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Evaluation of blood culture samples for contamination and assessment of possible causes

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ABSTRACT

Blood is an enriched growth medium for the growth of microorganisms. Blood culture is the key test for diagnosis of bacteremia and fungemia in patients. A false positive blood culture (blood culture contaminants) is a challenge for both consultants and microbiologists as well. This study based on highlighting source of blood culture contamination and ways of prevention in laboratory and hospitals.

Keywords: Enriched source, false positive, blood culture contamination, Nosocomial infection, antibiotic therapy, mortality, morbidity.

Introduction

Blood is an enriched source for the growth of microorganisms including bacteria and fungi (Castillo et al., 2019). Blood culture is a representative test to evaluate blood streaming bacteria and fungi. Positive blood culture can reveal a definitive diagnosis, enable the targeting of therapy against the specific organism (Bryan et al., 1989). In blood culture false-positive results can limit the utility of this important test. One of the lead cause of false positives result is contamination which occurs when organisms that are not actually present in a blood sample, have been grow in culture (Keri et al., 2006). Contaminated cultures have been recognized as an important hurdle for antibiotics therapy, since decades and still to be a source of frustration for clinical and laboratory personnel. Working with a positive blood culture result, clinicians must determine whether the organism represents a clinically significant infection associated with a high risk of morbidity and mortality or a false-positive result of no clinical consequence (MP Weinstein, 2003). The magnitude of this crucial lab problem is increased in recent era of medical advancement due to the use of central venous catheters (CVC) and other indwelling vascular access devices as reported in *National Nosocomial Infections Surveillance (NNIS) report* for the years of 1996 & 2004 consecutively. Interpretation of culture results for patients with these devices in place is particularly challenging as these individuals are at increased volume of false positive results. The clinical

uncertainty associated with the interpretation of ambiguous culture results is costly as has been demonstrated in a number of studies of both adult and pediatric patients (Bates et al., 1991; Segal et al., 2000; Souvenir et al., 1998; Thuler et al., 1997). Despite its limitations, the blood culture still today to last few decades, is considered as the “gold standard” for the detection of bacteremia. An accurate interpretation of culture results is critical not only from the perspective of individual patient benefit but also from the quality control of hospital epidemiology and public health (Pandey *et al.*, 2019). The tracking and reporting of nosocomial infections and monitoring of bloodstream infection rates are both essential infection control activities that depend heavily on the accurate differentiation of contamination from true bacteremia. Reliably making this determination continues to be very challenging for clinicians, epidemiologists, and microbiologists as highlighted by WHO report for the year 2002. In recent decades, multiple approaches have been studied, advocated, and utilized to control this issue. Clues that may help to differentiate contamination from bacteremia include identity of the organism, number of positive culture sets, number of positive bottles within a set, time to growth, quantity of growth, clinical and laboratory data, source of culture, and automated classification using information technology (Schifman et al., 1998). The identification of microorganisms that grows from a blood culture is a very helpful clue of evidence of contamination.

According to CAP Q-Probes study the most important indicator for interpreting blood culture results is the identity of the organism, which was cited as very important by 79% of laboratories (Hall & Layman., 2006). Second method that can help to differentiate blood culture contamination from true infection is the number of blood culture sets that grow organisms. The proportion of positive sets as a function of the total number of sets obtained can be a particularly useful tool (Beekmann et al., 2005; MacGregor, R. R. & H.N. Beaty, 1972). If only one set of at least two sets grows an organism known to often cause contamination referred as contaminant. For true bacteraemia, multiple blood culture sets will usually grow the same organism. Third method of determining blood culture contamination (BCC) is the bacterial load, that is high in true pathogens and low bacterial load in contaminant in an automation system. The true pathogens grow in 2.1 to +1.4 days (Khatib, R., et al., 1995). Despite of the above fact BCC, can be overcome or control by training phlebotomist staff for blood culture techniques using proper personal protective equipment PPE, use of standard SOP (Sanders et al., 2019). Use of standard practices such as to disinfect the tops of the culture bottles before inoculating them with blood, avoid CVC blood and use of posterior Venous blood can help controlling the contamination (Chandrasekar, P. H. et al., 1994). The rubber stopper on each bottle is not sterile despite being covered with a lid that requires removal prior to inoculation also needed to handle properly. In the CAP Q-Probes study of 640 institutions investigators found that 95.5% of organizations routinely applied an antiseptic to the top of the culture bottle before inoculating the bottle. Those institutions that prepped the bottle tops had significantly lower contamination rates of 2.3% than those that did not prep the bottle tops with 3.4% contamination rates (Schifman, R. B. et al., 1998). This study based on suggestion to apply precautionary measures to avoid contamination in all from tertiary care hospital to small laboratories. By using these simple methods lab financial burden can be controlled in limit. Clinicians and laboratory staff will be able to avoid frustration due to contamination in blood based growth media.

Material and Methods
Collection of samples:

Blood culture samples were collected from trained phlebotomist staff of tertiary care associated small diagnostic and research lab of Karachi and inoculated in a commercially prepared autoclaved enriched media containing bacteAlert bottles (bacteAlert is an automated 3D system machine used for incubation of blood culture bottles at 37c).

Samples Processing, Identification & Differentiation:

In Positive blood culture bottles bacteria primarily identified on gram stain basis, then secondary identification on Sheep blood agar, Chocolate Agar, MacConkey Agar on the basis of morphology further identification of bacteria upto species level performed by means of biochemical test catalase, coagulase, oxidase and IMVIC tests (Kirn, T. J., & Weinstein, M. P., 2013)

Samples sensitivity:

Samples sensitivity pattern were performed and checked by following CLSI Guidelines method (Wayne, PA. et al., 2014).

Results & Discussion:

Results showed that 75 blood culture tested positive for BCC. Positive sample was further specified and data revealed that among 75 positive samples, 18 blood samples were skin contaminants and 57 were true pathogens. Skin contaminants were identified as Coagulase negative *Staphylococcus* species (CoNS), *Bacillus* species (except anthrax), *Micrococcus* species, *Aerococcus* species, *Corynebacterium* species except diphtheria on the basis of cultural, morphological and biochemical testing. Whereas true pathogens were identified as *Salmonella typhi*, *Salmonella Paratyphi A*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* (Table 1). According to College of American Pathologists (CAP) blood culture contamination rate of 1.2% to 2% is acceptable (Wayne, PA. et al., 2014). However results revealed that which is also supported by many studies that contamination rate is 2.4% and that raises bar on the authenticity of lab testing. In order to avoid contamination it's suggested that staff of laboratories and hospitals, which are working in blood culture collection must should follow Standard of procedures (SOPs) and to avoid mistakes it should also monitor by quality assurance team of laboratories and hospital. This is the most economical way to avoid contamination

Table # 1: List of bacterial contaminants from positive blood samples

Name of organisms	Type of pathogens	Quantity of specific bacteria
<i>Salmonella typhi</i>	True pathogen	20
<i>Salmonella paratyphi A</i>	True pathogen	11

<i>Staphylococcus aureus</i>	True pathogen	12
<i>Pseudomonas aeruginosa</i>	True pathogen	05
<i>Klebsiella pneumoniae</i>	True pathogen	05
<i>Escherichia coli</i>	-----	04
Coagulase negative <i>Staphylococcus</i> species (CoNS)	Skin contaminants	06
<i>Bacillus</i> species (except anthrax)	Skin contaminants	04
<i>Micrococcus</i> species	Skin contaminant	03
<i>Aerococcus</i> species	Skin contaminant	03
<i>Corynebacterium</i> species (except diphtheria)	Skin contaminant	02

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