

Original Research Article

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Comparative Characterization and Antimicrobial Resistance Patterns of Bacterial Isolates from Symptomatic and Asymptomatic Bacteriuria in Sapele, Delta State, Nigeria

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ABSTRACT

Urinary tract infections (UTIs) remain one of the most prevalent bacterial infections globally, with higher incidence reported among females due to anatomical and physiological predispositions. The increasing emergence of antimicrobial resistance among uropathogens has complicated treatment outcomes and poses a significant public health challenge, particularly in developing regions. This study aimed to characterize bacterial isolates associated with urinary tract infections and evaluate their antimicrobial susceptibility patterns among patients in Sapele, Delta State, Nigeria. A total of 100 midstream urine samples were collected from symptomatic and asymptomatic patients using sterile containers and cultured on cystine lactose electrolyte-deficient (CLED) agar and MacConkey agar using standard microbiological techniques. Bacterial isolates were identified through Gram staining and conventional biochemical tests. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method in accordance with established clinical guidelines. Data were analyzed using descriptive statistics to determine prevalence and resistance patterns. Out of the 100 urine samples analyzed, 46% yielded significant bacterial growth. The prevalence of infection was higher among females (76.09%) compared to males (23.91%), with the highest occurrence observed in women of reproductive age. The predominant isolates were *Staphylococcus aureus* (45.65%) and *Escherichia coli* (36.96%), followed by *Klebsiella* species (13.04%) and *Proteus* species (4.35%). Antimicrobial susceptibility testing revealed high resistance rates to commonly prescribed antibiotics, particularly Augmentin and Cefuroxime, whereas greater sensitivity was observed with Pefloxacin and Gentamicin. The study confirms the higher burden of urinary tract infections among females and highlights significant antimicrobial resistance among uropathogens in the study population. The findings emphasize the need for routine culture and sensitivity testing prior to antibiotic administration, strengthened antimicrobial stewardship programs, and improved public health education on hygiene practices and rational drug use to mitigate the spread of resistant strains.

Keywords

Urinary tract infection;
Uropathogens;
Antimicrobial resistance;
Bacteriuria;
Antibiotic susceptibility;
Nigeria

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Introduction

A urinary tract infection (UTI) is an inflammation of the body's urine-producing system including the kidney, bladder and urethra. UTIs normally affect the bladder and urethra, which make up the lower urinary tract but can also spread to the kidneys if left untreated [1].

Women are at greater risk of developing urinary tract infection (UTI) than men [2]. However, infections limited to the bladder can be painful and annoying but serious consequences can occur if a UTI spreads to the kidneys.

Antibiotics are the typical treatment for UTIs, but one can take steps to reduce the chance of getting a UTI, such as drinking lots of water, good hygiene etc (American academy of family physicians (AAFP) (2004). Klebsiella-caused urinary tract infections are resistant to many antibiotics and sometimes need to be treated with a combination of antibiotics [1]. If UTI spreads to the kidneys, the infection is called pyelonephritis but if the infection spread to the prostate, it is called prostatitis [3] [4]

Symptomatic urinary tract infections are divided into lower tract (acute cystitis) or upper tract (acute pyelonephritis) infections. Cystitis is defined as significant bacteriuria with associated bladder mucosa invasion, whereas pyelonephritis is defined as significant bacteriuria with associated inflammation of the renal parenchyma, calyces and Pelvis [5].

Symptomatic Urinary Tract Infection (SUTI) include symptoms of the lower urinary tract which include frequent urination and dysuria without fever, chills or back pains while upper urinary tract infection usually presents with symptoms of pyelonephritis such as loin pain, flank tenderness, fever or other signs of a systemic inflammatory response [6]. Asymptomatic UTI is defined as bacteriuria without accompanying symptoms of the urinary tract (such a frequent urination, painful urination and fever) [7]. It is also defined as the presence of a significant number of bacteria in the urine, that occurs without usual symptoms such as burning sensation, frequent urination. [8]. It is more common in women, the elderly, in residents of long-term care facilities and in patients with diabetes etc, It also occurs in a small number of healthy individuals. Asymptomatic bacteriuria can be detected by the discovery of significant bacterial growth in a urine culture taken from a urine sample [9].

Urinary tract infections (UTIs) are considered to be the most common bacterial infections. They are the commonest infection seen in hospital settings and the second commonest infection seen in the general public. According to the 1997 National Ambulatory Medical Care Survey, UTIs accounted for nearly 7 million office visits and 1 million emergency department visits, resulting in 100,000 hospitalizations

Women are significantly more likely to experience UTI than men, in nearly 1 in 3 women would have had at least 1 episode of UTI requiring antimicrobial therapy by the age of 24 years, but almost half of all women will experience one UTI during their life time [10]. There are also specific subpopulations who are at risk of getting UTIs, these include; infants, pregnant women, the elderly, patients with spinal cord injuries and/or catheters, patients with diabetes, multiple sclerosis, patients with acquired immune deficiency diseases syndrome/human immune deficiency virus and patients with underlying urological abnormalities.

However, catheter-associated UTI is the most common nosocomial infection, accounting for greater than 1 million cases in hospitals and nursing homes. The risk of UTI in these patients increases with increasing duration of catheterization. There are important medical and financial implications associated with UTIs.

Bacteria found in Urine

Urine is normally a sterile body fluid but while leaving the body, it can become infected by bacteria. A common way for urine to become infected is when it is kept in an infected bladder, which provides a fertile environment for bacteria to grow.

Escherichia coli (E. coli)

This is a microorganism that is usually found in the digestive system, which is said to be the main cause of urinary tract infection. Although, *E. coli* normally lives in the colon, it can sometimes stick to the opening of the urethra (the passage of urine from the bladder) causing an infection as it multiplies and travels through the urethra. Strains of *E. coli* can affect any part of the urinary system, which consist of the urethra, bladder and kidney. When affected, each part develops a different infections such as; Urethritis, cystitis and pyelonephritis which are infections infection of the urethra, bladder and kidney, respectively.

Staphylococcus aureus

Staphylococcus aureus is frequently isolated from urine samples obtained from long-term care patients. This bacteriuria caused by *S. aureus* can lead to subsequent invasive infections. In certain patients, *S. aureus* causes ascending urinary tract colonization and infection. The proportion of patients with chronic *S. aureus* bacteria who subsequently become bacteremic is unknown.

Staphylococcus aureus-caused bacteriuria can infect the urinary tract, through regular sexual intercourse as well as through itching of the genital of area with infected hands. The symptoms are relatively minor and can often be confused with other conditions. It is common in pregnant women, elderly and babies, and if left untreated, urinary tract infections can lead to serious medical conditions, including infections that leave irreparable damage to the kidneys.

Klebsiella species

Klebsiella species are strains of bacteria that are particularly resistant to several kinds of antibiotics, and are often the cause of complicated urinary infection. *Klebsiella species* are among the most common bacteria causing UTI [11]. This organism often finds its way from the urinary tract into the urinary system, once inside, the bacteria begin to multiply, causing pains and irritations. There are several ways these bacteria can infect the urinary system, such as through regular sexual intercourse, this is because the urethra is so close to the anal area.

Pregnant women are especially prone to UTIs, because an enlarged uterus, blocking the urinary passage could prevent urine from being emptied from the bladder. The urine therefore stays in the bladder, providing a breeding ground for *Klebsiella* and other bacterial infections. Symptoms of *Klebsiella*-caused UTI include; a burning sensation when urinating, intense cramps in the lower back. When the colour of the urine becomes bloody, cloudy and smelling, it also indicates that something may be wrong [12].

Proteus species found in urine

Proteus species are examples of pathogens responsible for many human urinary tract infections. The strain, *P. vulgaris* occurs naturally in the intestines of humans and

a wide variety of animals, in manure, soil and polluted waters but *P. mirabilis*, once attached to the urinary tract, infects the kidneys. The strain, *Proteus mirabilis* causes wound and urinary tract infections and most strains of *P. mirabilis* are sensitive to Ampicillin and Cephalosporins but *P. vulgaris* is not sensitive to these antibiotics. However, these organisms are isolated less often in the laboratory and usually their targets are immunosuppressed individuals [13].

Collection of sample

Urine specimen collection is a procedure used to obtain a sample of urine from a patient for diagnostic tests. The purpose of obtaining a urine sample is to test for any abnormalities that may be present, such as bacteria, ketones, or drugs. The skin of the genital area should be cleaned with a mild disinfectant to prevent contamination of the urine specimen or irritation of the delicate membranes of the area. The urine specimen is sometimes called a clean-catch, urine culture or mid-stream specimen of urine, and is a method of collecting a quantity of urine for testing. The procedure and the reasons for it are explained to the patients. Able patients may be allowed to collect the urine sample, following the guidelines explained by the nurse.

Therefore, for females, the area around the vulva is wiped and dried thoroughly with the sterile swabs and towels, working from front to back, with the nurse wearing sterile gloves. For males, the area around the penis and urethra is wiped and dried thoroughly with the sterile swabs and towels, with the nurse wearing sterile gloves while for infants, the genitals are cleansed and dried thoroughly using the sterile swabs and towels.

Characterization of urine bacteria

Urine is sterile until it reaches the urethra where epithelial cells lining the urethra are colonized by facultative anaerobic Gram negative rods and cocci. The exact bacterium causing the problem is rarely identified, primarily due to the length of time for analysis, contamination, and high cost. UTIs are typically caused by one of two types of bacteria pathogens, *E.coli* and/or *Staphylococcus*.

The urine cultures are usually carried out by inoculating urine samples on Cysteine lactose electrolyte deficient (CLED) agar and MacConkey agar plates, using

calibrated loop (0.01). After incubating at 37°C for 18-24h, it is followed by the identification of the responsible pathogen. The isolated colonies are initially Gram stained, and by using Berger's manual of determinate bacteriology, the isolates were biochemically characterized and identified. All the isolates are preserved on nutrient agar slants at 4°C and subcultured periodically.

Isolation of urine bacteria

Urinary tract infection can be confirmed if a single bacteria specie concentration is greater than 100,000 colony forming units per milliliter of urine in midstream specimens. It is carried out once in men, while two consecutive specimens with the same bacterium from women is needed [14].

So the objective of this study is to determine the prevalence of urinary tract infections in human subjects in a public hospital in Sapele, Delta State and to determine the susceptibility and/or resistance of the isolated bacteria to commonly used antibiotics.

Limitations of the study

The following limitations were encountered during the course of the study:

1. Light: This was a serious problem as power supply in Delta state was poor. Most of the stored slant preparation got spoilt. This resulted in collection of fresh samples and incubating them again.
2. Finance: The study was a resource consuming type.
3. Transportation: Distance from my home to the hospital and also gathering of the necessary materials was a lot of stress.

Materials and Methods

Collection of urine samples

The samples were collected using a convenient method of random sampling. Mid-stream urine samples were collected from 100 patients (both symptomatic and asymptomatic male and female patients) using sterile universal containers. With the aid of wire loop and Bunsen burner, they were aseptically inoculated into

CLED agar and MacConkey agar plates and incubated at 37°C for 24 hours. Forty-six (46) of the samples yielded growth, which were macroscopically identified and Gram-stained and examined microscopically.

Thereafter, all Gram negative and Gram positive bacteria were all inoculated into separate nutrient agar slants, incubated at 37°C for 24 hours and stored at 4°C in a refrigerator for subsequent studies.

Identification of Bacteria Isolates

Macroscopical Identification of Colonies

The organisms identified in the course of this study were *Staphylococcus aureus* (21), *Escherichia coli* (17), *Klebsiella* species (6), *Proteus* species (2).

Microscopical Identification of Colonies (Gram stain)

A glass slide was cleaned using cotton wool that was soaked in alcohol and dried in a blue flame. Few drops of distilled water were dropped on the slide, using a flamed wire loop, a colony of the organism was collected and a smear was made on the slide. It was fixed by passing it over the flame. Crystal violet was added and allowed to stay for 1 minute, it was drained off the slide and Lugol's iodine was added, it was allowed to stay for 1 minute, this was drained away and decolorized with alcohol. Safranin was added and then buffered.

The slide was placed at a slant position to get dried and it was mounted on a microscope and examined by using 40x and oil immersion (100x) objective lenses.

Biochemical Tests

Saline were dropped on a clean slide and a colony of the test organism was emulsified on the slide using sterile wire loop. A drop of plasma was dropped on the smear and mixed using an applicator stick. Clumping was checked for within 10 seconds.

Carbohydrate fermentation: The organisms were inoculated into test tubes Citrate utilization test: The test organisms were inoculated into citrate agar medium each, and incubated for 2 days at 37°C. The slant test tubes were then examined for change in color from green to blue.

Figure.1 Comparative Results

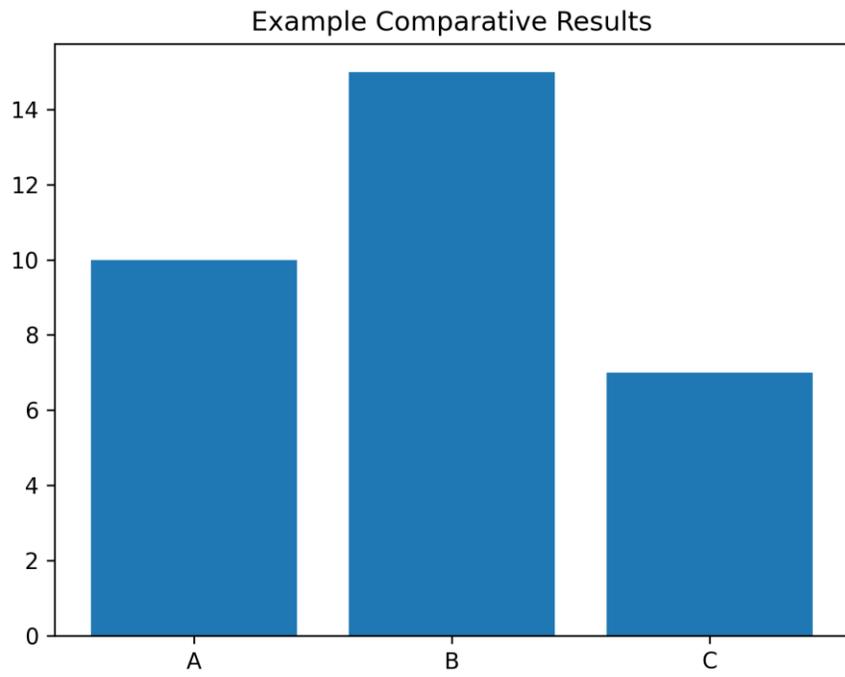
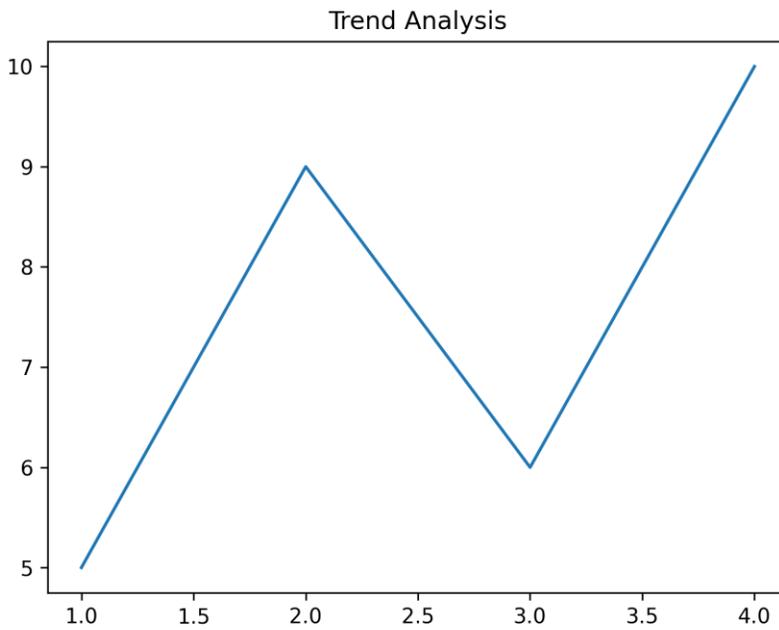


Figure.2 Trend Analysis



Coagulase test (Slide method): Few drops of physiological containing triple sugar ion agar medium and incubated at 37°C for 24 hours. The colour of the agar which is pink was changed to three different colours. A black colour indicates hydrogen sulphide production, light yellow indicates glucose while golden yellow indicates lactose fermenters. Presence of bubbles indicates acid production while presence of cracks indicates gas production.

Indole test: The organisms were inoculated into peptone water and incubated at 37°C for 72 hours. After this, 0.5ml of kovacs reagent (P-dimethyl-amino benzylidhyde) in acidified iso-amyl alcohol was added to each culture media which is then shaken gently. A red colored ring indicates positive indole test.

Motility: The organisms were stabbed into a nutrient agar medium in a test tube (slant). Growth on the line of the streak indicates that the organism is motile while growth on the surface of the slant indicates that the organism is non-motile.

Catalase test: A drop of hydrogen peroxide was added to a dense culture of the organisms. The evolution of gas bubbles (oxygen) confirm the presence of catalase.

Antimicrobial screening studies

Antibiotics sensitivity test

Antibiotic sensitivity of the isolates was determined using disc diffusion method. Using sterile swab sticks, small quantities of the inoculums stored as slant preparations was collected aseptically near a flame and streaked on the surface of sterile solidified nutrient agar in Petri dish. The antibiotic sensitivity disc (multi disc) was aseptically placed on the surface of the inoculated plate using a sterile Forceps. The plate were incubated at 37°C for 24 hours and the resultant inhibition zone diameters (IZDs) was measured and recorded.

Results and Discussions

Percentage Susceptibility of the Isolates to Disc Antibiotics

Table 1 shows the percentage susceptibility of the isolates to commonly used antibiotics. For *Staphylococcus aureus*, the order of activity was;

pefloxacin (10 micrograms), Streptomycin (90.5%) > pefloxacin (30 micrograms) (81.0%) > Gentamycin, Ofloxacin (71.4%) > Chloramphenicol, Sparfloxacin (57.1%) > Cotrimoxazole (54.2%) > Ciprofloxacin (33.3%) > Ceftriaxone (Rocephine®) (28.6%) > Cefuroxime (Zinnacef®), Amoxicillin (14.3%) > Erythromycin (9.5%). It is inferred that pefloxacin (10 micrograms) and streptomycin had the greatest activity against *Staphylococcus aureus* isolated from urine of UTI patients.

For *Escherichia coli*, the order of activity was; Gentamycin (94.1%) > Pefloxacin (10 micrograms), Streptomycin (88.2%) > Pefloxacin (30 micrograms), Ofloxacin (82.4%) > Cotrimoxazole (70.6%) > Sparfloxacin, Ceftriaxone (Rocephine®) (47.1%) > Amoxicillin (41.2%) > Chloramphenicol (35.3%) > Cefuroxime (Zinnacef®), Erythromycin (17.6%) > Ciprofloxacin (11.8%). Thus, Gentamycin had the best activity against *Escherichia coli* isolated from urine samples of UTI patients.

Table.1 Percentage distribution of the organisms obtained among males and females

S. No.	Organisms	Female %	Male %	Total %
1	<i>Staphylococcus aureus</i>	71.43	28.57	45.65
2	<i>Escherichia coli</i>	76.47	23.53	36.96
3	<i>Klebsiella spp</i>	83.33	16.67	13.04
4	<i>Proteus spp</i>	100	0	4.35

For *Klebsiella* species, the order of activity was; (30 and 10 micrograms), Streptomycin, Ofloxacin (50%) > Cotrimoxazole, Sparfloxacin, Gentamycin (33.3%) > Ciprofloxacin. Thus, Pefloxacin (30 and 10 micrograms), Streptomycin and Ofloxacin had greatest activities against *Klebsiella* species isolated from the urine of UTI patients. For *proteus* species, the order of activity was; Cotrimoxazole, Gentamycin, Pefloxacin (30 and 10 micrograms) and streptomycin (100%) > Ciprofloxacin and Ofloxacin (50%). Therefore, Cotrimoxazole, Gentamycin, Pefloxacin (30 and 10 micrograms) and Streptomycin had the greatest activity against *Proteus* species isolated from urine of UTI patients. These are illustrated in Figures 1-4 respectively.

Table.2 Biochemical and microscopic characterization of sample-

S. No	Sample organism	Shape	Arrangement	H ₂ S	Glucose	Lactose	Acid & gas	Indole	Motility	Citrate	Catalase	Oxidase	Coagulase	Gram stain
1	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
2	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
3	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
4	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
5	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
6	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
7	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
8	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
9	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
10	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
11	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
12	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
13	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
14	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
15	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
16	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
17	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
18	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
19	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
20	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
21	S	Cocci	Cluster	+	+	+	-	-	-	+	+	-	+	+ve
22	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
23	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
24	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
25	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
26	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
27	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
28	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
29	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
30	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
31	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
32	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
33	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
34	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
35	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
36	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
37	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
38	E	Rod	Chain	+	+	+	+	+	+	+	+	-	-	_ve
39	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
40	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
41	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
42	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
43	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
44	K	Rod	Chain	+	+	+	+	-	-	+	+	-	-	_ve
45	P	Rod	Chain	+	+	+	+	+	+	-	-	-	-	_ve
46	P	Rod	Chain	+	+	+	+	+	+	-	-	-	-	_ve

Key:

S= Staphylococcus aureus; E= Escherichia coli; P= Proteus species; + = Growth/conversion of triple sugar ion black (hydrogensulphide) light yellow (Glucose), golden yellow (lactose), then presence of bubbles (acid) and cracks indicates gas production.; - =No growth/conversion of triple sugar agar; + =Indole, citrate, motility, lactase, oxidase, and coagulase activity.; +ve = Gram positive; -ve = Gram negative

Table.3 Inhibition zone diameters (mm) produced by disc antibiotics against the isolated organisms

S.No	Isolate	SXT	CH	SP	CPX	AM	AU	CN	PEF 30ug	PEF 10ug	S	OFX	APX	Z	R	E
1	S	0	13	0	0	0	0	0	14	20	16	17	0	0	18	19
2	S	20	11	12	20	0	0	21	20	22	20	18	0	0	14	23
3	S	15	20	20	21	0	0	15	19	18	22	17	0	0	18	0
4	S	15	18	19	20	0	14	18	18	21	20	17	15	19	21	18
5	S	21	20	21	20	14	0	20	20	20	20	20	0	11	18	14
6	S	20	20	21	21	0	11	19	20	20	20	17	12	11	17	18
7	S	18	19	18	20	0	0	18	18	21	20	18	0	0	21	14
8	S	18	20	20	22	0	0	20	21	20	18	0	11	0	21	19
9	S	0	0	20	20	0	0	18	18	19	0	15	0	0	15	17
10	S	0	0	15	18	0	0	15	15	18	18	15	0	0	11	12
11	S	19	20	20	21	12	13	20	18	19	18	14	11	12	13	15
12	S	16	18	19	22	17	17	20	21	20	20	17	16	18	22	16
13	S	0	14	17	17	0	0	15	17	16	17	15	15	0	11	0
14	S	0	16	17	17	0	0	15	19	18	18	17	0	0	17	11
15	S	15	18	17	22	0	16	18	20	18	20	18	0	0	18	18
16	S	0	15	20	20	0	0	20	21	20	17	17	11	10	17	18
17	S	16	18	19	19	15	15	19	20	19	18	18	0	0	15	17
18	S	18	18	17	19	19	11	19	20	21	19	17	0	19	21	18
19	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	S	18	16	20	20	15	15	18	19	20	20	19	10	11	17	18
21	S	20	18	17	21	17	14	20	18	19	20	17	11	13	21	23
22	E	0	14	17	18	0	0	20	18	19	20	13	0	0	21	15
23	E	22	17	20	21	15	17	20	18	18	20	17	15	19	21	17
24	E	20	20	21	20	17	17	20	21	20	21	20	14	0	21	23
25	E	17	19	20	20	18	18	19	18	20	18	18	15	14	12	23
26	E	0	0	20	20	0	0	20	20	20	20	18	13	14	18	18
27	E	18	17	18	20	0	15	18	21	20	20	18	0	0	21	18
28	E	19	18	18	19	12	14	18	20	19	18	17	12	0	19	15
29	E	20	17	18	18	15	16	19	20	19	18	18	15	0	18	0
30	E	20	19	18	19	18	18	20	20	21	18	18	15	18	21	23
31	E	0	15	20	20	0	0	16	16	17	0	0	0	0	0	0
32	E	19	18	20	18	17	17	20	21	20	19	18	14	19	19	19
33	E	18	18	20	20	17	17	18	20	19	18	18	0	14	17	18
34	E	18	17	18	22	15	14	18	19	18	18	17	0	0	18	18
35	E	0	15	19	19	0	0	19	20	20	19	17	0	0	17	17
36	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	E	16	12	13	20	18	11	15	19	20	18	17	0	0	22	14
38	E	16	17	0	20	17	0	17	17	18	18	18	15	17	21	16
39	K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	K	0	0	0	0	0	0	10	0	0	11	0	0	0	0	0
41	K	17	11	19	21	12	0	17	18	20	18	18	0	0	11	17
42	K	18	17	18	17	11	11	18	19	20	18	16	0	0	11	17
43	K	0	15	20	20	0	0	18	19	18	19	18	0	0	0	11
44	K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	P	18	17	18	15	0	11	19	20	20	11	11	0	0	13	18
46	P	19	17	18	21	0	17	20	20	21	18	18	0	0	18	18

KEY:

SXT= Cotrimoxazole (Septrin)® CH= Chloramphenicol SP= Sparfloxacin
 CPX= Ciprofloxacin AM= Amoxicillin AU= Augmentin CN= Gentamycin
 PEF= Pefloxacin S=Streptomycin OFX= Ofloxacin (Tarivid)® APX=Ampiclox®
 Z=Cefuroxime (Zinnacef)® R= (Rocephine)® Ceftriaxone E=Erythromycin
 S= Staphylococcus aureus E= Escherichia coli K= Klebsiella species
 P= Proteus species

Table.4 Percentage susceptibility (%) of uti isolates to disc antibiotics based on nccls breakpoints

Isolates	1	2	3	4	5	6	7	8	9
	SXT	CH	SP	CPX	AM	AU	CN	PEF 30ug	PEF 10ug
<i>Staphylococcus aureus</i> (n=21)	11(52.4)	12(57.1)	12(57.1)	7(33.3)	3(14.3)	0	15(71.4)	17(81.0)	19(90.5)
<i>Escherichia coli</i> (n=17)	12(70.6)	6(35.3)	8(47.1)	2(11.8)	7(41.2)	0	16(94.1)	14(82.4)	15(88.2)
<i>Klebsiella species</i> (n=6)	2(33.3)	0	2(33.3)	1(16.7)	0	0	2(33.3)	3(50)	3(50)
<i>Proteus species</i> (n=2)	2(100)								

Percentage Resistance of the Isolates to Disc Antibiotics

Table 2 shows the percentage resistance of the isolated organisms to disc antibiotics used. For *Staphylococcus aureus*, the order of activity was; Augmentin (100%) > Ampiclox, Zinnacef® (Cefuroxime) (85.7%) > Amoxicillin (71.4%) > Cotrimoxazole (33.3%) > Erythromycin (23.8%) > Chloramphenicol, Ceftriaxone (Rocephine®) (19.0%) > Sparfloxacin (14.3%) > Ciprofloxacin, Pefloxacin, (30 micrograms) Streptomycin, Ofloxacin, Gentamycin (9.5%) > Pefloxacin (10 micrograms) (4.8%). Augmentin had the least activity; that is, the isolates were more resistant to Augmentin.

For *Escherichia coli*, the order of resistance was; Cefuroxime (zinnacef®) (76.4%) > Ampiclox (58.8%) > Amoxicillin, Augmentin (41.2%) > Cotrimoxazole (29.4%) > Chloramphenicol, Sparfloxacin, Erythromycin (17.6%) > Streptomycin, Ofloxacin, Ceftriaxone (Rocephine®) (11.8%) > Ciprofloxacin, Gentamycin, Pefloxacin (30 and 10 micrograms) (5.9%). It was inferred that *Escherichia coli* was more resistant to Cefuroxime (zinnacef®).

For *Klebsiella species*, resistance follow the order Amoxicillin, Augmentin, Ampiclox, Cefuroxime (zinnacef®), Ceftriaxone (Rocephine®), (100%) > Cotrimoxazole, Chloramphenicol, Erythromycin (66.7%) Sparfloxacin, Ciprofloxacin, Gentamycin, Pefloxacin (30 and 10 micrograms), Streptomycin and Ofloxacin (50%). *Klebsiella species* were most resistant to Amoxicillin, Augmentin, Ampiclox, Cefuroxime and Ceftriaxone.

For *Proteus species*, the order of resistance was; Amoxicillin, Ampiclox, Cefuroxime (zinnacef®) (100%) > Ciprofloxacin, Augmentin, Ofloxacin, and

Ceftriaxone (Rocephine®) (50%). *Proteus species* were were most resistant to Amoxicillin, Ampiclox and Cefuroxime.

In conclusion, the study revealed that urinary tract infection is more prevalent among females than in males. The percentage is 76.09% in females while for the males 23.91%. This is confirmed by study carried out by Sabahat and Perween [16], Amadi *et al.*, [4] and Moghadas and Iranian [12]. The study also revealed that the incidence of urinary tract infection is much higher in females of child bearing years. This confirms the usual report that the risk of urinary tract infection increases with age by Mohammed A. Fareld, [17]. The pattern of isolates reported in this study is consistent with the usually reported pattern in developing countries with *Staphylococcus aureus* being the most common organism isolated in cases of urinary tract infection, confirmed by Amadi *et al.*, [4] Moghadas and Irajian [12] followed by *Escherichia coli* which is the second most common organism isolated, followed by *Klebsiella species* and *Proteus species* was the least common isolates in this study. This is confirmed by the reports by Papazafropaulo *et al.*, [15] but this study contradicted the usual report that *Escherichia coli* is the main cause of urinary tract infection. This study also revealed that some of the patients who are asymptomatic are been infected with the above named bacteria species, but most of the patients infected are symptomatic. This study indicated that Pefloxacin and Streptomycin were highly effective against *Staphylococcus aureus* isolates. For *Escherichia coli*, this study indicated Gentamycin as highly effective. For *Klebsiella species*, Pefloxacin, Streptomycin and Ofloxacin were found to be highly effective while for *proteus species*, Cotrimoxazole, Gentamycin, Pefloxacin and Streptomycin were indicated to be highly effective.

On the other hand, *Staphylococcus aureus* shows

increased resistance to Augmentin. *Escherichia coli* shows increased resistance to Cefuroxime but *Klebsiella* species indicated a high resistance to Amoxicillin, Augmentin, Ampiclox, Cefuroxime and Ceftriaxone, while *Proteus* species indicated an increased resistance to Amoxicillin, Ampiclox and Cefuroxime respectively.

It was concluded that urinary tract infections are more common in women as compared to men. *Staphylococcus aureus* was found to be the most common urinary tract pathogens in all human subjects assessed in that study. This was followed immediately by *Escherichia coli*. This study also indicates a higher significant relation between Urinary tract infections (UTIs) and age.

Recommendations

Based on the present findings, it is being recommended that;

1. Patients who feel irritations and abnormal signs in their urinary tract should first take lots of water and if it continues, they should see a doctor.
2. Patients should avoid indiscriminate use of antibiotics, which is the main reason for high resistance to these conventional antibiotics.
3. For females, anus should be cleaned to the back so as to prevent contamination of opening of the urethra.
4. Good personal hygiene should be maintained always for both men and women.

Author Contributions

Kingsley Chukwuka Amaihunwa: Investigation, formal analysis, writing—original draft. Daniel Kelechi Egbule: Validation, methodology, writing—reviewing. Augustina O. Jewo:—Formal analysis, writing—review and editing. Marvelous Akpakpan: Investigation, writing—reviewing. Oghenemaro Felix Enwa: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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