

Insights Into The Clinical Profile And Risk Factors Of Acute Pyelonephritis In Hospitalised Patients

Dr. Naga Bhagyasri Mangam

MD – General Medicine, Junior Resident, Department Of General Medicine, Kasturba Hospital, Manipal,
576104 India

Dr. Shubha Seshadri,

MD – General Medicine, Professor And Unit Head, Department Of General Medicine, Kasturba Hospital,
Manipal, India.

Dr. Sharath Madhyastha P,

MD – General Medicine, Associate Professor, Department Of General Medicine, Kasturba Hospital, Manipal,
India.

Abstract

Background: Acute pyelonephritis (APN) is a potentially serious bacterial infection involving the renal pelvis and parenchyma, often arising as a complication of ascending urinary tract infection. Its presentation can vary widely, particularly in adults with comorbidities such as diabetes mellitus, which predisposes to severe forms including emphysematous pyelonephritis. Although diagnosis relies on the integration of clinical features, laboratory parameters, and imaging findings, comprehensive data describing their combined profile in adult inpatients are scarce.

Methods: This observational cross-sectional study included all adults (>18 years) admitted with APN to the Departments of General Medicine, Nephrology, and Urology between September 2018 and September 2020. Diagnosis was based on typical symptoms with pyuria, culture positivity (urine and/or blood), and radiological confirmation on ultrasonography (USG) and/or computed tomography kidneys-ureters-bladder (CT KUB). Patients were followed until discharge or death.

Results: Of 100 patients (58 men, 42 women; mean age ~54.6 years), the highest incidence was in the 52–63-year age group (33%). Diabetes mellitus was the most frequent comorbidity (65%), and renal/ureteric calculi the most common predisposing factor (27%). Fever (72%), flank pain (65%), and dysuria (35%) were the predominant symptoms; renal angle tenderness was found in 30%. Laboratory abnormalities included anemia (66%), leukocytosis (63%), neutrophilia (68%), elevated ESR (92.8%), and CRP (98.1%). Urine cultures were positive in 34.4% and blood cultures in 34.1%, predominantly *Escherichia coli*, with high antibiotic sensitivity to amikacin and cefoperazone–sulbactam. CT KUB detected pyelonephritis in 96.1% versus 64.9% on USG and was superior for identifying emphysematous changes, lobar nephronia, and abscesses. Emphysematous pyelonephritis occurred in 15% of patients, out of which 86.7% were diabetics with significantly higher mean HbA1c (10.7% in diabetics with emphysematous pyelonephritis vs. 8.5% in non-emphysematous pyelonephritis, $p=0.008$). Interventions included DJ stenting (27%), dialysis (12%), and percutaneous drainage (5%). Mean hospital stay was 10.1 ± 5.9 days; ICU admission was required in 26%. Outcomes: 94% discharged after recovery, 5% left against medical advice, 1% died.

Conclusions: Diabetes is the leading comorbidity in APN, strongly associated with severe forms such as emphysematous pyelonephritis. While USG is useful, CT KUB provides higher diagnostic yield and better delineation of complications, guiding timely intervention.

Keywords: acute pyelonephritis, diabetes mellitus, ultrasonography, CT KUB, emphysematous pyelonephritis, Renal calculi, *Escherichia coli*, Antibiotic sensitivity

I. Introduction:

Acute pyelonephritis, a term coined by Pierre Rayer in the 19th century, describes the inflammation of the renal pelvis along with the renal parenchyma—the cortex and medulla. It is defined as an infection-induced inflammation that affects the tubules, interstitium, and renal pelvis of the kidney. This condition primarily arises from bacterial infection, often as a complication of an ascending urinary tract infection, and represents a significant health burden worldwide with an estimated annual incidence ranging from 10.5 million to 25.9

million cases. Among the various risk factors, diabetes mellitus stands out as the most common independent factor predisposing individuals to pyelonephritis, with specific forms like emphysematous pyelonephritis occurring predominantly in diabetic patients. Despite its prevalence, comprehensive studies focusing exclusively on the clinical presentations, microbial profiles, inflammatory markers, and treatment outcomes of acute pyelonephritis remain limited. This gap underscores the need for focused research to better understand the disease's characteristics and improve patient management and prognosis.

II. Materials And Methods

We prospectively studied all consecutive adult patients (aged >18 years) diagnosed with acute pyelonephritis and admitted to the Departments of General Medicine, Nephrology, and Urology at our institution between September 2018 and September 2020. Patients were followed from admission until discharge or death.

The diagnosis of acute pyelonephritis was established when a patient presented with one or more classical clinical features suggestive of the condition—namely fever with chills, flank pain, dysuria, nausea/vomiting, or renal angle tenderness—accompanied by evidence of pyuria, with or without positive urine and/or blood cultures, and confirmed by radiological evidence of pyelonephritis on ultrasonography (USG) and/or computed tomography of the kidneys, ureters, and bladder (CT KUB).

Laboratory investigations included total leukocyte count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), glycated hemoglobin (GlycoHb), serum creatinine, blood culture, urine white blood cell count, and urine culture. Radiological evaluation with USG or CT KUB was performed at admission in all cases.

In-hospital morbidity parameters, such as duration of hospital stay and need for intensive care unit (ICU) admission, along with mortality outcomes, were recorded. Continuous variables were expressed as mean \pm standard deviation (SD) or median with interquartile range (IQR), while categorical variables were summarized as frequencies and percentages. The chi-square test was applied to assess associations between categorical variables.

III. Results:

A total of 100 patients with acute pyelonephritis were studied, of which 58% were males and 42% females. Among females, 21.43% were in the reproductive age group and 78.57% were postmenopausal. The mean age was 54.53 ± 15.37 years in males and 54.70 ± 13.72 years in females, with the highest incidence in the 52–63-year age group (33%).

Diabetes mellitus was the most common comorbidity (65%), followed by chronic kidney disease (22%). The most frequent predisposing factor was renal or ureteric calculi (27%), followed by prior urological instrumentation or surgery (12%).

Fever was the predominant symptom (72%), followed by flank pain (65%) and dysuria (35%).

On examination renal angle tenderness was present in 30% of cases, other clinical findings at presentation are as in table 1.

Table 1: Clinical findings

Table 1: CLINICAL FINDING	Percentage
TACHYCARDIA	19%
HYPOTENSION (SBP \leq 100 mmHg)	16%
GCS <15	8%
TEMPERATURE >98.9°F	9%
RENAL ANGLE TENDERNESS	30%
LUMBAR REGION TENDERESS	17%

Laboratory abnormalities (enumerated in table 2) included anaemia (66%), leucocytosis (63%), neutrophilia (68%), elevated ESR (92.8%), elevated CRP (98.1%), and elevated serum creatinine (75%).

Table 2: Laboratory parameters

Table 2- PARAMETER	NUMBER	PERCENTAGE
HB <12gm/dl	66	66%
WBC COUNT >10,000 cells/cu.mm	63	63%

NEUTROPHILIA (N>74%)	68	68%
Table 2- PARAMETER	NUMBER	PERCENTAGE
PLATELET COUNT <1.5lakh/cu.mm	20	20%
ESR >20mm/hr	65 (out of 70)	92.8%
CRP >5mg/l	52 (out of 53)	98.1%
DIABETICS WITH RBS ≥200 mg/dl	38 (out of 65)	58.46%
HbA1c ≥7%	54 (out of 65)	83%
Elevated serum creatinine	75	75%
Urine WBC >5	81 (out of 92)	88%

Among laboratory inflammatory markers, the median erythrocyte sedimentation rate (ESR) was 69mm/hr, with an interquartile range of 51.25mm/hr, while the median C-reactive protein (CRP) level was 125mg/L, with an interquartile range of 196.72mg/L. This indicates that most patients exhibited markedly elevated ESR and CRP values, reflecting significant systemic inflammation in cases of acute pyelonephritis. Average HbA1c in diabetics is $8.96 \pm 2.19\%$.

Urine cultures were positive in 34.41% of patients, most commonly yielding *Escherichia coli* (78.12%), which showed highest sensitivity to amikacin (88%) among first-line agents, and to cefoperazone–sulbactam (78.94%) and imipenem (78.9%) among second-line agents. Blood cultures were positive in 34.1% of cases, also predominantly with *E. coli* (83.33%), showing 100% sensitivity to amikacin and 90.48% to cefoperazone–sulbactam and imipenem. Hypotensive patients had a significantly higher rate of bacteremia ($p = 0.00$).

USG abdomen was done in 82% of the patients and CT KUB was done 95% of the patients. Imaging revealed that perinephric fat stranding was the most common finding on USG (43.9%) and CT KUB (81.6%), as shown in table 3 and 4.

Table 3: USG abdomen findings

Table 3-Findings suggestive of APN	Number (out of 82)	Percentage
PERINEPHRIC FAT STRANDING	36	43.9%
BULKY KIDNEY	26	31.7%
EMPHYSEMATOUS CHANGES	6	7.4%
ABSCISS	3	3.7%

Table 4: CT KUB findings

Table 4- Findings suggestive of APN	Number (out of 95)	Percentage
PERINEPHRIC FAT STRANDING	80	81.6%
BULKY KIDNEY	35	35.7%
EMPHYSEMATOUS CHANGES	15 (13 were diabetic)	15.3%
LOBAR NEPHRONIA	6	6.12%
ABSCISS	2	2.04%

CT was superior to USG in detecting emphysematous changes (15.3% vs. 7.4%), bulky kidney, lobar nephronia, and abscesses.

Overall, 86.7% of emphysematous pyelonephritis cases occurred in diabetics, with significantly higher mean HbA1c in this subgroup ($10.7 \pm 2.53\%$) compared to diabetics with non-emphysematous pyelonephritis ($8.5 \pm 1.86\%$), $p=0.008$. Acute pyelonephritis patients with CKD are more prone to develop AKI.

Average hospital stay was 10.07 ± 5.87 days. ICU care was required in 26% and dialysis in 11% of cases. Interventions included DJ stenting (27%), percutaneous drainage (5%), and emergency nephrectomy (1%). Clinical outcomes showed that 72% made a full recovery, 22% were discharged on request, 5% left

against medical advice, and mortality was 1%. While CT KUB identified more abnormalities than USG, the difference in detection rate for acute pyelonephritis itself was not statistically significant.

IV. Discussion:

Diabetes mellitus was identified as the most frequent comorbidity among patients with acute pyelonephritis in our study, confirming previous observations by Dhamotharan et al. [1] and Leelavathi Venkatesh et al. [2]. The increased susceptibility in diabetic patients is attributed to diabetic cystopathy and altered bacteria–host interactions, as well as impaired neutrophil bactericidal activity, phagocytosis, and chemotaxis, as described by Repine et al. [3]. These immunological alterations not only increase infection risk but also predispose diabetic patients to more severe disease presentations [4].

Positive blood cultures, particularly in those presenting with hypotension, indicate a significant systemic response and possible progression to sepsis. The predominant organism isolated was *Escherichia coli*, consistent with findings from multiple studies [1,5]. Geerlings et al. [5] have shown that *E. coli* adherence to uroepithelial cells is increased in diabetic individuals due to higher HbA1c levels, which alter the glycosylation of receptors for bacterial fimbriae, facilitating colonization.

Interestingly, among diabetic patients, those with emphysematous pyelonephritis exhibited higher mean GlycoHb compared to those with non-emphysematous pyelonephritis, paralleling findings by Dutta et al. [6]. Hyperglycemia has been implicated as a driver of gas formation in emphysematous pyelonephritis, since anaerobic bacterial metabolism of glucose produces a spectrum of gases (nitrogen, carbon dioxide, carbon monoxide, methane, ammonia), as highlighted by Huang et al. [7].

In our cohort, the majority (13 out of 15) of emphysematous pyelonephritis cases were diabetics; additional risk factors included struvite stones and history of DJ stenting for hydronephrosis. Acute kidney injury (AKI) was frequent, particularly among patients already known to have chronic kidney disease (CKD). This demonstrates the interplay between infection and worsening of existing renal dysfunction [8,9].

The selection of intravenous antibiotics was informed by our institutional antibiogram, and duration of treatment was tailored to clinical response, although conventional durations of 14 days for non-emphysematous and 28 days for emphysematous pyelonephritis are recommended [10,11]. Radiological evaluation revealed that CT KUB was superior to ultrasonography (USG) for detecting structural abnormalities and complications of pyelonephritis; this observation supports recommendations by Wan et al. [9] and Leelavathi et al. [2]. While USG is operator-dependent, CT offers greater reliability and may be cost-effective if used as the initial imaging modality and when there are no contraindications [12,13].

Management of emphysematous pyelonephritis can necessitate percutaneous drainage, and in cases of extensive parenchymal destruction, emergency nephrectomy may be required [19]. In our series, one patient required nephrectomy due to failure of less invasive measures. Ultimately, mortality was low, with one death due to sepsis and septic shock [14,15,16].

These findings reinforce the critical relevance of diabetes as a risk factor, the importance of microbial identification and glycemic control, and the value of CT imaging in guiding management and improving patient outcomes [17–20].

In summary, our study highlights that diabetes mellitus is the predominant comorbidity among adults with acute pyelonephritis, with peak occurrence in the 52–63-year age group. Fever remains the most common presenting symptom, and inflammatory markers such as ESR and CRP are elevated in nearly all patients. *Escherichia coli* was the leading causative organism, consistent with global epidemiological patterns. Emphysematous pyelonephritis occurred more frequently in diabetic patients, underscoring the need for heightened clinical vigilance in this subgroup. While ultrasonography remains a valuable initial imaging tool, CT KUB demonstrates superior sensitivity for detecting pyelonephritis and its complications. However, in our cohort, the difference in detection rates between USG and CT for diagnosing acute pyelonephritis was not statistically significant, suggesting that the choice of imaging should balance diagnostic accuracy, resource availability, and clinical urgency.

Acknowledgements

We would like to express our sincere gratitude to the faculty of the Departments of General Medicine, Nephrology, Urology, Radiology and Microbiology at Kasturba Hospital, Manipal, for their consistent support and cooperation throughout the course of this study. We are deeply indebted to the patients and their families for their participation and trust. Special thanks to the medical records and laboratory teams for their invaluable assistance in data acquisition and analysis. We thank our family members for their constant encouragement and support.

Bibliography:

- [1]. Dhamotharan VM, Ramadurai S, Gopalan S, Arthur P. Study Of The Clinical Profile Of Patients With CT-Proven Acute Pyelonephritis In A Tertiary Care Hospital. *Med Res Chron*. 2020;3(1):6468.
- [2]. Venkatesh L, Kumar R, John SJ, Valsan KV. Correlation Of Clinical Parameters With Radiological Imaging Abnormalities In Acute Pyelonephritis. *J Clin Diagn Res*. 2017;11(6):TC15TC18.
- [3]. Repine JE, Clawson CC, Goetz FC. Bactericidal Function Of Neutrophils From Patients With Acute Bacterial Infections And From Diabetics. *J Infect Dis*. 1980;142:86975.
- [4]. Rollino C, Beltrame G, Ferro M, Quattrocchio G, Sandrone M, Quarello F. Acute Pyelonephritis In Adults: A Case Series Of 223 Patients. *Nephrol Dial Transplant*. 2012;27(9):348893.
- [5]. Geerlings SE, Meiland R, Van Lith EC, Brouwer EC, Gaastra W, Hoepelman AI. Adherence Of Type 1Fimbriated Escherichia Coli To Uroepithelial Cells: More In Diabetic Women Than In Control Subjects. *Diabetes Care*. 2002;25(8):14059.
- [6]. Dutta P, Bhansali A, Singh SK, Bhat MH, Gupta KL, Rajput R, Et Al. Presentation And Outcome Of Emphysematous Pyelonephritis In Patients With Diabetes Mellitus. *Indian J Nephrol*. 2014;24(6):36771.
- [7]. Huang JJ, Tseng CC. Emphysematous Pyelonephritis: Clinicoradiological Classification, Management, Prognosis, And Pathogenesis. *Radiology*. 1996;198(2):43338.
- [8]. Gupta K, Hooton TM, Naber KG, Wullt B, Colgan R, Miller LG, Et Al. International Clinical Practice Guidelines For The Treatment Of Acute Uncomplicated Cystitis And Pyelonephritis In Women. *Clin Infect Dis*. 2011;53:E10320.
- [9]. Wan YL, Lee TY, Bullard MJ, Tsai CC. Acute GasProducing Bacterial Renal Infection: Correlation Between Imaging Findings And Clinical Outcome. *Radiology*. 1996;198(2):43338.
- [10]. Kumar S, Ramachandran R, Aggarwal AN, Gupta KL, Sakhuja V, Jha V. Acute Pyelonephritis In Diabetes Mellitus: Single Centre Experience. *Indian J Nephrol*. 2014;24(6):36771.
- [11]. Czaja CA, Scholes D, Hooton TM, Stamm WE. Population-Based Epidemiologic Analysis Of Acute Pyelonephritis. *Clin Infect Dis*. 2007;45:27380.
- [12]. Ki M, Park T, Choi B, Foxman B. The Epidemiology Of Acute Pyelonephritis In South Korea, 1997-1999. *Am J Epidemiol*. 2004;160:98593.
- [13]. Johnson JR, Russo TA. Acute Pyelonephritis In Adults. *N Engl J Med*. 2018;378(1):4859.
- [14]. Grabe M, Bartoletti R, Bjerkklund Johansen TE, Et Al. Guidelines On Urological Infections. *Eur Assoc Urol*. 2015.
- [15]. Sobel JD, Kaye D. Urinary Tract Infections. In: Bennett JE, Dolin R, Blaser MJ, Eds. *Mandell, Douglas, And Bennett's Principles And Practice Of Infectious Diseases*. 8th Ed. Philadelphia: Elsevier Saunders; 2014. P. 886913.
- [16]. Venkata C, Kashyap R, Farmer JC, Afessa B. Thrombocytopenia In Adult Patients With Sepsis: Incidence, Risk Factors, And Association With Clinical Outcome. *J Intensive Care*. 2013;1(1):9.
- [17]. Behzadi P, Behzadi E, Ranjbar R. Urinary Tract Infections And Candida Albicans. *Cent European J Urol*. 2015;68(1):96101.
- [18]. Alangaden GJ. Urinary Tract Infections In Renal Transplant Recipients. *Curr Infect Dis Rep*. 2007;9:4756.
- [19]. Nana GR, Brodie A, Akhter W, Karim O, Motiwala H. Nephroureterectomy For Emphysematous Pyelonephritis: An Aggressive Approach Is Sometimes Necessary. *Int J Surg Case Rep*. 2015;10:17982.
- [20]. Gorter KJ, Hak E, Zuithoff PA, Hoepelman AI, Rutten GE. Risk Of Recurrent Acute Lower Urinary Tract Infections And Antibiotic Use In Women With And Without Diabetes In Primary Care. *Fam Pract*. 2010;27:37985.