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Antibiotic Resistance of enteric bacterial pathogens in Accident and Emergency Units of Selected Public Hospitals in Calabar Metropolis, Cross River State

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Abstract

The rise in *Escherichia coli* and some other enteric pathogens resistance to antibiotics has been reported worldwide and this is of great concern in both developed and developing countries. This study is focused on investigation of the prevalence of enteric pathogens in the Accident and Emergency (A&E) units of some selected hospitals in Calabar metropolis. (Screening and characterizing and screening for antibiotic sensitivity of the isolated from each was conducted). A total of eighteen (18) samples comprising urine samples, stool samples and hospital surfaces were analysed using standard microbiological procedure. The findings of the study showed that the prevalent microorganisms in the selected hospitals were *E.coli*, *Klebsiella pneumoniae*, *Vibrio cholerae*, and *Proteus mirabilis*. Based on the sensitivity test, *E. coli* was highly sensitive to Ciprofloxacin (88.9%) (The most effective antibiotics for *E. coli*). While Erythromycin was the most resisted antibiotics by *E. coli*. The study also found that K *pneumoniae* was highly sensitive to Rifaximin (100%) though highly resistant to Levofloxacin (100%). The study also found that Levofloxacin, Nalidixic Acid, Gentamicin and Chloramphenicol were 100% effective on *P. mirabilis* isolates while Rifaximin was 100% sensitive. *V. cholerae* though not too prevalent was resistant to all antibiotics used except Septrin. The presence of *E. coli* and other enteric pathogens in the hospital setting may be a result of contamination of normal skin flora of patients, medical personnel and invasive devices. This study suggests that the antibiotics that were not effective to the pathogens should not be used for treatment except an antibiotic susceptibility test has been conducted.

Keywords: Antibiotics; Ciprofloxacin; Resistance; Antibiotic Sensitivity test;

Introduction

Over time, the fight against infections has been of major interest to healthcare providers, clinicians, medical researchers and microbiologists. The need to fight infections particularly bacterial infections brought about the use of antibiotics (Dungan & Bjorneberg, 2021). Antibiotics have been reported to reduce the severity and prevalence of bacterial infections in many areas (Jaja et al., 2020). However, the profile of bacteria towards antibiotics has also been reported by many authors and vary in regions (Arizpe et al., 2016; Olesen et al., 2018; Pfaller et al., 2019; Sahoo et al., 2012; Shindo & Hasegawa, 2017). Due to the high propensity of bacteria to develop certain attributes that enable them to resist certain antibiotics, the problem of antibiotic resistance cannot be overemphasized because of the short- and long-term effects imposed on human lives. Antibiotic resistance is described as the ability of bacteria to change in response to the use antibiotics that would resist the efficacy of the antibiotics.

Various aspects of human behaviour, industrial and agricultural practices, and healthcare facilities all are regarded as significant contributors to the spread of antibiotic-resistant bacteria (Boonyasiri et al., 2014; Pormohammad et al., 2019). Egorov et al. (2018) explained that resistance may arise through adaptive mechanisms unrelated to antibiotic structure or from the selection of antibiotic-resistant bacteria. Many studies have reported that the resistance profile of antibiotics depends on the medication history of the person taking the antibiotic (Aabed et al., 2021; Skarżyńska et al., 2021). Some have reported that bacteria respond to environmental/climate changes. For example, amoxicillin was reported to be effective against *E. coli* in Cross River State, Nigeria (Enyi-Idoh et al., 2017), while a meta-analysis in Ethiopia, E. *coli* was resistant to amoxicillin. (Tuem et al., 2018). In India, chloramphenicol was effective against E. *coli* (Sujatha et al., 2020), however, contrasting data were recorded in Lithuania (Šiugždaitž et al., 2018), in Malaysia (Ibrahim et al., 2021) and Cross River State, Nigeria (Nfongeh et al., 2018).

Some studies have reported that most people fail to take up the exact prescription of drugs, hence usually end their medication, halfway aiding the bacteria to develop resistance for the drug selection pressure (Boonyasiri, 2014; Pormohammad et al., 2019). It has also been reported that constant exposure to antibiotics increases the risk of Bacteria to develop antibiotic resistance. (Reinthaler et al., 2013). This has been a threat to many, including healthcare practitioners, pharmaceutical industries, researchers, and microbiologists (Massé et al., 2021). Empiric therapy is common especially in remote areas, which plays a role in antibiotic resistance.

The most frequent cause of nosocomial and community-acquired illnesses is Gram-negative coliform bacterium, E. *coli*, which is found in the gut flora of humans and other warm-blooded animals, however, it is a significant opportunistic pathogen (Marques, et al., 2018). This intestinal pathogen, considered to be a repository of virulence genes in various environments, lives in symbiosis with the human body. (Abdallah et al., 2015; Cortes-Cortes et al., 2017). A study in Nigeria that studied laboratory isolates revealed that; vancomycin was not effective to the three Gram negative isolates (*E. coli*, K *pneumoniae* and *Pseudomonas aeruginosa*) while, K *pneumoniae* and *P aeruginosa* were resistance to Tetracycline and Chloramphenicol respectively (Nkang et al., 2009).

From the foregoing, it has been observed that studies relating to antibiotic resistance have immensely been conducted across many countries including Nigeria. This could be because of the foresee threat of bacterial resistance to different antibiotics. It is incumbent from the cited studies that antibiotic that was effective to an organism at a particular time and region may be resisted by the same organism in a different time and location. This disparity may also be extended to individual differences. This implies that for every antibiotic therapy, a unique test is required. However, the reverse is almost the case as many antibiotics are carried out through empiric therapy. It is on this background that the present study is initiated to uncover the prevalence of

antibiotics resistant E. *coli* and other enteric pathogens in the Accident and Emergency unit of selected public hospitals in Calabar metropolis. This study is anticipated to promote the fight against antibiotic resistance because it may reveal the samples with the most resistance to an antibiotic.

Materials and Methods

Sample collection

A total of 18 samples were collected for this research from two hospitals which are; Dr Lawrence Henshaw Memorial Hospital (DLHMH) and General Hospital, both in Calabar. The samples were aseptically collected from the Accident and Emergency (A & E) unit of the hospitals, after informed consent of the patients was obtained. Three samples each of urine, stool and hospital surfaces swap respectively collected from both hospitals were used for the study. This resulted to 18 samples that were analysed in the study. The samples were collected and transported in an iced pack container immediately to the Department of Microbiology, University of Calabar, for further analysis.

Plating of samples and Determination of bacterial count

While working with the specimens, aseptic techniques were highly observed. The streaking method of plating was adopted for inoculation. All the agars used were freshly prepared by the researchers. The stool samples were measured and cultured in Selenite F broth for 24h, thereafter, the samples were cultured in Deoxycholate citrate agar (DCA) and Salmonella Shigella (SS) Agar. The urine samples were aseptically cultured in Cystine-lactose-electrolyte deficient (CLED) agar and Thiosulfate-citrate-bile salts-sucrose (TCBS) agar. While the hospital surfaces swaps were cultured in Nutrient agar. All the samples were incubated at 37^0C for 24h. After incubation of the plates, they were examined for growth, number of colonial morphologies, consistency and the colony sizes were also observed and noted. The discrete colonies were picked and sub-cultured into freshly prepared nutrient agar plates and incubated at 37^oC for 24h. Subsequently, discrete and pure colonies were observed and Gram stained. The pure colonies were then identified using Standard Microbiological methods (Cheesbrough, 2006). The biochemical test conducted in this research were Gram staining, Citrate, Indole, Catalase, Methyl red, Voges Proskauer and Motility test as explained in Upula et al. (2021).

Antibiotic susceptibility testing

The antibiotics used in this study includes: Ceporex, Chloramphenicol, Tarivid, Ampicillin, Gentamicin, Erythromycin, Nalidixic Acid, Rifaximin, Amoxicillin, Septrin, Rifampicin, Levofloxacin and Ciprofloxacin. The Kirby-Bauer disc diffusion method was used for the antibiotic sensitivity test. The isolates were inoculatedinto a nutrient broth using a sterile inoculating loop and incubated at 37^0C for 24h. After incubation, the inocula were standardised, equivalent to 0.5 MacFarland standard. Thereafter, a sterile cotton swab was dipped into the standardised bacteria suspension, excess broth was removed by squeezing the swap stick against the wall of the tube, and is utilized to inoculate the new Mueller-Hinton agar plate in a uniform manner. A sterile forceps was used to insert the appropriate antibiotic test disc on the agar surface after it had dried for approximately five minutes. The plates were incubated at 37^oC for 24h after allowing for diffusion of the antibiotics. After incubation, the diameters of the zone of inhibition were measured to the nearest mm. These zones were interpreted using Clinical and Laboratory Standard Institute (CLSI) guidelines (CLSI, 2021).

Results

Biochemical and cultural characteristics of isolates

After carrying out the biochemical test, the results of the biochemical test together with the cultural characteristic showed that of the 18 samples, there was no Gram-positive isolate with all the isolate identified as Gram-negative rods. However, there were four (4) different types of bacteria isolated from all the 18 samples analysed. These bacteria include *E. coli, Klebsiella pneumoniae, Proteus mirabilis* and *Vibrio cholerae* as presented in Table 1.

Table 1: Biochemical Identification

	TEST										TSI			
Sample	Gram stain	Shape	Catalase	MR	VP	Indole	Motility	Citrate	Urase	Butt	Slant	Gas	H_2S	Probable organism
ST1	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
ST2	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
ST3	-	Rod	+	-	+	-	-	+	+	Y	Y	+	-	*K. pneumoniae*
ST4	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
ST5	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
ST6	-	Rod	+	-	+	-	-	+	+	Y	Y	+	-	*K. pneumoniae*
UR1	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
UR2	-	Rod	+	-	+	+	+	+	-	Y	R	+	-	*V. cholerae*
UR3	-	Rod	+	-	+	-	-	+	+	Y	Y	+	-	*K. pneumoniae*
UR1	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
UR5	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
UR6	-	Rod	+	-	+	-	-	+	+	Y	Y	+	-	*K. pneumoniae*
HS1	-	Rod	+	+	-	+	+			Y	Y	+	-	*E. coli*
HS2	-	Rod	+	-	+	-	-	+	+	Y	Y	+	-	*K. pneumoniae*
HS3	-	Rod	+	+	-	+	+	-	-	Y	Y	+	-	*E. coli*
HS4	-	Rod	+	+	-	-	+	+	-	Y	R	+	+	*P. mirabilis*
HS5	-	Rod	+	+	-	-	+	+	-	Y	R	+	+	*P. mirabilis*
HS6	-	Rod	+	+	-	-	+	+	-	Y	R	+	+	*P. mirabilis*

Key: ST = Stool; UR = Urine; HS = Hospital surface; Y=yellow; R= red; (+) = positive samples, (-) = negative samples, VP =Voges Proskauer; MR = methyl red; H_2S = hydrogen sulphide; TSI = Triple sugar ion

Prevalence of bacterial isolates in the accidents and emergency (A&E) units

Out of the total number of the organism isolated (18), *E. coli* present were nine (9) in number, *K. pneumoniae* was isolated five (5) times, *P. mirabilis* occurred three (3) times while *Vibrio cholera* occurred one (1) time as presented in Table 2. The results showed that *E. coli* had the highest prevalence rate (50%), followed by *K. pneumoniae* (27.78), *P. mirabilis* (16.66) while *Vibro cholerae* (5.56) had the lowest prevalence rate as shown in Figure 1.

Table 2: Percentage occurrence of isolates from A&E in the hospitals.

Bacteria isolates	Number of occurrences	% Occurrence
E. coli	9	50.00
K. pneumoniae	5	27.78
P. mirabilis	3	16.66
V. cholerae	1	5.56
Total	**18**	100

Table 3: Antibiotics and Zone of Inhibition (mm)

	ISOLATE (mm)											
Antibiotics	*E. coli*	*E. coli*	*K. pneumoniae*	*E. coli*	*K. pneumoniae*	*E. coli*	*E. coli*	*V. cholerae*	*K. pneumoniae*	*P. mirabilis*	*P. pneumoniae*	*E. coli*
Ciprofloxacin (CIP) (5 µg)	38	26	26	22	32	30	26	18	36	36	19	-
Amoxicillin (AMX) (20 µg)	24	2	16	-	-	-	16	16	30	30	-	16
Gentamicin (CN) (10 µg)	-	-	18	20	8	-	16	-	7	-	-	-
Rifaximin (PFP) (5µg)	30	26	20	-	24	30	36	-	30	28	20	-
Nalidixic Acid (NA) (30µg)	-	17	-	22	19	-	16	-	2	-	-	24
Tarivid(OFL) (5 µg)	30	30	18	-	24	26	26	-	24	21	16	19
Ceporex (CEP) (30 µg)	-	24	-	-	20	-	26	10	16	10	-	-
Ampicillin (AM) (10 µg)	6	24	16	20	-	16	24	-	24	24	24	24
Septrin (SXT) (25 µg)	-	16	-	20	-	18	16	20	17	16	-	-
Streptomycin (STS) (1 0µg)	-	-	-	18	-	-	-	-	16	-	16	16
Rifampicin (RA) (5 µg)	16	20	20	22	-	18	22	11	2	16	20	11
Erythromycin (E) (15 µg)	-	-	6	-	16	-	-	16	19	21	-	16
Levofloxacin (LEV) (5 µg)	24	26	-	20	-	9	-	19	-	-	-	20
Chloramphenicol (CL) (30 µg)	16	5	-	20	19	-	4	-	-	-	-	-

Key: Resistance = (≤14 mm); Intermediate = (15-19 mm); Sensitivity = (≥20 mm); (-) = No zone of inhibition

Antibiotic susceptibility test

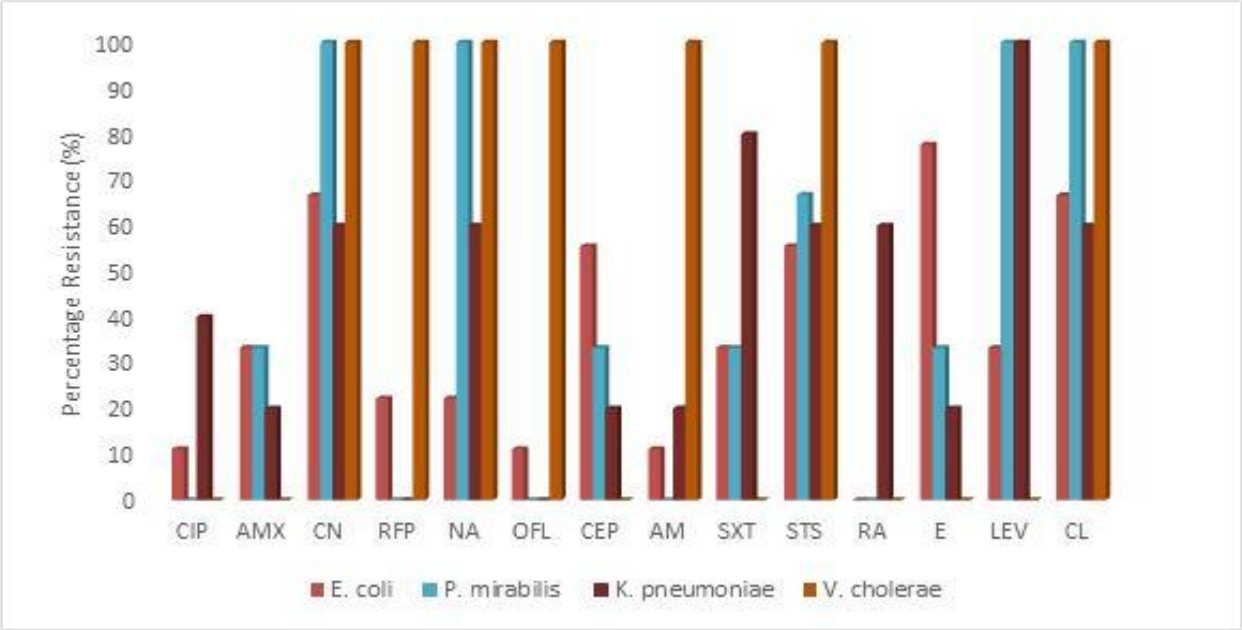
The results of the antibiotic sensitivity test of tested antibiotics showed that, out of the 14 antibiotics used in testing the susceptibility of the bacterial isolates, some of the bacterial isolates were resistant to the antibiotic tested, some were sensitive to some of the antibiotics while some also appeared as intermediate. The sensitivity, resistance and intermediate range were measured using the CLSI (2021) standard where; 0-14mm zone of inhibition is resistance, 15-19 mm zone of inhibition is intermediate and 20 mm zone of inhibition and above is susceptible as shown in Table 3. From the result in Table 4, out of 9 *E. coli* samples, 8 were very sensitive to Ciprofloxacin (88.9%); six (6) were sensitive to Rifaximin, Amplicin, Tarivid and Levofloxacin (66.7%) respectively; Five (5) isolates were sensitive to Rifampicin (55.5%); Four (4) isolates were sensitive Nalidixic acid (44.4%); three (3) isolates were Amoxicillin and Ceporex (33.3%) respectively; one (1) isolate was sensitive to Gentamicin, Septrin, Chloramphenicol and Streptomycin (11.1%) respectively; three (3) samples were intermediate to Amoxicillin, Nalidixic acid and Chloramphenicol (33.3%) respectively ; while no isolate was sensitive to Erythromycin (0%). Based on resistance, 7 samples also showed high resistance to Erythromycin (77.7). The result also indicated that K *pneumoniae* showed a total resistance to Levofloxacin 100%, and Ciprofloxacin 100% but was sensitive to Rifaximin (100%), Tarivid (60%). Again, *P. mirabilis* isolates were resistant to Levofloxacin, Nalidixic Acid, Gentamicinand Chloramphenicol (100%); while one (1) isolate was sensitive to Rifaximin (100%); Ciprofloxacin, Erythromycin and Amoxicillin (66.7%) respectively. The result also indicates that V. *cholerae* was 100% sensitive to septrin only but was 100% resistant to Gentamicin, Rifaximin, Nalidixic, Tarivid, Amplicin, Streptomycin and Chloramphenicol respectively as shown in Table 4.

Antibiotic Resistance profile of Isolates to the tested antibiotics.

From Table 4, *E. coli* isolates were highly resistant to Erythromycin (77.7%) Gentamycin (66.6%), Chloramphenicol (66.6%), Ceporex (55.5%) and Streptomycin (55.5%); *P. mirabilis* isolates were highly resistant to Gentamycin (100), Nalidixic Acid (100), Levofloxacin (100%), Chloramphenicol (100%) and Streptomycin (66.7); *K. pneumoniae* isolates were highly resistant to Levofloxacin (100%) Septrin (80%), Gentamycin (60%), Streptomycin (60%), Nalidixic Acid (60%), Rafampicin (60%), Chloramphenicol (60%) and Ciprofloxacin (40%); *V. cholerae* isolate was 100% resistant to Gentamycin, Streptomycin, Nalidixic Acid, Rafaximin, Ampicillin, Tarivid and Chloramphenicol respectively. The implicationof this is that the antibiotics that were highly resisted to were Gentamycin, Chloramphenicol, Streptomycin and Nalidixic Acid as shown in Figure 1.

Table 4: Antibiotic Percentage Sensitivity, Intermediate and Resistance Profile of Isolates

	E. coli *N= 9*			*P. mirabilis* *N = 3*			*K. pneumoniae* *N* = 5			*V. cholerae* *N = 1*		
Antibiotics	S%	I%	R%	S%	I%	R%	S%	I%	R%	S%	I%	R%
Ciprofloxacin (CIP)	8(88.9)	0(0)	1(11.1)	2(66.7)	1(33.3)	0(0)	0(0)	3(60)	**2(40)**	0(0)	1(100)	0(0)
Amoxicillin (AMX)	3(33.3)	3(33.4)	3(33.3)	2(66.7)	(0)	1(33.3)	2(40)	2(40)	1(20)	0(0)	1(100)	0(0)
Gentamicin (CN)	1(11.1)	2(22.2)	**6(66.6)**	0(0)	0(0)	**3(100)**	0(0)	2(40)	**3(60)**	0(0)	0(0)	**1(100)**
Rifaximin (PFP)	6(66.7)	1(11.1)	2(22.2)	3(100)	0(0)	0(0)	5(100)	0(0)	0(0)	0(0)	0(0)	**1(100)**
Nalidixic Acid (NA)	4(44.4)	3(33.3)	2(22.2)	0(0)	0(0)	**3(100)**	0(0)	2(40)	**3(60)**	0(0)	0(0)	**1(100)**
Tarivid (OFL)	6(66.7)	2(22.2)	1(11.1)	1(33.3)	2(66.7)	0(0)	3(60)	2(40)	0(0)	0(0)	0(0)	**1(100)**
Ceporex (CEP)	3(33.3)	1(11.1)	**5(55.5)**	0(0)	2(66.7)	1(33.3)	2(40)	2(40)	1(20)	0(0)	1(100)	0(0)
Ampicillin (AM)	6(66.6)	2(22.2)	1(11.1)	1(33.3)	2(66.7)	0(0)	2(40)	2(40)	1(20)	0(0)	0(0)	**1(100)**
Septrin (SXT)	1(11.1)	5(55.5)	3(33.3)	0(0)	2(66.7)	1(33.3)	0(0)	1(20)	**4(80)**	1(100)	0(0)	0(0)
Streptomycin (STS)	1(11.1)	2(22.2)	**5(55.5)**	0(0)	1(33.3)	**2(66.7)**	0(0)	2(40)	**3(60)**	0(0)	0(0)	**1(100)**
Rifampicin (RA)	5(55.5)	4(44.4)	0(0)	1(33.3)	2(66.7)	0(0)	2(40)	0(0)	**3(60)**	0(0)	1(100)	0(0)
Erythromycin (E)	0(0)	2(22.3)	**7(77.7)**	2(66.7)	0(0)	1(33.3)	0(0)	4(80)	1(20)	0(0)	1(100)	0(0)
Levofloxacin (LEV)	6(66.7)	0(0)	3(33.3)	0(0)	0(0)	**3(100)**	0(0)	0(0)	**5(100)**	0(0)	1(100)	0(0)
Chloramphenicol (CL)	1(11.1)	3(33.3)	**6(66.6)**	0(0)	0(0)	**3(100)**	0(0)	2(40)	**3(60)**	0(0)	0(0)	**1(100)**



Key: Ciprofloxacin (CIP); Amoxicillin (AMX); Gentamicin (CN); Rifaximin (PFP); Nalidixic Acid (NA); Tarivid (OFL); Ceporex (CEP); Ampicillin (AM); Septrin (SXT); Streptomycin (STS); Rifampicin (RA); Erythromycin (E); Levofloxacin (LEV); Chloramphenicol (CL)

Figure 1: Resistance Profile of Isolates to the Antibiotics

Discussion

Antibiotic resistance of enteric pathogens has been of serious concern in recent times. The presence of bacteria in the Accident and Emergency (A&E) unit of hospitals can impose great risk on the patients by causing nosocomial infections. Most organisms earlier reported to have caused infections in hospitalised patients includes *E. coli*, *Klebsiella* spp, *Staphylococcus aureus,* and *Bacillus* spp. In this study, eighteen (18) samples were collected from two public hospitals in Calabar metropolis. The study was able to reveal the prevalent microbes in the studied area. The highest prevalence was shown by *E. coli* (50.00%) followed by *K. pneumoniae*, (27.78), *P. mirabilis* (16.67%) and *V. cholerae* (5.56%). The prevalence of these microorganisms is not surprising because many previous studies have reported similar cases (Obenza et al., 2022; Palmer & Onifade, 2019). Again, activities in the Accident and Emergency units usually have traces of these microorganisms. Another reason could be from the samples collected in the study. *E. coli* harbours the intestinal tract of humans thereby rendering the organism common in stool samples (Olaniran *et al.*, 2015).

The study found that the prevalence of enteric pathogens in the A & E unit of a hospital is high, which is one of the major causes of infection such as; wound infection, urinary tract infection and diarrhoea in hospitalised patients. The presence of *E. coli* and other enteric pathogens in the hospital may be a result of the skin normal flora of patients, medical personnel, or through any intrusive equipment that comes into contact with their skin. *K pneumoniae* is also prevalent in hospitals and is also a common cause of hospital-acquired infections such as pneumonia and bloodstream infections. According to previous researches, many bacteria including *E. coli*, *Klebsiella* spp, *Staphylococcus aureus, Bacillus* spp have been known to cause infections in hospitalised patients. From this study, several bacteria were isolated from the samples collected. From the total samples collected, *E. coli* showed highest prevalence (50%), followed by *K. pneumoniae* (27.78%), *P.mirabilis* (16.67%) and *V. cholerae* (5.56%).

The prevalence of these microbes was a bit anticipated because previous studies have documented that enteric pathogens are often isolated from stool samples (Ekada & Stanley, 2021; Tobin et al., 2021). These pathogens have also been reported in several related studies across Nigeria and beyond (Cheung et al., 2020Manthey et al., 2018; Sitati et al., 2017; etc).

Among the antibiotics tested in the isolates, high resistance was generally observed against Chloramphenicol, Streptomycin, Gentamycin and Nalidixic Acid (NA). Based on the testisolates, *V. cholerae* and *K. pneumoniae* showed higher resistance rate compared to *E. coli* and *P. mirabilis.* This suggests that infections such as pneumonia, diarrhoea, bloodstream and surgical site infections may be more cumbersome to treat. The resistance of the tested isolates to these antibiotics does not imply that the antibiotic would be ineffective. Moreover, the samples collected in this study could be the cause of the high resistance, thus, a susceptibility test is always recommended before the administration of every antibiotic.

In details, the study also found that Levofloxacin, Nalidixic Acid, Gentamicin and Chloramphenicol were 100% not effective on *P mirabilis* isolates while Rifaximin was 100% sensitive. Finally, it was found that *V. cholerae* was 100% sensitive to septrin but was 100% resistant to Gentamicin, Rifaximin, Nalidixic, Tarivid, Amplicin, Streptomycin and Chloramphenicol respectively. The sensitivity of *E. coli* to gentamicin in this research is in agreement with the research of Poovendran and Ramanathan (2014) that showed that *E. coli* was sensitive to Gentamicin. This finding is also in consonant with Enyi-Idoh et al. (2017) that reported that *E. coli* was sensitive and resistant to Ciprofloxacin and Erythromycin respectively. The finding disagrees with that of Sujatha et al (2020), that reported that Ciprofloxacin (5.88%), Gentamicin (5.33%) and Chloramphenicol (1.17%) were not effective on *E. coli.* The study is also not in line with Gharavi et al., (2021) that found that Ciprofloxacin (23.5%) was ineffective on *E. coli.* The authors rather found that Ciprofloxacin was effective on *P. aeruginosa*.

The resistance to this antibiotic may be as a result of the selection of resistant mutant strains from the patient own flora during antibiotic therapy. Subsequently, resistance strains spread among patients and the environment in the hospitals. *K. pneumoniae* also showed total resistance to Levofloxacin (100%) but was 66.7% sensitive to Tarivid and 100% sensitive to Ciprofloxacin. *P. mirabilis* and *V. cholerae* were resistant to Levofloxacin and Chloramphenicol, it showed intermediate profile to Ciprofloxacin and Erythromycin having 33.3% and 66.7% respectively. *P. mirabilis* was less prevalent compared to *E. coli* and *K. pneumoniae,* though according to the result above, *K. pneumoniae* is also one of the most prevailing microorganisms that can be found in the A & E unit of public hospitals, accounting for most of the nosocomial infections such as pneumonia, this result is in agreement with Barma et al. (2017).

This study also found that *V.cholerae* and *P. mirabilis* isolates were resistant to Gentamicin, Chloramphenicol, Streptomycin and Nalidixic Acid there were also sensitive to Ciprofloxacin, Amoxicillin, Rifaximin and Septrim. Some antibiotics are not suitable for the treatments of some bacterial infections because the bacterial causing the infection is resistant to the antibiotic, for example, erythromycin can't be used for the treatment of *E. coli* infection because *E. coli* is resistant to it but rather Ciprofloxacin is the best option for the treatment of *E. coli* infection since it is sensitive to it sowing a sensitivity of 88.9%. Meanwhile, a higher dose of Amoxicillin may also be used for the treatment of *E. coli* infection

The prevalence of *E. coli* in the A & E unit of Hospitals in Calabar metropolis, showed that *E. coli* presence in hospital (as a cause of the hospital-acquired infection), there are also other prevalence microorganisms among which are *Vibrio cholerae, P. mirabilis, K. pneumoniae*. The results from the sensitivity test conducted showed that there were some antibiotics to which these prevalent pathogens were resistant to, therefore these antibiotics are not expected to be used for the treatment of any patient with the bacterial infection. (Apart from the bacteria being resistant, it was also sensitive to some other antibiotics and

showed as intermediate to some). Therefore, sensitive antibiotics can be used for the treatment of such bacterial infections caused by those pathogens. The antibiotics that gave intermediate results can also be used to treat the bacterial infection but in a higher dose.

Based on the findings of this study, it was recommended that: Quality control should be established in the A&E units of hospitals around the Calabar metropolis to reduce the rate of infection; antibiotics used for the treatment of infections should be tested against the organism for sensitivity before use for effective treatment; and the patient should be guided on how to take their medication appropriately to avoid misuse of the antibiotics thereby increasing the resistance rate.

References

Aabed, K., Moubayed, N., & Alzahrani, S. (2021). Antimicrobial resistance patterns among different Escherichia coli isolates in the Kingdom of Saudi Arabia. *Saudi Journal of Biological Sciences*, *28*(7), 3776–3782. https://doi.org/10.1016/j.sjbs.2021.03.047

Abdallah, H.M. Reuland, E.A., Wintermans, B.B., Al Naiemi, N.,Koek, A., Abdelwahab, A.M., Ammar, A.M., Mohamed, A.A.,& Vandenbroucke-Grauls, C.M.J.E. (2015). Extended-spectrum β-lactamases and/or carbapenemases- producing Enterobacteriaceae isolated from retail chicken meat in Zagazig, Egypt. *PLoS ONE, 10*, e0136052. https://doi.org/10.1371/journal.pone.0128120

Arizpe, A., Reveles, K.R., & Aitken, S.L. (2016). Regional variation in antibiotic prescribing among medicare part D enrollees, 2013. *BMC Infectious Disease 16*(744), 1-6. https://doi.org/10.1186/s12879-016-2091-0

Barma, M.M., Nasir I. A., & Babayo, A. (2017). Bacterial pathogens and their antibiotics susceptibility pattern in intensive care units of the university of Maiduguri teaching hospital Nigeria. *Journal of Tropical Biomedical*, *9*, 16-20. https://doi.org/10.4103/2276-7096.207587

Boonyasiri A, Tangkoskul T, Seenama C, Saiyarin J, Tiengrim S, & Thamlikitkul V. (2014). Prevalence of antibiotic resistant bacteria in healthy adults, foods, food animals, and the environment in selected areas in Thailand. *Pathog Glob Health*, *108*(5), 235–245. https://doi.org/10.1179/2047773214Y.0000000148

Cheesbrough, (2006). District laboratory practice in tropical countries. 2nd Edn., Cambridge University Press, Cambridge, UK. ISBN-13:9781139449298. https://doi.org/10.1017/CBO9780511543470

Clinical and Laboratory Standard Institute (2021). Performance standards for antimicrobial susceptibility testing. 31st edition.

Cortes-Cortes, G., Lozano-Zarain, P., Torres, C. Alonso, C. A., Rios-Torres, A.M., Castaneda, M.; Lopez-Pliego, L., Navarro, A., & Rocha-Gracia, R. (2017). Extended-spectrum beta-lactamase-producing Escherichia coli isolated from healthy humans in Mexico, including subclone ST131-B2-O25:H4-H30-Rx. *J. Glob. Antimicrob. Resist.*, *9*, 130–134. https://doi.org/10.1016/j.jgar.2017.02.014

Dungan, R. S., & Bjorneberg, D. L. (2021). Antimicrobial Resistance in Escherichia coli and Enterococcal Isolates From Irrigation Return Flows in a High-Desert Watershed. *Frontiers in Microbiology*, *12*(May), 1–14. https://doi.org/10.3389/fmicb.2021.660697

Egorov, A. M., Ulyashova, M. M., Rubtsova, M. Y. (2018). Material enzymes and antibiotic resistance. *Acta Naturae*, *10*(4), 33-48. https://doi.org/10.32607/20758251-2018-10-4-33-48

Enyi-Idoh, K., Akwa, O., Bassey, I., Idim, V., & Egeonu, S. (2017). Prevalence and Antibiotic Susceptibility Patterns of Escherichia coli O157:H7 in Children 0 – 24 Months in Calabar South L. G. A. of

Cross River State, Nigeria. *Journal of Advances in Medicine and Medical Research*, *22*(10), 1–10. https://doi.org/10.9734/JAMMR/2017/31023

Gharavi, M.J., Zarei, J., Roshani-Asl, P.Yazdanyar, Z., Sharif, M., & Rashid, N. (2021). Comprehensive study of antimicrobial susceptibility pattern and extended spectrum beta-lactamase (ESBL) prevalence in bacteria isolated from urine samples. *Scientific Reports 11*(578), 1-11. https://doi.org/10.1038/s41598-020-79791-0

Ibrahim, S., Wei Hoong, L., Lai Siong, Y., Mustapha, Z., C. W. Zalati, C. W. S., Aklilu, E., Mohamad, M., & Kamaruzzaman, N. F. (2021). Prevalence of antimicrobial resistance (AMR) Salmonella spp. and escherichia coli isolated from broilers in the east coast of peninsular malaysia. *Antibiotics*, *10*(5). https://doi.org/10.3390/antibiotics10050579

Jaja, I. F., Oguttu, J., Jaja, C. J. I., & Green, E. (2020). Prevalence and distribution of antimicrobial resistance determinants of Escherichia coli isolates obtained from meat in South Africa. *PLoS ONE*, *15*(5), 1–13. https://doi.org/10.1371/journal.pone.0216914

Marques, C., Belas, A., Franco, A., Aboim, C., Gama, L. T., & Pomba, C. (2018). Increase in antimicrobial resistance and emergence of major international high-risk clonal lineages in dogs and cats with urinary tract infection: 16year retrospective study. *Journal of Antimicrobial Chemotherapy*, *73*, 377–384. https://doi.org/10.1093/jac/dkx401

Massé, J., Lardé, H., Fairbrother, J. M., Roy, J. P., Francoz, D., Dufour, S., & Archambault, M. (2021). Prevalence of Antimicrobial Resistance and Characteristics of Escherichia coli Isolates From Fecal and Manure Pit Samples on Dairy Farms in the Province of Québec, Canada. *Frontiers in Veterinary Science*, *8* Article 654125 https://doi.org/10.3389/fvets.2021.654125

Nfongeh, J. F., Owoseni, M. C., Adogo, L. Y., Upla, P. U., Ekpiken, S. E., & Uchenwa, M. O. (2018). Prevalence and Antibiotic Resistance of Escherichia coli O157: H7 Serotype from Chicken Droppings Produced by Free - Ranged and Poultry Birds in Cross River, Nigeria. *American Journal of Biomedical and Life Sciences*, *6*(3), 51–55. https://doi.org/10.11648/j.ajbls.20180603.13

Nkang, A. O., Okonko, I. O., Mejeha, O. K., Adewale, O. G., Udeze, A. O., Fowotade, A., Fajobi, E. A., Adedeji, A. O., & Babalola, E. T. (2009). Assessment of antibiotics susceptibility profiles of some selected clinical isolates from laboratories in Nigeria. *Journal of Microbiology and Antimicrobials*, *1*(2), 19–26.

Olesen, S. W., Barnett, M. L., MacFadden, D. R., Brownstein, J. S., Hernández-Díaz, S., Lipsitch, M., & Grad, Y. H. (2018). The distribution of antibiotic use and its association with antibiotic resistance. *Elife*, *7*, e39435. https://doi.org/10.7554/eLife.39435.001

Pfaller, M. A., Cormican, M., Flamm, R. K., Mendes, R. E., & Jones, R. N. (2019). Temporal and geographic variation in antimicrobial susceptibility and resistance patterns of enterococci: results from the SENTRY Antimicrobial Surveillance Program, 1997–2016. *In Open Forum Infectious Diseases*, *6*(S1),S54-S62. https://doi.org/10.1093/ofid/ofy344

Poovendran, P., & Ramanathan, N. (2014). *In vitro* study on antibiotic susceptibility pattern of biofilm producing uropathogenic *Escherichia coli* isolates and their molecular characterization. *Asian Journal of Pharmaceutical and Clinical Research*, *7*(3), 181-185. https://cutt.ly/wR9Tq1g

Pormohammad, A., Nasiri, M. J., & Azimi, T. (2019). Prevalence of antibiotic resistance in escherichia coli strains simultaneously isolated from humans, animals, food, and the environment: A systematic review and meta-analysis. *Infection and Drug*

Resistance, *12*, 1181–1197. https://doi.org/10.2147/IDR.S201324

Reinthaler, F. F., Galler, H., Feierl, G., Haas, D., Leitner, E., Mascher, F., Melkes, A., Posch, J., Pertschy, B., Winter, I., Himmel, W., Marth, E., & Zarfel, G. (2013). Resistance patterns of Escherichia coli isolated from sewage sludge in comparison with those isolated from human patients in 2000 and 2009. *Journal of Water and Health*, *11*(1), 13–20. https://doi.org/10.2166/wh.2012.207

Sahoo, K. C., Tamhankar, A. J., Sahoo, S., Sahu, P. S., Klintz, S. R., & Lundborg, C. S. (2012). Geographical variation in antibiotic-resistant Escherichia coli isolates from stool, cow-dung and drinking water. *International Journal of Environmental Research and Public Health*, *9*(3), 746–759. https://doi.org/10.3390/ijerph9030746

Shindo Y., & Hasegawa Y. (2017). Regional differences in antibiotic-resistant pathogens in patients with pneumonia: Implications for clinicians. *Respirology*, *22*(8), 1536-1546. https://doi.org/10.1111/resp.13135

Šiugždaitž, J., Gabinaitienž, A., Kerzienž, S., Laurusevičius, S. A., & Laurusevičius, T. (2018). Antimicrobial resistance of Escherichia coli isolated from healthy dogs in Lithuania. *Veterinarski Arhiv*, *88*(3), 355–373. https://doi.org/10.24099/vet.arhiv.170110

Skarżyńska, M., Zając, M., Bomba, A., Bocian, Ł., Kozdruń, W., Polak, M., Wiącek, J., & Wasyl, D. (2021). Antimicrobial Resistance Glides in the Sky—Free-Living Birds as a Reservoir of Resistant Escherichia coli With Zoonotic Potential. *Frontiers in Microbiology*, *12*(April), 1–12. https://doi.org/10.3389/fmicb.2021.656223

Sujatha, T., Srivani, M., Subramanyam, K. V., & Rao, T. S. (2020). Epidemiology and Molecular Characterization of Shiga Toxigenic Escherichia coli from Diarrhoeic Lambs in Andhra Pradesh. *International Journal of Current Microbiology and Applied Sciences*, *9*(9), 3070–3077. https://doi.org/10.20546/ijcmas.2020.909.379

Tuem, K. B., Gebre, A. K., Atey, T. M., Bitew, H., Yimer, E. M., & Berhe, D. F. (2018). Drug Resistance Patterns of Escherichia coli in Ethiopia: A Meta-Analysis. *BioMed Research International*, 1–13. https://doi.org/10.1155/2018/4536905

Upula, S. A., Bassey, E. E., & Ije, U. E. (2021). Antiseptic soaps and body cleansing agents and its effects on the normal flora of the human skin. *World Journal of Pharmaceutical and Medical Research*, *7*(4), 28-34.

Palmer, O. G., & Onifade, A. K. (2019). Microorganisms Isolated from Hospital Environmental Surfaces in Akure Metropolis, Ondo State, Nigeria. *Journal of Advances in Microbiology*, *15*(3), 1-8.

Obenza, A., Cruz, P., Buttner, M., & Woodard, D. (2022). Microbial contamination on ambulance surfaces: a systematic literature review. Journal of Hospital Infection. *Journal of Hospital Infection*, *122*, 44-59.

Olaniran, O., Magaret, J. O., Jesuloluwa, A. H., Olajokun-Hassan, R. E., Ayobami, A. E., & Temitope, A. O. (2015). Isolation and evaluation of e. coli in diarrhoeic stool samples from children in Ile–Ife Nigeria. *Journal of Disease and Global Health*, *4*(4), 145-151.

Ekada, I., & Stanley, C. N. (2021). Prevalence, Distribution and Antibiotic Susceptibilities of Nosocomial Infections at a Tertiary Hospital in Port Harcourt, Nigeria. *Journal of Pharmaceutical Research International*, *33*(7), 1-12.

Tobin, E. A., Samuel, S. O., Inyang, N. J., Adewuyi, G. M., & Nmema, E. E. (2021). Bacteriological Profile and Antibiotic Sensitivity Patterns in Clinical Isolates from the Out-Patient Departments of a Tertiary Hospital in Nigeria. *Nigerian Journal of Clinical Practice*, *24*(8), 1225.

Sitati, F. C., Mosi, P. O., & Mwangi, J. C. (2017). Early bacterial cultures from open fractures-differences before and after

debridement. *Annals of African Surgery*, *14*(2), 66-70.

Manthey, C. F., Dranova, D., Christner, M., Berneking, L., Kluge, S., Lohse, A. W., & Fuhrmann, V. (2018). Stool cultures at the ICU: get rid of it! *Annals of Intensive Care*, *8*(1), 1-4.

Cheung, D. A., Nicholson, A., Butterfield, T. R., & DaCosta, M. (2020). Prevalence, co-infection and antibiotic resistance of Escherichia Coli from blood and urine samples at a hospital in Jamaica. *The Journal of Infection in Developing Countries*, *14*(02), 146-152.

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