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Newsletter

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BLOOD CULTURES: CLINICAL ASPECTS AND CONTROVERSIES

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Introduction

Bloodstream infections continue to be a major cause of morbidity and mortality despite advances in antimicrobial therapy and supportive care. Early diagnosis and appropriate treatment of bloodstream infections are important clinical concerns.

Culturing of blood is the only method to detect bloodstream infection. During the last two decades, there have been major advances in blood culture technology. These advances (e.g. automated systems that monitor blood culture bottles every ten to fifteen minutes) have decreased the time to detection and identification of organisms causing bloodstream infections. However, there are many facets of the blood culture as a diagnostic test that are not affected by new culture methods, but continue to cause problems with interpretation of test results.

Types of Bloodstream Infection

In general, bloodstream infections have been classified as transient, intermittent, and continuous. Transient bloodstream infection usually follows mechanical or surgical manipulation of infected tissue. It might also occur during routine daily activities, such as toothbrushing or bowel movements. Intermittent bacteraemia is typically seen with undrained abscesses or in association with localised infections such as pneumonia, urinary tract infection and central nervous system infection. Continuous bacteraemia is observed with intravascular infections such as infective endocarditis, septic thrombophlebitis, or a mycotic aneurysm.

Indications for Blood Cultures

Indications for blood cultures are varied and not standardised. Patients admitted to the hospital with suspected or proven infection at any site usually have blood cultures taken as part of their initial work-up. Fever, a frequent sign of bloodstream infection, is the most common reason and indication for culturing blood. However, fever may not be present in all patients with bloodstream infection.

Elderly patients may be afebrile or present with low grade fever during a bacteraemic episode. Changing may be the only sign of bloodstream infection in elderly patients or those with end-stage renal disease. Hypotension may be a manifestation of bloodstream invasion by micro-organisms. If bloodstream infection is identified, it is usually not necessary to repeat blood cultures after treatment has been initiated, with the following exceptions:

- Patients with fungaemia who have begun antifungal therapy should have repeat cultures done to document clearance of the organism.
- Similarly, patients with Staphylococcus aureus bacteraemia with or without endocarditis should have repeat blood cultures performed after treatment is started, to document clearance of the bacteraemia.

Skin Preparation

Poor skin preparation prior to drawing blood cultures is the most common cause of culture contamination. The recommended approach is to first palpate the vessel to be punctured, then put on sterile gloves and then to apply 0.5% chlorhexidine in 70% isopropyl alcohol to the skin by scrubbing the skin vigorously for 60 seconds with soaked gauze and allow the skin to dry for 1 minute.

DO NOT PALPATE AFTER CLEANING THE SKIN!

Clean the seal of the bottle with 70% alcohol and squirt the blood into the bottle without changing needles.

The vacuum in the bottle allows filling of the bottle with the correct volume of blood (8 - 10 mL in adults). Each set of blood cultures should be obtained from a different site using the same technique.

Timing and Intervals of Blood Cultures

The optimal time to obtain blood cultures is when the magnitude of the micro-organisms is greatest in the bloodstream. It was found in experimental infections that the largest number of micro-organisms in the blood occurred 12 hours before onset of fever or chills.

Since it is not feasible to obtain blood cultures before the onset of symptoms, it is recommended to obtain cultures as soon as symptoms (e.g. fever, chills) occur. Previously, an interval of 30 to 60 minutes between blood culture sets was recommended for optimal results.

However, it was found that there is no significant difference in the yield of blood culture sets drawn simultaneously and those drawn with an interval period between sets. An exception to this may be when endocarditis is suspected; in this situation, drawing blood cultures over several hours can document continuous bloodstream infection typical of endocarditis.

Sites for Obtaining Blood Cultures

Blood obtained by venipuncture is the method most commonly used for obtaining samples for culture. In the intensive care setting, blood for culture is frequently obtained from intravascular catheters (venous or arterial). However, there is concern about an increased risk for contamination of blood cultures obtained via intravascular catheters. If blood cultures are obtained from intravascularcatheters, the y should be labeled as such to take this into consideration when assessing positive cultures.

Number of Blood Culture Sets

Eighty percent of bacteraemic episodes are detected by the first set of blood cultures, while 89% and 99% of episodes are identified by the first two or three sets, respectively. New literature even suggests that 99% sensitivity can only be obtained by using four sets ofblood cultures. The yield from blood cultures is directly influenced by the collection technique used, volume of blood inoculated into each blood culture bottle, and the clinical likelihood of infection (pre-test probability). These are the recommendations regarding the number of blood culture sets:

- One blood culture set is never sufficient for identifying or excluding bacteraemia.
- Two blood culture sets are necessary and sufficient to exclude or identify bacteraemia when the organism is not a commoncontaminant and the probability of bacteraemia is low (5%) or moderate (20%), such as with pneumonia, intra-ab dominal infection, or urinary tract infection.
- Three to four blood culture sets (high sensitivity) should be obtained to exclude bacteraemia when the probability of is high or continuous bacteraemia (e.g. endovascular infection) is a consideration; and the suspected pathogen is a comm oncontaminant (e.g. prosthetic valve endocarditis caused by a coagulase negative staphylococcus) or the patient with suspected endocarditis has recently received antibiotic therapy.

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Volume of Blood for Culture

During a bacteraemic episode in adults, the number of micro-organisms in the bloodstream is usually low (~110 cfu/mL). Therefore, the volume of blood obtained for culture is relevant to the detection of bloodstream infection.

Most authors recommend a 16 - 30 mL volume of blood be drawn for each set of blood cultures. In paediatric patients, a lesser volume of blood (1 - 6 mL) is required for culture because the magnitude of bacteraemia is greater in children and neonates.

Culture Media and Blood-to-Broth Ratio

Blood drawn for culture should be inoculated immediately into broth media prior to its transfer to the laboratory. It is well known that human blood contains substances such as complement, phagocytes, and antibodies with antimicrobial activity. These substances will decrease the yield of blood culture if they remain in high concentration in the blood during incubation. Thus, adding a special broth media to dilute blood for culture can minimise the activity of these substances. The opposite is also true. Too little blood will be diluted by the culture media and growth might not be detected.

Anaerobic Blood Cultures

It has been a standard of practice that a set of blood cultures consists of one aerobic bottle and one anaerobic bottle. However, because the likelihood of detecting fungi or obligate aerobic organisms is low when blood is incubated anaerobically, anaerobic blood cultures may decrease the overall sensitivity of blood cultures. Several studies have found a signi cant decrease in the incidence of anaerobic bloodstream infections during the last two decades. At the same time, there has been an increase in the incidence of candidaemia. These ndings have raised the question of the need for routine anaerobic blood cultures. Based on these findings, it seems reasonable to adopt the approach of inoculating two blood culture bottles per set and incubating both of them aerobically. There may be circumstances in which blood should be cultured anaerobically, but these should be well de ned. Examples of conditions that predispose a patient to anaerobe-associated infections or disease are:

- Gastro-intestinal tract surgery or traumatic puncture of the bowel
- Genital tract surgery or traumatic puncture of the genital tract
- Introduction of soil into a wound with the presence of a large quantity of gas
- Human or animal bite wounds
- Aspiration pneumonia

Keypoints

- *One blood culture set is NEVER sufficient for identifying or excluding bacteraemia.*
- *Skin preparation is of the utmost importance to reduce the risk of contamination.*
- *Blood culture sets can be drawn at the same time, but from different sites.*
- *A set should consist of two aerobic bottles. Anaerobic cultures for specific indications only.*
- *Fill each blood culture bottle with 8 - 10 mL of blood in adults and 1 - 3 mL in children.*
- *PLEASE CONTACT A MICROBIOLOGIST WITH ANY QUERIES!*

Duration of Incubation

Most laboratories incubate blood cultures for 5 days, using an automated system. During incubation, if there is evidence of growth in a bottle, a sample from the bottle is examined microscopically using a Gram stain and subcultured onto solid media to identify the organism. If there is no evidence of growth after 5 days the laboratory will send out a no growth report. When fastidious organisms are suspected as a cause of bloodstream infection, e.g. HACEK (Haemophilus aphrophi lus /paraphrophi lus , Actinobaci l lus actinomycetemcomitans, Cardiobacterium nominis, Eikenella corrodens, and Kingella kingae) organisms, the laboratory should benotified of this possibility, and the primary blood cultures should be incubated for longer (14 days). Brucella cultures should be incubated for 28 days and Mycobacterium tuberculosis for 42 days.

Blood Culture Contamination

Of all positive blood cultures, approximately half represent contamination. These high rates of contamination create confusion regarding the need for antimicrobial therapy. Some useful guidelines for differentiating between contaminated and true positive blood cultures: both the number of positive blood cultures and the identi cation of the organism are helpful in differentiating true positive from contaminated blood cultures. Isolation of organisms such as group A streptococci, pneumococci, Escherichia coli, and Candida species almost always indicated true bacteraemia. In contrast, organisms such as diphtheroids and Bacillus species were found only as contaminants.

References

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