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Prevalence and Antimicrobial Susceptibility of *Enterobacteriaceae* Collected from Patients with Wounds at Kenyatta National Hospital, Nairobi, Kenya.

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Prevalence and sensitivity trends of *Enterobacteriaceae* isolated from septic wounds were determined through a prospective cross sectional study. One hundred and fifteen specimens isolated from in-patients in the Department of Orthopaedics were studied and antibiotic sensitivity testing performed using the Kirby and Bauer disc diffusion technique. The prevalence of organisms isolated was *Proteus* spp (33.9%), *Eschericia* coli (13.2%), *Klebsiella* spp (7.9%), *Alcaligenes* (1.7%), *Citrobacter freundii* (0.9%), *Serratia* spp (0.9%) *and Acinetobacter baumanii* (0.9%). The sensitivity rate of ceftriaxone, ceftazidime and ciprofloxacin was above 70% in all cases. Co-amoxiclav, gentamicin, cefuroxime, minocycline and piperacillin showed moderate to high activity. *Klebsiella* spp isolates portrayed high resistance against several drugs. The sensitivity patterns showed that empirical prescribing should be discouraged since the organisms appear to be developing resistance against commonly used antibiotics.

Key words: Sensitivity trends, Prevalence, *Enterobacteriaceae,* antimicrobial susceptibility

INTRODUCTION

Bacteria of the *Enterobacteriaceae* family are primary inhabitants of the lower gastrointestinal tract of man and animals. Many survive readily in nature while some are found living free where water and minimum energy sources are available. In humans they comprise the highest proportion of the bacterial content in the gut. They are also found in the female genital tract and as transient colonizers of the mucous membrane. As a family these microorganisms produce the widest variety of infections compared to other microbial agents [1]. *Escherichia coli* is the most frequently encountered member of the *Enterobacteriaceae* family in the normal colonic flora and a leading cause of opportunistic infections. Virulent factors include alpha hemolysins, siderophores, aerobactin, capsular polysaccharide, toxins and pili. The organism causes several diseases such as urinary tract infection, intestinal infections, meningitis and wound infections [1].

Klebsiella spp are gram-negative non-motile capsulated rods. They are found in the intestinal tract of humans and animals and also in plants, soil and water. *Klebsiella pneumoniae* can be found as a commensal in the mouth and upper respiratory tract and also in most hospital environments as well as other habitats. Virulence factors are pili and capsules. Pathogenicity includes chest infections, urinary tract infection, wound infections and peritonitis, as well as septicemia and meningitis [2].

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MATERIALS AND METHODS

A sample size of 115 specimens was selected using the convenient sampling method. Fishers formula was applied in sample size calculation [3]. Each specimen was inoculated on blood agar and MacConkey agar. The inoculated blood agar was put in a candle jar to facilitate the growth of some organisms. Growth was observed after 24 h following incubation at 37 °C. Identification was done using catalase, urease, IMVIC, coagulase, esculin, optochin and oxidase tests. Isolates that were difficult to identify biochemically were identified using the analytical profile index. Culture characteristics also played a significant role in identification.

Drug sensitivity testing was carried out using Kirby and Bauer disk diffusion technique on Muller Hinton Agar. A zone of inhibition around the discs was an indication of sensitivity to a given antimicrobial drug. The diameter of the zone was measured and compared with standard values [4]. The results were interpreted according to the National Committee for Laboratory Standards (NCLS) criteria. Readings were taken 24 h after the second inoculation. *Eschericia coli* ATCC 25922 was used as the standard for comparison.

RESULTS

Prevalence of organisms

Eight different organisms were isolated as shown in table 1. From the 115 specimens collected, the prevalence was *Proteus* spp (33.9 %), *Eschericia coli* (13.2 %), *Klebsiella* spp (7.9 %), *Enterobacter* spp (2.6 %), *Alcaligenes spp* (1.7 %), *Citrobacter freundii* (0.9 %), *Serratia* spp (0.9 %) and *Acinetobacter baumanii* (0.9 %).

Table 1: Prevalence of *Enterobacteriaceae*

Organism	Frequency (%)	Prevalence (%)
Proteus spp	39 (23.4)	33.9
E. coli	15 (9)	13.2
Klebsiella spp	9 (5.4)	7.9
Enterobacter spp	3 (1.8)	2.6
Alcaligenes spp	2 (1.2)	1.7
Citrobacter freundii	1 (0.6)	0.9
Serratia spp	1 (0.6)	0.9
A. baumanii	1 (0.6)	0.9
Total	**71 (42.6)**	**61.9**

Antimicrobial susceptibility

The eight antibiotics tested were co-amoxiclav, cefuroxime, gentamicin, ciprofloxacin, minocycline, piperacillin, ceftazidime and ceftriaxone. Different organisms showed varying sensitivity patterns as illustrated in tables 2 to 6. The *Acinetobacter baumanii* isolate was resistant to cefuroxime and ceftriaxone but sensitive to the other six antibiotics. The *Serratia spp* isolate exhibited resistance to cefuroxime, had intermediate sensitivity to minocycline and was sensitive to the rest of the antibiotics tested. The *Citrobacter freundii* isolate was sensitive to the 8 antibiotics.

Table 2: Antimicrobial susceptibility of *Proteus* spp

Drug	Count (Percentage)		
	R	I	S
Co-amoxiclav	8 (20.5)	1 (2.6)	30 (76.9)
Cefuroxime	14 (35.9)	1 (2.6)	24 (61.5)
Gentamicin	20 (51.3)	1 (2.6)	18 (46.2)
Ciprofloxacin	5 (12.8)	0	34 (87.2)
Minocycline	36 (92.3)	1 (2.6)	2 (5.1)
Piperacillin	18 (46.2)	2 (5.1)	19 (48.7)
Ceftazidime	4 (10.3)	0	35 (89.7)
Ceftriaxone	5 (12.8)	3 (7.7)	31 (79.5)

R = Resistant, I = Intermediate, S = Sensitive; n = 3

Table 3: Antimicrobial susceptibility of *Eschericia coli*

Drug	Count (Percentage)		
	R	I	S
Co-amoxiclav	3 (20.0)	1 (6.7)	11 (73.3)
Cefuroxime	3 (20.0)	4 (26.7)	8 (53.3)
Gentamicin	4 (26.7)	0	11 (73.3)
Ciprofloxacin	1 (6.7)	0	14 (93.3)
Minocycline	6 (40.0)	1 (6.7)	8 (53.3)
Piperacillin	9 (60.0)	0	6 (40.0)
Ceftazidime	0	1 (6.7)	14 (93.3)
Ceftriaxone	1 (6.7)	1 (6.7)	13 (86.7)

R = Resistant, I = Intermediate, S = Sensitive; n = 15

Table 4: Antimicrobial susceptibility of *Klebsiella* spp

Drug	Count (Percentage)		
	R	I	S
Co-amoxiclav	5 (55.6)	0	4 (44.4)
Cefuroxime	4 (44.4)	2 (22.2)	3 (33.3)
Gentamicin	2 (22.2)	0	7 (77.9)
Ciprofloxacin	2 (22.2)	0	7 (77.8)
Minocycline	6 (66.7)	1 (11.1)	2 (22.2)
Piperacillin	5 (55.6)	1 (11.1)	3 (33.3)
Ceftazidime	2 (22.2)	0	7 (77.8)
Ceftriaxone	2 (22.2)	0	7 (77.8)

R = Resistant, I = Intermediate, S = Sensitive; n = 9

Table 5: Antimicrobial susceptibility of *Enterobacter* spp

Drug	Count		
	R	I	S
Co-amoxiclav	2	0	1
Cefuroxime	1	2	0
Gentamicin	1	0	2
Ciprofloxacin	0	0	3
Minocycline	1	2	0
Piperacillin	0	0	3
Ceftazidime	0	0	3
Ceftriaxone	0	0	3

R = Resistant, I = Intermediate, S = Sensitive; n=3

Table 6: Antimicrobial susceptibility of *Alcaligenes* spp

Drug	Count		
	R	I	S
Co-amoxiclav	2	0	0
Cefuroxime	0	1	1
Gentamicin	0	0	2
Ciprofloxacin	0	0	2
Minocycline	2	0	0
Piperacillin	0	0	2
Ceftazidime	0	0	2
Ceftriaxone	0	0	2

R = Resistant, I = Intermediate, S = Sensitive; n=2

DICUSSION

Enterobacteriaceae formed the largest group of organisms isolated from wounds. Since these bacteria mainly originate from the gut and are able to remain viable for a long time outside the body, their likely source is environmental contamination at the Kenyatta National Hospital. Spread between patients may have been propagated by use of unsterilized equipments. The prevalence patterns are in agreement with reports in the literature [5-8] but more types of microorganisms were isolated in this study.

All the isolates were highly sensitive to third generation cephalosporins (ceftriaxone and ceftazidime) but showed variable susceptibility towards penicillins and cefuroxime. This shows that resistance is present probably due to changes in the permeability of bacteria, β-lactamase production or changes in the affinity of penicillin binding proteins. In addition, the antibiotic may fail to induce autolysis rendering it bacteriostatic [9]. The susceptibility trend could have been due to widespread use of antibiotics within the hospital. Sensitivity to ciprofloxacin was good and this drug may be a suitable choice for the treatment of wounds. Furthermore it is easily available, relatively affordable and convenient to administer. Studies carried in different regions [7-8] showed some similar findings on quinolone antibacterials. Gentamicin was effective against all the microorganisms except *Proteus* spp, probably

due to the plasmid mediated production of a degrading enzyme [8].

CONCLUSION

The results show that the *Enterobacteriaceae* family forms the majority of common pathogens in septic wounds at the Kenyatta National Hospital. This suggests that the environment could be contaminated or that wound management is inadequate. It is, therefore, important to formulate and implement an effective infection control programme to prevent development of widespread resistance against antibiotics and reduce cost of hospitalization to patients.

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