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Prevalence and Drug Susceptibility Profiles of Bacterial Urinary Tract Infections Isolated among Diabetes Mellitus Patients at Bosaso health centers

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Abstract

Background: Urinary Tract Infections (UTIs) are the commonest infections described among diabetes mellitus patients. More often, empirical antimicrobial therapy is initiated before the laboratory results are made available with minimal treatment success. The knowledge of etiology and antibiotic susceptibility pattern of the organisms causing urinary tract infections among diabetes mellitus patients remains scarce, despite its vitality. This study sought to determine the prevalence, bacteria species and drug susceptibility patterns of common causes of urinary tract infections among diabetes mellitus patients attending Bosaso health centers. Materials and methods: We conducted a cross sectional study involving adult diabetic patients at Bosaso health centers between the months of May and July 2020. Laboratory assay of mid-stream urine samples was done to isolate bacteria causes of UTIs.

These were biochemically identified using Gram stain, Kligler iron agar (KIA), Indole test, citrate, urea, coagulase, catalase, motility agar and lysine iron agar. Their antibiotic susceptibility pattern for the isolated organisms was done for Ampicillinn 10µg, Ciprofloxacin 5µg, Cotrimoxazole 25µg, Gentamycin 10µg, Ceftriaxone 10µg, and determined using Kirby Bauer Disc Diffusion method. Results: Of 177 participants, 69 (39.0%) were males and 108 (61.0%) were females. Their mean age was 33.1 years (range; 18-67 years) . Of these, 14.7% (26/177) of the samples revealed significant growth (>= 105 CFU/mL) giving a prevalence of 14.9 % (95% CI: 10.6 to 16.3).

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The organisms isolated were Escherichia coli -50% (N=13), Klebsiella pneumoniae 30.8% (N=8), Staphylococcus aureus 15.4% (N=4) and un identified organism 3.8% (N=1), and these were associated with such socio-demographic factors like history of catheterization and sexual activity. Antibiotic susceptibility to the commonly used agents for treating UTI's indicated higher sensitivity to Gentamicin and Ceftriaxone.

Keywords: Antimicrobials; bacteria; Urinary tract infections; diabetes.

1. Introduction

Diabetes Mellitus (DM) has gradually become a global health concern with significant health impact on individuals, communities and health budgets of various countries. Diabetes Mellitus patients are more susceptible to urinary tract infections (UTIs) as compared to non-diabetics, however treatment is complicated as most of the cases present with asymptomatic clinical features.

Globally, DM accounts for 68% (38 million) of all deaths. The incidence is not any different for sub Saharan Africa as an estimated 22 million adults have diabetes. The burden is reportedly high among certain countries, including: Nigeria with 3.8 million, South Africa with 2.7 million, Ethiopia with 2.1 million, and Uganda with 1.8 million [1].

Various bacteria species have been isolated from different studies carried out to determine bacterial causative agents of UTIs in DM. These included; *Escherichia coli (E.coli), Staphylococcus aureus, Klebsiella pneumoniae*, *Enterobacter species*, *Pseudomonas aeruginosa*, Serratia species, *Proteus* species and *Enterococcus faecalis* [2]. The susceptibility of DM patients to urinary tract infections has been associated with a number of factors. The glycosuria creates a favorable environment for the growth of microbes, therefore increasing their rate of growth and replication. Increased adherence of microbes to uroepithelial cells has also been observed. This promotes biofilm formation, which makes them more resistant to elimination by the immune system or antimicrobial therapy. Other defects that occur include increased leukocyte apoptosis and reductions in cytokine production [3]

2. Materials and methods

One hundred seventy seven clinical urine samples from diagnosed diabetic patients were collected between May 2020 and July 2020. Midstream urine sample was collected from diagnosed diabetics attending outpatient diabetic clinic at Bosaso health centers. Patients were asked to bring "mid-stream" urine of 15–20 ml volume. All urine specimens were obtained in a well labeled, sterile, dry, wide-necked, leak proof and screw capped universal container. After inoculating onto a different culture media, about 10 mL of each urine sample was taken for chemical tests and microscopic examination. Using a calibrated loop, a volume of 0.001 mL, the un-centrifuged well mixed urine specimen was streaked onto cysteine-Lactose electrolyte deficient medium (CLED) and blood agar plate and was incubated at 37°C for 24 hrs. A specimen was considered positive for UTI if a single organism was cultured at a concentration of $>10^5$ colony-forming units/mL. The Gram positive and Gram negative bacterial isolates was further identified using various biochemical reactions [7].

3. Results

Of the 177 participants, 26 of them had UTIs; giving a prevalence of 14.7% (95% Confidence Interval: 10.6 to 16.3) as indicated in the pie-chart below.

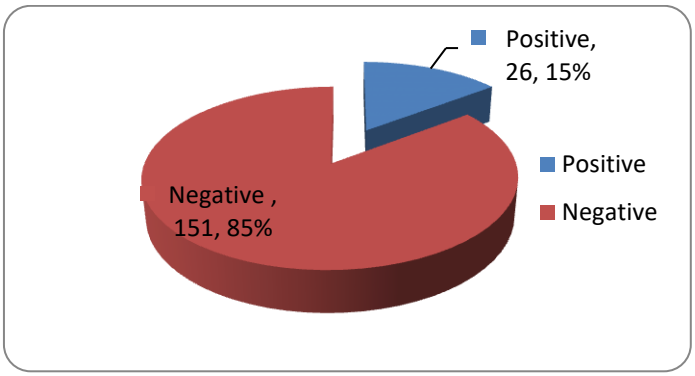

Figure 1

We assessed for socio-demographic factors associated with the risk of UTI. In this regard, sexual activity, age, history of catheterization and educational status were assessed as shown in **table 1.**

Table 1: Socio-demographic characteristics associated with the risk factors of UTI

	Culture		
Characteristic	Significant bacteriuria n, (%)	No significant bacteriuria n, (%)	Total number (%)
Age (Years)			
<20	9 (5.1)	25 (14.1)	34 (19.2)
20 to 24	11 (6.2)	71 (40.1)	82 (46.3)
25 to 29	3 (1.7)	27 (15.3)	30 (17.0)
30 to 34	2 (1.1)	21 (11.9)	23 (13.0)
35 to 39	1 (0.6)	4 (3.41)	5 (4.01)
>40	0 (0)	4 (3.41)	4 (3.41)
Sexual activity			
Yes	26 (14.7)	0 (0)	26 (14.7)
No	151 (85.3)	0 (0)	151 (85.3)
History of catheterization			
Yes	21 (11.9)	5 (2.8)	26 (14.7)
No	151 (88.1)	0 (0)	151 (85.3)
Educational status			
Yes	16 (9.0)	10 (5.7)	26 (14.7)
No	151 (85.3)	0 (0)	151 (85.3)

14.7% (26/177) of the samples revealed significant growth (>= 10^5 CFU/mL). The organisms isolated were *Escherichia coli* -50% (N=13), *Klebsiella pneumoniae* 30.8% (N=8), *Staphylococcus aureus* 15.4% (N=4) and unidentified organism 3.8% (N=1). The results are summarized in figure **2 below.**

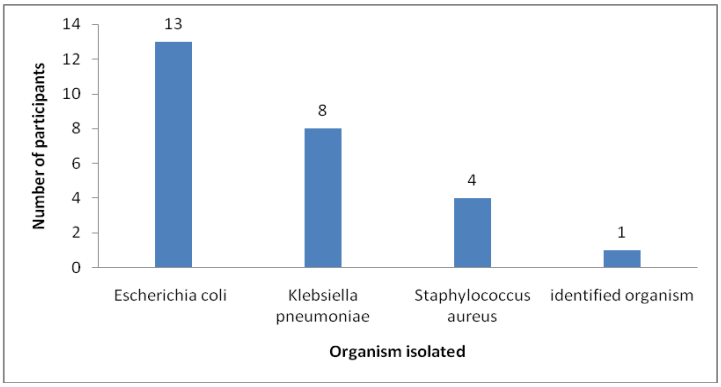

Figure 2

Antibiotic susceptibility to the commonly used antibiotics in the diabetes clinic for treating UTI's was done for all the isolated bacteria and the results summarized in the graphs below.

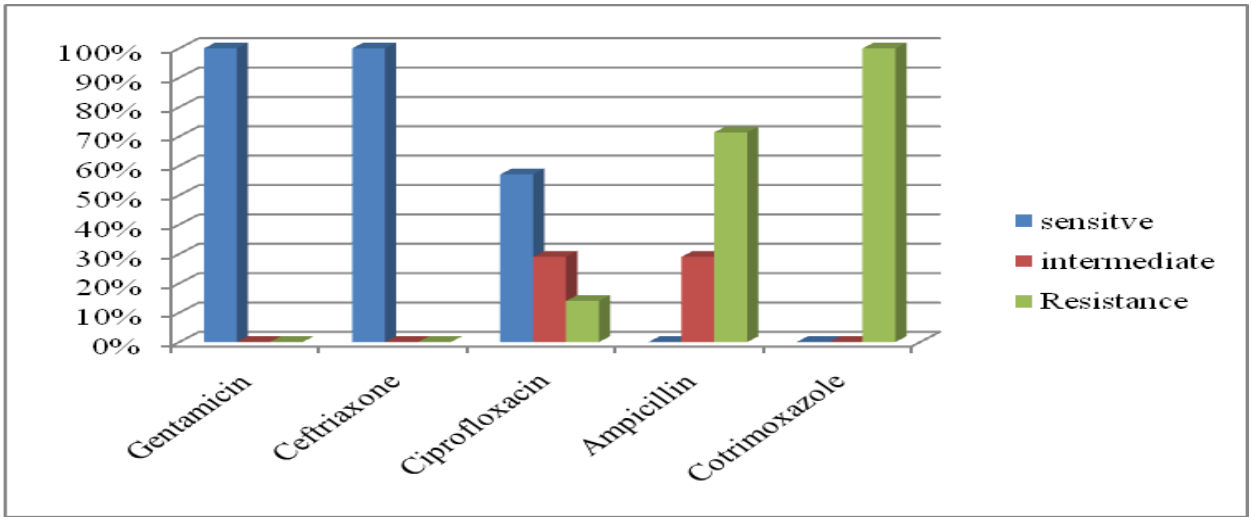

Figure 3: Graph showing antibiotic susceptibility pattern of *Escherichia coli* to the antibiotics used

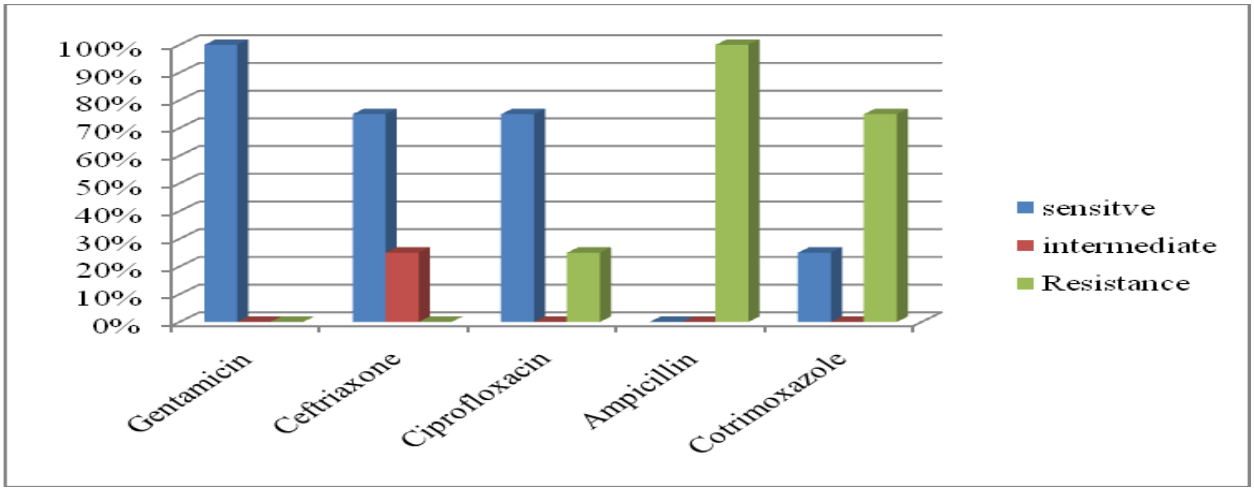

Figure 4: Graph showing antibiotic susceptibility pattern of *Klebsiella pneumoniae* to the antibiotics used

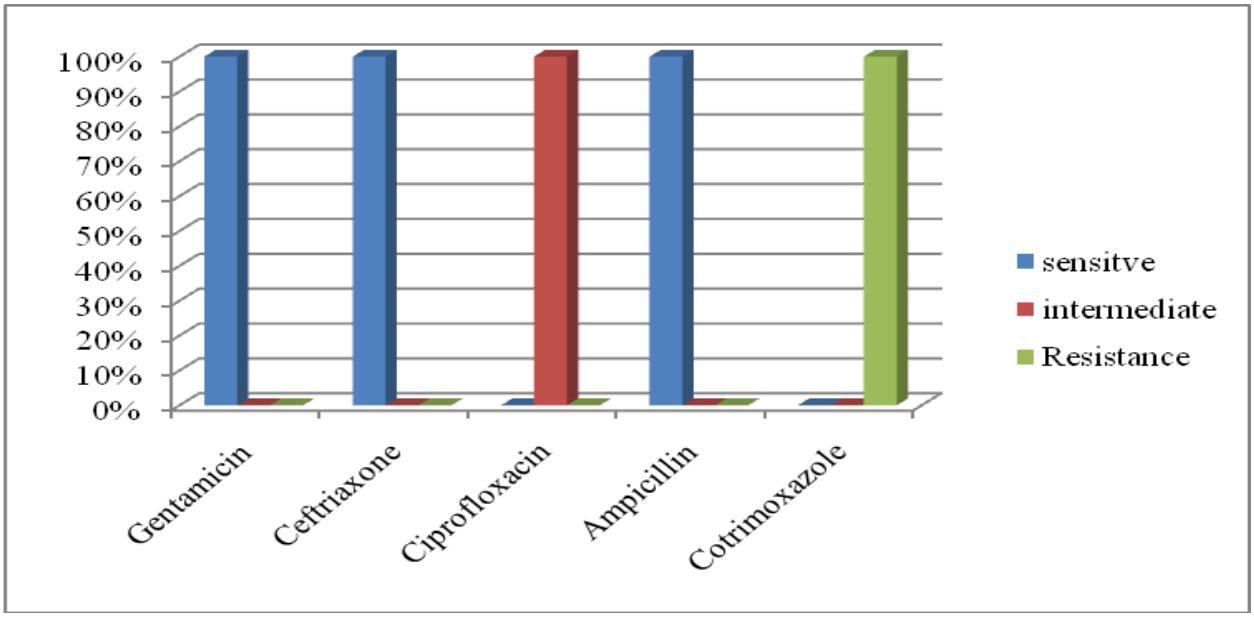

Figure 5: Graph showing antibiotic susceptibility pattern of unidentified organism to the antibiotics used

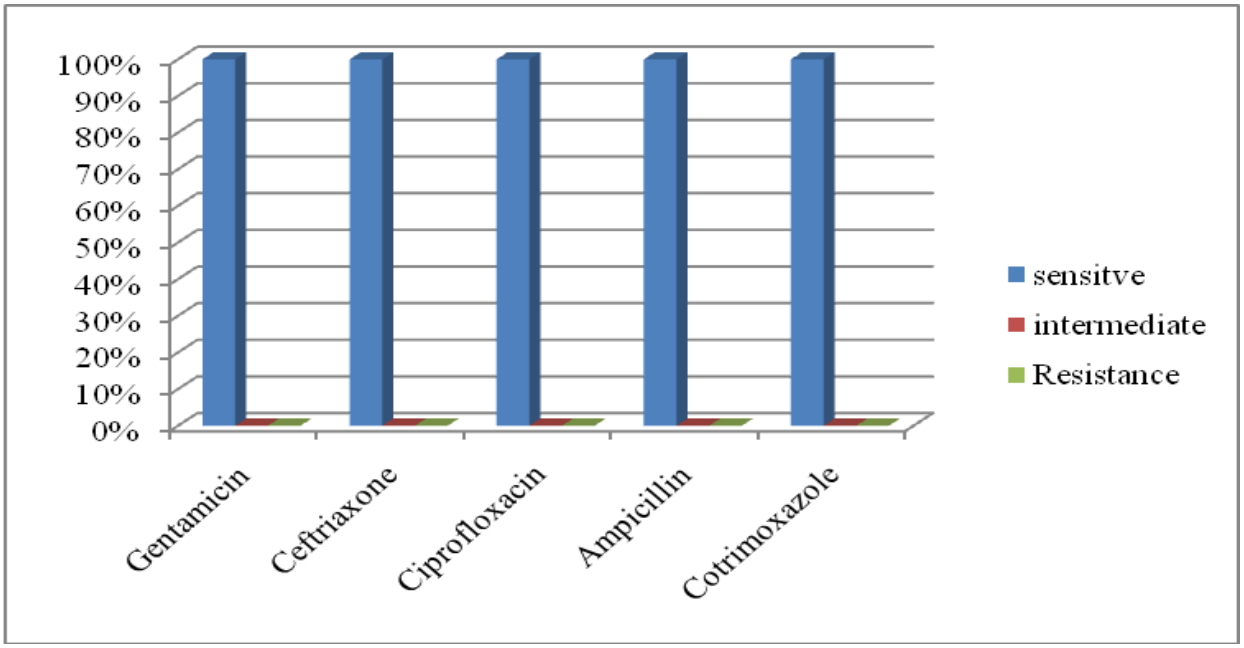

Figure 6: Graph showing antibiotic susceptibility pattern of *Staphylococcus aureus* to the antibiotics used

4. Discussion

The study showed a bacterial UTI prevalence of 14.7% (26/177). These results correlated with a range that was got in studies carried out in Ethiopia that indicated the prevalence of UTI's among diabetes patients to be between10.5-39.5% [11], relatedly, a study done in Uganda, research conducted by Ampaire *and his colleagues* [8] indicated that significant bacteriuria was detected in 13.3% (14/105) of the participants. It is higher than the 13.7% reported in Muhimbili National Hospital- Dar es Salaam, Tanzania [4]. However the study showed a

lower prevalence compared to that of Ouma (2001) that showed a prevalence of 18.7%. The most probable reason for the deviation of the results may have been due to the introduction of new antibiotics that are more effective in treatment of the infection and proper management of the blood sugar by the patients.

The bacterial causative agents isolated in the study were *Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus* which were among those that were identified in a study on prevalence of UTI's in diabetes in Ethiopia by [13]. The most common bacterial causative agent of UTI in our study was *Escherichia coli* (n=13) contributing 50% of the isolates. This is in agreement with a study by [14] in which *Escherichia coli* caused majority of the bacterial UTI infections (47%). In another study *Escherichia coli* contributed 56% of the bacterial causative agents isolated. In general this study tends to have a similar pattern of bacteria causative agents isolated in other studies [10].

Klebsiella pneumoniae was the second most isolated bacteria (n=4) of the 14 culture positive samples contributing 28.6%. This result was in agreement with a study by [5] that reported 25% of isolates as Klebsiella pneumoniae. However the percentage was slightly lower than that got in a study on Prevalence of UTI's among diabetes patients by [6] that isolated 35% of the organisms as Klebsiella pneumonia.

In the study, bacterial isolates showed varying sensitivity patterns to the antibiotics used: *Escherichia coli* isolates were highly susceptible to Gentamicin (100%), Ceftriaxone (100%), moderately susceptible to Ciprofloxacin (57.1%), and showed absolute resistance to Ampicillin and cotrimoxazole (100%) while 28.6% of E. coli showed intermediate sensitivity. These results showed relatively a similar antibiotic sensitivity pattern in a study by [6] except for Ciprofloxacin where it showed 92.3% sensitivity whereas in our study it showed 57.1% sensitivity. The most probable explanation for the difference may be due to the increasing levels of resistance to the drug because of its erroneous use in empirical treatment *Klebsiella pneumoniae* isolates were highly susceptible to Gentamicin (100%), Ceftriaxone (75%), Ciprofloxacin (75%), Cotrimoxazole (25%) and Ampicillin showed 0% sensitivity.

Generally the Enterobacteriacae organisms isolated in the study show a slight production of ESBLs as both are resistant to Ampicillin and *Klebsiella pneumoniae* has a slight decrease in sensitivity to the third generation Cephalosporin (Ceftriaxone). This is in agreement with a study by (7), that describes the production of ESBLs by *E.coli* and *Klebsiella pneumoniae*.

Staphylococcus aureus isolates showed 100% sensitivity to all the antibiotics used.

Unidentified coliform isolate was highly susceptible to Gentamicin (100%), Ceftriaxone (100%), Ampicillin (100%), Ciprofloxacin showed intermediate sensitivity and the isolate was resistant to Cotrimoxazole.

In the study females were most affected (64.3%) compared to males (35.7%). This percentage pattern partially correlates to a study by [10] where UTI's in female diabetics was (55%) compared to male diabetics (45%). The study showed a wide gap in percentage prevalence according to gender compared to a study where the prevalence in females was (46%) and in males (43%). The most probable explanation for the high percentage difference between males and females in the study could have been that the female participants in the study

were slightly higher than the male participants.

5. Recommendations

Clinicians should consider laboratory diagnosis of UTI's among the diabetes patients and also request for culture and sensitivity for better diagnosis and efficient treatment as this will reduce the cases of development of resistance. In absence of culture and sensitivity, Gentamicin and Ceftriaxone should be considered first for empiric treatment as all isolates were sensitive to them.

Acknowledgement

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6. Author's contribution

Dr Said Abdirasak Abdirahman: Conducted the laboratory work ranging from clinical sample registration, direct gram staining, culturing samples using different culture media and performing sorts of biochemical tests to differentiate isolated bacteria and manuscript writing.

Dr Ibrahim Mohamed: Contributed to data analysis.

7. Ethics

All individuals included in this study, signed a written informed consent and answered a questionnaire to obtain socio-demographic and clinical data.

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