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RESEARCH ARTICLE
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CLINICAL SPECTRUM OF ACUTE PYELONEPHRITIS IN FEMALES AND ITS CORRELATION WITH METABOLIC SYNDROME

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ABSTRACT

BACKGROUND: Acute pyelonephritis (APN) is a severe upper urinary tract infection that predominantly affects women, with an annual incidence of 15–17 cases per 10,000 females in the United States[1]. This condition is characterized by renal inflammation, often resulting from the ascension of bacteria from the lower urinary tract. The most common pathogen implicated is Escherichia coli, responsible for approximately 80% of cases[2].

Metabolic syndrome (MetS), a cluster of interrelated risk factors including abdominal obesity, hypertension, hyperglycemia, and dyslipidemia, has been increasingly recognized as a significant health concern among women.

Recent studies have suggested a potential link between MetS and an increased susceptibility to urinary tract infections (UTIs), including APN, in women

However, the specific mechanisms underlying this association remain poorly understood, and the extent to which MetS contributes to the incidence and severity of APN in women warrants further investigation

AIMS AND OBJECTIVE: Aim of this study is to assess demographic and clinical profile of patients with Acute Pyelonephritis in females as well as to assess the relationship between metabolic syndrome and acute pyelonephritis.

METHODS: It was a Prospective observational single center hospital-based study conducted at Govt. Medical College Jammu in the Department of General Surgery in collaboration with department of Urology and Physiology from December 2024- June 2025.

RESULTS: The mean age of patients in our study was 55 years. Hyperlipidemia was the most common seen in 70% patients, followed closely by Diabetes mellitus 56%. Most common organism isolated in urine cultures was E. Coli which was seen in 72% of the patients. Mortality was around 2%. In our study, we found out that out of various parameters of metabolic syndrome, Diabetes Mellitus, Obesity (BMI>30) and Hyperlipdemia (TG>150mg/dl) were the prognostic factors and predictors for failure of medical management and need for intervention thus establishing a clear relationship between metabolic syndrome and Acute Pyelonephritis.

CONCLUSION: The intersection of acute pyelonephritis and metabolic syndrome in the female population underscores the need for comprehensive healthcare strategies that address both infectious and metabolic health. Further research is essential to elucidate the mechanisms linking MetS with increased susceptibility to APN and to develop targeted interventions that can mitigate this risk.

Keywords: Acute Pyelonephritis, Metabolic Syndrome, Obesity, Hyperlipidemia, Diabetes Mellitus.

Introduction

Acute pyelonephritis (APN) is a severe upper urinary tract infection that predominantly affects women, with an annual incidence of 15–17 cases per 10,000 females in the United States[1]. This condition is characterized by renal inflammation, often resulting from the ascension of bacteria from the lower urinary tract. The most common pathogen implicated is Escherichia coli, responsible for approximately 80% of cases[2].

Metabolic syndrome (MetS), a cluster of interrelated risk factors including abdominal obesity, hypertension, hyperglycemia, and dyslipidemia, has been increasingly recognized as a significant health concern among women. The prevalence of MetS among women is rising globally, with studies indicating that approximately 30% of women in the United States are affected[3]. This syndrome is associated with an elevated risk of cardiovascular diseases, type 2 diabetes, and chronic kidney disease.

Recent studies have suggested a potential link between MetS and an increased susceptibility to urinary tract infections (UTIs), including APN, in women. The interplay between metabolic abnormalities and immune function may predispose individuals with MetS to infections. However, the specific mechanisms underlying this association remain poorly understood, and the extent to which MetS contributes to the incidence and severity of APN in women warrants further investigation.

Acute pyelonephritis is more prevalent in women, particularly those aged 15–29 years. A population-based study in the United States reported annual outpatient rates of 12–13 cases per 10,000 women, with inpatient rates of 3–4 cases per 10,000 women[4]. The incidence decreases with age but remains a significant health concern among premenopausal women.

Several factors increase the risk of developing APN in women. These include sexual activity, use of spermicides, a history of UTIs, and anatomical abnormalities of the urinary tract[2]. Additionally, conditions such as diabetes mellitus and obesity have been identified as significant risk factors. Obesity, in particular, has been associated with an increased risk of recurrent UTIs in premenopausal women[5].

Metabolic syndrome is characterized by a combination of risk factors that predispose individuals to cardiovascular and metabolic diseases. Emerging evidence suggests that MetS may also influence the susceptibility to infections. The association between MetS and UTIs, including APN, is thought to be mediated through several mechanisms:

- **Immunological Dysfunction**: Components of MetS, such as hyperglycemia and dyslipidemia, may impair immune responses, reducing the body's ability to combat infections[6].
- **Obesity and Inflammation**: Adiposity is associated with chronic low-grade inflammation, which may alter the immune system's function and increase the risk of infections[5].
- **Urinary Tract Abnormalities**: MetS is often accompanied by conditions like hypertension and diabetes, which can lead to structural and functional abnormalities in the urinary tract, facilitating bacterial colonization and ascent[2].

Understanding the relationship between MetS and APN is crucial for developing effective prevention and treatment strategies. Women with MetS may require tailored approaches to reduce their risk of APN. Management strategies should focus on controlling the components of MetS, such as blood pressure, blood glucose, and lipid levels, alongside standard antimicrobial therapies for APN. Additionally, lifestyle modifications, including weight management and increased physical activity, are essential components of care[2].

AIMS AND OBJECTIVES:

a. To assess demographic and clinical profile of patients with Acute Pyelonephritis in females.
b. To assess the relationship between metabolic syndrome and acute pyelonephritis.

METHODS: The study was done in the Department of General Surgery in collaboration with department of Urology and Physiology in Government Medical College Jammu. Due informed consent was taken from the patients enrolled in the study. Patient details were taken according to the established proforma. The data was tabulated and results were expressed using statistical package for the social sciences (SPSS) software.

DESIGN: It was a Prospective observational single center hospital-based study conducted at Govt. Medical College Jammu.

DURATION: duration of study was from December 2024- June 2025

INCLUSION CRITERIA: All female patients with diagnosis of Acute Pyelonephritis were included in the study.

EXCLUSION CRITERIA: Male Gender, children below 18 yrs, patients with previous h/o acute pyelonephritis were excluded from the study. Also patients with chronic inflammatory conditions of kidney were excluded.

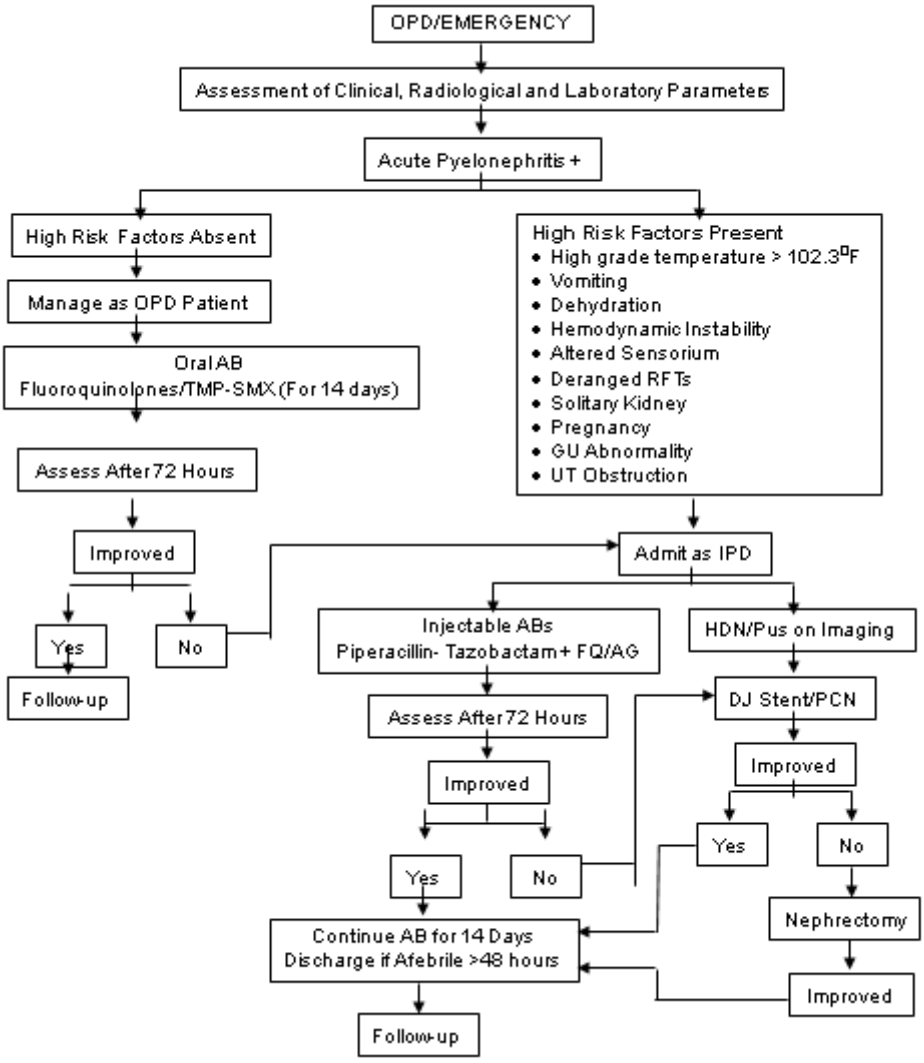
Acute pyelonephritis was said to be present when patient presented with fever with chills and rigors, flank pain, nausea and vomiting.

Patient details were taken according to the established proforma and noted down to elucidate the risk factors. Patients' characteristics like name, age, gender, BMI, comorbidity if any were noted. His vitals were recorded such as temperature, Pulse Rate, Blood Pressure, Respiratory Rate and SPO2. Investigations included:

- Complete Blood Count including TLC, Neutrophils count and platelet count.
- Renal Function tests including serum creatinine and electrolytes.
- Liver function tests.
- Complete Lipid Profile
- Fasting and postprandial blood sugar levels,
- HbA1C.
- CRP levels
- Urine routine and urine culture and sensitivity
- Ultrasound KUB.

CECT- KUB/ NCCT (in case of deranged RFTs).

Management: patients were managed according to the following treatment algorithm.



Patients were divided into two groups, **Medical Management group (Group A)** and **Interventional group (Group B)** to elucidate the risk factors. The patients who were successfully treated in OPD or IPD with supportive care, oral or injectable antibiotics were allotted Group A. Those who were managed with DJ Stent, PCN or Nephrectomy were allotted Group B.

RESULTS:

AGE DISTRIBUTION

The mean age of patients in our study was 55 years, majority of patients in the age group of 51-60 years 34%. The youngest patient was 16 years and the oldest 84 years. **(Table 1)**

Table 1: Age distribution of study patients

Age (Years)	Number	Percentage
≤ 30 Years	2	2
31-40 Years	15	15
41-50 Years	17	17
51-60 Years	34	34
61-70 Years	22	22
71-80 Years	10	10
Total	100	100
Mean±SD (Range)=54.8±13.12 (16-80 Years)		

COMORBIDITIES

In our study, out of all the comorbidities, Hyperlipidemia was the most common seen in 70% patients, followed closely by Diabetes mellitus 56%. **(Table 2)**

Table 2: Underlying comorbidities among study patients		
Comorbidity	**Number**	**Percentage**
Hyperlipidemia	70	70
Diabetes mellitus	56	56
Obesity (BMI>30)	42	42
Hypertension	49	49
Hypothyroidism	10	10

LABARATORY PARAMETERS:

Total Leucocyte counts (TLC): mean TLC among our study group was 13570.3 cells/ mm^3 (95% CI 12952-14189).

Neutrophils: differential count for neutrophils was studied and mean neutrophil count was 80.95 % (95% CI between 80.37-81.53).

Platelet count: mean platelet count in our study group was 189600 cells/ mm^3. (95% CI 180965-198235).

Serum Creatinine: mean serum creatinine in our study was found to be 1.87 mg/dl (95% CI between 1.21-2.52).

Fasting Blood Sugar (FBS): mean FBS was found to be around 150.1 mg/dl with 95% CI between 138.3-161.8 mg/dl.

HbA1c (%): amongst our study group of 238 patients, mean HbA1c was around 7.11%. (95% CI 6.94-7.27).

CRP: in our study group of 238 patients, mean CRP was 113.5 mg/L (95% CI 108.33-118.67). **(Table 3)**

Table 3: Descriptive statistics of lab parameters			
Parameter	**Mean**	**SD**	**95% CI For Mean**
TLC	13570.3	4868.1	12952-14189
Neutrophils	80.95	4.47	80.37-81.53
Platelets	189600	67970	180965-198235
Serum creatinine	1.87	5.14	1.21-2.52
Fasting blood sugar	150.1	92.49	138.3-161.8
HbA1c (%)	7.11	1.27	6.94-7.27
CRP (mg/L)	113.5	40.7	108.33-118.67

MICROBIOLOGICAL PROFILE

In our study group of 100 patients, most common organism isolated in urine cultures was E. Coli which was seen in 72% of the patients. The second most common organism isolated was Proteus 12% followed by Candida 5% and Klebsiella 5%. **(Table 4)**

Table 4: Microorganism isolated		
Microorganism isolated	**Number**	**Percentage**
E.coli	72	72
Proteus	12	12
Candida	5	5
Pseudomonas	3	3
Klebsiella	5	5
Acinetobacter	1	1
Enterococcus	1	1
Staphylococcus Aureus	1	1
Providentia	1	1
No growth	11	11

MANAGEMENT AMONG STUDY PATIENTS:
72% were managed conservatively. DJ stent was placed in 20 pateints. PCN was placed in 4 patients. 4 patients eventually needed Nephrectomy either after diversion by stent or PCN or direct. **(Table 5)**

Table 5: Management among study patients		
Management	**Number**	**Percentage**
Conservative	72	72
DJ Stent	20	20
PCN	4	4
PCN and Nephrectomy	2	2
DJ Stent and Nephrectomy	1	1
DJ Stent, PCN and Nephrectomy	1	1
Total	100	100

Mortality:
In our study, 2 out of 100 patients eventually died (Mortality 2%) **(Table 6)**

Table 6: Mortality among study patients		
Mortality	**Total patients**	**Percentage**
2	100	2%

DIFFERENT PARAMETERS OF METABOLIC SYNDROME IN RELATION TO MANAGEMENT:
As shown in **Table 7, Diabetes Mellitus (DM)**: DM was seen 49% in Group A and 22 patients in Group B (73.%). This association was found to be statistically significant with a p-value < 0.0005.
Hypertension (HTN): HTN was seen in in 49% in Group A and 15 patients in Group B (50%). However, this association was not found to be statistically significant (p-value 0.869).
Hyperlipidemia: Hyperlipidemia was seen in 65% patients who were managed with medical management and 83% patients in Group B who were managed with intervention. This association was found to be statistically significant with a p-value < 0.005.
BMI: obesity (BMI>30) was seen in 80 % of interventional group as compared to 25% of Group A females. This association was found to be statistically significant with a p-value < 0.04.

Table 7: Metabolic Profile					
Parameter	**Group A [n=70]**		**Group B [n=30]**		**P-value**
	No.	**%age**	**No.**	**%age**	
Diabetes mellitus	34	49	22	73	0.0005*
Hypertension	34	49	15	50	0.869
Hyperlipidemia	45	65.2	25	83	0.005*
Obesity BMI >30	18	25.7	24	80	0.04*

***Statistically Significant Difference (P-value<0.05)**
Group A (Medical management group); Group B (interventional group)

DISCUSSION:
Mean age in our study was 54.8 yrs. This was also observed in one study by **Chung VY et al., 2014** where the mean age was around 58 years of age.[7] In other study by **Sajeer K et al., 2025** the mean age was around 50.3 years[8]. In our study, The highest number of patients (33.2 %) were observed in 51-60 years age group, followed by 61-70 years (22.3%). In study by **Sajeer K et al**, maximum number of people were also from 51-60 years age group (32.9%) followed by 61-70 years age group (18.8%)[8].

In our study, diabetes mellitus was one of the most common comorbidity which was seen in around 55.9% of our study patients out of which most were females. This finding was also corroborated by other studies such as a study by **George A et al** done in 2024 where 61% of the patients had DM[9]. In the study by **Sajeer K et al**, around 74% of the patients were Diabetics which supports our study findings[8]. However, **Buonaiuto VA** et al found only 28.8% of patients in his study had DM. HTN was observed in 49.2% of our study patients[10]. **Chawla A et al** in 2022 found in their study that HTN was present in 37% of the patients[11].

In our study, out of 238 study patients, 89.46% patients had positive urine culture. E. coli was the most commonly organisms isolated (72.3%), followed by Proteus (12.6%), Candida (5%), Klebsiella (4.2%), Pseudomonas (3.4%), Acinetobacter (1.3%), Enterococcus (0.8%) and others. **Sajeer K et al** in their study found growth in urine culture in 70% of the patients. E. Coli was seen in 57%, Klebsiella 8.5%, Pseudomonas 4.2% and Proteus 2.8%[8].

In our study, 170 patients (71.4%) were managed conservatively with antibiotics whereas in 68 patients (28.6%), intervention was required. **Sajeer K et al**, in his study, found out that 83% of the patients were managed conservatively[8].

Mortality in our study was around 0.8%, where 2 out of 238 patients died from complications directly attributable to APN. Mortality rate in other studies was comparatively higher with **George A et al** observed around 2.4% mortality in their study and **Chung VY** reported 4.4% mortality[7,9].

In our study we found out that out of various parameters of metabolic syndrome, following were the prognostic factors and predictors for failure of medical management and need for intervention.

- Diabetes Mellitus
- Obesity (BMI>30)
- Hyperlipdemia (TG>150mg/dl)

CONCLUSION:

The intersection of acute pyelonephritis and metabolic syndrome in the female population underscores the need for comprehensive healthcare strategies that address both infectious and metabolic health. Further research is essential to elucidate the mechanisms linking MetS with increased susceptibility to APN and to develop targeted interventions that can mitigate this risk. A multidisciplinary approach involving urologists, endocrinologists, and primary care providers is vital in managing and preventing APN in women with metabolic syndrome.

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