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Antibiotic Profiles of Bacterial Enteropathogens associated with Diarrhea among HIV Positive and Negative Patients aged below five years in Western Kenya

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ABSTRACT

Background: *The progressive increase in antibiotic resistance among enteric pathogens, particularly in developing countries, is an issue of special concern and it is believed that bacterial enteropathogens in AIDS patients may manifest differently from infections in immune competent hosts.*

Objectives: *To investigate antibiotic profiles diarrhea genic E coli, Salmonella, Shigella associated with diarrhea among HIV positive and negative children aged below five years and identify factors predisposing to antibiotic resistance.*

Methods: *Antibiotic susceptibility profiles of 105 E coli, 5 Salmonella and 6 Shigella isolates including 36 pathotypes of diarrheagenic E coli namely enteropathogenic (EPEC), Enterotoxigenic (ETEC), enteroinvasive (EIEC), enteroaggregative (EAEC), Enterohaemorrhagic E coli (EHEC) were evaluated against the antibiotics ampicillin, amikacin, ceftriaxone, cefuroxime, ceftazidime, gentamicin, cotrimoxazole, cefipime, ciprofloxacin and imipenem using the Kirby-Bauer disc-diffusion method.*

Results: *Escherichia coli, Salmonella and Shigella species in HIV negative cases were more susceptible to cefuroxime (74.6%, 20%, 40%), ceftazidime (89.6%, 60% 40%), cefepime (97%, 60%, 60%) and amikacin (46.3%, 60%, 80%) respectively compared to isolates from HIV positive cases. However, all isolates from HIV positive and negative cases exhibited resistance to ampicillin (44.7%, 100%) vs (49.2%, 40%, 60%) and cotrimoxazole (78.9%, 100%) vs (40.3%, 80%, 80%) respectively. Virulence genes including bundle forming pilus (bfp) in EPEC, invasive plasmid adhesin (ipaH) in EIEC and aggregative attachment adhesin (aatA) in EAEC were significantly linked to resistance unlike shigatoxigenic factors (stx_1, stx_2) in ETEC and EHEC (lt, est).*

Conclusion: *Significant differences in antibiotic susceptibility profiles exist between E coli, Salmonella and Shigella species. Virulence genes including EPEC (bfp), EIEC (ipaH) and EAEC (aatA) were associated with resistance whereas cytotoxic factors in ETEC and EHEC had no effect. The antibiotics cefuroxime, ceftazidime, ciprofloxacin, cefipime and amikacin were effective in treatment of childhood diarrhea and may be incorporated into treatment regimens in Kenya. History of drug use prior to admission may influence antibiotic susceptibility of enteric species.*

Key words: *Bacterial Enteropathogens, Escherichia coli, Salmonella, Shigella, Antibiotic Profiles, HIV*

INTRODUCTION

Diarrhea is a major cause of morbidity and mortality among infants and children worldwide [1]. In Kenya, diarrhea is ranked third as a cause of death after malaria and pneumonia [2] and the third leading cause of pediatric admissions at Moi Teaching and Referral Hospital (MTRH) in Western Kenya. Diarrhea, defined as the passage of three or more loose stools within a 24 hour period, may present as watery or loose stools and may contain blood and mucus in dysentery [1]. Other symptoms include abdominal pain, nausea, vomiting and fever. The severity of acute diarrhoeal episodes can range from mild, moderate to severe cases that may lead to dehydration and death [1, 3]. Severity is influenced by various factors including the etiological agent and its virulence as well as host characteristics such as immunodeficiency and age [4]. Children infected with HIV are known to experience diarrhea episodes that are more severe, prolonged and recurrent requiring frequent and prolonged usage of antibiotics [5] in cases of bacterial etiology. This is thought to induce resistance in strains of gut flora and possible transfer of resistance genes to pathogens [6- 8].

Treatment of acute diarrhea is dependent on the severity of clinical signs and symptoms [1]. Dehydration is managed according to WHO guidelines which recommend administration of oral rehydration salts (ORS) and zinc as well as continued feeding [9, 4]. ORS is the 'gold standard' oral rehydration therapy that enhances fluid replacement while Zinc reduces the duration and severity of diarrhea episodes, stool volume and the need for advanced medical care [3]. Food

intake supports fluid absorption from the gut into the bloodstream to prevent dehydration and helps maintain nutritional status and immunity [4, 10, 2]. Though fluid and electrolyte replacement is the treatment of choice for acute diarrhea, antibiotics are also indicated for treatment of suspected shigellosis, invasive Salmonellosis and diarrheagenic *E coli* infections [10]. Several antibiotics are recommended for treatment of diarrhea and improve patient health but their impact on evolution of antibiotic resistance strains and circulating bacterial pathogens needs regular monitoring to curb increased multi-drug resistant (MDR) strains and reduce their spread [11]. Management of diarrhea at MTRH is done as per the clinical management protocol adopted by the Ministry of Health, Kenya [12], in line with WHO guidelines [9].

The progressive increase in antibiotic resistance among enteric pathogens, particularly in developing countries is of special concern [13]. Bacterial enteropathogens commonly associated with diarrhoea in children aged below five years include E coli, Salmonella and Shigella species [10]. Previous studies in Kenya have demonstrated resistance of enteric pathogens such as *E coli* and non-typhoidal *Salmonella* to prescribed antibiotics [14-18]. Sang et al. [19], demonstrated a multi-drug resistant Enteroaggregative E. coli O44, associated with acute and persistent diarrhoea in Kenyan children. However, there is limited data to link antibiotic profiles to genotypic diversity and virulence genes encoding cytotoxins; adherence or invasion factors in HIV positive and negative patients. This study sought to determine the antibiotic profiles of diarrheagenic *Escherichia coli*, *Salmonella, Shigella* and identify factors predisposing to resistance among children aged 0-60 months and with a view to establishing appropriate treatment regimens and prevent antibiotic resistance. This strategy of "trying to keep one step ahead" implicates the continual development and testing of new antibiotics, which inevitably is more expensive [20] but is hoped to be cost effective in disease management.

MATERIALS AND METHODS

Study site and Population

The study was conducted at Moi Teaching and Referral Hospital, the second Referral hospital in the Western region of Kenya. This was a cross sectional comparative study involving children aged below five years admitted with diarrhea between July 2011 and April 2012. A total of 216 children were involved in the study out of which 109 were HIV seropositive, 107 HIV seronegative and 20 HIV sero-exposed cases. HIV status was routinely determined on admission using HIV screening rapid methods; Determine (Abbott, Tokyo, Japan) and Uni-Gold_ (Trinity Biotech, Ireland) and seropositive cases were confirmed by HIV RNA PCR.

Ethical Considerations

Ethical review and approval was obtained from the Institutional Research and Ethics Committee of Moi University / Moi Teaching and Referral Hospital (FAN: IREC 000711). The rights of all

participants and their dignity was respected and protected with utmost confidentiality.

Data Analysis

Data was coded and analyzed using STATA 10 and descriptive statistics including mean, median, standard deviation and interquartile range (IQR) were applied for categorical variables and frequency listings for continuous variables. Chi square (X^2) test was used to test for associations between categorical variables while Kruskal-Wallis non-parametric test was used to compare means between groups at 0.05%level of significance for statistical inference.

METHODS

Determination of Antibiotic Susceptibility Profiles

A total of 116 isolates of *Salmonella*, *Shigella and* diarrheagenic *E coli* obtained from stool samples and identified using standard bacteriological methods [21] and pathotypes of *diarrheagenic E coli* with their virulence genes including ETEC heat labile toxin (*lt*), ETEC heat stable enterotoxin (*est*), EHEC shigatoxin, (stx_1 and stx_2), EPEC bundle forming pilus (*bfp*), EIEC invasive plasmid adhesin (*ipaH*) and EAEC aggregative attachment adhesin (*aatA*) factors were evaluated for antibiotic susceptibility using the Kirby-Bauer disc-diffusion method [22].

A total of 10 antibiotics (Oxoid Laboratories) tested including ampicillin (AMP, 10 µg), ceftazidime (CDM 30µg), cefuroxime (CXM 30µg), ceftriaxone (CRO 30 µg), ciprofloxacin (CIP 30 µg), amikacin (AMK 30µg), gentamicin (GEN 10 µg), cefipime (CFM) 10 µg), cotrimoxazole (CXT 20 µg) and imipenem (IMP 15 µg). *Escherichia coli* ATCC ® 25922, *Salmonella enterica* ATCC 35987 and *Shigella sonnei* ATCC 259310 were used as reference control strains. Two pure colonies of each bacterial strain were inoculated into 2 ml sterile Mueller Hinton (MH) broth in Bijou bottles and incubated at 37°C for 6 hours. Turbidity was adjusted to 0.5 units McFarland standard and a sterile cotton swab dipped into the suspension and squeezed to remove excess inocula then swabbed on the surface of each of two Mueller-Hinton agar (MHA) plates.

Five antibiotic sensitivity discs were dispensed onto the surface of each MHA plate one at a time using sterile forceps and incubated at 35-37°C for 18-24 hours. The diameter of the zones of inhibition was measured using a vernier caliper and interpreted according to NCCLS guidelines for Enterobacteriaceae as sensitive (S), intermediate (I) and resistant (R).

Determination of Factors Predisposing to Antibiotic Resistance

Using questionnaires, parents / guardians were probed to elicit any information related to antibiotic use such as history of medication prior to admission and source of drugs used, which was useful in establishing any possible association with antibiotic resistance.

RESULTS

Antibiotic Susceptibility Profiles of E *coli*, *Salmonella* and *Shigella Species*

Analysis of antibiotic susceptibility profiles of *Escherichia coli*, *Salmonella* and *Shigella species* revealed that enteric species in HIV negative cases (**Table 1**) were more susceptible to cefuroxime (74.6%, 20%, 40%), ceftazidime (89.6%, 60% 40%), cefepime (97%, 60%, 60%) and amikacin (46.3%, 60%, 80%) respectively compared to isolates from HIV positive cases. The isolates in both HIV positive and negative cases exhibited resistance to ampicillin (44.7%, 100%) vs (49.2%, 40%, 60%) and cotrimoxazole (78.9%, 100%) vs (40.3%, 80%, 80%). Chi square test for association revealed statistically significant differences in antibiotic profiles between HIV positive and negative cases to all except the antibiotics ampicillin and amikacin, ($p<0.05$).

The comparison antibiotic resistance profiles of *Escherichia coli*, *Salmonella* and *Shigella species* and revealed that all the species exhibited over 45% resistance to ampicillin and cotrimoxazole but were moderately resistant to ceftriaxone, amikacin and imipenem (**Figure 1**). However, the isolates had extremely low levels of resistance to the cephalosporins; ceftazidime, cefepime, cefotaxime and ciprofloxacin.

Table 1: Comparison of Antibiotic Profiles of *E coli, Salmonella* and *Shigella* isolates from HIV Positive and Negative Patients

		HIV Positive				HIV Negative				
Antibiotic	**Sensitivity**	***E coli*** n=38 No.(%)	***Salmonella*** n= 0 No. (%)	***Shigella*** n= 1 No. (%)	**Sub-Total N= 39 No. (%)**	***E coli*** n= 67 No. (%)	***Salmonella*** n= 5 No. (%)	***Shigella*** n= 5 No. (%)	**Sub-Total N=77 No. (%)**	**p-value**
AMP	Intermediate Sensitive Resistant	18 (47.4) 3 (7.9) 17 (44.7)	0	0 0 1 (100)	**18 (34.6)** **3 (37.5)** **18 (32.1)**	30 (44.8) 4 (6.0) 33 (49.2)	2 (40) 1 (20) 2 (40)	2 (40) 0 3 (60)	**34 (65.4)** **5 (62.5** **38 (67.9)**	**0.996[1]**
AMK	Intermediate Sensitive Resistant	23 (60.5) 4 (10.5) 11 (29.0)	0	0 0 1 (100)	**23 (37.7)** **4 (15.4)** **12 (41.4)**	31 (46.3) 21 (31.3) 15 (22.4)	3 (60) 1 (20) 1 (20)	4 (80) 0 1 (20)	**38 (62.3)** **22 (84.6)** **17 (58.6)**	**0.078[1]**
CXN	Intermediate Sensitive Resistant	27 (71.1) 7 (18.4) 4 (10.5)	0	0 (100) 1 0	**27 (37)** **7 (21.9)** **4 (40)**	43 (64.2) 20 (29.8) 4 (6.0)	1 (20) 3 (60) 1 (20)	2 (40) 2 (40) 1 (20)	**46 (63)** **25 (78.1)** **6 (60)**	**0.013[1]**
CXM	Intermediate Sensitive Resistant	28 (73.7) 9 (23.7) 1 (2.6)	0	1 (100) 0 0	**29 (56.9)** **9 (14.3)** **1 (50)**	17 (25.4) 50 (74.6) 0	3 (60) 1 (20) 1 (20)	3 (60) 2 (40) 0	**22 (43.1)** **54 (85.7)** **1 (50)**	**0.000[1]**
CDM	Intermediate Sensitive Resistant	17 (44.7) 19 (50.0) 2 (5.3)	0	0 1 (100) 0	**17 (60.7)** **19 (22.6)** **3 (75)**	7 (10.4) 60 (89.6) 0	1 (20) 3 (60) 1 (20)	3 (60) 2 (40) 0	**11 (39.3)** **65 (77.4)** **1 (25)**	**0.000[1]**
GEN	Intermediate Sensitive Resistant	10 (26.3) 12 (31.6) 16 (42.1)	0	1 (100) 0 0	**11 (18.6)** **12 (37.5)** **16 (64)**	45 (67.2) 14 (20.8) 8 (12.0)	1 (20) 3 (60) 1 (20)	1 (20) 3 (60) 1 (20)	**48 (81.4)** **20 (62.5)** **(36)**	**0.000[1]**
CTX	Intermediate Sensitive Resistant	8 (21.1) 0 30 (78.9)	0	0 0 1 (100)	**8 (17.4)** **0** **31 (47)**	36 (53.7) 4 (6.0)) 27 (40.3)	1 (20) 0 4 (80)	1 (20) 0 4 (80)	**38 (82.6)** **4(100)** **35 (53.0)**	**0.003[1]**
CPM	Intermediate Sensitive Resistant	21 (55.3) 16 (42.1) 1 (2.6)	0	0 0 1 (100)	**21 (84)** **16 (18.3)** **2 (50)**	2 (60) 65 (97.0) 0	1 (20) 3 (60) 1 (20)	1 (20) 3 (60) 1 (20)	**4 (16)** **71 (81.7)** **2 (50)**	**0.000[1]**
CIP	Intermediate	19 (50)	0	0	**19 (30.6)**	40 (59.7)	1 (20)	2 (40)	**43 (69.4)**	**0.000[1]**

	Sensitive Resistant	1 (2.6) 18 (47.4)		0 1 (100)	**1 (3.1)** **19 (86.4)**	27 (40.3) 0	3 (60) 1 20)	1 (20) 2 (40)	**31 (96.9)** **3 (13.6)**	
IMP	Intermediate Sensitive Resistant	20 (52.6) 10 (26.3) 8 (21.1)	0	0 1 (100) 0	**20 (34.5)** **11 (23.9)** **8 (66.7)**	36 (53.7) 27 (40.3) 4 (6.0)	1 (20) 4 (80) 0	1 (20) 4 (80) 0	**38 (65.5)** **35 (76.1)** **4 (33.3)**	**0.024**[1]

[1]Kruskal-Wallis test: Confidence interval = 95%; p = 0.05

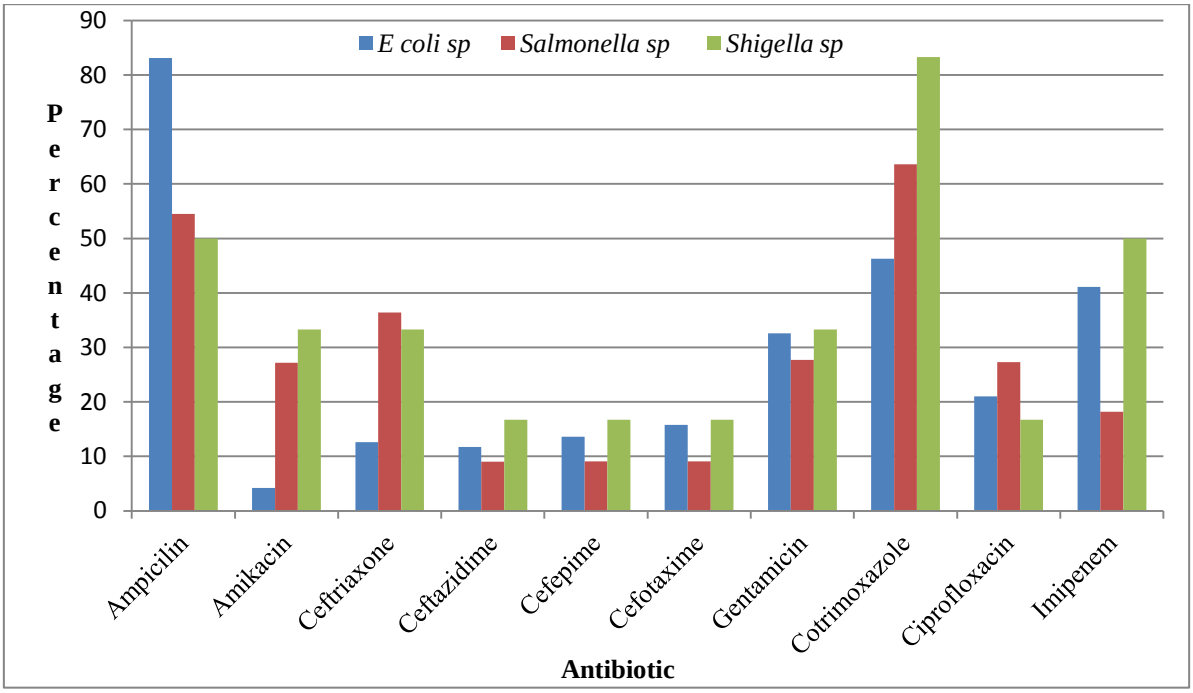

Figure 1: Comparison of Antibiotic Resistance Profiles of *E coli, Salmonella* and *Shigella* isolates

Diarrheagenic E coli in HIV positive and negative cases (Table 2) exhibited significant differences in antibiotic susceptibility to ampicillin, amikacin, ciprofloxacin and cefepime and imipenem, (Kruskal-Wallis test: H =-26.2, df = 13, p= 0.001) Similarly, DEC in both HIV positive and negative cases showed marked resistance to cotrimoxazole (43.7% vs 56.3%), ceftriaxone (66.7% vs 33.3%), amikacin (36.4% vs 63.6%) and ampicillin (44.4% vs 55.9%). Virulence genes in EPEC, bfp, EIEC, ipaH and EAEC, aatA appeared to be linked to resistance in both categories whereas ETEC (stx1 and stx2) and EHEC (lt and est) were notably insignificant.

37.5% of our cases were reported to have used other forms of medication prior to admission while 62.5% had none (Table 3). Some of the medications included herbal remedies (42.9% vs 52.1%) and multivitamins / supplements (64.3%, vs 35.7%) in HIV positive and negative cases. However both groups had equally used anti-malarial drugs, antibiotics and ORS.

Some of the HIV positive cases were reportedly on anti-tuberculosis and Antiretroviral (ARV) drugs. Some of the sources of medications reported included health facility; left over drugs from previous illness (60% vs 40%), community health workers (50% vs 50%), purchased from chemist without prescription (20% vs 80%) while those given by friends and relatives (25% vs 75 %) respectively among HIV positive and negative cases.

Table 2: Pathotypes of Diarrheagenic E coli and Antibiotic Resistance

	HIV Positive								HIV Negative								
	ETEC n=0		EHEC n=0		EAEC n=15	EIEC n=2	EPEC n=2	Sub Total	ETEC n=2		EHEC n=4		EAEC n=6	EIEC n=1	EPEC n=4		
Drug	*Lt*	*St*	*stx1*	*stx1*	*AttA*	*IpaH*	*bfp*	*N=19*	*lt*	*est*		lue	*stx2*	*att4*	*ipaH*	*bfp*	Sub total N=17	p value
AMP	0	0	0	0	15(44.1)	2(5.9)	2(5.9)	19(55.9)	1(2.9)	1(2.9)	1(2.9)		1(2.9)	6(17.6)	1(2.9)	4 (11.7)	15 (44.1)	0.001[1]
AMK	0	0	0	0	13(59.1)	0	1(4.5)	14(63.6)	0	0	0		1(4.5)	2(9.1)	1(4.5)	4(18.2)	8(36.4)	
CXN	0	0	0	0	2(33.3)	0	0	2(33.3)	0	0	0		0	1(16.7)	1(16.7)	2(33.3)	4 (66.7)	
CXM	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	
CDM	0	0	0	0	1(50)	1(50)	0	2(100)	0	0	0		0	0	0	0	0	
GEN	0	0	0	0	12(66.7)	1(5.6)	2(11.1)	15(83.3)	0	0	0		0	1(5.6)	1(5.6)	1(5.6)	3(16.7)	
CTX	0	0	0	0	14(43.8)	2(6.3)	2(6.3)	18(56.4)	1(3.1)	1(3.1)	1(3.1)		1(3.1)	5(15.6)	1(3.1)	4(12.5)	4(43.6)	
CPM	0	0	0	0	1(100)	0	0	1(100)	0	0	0		0	0	0	0		
CIP	0	0	0	0	11(61.1)	2(11.1)	2(11.1)	15(83.3)	0	1(5.5)	0		0	1(5.5)	1(5.5)	0	3(16.5)	
IMP	0	0	0	0	6(75)	1(12.5)	0	7(87.5)	0	0	0		0	1(12.5)	0	0	1(16.7)	

[1]Kruskal-Wallis test: H -26.2; df = 13; p= 0.001, Confidence interval = 95%

Table 3: Drug use and Sources versus HIV status

Variable	**HIV Positive** No. (%)	**HIV Negative** No. (%)	**Total** No. (%)	**p value**
Any other medication prior to admission?				
YES	10 (40)	15 (60)	25 (21.6)	0.005[2]
NO	29 (31.9)	62 (68.1)	91 (78.4)	
Sub-total	**39 (33.6)**	**77 (66.4)**	**116 (100)**	
Type of medication used				
ORS	2 (50)	2 (50)	4 (8)	0.005[2]
Anti-TB drugs	6 (100)	0	6 (12)	
Multivitamins /Supplements	9 (64.3)	5 (35.7)	14 (28)	
Herbal Remedies	3 (42.9)	4 (57.1)	7 (14)	
Antimalarial Drugs	2 (50)	2 (50)	4 (8)	
Antibiotics	3 (50)	3 (50)	6 (12)	
ARVs	9 (100)	0	9 (18)	
Sub-total	**34 (68)**	**16 (32)**	**50 (100)**	
Source of drugs				
Health facility	18 (85.7)	3 (14.2)	21(43.8)	0.010[2]
Left over drugs from previous illness	4 (40)	6 (60)	10 (20.8)	
Community Health workers	3 (50)	3 (50)	6 (12.5)	
Purchased from a chemist without prescription	1 (16.7)	5 (83.3	6 (12.5)	
Given by Friends / Relatives	1(20)	4 (80)	5 (10.4)	
Sub –Total	**27 (56.3)**	**21 (43.7)**	**48 (100)**	

[2] Chi square test, Confidence interval = 95%; p = 0.05; ORS- Oral Rehydration Salts, ARV – Anti-retroviral, TB-tuberculosis

DISCUSSION

Significant differences in antibiotic susceptibility were evident among HIV positive and negative patients to ampicillin, amikacin, ciprofloxacin, cefipime and imipenem respectively with greater resistance in the latter. This agreed with findings of a previous study in Senegal in which enteropathogens from HIV positive cases displayed high resistance to most antibiotics used for treating diarrhoea including ampicillin, tetracycline, and cotrimoxazole but were susceptible to amikacin, gentamicin, and norfloxacin [11]. E *coli*, *Salmonella* and *Shigella* isolates were all highly resistant to the conventional antibiotics ampicillin and cotrimoxazole. Previous studies in Kenya have also demonstrated resistance of enteropathogenic bacteria to commonly prescribed antibiotics [14-16]. The high antibiotic resistance noted among HIV positive cases may either be attributed to their prolonged use as prophylaxis in HIV-infected and exposed infants and children [1] or the frequent use of antibiotics to treat opportunistic infections as well as poor adherence to treatment.

Cotrimoxazole (trimethoprim-suphamethoxazole) is one of the first-line drugs recommended for the empiric treatment of diarrhea [10], however a high level of resistance was noted in all the three species with greater resistance among HIV positive cases. Diarrheagenic *E coli* strains EHEC, ETEC, EAEC, EIEC and EPEC were susceptible to ceftriaxone, cefuroxime, ceftazidime, ciprofloxacin and amikacin. Although cephalosporins are not usually used in treatment of diarrhea, the susceptibility of most isolates to second (cefuroxime), third (ceftazidime and ceftriaxone) and fourth generation cephalosporins (cefepime) and intermediate susceptibility amikacin, imipenem and gentamicin signifies the relevance of these drugs in treatment of acute and persistent diarrhea in addition to other management strategies. However, these drugs are not affordable to the common man surviving on low income [23].

Virulence factors in EIEC ipaH, EPEC bfp and EAEC aatA were linked to antibiotic resistance with the latter being the most resistant in both cases. Previous studies in Kenya [17, 24] and elsewhere [10, 25] have established resistance to commonly used antibiotics and emerging multi-resistance of different categories of DEC strains in developing countries. A study in Kenya documented resistant EAEC strains containing aggR gene and exhibiting classical stacked-brick-like aggregative adherence pattern on Hep-2 cells [26]. Elsewhere, EAEC strains from diarrheic stool had increased resistance than ETEC [27, 28]. There is fear that carriers of EAEC strains could risk a treatment failure [13]. Similarly, another study linked multidrug resistant species of non-typhoidal *Salmonella* (MDR NTS) with increased rate and duration of hospitalization and a twofold increased risk of death and invasive infection [29]. Extended-spectrum beta-lactamase (ESBL) enzymes produced by the specific strains has been cited as one of the causes of increased resistance[30] and the evolution of microbial

populations via exposure to selective forces has been linked to widespread use of antibiotics in poultry farming [23].

On history of medication among subjects, both HIV positive and negative patients had taken some form of medication prior to admission but there were significant differences among those on ORS, antibiotics and anti-malarial drugs. Multi-vitamins and herbal remedies were applied in different proportions among HIV positive and negative cases. A previous study in sub-Saharan Africa also reported the use of antibiotics, local herbs and ORS in the treatment of diarrhoea at home [31]. There is a possibility that herbal remedies commonly used in rural settings in Kenya may interfere with effective antibiotic therapy, although their exact mechanism remains unclear. Interestingly, parents / guardians of HIV positive patients seemed however, careful to obtain medication from the right sources such as health facility rather than friends and relatives or purchased without prescription as was common in HIV negative cases, a risk factor predisposing to antibiotic resistance. This may be attributed to proper advice provided by clinicians for those on ARV therapy. Furthermore, HIV seropositive patients had access to free care and treatment for opportunistic infections at the hospital. This also explains why some of them had left over drugs from previous illnesses. As suggested in previous studies, the overuse and misuse of antibiotics in the treatment of diarrhea could lead to increased resistance [14, 34-35]. Evidence of patients obtaining drugs from retail pharmacies in Kenya without prescription is a common phenomenon. These retailers, often operating without a license are preferred because they are more accessible to patients as they are located within the community and most often do not charge consultation fees while at the same time providing quick and negotiable treatment services that meet the financial needs of clients [7].

CONCLUSIONS

The study depicts significant differences in antibiotic susceptibility profiles between *E coli*, *Salmonella* and *Shigella species* among HIV positive and negative cases, ($P < 0.05$). Virulence genes including EPEC (*bfp)*, EIEC (*ipaH)* and EAEC (*aatA)* are linked with antibiotic resistance. The antibiotics cefuroxime, ceftazidime, ciprofloxacin, cefipime and amikacin are effective in treatment of childhood diarrhoea while cotrimoxazole and ampicillin are ineffective. History of drug use prior to admission has significant influence on antibiotic susceptibility of enteric species.

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