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The Susceptibility Pattern of Urinary Tract Isolates of *Escherichia Coli*

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Abstract

Background:*Escherichia coli is the major cause of urinary tract infections (UTI) of all ages and gender. The treatment usually follows a known regimenfrom experience with similar infections over the years. However, the emergence of antimicrobial resistance worldwide has rendered this empirical approach unreliable in the treatment of UTI E. coli, hence the need to strictly determine the antimicrobial susceptibility pattern of each isolate for effective chemotherapy. This study was conducted to isolate and identify E. coli from urine specimens and to determine their antimicrobial susceptibility patterns.*

Materials and methods:*One hundred and twenty-five urine specimens were collected from patients,processed by standard bacteriological techniques and the resulting isolates identified by biochemical tests. The pattern of antimicrobial susceptibility was determined by disc diffusion method against 11 antibiotics belonging to 7 classes. This includes Gentamicin, Ciprofloxacin, Levofloxacin, Ceftazidime, Cefotaxime, Ceftriaxone, Cefpodoxime, Imipenem, Aztreonam, Amoxicillin/Clavulanate and Ampicillin. Statistical analysis was done using SPSS version 20.*

Results:*Fifty-six isolates of E. coli were obtained (prevalence rate of 44.8%) from 25 males and 31 females within the ages of 21 – 50 years. Gender was significantly associated with infection (p< 0.05) while age was not associated with infection (p>0.05). Forty-one (73.2%) of the isolates were multidrug resistant with MDR level of 42.9% (resistant to at least 1 from only 3 classes) to 100% (resistant toat least 1 from the entire 7 classes of antibiotics). The MAR index with respect to the entire 11 antibiotics ranged from 0.18 (resistant to 2 antibiotics) to 0.91 (resistant to 10 out of 11 antibiotics).*

Conclusion: *The urinary tract isolates of E. coli in this study possess high Multidrug Resistant activity. It is recommended that the antimicrobial susceptibility profile of every urinary E. coli isolate be determined and effectively treated with right choice of antibiotics to avoid treatment failures.*

Key words*: Multidrug resistance, E. coli, Urinary tract infection, Antibiotics, Resistance, Susceptibility.*

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I. Introduction

E. coli is the major aetiologic agent of human urinary tract infection of all ages and gender[1,2]. Reports have shown that Nigeria parades high multidrug resistant strains of *E. coli* causing infections of different parts of the body including the urinary tract[3,4,5,6,7].

The reasons for developing resistancevarybut majority border onmutations and misuse of antibiotics[8],fueled by over – the – counter purchase of antibiotics in many countries including Nigeria[9]. Such abuse of antibiotics includes self-medication, over use, subclinicaldosing[10, 11],unnecessary prescriptions by clinicians occasioned by misdiagnosis e.g., prescribing antibiotics for nonbacterial or self-limiting conditions[12],etc.

The emergence of drug resistant *E. coli* strains has compromised the already established treatment regimen[13,14], leading to treatment failures. The repeated treatment of failed *E. coli* UTI puts a huge financial burden on patients[15]. This continued emergence of resistance to drugs used for empirical therapy[16] has made it necessary to continue to assess the antimicrobial susceptibility pattern of *E. coli* isolates from time to time. This is pertinent in order to avoid the trauma and extra cost of retreating therapeutic failures. It is also necessary to have a firm knowledge of the susceptibility profile of isolates in every region for epidemiological purposes and in order to plan for empirical therapy when and where immediate culture and sensitivity test is not possible and to plan for infection control exercises[17].

Furthermore, the impetus for constant antibacterial susceptibility testing is the fact that antibiotic resistance plasmids are constantly shared among bacteria of the same or different species by conjugation, transduction and transformation[16,18].

This study is therefore aimed at isolating *E. coli* from patients suspected of urinary tract infection and determining their antibacterial susceptibility pattern using available antibiotics.

II. Materials And Methods

One hundred and twenty-five urine specimens were collected randomly from patients referred for UTI to the laboratory department of Federal Medical Centre, Owerri.

The specimens were collected using sterile universal container and processed using standard microbiological procedure[19] at the laboratory department of Salvation Hospital, Owerri, Imo State. The patients were instructed to collect mid-stream urine aseptically into the sterile screw cap universal container. Biometric data of the patients (age, sex, etc) were collected as well. The urine specimen was mixed thoroughly and using calibrated wire loop of 0.001 ml, a loopful was inoculated on the surface of MacConkey agar and incubated for 24 hours aerobically at 37^{o}C. Lactose fermenting coonies wereselected and further identified by biochemical tests for *E. coli* (Gram stain, indole test, Citrate utilization, urease test, catalase, TSIA, Methyl red test, and Voges-Proskauer test). The colonies were counted and recorded as colony forming units per ml urine (CFU/ml). Specimens yielding up to 10^5 CFU/ml were considered significant for UTI. Also, specimens with bacterial counts less than 10^5 but with significant number of pus cell suggestive of UTI were considered significant[20].

Antimicrobial susceptibility testing was carried out by disc diffusion method using the following antibiotics belonging to 7 classes according to the classification of Magiorakos *et al*[21]: Gentamicin (Aminoglycoside), Ciprofloxacin and Levofloxacin (Fluoroquinolones), Ceftazidime, Cefotaxime, Ceftriaxone, Cefpodoxime (Cephalosporins), Aztreonam (Monobactam), Imipenem (Carbapenem), Amoxicillin/Clavulanate (Beta lactam/Beta lactamase inhibitor), Ampicillin (Penicillin).

A suspension of the isolate was made in 5 ml sterile normal saline. The turbidity of the suspension was visually matched with the turbidity of 0.5 McFarland Standard. With sterile cotton-tipped swab, the suspension of the isolate was evenly seeded across the plate of Mueller Hinton agar. The antibiotics discs were applied using sterile forceps. The plate was placed in the incubator for 24 hours at 37^{o}C. The diameter of the clearing around each disc was measured (in millimeters), the results interpreted as sensitive (S), intermediate (I) or resistant (R) using CLSI[22] interpretative criteria.

III. Results

The culture result shows that 56 out of the 125 urine specimens (44.8%) yielded significant growth of *E. coli.* The isolates were obtained from 31 (55.4%) females and 25 (44.6%) males aged 21-50 years. The age ranges 21-30 years and 31-40 years have highest *E. coli* UTI prevalence (Table 1).Gender is significantly associated with having infection ($p<0.05$). Female patients are more infected than male patients. However, age does not have significant association with infection ($p> 0.05$).

Table 1: Age Range and gender of patients with positive cultures

Age range	Positive cultures (Males)	Positive cultures (Females)	Total
1-20	0	0	0
21-30	12	13	25
31-40	12	13	25
41-50	1	5	6
51-60	0	0	0
Total	25	31	56

The antibiogram revealed that the isolates were moresusceptible to Imipenem (96.4%), none was resistant to it and 3.6% were of intermediate susceptibility to itincomparison to other antibiotics, whereas the least susceptibility was to Ampicillin (1.8%).About 80.4% of the isolates were susceptible to gentamicin while 19.6% were resistant to the drug. Ciprofloxacin and Levofloxacin have 62.5% and 75% susceptibility and 26.8% and 17.9% resistance respectively. The extended spectrum β-lactams have a susceptibility range of 23.2% (cefpodoxime) to 60.7% (ceftriaxone) and resistance range of 23.2% to 51.8% respectively. Aztreonam (a monobactam) had a susceptibility of only 32.1% and resistance of 44.6% as reflected in Figure 1.

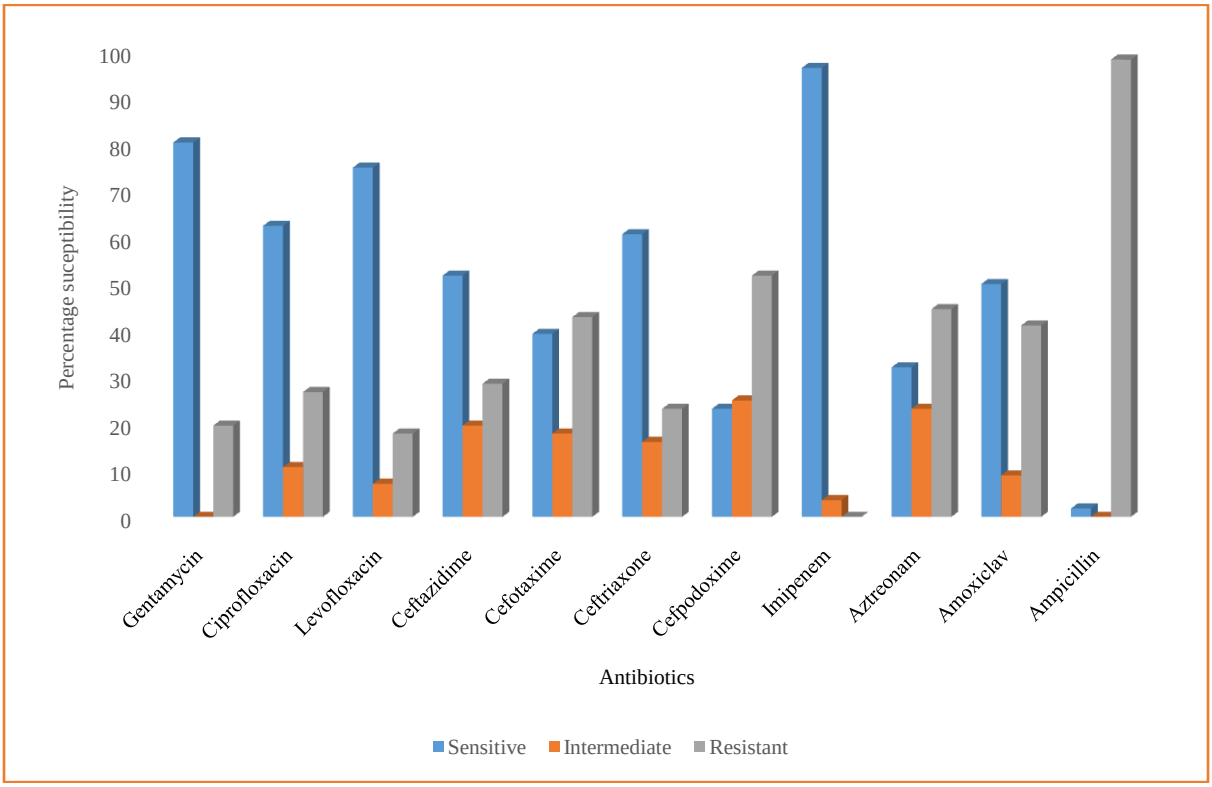

Figure 1: Comparative susceptibility pattern of *E. coli* isolates

With respect to the classes of antibiotics, one isolate (1.8%) was resistant to at least 1 antibiotic from the entire 7 classes of antibiotics (100% MDR) whereas 17.9% of the isolates had MDR of 85.1% (resistant to at least 1 antibiotic from6 out of 7 antibiotic classes (Table 2).

Table 2: Percentage Multidrug resistance (MDR) level with the 7 classes of Antibiotics

No of Classes of Antibiotics	% MDR	No of Isolates (%)
3	42.9	15 (26.8)
4	57.1	12 (21.4)
5	71.4	5 (8.9)
6	85.1	10 (17.9)
7	100	1 (1.8)

The Multiple Antibiotic Resistance(MAR) index ranges from 0.18 (resistant to only 2 out of the 11 antibiotics irrespective of the class) to 0.91 (resistant to 10 out of 11 antibiotics (Table 3).

Table 3: Multiple Antibiotic Index (MAR) with respect to the entire 11 Antibiotics

No of Antibiotics	No of Isolates in the group	MAR Index
2	6	0.18
3	2	0.27
4	4	0.36
5	6	0.45
6	5	0.55
7	8	0.64
8	9	0.73
9	7	0.82
10	3	0.91
11	0	-

IV. Discussion

The prevalence rate of urinary tract infection in this study was 44.8%. Similar studies conducted in parts of Nigeria showed varying relatedness with our findings. While some are in agreement with our result, others show dissimilarities. For instance, Rivers State had a mean prevalence of urinary isolates among hospital attendees of 44.9%[23], while Oladeinde *et al.*[2] reported 36.69% in Edo State and Iregbu *et al.*[14], reported a low prevalence of 13% in Abuja, Nigeria. In reports review of various prevalence of UTI in children, Uwaezuoke[24], reported rates of 6% to 36% among children presenting with severe acute malnutrition among developing countries. The differences in the prevalence of urinary tract infections could be attributed to the socio-economic attributes of the people including their hygiene practices and education.

Gender was significantly associated with infection ($p< 0.05$) while age was discovered to have no significant association with infection: ($p >0.05$). These findings corroborate the findings of Oladeindeet al[2], who reported that sex and acquisition of UTI are significantly related while no significant relationship exists between age and infection. The observation of higher female than male rate of UTI in this present study (55.4% female versus 44.6% male) is also in consonant with other studies[23, 25]. This is attributable to many factors like the female urogenital tract anatomical features; its closeness to the anal opening, the short urethral length and more frequent sexual activity as postulated by Omoregie *et al,*[26]. Some physiological activities in females such as monthly menstrual cycle, hygienic conditions, activities like vaginal douching and contraceptives use, all help to disorganize the normal microbial population around the female urogenital area, and pre-dispose her to colonization/infection with urogenital pathogens. The age ranges 21-30 years and 31 to 40 yearshave the highest frequency of infection in our study which corresponds to the report of Oladeindeet al[2]. Although not statistically significant, it could be pointed out that these affected groups are very active age groups in social considerations and have greater chances of involvement in risky sexual acts, such as unprotected sex, plurality of sexual partners and anal sex that in turn could result to UTI.

This study revealed that among all antibiotics used the highest susceptibility was to Imipenem (Carbapenem) with 3.4% intermediate susceptibility and none that was out rightly resistant. Penicillins recorded the highest resistance by all the isolates with Ampicillin showing 98.2% resistance and only 1.8% susceptibility. The next antibiotics that attracted lower resistance from the isolates include Aminoglycoside, Gentamicin (19.6% resistance versus 80.4% susceptibility), Levofloxacin (17.9% resistance versus 70% susceptibility), and Ciprofloxacin (26.8% resistance versus 62.5% susceptibility). The overall resistance to the 3rd generation Cephalosporins (Ceftazidime, Cefotaxime, Ceftriaxone and Cefpodoxime) ranged from 23.2% to 51.8%. The findings agreed significantly with reports of Iregbu and Nwajiobi[14] in Abuja Nigeria who reported all tested bacteria as highly susceptible to Imipenem. The reason for such low resistance to Imipenem may possibly be that carbapenems are expensive, not readily accessible indiscriminately and has also not been abused like other relatively cheap antibiotics. This view agrees with the observation by Troillet *et al*[27], that wherever resistance to Imipenem occurs, therapy with Imipenem was responsible for the developing and disseminating resistance to same drug. There is also a possibility that the resistance mode of the isolates precludes carbapenemase production which answers for most observed resistances to carbapenem antibiotics[28, 29]. Wade and Benjamin[30] attributed the extensive susceptibility of pathogens to Imipenem to the drug's efficiency in penetrating the organisms' outer membrane plus its strong affinity for PBP-2 (Penicillin Binding Protein-2). Resistance to Gentamicin and the 3rd generation cephalosporins in this study is also in consonant with the report of Iregbu and Nwajiobi[14]. Most isolates demonstrated non-susceptibility to Ampicillin, a Penicillin which is the oldest antibiotic with the oldest history of abuse and misuse in the developing countries[31]. Mohammed *et al*[32] reported similar resistance pattern to Ampicillin (94.1%). The observed non-susceptibility to Ampicillin therefore is not unexpected. Several reports have emphasized resistance of isolates especially Enterobacteriaceae to Ampicillin[33, 34].

The Multiple Antibiotics Resistance Index of all isolates ranged from 0.18 (resistance to 1 antibacterial) to 0.91 (non-susceptibility to 10 out of 11 used). With respect to the 7 classes of antibiotics, the Multidrug resistance (MDR) level of 42.9% (resistant to at least one agent in 3 different classes as described by Magiorakos *et al*.,[21]) to 100% (resistant to the entire 7 classes of antibiotics). The import of this is the reality of the threat of the continued resurgence of generations of bacteria that are continually non-susceptible to commonly used antibiotics. This has seriously challenged the capability of healthcare providers to effectively curtail the morbidity and death rate associated with infectious agents including *E. coli.*

V. Conclusion

The urinary tract isolates of *E. coli* in this study possess high multidrug resistant activity. While most isolates were susceptible to Imipenem, most are resistant to Ampicillin. The high level multidrug resistance makes it difficult to predict drugs for empirical therapy in *E. coli* urinary tract infections. It is therefore recommended that the antimicrobial susceptibility profile of every urinary *E. coli* isolate be determined before

being effectively treated with right choice of antibiotics to avoid treatment failures and selection of multi-drug resistance pathogens.

References

[1]. Orrett FA, Davis GK. A comparison of the antimicrobial susceptibility profile of urinary pathogens for the years 1999 and 2003. West Indian Medical Journal. 2006;55: 95–99.

[2]. Oladeinde BH., Omoregie R, Olley M, et al. Urinary tract infection in a rural community of Nigeria. North American Journal of Medical Science.2011; 3 (2): 75 - 77.

[3]. Ozumba UC. Antimicrobial resistance problems in a university hospital. Journal of National Medical Association.2005; 97(12): 1714–1718.

[4]. Aboderin OA, Abdu AR, Odetoyin BW, et al. Antimicrobial resistance in *Escherichia coli* strains from urinary tract infections.Journal National Medical Association.2009; 101:1268–1273.

[5]. Dada-Adegbola HO, Muili KA. Antibiotic susceptibility pattern of urinary tract pathogens in Ibadan, Nigeria. African Journal of Medicine and Medical Science.2010; 39(3):173-179.

[6]. Akujobi CN, Enwuru CP. Detection of extended spectrum beta-lactamases in gram negative bacilli from clinical specimens in a teaching hospital in South eastern Nigeria. Nigerian Medical Journal.2010; 51: 141-146.

[7]. Enwuru C, Otokunefor K. Multidrug Resistance and Diversity of Gram negative clinical isolates from South East Nigeria Journal of Anatomical Sciences.2018; 9 (1): 125-129.

[8]. LeeDS, Lee SJ, Choe HS. Community-Acquired Urinary Tract Infection by *Escherichia coli* in the Era of Antibiotic Resistance. BioMedical Research International.2018; 14 pages.https://doi.org/10.1155/2018/7656752

[9]. Omoregie R, Christopher AE, Igbarumah IO, et al. Prevalence and etiologic agents of female reproductive tract infection among in-patients and out-patients of a tertiary hospital in Benin City. Nigeria. North American Journal of Medical Science. 2010; 2(10): 473–477.

[10]. Trostle JA, Yépez-Montufar JA, Corozo-Angulo B, et al. Diarrheal illnesses on the Ecuadorian coast: socio-environmental changes and health concepts. Cad Saúde Pública. 2010; 26:1334–1344.

[11]. Kolár M, Urbánek K, Látal T. Antibiotic selective pressure and development of bacterial resistance. International Journal of Antimicrobial Agents. 2001; 17(5):357-63.

[12]. Pickering LK. Antimicrobial resistance among enteric pathogens. Seminars in Pediatric Infectious Disease. 2004; 15:71–77.

[13]. Orrett FA. Urinary tract infection in general practice in a rural community in south Trinidad. Saudi Medical Journal. 2001; 22(6): 537–540.

[14]. Iregbu KC, Nwajiobi PI. Urinary tract infections in a tertiary hospital in Abuja, Nigeria. African Journal of Clinical and Experimental Microbiology.2013; 14 (3): 169-173.

[15]. Vasquez V, Hand WL. Antibiotic susceptibility patterns of community–acquired urinary tract infection isolates from female patients on the US (Texas)–Mexico border. Journal of Applied Research. 2004;4(2):321–326.

[16]. Oladeinde BH, Omoregie R, Olley M, et al. A 5 - year surveillance of wound infections at a rural tertiary hospital in Nigeria.African Health Science. 2013; 13(2): 351–356.

[17]. Khanal S. Antibiotic Resistance: Origin, Causes, Mechanism and Prevention.Antibiotic Resistance, Bacteriology 2.2017;https://microbeonline.com (Accessed 02/12/2019)

[18]. Cheesbrough M. District laboratory practice in tropical countries. Part 2. University Press, Cambridge, 2006; p 357.

[19]. Bates BN. Interpretation of Urinalysis and Urine Culture for UTI Treatment. US Pharmacy. 2013; 38(11): 65-68.

[20]. Magiorakos AP, Srinivasan A, Carey RB, et al. Multidrug- resistant, extensively drug- resistant and pandrug- resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clinical Microbiology and Infections,2012; 18(3): 268 - 281.

[21]. Clinical and Laboratory Standards Institute. Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically; Approved Standard—Tenth Edition. CLSI. Document M07- A10. Wayne PA: Clinical and Laboratory Standards Institute: 2015.

[22]. Agbagwa OE, Ifeanacho EJU. The Prevalence of UTI pathogens in urine specimen obtained from a hospital in Rivers State Nigeria. Journal of Microbiology Research.2015; 5(5): 143 - 148.

[23]. Uwaezuoke SN. The prevalence of urinary tract infection in children with severe acute malnutrition: a narrative review, Dove Medical Press Limited.2016; 7: 121 – 127.

[24]. Giwa FJ, Ige OT, Haruna DM, et al. Extended- spectrum beta- lactamase production and antimicrobial susceptibility pattern of uropathogens in a Tertiary Hospital in Northwestern Nigeria. Annals of Tropical Pathology.2018; 9: 11 – 16.

[25]. Omoregie R, Erebor JO, Ahonkhai I, et al. Observed changes in the prevalence of uropathogens in Benin City, Nigeria. New Zealand Journal of Medical Laboratory Science.2008; 62: 29 - 31.

[26]. Troillet N, Samore MH, Carmali Y. Imipenem resistant *P. aeruginosa*: risk factors and antibiotic susceptibility patterns.Clinical Infectious Disease.1997; 25(5): 1094- 1098.

[27]. Lee JH, Lee SH. Carbapenem Resistance in Gram- negative Pathogens: Emerging Non- metallo- carbapenemases. Research Journal of Microbiology.2006; 1: 1 - 22.

[28]. Datta S, Wattal C. Carbapenemase producing Gram negative bacteria in tertiary health care setting: therapeutic challenges.Journal of International Medical Science Academy.2010; 23(1): 17 - 20.

[29]. Wade KC, Benjamin DK, Jr. Clinical pharmacology of anti-infective drugs In: Infectious Diseases of the fetus and Newborn 7th edition, Elservier, Amsterdam, 2019; 1160 - 1211.

[30]. Faari BU, Akanbi AA, Fadeyi A, et al. Prevalence of extended- spectrum beta- lactamase- producing *Klebsiella* species at the University of Ilorin Teaching Hospital. Journal of Medical Investigations and Practice.2015; 10: 20 – 23.

[31]. Mohammed A, Seid ME, Gebrecherkos T, et al. Bacterial isolates and their antimicrobial susceptibility patterns of wound infections among inpatients and outpatients attending the University of Gondar Referral Hospital, Northwest Ethiopia. International Journal of Microbiology.2017; 10 pages, Doi: 10.1155/2017/8953829

[32]. Papich MG. Saunders Handbook of Veterinary Drugs: Small and Large Animal. Elsevier Health Sciences, Amsterdam,2015; pp. 43-47. ISBN 978-0-323-24485-5.

[33]. Magdesian KG.Equine Pharmacology, an Issue of Veterinary Clinics ofNorth America: Equine Practice, E-Book. Elsevier Health Sciences, Amsterdam 2017; p. 59. ISBN 978-0-323- 52438-4.