A Cross Sectional Study on Risk Factors, Clinical Profile and Aetiology of Acute Pyelonephritis in a Tertiary Teaching Hospital in Kerala

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ABSTRACT

BACKGROUND
Acute pyelonephritis (APN) is one of the most severe forms of urinary tract infections (UTI) with a higher incidence among females compared to males. Escherichia coli is the commonest causative organism isolated in 80% of the cases in Kerala. Risk factors like structural or functional abnormalities of urogenital system, immunosuppression, comorbidities and virulence & resistance of microorganism play vital roles in predicting the prognosis. Our aim was to study the prevalence of various risk factors of acute pyelonephritis in adult patients, the clinical profile, aetiological agents and their sensitivity to antibiotics, and related complications on their usage.

METHODS
In a cross-sectional observational study, 100 adult patients with acute pyelonephritis admitted in a tertiary teaching hospital in Kerala were studied between January 2016 and January 2017. Detailed history and clinical examination were carried out. Complete haemogram, random blood sugar, renal function test, urine culture and sensitivity, and ultrasonogram of abdomen and pelvis were done.

RESULTS
The most common age group was 40 - 49 years with a male to female ratio of 2:3. Dysuria was observed in 82 % of patients followed by increased frequency of micturition in 65 % and vomiting in 42 %. Diabetes mellitus was observed in 55 % of patients and recurrent UTI in 44 %. Escherichia coli was found in 66 % of patients followed by Klebsiella in 23 %. Culture showed that 85 % of the bacteria were sensitive to piperacillin-tazobactam. 44 % of the patients did not respond to the empirical antibiotic, and the failure rate was higher among those empirically treated with ciprofloxacin. 41 % of the patients developed acute kidney injury, which necessitated haemodialysis in 23 %. 14 % of the patients developed septic shock and the mortality was 10 %.

CONCLUSIONS
Certain risk factors such as diabetes, hypertension, chronic kidney disease and indwelling catheters were associated with increased incidence of complications. Hence, in presence of such risk factors appropriate treatment and preventive measures should be initiated promptly. Among the pathogens, 85 % of the organisms were sensitive to piperacillin-tazobactam. Hence, piperacillin-tazobactam can be recommended as the first line empirical antibiotic.

KEYWORDS
Acute Pyelonephritis, Urinary Tract Infection, Acute Kidney Injury (AKI), and E. coli
BACKGROUND

Acute Pyelonephritis (APN) is the inflammation of renal pelvis and renal parenchyma. It is considered one of the most severe forms of urinary tract infection (UTI) and is associated with significant morbidity and mortality. Its incidence is higher among females compared to males.1,2,3 The commonest bacteria causing it is E. coli constituting 80 % of the cases.4 The estimated overall mortality of APN was 6.1 %.5 The prognosis of APN is based on risk factors like structural or functional abnormalities of urogenital system, immuno suppression, co-morbidities and virulence of microorganisms & their resistance to antibiotics.6,7 Stimulaton of cyclic adenosine 3′,5′ monophosphate (cAMP) and subsequent production of cyclic guanosine 3′,5′ monophosphate (cGMP) is an important mechanism of virulence of microorganisms.8 Irrational prescription of antibiotics and poor patient compliance results in emergence of bacterial antibiotic resistance among UTI patients.7,8 Studies related to risk factors are very few from South India, especially, Kerala.9

The microbial spectrum of complicated UTI includes Pseudomonas, E. coli, Serratia, and Providencia species, in addition to enterococci, staphylococci, and fungi.10 The routes of spread of bacteria are through the bloodstream or from the lower urinary tract.11

The pathogenesis shows patchy interstitial supplicative inflammation, intratubular aggregates of neutrophils, neutrophilic tubulitis and tubular necrosis.2 Fever is the main feature and gross haematuria (haemorrhagic cystitis) is present in 30 - 40 % of APN especially in females; most often young women. Gross haematuria is unusual in males and should prompt consideration of a more serious cause.12

Supra pubic tenderness ranging from mild to moderate degree without rebound tenderness; unilateral flank or costovertebral angle (CVA) tenderness may be present. On pelvic examination tenderness of the cervix, uterus, and adnexa should be absent.13 Complications include renal failure, sepsis, and renal abscess formation.14

A preliminary ultrasonogram usually clinches the diagnosis, but in a few patients CT scan is necessary.15 Empirical usage of trimethoprim-sulfamethoxazole resistance (TMP-SMX), fluoroquinolones as the first-line therapy for acute uncomplicated pyelonephritis or a 7-day course of therapy with oral ciprofloxacin (500 mg twice daily, with or without an initial IV 400 - mg dose) was highly effective for the initial management of APN.16,17,18 Recently, vaginal probiotics / lactobacilli, immuno-stimulation / vaccines, inhibitors of bacterial adhesion, inhibitors of bacterial bio films, stimulation of cyclic adenosine / forskolin, hormone therapy and instillation of attenuated bacteria into the urinary bladder are being tried.19,20,21

METHODS

Objectives

To study the prevalence of various risk factors, clinical profile and aetiology of acute pyelonephritis in a tertiary teaching hospital in Kerala in adult patients.

Sample Size

A cross sectional, observational study was conducted over a period of 12 months, from January 2016 and January 2017 at the Department of General Medicine, Govt. Medical College, Kottayam.

A rigorous protocol was adhered to. Ethics committee clearance was obtained, and the study was conducted among patients admitted in wards under the Department of General Medicine. Detail history and clinical examination were carried out on all patients. Investigations included were complete haemogram, random blood sugar, renal function test, and urine microscopy and ultrasonogram of abdomen and pelvis was carried out. Urine culture and sensitivity tests were done.

Sample Size Calculation

Sample size calculated by the formula.

\[ Z^2 \times (p) \times (1 - p) \]

Where,

\[ Z = Z \text{ value (e.g., 1.96 for 95% confidence level)} \]

\[ p = \text{percentage picking a choice, expressed as decimal (0.5 used for sample size needed)} \]

\[ c = \text{confidence interval, expressed as decimal (e.g., 0.04 = 4)} \]

\[ n = 1.96^2 \times 0.5 \times (1-0.5) / (20 \times 0.5/100)^2 \]

\[ = 6.06 \times 0.5 \times 0.5 / (20 \times 0.5/100)^2 \]

= 96

Hence, sample size was approximately taken as 100.

Inclusion Criteria

1. Patients aged above 16 years with clinical features of fever with chills / rigors and flank pain at renal angle & tenderness were included.
2. Patients with or without dysuria were included.
3. Patients with laboratory evidence of leukocytosis and pyuria were included.
4. Patients with ultrasound evidence of APN were included.

Exclusion Criteria

Patients not willing to be a part of the study were excluded.

Statistical Analysis

SPSS version 20.0 was used for data analysis. Continuous variables were analysed by mean, SD, median, minimum and maximum. Qualitative variables were described by percentage distribution among groups. Comparison of
quantitative variables was done by ‘student ‘t’ test and qualitative variables compared by chi square test. ‘p’ value at less than 0.05 was taken as significant statistically.

RESULTS

Age distribution showed that the maximum number of patients were clustered in the age groups of 40 - 49 & 50 - 59 years; with the mean age of 52.16 ± 17.81 years. Of the 100 patients, 40 were males and 60 were females. Dysuria was the most common symptom, observed in 82 % of the patients, increased frequency of micturition in 65 %, vomiting in 42 % and 21 % patients had oliguria. 18 % of the patients with APN presented with altered sensorium.

| Observation | Total Number | Male = 40 | Female = 60 |
|-------------|--------------|-----------|-------------|
| Age         |              |           |             |
| 20 - 29     | 09           | 03        | 06          |
| 30 - 39     | 14           | 06        | 08          |
| 40 - 49     | 25           | 10        | 15          |
| 50 - 59     | 20           | 07        | 13          |
| 60 - 69     | 11           | 04        | 07          |
| 70 - 79     | 10           | 05        | 05          |
| 80 - 89     | 09           | 03        | 06          |
| 90 - 99     | 02           | 01        | 01          |
| Symptoms    |              |           |             |
| Dysuria     | 82           | 40        | 42          |
| Haematuria  | 10           | 05        | 05          |
| Pyuria      | 20           | 06        | 14          |
| Frequency   | 65           | 30        | 35          |
| Oliguria    | 21           | 12        | 09          |
| Vomiting    | 42           | 19        | 23          |
| Diarrhoea   | 11           | 06        | 05          |
| Altered Sensorium | 18 | 08 | 10 |

Risk Factors

| Risk Factors   | Total Number | Male = 40 | Female = 60 |
|----------------|--------------|-----------|-------------|
| Diabetes Mellitus | 55          | 25        | 30          |
| Hypertension    | 27           | 16        | 11          |
| Chronic Kidney Disease | 07 | 03        | 04          |
| Childhood UTI  | 16           | 09        | 07          |
| Recurrent UTI  | 44           | 20        | 24          |
| Urinary incontinence | 18 | 07        | 11          |
| Urolithiasis    | 19           | 10        | 09          |
| Indwelling catheter | 14 | 08        | 06          |

Gender specific risk factors

| Males: BPH | 13 | 13 |
| Females: Menopause | 27 | -   |
| Carcinoma cervix | 01 | -   |
| Pregnancy | 02 | -   |

Complications:

| AKI          | 41 | 20 | 21 |
| Septicemia   | 34 | 11 | 23 |
| Septic shock | 14 | 05 | 09 |
| Emphysematous pyelonephritis | 06 | 02 | 04 |
| Failed empirical antibiotics | 44 | 20 | 24 |

Table 1. Age, Gender Incidence, Symptoms, Risk Factors, and Complications in the Study Group (n = 100)

68 % of organisms showed resistance to ciprofloxacin whereas only 15 % of them were resistant to piperacillin-tazobactam. 1st and 2nd generation cephalosporins were having sensitivity and resistance pattern comparable to that of piperacillin-tazobactam. Cefoparazon-sulbacotam also showed better sensitivity pattern than ciprofloxacin, though not as good as the two classes of antibiotics mentioned above. Amikacin showed reasonably good sensitivity pattern, not used due to the risk renal impairment in this study (Figure 1). 54 patients were treated with empirical antibiotic ciprofloxacin. Piperacillin-tazobactam & cefoparazon-sulbacotam were used in 35 & 11 patients respectively.

Mean duration of hospital stay was 11.64 days (range 1 to 18 days) with standard deviation 03.67. The mortality during the course of the illness was 10 %. 90 % of the patients survived in spite empirical antibiotic failure and complications. In this study risk factors like male gender, bilateral pyelonephritis, emphysematous pyelonephritis and AKI contributed to statistically significant prolongation of hospital stay (“t” test was used to calculate the p value which was 0.05) (Table 3).

Correlation between symptoms and mortality was significant (“t” test was used to know p value which was < 0.05) among patients with dysuria which was 04.8 % and without dysuria was 33.3 %. Presence of frequency of micturition with mortality (01.5 %) and absence of frequency with mortality (25.7 %) was correlated and found...
that patients with absence of frequency of micturition had higher mortality; it was statistically significant (p value < 0.05). Patients with oliguria or altered sensorium had a higher mortality compared to those without them and this relationship was found to be statistically significant (p value < 0.05).

Comparing the presence of various risk factors versus mortality, patients with urinary incontinence and DM had significantly higher mortality compared to those without them. The chi square test was used to calculate the significance and found that it was statistically significant with p values 0.019 for diabetes mellitus and 0.001 for urinary incontinence (Table 4).

Type 2 diabetes mellitus: 12 / 55 (21.81 %) of diabetic patients developed septic shock whereas only 03 / 45 (06.66 %) nondiabetic patients developed it. All the 06 patients in the study who developed emphysematous pyelonephritis were diabetics. Only 04 / 55 (07.27 %) diabetics had hydronephrosis on USG whereas 12 / 45 (26.66 %) nondiabetic patients had hydronephrosis (Table 5).

09 / 27 (33.33 %) hypertensive had hydronephrosis on USG while only 07 / 73 (09.58 %) non hypertensive patients had hydronephrosis on USG. 16 / 27 (59.25 %) hypertensive patients developed AKI which was considerably higher than non-hypertensive 20 / 73 (27.39 %) patients (Table 4). 57.14 % patients with CKD had to undergo haemodialysis (HD) while only 19.35 % patients without CKD required it. 06 / 07 (85.71 %) CKD patients developed AKI which was higher compared to patients without CKD (32.2 %). 05 / 07 (14.28 %) patients with CKD had hydronephrosis whereas 82 / 93 (88.17 %) patients without CKD had hydronephrosis (Table 5). Haemodialysis was done in more patients with indwelling catheter (50 %) than the rest (17.4 %). 10 / 14 (71.4 %) patients with indwelling catheter developed bilateral pyelonephritis while only 28 / 86 (32.55 %) patients without indwelling catheter developed bilateral pyelonephritis. 50 % developed septic shock with indwelling catheter while only 09.3 % developed septic shock without it.

Hydronephrosis was found to be higher among patients with indwelling catheter. 06 / 14 (42.8 %) patients with an indwelling catheter showed hydronephrosis on USG, while 10 / 86 (11.62 %) patients showed it without an indwelling catheter. Thus, an indwelling catheter was an independent risk factor for various complications of APN (Table 5).

Patients with urinary incontinence (UI) showed greater need for dialysis (61 %), tendency to develop bilateral pyelonephritis (88.8 %), septic shock (50 %) and AKI (27.7 %). Whereas 13.4 % patients without UI had dialysis, 26.8 % developed bilateral pyelonephritis, 07 % developed septic shock and AKI in 28 % of patients (Table 5). 42.1 % of renal calculi patients had hydronephrosis while 09.8 % developed hydronephrosis in absence of renal calculi (Table 5).

Comorbid conditions like DM, hypertension, CKD, in dwelling catheter, UI and urinary calculi resulted in complications such as septic shock, emphysematous pyelonephritis, hydronephrosis, AKI, hydronephrosis and necessity for haemodialysis respectively in patients with
acute pyelonephritis; statistical significance was observed with p values below 0.05 for all these co-morbid conditions (Table 5).

| Risk Factors | Complications Present | Complications Absent | χ² | P Value |
|--------------|------------------------|----------------------|----|---------|
| T2DM         | Septic shock-12        | Septic shock-43      | 04.45| 0.03   |
|              | Septic shock-42        | Septic shock-43      | 04.45| 0.03   |
| T2DM         | Hydronephrosis-01      | Hydronephrosis-32    | 06.9| 0.008  |
|              | Hydronephrosis-01      | Hydronephrosis-32    | 06.9| 0.008  |
| T2DM         | Empysematous Pyelonephritis-01 | Empysematous Pyelonephritis-01 | 05.22| 0.02    |
|              | Empysematous Pyelonephritis-01 | Empysematous Pyelonephritis-01 | 05.22| 0.02    |
| Hypertension | Hydronephrosis-09      | Hydronephrosis-18    | 08.2| 0.004  |
|              | Hydronephrosis-09      | Hydronephrosis-18    | 08.2| 0.004  |
| CKD          | AKI-16                 | AKI-33               | 06.8| 0.003  |
|              | AKI-16                 | AKI-33               | 06.8| 0.003  |
| Indwelling catheter | Haemodialysis-07   | Haemodialysis-07    | 04  | 0.066   |
|              | B / L Pyelonephritis-10 | B / L Pyelonephritis-10 | 07.7 | 0.005   |
|              | B / L Pyelonephritis-28 | B / L Pyelonephritis-28 | 07.7 | 0.005   |
|              | Septic shock-07        | Septic shock-07      | 07.7| 0.005   |
|              | Septic shock-08        | Septic shock-08      | 15.6| 0.001   |
|              | Hydro nephrosis-08      | Hydro nephrosis-08    | 08.7| 0.003   |
|              | Hydro nephrosis-10      | Hydro nephrosis-10    | 08.7| 0.003   |
| Urinary Incontinence | Haemodialysis-07     | Haemodialysis-07     | 04  | 0.066   |
|              | B / L Pyelonephritis-10 | B / L Pyelonephritis-10 | 07.7 | 0.005   |
|              | B / L Pyelonephritis-28 | B / L Pyelonephritis-28 | 07.7 | 0.005   |
|              | Septic shock-07        | Septic shock-07      | 07.7| 0.005   |
|              | Septic shock-08        | Septic shock-08      | 15.6| 0.001   |
|              | Hydro nephrosis-08      | Hydro nephrosis-08    | 08.7| 0.003   |
|              | Hydro nephrosis-10      | Hydro nephrosis-10    | 08.7| 0.003   |
| Urinary Calculi | Haemodialysis-07      | Haemodialysis-07     | 04  | 0.066   |
|              | B / L Pyelonephritis-10 | B / L Pyelonephritis-10 | 07.7 | 0.005   |
|              | B / L Pyelonephritis-28 | B / L Pyelonephritis-28 | 07.7 | 0.005   |
|              | Septic shock-07        | Septic shock-07      | 07.7| 0.005   |
|              | Septic shock-08        | Septic shock-08      | 15.6| 0.001   |
|              | Hydro nephrosis-08      | Hydro nephrosis-08    | 08.7| 0.003   |
|              | Hydro nephrosis-10      | Hydro nephrosis-10    | 08.7| 0.003   |

Table 5. Showing the Multivariate Analysis of Correlation between Risk Factors and Present or Absent Complications in UTI Patients (n = 100)

Failure rate of empirical treatment was considerably higher among the patients who were started on ciprofloxacin (70.37 %) compared to piperacillin-tazobactam (22.8 %) and cefoparazone-sulbactam (18.18 %). This fact was statistically significant with p value 0.001 (p significant at < 0.05). Analysis of USG features showed significant association between presence of abscess & emphysematous pyelonephritis and mortality. The complications observed were AKI in 36 % patients, hydronephrosis in 16 %, emphysematous pyelonephritis in 06 %, bilateral pyelonephritis in 38 %, septic shock in 14 %, failure to respond to antibiotic therapy in 48 % and the requirement of haemodialysis in 22 %. All of the complications, except for hydronephrosis had significant attributable mortality (p value > 0.05), (Table 7).

| Observations | Total | Death | Recovery | χ² | P Value |
|--------------|-------|-------|----------|----|---------|
| USG          |       |       |          |    |         |
| Nephrolithiasis | 34   | 3     | 31       | 0.08 | 0.77   |
| Abscess      | 08    | 05    | 03       | 07.30| 0.007  |
| EPN          | 06    | 03    | 03       | 11.34| 0.001  |
| Anomalies    | 02    | 00    | 02       | 02.23| 0.06   |
| Complications |      |       |          |    |         |
| AKI          | 36    | 10    | 26       | 19.75| 0.001  |
| Hydro nephrosis | 16   | 03    | 13       | 01.62| 0.20   |
| Septic shock | 14    | 09    | 06       | 49.02| 0.001  |
| B/L Pyelonephritis | 38   | 10    | 28       | 18.12| 0.001  |
| Failed empirical therapy | 68  | 28    | 40       | 04.55| 0.03   |

Table 7. Showing the Relation between USG Findings & Complications with Death and Recovery of UTI Patients (n = 100)

DISCUSSION

Out of 100 patients, 25 % belonged to the age groups of 40-49 years and 20 % belonged to 50 - 59 years. V M Dhamotharan et al.24 reported 23 % and 35 % frequency among the ages of 41 - 50 and 51 - 60 years respectively. Nicholle et al.16 reported APN highest among the patients aged above 59 years followed by 20 to 29 years. As in this study inclusion of only inpatients and excluding patients < 16 years has resulted presentation of higher incidence of APN in among the younger age groups. There were 60 females and 40 males in this study with male to female ratio of 3:2 which was similar to the global reports by population based epidemiological study by Czaja et al.25 Dysuria was present in 82 % of the patients followed by frequency of micturition in 35 %, pyuria in 20 % of the patients & haematuria in 10 %. Vomiting & diarrhoea was present in 42 % and 11 % of patients respectively. 18 % of the patients presented with altered sensorium. V M Dhamotharan et al., observed similarly; dysuria in 52 % of the patients.24 Higher incidence of dysuria may be due to inclusion of fever and flank pain as inclusion criteria, excluding atypical cases of pyelonephritis, where dysuria could be absent. M. Eshwarappa et al.8 observed oliguria / anuria in 12.8 % of their patients with APN unlike 21 % observed in this study. Huang J et al.26 observed that haematuria, oliguria, and altered consciousness were having attributable risk of mortality. But Buonaiuto et al.27 in an urban hospital in Spain, observed absence of fever and absence of costo vertebral angle tenderness were found to have attributable risk to mortality. Diabetes mellitus was present in 55 % of the patients in this study. M. Eshwarappa et al.8 reported DM in 42.6 % patients which was a common risk factor in patients with APN. The incidences of urinary incontinence, urinary stones and benign prostatic hyperplasia (BPH) in this study were 18 %, 19 % & 13 % respectively. It was similar to the study by Buonaiuto et al.27 the incidences were 16, 25 & 15 respectively. The prevalence of indwelling catheter...

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was 14 % in this present study similar to Veronica et al.28 The present study showed a prognostic significance in the presence of risk factors such as DM and urinary incontinence. There was a statistically significant correlation between DM and UI with mortality in this study (Table 5). Risk factors observed in the study by Buonaito et al.27 was indwelling bladder catheterization and chronic kidney disease (CKD). But the present study could not find any significant relationship with mortality for either indwelling catheter or CKD. Vera Y Chung et al.29 reported no significant prognostic implications for any of the above-mentioned risk factors such as DM, CKD or renal stones. Nitzan et al.30 observed from their study that the percentage of mortality in APN to be 5 times that of the general population in patients with DM.

Study by Pallet et al.31 concluded that outcome in patients with pyelonephritis was worse in presence of UI. The present study opines that the patients with DM were found to have higher probability of developing septic shock and emphysematous pyelonephritis when compared to APN patients without diabetes mellitus (DM), (Table 5). A study by Kaia and Raizada et al.32 reported higher risk for sepsis among patients with DM and immunosuppression; hypertension and CKD were found to be risk factors causing AKI. CKD, indwelling catheter and UI were found to increase the need for haemodialysis. Hsiao et al.33 reported risk factors like neurogenic bladder, pre-existing renal disease, instrumentation and emphysematous pyelonephritis were independent variables leading to dialysis. Hydronephrosis was found to be higher among patients with DM, hypertension, CKD, indwelling catheter and urolithiasis compared to patients without these risk factors. Mean systolic & diastolic BP were 114.6 and 74.2 respectively in this study; mean pulse rate & temperature were 110.6 and 101.06 respectively. The mean BP was lower in deceased patients compared to survived patients. This relationship was found to be statistically significant (Table 2). There was no significant relationship between rise in temperature and mortality. In this study haemoglobin levels were lower whereas blood urea, serum creatinine and total leucocyte count were above normal in deceased patients. This correlation was statistically significant (Table 6).

Anaemia, leukocytosis, DM and AKI at the time of presentation were important predictors of grave prognosis, with higher mortality. Thus, these patients warrant more aggressive management. Buonaito et al.27 reported correlation between higher total leucocyte counts above 20,000, high serum creatinine with mortality. E. coli was the most common causative organism in the present study. Klebsiella, Pseudomonas, staphylococci and streptococci caused the rest of the infections & Acinetobacter was the culprit in a single case. The mortality was maximum among Acinetobacter followed by streptococci and staphylococci. Buonaito et al.27 reported Escherichia coli as the causative agent in 67 % followed by Klebsiella species in 07.9 %. In the present study E. coli was isolated in urine culture sensitivity in 66 % patients and Klebsiella in 23 % and rest were constituted by Pseudomonas, staphylococci, streptococci and Acinetobacter. 54 / 100 patients were treated with empirical antibiotic ciprofloxacin. Piperacillin-tazobactam & cefoperazone-sulbactam was used in 35 & 11 patients respectively. Empirical therapy failure rate was found to be considerably higher among the patients who were given ciprofloxacin compared to other antibiotics and this was found to be statistically significant (Figure 1). In an Indian study by M. Eshwarappa et al.8 the resistance to quinolones were found to be 74 %. Buonaito et al.27 reported the prevalence of renal abscess to be 09.7 % which was comparable with our study where USG showed evidence of abscess in 08 % of the patients. In this study urolithiasis was present in 37 % of the patients which was almost double in the study by Eshwarappa et al.; 17.9 %. Among the USG features, abscess and evident emphysematous pyelonephritis were found to have significant mortality which is in accordance with the study by Vera Y Chung et al.29 Among the complications, AKI, bilateral (B / L) pyelonephritis, septic shock and failure of empirical treatment had significant attributable mortality. Vera Y Chung et al.29 reported significant attributable mortality for AKI, emphysematous pyelonephritis and septic shock, hence the results were comparable.

## CONCLUSIONS

Certain risk factors such as diabetes, urinary incontinence, hypertension, chronic kidney disease, hypertension and indwelling catheters were associated with increased incidence of complications. Hence, in the presence of such risk factors, appropriate treatment and preventive measures should be initiated promptly. Among the pathogens, 85 % of the organisms were sensitive to piperacillin–tazobactam. Hence, piperacillin-tazobactam can be recommended as the first line empirical antibiotic.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com. Financial or other competing interests: None. Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

## REFERENCES

1. Ramakrishnan K, Scheid DC. Diagnosis and management of acute pyelonephritis in adults. Am Fam Physician 2005;71(5):933-942.
2. Kumar V, Abbas A, Fausto N, et al. Robbins and Cotran Pathologic basis of disease. Professional edition. 1st edn. London: Elsevier Health Sciences 2014: p. 1413.
3. Ki M, Park T, Choi B, et al. The epidemiology of acute pyelonephritis in South Korea, 1997–1999. Am J Epidemiol 2004;160(10):985-993.
4. Khalesi N, Khosravi N, Jalali A, et al. Evaluation of maternal urinary tract infection as a potential risk factor for neonatal urinary tract infection. J Fam Reprod Health 2014;8(2):59-62.
[5] Umesha L, Shivprasad SM, Rajiv EN, et al. Acute pyelonephritis: a single-center experience. Indian J Nephrol 2018;28(6):454-461.

[6] Foxman B. Epidemiology of urinary tract infections: Incidence, morbidity and economic costs. Disease Month 2003;49(2):53-70.

[7] Diagnosis of acute pyelonephritis with trends in management. Medscape. [cited 2016 Nov 2]. http://www.medscape.com/viewarticle/771300.

[8] Eshwarapppa M, Dosegowda R, Apramey A, et al. Clinico-microbiological profile of urinary tract infection in south India. Indian J Nephrol 2011;21(1):30-36.

[9] Vasudevan R. Urinary tract infection: an overview of the infection and the associated risks factors. J Microbiology Experimentation 2014;1(2):42-54.

[10] Zaffanello M, Malerba G, Cataldi L, et al. Genetic risk for recurrent urinary tract infections in humans: a systematic review. Journal of Biomedicine and Biotechnology 2010;2010:321082.

[11] Waligankar SS, Patel V. Role of probiotics in urogenital healthcare. J Life Health 2011;2(1):5-10.

[12] Kline KA, Lewis AL. Gram-positive uropathogens, polymicrobial urinary tract infection and the emerging microbiota of the urinary tract. Microbiology Spectrum 2016;4(2):10.1128/microbiolspec.UTI-0012-2012.

[13] Flores-Mireles AL, Walker JN, Caparon M, et al. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Micr 2015;13(5):269-284.

[14] Longo DL, Fauci AS, Kasper DL, et al. Harrison's Principles of Internal Medicine. 19th edn. New York: McGraw-Hill 2015: p. 861-868.

[15] Lee DG, Jeon SH, Lee CH, et al. Acute pyelonephritis: clinical characteristics and the role of the surgical treatment. J Korean Med Sci 2009;24(2):296-301.

[16] Nicolle LE, AMMI Canada Guidelines Committee. Complicated urinary tract infection in adults. Can J Infect Dis Med Microbiol 2005;16(6):349-360.

[17] Gupta K, Hooton TM, Naber KG, et al. International Clinical Practice Guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: a 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis 2011;52(5):e103-e120.

[18] Pyelonephritis, acute, uncomplicated, Johns Hopkins Guides. 2016. [cited 20 November 2016]. Hopkinsguides.com http://www.hopkinsguides.com/hopkins/view/Johns_Hopkins_ABX_Guide/540458/all/Pyelonephritis_Acute_Uncomplicated.

[19] Guay DRP. Cranberry and urinary tract infections. Drugs 2009;69(7):775-807.

[20] Sun D, Abraham SN, Beachey EH. Influence of berberine sulfate on synthesis and expression of Pap fimbrial adhesion in uropathogenic Escherichia coli. Antimicrob Agents Chemother 1988;32(8):1274-1277.

[21] Jepson RG, Craig JC. A systematic review of the evidence for cranberries and blueberries in UTI prevention. Mol Nutr Food Res 2007;51(6):738-745.

[22] Pereira RS, Sumita TC, Furlan MR, et al. Antibacterial activity of essential oils on microorganisms isolated from urinary tract infection. Rev Saude Publica 2004;38(2):326-328.

[23] Schaeffer AJ, Story KO, Johnson SM. Effect of silver oxide/trichloroisocyanuric acid antimicrobial urinary drainage system on catheter-associated bacteriuria. J Urol 1988;139(1):69-73.

[24] Dhamotharan VM, et al. Study of the clinical profile of patients with CT proven acute pyelonephritis in a tertiary care hospital. Med Res Chron 2015;3(1):64-68.

[25] Czaja CA, Scholes D, Hooton TM, et al. Population-based epidemiologic analysis of acute pyelonephritis. Clin Infect Dis 2007;45(3):273-280.

[26] Huang JI, Tseng CC. Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis and pathogenesis. Arch Intern Med 2000;160(6):797-805.

[27] Buonaiuto VA, Marquez I, De Toro I, et al. Clinical and epidemiological features and prognosis of complicated pyelonephritis: a prospective observational single hospital-based study. BMC Infect Dis 2014;14:639.

[28] Olejnickova K, Hola V, Ruzicka F. Catheter-related infections caused by Pseudomonas aeruginosa: virulence factors involved and their relationships. Pathogens and Disease 2014;72(2):87-94.

[29] Chung VY, Tai CK, Fan CW, et al. Severe acute pyelonephritis: a review of clinical outcome and risk factors for mortality. Hong Kong Med J 2014;20(4):285-289.

[30] Nitzan O, Elias M, Chazan B, et al. Urinary tract infections in patients with type 2 diabetes mellitus: review of prevalence, diagnosis and management. Diabetes Metab Syndr Obes 2015;8:129-136.

[31] Pallett A, Hand K. Complicated urinary tract infections: practical solutions for the treatment of multidresistant Gram-negative bacteria. J Antimicrob Chemother 2010;65(Suppl 3):iii25-iii33.

[32] Kalra OP, Raizada A. Approach to a Patient with urosepsis. J Glob Infect Dis 2009;1(1):57-63.

[33] Hsiao CY, Yang HY, Chang CH, et al. Risk factors for development of septic shock in patients with urinary tract infection. Biomed Res Int 2015;2015:717094.