend toward increased complications. Requirement for hemodialysis was significantly associated with complications (p=0.005), indicating severe renal dysfunction as an important marker.

Table 3: Multivariate Logistic Regression Analysis for Independent Predictors of Early Complications

Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age >50 years	1.9	1.1 – 4.6	0.043
Diabetes Mellitus	2.3	1.2 – 5.8	0.031
CKD	3.1	1.4 – 7.2	0.015
Grade 3a EPN	3.8	1.6 – 9.4	0.009
Serum Creatinine >3 mg/dL	2.7	1.3 – 6.4	0.021
TLC >15 ×10⁹/L	2.4	1.2 – 5.9	0.027
Hemodialysis Requirement	4.6	1.9 – 11.3	0.005

Multivariate logistic regression analysis identified several independent predictors of early complications. Patients aged more than 50 years had 1.9 times higher odds of complications (p=0.043). Diabetes mellitus increased the risk by 2.3 times (p=0.031), while CKD increased the risk by 3.1 times (p=0.015).

Grade 3a EPN was found to be a strong predictor, increasing the odds of complications by 3.8 times (p=0.009). Elevated serum creatinine (>3 mg/dL) was associated with a 2.7 times increased risk (p=0.021), and elevated TLC (>15 ×10⁹/L) increased the risk by 2.4 times (p=0.027).

The strongest independent predictor was the requirement of hemodialysis, which increased the odds of complications by 4.6 times (p=0.005). This finding emphasizes that patients presenting with severe renal impairment require closer monitoring and aggressive management.

DISCUSSION

Emphysematous pyelonephritis (EPN) remains a highly aggressive necrotizing renal infection, most frequently seen in patients with diabetes mellitus and other comorbid conditions that impair host defense and renal reserve. The present study demonstrated that Double J (DJ) stenting, combined with antibiotics, glycemic control, and supportive care, achieved radiological clearance in 76.3% of patients, with nephrectomy required in only 11.8%, and mortality was also 11.8%.

These findings support the growing trend toward kidney-preserving minimally invasive management in selected Grade 2 and Grade 3a EPN cases. 13-15 Also, a broader shift in EPN management away from upfront nephrectomy toward antibiotics plus minimally invasive drainage, especially in patients without fulminant deterioration. [15]

Other cohorts similarly report diabetes in 84.7–100% of cases and class 2 disease as the most frequent radiologic pattern, supporting that the current sample is clinically representative of typical EPN presentations. [16,17]

The 76.3% radiological clearance and low 11.8% nephrectomy rate observed here support the utility of DJ stenting as an organ-preserving strategy in selected Grade 2 and 3A disease. This aligns with the contemporary literature showing improved outcomes with conservative and minimally invasive approaches over emergency nephrectomy. A 2022 meta-analysis of 1,146 patients found mortality of 10% with medical management plus minimally invasive treatment versus 26% after upfront emergency nephrectomy, while salvage nephrectomy after failed conservative treatment carried mortality exceeding 27%. [14] A second meta-analysis of 1,303 patients similarly found that minimally invasive intervention reduced mortality (OR 0.47), whereas emergency nephrectomy increased mortality risk (OR 3.73). [15]

DJ stenting-specific data also support these findings. In a retrospective comparison, JJ stenting achieved overall success comparable to PCN and was concluded to be an effective drainage method in EPN. [18] Another minimally invasive EPN series used DJ stenting as the primary intervention in 40% of patients, including both class 2 and class 3A cases, and reported that class 2 and 3A patients generally required no further intervention, with no emergent nephrectomy and no mortality in that cohort. [19] Similarly, a larger 66-patient series reported DJ stenting in 25.8% of patients with an overall mortality of only 6% and a nephrectomy rate of 3%, reinforcing that timely urinary drainage can achieve favorable renal salvage. [20]

The 11.8% mortality in the present study is slightly higher than several recent institutional series, where mortality ranged from 0% to 10%. [14,15, 21] However, it remains close to pooled contemporary estimates of 12.5% across older-to-modern studies and 7.6–7.7% in more recent meta-analytic datasets. [15,22] This somewhat higher mortality is plausibly explained by the severity profile of the cohort, particularly the mean serum creatinine of 3.1 ± 1.4 mg/dL and the fact that 25.8% required hemodialysis, both markers of advanced systemic and renal involvement.

The predictors of early complications in this study are also broadly concordant with prior literature. Age >50 years independently increased complications (OR 1.9, 95% CI 1.1–4.6, p=0.043), which is consistent with mortality studies identifying older age as a significant adverse prognostic factor. [14,23] CKD and renal impairment were also important in the present cohort, where CKD increased complication odds 3.1-fold and serum creatinine >3 mg/dL increased odds 2.7-fold. This agrees with prior studies linking renal failure to mortality and poorer long-term renal outcomes; Kapoor et al. identified renal failure as a significant mortality-associated factor, and Lin et al. found higher initial creatinine among those who later developed CKD (2.8 ± 1.4 vs 1.6 ± 0.8 mg/dL; p=0.015).[24]

The strong effect of Grade 3A disease in the multivariable model (OR 3.8, 95% CI 1.6–9.4, p=0.009) is biologically and clinically plausible because extension into the perinephric space reflects more advanced infection. Meta-analysis data show that Huang-Tseng class III–IV disease increases mortality risk (OR 2.4). [17] Prospective institutional data also suggest that Grade 3A patients often require escalation beyond stenting alone when associated with extensive parenchymal destruction or delayed presentation, including PCN, PCD, or nephrectomy in selected non-responders. [25-27]

The inflammatory and renal markers identified here also match established prognostic signals. TLC >15 ×10⁹/L independently predicted early complications (OR 2.4, p=0.027), similar to prior reports where high TLC was significantly associated with mortality [3]. The strongest predictor in the current model was hemodialysis requirement (OR 4.6, 95% CI 1.9–11.3, p=0.005), which parallels recent outcome studies identifying dialysis need as a mortality-associated factor (p=0.008) and reflects severe renal dysfunction at presentation. [26]

These findings therefore support a stepwise, minimally invasive strategy for Grade 2 and 3A EPN, with DJ stenting serving as an effective decompressive option in appropriately selected patients, particularly when obstruction or hydronephrosis is present. Still, the results should be interpreted cautiously because patients with dialysis dependence, CKD, higher creatinine, leukocytosis, and Grade 3A disease had substantially worse outcomes, indicating that DJ stenting is not uniformly sufficient across all presentations. A urologist and critical care team should individualize personal treatment decisions, because the evidence supports selection-based use of DJ stenting rather than a one-size-fits-all approach.

This study provides important local data regarding the role of Double J stenting in the management of Grade 2 and Grade 3a emphysematous pyelonephritis. The inclusion of a relatively adequate sample size with detailed clinical, laboratory, microbiological, and radiological assessments strengthens the reliability of the findings. Furthermore, the study evaluated both safety and efficacy outcomes along with predictors of complications, which adds clinical value for risk stratification and management planning.

The limitations of the study included being single-centered and employing a non-probability consecutive sampling method, both of which could influence the generalization of the results. In addition, the lack of a comparison group in the form of patients under the management of either percutaneous drainage or nephrectomy is another limitation. Lastly, the short duration of follow-up affected the evaluation of the results in the long run.

Furthermore, future prospective multicenter studies with larger sample sizes and longer follow-up periods are suggested for validation of the safety and efficacy of Double J stenting in emphysematous pyelonephritis. Comparative studies between DJ stenting, percutaneous drainage, and surgical management may help to establish standardized treatment protocols. Further studies should also focus on long-term renal outcomes and identifying early predictors of treatment failure to optimize patient selection and improve clinical outcomes

CONCLUSION

Double J stenting is a safe and effective minimally invasive management option for Grade 2 and Grade 3a Emphysematous Pyelonephritis, with a high radiological clearance rate and low nephrectomy requirement. However, patients with advanced disease, renal dysfunction, and associated comorbidities remain at higher risk of complications and require close monitoring.

REFERENCES

1. Michaeli J, Mogle P, Perlberg S, Heiman S, Caine M. Emphysematous pyelonephritis. The Journal of Urology. 1984 Feb;131(2):203-8.
2. Das D, Pal DK. Double J stenting: A rewarding option in the management of emphysematous pyelonephritis—Urology Annals. 2016 Jul 1;8(3):261-4.
3. Ma LP, Zhou N, Fu Y, Liu Y, Wang C, Zhao B. Emphysematous pyelonephritis: six case reports and review of literature. World Journal of Clinical Cases. 2022 Apr 6;10(10):3268.
4. Kamal M, Pandey S, Jha R, Paudel R, Neupane K, Pathak C. Medical management of emphysematous pyelonephritis: a case report. Annals of Medicine and Surgery. 2025 Oct 1;87(10):6724-8.
5. Pontin AR, Barnes RD. Current management of emphysematous pyelonephritis. Nature Reviews Urology. 2009 May;6(5):272-9.
6. Choi SK, Lee JW, Jung SI, Hwang EC, Choi J, Kim WB, Huh JS, Choi JB, Kim Y, Chung JM, Shin JH. Mortality and risk factors for emphysematous pyelonephritis in Korea: a multicenter retrospective cohort study. Urogenital Tract Infection. 2025 Apr 30;20(1):34-41.
7. Aggarwal D, Mandal S, Parmar K, Manoharan V, Singh S, Yadav AK, Kumar S, Sharma AP, Singh SK. Predictors of mortality and nephrectomy in emphysematous pyelonephritis: a tertiary care centre study. The Annals of The Royal College of Surgeons of England. 2023 Apr 26;105(4):323.
8. Krishnamoorthy S, Thiruvengadam G, Sekar H, Palaniyandi V, Ramadurai S, Narayanasamy S. Modified National Early Warning Score 2, a reliable early warning system for predicting treatment outcomes in patients with emphysematous pyelonephritis. World Journal of Nephrology. 2025 Jun 25;14(2):103035.
9. Du J, Yang T, Wu T, Peng X, Gou C, Liang G. Emphysematous pyelonephritis: eight case reports and literature review. Frontiers in Medicine. 2025 Sep 3;12:1570638.
10. Gupta K, Attri JP, Singh A, Kaur H, Kaur G. Basic concepts for sample size calculation: a critical step for any clinical trials. Saudi Journal of Anaesthesia. 2016;10(3):328-331.
11. Ghimire P, Sah BK, Shrestha S, Ghimire PG. Neglected case of recurrent abdominal pain due to a chronically retained and broken Double J (DJ) stent following percutaneous nephrolithotomy (PCNL): A case report. Radiology Case Reports. 2024 Feb 1;19(2):812-7.
12. Narayan N. Study of indications and early complications of ureteric Double-J stent: A prospective study. Int J Acad Med Pharm. 2025;7(4):1489-96.
13. Aravind S, Jain P, Palaniyandi V, Sekar H, Krishnamoorthy S. From Mortality to Morbidity Control: A Paradigm Shift in Emphysematous Pyelonephritis Management. Cureus. 2025 Jul 28;17(7).
14. Desai R, Batura D. A systematic review and meta-analysis of risk factors and treatment choices in emphysematous pyelonephritis. International urology and nephrology. 2022 Apr;54(4):717-36.
15. Ngo XT, Vu DH, Thai MS, Hoang KC, Thai KL, Duong NX, Nguyen DD, Sharifi SH, Dobbs RW, Tiong HY, Nguyen TT. 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. 2025 Jun 2;43(1):347.
16. Jain A, Manikandan R, Dorairajan LN, Sreenivasan SK, Bokka S. Emphysematous pyelonephritis: Does a standard management algorithm and a prognostic scoring model optimize patient outcomes?. Urology Annals. 2019 Oct 1;11(4):414-20.
17. Latif A, Samad T, Chowdhury T, Moonmoon SA, Billah MM, Rahim MA. Emphysematous pyelonephritis: three-year experience of managing 16 cases in a tertiary care hospital of Bangladesh. BIRDEM Medical Journal. 2025 Jan 30;15(1):5-8.

18. Elbaset MA, Osman Y, Ghobrial FK, Ashour R, Badawy M, El Refaie E, Zahran MH. Is JJ ureteral stenting inferior to percutaneous nephrostomy as a drainage method in emphysematous pyelonephritis?. Urologia Internationalis. 2022 Dec 8;106(12):1252-9.
19. Sengupta S, Basu S. Outcome of conservative and minimally invasive management in emphysematous pyelonephritis. Urology Annals. 2021 Jul 1;13(3):277-81.
20. Karthikeyan VS, Manohar CM, Mallya A, Keshavamurthy R, Kamath AJ. Clinical profile and successful outcomes of conservative and minimally invasive treatment of emphysematous pyelonephritis. Central European journal of urology. 2018 Apr 16;71(2):228.
21. Rahim MA, Ananna MA, Iqbal S, Uddin KN, Latif ZA. Emphysematous pyelonephritis: experience at a tertiary care hospital in Bangladesh. Journal of the Royal College of Physicians of Edinburgh. 2021 Mar;51(1):19-23.
22. Okobi OE, Fernandez A, Isikwei E, Traoré K, Desai VS, Oladimeji A, Ekome O, Diaz-Miret M, Borges SH, Traoré KI. Contemporary Mortality and Comparative Outcomes of Nephrectomy Versus Non-nephrectomy Management in Emphysematous Pyelonephritis: A Systematic Review and Meta-Analysis. Cureus. 2026 Apr 2;18(4).
23. Chen CC, Hsieh MS, Hu SY, Huang SC, Tsai CA, Tsai YC. Performance of scoring systems in predicting clinical outcomes of patients with emphysematous pyelonephritis: a 14-year hospital-based study. Journal of Clinical Medicine. 2022 Dec 8;11(24):7299.
24. Kapoor R, Muruganandham K, Gulia AK, Singla M, Agrawal S, Mandhani A, Ansari MS, Srivastava A. Predictive factors for mortality and need for nephrectomy in patients with emphysematous pyelonephritis. BJU International. 2010 Apr;105(7):986-9.
25. Lin YC, Lin YC, Lin HD, Lin LY. Risk Factors of Renal Failure and Severe Complications in Patients With Emphysematous Pyelonephritis—A Single-Center 15-Year Experience. The American journal of the medical sciences. 2012 Mar 1;343(3):186-91.
26. Kumar G, Devaraj R, Sagar V, D, Ch R. Emphysematous pyelonephritis (EPN): A prospective study on management modalities and outcome in a tertiary care hospital. International Journal of Surgery Science. 2021:65-70. doi:10.33545/surgery.2021.v5.i1b.587
27. Kanagali R, Achar M, Makannavar P, Kalabhavi S. Outcome Of Different Surgical Interventions In Management Of Emphysematous Pyelonephritis: A Retrospective Cohort Study From Dharwad, India. Journal Of Clinical & Diagnostic Research. 2025 May 1;19(5).