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Antimicrobial susceptibility profile of community acquired and nosocomial isolates of *Escherichia coli* from clinical blood culture specimens at a Nigerian university teaching hospital

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ABSTRACT

Objective: To ascertain the antibiotic susceptibility patterns of *Escherichia coli* recovered from blood culture specimens in Calabar, Nigeria. **Methods:** The study was retrospective in nature and was carried out at University of Calabar Teaching Hospital (UCTH) Calabar. Data generated from blood culture specimens over a five year period (Feb. 2004–Feb. 2009) was compiled, relevant information such as age, sex, organism recovered and antibiotic susceptibility patterns were obtained from patients records. Samples were collected, transported, stored and processed using standard laboratory procedures. Data obtained was analysed using Epi Info 6 statistical software. **Results:** *Escherichia coli* was responsible for 15.3% (31/203) of the blood infections being the third most common microorganism encountered. The community acquired (CA) isolates of the organism were significantly less resistant ($P<0.05$), compared to the nosocomial (NC) isolates against ampicillin, cloxacillin, amoxicillin, tetracycline, co-trimoxazole, chloramphenicol and erythromycin. The sensitivity of both the NC and CA isolates of *Escherichia coli* to amikacin, augmentin, ofloxacin, ciprofloxacin, ceftazidime, cefuroxime, ceftriaxone and rifampicin was generally high (80–100%) with no significant difference ($P>0.05$). Majority (>95.0%) of the NC isolates of *Escherichia coli* were resistant to six of the antibiotics tested. **Conclusions:** Control mechanisms for hospital acquired infections should be stepped up so as to limit the spread of the highly resistant bacterial strains. Also the sale and consumption of antibiotics by the public need to be regulated.

1. Introduction

Escherichia coli (E. coli) is, really, not an unpopular bacterium among members of the *Enterobacteriaceae* as well as members of other bacterial families[1,2]. The organism is a potential isolate from most clinical specimens subjected to bacteriological cultures and non-invasive conditions such as food poisoning[3–5]. *E. coli* has several inherent virulent factors that that tend to trigger process of infection and to a large extent influence the pathogenesis of its diseases in various parts of the human body[6,7]. These include fimbriae, flagella, outer membrane proteins, lipopolysaccharide, capsule antigen, urease, immunoglobulin A proteases, haemolysins and amino acid deaminases[8–10].

Quite a large number of the *E. coli* strains isolated from clinical specimens in contemporary medical practice have been found to be beta-Lactamase producing, and hydrolysing the same drugs meant for their treatment[11–13]. And with the emergence of a newer variant of the organism called- expanded-spectrum beta-Lactamase-producing strains of *E. coli*. Treatment failure from widespread resistance against several antimicrobials is gradually assuming a significant feature of the organism[14,15]. The expanded resistant isolates from nosocomial infections have continued to consistently prove more difficult to be treated compared to their community-acquired counterpart[16,17].

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The paradigm shift in the antimicrobial susceptibility profile of *E. coli* among humans as serially documented across the globe calls for the need for a periodic review of its antimicrobial susceptibility patterns at local health institutions. This would make up-to-date information on the above issue available concerning the organism and hence offer useful guide in the choice of antibiotics for the treatment of its infections and associated ailments such as life threatening septicaemia.

2. Materials and methods

The study was carried out at University of Calabar Teaching Hospital (UCTH), situated in Calabar city, the capital of Cross Rivers state, south-south Nigeria.

It was retrospective in nature, and data generated from the antibiotic susceptibility pattern of bacteria recovered from blood culture specimens were compiled for a period of five years (1st February, 2004-31st January, 2009). Specimens were collected, transported, stored and processed using standard laboratory procedures[18]. Briefly, using sterile procedures 2-4 mL of blood were collected and introduced into separate blood culture bottles (containing brain heart infusion and thioglycolate broths) and incubated for subsequent subcultures, Gram staining and biochemical methods. Modified Kirby-Bauer's diffusion method was used to carry out susceptibility testing[19]. Microorganisms recovered were grouped into nosocomial or community acquired based on the epidemiological circumstance of the blood specimens. Other relevant information such as age, sex were obtained from patients records.

The results were analysed using Epi Info-6, statistical software, P values $\leqslant 0.05$ were considered significant.

3. Results

Of the 3 255 blood culture specimens processed during the study period, 203 bacterial isolates were recovered of which *E. coli* was responsible for 15.3% (n=31) of the infections. Other bacteria recovered were: *Staphylococcus aureus* 22.7% (n=46), Coagulase negative *Staphylococci* (CONS) 14.3% (n=29), *Proteus* species 11.3% (n=23), *Klebsiella* species 20.2% (n=41), *Salmonella typhi/paratyphi* 10.3% (n=21) and *Citrobacter/Enterobacter* spp. 4.4% (n=9). Community acquired (CA) and nosocomial (NC) isolates of *E. coli* recovered were 61.3% (19) and 38.7% (12), respectively.

Based on age, the rate of *E. coli* infection in the blood was found to be highest among those aged 70-79 (7, 22.6%). There were 6 in age group of 40-49 years (19.4%), 5 both in 10-19 and 60-69 years old group, respectively (16.1%), 3 in 20-29 years old (9.7%), 2 in 0-9 and 30-59 years old group, respectively (6.5%). Those with 30-39 years old (1, 3.2%) had the lowest number of *E. coli* isolates recovered from their blood (P>0.05)(Table 1).

Antimicrobial susceptibility pattern of isolates of *E. coli* recovered from blood culture specimens against the antimicrobial agents tested showed that both the NC and CA isolates of organism were all (100%) susceptible to ofloxacin, ciprofloxacin, ceftazidime and cefuroxime but only the CA and NC isolates were susceptible (100%) to augmentin and rifampicin, respectively. The susceptibility of both the NC and CA isolates of *E. coli* were generally below 60% to penicillin G, ampicillin, cloxacillin, amoxicillin, tetracycline, co-trimoxazole, chloramphenicol and erythromycin with also significantly higher resistance of the NC compared to the CA isolates of the organism against the same group of antibiotics (P<0.05). There was no significant difference in the sensitivity of both the CA and NC isolates of the organism against augmentin, colistin, streptomycin, gentamicin, amikacin, ceftriaxone and rifampicin (P>0.05) (Figure 1).

Table 1

Age and gender distribution of *E. coli* recovered from blood culture specimens in Calabar, Nigeria [n(%)].

Age interval (Years old) *	Male **	Female	Total
0-9	0 (0.0)	2 (6.5)	2 (6.5)
10-19	4 (12.9)	1 (3.2)	5 (16.1)
20-29	3 (9.7)	0 (0.0)	3 (9.7)
30-39	1 (3.2)	0 (0.0)	1 (3.2)
40-49	4 (12.9)	2 (6.5)	6 (19.3)
50-59	0 (0.0)	2 (6.5)	2 (6.5)
60-69	1 (3.2)	4 (12.9)	5 (16.1)
70-79	2 (6.5)	5 (16.1)	7 (22.6)
⩾80	0 (0.0)	0 (0.0)	0 (0.0)
Unclassified	0 (0.0)	0 (0.0)	0 (0.0)
Total	15 (48.3)	16 (51.7)	31 (100)

*X^2 (Yates Corrected)= 0.02, OR= 0.94, RR=0.96, P= 0.90;
**X^2 (Yates Corrected)= 0.51, OR=0.73, RR=0.76, P= 0.47.

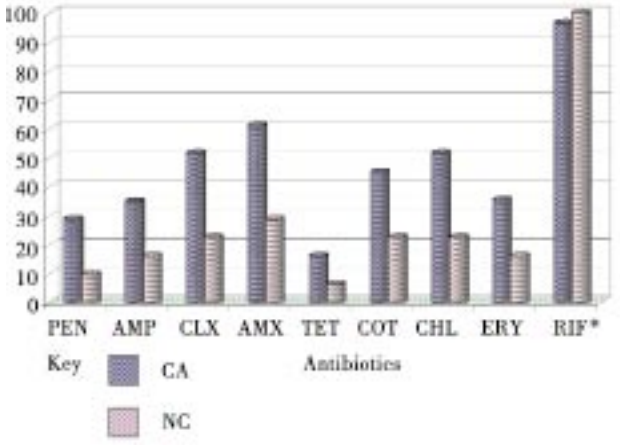

Figure 1. Antimicrobial susceptibility pattern of *E. coli* recovered from blood culture specimens in Calabar, Nigeria.
PEN=Penicillin G, AMP= Ampicillin, CLX=Cloxacillin, AMX= Amoxicillin, TET=Tetracycline, COT=Cot-trimoxazole, CHL=Chloramphenicol, ERY=Erythromycin, RIF=Rifampicin, *= P> 0.05

4. Discussion

E. coli was the third most common microorganism recovered and was found to account for 15% of the entire blood infections with no significant gender or age difference, though more isolates were recovered from paediatric and elderly patients. These findings compare well with that of Moreno *et al* in Spain[20] Ling *et al* in China[21], Blomberg *et al* in Tanzania[22] and Mugalu *et al* in Uganda[23] where *E. coli* was among the commonest microorganisms recovered from blood in various proportions. The finding of *E. coli* as the commonest agent causing blood infections in South Korea[24] and Italy[25] also partly agrees with findings from the present study. The inherent virulent factors that tend to accentuate survival of the organism in human tissues. Its ability to trigger quick release of cytokines and the rapid progression of its associated septic shock calls for the need for prompt management of its bacterial colonization[6-9].

All the CA and NC isolates of *E. coli* were sensitive (100%) to ofloxacin, ciprofloxacin, ceftazidime and cefuroxime while only the NC isolates were 100% sensitive to amikacin and ceftriaxone. Also the sensitivity of both the CA and NC isolates of the organism ranged from 0-60% against penicillin G, ampicillin, cloxacillin, amoxicillin, tetracycline, co-trimoxazole, chloramphenicol and erythromycin which this same group of antibiotics recorded significantly higher resistance among the NC isolates compared to the CA ($P<0.05$). This is a major deviation from the past where most of these antibiotics were at the disposal the physician to manage *E. coli* related infections. This paradigm shift in resistance pattern has similarly been documented in Jombo[26,27] in Nigeria. The fact that each *E. coli* isolate was resistant to at least 3 antimicrobials (range 3-6) calls for urgent need to regulate both sale and consumption of antibiotics in the country. This should probably include ban on free sale and purchase of antibiotics at will over the counter by the public the current norm is.

The high activity generally recorded in the present study by quinolones and cephalosporins against *E. coli* has also been elaborately documented in Slovak republic[28], United Kingdom[29], Russia and Norway[30] and Spain[31]. Most of the *E. coli* isolates resistant to up to 6 antibiotics were NC in origin. There should be in place a more comprehensive policy for control of NC infections with proper monitoring, evaluation and surveillance[32,33]. This would limit the spread of highly resistant microorganisms in the hospital environment and also their probable spill over to the larger society with the attendant consequences[29-31].

In conclusion, the present study has shown that, contrary to its favourable susceptibility pattern in the past, most of the *E. coli* recovered from blood especially the hospital acquired were resistant to up to six antibiotics. Quinolones, cephalosporins and aminoglycosides were generally the more active antibiotics against the organism in Calabar. A more comprehensive approach towards control of NC infections should be put in place so as to limit the degree of dissemination of the causative agents. In addition an integrated approach should be put in place to properly regulate both the sale and consumption of antibiotics so as to limit their abuse in the country.

Conflict of interest statement

We declare that we have no conflict of interest.

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