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Original article

Microbial isolates from clinical specimens of blood culture and their antimicrobial susceptibility profiles: Findings from an analysis of 3,255 blood culture specimens at a university teaching hospital in southern Nigeria

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ABSTRACT

The study was carried out to ascertain the pattern of antimicrobial distribution and their antibiotic susceptibility profile from blood culture samples. The study was retrospective in nature and 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. The incidence of positive blood culture was 6.2% (203/3,255); 7.1% (89/1,260) among males and 5.8% (111/1,910) among females with no significant age and gender differences (P> 0.05). Staphylococcus aureus 22.7%, Klebsiella spp. 20.2% and Escherichia coli 15.3% were the three most common bacterial isolates and Citrobacter/Enterobacter spp the least 4.4%. None of the antibiotics tested was 100% active against isolates of Staphylococcus aureus, coagulase negative Staphylococci, Proteus spp. and Salmonella typhi/paratyphi; majority of the bacterial agents, mostly nosocomial in origin, were resistant to at least four antibiotics. The most inactive antibiotics were: penicillin G, ampicillin, cloxacillin, amoxicillin, tetracycline and chloramphenicol (0-58.1% activity), and the most active were: Ofloxacin, ciprofloxacin, ceftazidime, cefuroxime, ceftriaxone, augmentin and colistin (42.9%-100% activity. Microorganisms causing blood infections are diverse with high resistance; hence, proper standards for infection control, antisepsis and disinfection should be stepped up in hospital environments in order to reduce the spread of the highly resistant bacteria.

1. Introduction

Bacteraemia, an episode of the presence of bacterial colonization of the blood circulation is usually not a life threatening condition. This is because several physiological conditions such as post-prandial, give rise to transient bacteraemia without any obvious clinical sequelae [1-3]. Septicaemia on the other hand is obviously a medical emergency, and with rapid progression keeps health personnel on their toes in a bid to arrest the situation [4,5]. This makes septicaemiaarising from various causes; a disease of serious clinical importance, and the diagnosis of other non-septicaemic bacterial ailments by recovering such bacteria from blood make blood cultures very useful tools for diagnosing several bacterial infections [6-8].

The diversity of bacteria recovered from blood cultures in the present day medical practice appears endless, and published works from leading medical laboratories worldwide appear not to have really come up with the final list of this group of organisms [9-11]. The important factors contributing to this scenario probably being due to: the sources of clinical infections in a locality; the extent and precision of the laboratory procedures carried out; and also very importantly, experience of the laboratory personnel involved [12-14]. These factors listed above have also contributed in no small way to the pattern and types of bacteria recovered from blood culture specimens in various health centres across the

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country ranging from the specialist and teaching hospitals to the clinics at the district levels [15-17].

In view of the serious threat septicaemia poses to the life of a patient, it is necessary that clinicians practicing especially in the tropics be squinted with the pattern and nature of bacteria commonly implicated [18,19]. This would guarantee prompt and a more efficient management of the affected patients especially where facilities are lacking or inadequate for accurate diagnosis, as is often the situation in Africa's rural communities [20,21]. Also, good background knowledge of the antimicrobial susceptibility patterns of the bacterial isolates by the personnel may also contribute to a more efficient management of patients encountered in such scenarios. A study on microorganisms recovered from blood culture specimens and their antimicrobial susceptibility patterns at a University Teaching Hospital in southern Nigeria was therefore carried out for this purpose.

2. Materials and Methods

2.1.Setting

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

2.2.Procedure

The study was retrospective in nature; 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 [22]. Briefly, using sterile procedures 2-4 mls of blood was 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 [23]. 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.

2.3.Analysis of Results

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

3. Results

Of the 3,255 blood culture specimens processed at the Microbiology laboratory of UCTH Calabar consisting of 1,283 (39.4%) and 1,972 (60.6%) from males and females respectively; the youngest and oldest patients were two days and 87 years respectively (Table 1).

Table 1. Age and gender distribution of patients referred for blood culture at the University of Calabar Teaching Hospital, Calabar.

Age (Years)	Male%	Female%	Total%
0-9	357 (10.9)	421 (13.0)	778 (23.9)
10-19	223 (6.9)	334 (10.3)	557 (17.1)
20-29	197 (6.1)	242 (7.4)	439 (13.5)
30-39	185 (5.7)	270 (8.5)	455 (14.0)
40-49	57 (1.7)	181 (5.6)	238 (7.3)
50-59	104 (3.2)	147 (4.5)	251 (7.7)
60-69	70 (2.2)	164 (5.0)	234 (7.2)
70-79	62 (1.9)	134 (4.1)	196 (6.0)
>_80	5 (0.1)	17 (0.5)	22 (0.7)
Unclassified	23 (0.7)	62 (1.9)	85 (2.6)
Total	1,283 (39.4)	1,972 (60.6)	3,255 (100)

The incidence of positive blood culture among the samples processed was 6.2% (203/3,255) (Figure 1).

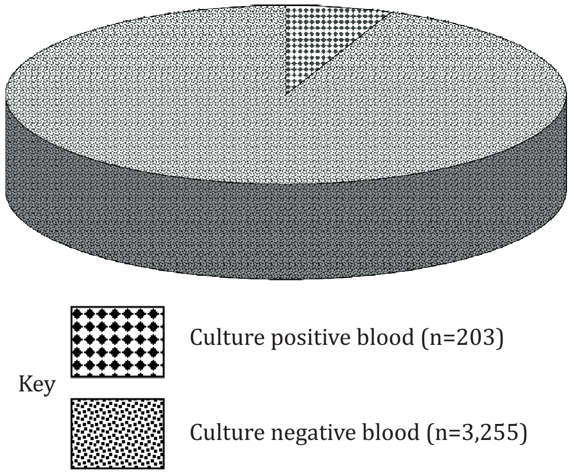
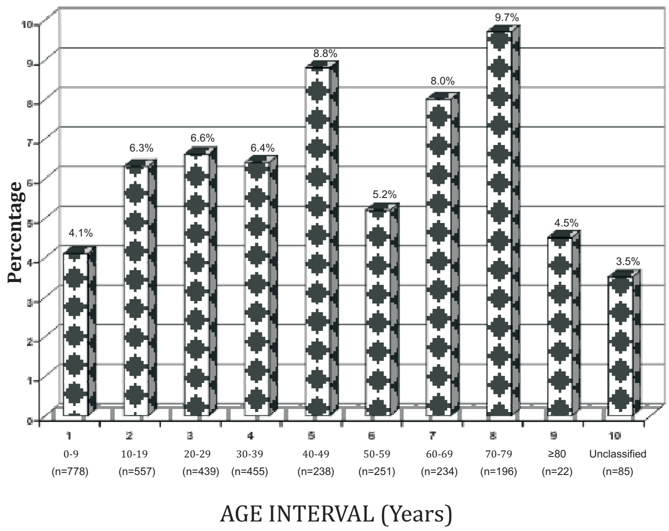


Figure 1. Incidence of culture positive blood among clinical blood culture specimens processed at the University of Calabar Teaching Hospital, Calabar.

In relation to age, the incidence of positive blood culture was found to be 4.1% (32/775), 6.3% (35/557), 6.6% (29/439) and 6.4% (29/455) for those aged 0-9, 10-19, 20-29 and 30-39 respectively, while the incidence of infection among those aged 40-49, 50-59, 60-69, 70-79 and those 80 years and above was 8.8% (21/238), 5.2% (13/251), 8.0% (21/234), 9.7%(19/196) and 4.5% (1/22) respectively, (P> 0.05) (Figure 2).

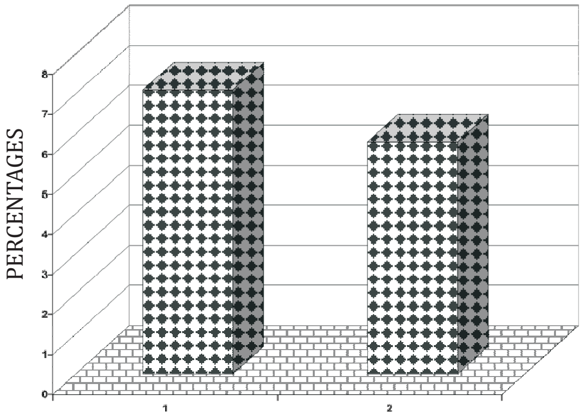


X^2 (Yates Corrected)= 0.95, OR=1.27, RR=1.10, P> 0.05

NB: n= Number of persons in each age interval

Figure 2. Incidence of positive blood culture in relation to age among clinical blood culture specimens processed at the University of Calabar Teaching Hospital, Calabar.

In relation to gender, the incidence of blood infection among males and females was 7.1% (89/1,260) and 5.8% (111/1,910) respectively, (P> 0.05) (Figure 3).



Male (n=1,260) Female (n=1,910)

GENDER

NB: n= Total number of subjects in each group

Microorganisms recovered from infected blood culture specimens 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), Escherichia coli 15.3% (n=31), Salmonella typhi/paratyphi 10.3% (n=21) and Citrobacter/Enterobacter spp. 4.4% (n=9) Table 2.

Table 2. Micro-organisms recovered from clinical blood culture specimens at the University of Calabar Teaching Hospital, Calabar.

Micro-organisms	Number (%)
Staphylococcus aureus	46 (22.7)
Coagulase Negative Staphylococci	29 (14.3)
Proteus species	23 (11.3)
Klebsiella species	41 (20.2)
Escherichia coli	31 (15.3)
Salmonella typhi/paratyphi	21 (10.3)
Citrobacter/Enterobacter	9 (4.4)
Others	3 (1.5)
Total	203 (100)

All the bacteria recovered were resistant to penicillin while 9.7% and 11.1% of the E. coli and Citrobacter/Enterobacter spp. were susceptible to ampicillin. None of the antimicrobials tested was 100% active against the isolates of S. aureus, CONS, Proteus spp. and Salmonella typhi/paratyphi. Majority of the bacteria nosocomial in origin were resistant to at least four antitiotics tested. Staphylococcus. Aureus was 45.6% sensitive to streptomycin, 89.1% sensitive to ceftazidime and 93.5% sensitive to Ofloxacin and ceftriaxone. All the isolates of CONS were resistant to chloramphenicol, tetracycline, cloxacillin, ampicillin and penicillin G with sensitivities to amoxicillin, gentamicin and, ciprofloxacin and ceftriaxone in the range of 3.4%, 58.6% and 96.6% respectively. None of the 23 isolates of Proteus spp. was susceptible to ampicillin, cloxacillin and tetracycline while sensitivities to amoxicillin and co-trimoxazole, gentamicin and amikacin, ciprofloxacin and ceftriaxone, and colistin were respectively 8.6%, 56.5%, 91.3% and 87.8%.

The sensitivity profile of the 41 isolates of Klebsiella spp. to ampicillin, tetracycline, streptomycin, ceftriaxone and ofloxacin were 0%, 14.6%, 80.5%, 97.6% and 100% respectively. Of the 31 E. coli isolates, 9.7%, 25.8%, 58.1%, 80.6%, 87.1%,96.7% and 100% respectively against ampicillin, co-trimoxazole, chloramphenicol, colistin and amikacin, ceftazidime, cefuroxime and ceftriaxone and, Ofloxacin and ciprofloxacin. All the 21 isolates of Salmonella typhi/paratyphi were resistant to ampicillin, cloxacillin and tetracycline with sensitivities in the range of 14.3%, 19.0%, 42.9%, 66.7%, 85.7% and 95.2% against co-trimoxazole, amoxicillin, colistin, ceftazidime, cefuroxime and, ceftriaxone and Ofloxacin respectively. Hundred percent sensitivity was recorded by all the 9 isolates of Citrobacter/Enterobacter spp. against Ofloxacin, ciprofloxacin and ceftriaxone, while the activities of ampicillin, augmentin, gentamicin and ceftazidime were in the range of 11.1%, 66.7%, 77.9% and 88.9% against the organisms (Table 3).

Table 3. Antimicrobial susceptibility pattern of micro-organisms recovered from clinical specimens of blood culture at University of Calabar Teaching Hospital, Calabar. (Figures in Percentages).

		A	N	T	I	M	I	C	R	O	B	I	A	L	S		
Micro-organism	PEN	AMP	CLX	AMX	TET	COT	AUG	COL	STR	GEN	AMK	OFX	CIP	CTZ	CFU	CFX	CHL
S-aureus (n=46)	0	0	0	0	0	0	69.5	63.0	45.6	63.0	69.6	93.5	93.5	89.1	69.6	93.3	0
CONS(n=29)	0	0	0	3.4	0	0	58.6	55.2	65.5	58.6	75.8	93.1	96.6	93.1	75.8	96.6	0
Proteus spp. (n=23)	-	0	0	8.6	0	8.6	56.5	87.8	82.6	56.5	56.5	95.7	91.3	91.3	82.6	82.6	8.6
Klebsiella spp. (n=23)	-	0	14.6	14.6	14.6	17.1	92.7	75.6	80.5	78.0	75.6	100	97.6	80.5	75.6	97.6	41.6
E.coli (n=31)	-	9.7	19.4	12.9	19.4	25.8	96.8	80.6	74.2	87.1	80.6	100	100	87.1	96.7	96.7	58.1
Salmonella spp.(n=21)	-	0	0	19.0	0	14.3	85.7	42.9	66.7	33.3	66.7	90.5	95.2	66.7	85.7	85.7	42.9
Citrobacter/Enterobacter spp. (n=9)	-	11.1	33.3	33.3	11.1	22.2	66.7	44.4	55.6	77.9	44.4	100	100	88.9	77.9	100	55.6

Key: PEN=Penicillin G, AMP = Ampicillin, CLX=Cloxacillin, AMX=Amoxicillin, TET=Tetracycline, COT=Co=trimoxazole, AUG=Augmentin (clavulanate potentiated amoxicillin), COL-Colistin, STR=Streptomycin, GEN=Gentamicin, AMK= Amikacin, OFX = Ofloxacin, CIP=Ciprofloxacin, CTZ= Ceftazidime, CFU= Cefuroxime, CTX=Ceftriaxone, CHL=Chloramphenicol, CONS= Coagulase negative Staphylococci, n= Number of isolates.

4.Discussion

From the 3,255 blood specimens cultured within a span of five years, the incidence of positive blood culture was 6.2% (n=203) with no gender or age difference (P> 0.05). Staphylococcus aureus 22.7%, Klebsiella spp. 20.2% and Escherichia coli were the three most common bacteria recovered: other bacteria being coagulase negative staphylococci (CONS) 14.3%, Proteus spp. 11.3%, Salmonella typhi/paratyphi 10.3% and the least encountered organisms- Citrobacter/Enterobacter spp. 4.4%. This pattern of bacterial isolates partly agrees with that of a similar study in Yobe state, Nigeria [24], where E. coli, S. aureus and Klebsiella spp. were among the commonest agents encountered; similar findings were also documented in Slovakia [25] where E. coli and Klebsiella spp. were the dominant microorganisms; and from Warsaw, Poland [26] where E. coli, Klebsiella and Proteus spp. were the dominant members of Enterobacteriaceae encountered.

Considering the potential of bacteriaemia and septicaemia to rapidly deteriorating clinical progression, laboratory personnel especially in the developing world, where processing and distribution of laboratory results is still largely done manually, should endeavour to supply relevant periodic preliminary reports on blood culture specimens so as to properly direct the course of effective management of these patients. The microbial isolates from the present study are partly different from that documented in: New Mexico [11] where Capnocytophaga carnimorsus was recovered from the blood samples of a fatal case of septicaemia; Madrid, Spain [12], where Cokeromyces recurvatus, Cunninghamella bertholletiae and Mucor circinelloides among other Zygomycota were variously recovered from blood of, principally immunosuppressed patients; Lagos, Nigeria [10], where Acinetobacter spp. were isolated; and from Ramat Aviv Israel [9] where Vibrio vulnificus was principally recovered from the blood of subjects of with liver disease or impaired immunity. Apart from the obvious morbid and pre-morbid conditions behind the apparent unusual findings from other research centres, the quality of laboratory facilities at each centre also has a significant role to play. The isolation of Trichosporon beigelii in Bethesda, Maryland [27], Cryptococcus neoformans in Manitoba, Canada [28], and Candida lustaniae in Solna, Sweden [29] contrary to the present findings, all attest to the diverse and unending list of microorganisms recoverable from blood cultures; these should as well be looked up for.

Antimicrobial susceptibility profile of the microorganisms showed that the activity of penicillin G, ampicillin, cloxacillin, tetracycline, co-trimoxazole and chloramphenicol on most of the bacterial isolates ranged from 0% to 58%; Ofloxacin, ciprofloxacin, ceftazidime, cefuroxime and augmentin had the highest activity against majority of the isolates in the range of 36.5% to 100%. In view of the fact that no antimicrobial agent tested had 100% activity against S. aureus, CONS, Salmonella typhi/paratyphi and Proteus spp. and each recovered agent being resistant to at least 4 antimicrobial agents underscores the depth of antibiotics resistance in contemporary medical practice. This growing antibiotic resistance of Enterobacteriaceae has also been well documented in Brazil [30], Vietnam [31] and South Africa [32]. The rapid acquisition of plasmid-mediated beta-lactamases has largely been implicated [33,34]. Treatment of Staphylococcal infections at present is also a major clinical challenge; findings from Asia Pacific [35], Germany [36] and Ile Ife Nigeria [37], similar to that from the present findings, have also clearly unveiled this widespread antibiotics resistance pattern with more disturbing methicillin-resistanct strains [38].

Proper control of infections at hospital settings would drastically reduce the spread of nosocomial infections whose bacterial isolates often times have presented with challenging scenarios in their management [39,40]. Also standardized antibiotics sensitivity tables comprising mainly local antibiotics in use should be made available at the local health centres and reviewed periodically. This would offer meaningful guide to clinicians on daily basis when confronted with medical emergencies.

5.Conclusion

This study has also reaffirmed the wide microbial diversity of clinical blood culture specimens. In view of the diverse and probably unending list of microorganisms causing blood infections, laboratory facilities should by deployed to accommodate as wide possibilities as possible. Most of the bacteria recovered from blood specimens were resistant to at least four antibiotics and several microorganisms were not sensitive (100%) to all the antibiotics tested. In view of the emergencies associated with septicaemia and bacteraemia, sensitivity charts should be readily consulted for their prompt management.

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