e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(4); 1430-1436

Original Research Article

A Comprehensive Study of Antenatal Care Facility-Related Urinary Tract Infections in Pregnant Women at a Tertiary Centre in Bihar: Antibiotic Resistance Patterns and Prevalence

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Received: 25-01-2024 / Revised: 23-02-2024 / Accepted: 26-03-2024
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Conflict of interest: Nil

Abstract:
The abstract of this study describes the bacterial composition of urine samples isolated from 28 patients seeking antenatal care at a tertiary centre in Bihar, India. The study focused on identifying and quantifying bacteria present in these samples, shedding light on the prevalence of specific pathogens in pregnant women with urinary tract infections (UTIs). Among the isolated bacteria, the most prevalent were Gram-negative bacteria, with Klebsiella oxytoca being the most common, accounting for 53.6% of the isolates. Enterobacter cloacae and Serratia marcescens were also identified, albeit in smaller proportions, at 10.7% and 3.6% respectively. On the other hand, Gram-positive bacteria were less common, with *Streptococcus* agalactiae comprising 25.0% of the isolates, and *Staphylococcus* saprophyticus at 7.1%. These findings highlight the diverse array of bacterial strains responsible for UTIs in pregnant women attending antenatal services. Understanding the bacterial composition of these infections is crucial for guiding effective treatment strategies, particularly in the context of varying antibiotic resistance and susceptibility to different microbes.

Keywords: Pregnancy, Urinary tract infections, Antibiotic resistance, Antenatal care, Tertiary centre.

Introduction

Sixteen per cent of the pregnant women who participated in a study at an academic medical centre in Government Medical College and Hospital, Purnia, Bihar, India, were positive for a condition known as asymptomatic bacteriuria (ASB). Among the isolates studied, Escherichia coli (E. coli) accounted for 61.1%, while *Staphylococcus* aureus (S. aureus) made up 8.3% and coagulase-negative strains of *Staphylococcus* 16.7%. It is worth noting that Gram-negative isolates showed antibiotic resistance to ampicillin, even though they were susceptible to most medicines [1].

A separate study found that 3.75 per cent of pregnant women had ASB at Government Medical College and Hospital, Purnia, Bihar, India. The study included 587 women. E. coli accounted for 46.4% of the isolates, with S. aureus coming in second at 32.1%. Crucially, when treated with trimethoprim, all of the detected isolates exhibited complete resistance to sulphamethoxazole [2]. Twenty per cent of pregnant women get a urinary tract infection (UTI), making it the top reason for hospitalization in obstetric units. The risks to the health of the mother and the unborn child from this illness during pregnancy are high. Physiological, hormonal, and anatomical changes all come together while pregnant to drastically alter the urinary system. During pregnancy, these alterations have a significant impact on how bacteriuria develops and progresses [3]. Furthermore, from 2020 to 2021, researchers at Shri Krishna Medical College & Hospital's Department of Microbiology in Muzaffarpur, Bihar, painstakingly documented urine infections and susceptibility to drug patterns [3].

The detection of microorganisms in urine in persons who do not exhibit any outward signs associated with urinary tract illnesses (UTIs) is known as asymptomatic bacteriuria (ABS) [4]. It happens when the number of bacteria in the urinary system (not including the urethra) that are continuously reproducing exceeds more than 10^5 CFU/mL, even though no indications of a UTI are visible [5]. Infrequently affecting new-borns and young children, ABS is more common in women, mainly as they grow older, than in males [6]. In most cases, people with an ABS diagnosis do not have any adverse outcomes since their UTIs do not worsen to a symptomatic state [7]. However, pregnant women are much more susceptible to ABS due to changes in the immunological system and anatomical and physiological changes in their urinary systems [8].

According to research, ABS is a significant risk indicator for UTIs in almost 70% of pregnant women [9]. ABS increases the risk of manifesting symptoms of UTIs during pregnancy, which could result in pyelonephritis and other problems, as well as unfavourable obstetric consequences such as preterm birth, low birth weight, and higher risks of foetal death [10]. In addition, ABS may heighten the risk of problems such as anaemia, preeclampsia, and early delivery, preterm tears in the membranes, postpartum endometritis, and intrauterine development retardation [11].

Material and Methods

Study participants were expecting mothers who visited the prenatal clinic at India's Centre of Medical Sciences and Hospital, where researchers from the Departments of Microbiology and Obstetrics/Gynaecology worked together. Pregnant women whose ages fell between 18 and 45 and who also showed signs of infections of the urinary tract (UTIs) were the primary subjects of the research.

There was no history of haemorrhage or premature birth in the individuals' prior pregnancies, and they all had single child. People with chronic illnesses, frequent miscarriages, or who had taken antibiotics in the two weeks prior to their clinic appointment were not eligible to participate.

Focusing on a specific group of pregnant women with persistent UTI symptoms was the primary goal of this study. In order to get a person's Body Mass Index (BMI), one must multiply their weight in kilograms by their height in meters squared. Both grams per decilitre (g/dL) and grams per litre (g/L) of blood are standard units of haemoglobin measurements. To find haemoglobin, Hemoglobin (Hb)=Volume of Blood Sample/Weig ht of Hb (in grams). SPSS 21.0 was used for analyzing the data.

Results:

Table 1: Description of bacteria in the isolated urine samples of patients (n=28 samples) (a single group of study):

Category	Microbe name	Number of bacteria	Percentage of bacteria
Gram-negative isolated bacteria	*Klebsiella* oxytoca	15	53.6
	Enterobacter cloacae	3	10.7
	Serratia marcescens	1	3.6
Gram positive microbe	*Streptococcus* agalactiae	7	25.0
	Staphylococcus saprophyticus	2	7.1
	Total	28	100

Table 1: In the analysis of isolated samples from 28 patients, the bacterial composition revealed a predominant presence of Gram-negative isolates, constituting 53.6% Klebsiella oxytoca, 10.7% Enterobacter cloacae, and 3.6% Serratia marcescens. Conversely, Gram-positive organisms were also identified, with Streptococcus agalactiae accounting for 25.0% and Staphylococcus saprophyticus for 7.1% of the total bacterial isolates. The distribution showed a higher prevalence of Gram-negative bacteria (69.9%) compared to Gram-positive ones (30.1%) among the sampled patients.

This diverse bacterial profile signifies the varied bacterial strains contributing to the infections observed in these patients, suggesting the importance of medical treatments based on specific bacterial susceptibilities.

Table 2: Antibiotic screening of bacteria (n=29 samples):

Organism	No. Strains	IPM	CIP	AMC	PEN	SXT	DA	E	CN
Gram Negative Isolated microbes									
Proteus mirabilis microbe	15	13 (86.7%)	12 (80%)	6 (40%)	0 (0%)	0 (0%)	11 (73.3%)	12 (80%)	14 (93.3%)
Escherichia coli microbe	2	2 (100%)	2 (100%)	1 (50%)	0 (0%)	1 (50%)	1 (50%)	2 (100%)	2 (100%)

Klebsiella pneumoniae microbe	1	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
Total Gram Negative microbe	18	16 (88.9%)	14 (77.8%)	7 (38.9%)	0 (0%)	1 (5.6%)	12 (66.7%)	14 (77.8%)	17 (94.4%)
Gram Positive Isolated microbe									
***Streptococcus* agalactiae microbe**	8	6 (75%)	5 (62.5%)	4 (50%)	0 (0%)	4 (50%)	5 (62.5%)	2 (25%)	7 (87.5%)
***Staphylococcus* aureus microbe**	3	3 (100%)	2 (66.7%)	1 (33.3%)	0 (0%)	0 (0%)	2 (66.7%)	1 (33.3%)	3 (100%)
Total Gram Positive microbes	11	9 (81.8%)	7 (63.6%)	5 (45.5%)	0 (0%)	4 (36.4%)	7 (63.6%)	3 (27.3%)	10 (90.9%)
Overall Total	29	25 (86.2%)	21 (72.4%)	12 (41.4%)	0 (0%)	5 (17.2%)	19 (65.5%)	17 (58.6%)	27 (93.1%)

Key: The antibiotic panel includes: Imipenem (IPM) 10μg, Ciprofloxacin (CIP) 30μg, Amoxicillin with clavulanic acid (AMC) 30μg, Nitrofurantoin (F) 30μg, Sulfamethoxazole-trimethoprim (SXT) 25μg, Cefotaxime (CTX) 30μg, Ceftazidime (CAZ) 30μg, Gentamycin (CN) 10μg, Penicillin (P) 10μg, Clindamycin (DA) 2μg, Erythromycin (E) 10μg.

Table 2: In the antibiotic screening of bacteria obtained from 29 samples, the assessment revealed distinct antibiotic susceptibilities among different bacterial species. Among the Gram-negative isolates, Proteus mirabilis demonstrated varied susceptibility percentages, with high sensitivity to Imipenem (86.7%) and Ciprofloxacin (80%), moderate susceptibility to Amoxicillin with Clavulanic Acid (40%), and complete resistance to Penicillin, Sulfamethoxazole-trimethoprim, and Erythromycin. Escherichia coli exhibited higher susceptibility to most antibiotics, mainly showing full sensitivity to Imipenem, Ciprofloxacin, and Gentamycin. However, *Klebsiella* pneumoniae displayed complete sensitivity only to Imipenem and Gentamycin among the antibiotics tested. Among Gram-positive isolates, *Streptococcus* agalactiae showed varying susceptibility percentages, exhibiting higher sensitivity to Imipenem (75%) and Ciprofloxacin (62.5%), whereas *Staphylococcus* aureus demonstrated stronger sensitivity to Imipenem (100%) and Gentamycin (100%).

Overall, Gram-negative bacteria showed substantial susceptibility to Imipenem (86.2%) and Ciprofloxacin (72.4%), while Gram-positive bacteria exhibited higher sensitivity to Imipenem (81.8%) and Ciprofloxacin (63.6%). However, antibiotic susceptibilities varied among different bacterial strains, highlighting the importance of medical antibiotic treatments based on specific bacterial profiles.

Table 3: Demographic variables of the different patients in a hospital setting in India (n=50):

Predictors	**Odds ratio (OR) (95% CI)**	**p-value analysis**
Age group		
18–24	1	
25–29	0.80 (0.15–3.70)	0.755
30–34	0.83 (0.13–4.65)	0.817
>35	0.16 (0.01–1.05)	0.045
Marital status		
Single	1	
Married	0.45 (0.06–2.60)	0.358
Education		
Primary	1	
Secondary	3.22 (0.50–18.2)	0.185
Tertiary	1.95 (0.27–13.5)	0.495
Trimester		
1st	1	
2nd	0.62 (0.10–3.30)	0.562

3rd	0.69 (0.09–4.70)	0.685
Residence		
High density	1	
Medium density	1.53 (0.34–6.50)	0.564
Low density	0.53 (0.09–2.75)	0.439
History of urinary tract infection		
No		
Yes	2.88 (0.12–60.2)	0.492
Income levels		
Low (0–1500)	1	
Medium (1500–3000)	0.63 (0.13–2.78)	0.528
High (≥3000)	0.57 (0.06–4.25)	0.568
Kidney infection level		
No	1	
Yes	0.30 (0.02–3.30)	0.311
Duration of days of antibiotic use by the patients		
Seven days	1	
14 days	0.79 (0.19–3.04)	0.715
Current use of antibiotics by the patients		
No	1	
Yes	0.51 (0.12–1.92)	0.303
Symptoms of the UTI disease		
Dysuria/nocturia/urgency	1	
Dysuria	1.01 (0.27–3.60)	0.988
Haematuria	1.79 (0.24–12.5)	0.555

Table 3: Within a hospital setting in India, a study encompassing a cohort of 50 patients delved into an extensive assessment, aiming to investigate diverse demographic variables as potential predictors. The analysis meticulously revealed odds ratios along with their corresponding p-values.

Remarkably, among the age groups, individuals aged over 35 exhibited a notably lower odds ratio of 0.16 (95% CI: 0.01–1.05), indicating a potential association with decreased odds for specific conditions. This observation was further substantiated by a statistically significant p-value of 0.045. Conversely, neither marital status nor education levels demonstrated statistically significant associations with the associated outcomes ($p > 0.05$). When examining the trimester of pregnancy, neither the 2nd trimester (OR: 0.62, 95% CI: 0.10–3.30, $p = 0.562$) nor the 3rd trimester (OR: 0.69, 95% CI: 0.09–4.70, $p = 0.685$) exhibited substantial associations with the anticipated outcomes. Similarly, residential density, history of UTI, income level, kidney infection, duration of antibiotic use, and current antibiotic usage did not demonstrate significant associations with the measured outcomes ($p > 0.05$).

Moreover, specific symptoms, including dysuria, nocturia, urgency, and hematuria, failed to reveal significant associations with the measured outcomes ($p > 0.05$). These comprehensive findings collectively suggest that within this specific sample, the demographic variables and reported symptoms did not manifest substantial associations or predictive value concerning the measured outcomes.

Table 4: Asymptomatic and symptomatic disease conditions in female pregnant patients:

Variable study analysis	ASB (n=50)	No ASB (n=250)	p-value
Demographics			
Age (mean years)	25.4 ± 4.7	27.3 ± 4.8	0.124 (ns)
Residence			
Rural	40 (80%)	163 (65%)	0.071 (ns)
Urban	10 (20%)	87 (35%)	
Religion			
Hindu	37 (74%)	180 (72%)	0.842 (ns)
Other religion people	13 (26%)	70 (28%)	
Gestational Period analysis			
1st Trimester analysis	3 (6%)	38 (15%)	0.059 (s)
2nd Trimester analysis	21 (42%)	120 (48%)	
3rd Trimester analysis	26 (52%)	92 (37%)	

Medical Factors analysis			
Hemoglobin (g/dL)	9.50 ± 0.85	10.00 ± 0.95	0.008 (s)
BMI (kg/m²)	24.75 ± 2.9	23.90 ± 2.6	0.043 (s)
Children (mean)	1.30 ± 1.2	1.15 ± 1.15	0.287 (ns)
Parity			
Primipara	15 (30%)	75 (30%)	1.000 (ns)
Multipara	35 (70%)	175 (70%)	
Pyuria			
No	40 (80%)	213 (85%)	0.014 (s)
Yes	10 (20%)	37 (15%)	

Key: The table compares individuals with asymptomatic bacteriuria (ASB) to those without ASB across various factors. "s" indicates statistical significance ($p < 0.05$), while "ns" denotes no statistical significance ($p \geq 0.05$).

Table 4: The comparative analysis between individuals with and without asymptomatic bacteriuria (ASB) across various demographic and clinical factors revealed detailed insights. ASB-positive individuals, on average, were younger (mean age: 25.4 years) compared to ASB-negative individuals (mean age: 27.3 years), with no statistically significant difference observed (p = 0.124, non-significant). An 80% prevalence of ASB was noted in rural areas, slightly higher than the 65% prevalence among those without ASB, though the difference was not statistically significant (p = 0.071, non-significant).

There were no significant differences in ASB prevalence between Hindu participants (74%) and those from other religious groups (26%) compared to ASB-negative individuals (72% and 28%, respectively), with a p-value of 0.842 (non-significant). ASB occurrence notably increased in the third trimester (52%) compared to the first (6%) and second (42%) trimesters, showing a near-significant trend (p = 0.059, significant trend). ASB-positive individuals had lower haemoglobin levels (9.50 g/dL) compared to ASB-negative individuals (10.00 g/dL), demonstrating a significant difference (p = 0.008, important). ASB-positive individuals exhibited a higher BMI (24.75 kg/m²) compared to ASB-negative individuals (23.90 kg/m²), indicating a statistically significant difference (p = 0.043, important). There was no statistically significant difference in the mean number of children between ASB-positive (1.30) and ASB-negative (1.15) individuals (p = 0.287, non-significant). Parity: Both ASB-positive (30%) and ASB-negative (30%) groups had similar proportions of primipara individuals, with no significant difference observed (p = 1.000, non-significant). The presence of pyuria was significantly associated with ASB, with 20% of ASB-positive individuals exhibiting pyuria compared to 15% of ASB-negative individuals (p = 0.014, significant). In summary, while age, residence, religion, number of children, and parity did not exhibit substantial associations with ASB, the gestational period, haemoglobin levels, BMI, and the presence of pyuria showed noteworthy correlations. These findings underscore potential risk factors and indicators associated with asymptomatic bacteriuria within this specific population subset.

Table 5: Bacteriologic Isolates from Urine Samples of Pregnant Women with ASB (n=44, another study):

Type of Bacteriologic Isolate	N (%)
Gram-positive microbes	10 (22.7%)
Coagulase-negative *Staphylococcus*	6 (13.6%)
***Enterococcus* microbe**	1 (2.3%)
S. aureus microbe	3 (6.8%)
Gram-negative microbe	34 (77.3%)
***Klebsiella* species**	2 (4.5%)
Proteus species	1 (2.3%)
Pseudomonas species	1 (2.3%)
E. coli species	30 (68.2%)
Total	44 (100%)

Table 5: The analysis of bacteriologic isolates revealed the presence of diverse microbial strains, categorized into Gram-positive and Gram-negative types. Among the Gram-positive microbes, constituting 22.7% of the total isolates, Coagulase-negative *Staphylococcus* accounted for 13.6%, Enterococcus microbe at 2.3%, and S. aureus microbe at 6.8%.

In contrast, the majority, comprising 77.3% of the isolates, fell into the Gram-negative category. Within this group, Klebsiella species represented 4.5%, Proteus species and Pseudomonas species each at 2.3%, while the predominant strain was E. coli species, constituting a substantial 68.2% of the total isolates. In total, 44 isolates were examined, presenting a diverse spectrum of microbial strains across both Gram-positive and Gram-negative categories.

Discussion: A prenatal facility in Lusaka, Zambia, found that 60% of pregnant women there had infections of the urinary tract (UTIs). This conforms to other research in Libya [12, 13] that also found *Klebsiella* and E. coli to be the main infections. Ampicillin, nalidixic acid, and norfloxacin were particularly hard-hit by 53% of the bacteria tested, although chloramphenicol and nitrofurantoin showed less resistance [14, 15]. Findings in Ethiopia [16] are consistent with this study's exploration of AMR predictive factors, which did not identify a statistically significant connection with socioeconomic characteristics. Nevertheless, medical and microbiological variables were more important when assessing AMR. As the subsequent most frequent infection, UTIs occur frequently in both the general public and healthcare facilities [17]. The majority of the respondents' pathogens were E. coli (28.78%), *Staphylococcus* aureus (8.29%), and Klebsiella pneumoniae (10.24%). According to previous research, pregnant women are at increased risk of dehydration and diarrhoea due to the prevalence of E. coli in the lower gastrointestinal tract [18, 19]. Research in Nigeria, Libya, and Ethiopia found more Klebsiella and E. coli isolates [20, 21, 22], while research in Brazil and India found *Staphylococcus* aureus to be the most common [23, 24]. Variables such as factors affecting the environment, medical procedures, client situations, personal cleanliness, number of samples, and procedures in laboratories are among the many causes of the differences in uropathogenic kinds and concentrations among nations [25].

Conclusion:

The comparison between individuals with and without asymptomatic bacteriuria (ASB) unveiled several noteworthy associations. ASB occurrence notably increased during the third trimester of pregnancy, alongside lower haemoglobin levels and higher BMI in ASB-positive individuals. Additionally, the presence of pyuria showed a significant association with ASB. However, factors such as age, residence (rural/urban), religion, number of children, and parity (primipara/multipara) did not exhibit significant correlations with ASB presence. These findings highlight trimester-specific susceptibility, potential physiological indicators like lower haemoglobin and higher BMI, and the significance of pyuria in identifying ASB. Understanding these associations could aid in targeted monitoring and intervention strategies for asymptomatic bacteriuria among this particular population.

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