

Study of Clinical, Laboratory Profile, and Outcome of Patients with Acute Pyelonephritis in a Tertiary Care Hospital

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Abstract

Aims: This study aims to study the clinical profile of patients with acute pyelonephritis (APN), yield of urine culture in APN; common causative agents and their antibiotic sensitivity pattern and to study the outcome of patients with APN in terms of mortality, duration of hospital stay, need of intensive care unit (ICU) care and necessitation of urological intervention. **Materials and Methods:** This study was a prospective observational study of patients who were admitted to the Postgraduate Department of General Medicine, Shri Maharaja Hari-Singh Hospital, an associated hospital of Government Medical College Srinagar as clinically suspected cases of APN and then proven radiologically. The study was conducted over a period of 2 years from August 2018 to August 2020 and a total of 200 patients fulfilling the selection criteria were included in the study. **Results:** Classical triad of fever, dysuria, and flank pain was seen in 55% of our patients with fever as the predominant symptom seen in 92% of patients. In our study, 70% were diabetic, 11% had nephrolithiasis, 8% of patients had obstructive uropathy, 7% were immunosuppressed, 3% had indwelling catheters while as 9% were documented cases of chronic kidney disease. Out of all positive urine cultures, 60% were *Escherichia coli*, 16.6 were *Enterococcus*, 13.3% were *klebsiella*, and 10% were *Pseudomonas*. **Conclusion:** Fever is predominant symptom in APN. Diabetes is the most common underlying predisposing condition. Yield of urine culture is very low with *E. coli* is the predominant organism. USG has less sensitivity for diagnosing APN than CT. The outcome of patients in terms of duration of hospital stay and need of ICU care is poor in diabetic patients. In our study, USG underestimated the cases of APN; detected only 132 out of 184 cases of computed tomography-proven nonemphysematous pyelonephritis and only 8 out of 16 patients of emphysematous pyelonephritis with an overall sensitivity of 70%. In our study, 3% of patients needed ICU care while 46% and 4% develop acute kidney injury and multiple organ dysfunction syndromes, respectively. Eleven percent of patients required urological intervention. Unfortunately, 2 out of 200 patients died during disease in the hospital.

Keywords: Acute pyelonephritis, dysuria, nephrolithiasis

INTRODUCTION

Urinary tract infection (UTI) is the most common urological disease with an annual incidence of over 7 million offices and 1 million emergency department visits in the United States. The diagnosis of UTI is typically based on characteristic clinical features and abnormal laboratory findings. UTI typically originates in urinary bladder from where it migrates to the kidney through an ascending infection leading to a tubulointerstitial inflammatory reaction involving the renal pelvis and parenchyma. This condition is termed pyelonephritis. Computed tomography (CT) when performed before, immediately after, and at delayed intervals from contrast material injection is a preferred modality for acute pyelonephritis (APN). CT is also preferred over conventional radiography and ultrasonography (US) for assessing emphysematous pyelonephritis.^[1]

The estimated annual incidence of pyelonephritis is 459,000–1,138,000 cases in the United States and 10.5 million to 25.9 million cases globally.^[2] In general, the percentage of patients who are hospitalized is lower than 20% among young women but higher among children and adults older than 65 years of age. A total of 712 deaths were attributed to kidney infection in the U. S. National Vital Statistics Reports for 2014, but 38,940 deaths were attributed to septicemia; on

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the basis of a conservative estimate that 10% of septicemia cases originate from pyelonephritis, there may be nearly 4000 deaths from pyelonephritis annually.^[3] The total (direct and indirect) estimated cost related to pyelonephritis in the United States was \$2.1 billion (in the year 2000 dollars), but the use of observation units has decreased the rate of admissions for pyelonephritis and presumably the costs.^[4]

APN is subdivided into uncomplicated and complicated categories. Uncomplicated pyelonephritis refers to one which is seen in nonpregnant outpatient women without any anatomical abnormalities or instrumentation of the urinary tract. Complicated pyelonephritis is a catch-all term that encompasses all other types. The risk factors for uncomplicated APN include sexual intercourse, acute cystitis, stress incontinence, new sexual partner, and use of spermicidal gel as part of contraception. Complicated APN occurs in presence of systemic predisposing factors like an immune-compromised state, diabetes, collagen vascular diseases, neoplasia, chemotherapy, HIV positivity, neuromuscular diseases, hemoglobinopathies, or anatomical factors such as obstructive uropathy, active stone disease, prostatic hypertrophy, kidney malformations, reflux nephropathy, polycystic kidney disease, and indwelling catheters.^[5]

According to the British Medical Research Council Bacteriuria Committee, the definition of APN is clinical based on a classic syndrome of high-grade fever, costovertebral angle tenderness, flank pain, laboratory findings of a UTI (including leukocytosis, pyuria) and a positive urinary culture. As this definition does not differentiate between upper UTI with or without renal parenchymal involvement, other authors follow a “pathological” criterion based on the demonstration of kidney involvement by imaging techniques.^[6]

Pathologically

APN is defined as suppurative inflammation of renal parenchyma and pelvicalyceal system distributed along one or more medullary rays supporting an ascending route of Infection.

Radiologically

On contrast-enhanced CT scan, it is seen as hypoenhancing lesion with striated appearance of renal parenchyma and may be focal or diffuse. It includes all acute infections related to parenchymal abnormalities without abscesses.^[7]

The clinical spectrum of APN ranges from mild illness to pyonephrosis and emphysematous pyelonephritis with a fulminant course. It may be uncomplicated and resolved without serious sequelae. However, a minority of patients may be complicated by acute kidney injury (AKI), sepsis, septic shock, renal papillary necrosis, renal or perinephric abscess, or the development of emphysematous pyelonephritis.^[8]

Clinical presentation

Complicated UTI manifests across a wide clinical spectrum of signs and symptoms from mild, irritative symptoms of lower tract infection to pyelonephritis and bacteremia, including septic shock.^[9] Symptoms and signs of pyelonephritis classically include fever,

chills, flank pain, costovertebral angle tenderness, and nausea/vomiting.^[10] Symptoms of cystitis are often but not universally present. Atypical symptoms have also been described, with some patients complaining of pain in the epigastrium or lower abdomen.

Patients with acute complicated pyelonephritis can also present with bacteremia, sepsis, multiple organ system dysfunction, shock, and/or acute renal failure. This is more likely to occur in patients with urinary tract obstruction, recent urinary tract instrumentation, or other urinary tract abnormalities, and in patients who are elderly or have diabetes mellitus. APN can also be complicated by the progression of the upper UTI to a renal corticomedullary abscess, perinephric abscess, emphysematous pyelonephritis, or papillary necrosis.^[11]

Aim and objectives

- To study the clinical profile of patients with APN
- Yield of urine culture in APN; common causative agents and their antibiotic sensitivity pattern
- To study the outcome of patients with APN in terms of mortality, duration of hospital stay, need of intensive care unit (ICU) care, and necessitation of urological intervention.

MATERIALS AND METHODS

This was a prospective observational study of patients who were admitted to Postgraduate Department of General Medicine, Shri Maharaja Hari-Singh Hospital, an associated hospital of Government Medical College Srinagar as clinically suspected cases of APN and then proven radiologically. The study was conducted over a period of 2 years from August 2018 to August 2020 and a total of 200 patients fulfilling the selection criteria were included in the study.

Inclusion criteria

All patients with radiologically confirmed pyelonephritis and age more than 18 years.

Exclusion criteria

APN in a pregnant woman and patients with age <18 years.

Clinically suspected case was defined as patients having typical symptoms of APN like fever, flank pain, rigors and chills, nausea/vomiting. All clinically suspected patients of APN underwent complete physical examination (looking for signs such as tachycardia, abdominal and renal angle tenderness) and baseline laboratory investigations such as complete blood count, kidney function test (KFT), random blood sugar, and urine routine microscopy.

On urine microscopy, pyuria was defined as the presence of > 10 polymorphonuclear leukocytes and hematuria as >5 red blood cells per high power field.

These patients were subjected to Ultrasonography (USG) abdomen followed by plain CT or contrast CT (if KFT was normal). Radiological criteria for diagnosis of APN included: Bulky kidneys, perinephric stranding, compression of renal sinus fat (USG),

focal hypoenhancing areas on contrast CT or Emphysematous pyelonephritis. LOGIQ S8 was used for the US while Siemens Somatom 16 Slice CT scanner was used for CT scan.

In all proven cases of APN, history and data of previous hospital admissions were recorded including underlying comorbidities and history of any previous urological intervention. Urine and blood samples were then collected for culture and sensitivity testing. Patients were followed till discharge, referral to other departments, or death in the hospital.

Microbiological studies

Urine specimens for culture were obtained using the midstream clean-catch urine technique. In the case of a urinary catheter, the urine sample was collected from the port of the catheter. All urine cultures were sent in a sterile universal container (Himedia) to the department of Microbiology GMC Srinagar. Samples were processed as per standard protocol using 0.01 ml Nichrome inoculation loop.

A positive urine culture was defined as the presence of one or two uropathogens at 10^4 cfu/mL or greater, or 10^3 cfu/mL in the presence of pyuria when the patient had a bladder or nephrostomy catheter. Urine cultures revealing growth of more than two different bacterial species reflecting mixed skin or gut flora were considered to indicate contamination. Positive urine cultures underwent identification and sensitivity analysis.

For blood cultures, 10 mL of venous blood was obtained from all the patients and inoculated into aerobic and anaerobic bottles. At least two sets of blood cultures were obtained from each patient. Blood cultures were processed following conventional protocols for 5 days in a continuous automated blood culture system BacT/ALERT (BioMerieux, Inc). The following isolates were considered to be contaminants if they were isolated in only one culture bottle and discordant from urine cultures: *Bacillus spp*, *Corynebacterium spp*, *Micrococcus spp*, and coagulase-negative *Staphylococci* except *Staphylococcus saprophyticus*.

Preliminary identification of bacterial isolates on solid culture media was done based on colonial morphology, Gram staining characteristics, and bench top test of catalase test, oxidase test, and coagulase test. Bacterial isolates obtained on culture were confirmed by Conventional biochemical tests as per standard methods or by VITEK-2 compact automated (BioMerieux, Inc) detects by means of computations involving the software contained in the VITEK 2 ID/AST microbial detection system.

Antimicrobial susceptibility testing was performed using: Conventional: Kirby-Bauer disk diffusion method as per Clinical and Laboratory Standards Institute (CLSI) guidelines 2018 and VITEK-2 Compact AST microbial detection system.

Clinical evaluation, antibiotic therapy, and follow-up

After the initial diagnosis, all the patients were admitted to a conventional hospital ward or the ICU depending on their clinical status and treated immediately, first empirically and then, after identification of the causative microorganism, with

targeted therapy. Empirical treatment was based on National treatment guidelines and hospital antibiogram. An empirical treatment schedule was considered appropriate when it was shown to contain at least one active agent against the causative microorganism of the particular episode of APN and was used at the recommended dose. Defervescence was defined as the time needed for the axillary temperature to be $<37^{\circ}\text{C}$ in the presence of clinical improvement.

Statistical analysis

The results were expressed as percentages for analysis of various epidemiological details and for analyzing the distribution of different bacterial isolates and their sensitivity pattern. The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to the data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean \pm standard deviation and categorical variables were summarized as frequencies and percentages. Graphically, the data were presented by bar and pie diagrams. Student's independent *t*-test was employed for comparing continuous variables. The Chi-square test or Fisher's exact test, whichever is appropriate, was applied for comparing categorical variables. A $P < 0.05$ was considered statistically significant.

OBSERVATIONS AND RESULTS

A total of 200 cases were included in our study. In our study, 59% were female and 41% were male. Most of our study patients were in the age group of 41–60 years with the mean age of 52.4 years.

The classical triad of fever, dysuria, and flank pain was seen in 55% of our patients with fever as the predominant symptom seen in 92% of patients followed by rigors and chills (77%), dysuria (69%), flank pain (55%), lower urinary tract symptom (LUTS) (52%), vomiting (22%), gross hematuria (12%), and Altered sensorium (4%).

In our study, 70% were diabetic, 11% had nephrolithiasis, 8% patients had obstructive uropathy, 7% were immunosuppressed, 3% had indwelling catheters while as 9% were documented cases of chronic kidney disease.

The biochemical variables observed in our study are shown in Table 1.

Out of all positive urine cultures, 60% were *Escherichia coli*, 16.6 were *Enterococcus*, 13.3% were *klebsiella*, and 10% were *Pseudomonas*.

The antibiotic sensitivity of the organism isolated from urine is shown in Table 2.

USG detected only 140 out of 200 cases of APN. Out of which 132 were nonemphysematous while as 8 showed emphysematous change. On CT imaging, out of total of 200 patients, 184 were having nonemphysematous pyelonephritis with emphysematous change in 16 patients. As of laterality is concerned, among the nonemphysematous

Table 1: Distribution of biochemical findings in study group

Biochemical variable	Number of patients, n (%)
Urine microscopy (/hpf)	
Pus cells >10	186 (93)
RBC >5	38 (19)
WBC count (cells/ μ L)	
Normal (4000-11,000)	44 (22)
Increased (>11,000)	156 (78)
Hb (g/dL)	
<10	28 (14)
>10	172 (86)
Platelet count (lacs/mL)	
<1	12 (6)
1-1.5	28 (14)
>1.5	160 (80)
Urine culture	
Positive	30 (15)
No growth	170 (85)
Blood culture	
Positive	5 (2.5)
No growth	195 (97.5)

RBC: Red blood cell, WBC: White blood cell, Hb: Hemoglobin

pyelonephritis 64% were unilateral and 36% were bilateral. Among the emphysematous pyelonephritis, 75% were unilateral and 25% were bilateral. However, in our study, USG underestimated the cases of APN; detected only 132 out of 184 cases of CT-proven nonemphysematous pyelonephritis and only 8 out of 16 patients of emphysematous pyelonephritis with an overall sensitivity of 70%.

A total of 92 patients developed azotemia. Forty percent had creatinine in the range of 1.5–2.0 md/dl followed by 32% in the range of 1.3–1.5 md/dl and 28% with creatinine >2.5 mg/dl.

In our study, 3% of patients needed ICU care while 46% and 4% develop AKI and multiple organ dysfunction syndrome (MODS), respectively. Eleven percent of patients required urological intervention. Unfortunately, 2 out of 200 patients died during disease in hospital.

In 77% of patients, the duration of hospital stay was <10 days with the mean duration of hospital stay was 7.3 days.

Diabetics patients presented more frequently with severe symptoms such as altered sensorium and MODS. Emphysematous change was seen exclusively in diabetic patients. AKI, need of ICU care, MODS, need of urological intervention, and duration of hospital stay was more in diabetic patients. Only 2 deaths were seen and both were diabetics [Table 3].

DISCUSSION

Symptomatic infection in patients with complicated UTI varies across a wide spectrum, ranging from mild lower tract symptoms to APN with systemic manifestations such as bacteremia and severe sepsis. Independently of whether

complicated pyelonephritis is community-acquired, associated with health care, or nosocomial, its incidence is still high.^[12,13] CT imaging is often the modality of choice for the evaluation of APN and renal abscesses.^[1] It is superior to intravenous Urogram or renal US in detecting renal parenchymal abnormalities such as perinephric stranding, inflammatory masses, decreased or delayed cortical enhancement, kidney enlargement, or gas formation [Figures 1 and 2], all of which may indicate more severe APN.^[14,15]

We studied 200 patients with radiologically proven APN. Criteria for APN on CT/USG include patients with clinical suspicion with at least 2 of the following findings: bulky kidneys, perinephric stranding, compression of renal sinus fat (USG), focal hypoenhancing areas on contrast CT, renal abscess, or emphysematous pyelonephritis.

A classical triad of fever, dysuria, and flank pain was seen in 55% of our patients with fever as the predominant symptom seen in 92% of patients followed by rigors and chills (77%), dysuria (69%), flank pain (55%), LUTS (52%), vomiting (22%), gross hematuria (12%), and altered sensorium (4%). These results are comparable to various internationally published research papers: Buonaiuto *et al.*^[16] reported fever as a predominant symptom in 87% of patients, followed by rigors and chills in 74% and flank pain in 59%. Dharmotharan *et al.*^[17] reported fever in 94% of patients followed by rigors and chills in 80% of patients, flank pain in 69% and hematuria in 7% of patients. Efstathiou *et al.*^[9] reported fever as a predominant symptom in 96% of patients, vomiting in 18% of patients. Venkatesh and Hanumegowda^[7] reported a triad of fever, flank pain, and renal angle tenderness in 87% of patients.

As for as laboratory findings are concerned pyuria was seen in 93% of patients while leukocytosis was seen in 78% of patients. Moreover, only 14% of patients had hemoglobin of <10 g/dl. Regarding platelet count 20% of patients had thrombocytopenia. Our findings are comparable with studies done by Venkatesh and Hanumegowda^[7] who reported pyuria in 87% of patients, leukocytosis in 68% of patients, and thrombocytopenia in 16%. Efstathiou *et al.*^[18] also reported pyuria in 89% of patients.

As for as underlying predisposing factors are concerned, 70% were diabetic, 11% had nephrolithiasis, 8% patients had obstructive uropathy, 7% were immunosuppressed, 3% had indwelling catheter while as 9% were documented cases of chronic kidney disease. Dharmotharan *et al.*^[17] reported similar results with diabetes being the commonest predisposing factor with a percentage of 73% followed by nephrolithiasis (12%) and benign prostatic hyperplasia (7%). Umesha *et al.*^[19] also reported diabetes as the most common predisposing factor (54%) followed by nephrolithiasis (14%) and immunocompromised state (3.3%). However, Buonaiuto *et al.*^[16] reported diabetes as predisposing factor in only 28%. This is in contrast to our study probably due to the high incidence of diabetes in India. India is deemed as world's diabetes capital.^[20]

Table 2: Drug sensitivity of isolated organism

	<i>Escherichia coli</i> (n=18), n (%)	<i>Enterococcus</i> (n=5), n (%)	<i>Klebsiella</i> (n=4), n (%)	<i>Pseudomonas</i> (n=3), n (%)
Ceftriaxone				
Sensitive	1 (6)	-	1 (25)	-
Resistant	17 (94)		3 (75)	
PIT				
Sensitive	16 (88)	-	2 (50)	2 (67)
Resistant	2 (12)	-	2 (50)	1 (33)
AS				
Sensitive	13 (72)	-	3 (75)	-
Resistant	5 (28)	-	1 (25)	-
Ampicillin				
Sensitive	-	2 (40)	-	-
Resistant	-	3 (60)	-	-
Ciprofloxacin				
Sensitive	2 (11)	1 (20)	1 (25)	1 (33)
Resistant	16 (89)	4 (80)	3 (75)	2 (67)
Amikacin				
Sensitive	14 (78)	-	3 (75)	2 (67)
Resistant	4 (22)	-	1 (25)	1 (33)
Meropenem				
Sensitive	18 (100)	-	3 (75)	2 (67)
Resistant	0	-	1 (25)	1 (33)
Vancomycin				
Sensitive	-	4 (80)	-	-
Resistant	-	1 (20)	-	-
Linezolid				
Sensitive	-	5 (100)	-	-
Resistant	-	0	-	-
Ceftazidime				
Sensitive	-	-	-	3 (100)
Resistant	-	-	-	0
Levofloxacin				
Sensitive	-	-	-	1 (33)
Resistant	-	-	-	2 (67)
Cotrimoxazole				
Sensitive	10 (55)	-	2 (50)	-
Resistant	8 (45)	-	2 (50)	-

PIT: Piperacillin/tazobactam, AS: Ampicillin/sulbactam

In our study, positive urine culture was seen only in 15% of study patients. Out of positive urine culture, 60% grew *E. coli*, with *Pseudomonas* 10%, *Enterococcus* 17%, and *Klebsiella* 13%. Venkatesh and Hanumegowda^[7] also reported positive urine culture in 24% of study patients with majority growing *E. coli* followed by *Enterococcus*, *Klebsiella* and *Candida*. Dhamotharan *et al.*^[17] and Eswarappa *et al.*^[9] reported positive urine culture of in 51% and 43% of patients, respectively. Buonaiuto *et al.*^[16] and Lim and Ng^[10] also reported positive urine culture in 67% and 40% of study patients respectively. The low yield of urine culture in our study may be due to prior use of antibiotics (either at outside hospital before referral or to the late collection of samples) and the presence of atypical organisms which require special culture media. Though the above-mentioned studies have high culture yield for urine

as compared to ours, but the prevalence of organisms from positive cultures was similar to our study.

The *in vitro* antimicrobial sensitivity testing was conducted in all nonrepetitive pure culture growths showing significant bacteria. The choice of antimicrobial agent was based on current CLSI guidelines and standard treatment protocol for pyelonephritis followed in our wards. Gram-negative bacteria (*E. coli* and *Klebsiella*) grown on culture were tested for *in vitro* susceptibility to; ceftriaxone, Piperacillin/tazobactam (PIT), ampicillin/sulbactam (AS), ciprofloxacin, amikacin, cotrimoxazole, and meropenem. Gram-negative bacteria (*Pseudomonas*) was tested against PIT, ciprofloxacin, amikacin, meropenem, levofloxacin and ceftazidime. Gram-positive bacteria (*Enterococcus*) were tested against ciprofloxacin, vancomycin, ampicillin, and linezolid.

Table 3: Comparison of patient characteristics between diabetic and nondiabetic patients

Patient characteristics	Diabetics (n=140), n (%*)	Nondiabetics (n=60), n (%*)	P
Mean age	54.00	47.00	0.45
Females	85.00	33.00	
Males	55	27	0.62
Fever (n=184)	127 (91)	57 (95)	0.30
Vomiting (n=44)	32 (23)	12 (20)	0.65
Gross hematuria (n=24)	17 (12)	7 (12)	0.92
Altered sensorium (n=8)	7 (5)	1 (2)	0.27
Flank pain (n=110)	78 (56)	32 (53)	0.49
Microbiology			
Positive urine culture (n=30)	21 (15)	9 (15)	1.00
Bacteremia (n=5)	3	2	0.60
Imaging (CT)			
Emphysematous pyelonephritis (n=16)	16 (11)	0	0.006*
Nonemphysematous pyelonephritis (n=184)	124 (89)	60 (100)	0.006*
Outcome			
AKI (n=92)	72 (51)	20 (33)	0.01*
MODS (n=8)	7 (5)	1 (2)	0.27
Urological intervention needed (n=21)	17 (12)	4 (7)	0.24
ICU care needed (n=6)	5 (4)	1 (2)	0.46
Death (n=2)	2 (1)	0	

*Statistically significant. CT: Computed tomography, AKI: Acute kidney injury, ICU: Intensive care unit, MODS: Multiple organ dysfunction syndrome

In our study, we found that all *E. coli* infections had a very low sensitivity to 3rd generation cephalosporins (6% to ceftriaxone.) A significant percentage of infections were sensitivity to inhibitor drug combinations (88% to PIT, 72% to AS). Sensitivity to aminoglycosides like amikacin was also significant (78% to amikacin). Fifty-five percent of the isolates were found to be sensitive to cotrimoxazole which showed a growing susceptibility to Trimethoprim/Sulfamethoxazole combination as this drug had fallen off favor by the clinicians. Only 11% of *E. coli* infections were susceptible to ciprofloxacin.

Among the isolates of *Klebsiella*, 75% were sensitive to meropenem, AS, and amikacin each. 50% were sensitive to PIT and cotrimoxazole. Sensitivity to ciprofloxacin was again low (25%). All the isolated *Pseudomonas* were sensitive to ceftazidime while 60% were sensitive to meropenem, amikacin, and PIT each.

All the isolated *Enterococci* were sensitive to linezolid, while as 80% were sensitive to vancomycin, 40% were sensitive to ampicillin and just 20% sensitive to ciprofloxacin.

The Above findings are in conformity with the annual AMS surveillance data published by ICMR 2019 which shows emerging drug resistance patterns among urinary isolates as in other parts of the country. The present study showed that Gram-negative infections in pyelonephritis by *Enterobacteriaceae* were highly resistant to 3rd generation cephalosporins (91%) and fluoroquinolones (89%). This is an alarming trend and demands judicious use of antibiotics as per hospital antibiotic policy and local antibiograms. Umesh *et al.*^[19] in 2018 also reported similar results from tertiary care hospital in Bengaluru.

In our study, Carbapenem resistance was found to be low (4%). This showed that imipenem or meropenem can be safely given in Gram-negative infections resistant to PIT/AS drug combinations as of now.

Imaging features of APN are well known. APN can be emphysematous or nonemphysematous. The emphysematous variety has poor prognosis as compared to nonemphysematous one. On CT imaging, out of total 200 patients, 184 were having nonemphysematous pyelonephritis with emphysematous change in 16 patients. As of laterality is concerned, among the nonemphysematous pyelonephritis 64% were unilateral and 36% were bilateral. Among the emphysematous pyelonephritis, 75% were unilateral and 25% were bilateral. Our results are comparable to various previously published studies. Dhamotharan *et al.*^[17] reported acute nonemphysematous pyelonephritis in 82% of patients with emphysematous change in 18% of patients. Umesh *et al.*^[19] studied 296 patients of clinically APN with CT documentation in 207 patients. Out of CT documented APN, they reported nonemphysematous pyelonephritis in 94% of patients with emphysematous change in 6% of patients. Venkatesh and Hanumegowda^[7] studied 100 patients with the clinical diagnosis of APN, however CT documented APN in only 70 patients, out of which 94% were nonemphysematous and 6% were emphysematous. However, in our study, USG underestimated the cases of APN; detected only 132 out of 184 cases of CT-proven nonemphysematous pyelonephritis and only 8 out of 16 patients of emphysematous pyelonephritis with sensitivity of 70% in nonemphysematous and 50% in emphysematous pyelonephritis. This is comparable to study done by Venkatesh and Hanumegowda^[7] who reported sensitivity of USG in APN as 66%.



Figure 1: Coronal contrast CT showing hypoenhancing area in right kidney consistent with acute pyelonephritis

Mean hospital stay in our study was 7.3 days. Kofteridis *et al.*^[11] also reported similar results both in diabetics and nondiabetics (10 in diabetics and 7 in nondiabetics).

Clinical course in terms of the development of AKI, MODS, need of ICU care, and necessitation of urological intervention was evaluated in our study. Three percent of patients needed ICU care at least once during the hospital stay while 46% and 4% develop AKI and MODS, respectively. Eleven percent of patients required urological intervention.

PCN was done in 4% of patients while DJ stenting was done in 7% of patients. Unfortunately, 2 out of 200 patients died during disease in hospital. Venkatesh and Hanumegowda^[7] reported similar results in the form of 47% develop AKI while as MODS was seen in 7% of cases. As for as the need of ICU care is concerned Dhamotharan *et al.*^[17] reported 29% of patients needed ICU care during their hospital stay. The higher rate of ICU admission in these studies may be due to low threshold for admission to ICU and easy availability of ICU beds. Venkatesh and Hanumegowda^[7] reported need of urological intervention in 12% of patients.

One important aspect that we evaluated during our study was a comparison of patient characteristics, microbiological evaluation, and clinical course in hospital between diabetic and Nondiabetic patients. Mean Age was more in diabetics. Fever, vomiting, and flank pain were seen with nearly equal frequency in both groups. Diabetics patients presented more frequently with severe symptoms such as altered sensorium and MODS. Emphysematous change was seen exclusively in diabetic patients. AKI, need of ICU care, MODS, need of urological intervention, and duration of hospital stay were more in diabetic patients. Only 2 deaths were seen and both were diabetics. Eswarappa *et al.*^[9] and Kofteridis *et al.*^[11] reported comparable results in terms of patient care and clinical outcome. The mean age in diabetics was 52 years in Eswarappa *et al.*^[9] which is slightly higher than nondiabetics. Kolla *et al.*^[21]



Figure 2: Coronal non contrast CT showing air in PCS of right kidney and parenchymal of left kidney , consistent with emphysematous pyelonephritis

also reported emphysematous pyelonephritis exclusively in diabetics.

CONCLUSION

- Fever is predominant symptom in APN
- Diabetes is the most common underlying predisposing condition followed by nephrolithiasis
- Yield of urine culture is very low in developing countries
- *E. coli* is the predominant organism followed by *Enterococcus* causing APN with Amikacin and inhibitor drug combination showing good sensitivity to *E. coli*. *Enterococcus* is very much sensitive to Linezolid and Vancomycin while as *Klebsiella* shows good sensitivity to Meropenem, Ampicillin-Sulbactam, and ceftriaxone
- USG has less sensitivity for diagnosing APN than CT more so for emphysematous one
- The outcome of patients in terms of duration of hospital stay and need of ICU care is poor in diabetic patients.

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Conflicts of interest

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