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Antibiogram of urinary tract pathogens in a tertiary hospital in south-south Nigeria

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Abstract

Background: Antibiograms represent the antimicrobial susceptibility patterns of bacterial isolates in a given healthcare setting and guides the selection of empiric antimicrobial therapy. Repeated antibiograms over time can be used to ascertain resistance trends of microbes. There is paucity of data on the antibiogram of urinary isolates in Nigeria.
Objective: This study aimed to determine the antibiogram of urinary isolates in a tertiary hospital.
Materials and Methods: A review of records of mid-stream urine samples received in the Medical Microbiology Laboratory and analysed for pathogen identification and subsequent antimicrobial susceptibility testing over a 4 month period, was carried out. Multiple antibiotic resistance (MAR) index for each isolate was calculated and data was summarized on SPSS 20 using descriptive statistics.
Results: Out of the 959 urine samples submitted to the laboratory during the study period, 283 (29.5%) had positive cultures. *Escherichia coli* and *Klebsiella pneumonia* were the most frequently isolated organisms. The total mean MAR index was 0.61 ± 0.30. Providencia spp had the highest mean MAR index of 0.82 ± 0.26, followed by *Klebsiella spp* and *Pseudomonas aeruginosa* with mean MAR index of 0.68 ± 0.28 and 0.64 ± 0.32 respectively.
Conclusion: There is a high level of resistance to commonly prescribed antibiotics among UTI pathogens in the hospital. Antimicrobial stewardship strategies are needed to address this negative trend.

Keywords: Urinary tract infection, antibiogram, multiple antibiotic resistance index

Introduction

Antibiograms represent the antimicrobial susceptibility patterns of bacterial isolates in a given healthcare setting.[1] It often highlights the commonly isolated organisms, their susceptibility rates and resistance patterns. It guides the selection of empiric antimicrobial therapy in any institution as part of its antibiotics policy. Repeated antibiograms over time can be used to ascertain resistance trends of microbes.
Urinary tract infections (UTIs) are one of the most commonly diagnosed infections in healthcare settings.[2,3] It results from the invasion of the urinary tract by the infective organisms, usually from the gastrointestinal tract. UTI is more common in women than men due to the close proximity of the urethra to the rectum in women. It is often caused by gram negative organisms such as *Escherichia coli, Klebsiella pneumonia, Citrobacter spp, Enterobacter sp, Proteus mirabilis* and sometimes gram positive organisms such as *Staphylococcus saprophyticus* and *Enterococcus* may be isolated from patients with UTI.[3] Treatment of UTI often involves use of antimicrobials.
Antimicrobial resistance (AMR) is a public health problem in most parts of the world. Inappropriate antimicrobial use leads to the emergence of drug resistance, resulting in poor patient outcomes. AMR is estimated to account for more than 700,000 deaths

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per year worldwide and costing about US$100 trillion per year.[4] There is paucity of data on the antibiogram of urinary isolates in Nigeria. The aim of this study was to develop an antibiogram of urinary tract bacterial isolates in our hospital to guide empirical antibiotic therapy for UTI.

Materials and methods

Setting: This study was carried out in the Medical Microbiology Laboratory of a 500-bed tertiary hospital in Southern Nigeria. An average of 11,500 samples are processed in this laboratory yearly.

Study design: This was a review of records of urine samples received in this laboratory between June and September 2019.

Sample processing: Mid-stream urine samples received were cultured on Cysteine Lactose Electrolyte Deficient (CLED) agar overnight. Cultures which grew up to 10^5 colony-forming unit (CFU)/ml had colonies taken for identification and antimicrobial susceptibility testing. Bacterial identification was carried out using colonial morphology, Gram stain characterization and traditional biochemical tests. Antimicrobial susceptibility testing was done according to the Kirby-Bauer disk diffusion method on Mueller Hinton agar using standard antibiotic disks (Oxoid Ltd, USA).

Data collection and statistical analysis: Data collected included accession number, gender, age, department/ward, isolate and resistance/susceptibility to tested antibiotics. Data was entered into Microsoft Excel and transferred to SPSS version 20 (IBM, USA) for further analysis. Data was summarized using descriptive statistics. Multiple antibiotic resistance (MAR) index for each isolate was calculated by dividing the number of antibiotics each isolate was resistant to by the total number of antibiotics tested.[5]

Results

There were 959 urine samples submitted to the laboratory during the study period out of which 283 (29.5%) had positive cultures with more than 10^5 CFU/ml. Positive cultures were from 267 participants, with 16 of the participants having two isolates each. The mean age of participants with positive cultures was 54.4 ± 20.2 years and 154 (57.7%) were male (Table 1).

Table 1: Sociodemographic characteristics of subjects

The most frequently isolated organism was *Escherichia coli* with 83 (29.3%) isolates, followed by *Klebsiella pneumonia* with 79 (27.9%) isolates and *Pseudomonas aeruginosa* with 41 (14.5%) isolates. The mean MAR index of all the isolates was 0.58 ± 0.30. *Providencia spp* had the highest mean MAR index of 0.80 ± 0.28, followed by *Klebsiella spp* and *Pseudomonas aeruginosa* with mean MAR index of 0.65 ± 0.29 and 0.61 ± 0.31

Table 1: Sociodemographic characteristics of subjects

Characteristic		Number	Percentage
Age (years)	(mean, sd)	54.4 ± 20.2	
Sex	F	112	41.95
	M	154	57.68
	Unspecified	1	0.37
	Total	267	100.00
Department	Inpatients	73	27.34
	Outpatients	107	40.07
	Unspecified	87	32.58
	Total	267	100.00

respectively (Table 2).

Table 2: Frequency of isolated organisms and multiple antibiotic resistance index

Among the cephalosporins, *E. coli* had the highest susceptibility for ceftriaxone (66.7%). Nitrofurantoin showed good sensitive patterns to *E. coli* (50%), *Morganella morganii* (66.7%) and *S. aureus* (75%). *Proteus spp*. showed good susceptibility to the cephalosporins ceftazidime (71.4%) and cefotaxime (50%); coamoxiclav (54.5%) and the carbapenems (66.7%) (Table 3).

Table 3: Antimicrobial susceptibility pattern of

Table 2: Frequency of isolated organisms and multiple antibiotic resistance index

Organism	Number of isolates (%)	Mean MAR index
Candida spp.	38 (13.43)	n/a
Escherichia coli	83 (29.33)	0.56 ± 0.29
Klebsiella spp.	79 (27.92)	0.65 ± 0.29
Morganella morganii	3 (1.06)	0.60 ± 0.00
Proteus spp.	12 (4.24)	0.43 ± 0.27
Providencia spp.	2 (0.71)	0.80 ± 0.28
Pseudomonas aeruginosa	41 (14.49)	0.61 ± 0.31
Serratia spp.	1 (0.35)	0.50 ± 0.00
Staphylococcus aureus	24 (8.48)	0.39 ± 0.27
Total	283 (100)	0.58 ± 0.30

n/a: not applicable

Table 3: Percentage antimicrobial susceptibility pattern of urinary isolates

	Escherichia coli	*Klebsiella spp.*	*Morganella morganii*	*Proteus spp.*	*Providencia spp.*	*Pseudomonas aeruginosa*	*Serratia spp.*	*Staphylococcus aureus*
Cefuroxime	26.1	18.2	0.0	25.0	0.0	0.0	0.0	45.5
Ceftazidime	29.4	15.8	0.0	71.4	50.0	32.4	0.0	0.0
Ceftriaxone	66.7	50.0	0.0	0.0	100.0	100.0	0.0	0.0
Cefotaxime	27.3	21.3	0.0	50.0	0.0	0.0	100.0	25.0
Cefepime	34.8	15.8	0.0	33.3	0.0	40.0	0.0	16.7
Ciprofloxacin	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
Levofloxacin	20.8	8.0	0.0	40.0	0.0	17.6	0.0	46.2
Ofloxacin	18.3	10.0	0.0	20.0	0.0	13.2	0.0	40.9
Nitrofurantoin	50.0	22.4	66.7	36.4	0.0	25.0	0.0	75.0
Gentamicin	40.0	26.9	66.7	36.4	0.0	35.0	100.0	58.3
Coamoxiclav	20.5	20.0	33.3	54.5	0.0	0.0	0.0	71.4
Meropenem	65.4	54.8	0.0	66.7	0.0	44.0	0.0	0.0
Imipenem	77.8	76.2	100.0	66.7	50.0	57.1	0.0	88.9

urinary isolates

Discussion

Hospital antibiograms help to make antimicrobial prescribing more appropriate by providing data for effective empirical prescriptions. In this study, retrospective laboratory record of antimicrobial susceptibility data of unselected patients over a 4-month period was used to develop an antibiogram. As a result of changes in local bacteriology of UTI pathogens, emergence of new pathogens and changes in antimicrobial resistance pattern, periodic evaluation of pathogen epidemiology is recommended in order to revise treatment advice.[6,7]

The prevalence of positive cultures was 29.5%. This is similar to the findings from a study in north-central Nigeria involving a retrospective analysis of data from 12,458 urine samples in which the overall prevalence of UTI was found to be 22%.[8] Participants with positive cultures had an average age of 54 years with over 50% of them being males. Although UTI is generally commoner in females,[7] our finding may have been due to increased referrals for urine culture of men with urological conditions. Enlarged prostate is a risk factor for complicated UTI.[9] Younger women often present with uncomplicated UTI which promptly respond to prescribed or over the counter medications and less often present for urine culture in a tertiary setting like ours.

As expected, *E. coli* followed by *Klebsiella spp* and *Pseudomonas spp* were the most commonly isolated uropathogens. The finding of *E. coli* as the most frequent pathogen in urine is consistent with established aetiology and the result of other studies in Nigeria, Ethiopia, Saudi Arabia, Bangladesh and Turkey.[10-14] It is therefore imperative that empirical therapy for UTI should have adequate coverage for *E. coli*. The higher frequency of isolating enterobacteriacea in urine has been attributed to the capacity of these organisms to attach to the uroepithelium using pili and fimbriae.[15]

The susceptibility rates of isolates were generally low and highly variable in this study. Similar rates have been reported from tertiary hospitals in South west Nigeria,[11] although another study has reported higher susceptibility rates.[14] Among the cephalosporins, the susceptibility rates were low except for *E. coli.*, which showed a fairly high susceptibility to ceftriaxone. This is much higher than reports from Osogbo and Ife in South west Nigeria.[11] *S. aureus* had the highest susceptibility rate as well as the lowest average MAR index. This is partly due to the absence of antibiotics like erythromycin and penicillin, to which *S. aureus* commonly shows resistance to in the laboratory test menu. Among the Gram-negative isolates, susceptibility rates were highest for *Proteus spp*. A similar pattern has been reported from Pakistan,[16] and high susceptibility rates has also been noted from Calabar,[17] although they were lower than those of *Klebsiella sp* and *E. coli*. Although not tested for during the period of this study, these patterns may point to the wide prevalence of antimicrobial resistance phenotypes such as extended spectrum beta-lactamases and carbapenem resistant entero-bacteriaciae. Nitrofurantoin appears to be a good option for oral empirical therapy of UTI in the study hospital considering the relatively high susceptibility rates.

The MAR index is a tool for assessing the risk of antimicrobial overuse, with a baseline of 0.200 being used to distinguish between low and high antibiotics use.[18] The mean MAR index in our study was 0.58 and none of the isolates had an index of less than or equal to 0.200, suggesting high antibiotic usage and abuse. A recent point prevalence survey of antimicrobial consumption in this hospital showed a fairly high antibiotic consumption rate across the departments.[19] This highlights the need for a local empirical guideline on UTI management to help curtail antimicrobial misuse.

The retrospective nature of this study and the secondary data source used posed a significant limitation to our study as substantial data were missing from the record making it difficult to determine further associations among variables. However, the findings reveal important information for prescribers.

Conclusion

There is a high level of resistance to common antibiotics among UTI pathogens in the hospital. Antimicrobial stewardship strategies are urgently required to address this negative trend.

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