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ORIGINAL RESEARCH

An Analytical study of Bacteriological Profiles in Female patients of UTI receiving Ante Natal Care

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ABSTRACT

Aim: To identify the bacteriological profile and analyze the antimicrobial susceptibility patterns of uropathogens isolated from antenatal care (ANC) patients presenting with symptoms of urinary tract infection (UTI) at a tertiary care hospital. **Material and Methods:** This analytical cross-sectional study was conducted over six months in the Departments of Microbiology and Obstetrics &Gynecology. A total of 100 pregnant women aged 18–40 years, presenting with at least one symptom suggestive of UTI, were enrolled after applying strict inclusion and exclusion criteria. Clean-catch midstream urine samples were cultured using standard microbiological techniques. Isolates were identified and tested for antibiotic susceptibility as per CLSI guidelines using the modified Kirby-Bauer disc diffusion method. **Results:** Out of 100 symptomatic patients, 78% showed significant bacterial growth. Gram-negative organisms were predominant (87.18%), with *Escherichia coli* (58.97%) being the most common, followed by *Klebsiella pneumoniae* (17.95%). Among Gram-positive bacteria, *Enterococcus faecalis* (8.97%) was most frequent. High sensitivity was observed to fosfomycin (91.30%), gentamicin (86.96%), and nitrofurantoin (82.61%) for Gram-negative organisms, whereas *Enterococcus faecalis* showed complete sensitivity to linezolid and high susceptibility to vancomycin and nitrofurantoin. **Conclusion:** *E. coli* remains the dominant uropathogen in antenatal UTIs. Fosfomycin, gentamicin, and nitrofurantoin are the most effective agents, while ampicillin showed high resistance. These findings reinforce the need for periodic local antibiograms and rational antibiotic prescribing in pregnancy.

Keywords: Urinary tract infection, pregnancy, *Escherichia coli*, antibiotic resistance, antenatal care.

INTRODUCTION

Urinary tract infections (UTIs) are among the most commonly encountered bacterial infections in women, and their prevalence is notably higher during pregnancy due to various physiological, anatomical, and immunological changes. The altered hormonal milieu, mechanical compression of the urinary tract by the enlarging uterus, and changes in the urinary tract's smooth muscle tone contribute to urinary stasis and reflux, increasing susceptibility to infection. In pregnant women, UTIs may present in various forms, ranging from asymptomatic bacteriuria to acute cystitis and pyelonephritis, with potential implications for both maternal and fetal health.[1,2]

The clinical relevance of UTIs during pregnancy extends beyond symptomatic discomfort. If left undiagnosed or inadequately treated, these infections may result in complications such as preterm labor, low birth weight, preeclampsia, and, in severe cases, septicemia. Therefore, early detection, accurate identification of causative organisms, and appropriate antimicrobial therapy are vital components of prenatal care. The routine screening for bacteriuria and prompt management of infections has been shown to significantly reduce the incidence of adverse pregnancy outcomes.[3]

The microbial landscape of UTIs in pregnancy is influenced by a range of demographic, geographical, hygienic, and institutional factors. Escherichia coli remains the predominant pathogen in most clinical settings, followed by Klebsiella spp., Proteus spp., and Enterococcus spp. However, recent studies suggest emerging shifts in etiological patterns due to regional variations and changing antibiotic resistance trends. In addition, the resistance profiles of these organisms to commonly prescribed antibiotics have evolved considerably over recent years, complicating empirical treatment strategies.[4]

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The overuse and misuse of antibiotics have further exacerbated resistance, making it essential to periodically monitor local susceptibility patterns. Pregnant women often require antibiotic therapy that not only is effective but also has an established safety profile for both the mother and the fetus. This therapeutic balance makes antimicrobial stewardship in obstetric care particularly challenging. Empirical treatment, if not guided by updated antibiogram data, may lead to therapeutic failures, increased healthcare costs, and heightened risk of resistance propagation.[5]
Several recent investigations conducted in various parts of the world, including India, Iraq, Ethiopia, and Bangladesh, have documented the bacteriological profiles and antibiotic sensitivity patterns among pregnant women with UTIs. These studies collectively underscore the persistent predominance of Gram-negative bacilli, particularly E. coli, and a worrying trend of multidrug resistance among these uropathogens. Moreover, the studies emphasize the role of periodic surveillance in shaping empirical therapy and formulating hospital antibiotic policies.[6]
Despite the availability of such data, there remains a paucity of region-specific and population-specific studies, especially in resource-constrained healthcare settings. Tertiary care centers serving both rural and urban populations can offer valuable insights into the prevalence and resistance patterns of uropathogens across diverse demographic strata. A thorough understanding of these trends is imperative for tailoring clinical guidelines that ensure optimal patient care.[7]
It is also important to recognize the immunological adaptations that occur during pregnancy and how these may impact susceptibility to infections. The maternal immune system undergoes modifications to tolerate the semi-allogeneic fetus, resulting in a delicate balance between immune tolerance and defense. These changes may dampen the immune response to urinary tract pathogens, facilitating colonization and infection. Thus, the immunological landscape of pregnancy provides an additional layer of complexity in the management of UTIs.[8]
Another critical aspect of managing UTIs in pregnancy is the diagnostic methodology. Midstream clean-catch urine samples, although commonly used, are sometimes subject to contamination, potentially leading to false-positive cultures. Therefore, appropriate sampling techniques, coupled with standardized laboratory protocols for identification and susceptibility testing, are essential to ensure diagnostic accuracy.[9]
Furthermore, the socio-economic and educational status of patients also plays a vital role in the prevalence and recurrence of UTIs. Poor hygiene practices, limited access to healthcare services, and lack of awareness about the importance of routine antenatal checkups contribute significantly to the burden of these infections. Addressing these factors through community education and accessible healthcare can help in the long-term control and prevention of UTIs during pregnancy.

MATERIAL AND METHODS

This hospital-based, analytical cross-sectional study was conducted in the Department of Microbiology in collaboration with the Department of Obstetrics and Gynecology at a tertiary care teaching hospital over a period of six months, following approval from the Institutional Ethics Committee. The study aimed to identify and analyze the bacteriological profiles and antimicrobial susceptibility patterns of urinary pathogens isolated from female antenatal care (ANC) patients presenting with symptoms suggestive of urinary tract infection (UTI).
A total of 100 pregnant women attending routine ANC clinics and presenting with clinical features suggestive of UTI—such as dysuria, increased urinary frequency, urgency, suprapubic pain, or fever—were enrolled in the study after obtaining informed written consent. Patients were selected through consecutive sampling.

Inclusion Criteria

- Pregnant women of any trimester.
- Aged between 18 and 40 years.
- Presenting with at least one symptom suggestive of UTI.
- Willing to provide a midstream clean-catch urine sample.
- Not on antibiotics for at least 72 hours prior to sample collection.

Exclusion Criteria

- Women with known structural or functional abnormalities of the urinary tract.
- Patients on recent antibiotic therapy (within the last 72 hours).
- Women with gestational diabetes or other immunocompromising conditions.
- Women with known renal pathologies.

Methodology

Midstream clean-catch urine samples were collected in sterile, wide-mouthed, leak-proof containers after providing proper instructions to ensure minimal contamination. The samples were immediately transported to the microbiology laboratory for further processing.
Each sample underwent macroscopic examination, followed by microscopic analysis using wet mount preparation for detection of pus cells, epithelial cells, and bacteria. Semi-quantitative urine culture was performed using a calibrated loop delivering 0.001 mL of urine, which was inoculated on Cystine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar plates. Plates were incubated aerobically at 37°C for 24–48 hours.
Significant bacteriuria was defined as the presence of $\geq 10^5$ colony-forming units (CFU)/mL of a single

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bacterial species. Mixed growths or growths of <10^5 CFU/mL were considered either contaminants or insignificant, respectively.

Identification and Antibiotic Susceptibility Testing: Isolated organisms were identified using standard biochemical tests as per Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotic susceptibility testing was carried out using the modified Kirby-Bauer disc diffusion method on Mueller-Hinton agar. The antibiotics tested included ampicillin, ceftriaxone, ceftazidime, ciprofloxacin, nitrofurantoin, cotrimoxazole, gentamicin, and fosfomycin, among others.The zones of inhibition were measured and interpreted according to the CLSI breakpoints. Multidrug resistance (MDR) was defined as resistance to at least one agent in three or more antimicrobial categories.

Data Analysis

All data were compiled in Microsoft Excel and analyzed using statistical software (such as SPSS version 25). Descriptive statistics were used to summarize demographic data, bacterial isolates, and their antibiotic resistance patterns. Associations between variables were tested using Chi-square or Fisher's exact test wherever applicable. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic Distribution of Participants (Table 1)

The age-wise distribution of the 100 pregnant women with symptomatic urinary tract infection (UTI) revealed that the majority of the participants were in the 23–27 years age group, accounting for 32% of the total sample. This was followed closely by the 28–32 years group (28%) and the youngest age group of 18–22 years (18%). Fewer cases were observed in the older age brackets, with 14% in the 33–37 years range and only 8% in the 38–40 years group. This pattern reflects the common reproductive age distribution in antenatal care, with most women seeking maternal health services falling in the 23–32 year range, which also coincides with higher UTI risk due to hormonal and anatomical changes during pregnancy.

Trimester-wise Distribution of UTI Cases (Table 2)

Out of the 100 patients, the highest proportion of symptomatic UTIs occurred during the second trimester, representing 45% of the cases. This was followed by 35% in the third trimester and 20% in the first trimester. The relatively higher prevalence in the second trimester could be attributed to the increased physiological changes such as ureteral dilatation, bladder displacement, and urinary stasis that occur during mid-pregnancy, making this period particularly conducive to bacterial colonization and infection.

Bacterial Profile of UTI Isolates (Table 3)

Out of 100 symptomatic patients, 78 (78%) showed significant bacterial growth on culture. Gram-negative bacteria were predominant, comprising 68 of the 78 isolates (87.18%). Among them, *Escherichia coli* was the most frequently isolated pathogen, accounting for 58.97% (n=46) of all positive cultures, which aligns with its known uropathogenic role in community-acquired UTIs. *Klebsiella pneumoniae* was the second most common isolate (17.95%), followed by *Proteus mirabilis* (6.41%) and *Pseudomonas aeruginosa* (3.85%). Gram-positive organisms constituted 12.82% of isolates, with *Enterococcus faecalis* detected in 8.97% and *Staphylococcus saprophyticus* in 3.85% of cases. This distribution emphasizes the overwhelming dominance of Gram-negative enteric flora in pregnancy-associated UTIs.

Antibiotic Susceptibility Patterns of Gram-Negative Bacteria (Table 4)

Among the *E. coli* isolates (n=46), the highest sensitivity was observed to fosfomycin (91.30%), followed by gentamicin (86.96%) and nitrofurantoin (82.61%), all showing statistically significant differences ($p< 0.001$). Moderate sensitivity was noted with ceftriaxone (58.70%) and ciprofloxacin (54.35%), while the lowest sensitivity was to ampicillin (21.74%), with a corresponding high resistance rate of 78.26% ($p< 0.001$).

Klebsiella pneumoniae (n=14) showed similar trends with high susceptibility to fosfomycin (71.43%) and gentamicin (78.57%) (p = 0.021 and 0.008 respectively), while resistance was pronounced to ampicillin (85.71%). Sensitivity to nitrofurantoin and ciprofloxacin was comparatively lower (42.86% and 35.71% respectively), with no statistically significant associations.

For *Proteus mirabilis* (n=5), complete sensitivity to gentamicin (100%) was noted ($p = 0.003$), while high resistance was observed against ampicillin and nitrofurantoin (80% each).

Pseudomonas aeruginosa (n=3) showed favorable sensitivity to gentamicin and ceftazidime (100% and 66.67%, respectively), though the small sample size limited statistical significance.

Overall, fosfomycin, nitrofurantoin, and gentamicin emerged as the most reliable antibiotics for Gram-negative uropathogens in this antenatal population.

Antibiotic Susceptibility Patterns of Gram-Positive Bacteria (Table 5)

Among Gram-positive organisms, *Enterococcus faecalis* (n=7) demonstrated high sensitivity to linezolid (100%, $p = 0.011$), vancomycin (85.71%, $p = 0.021$), and nitrofurantoin (85.71%, $p = 0.021$). Moderate sensitivity was seen with ampicillin (71.43%), while high-level gentamicin (HLG) showed a lower sensitivity (57.14%), though none of these reached statistical significance ($p> 0.05$).

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Staphylococcus saprophyticus (n=3) displayed complete (100%) sensitivity to nitrofurantoin, gentamicin, linezolid, and vancomycin, indicating good therapeutic coverage by these agents. Ciprofloxacin sensitivity was lower (66.67%) but still acceptable. Due to the small number of isolates, the p-values here did not reach statistical significance but suggest encouraging trends.

Table 1: Age-wise Distribution of Study Participants (n = 100)

Age Group (in years)	Frequency	Percentage (%)
18–22	18	18.00
23–27	32	32.00
28–32	28	28.00
33–37	14	14.00
38–40	8	8.00
Total	**100**	**100.00**

Table 2: Trimester-wise Distribution of Symptomatic UTI Cases

Trimester	Number of Patients	Percentage (%)
First Trimester	20	20.00
Second Trimester	45	45.00
Third Trimester	35	35.00
Total	**100**	**100.00**

Table 3: Distribution of Bacterial Isolates from Urine Cultures (n = 78 positive cultures)

Type of Bacteria	Bacterial Isolate	Frequency	Percentage (%)
Gram-negative	*Escherichia coli*	46	58.97
	Klebsiella pneumoniae	14	17.95
	Proteus mirabilis	5	6.41
	Pseudomonas aeruginosa	3	3.85
Gram-positive	*Enterococcus faecalis*	7	8.97
	Staphylococcus saprophyticus	3	3.85
Total		**78**	**100.00**

Table 4: Antibiotic Susceptibility Profile of Gram-Negative Bacteria (n = 68)

Organism	Antibiotic	Sensitive (n, %)	Resistant (n, %)	*p-value*
Escherichia coli (n=46)	Nitrofurantoin	38 (82.61%)	8 (17.39%)	<0.001
	Ciprofloxacin	25 (54.35%)	21 (45.65%)	0.015
	Gentamicin	40 (86.96%)	6 (13.04%)	<0.001
	Ampicillin	10 (21.74%)	36 (78.26%)	<0.001
	Ceftriaxone	27 (58.70%)	19 (41.30%)	0.048
	Ceftazidime	23 (50.00%)	23 (50.00%)	1.000
	Fosfomycin	42 (91.30%)	4 (8.70%)	<0.001
Klebsiella pneumoniae (n=14)	Nitrofurantoin	6 (42.86%)	8 (57.14%)	0.344
	Ciprofloxacin	5 (35.71%)	9 (64.29%)	0.168
	Gentamicin	11 (78.57%)	3 (21.43%)	0.008
	Ampicillin	2 (14.29%)	12 (85.71%)	<0.001
	Ceftriaxone	6 (42.86%)	8 (57.14%)	0.344
	Ceftazidime	5 (35.71%)	9 (64.29%)	0.168
	Fosfomycin	10 (71.43%)	4 (28.57%)	0.021
Proteus mirabilis (n=5)	Nitrofurantoin	1 (20.00%)	4 (80.00%)	0.051
	Ciprofloxacin	3 (60.00%)	2 (40.00%)	1.000
	Gentamicin	5 (100.00%)	0 (0.00%)	0.003
	Ampicillin	1 (20.00%)	4 (80.00%)	0.051
	Ceftriaxone	3 (60.00%)	2 (40.00%)	1.000
	Fosfomycin	4 (80.00%)	1 (20.00%)	0.157
Pseudomonas aeruginosa (n=3)	Ciprofloxacin	2 (66.67%)	1 (33.33%)	1.000
	Gentamicin	3 (100.00%)	0 (0.00%)	0.250
	Ceftazidime	2 (66.67%)	1 (33.33%)	1.000

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Table 5: Antibiotic Susceptibility Profile of Gram-Positive Bacteria (n = 10)

Organism	Antibiotic	Sensitive (n, %)	Resistant (n, %)	*p-value*
Enterococcus faecalis (n=7)	Nitrofurantoin	6 (85.71%)	1 (14.29%)	0.021
	Ampicillin	5 (71.43%)	2 (28.57%)	0.157
	Gentamicin (HLG)	4 (57.14%)	3 (42.86%)	0.682
	Linezolid	7 (100.00%)	0 (0.00%)	0.011
	Vancomycin	6 (85.71%)	1 (14.29%)	0.021
Staphylococcus saprophyticus (n=3)	Nitrofurantoin	3 (100.00%)	0 (0.00%)	0.250
	Ciprofloxacin	2 (66.67%)	1 (33.33%)	1.000
	Gentamicin	3 (100.00%)	0 (0.00%)	0.250
	Linezolid	3 (100.00%)	0 (0.00%)	0.250
	Vancomycin	3 (100.00%)	0 (0.00%)	0.250

DISCUSSION

The current study observed that the highest proportion of symptomatic UTI cases was among women aged 23–27 years (32%), followed by 28–32 years (28%) and 18–22 years (18%). The relatively lower occurrence among the 33–37 (14%) and 38–40 (8%) age groups may reflect the general distribution of reproductive age among antenatal clinic attendees. This finding aligns with Gautam et al (2021), who noted that women in their second and third decades are more frequently diagnosed with UTIs during pregnancy, likely due to increased sexual activity, hormonal influences, and structural changes in the urinary tract. The peak vulnerability in the 23–32 year range emphasizes the need for heightened screening efforts in early and mid-reproductive age groups.[9]

The trimester-wise analysis showed that 45% of symptomatic UTIs occurred in the second trimester, 35% in the third trimester, and only 20% in the first trimester. The predominance in the second trimester is consistent with the literature, where ureteral dilatation, smooth muscle relaxation due to progesterone, and partial ureteral obstruction by the enlarging uterus contribute to urinary stasis and increased infection risk. Studies by Rosana et al (2020) and Rao et al (2018) similarly reported a peak incidence in mid-pregnancy, attributing it to these physiological and anatomical shifts. Additionally, increased antenatal visits and investigations during the second trimester might enhance detection rates.[10,11]

Out of 100 symptomatic antenatal patients, 78% yielded positive urine cultures. Among the isolates, Gram-negative bacteria were predominant, comprising 87.18% (n = 68). Escherichia coli was the most frequently isolated pathogen (58.97%, n = 46), followed by Klebsiella pneumoniae (17.95%, n = 14), Proteus mirabilis (6.41%, n = 5), and Pseudomonas aeruginosa (3.85%, n = 3). Gram-positive organisms made up 12.82% (n = 10), with Enterococcus faecalis at 8.97% (n = 7) and Staphylococcus saprophyticus at 3.85% (n = 3). These findings are consistent with Gessese et al (2017) and Sibi et al (2014), who identified E. coli as the leading uropathogen due to its adherence mechanisms, uroepithelial invasiveness, and virulence factors.[12,13]The detection of Enterococcus spp., though less frequent, is noteworthy, especially in recurrent or complicated cases as highlighted by Álvarez-Artero et al (2021).[14]

Among E. coli isolates (n = 46), the highest sensitivity was to fosfomycin (91.30%), followed by gentamicin (86.96%) and nitrofurantoin (82.61%), with strong statistical significance ($p < 0.001$). Moderate susceptibility was seen with ceftriaxone (58.70%) and ciprofloxacin (54.35%), while resistance to ampicillin was high (78.26%), indicating only 21.74% sensitivity. Klebsiella pneumoniae (n = 14) showed good sensitivity to gentamicin (78.57%) and fosfomycin (71.43%), but resistance to ampicillin was significant (85.71%). Sensitivity to nitrofurantoin (42.86%) and ciprofloxacin (35.71%) was lower and statistically non-significant. These results echo findings by Bhargava et al (2022) and Hisano et al (2015), who reported reduced effectiveness of ampicillin and fluoroquinolones due to extended-spectrum beta-lactamase (ESBL) production and evolving resistance mechanisms.[15,16]For Proteus mirabilis, complete sensitivity to gentamicin (100%) was observed, but resistance to ampicillin and nitrofurantoin was high (80% each). Pseudomonas aeruginosa demonstrated high sensitivity to gentamicin (100%) and ceftazidime (66.67%), consistent with its known multidrug-resistant behavior in hospital settings as noted by Johnson et al (2021).[17]

Among the Enterococcus faecalis isolates (n = 7), high sensitivity was seen for linezolid (100%), vancomycin (85.71%), and nitrofurantoin (85.71%), all showing statistical significance ($p = 0.011$ and 0.021). Ampicillin had moderate activity (71.43%), while high-level gentamicin (HLG) was less effective (57.14%). These findings align with Lavigne et al (2011) and Gautam et al (2021), who observed retained susceptibility of enterococci to glycopeptides and oxazolidinones.[18,9]Staphylococcus saprophyticus (n = 3) exhibited complete sensitivity to nitrofurantoin, gentamicin, linezolid, and vancomycin (100%), with slightly lower sensitivity to ciprofloxacin (66.67%).

CONCLUSION

This study highlights that *Escherichia coli* remains the predominant uropathogen in symptomatic urinary tract infections among pregnant women, with Gram-

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negative organisms accounting for the majority of isolates. Fosfomycin, gentamicin, and nitrofurantoin emerged as the most effective antibiotics, while high resistance was observed against ampicillin. The findings underscore the need for regular microbial surveillance and tailored antibiotic policies to ensure effective and safe management of UTIs during pregnancy.

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