ORIGINAL ARTICLE

Quality assurance in blood culture: A retrospective study of blood culture contamination rate in a tertiary hospital in Nigeria

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ABSTRACT

Background: Blood culture is a critical tool for diagnosing septicaemia. Quite frequently, contamination of blood sample poses a great challenge to accurate diagnosis. This study evaluated the rate of blood culture contamination in our hospital over a one-year period. **Materials and Methods:** It was a retrospective study of 1032 blood cultures carried out in a clinical laboratory of a tertiary hospital in North Central part of Nigeria between 2010 and 2011. **Results:** There were 730 blood cultures from paediatric and 302 adult patients. The overall yield was 22%; 107 out of the 730 were contaminated giving a contamination rate of 10.4%. Contamination rate was higher in children than in adult (11% vs 8%) specimen. These rates were much higher than the acceptable benchmark of 2-3%. The main contaminants were coagulase negative *Staphylococcus, Bacillus* species, *Diphtheroids* and *Enterococcus* species. **Conclusion:** Contamination rate is high, and mainly due to normal skin flora, suggesting aseptic collection challenges as the main cause. We recommend a review of the entire process of blood collection for culture and analysis with a view to instituting appropriate quality assurance measures to reduce the contamination rate.

Key words: Blood culture, contamination, quality assurance

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INTRODUCTION

Blood culture is a very important life-saving investigation in patients with sepsis and bloodstream infections.[1] The aim of culture is to isolate pathogen and select appropriate antibiotic agents for an effective therapy based on *in vitro* sensitivity of the pathogens against a range of antibiotics.[2-4] A false positive blood culture tends to limit the utility of this important investigative tool with associated negative patient outcomes. Blood culture contamination rate is a commonly used quality indicator in blood culture processing.

One of the major challenges in blood culture is contamination, which occurs mainly from the resident skin flora of the patient, and poses serious challenges to both clinicians and laboratory staff.[1,5,6] A potential bacterial contaminant is defined as bacteria that commonly inhabit human skin, and when grown in culture represents contamination in more than 50% of the time.[7] Contamination due to skin flora especially in a solitary culture, makes interpretation difficult, and may result in excessive and sometimes unnecessary use of antibiotics with the risk of promoting bacterial resistance, increased morbidity and mortality, extended hospital stay and increased cost.[8]

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The acceptable blood contamination rate benchmark is 2-3%,[7,9-12] with rates ranging from 1% to 9%.[13] Factors associated with blood culture contamination include, but are not limited to, poor technique and procedure used to collect blood, lack of dedicated phlebotomists,[8,9,14] improper skin antisepsis.[15-17] This study determined the contamination rate of blood culture in our facility within a one year period.

MATERIALS AND METHODS

This was an one-year retrospective study of all blood cultures carried out between July 2010 and June 2011 at the Medical Microbiology Laboratory of the National Hospital, Abuja (NHA) Nigeria. Initially, solitary blood cultures were carried out using the oxoid signal culture bottle (Oxoid Ltd., Basingstroke, UK) or the Bactec culture bottle (Becton Dickinson). Later on, blood culture for adults was by the use of two or three bottles of Bactec in a single set aiming at

culturing between 20-24 ml of blood, whereas the solitary cultures for paediatrics continued. The third bottle was often added where either anaerobic or fungal infection was suspected. All culture bottles were incubated at 35-36°C at atmospheric pressure for a maximum duration of seven days. Cultures indicating growth were sub-cultured for isolation and subsequent identification. Records of all the blood cultures were reviewed, and the data were analysed for age and gender of the patients, type of cultures (solitary or multiple), total number of culture and the growths, and the type of culture systems used. We also sought information from clinicians on the techniques of collection and the type of antiseptic often used. Number of cultures was based on number of patients and not on number of culture bottles or set. Interpretation of results was based on the following criteria:

Growth of a known skin flora in a solitary culture — Contaminant

Growth of a known skin flora in more than one bottle in a multiple culture — Pathogen

Growth of a known pathogen in a solitary or multiple cultures — Pathogen

RESULTS

A total of 1032 blood cultures were carried out during the period; of which, 730 (70.7%) were blood specimens from paediatric group while 302 (29.1%) were from adults. There were 620 (60%) males and 412 (40%) females, in total [Table 1].

The total yield was 226 (22%), out of which 107 (47%) were contaminants while 119 (53%) were pathogens [Table 2]. The overall contamination rate was 10.4%; while it was 11% in paediatrics and 8% in adults. Every 16 adult and 7 paediatric cultures yielded a pathogen while every 13 adult and 9 paediatric cultures yielded a contaminant.

The four most common contaminants were coagulase negative *Staphylococus* (CoNS) (55%), *Enterococcus faecalis* (16%), *Bacillus* Spp (8%), and *Diphtheroids* (6%) [Table 3]. *S. aureus* (56%) and and *Klebsiella pneumoniae* (13%) were the predominant pathogens [Table 4].

Table 1: Age category and gender of patients

Age category	Gender distribution		
	Males (%)	Females (%)	Total (%)
Paediatric	430 (42)	300 (29)	730 (71)
Adult	190 (18)	112 (11)	302 (29)
Total	620 (60)	412 (40)	1032 (100)

Table 2: Age category and blood culture yield

Age category	No of bacteria Isolated		
	No of pathogens (%)	No of contaminants (%)	Total (%)
Paediatric	100 (44)	83 (37)	183 (81)
Adults	19 (8)	24 (11)	43 (19)
Total	119 (53)	107 (47)	226 (100)

Table 3: Profile of contaminants isolated from different age categories

Contaminants	Age categories		
	Paediatrics (%)	Adults (%)	Total (%)
CoNS	44 (41)	15 (14)	59 (55)
E. faecalis	14 (13)	3 (3)	17 (16)
Bacillus spp	8 (7)	1 (1)	9 (8)
Diphtheroids	4 (4)	2 (2)	6 (6)
Candida spp	1 (1)	—	1 (1)
Others	12 (11)	3 (3)	15 (14)
Total	83 (77)	24 (23)	107 (100)

CoNS – Coagulase negative *staphylococcus*; E – *Enterococcus*

Table 4: Profile of pathogens isolated from different age categories

Pathogens	Age category		
	Paediatrics (%)	Adults (%)	Total (%)
S. aureus	61 (51)	6 (5)	67 (56)
K. pneumonia	14 (12)	2 (2)	16 (14)
S. typhi	7 (6)	2 (2)	9 (8)
P. aeruginosa	7 (6)	6 (5)	13 (11)
P. mirabilis	5 (4)	1 (1)	6 (5)
Others	6 (5)	2 (2)	8 (7)
Total	100 (84)	19 (16)	119 (100)

DISCUSSION

The results of this study revealed that there were more males than females, and more paediatric patients than adults investigated for bloodstream infection. Although the reason for the preponderance of paediatric patients was not quite clear, one reason could be due to the fact that clinical history and elicitation of signs are much easier in adults than in paediatric patients, thus helping internal medicine clinicians to be more objective in making a clinical impression of sepsis in adults than likely in paediatrics; and therefore, make less blood culture requests. However, the total number of cultures per pathogen yield was more in adults than paeditrics suggesting that paediatricians were more exact in their clinical impressions than the internal physicians. This seeming contradiction may be due to ingestion of antibiotics prior to blood sample collection, a situation that lowers the true positive rate in the adult population in an environment of inappropriate antibiotics use like ours.

The total blood culture contamination rate in National Hospital Abuja was found to be 10.4%, far above the benchmark of 2-3%.[7,9-12] Contamination was relatively more in paediatric patients than in adults, with a total culture per contaminant yield of 9 against 13, and rate of 11% against 8%. Most likely, factors responsible for this high rate include, but are not limited to, poor techniques, the use of non-dedicated phlebotomists and variable

types of skin antiseptics, which, unfortunately, do not include iodine or iodophore. Difficulty in collecting blood from paediatric patients also account for the higher contamination rate. A previous study has shown that contamination rate can be significantly reduced through, among others, scrupulous attention to aseptic skin cleansing and improved venipuncture technique, using isopropyl alcohol and a tincture of iodine.[18] The use of dedicated phlebotomists has also been found to have similar improvement effect.[8]

Coagulase negative *Staphylococcus* (CoNS) was found to be the predominant contaminant in this study, similar to studies elsewhere.[9,19,20] This does not suggest that all CoNS grown in blood culture are contaminants. It has been found to cause 12.4% of clinically significant isolates from blood culture, and the third most common cause of bacteraemia because of their high prevalence, especially in patients with prosthetics and central venous catheters.[15,21,22] *Staphylococcus aureus* and *K. pneumoniae* were the most common pathogens isolated. This agrees with the results of earlier studies where these same organisms have been identified as the most common causes of bloodstream infections.[23-25]

In conclusion, rates of blood culture contamination in the National Hospital Abuja are high. There is an urgent need to institute established preventive measures to reduce the rates. This will go a long way in mitigating all the adverse consequences of blood culture contaminations such as increased cost of care, increased morbidity and mortality rates. A prospective study will be necessary to identify the main factors responsible for the contaminations and to evaluate the impact of interventions.

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