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Antimicrobial Profile of Bacterial Agents of Urinary Tract Infection in Pregnant Women from Selected Hospitals in Gusau, Nigeria

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Abstract

This study aimed at determining the bacteriological agents of Urinary Tract Infection (UTI) in pregnancy and their susceptibility profile to a battery of antibiotics. One hundred and fifty (150) mid-stream clean catch urine samples were collected from pregnant women attending antenatal clinic in Gusau. Samples were analyzed by microscopy and culture to isolate and characterize biochemically the etiologic agents of UTI. Out of 150 urine samples collected from the pregnant women, 36.7% were prevalent for UTI with highest prevalence in those aged 25-29 and 35-39 years (50.0%), in middle class (38.4%), third trimester (38.5%) and in polygamy (40.0%). Thirty-three (33) isolates obtained comprise four bacteria namely: *Escherichia coli* (51.5%), *Klebsiella pneumoniae* (21.2%), *Pseudomonas aeruginosa* (12.1%), and *Proteus* spp. (15.1%) that were tested for their susceptibility to eight (8) different antibiotics namely: Augmentin (30 µg), Gentamycin (10 µg), Ceftazidime (30 µg), Ceftriaxone (30 µg), Cefuroxime (30 µg), Cloxacillin (5 µg), Erythromycin (5 µg), and Ofloxacin (5 µg), using disc diffusion method. The isolated bacteria showed varying susceptibility patterns to the used antibiotics. All the isolates were generally highly resistant to Cloxacillin, Erythromycin, Ceftazidime, Augumentin, Cefuroxime and Ceftriaxone at 100, 93.5, 92.0, 84.3, 73.9 and 71.6% respectively. Ofloxacin had the highest susceptibility profile to *E. coli* (76.4%) the dominant isolates, *K. pneumonia* (85.7%), *P. aeruginosa* (100.0%), and *Proteus* spp. (100.0%). Bacteriologic examination therefore should be encouraged in the treatment of UTIs as this will not only indicate the presence of bacteria but also outline the possible appropriate antibiotics to take care of the bacteria.

Keywords: *Antibiotic susceptibility, Bacterial agent, Urinary tract infection, Pregnant women, Antenatal clinic*

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1. Introduction

Urinary Tract Infections (UTIs) in pregnant women contribute about 25% of all infections and are among the most frequent clinical bacterial infections. Pregnancy changes in women that include anatomical, physiological and hormonal make them susceptible to develop UTI. The changes include dilatation of urethra, increased bladder volume and decreased bladder tone, decreased ureteral tone that leads to increased urinary stasis and vesico-ureteric reflux. These changes are partly due to increased levels of progesterone and estrogen but also due to pressure created by the growing uterus (Taye *et al.*, 2018). Up to 70% of women during pregnancy develop glycosuria, which encourages bacterial growth in the urine (Kant *et al.*, 2017). Untreated UTI in pregnancy is associated with complications like pyelonephritis, sepsis, severe sepsis and septic shock, hypertensive disease of pregnancy, anaemia, acute and chronic renal failure, intrauterine growth restriction, premature delivery, foetal mortality, and increased caesarean delivery (Taye *et al.*, 2018). These complications can be decreased by proper and prompt diagnosis and treatment of UTI in pregnancy (Assafi *et al.*, 2015).

It has been estimated that globally symptomatic UTIs result in as many as 7 million visits to outpatient clinic, 1 million visits to emergency departments, and 100,000 hospitalizations annually (Hamdan *et al.*, 2011).

A limited spectrum of organisms causes UTI and these include *Escherichia coli*, which accounts for the majority of uncomplicated urinary tract infection isolates (Nandy *et al.*, 2007). Others are *Staphylococcus saprophyticus*, *Klebsiella* spp., *Proteus* spp., *Enterococcus* spp. and *Enterobacter* spp. (Masinde *et al.*, 2009). Many of these organisms are highly resistant to the commonly used antibiotics (Johnson *et al.*, 2021).

2. Materials and Methods

2.1. Study Area

The study was carried out in Gusau Metropolitan area which had an estimated population of 226,873 people, located in north-western Nigeria at Latitude: 12° 10' 12.86" N and Longitude: 6° 39' 50.83" E. Urine samples were collected from a total of one hundred and fifty (150) pregnant women attending antenatal clinics at Federal Medical Center Gusau, King Fahad Women and Children Hospital and Yariman Bakura Specialist Hospital, Gusau, Zamfara State, North Western, Nigeria.

2.1.1. Inclusion Criteria

- Pregnant women aged 15-39 years.
- Pregnant women attending antenatal clinics.

2.1.2. Exclusion Criteria

- Pregnant women age $\leq$ 14 and those above 39 years.
- Pregnant women not attending antenatal.

2.1.3. Ethical Permission/Informed Consent

- Ethical permission was granted by the ethical review committee of the selected hospitals.
- Informed consent was obtained from the pregnant women after explaining to them about the research.

2.2. Questionnaire Administration

A questionnaire was distributed to all consenting pregnant women. Data collected include age, gestational age, gravidity, marital type, educational status, trimester, previous history of UTI and type of toilet use.

2.2.1. Sample Size

One hundred and fifty (150) samples were collected randomly from the selected hospitals.

2.3. Sample Collection

One hundred and fifty (150) mid-stream clean catch urine samples were collected in a sterile universal disposable bottles from pregnant women suspected of UTI at first antenatal booking. They were instructed on

how to collect sample and prompt delivery to the laboratory. Collected samples were taken to Microbiology Laboratory, Federal University Gusau for analysis.

2.4. Sample Analysis

Urine specimens were cultured on Cystein Lactose Electrolyte Deficiency (CLED) agar as described by Cheesbrough (2006) and incubated at 37 °C for 24 h and further sub-cultured on MacConkey agar to get pure isolates. Specimen that yielded pure isolate of bacterial pathogens was considered positive, isolates were taken and sub cultured on nutrient agar slant for further analysis.

2.4.1. Identification of the Bacterial Isolates

Presumptive identification of bacteria was conducted based on staining techniques, cultural morphology and biochemical tests.

2.5. Antibiotic Susceptibility Test

Mueller Hinton agar was prepared and dispensed into sterile petri dishes, and was allowed to solidify. The isolates which were prepared to a turbidity standard of 0.5 McFarland's standard (approximately 1 x 10^8 CFU/mL) were then swabbed on the surface of the solidified Mueller Hinton agar using sterile swab sticks. The isolates were tested for their susceptibility to eight (8) different antibiotics namely: Augmentin (30 µg), Gentamycin (10 µg), Ceftazidime (30 µg), Ceftriaxone (30 µg), Cefuroxime (30 µg), Cloxacillin (5 µg), Erythromycin (5 µg), and Ofloxacin (5 µg).

The antibiotic discs were gently pressed to bring them in contact with surface of the inoculated Mueller-Hinton agar and the plates were incubated at 37 °C for 24 h. The diameter of zone of inhibition was measured with a meter rule to the nearest millimeter. The interpretation of the zones of inhibition was done using the method adapted from Clinical and Laboratory Standards Institutes (CLSI) (2016).

2.6. Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 17. The differences and statistical significance were assessed by Chi-square test and a p-value ≤ 0.05 was considered statistically significant.

3. Results

Table 1 shows prevalence of 36.7% for UTI in 150 urine samples collected from pregnant women attending antenatal clinics in some hospitals in Gusau. Prevalence of UTI based on age is shown in Table 2. The

Table 1: Prevalence of UTI among Pregnant Women

Subjects	Cases	Prevalence (%)
UTI	55	36.7
Non-UTI	95	63.3
Total	150	100

Table 2: Prevalence of UTI among Pregnant Women Based on Age

Age (Years)	No. of Samples Analyzed	No. of Positive Samples	Prevalence (%)	p-value
15-19	28	6	21.4	0
20-24	80	30	37.5	
25-29	22	11	50	
30-34	16	6	37.5	
35-39	4	2	50	

Highest prevalence of UTI (50.0%) was observed in pregnant women aged 25-29 and 35-39 years and lowest incidence (21.4%) was noticed in ages between 15-19 years with *p*-value less than 0.05 which is statistically significant.

Prevalence of UTI on the basis of trimester is shown in Table 3. Highest prevalence was observed among pregnant women in third trimester (38.5%), followed by second trimester (36.4%) and then first trimester (25.0%), this was statistically significant as the *p*-value is less than 0.05.

Prevalence of UTI among pregnant women based on risk factors and socioeconomic status is shown in Table 4. Highest prevalence was seen among those using modern toilet (39.2%) and lowest prevalence was observed among those using pit toilet (31.2%) with *p*-value less than 0.05 which is statistically significant. Highest prevalence was observed in polygamy (40.0%) and lowest prevalence was seen in monogamy (35.0%)

Table 3: Prevalence of UTI in Pregnant Women Based on Gestation Period

Gestation Period	No. of Samples Analyzed	No. of Positive Samples	Prevalence (%)	*p* -value
First Trimester	8	2	25	0.02
Second Trimester	85	31	36.4	
Third Trimester	57	22	38.5	

Table 4: Prevalence of UTI in Pregnant Women Based on Risk Factors/Socioeconomic Class

Variables	No. of Samples Analyzed	No. of Positive Samples	Prevalence (%)	*p* -value
Type of toilet used				
Modern toilet	102	40	39.2	0
Pit toilet	48	15	31.2	
Marital type				
Monogamy	100	35	35	0
Polygamy	50	20	40	
Gravidity				
Primigravida	69	25	36.2	0.31
Multigravida	81	30	37	
Socio economic class				
High class	2	0	0	0
Middle class	125	48	38.4	
Low class	23	7	30.4	

Note: 1% level of significance.

Table 5: Frequency of Bacterial Agents of UTI Isolated in Pregnant Women

Bacterial Isolate	Frequency	Percentage (%)
Escherichia coli	17	51.2
Klebsiella pneumonia	7	21.2
Pseudomonas aeruginosa	4	12.1
Proteus spp	5	15.1

Table 6: Antibiotics Susceptibility Profile of *E. coli* Isolated from Pregnant Women (n = 17)

Antibiotics	Disk Concentration	No. and % Sensitive	No. and % Resistant
Augumentin	30µg	03(17.6)	14(82.3)
Ceftazidime	30µg	03(17.6)	14(82.3)
Ceftriaxone	30µg	01(05.8)	16(94.1)
Cefuroxime	30µg	01(05.8)	16(94.1)
Cloxacillin	5µg	00(00.0)	17(100.0)
Erythromycin	5µg	02(11.7)	15(88.2)
Gentamicin	10µg	12(70.5)	05(29.4)
Ofloxacin	5µg	13(76.4)	04(23.5)

Table 7: Antibiotics Susceptibility Profile of *K. pnuemoniae* Isolated from Pregnant Women (n = 07)

Antibiotics	Disk Concentration	No. and % Sensitive	No. and % Resistant
Augumentin	30µg	00(00.0)	07(100.0)
Ceftazidime	30µg	01(14.2)	06(85.7)
Ceftriaxone	30µg	03(42.8)	04(57.1)
Cefuroxime	30µg	02(28.5)	05(71.4)
Cloxacillin	5µg	00(00.0)	07(100)
Erythromycin	5µg	01(14.2)	06(85.7)
Gentamicin	10µg	07(100.0)	00(00.0)
Ofloxacin	5µg	06(85.7)	01(14.2)

Table 8: Antibiotics Susceptibility Profile of *P. aeruginosa* Isolated from Pregnant Women (n = 04)

Antibiotics	Disk Concentration	No. and % Sensitive	No. and % Resistant
Augumentin	30µg	01(25.0)	03(75.0)
Ceftazidime	30µg	00(00.0)	04(100.0)
Ceftriaxone	30µg	01(25.0)	04(75.0)
Cefuroxime	30µg	02(50.0)	02(50.0)
Cloxacillin	5µg	00(00.0)	04(100.0)
Erythromycin	5µg	00(00.0)	04(100.0)
Gentamicin	10µg	00(00.0)	04(100.0)
Ofloxacin	5µg	04(100.0)	00(00.0)

which was statistically significant. Highest prevalence of UTI was seen in multigravida (37.0%) and lowest prevalence was seen in primigravida (36.2%) with the p-value greater than 0.05 although this is not statistically significant. In middle class, highest prevalence was seen (38.4%) and lowest prevalence was seen in low class (30.4%) and this was statistically significant as the p-value is less than 0.05.

Frequency of bacteria causing UTI is shown in Table 5. The commonest causative organism was found to be *E. coli* (51.2%).

The antibiotic susceptibility profile of *E. coli* is shown in Table 6. Ofloxacin and Gentamicin were susceptible with 76.6 and 70.5% respectively. Coxacillin was highly resistant (100%).

Table 7 shows the antibiotic susceptibility profile of *K. pneumonia* isolated from pregnant women where Ofloxacin had the highest susceptibility profile (85.7%) and cloxacillin was highly resistant (100%).

The antibiotic susceptibility profile of *P. aeruginosa* is shown in Table 8. Ofloxacin was highly susceptible (100%) and Cloxacillin was highly resistant (100%)

Antibiotic susceptibility profile of *Proteus* spp is shown in Table 9. Ofloxacin had the highest susceptibility profile and Cloxacillin was highly resistant.

Table 9: Antibiotics Susceptibility Profile of *Proteus spp* Isolated from Pregnant Women (n = 05)

Antibiotics	Disk Concentration	No. and % Sensitive	No. and % Resistant
Augumentin	30µg	01(20.0)	04(80.0)
Ceftazidime	30µg	00(00.0)	05(100.0)
Ceftriaxone	30µg	02(40.0)	03(60.0)
Cefuroxime	30µg	01(20.0)	04(80.0)
Cloxacillin	5µg	00(00.0)	05(100.0)
Erythromycin	5µg	00(00.0)	05(100.0)
Gentamicin	10µg	03(60.0)	02(40.0)
Ofloxacin	5µg	05(100.0)	00(00.0)

4. Discussion

In this study, the prevalence of UTI among pregnant women was 36.7%. This figure varies with other finding in Nigeria (Jido *et al.*, 2006), Africa (Johnson *et al.*, 2021) and other part of the world (Ghaima *et al.*, 2018). The finding of 36.7% prevalence of UTIs in this study was within the same range with 31.6% in Kano, Northwestern Nigeria (Jido *et al.*, 2006) and 35% at Mbarara Regional Referral Hospital, South-Western Uganda (Johnson *et al.*, 2021) but lower than prevalence rate of 46.5% obtained in Abakaliki, Ebonyi, Southeast Nigeria (Onoh *et al.*, 2013) where the subjects were only pregnant women with laboratory confirmed UTI (culture positive UTI) which determined the social class of the subjects.

This study shows that there was high incidence of UTI between age groups 25-29 years (50.0%) and 35-39 years (50.0%). This result is similar to the findings of Adeyeba *et al.* (2002) and Obiogbolu *et al.* (2009). In the study of Onoh *et al.* (2013), the subjects were predominantly within the range of 20-29 years but with lower mean age.

Obiogbolu (2004), stated that high incidence of UTI may be due to hormonal effects produced during pregnancy which reduces the tone of uteri musculature aided by mechanical pressure from the gravid uterus resulting to urinary stasis thus encouraging bacterial proliferation in urine. It may also be due to social economic status and sexual intercourse (Ebie *et al.*, 2001). Traditionally, *E. coli* has been the dominant uropathogen owing to its possession of toxins, adhesins, pili and fimbriae that allow adherence to uroepithelium. These protect the bacteria from urinary clearance and allow bacterial multiplication and uroepithelial tissue invasion. Recent studies however indicate that *Klebsiella pneumoniae* which has traditionally been a nosocomial organism is an emerging dominant community acquired uropathogen (Taye *et al.*, 2018; Manjula *et al.*, 2013; Caneiras *et al.*, 2019; Kaduma *et al.*, 2019; RN-t *et al.*, 2016).

In this study, isolation of bacteria was predominantly obtained from multigravida subjects (37.0%). However, *E. coli* was the most frequently isolated organism among patients enrolled with 51.5%. This report is in support of other findings where *Escherichia coli* was reported as the major uropathogen (Kalantar *et al.*, 2008; Agersew *et al.*, 2012; Sevki *et al.*, 2011; Okonko *et al.*, 2009). This finding is contrary to that of Akinola *et al.* (2012) where *Staphylococcus aureus* was reported as the commonest isolate in antenatal patients. Other isolated

uropathogen in this study were *Klebsiella pneumoniae* (21.2%), *Pseudomonas aeruginosa* (12.1%) and *Proteus* spp. (15.1%). The differences observed may not be due to characteristic differences in their cell wall, but may probably be related to individual bacterial colonization. This supports the fact that UTI were derived from organisms that colonizes the lower gastrointestinal tract and lower genital tract.

The antibiotics susceptibility showed that all the isolated organisms were generally highly resistant to Cloxacillin, Erythromycin, Ceftazidime, Augumentin, Cefuroxime and Ceftriaxone at 100, 93.5, 92.0, 84.3, 73.9 and 71.6% respectively, and these are the commonly prescribed antibiotics in the study area. *E. coli*, the most frequently isolated organism was resistant to both Ceftriaxone and Cefuroxime at 94.1% and to Cloxacillin at 100%. This has been demonstrated in other studies where resistance values obtained in this study were higher than those mentioned in the studies (Johnson *et al.*, 2021; Ghaima *et al.*, 2018; Caneiras *et al.*, 2019; Vicar *et al.*, 2023). The irrational use and abuse of broad-spectrum antibiotics due to their affordability and easy access may be the reason for the high resistance to these drugs (Afoakwa *et al.*, 2018; Newman *et al.*, 2011). Ofloxacin had the highest susceptibility profile to *E. coli* (76.4%), *K. pneumonia* (85.7%), *P. aeruginosa* (100.0%), and *Proteus* spp. (100.0%), in this study. This result is in contrast with that of Vicar *et al.* (2023) where most isolates were susceptible to gentamycin.

This study revealed the significance of bacteriologic examination of urine in the diagnosis of UTIs rather than radiologic scan. In communities with low socio-economic status, empirical treatment should be discouraged. Bacteriologic examination therefore should be encouraged as this will not only indicate the presence of bacteria but also outline the possible appropriate antibiotics to take care of the bacteria.

5. Conclusion

The prevalence of Urinary Tract Infection (UTI) in pregnant women in the study area is 36.6%. The sociodemographic and risk factors such as age, sexual activity, multiparity, previous history of UTI and socioeconomic conditions predispose to UTI. All isolated organisms were generally highly resistant to Cloxacillin, Erythromycin, Ceftazidime, Augumentin, Cefuroxime and Ceftriaxone, the commonly prescribed antibiotics in the study area at 100, 93.5, 92.0, 84.3, 73.9 and 71.6% respectively. *E. coli*, the predominant isolated organism was resistant to both Ceftriaxone and Cefuroxime at 94.1% and to Cloxacillin at 100%. Ofloxacin had the highest susceptibility profile to *E. coli* (76.4%), *K. pneumonia* (85.7%), *P. aeruginosa* (100.0%), and *Proteus* spp. (100.0%). Routine microbiological analysis and antibiotic susceptibility test of mid-stream urine samples of pregnant women should always be carried out so as to enhance the administration of drugs and for proper treatment and management of UTIs.

Conflicts of Interest

The authors declare no conflicts of interest.

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