Review on Blood Culture

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ABSTRACT

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Blood stream infections (BSIs) are one of the most serious problems in infectious disease. The mortality rates reported is between 20% and 50%. From a diagnostic standpoint, positive blood cultures establish an infectious etiology for a patient's illness and reveal a microorganism for susceptibility testing. This helps the clinician to optimize the antimicrobial therapy. This article discuses the basics of blood culture from a clinician's point of view. Blood culture is a very valuable tool for the physician in diagnosis & treatment of infections. Every care should be taken to collect & transport the blood samples in an ideal fashion to make a full utilization of this very important investigation.

Keywords: Blood stream infections, Blood culture, Bacteremia, Culture media, Fungaemia.

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Blood stream infections (BSIs) are one of the most serious problems in infectious disease. The mortality rates reported is between 20% and 50%. From a diagnostic standpoint, positive blood cultures establish an infectious etiology for a patient's illness and reveal a microorganism for susceptibility testing. This helps the clinician to optimize the antimicrobial therapy. In modern times, it is considered unethical to start an antibiotic in a patient before drawing a proper blood culture. This may not be possible in all situations, but an attempt must be made to comply with this in all possible situations.

Key Principles in obtaining Good Blood Cultures[1]

Selection of the Best Available Site

The site chosen for venipuncture is an important factor. Blood obtained from femoral vessels or from sites affected by dermatologic disease is more likely to yield contaminant than blood obtained from antecubital veins or other upper extremity vessels. Arterial blood provides no higher yield than venous blood. It has become a common practice to draw blood through central venous catheters. This is especially true for patients on hemodialysis or in patients with hematologic and other malignancies, because of convenience and less trauma to the veins. When blood for culture is obtained from such intravenous (IV) catheters it should always be paired with a second sample of blood obtained by peripheral venipuncture. This is to make a correct interpretation of a positive blood culture result in such a situation.

Skin Antisepsis

The effectiveness of skin antisepsis at the time of the venipuncture is an important determinant in interpreting a positive culture as an infection rather than a contaminant. After selecting an accessible vein, the site should be cleansed with 70% isopropyl or ethyl alcohol and allowed to air dry. A second cleansing should be performed using 1% to 2% tincture of iodine or 10% povidone-iodine solution applied concentrically; this should be allowed to air dry before the vein is punctured. According to the authors' view tincture of iodine is preferred over povidone- iodine because it dries faster in approximately 30 seconds.

Blood Volume and Number of Blood Culture Sets

Because there is a direct relationship between the volume of blood obtained for culture and detection of bacteremia or fungemia, blood volume is a key variable for successful detection of bloodstream infections. Most bacteremias in adults are of low order of magnitude (often <1 to 10 CFU/mL). In infants and young children, the magnitude of bacteremia tends to be greater (often >100 CFU/mL). Based on the available data, it is recommended that 20 to 30 mL of blood should be collected per venipuncture from adults. The lower limit of acceptability is 10 mL. This very important fact is often not followed, even in teaching institutes. In pediatric patients, expert opinion recommends 1 to 2 mL of blood per culture for neonates, 2 to 3 mL for infants ages 1 month to 2 years, 3 to5 mL for older children, and 10 to 20 mL

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for adolescents. There are good data to document that two or three blood cultures are adequate for detecting episodes of bacteremia and fungemia caused by common microbial pathogens. Based on the data available, the authors conclude that it is rarely necessary to collect more than two blood culture sets per 24 hours. On the other hand, it is not appropriate to collect only a single blood specimen for culture. A single blood culture sample will not have sufficient volume for optimal detection of bacteremias and fungemias, and the significance of a positive result may be difficult, if not impossible, to interpret. For example, isolation of coagulase-negative staphylococci or diphtheroids in a single blood culture most likely represents contamination, but may rep resent clinically import ant infection in immunosuppressed patients with long-term IV access devices, prosthetic heart valves, or joint prostheses

Timing of Blood Cultures

The optimal time for collection of blood culture specimens is just before the onset of a shaking chill; i.e. when there is maximum bacteremia. However, it is not possible clinically to anticipate the precise timing of this event. Thus, as a practical point, it is recommended to draw blood cultures when fever is detected and the possibility of bacteremia is entertained. As a general rule, it is reasonable to obtain two blood culture sets simultaneously, especially if antibiotic therapy is going to be initiated; however, in less urgent situations, blood cultures may be spaced at intervals. The authors believe that the timing of blood cultures should be a clinical decision based on the acuity of the patient's illness and whether immediate antimicrobial therapy is contemplated. Key Technical Variables that form the Scientific Basis for Current Blood Culture Methods

Culture Medium

Many published studies have compared various broth culture media in head-to-head comparisons. No one culture medium optimally supports the growth of all potential bloodstream pathogens

Ratio of Blood to Broth

Dilution of blood in the broth medium of blood culture bottles reduces the concentration of all the inhibitory factors in the blood. Indeed, published studies have confirmed that the optimal dilution of blood in broth is 5- to 10-fold (i.e., a blood:broth ratio of 1:5 to 1:10).

Resin and charcoal containing media

In general, the resin- or charcoal-containing media detect more microorganisms , particularly staphylococci, than similar media without these additives. But the resin- and charcoal-containing media are more costly and grow more coagulase- negative staphylococcal contaminants that may cause confusion among both laboratorians and clinicians

Duration of Incubation of Blood Cultures

Most clinical microbiology laboratories now use one of the commercial continuous-monitoring blood culture systems. Five-day incubation protocols in these systems are satisfactory for the detection of the overwhelming majority of pathogens.

Longer incubation period may be needed for some fastidious pathogens such as Bartonella, Legionella, Brucella, and certain fungi. Blood cultures for the detection of mycobacteria should be incubated for four weeks.

Current Blood Culture Systems

Three types of blood culture systems are currently used: manual (conventional) detection systems, the lysis -centrifugation system, and automated continuous-monitoring blood culture systems

Special Considerations for Specific Pathogen groups

Some microorganisms are isolated infrequently from blood or have unique growth requirements. These organism groups may not be detected using routine blood culture methods and systems.

Anaerobic Bacteria

Currently, there is no consensus about the routine use of anaerobic bottles; some authorities still advocate the continued use of anaerobic bottles whereas others recommend their selective use only in patients who are at the risk for anaerobic infections.

Fungi

During the past 20 years, there has been a trend toward increasing isolation of fungi as the etiologic agents of BSIs. Important factors for the optimal detection of fungi in the blood include the temperature and duration of incubation and the blood culture media used to support growth. The optimal temperature for the growth of fungi varies according to organism

Interpretation of Positive Blood Cultures[2]

In many cases, the interpretation of positive blood culture results is straightforward. In contrast, the clinician and microbiologist often are faced with results that cannot be interpreted so easily. Presence of bacteremia or fungemia has very important implications for both the patient and physician. So a correct interpretation of test results is absolutely necessary.

Several careful observations ma y assist in interpreting the clinical importance of a positive blood culture.

The pattern of positivity of blood cultures is often very helpful. When most or all blood cultures especially if obtained from different venipuncture sites grow the same microorganism, the probability of this microorganism causing a true infection is exceedingly high. This is true regardless of the identity of the organism.

The identity of the microorganism isolated also provides predictive value. Common blood isolates that always or nearly always (>90%) represent true infection include St aphylococcus aureus, Streptococcus pneumoniae, Escherichia coli and other members of the Enterobacteriaceae family, Pseudomonas aeruginosa, and Candida albicans. Other microorganisms, such as Corynebacterium species, and Propionibacterium acnes, rarely (<5%) represent true bacteremia. Isolation of viridans streptococci, enterococci, and coagulase-negative staphylococci (CoNS), represent true bacteremia only in 38%, 78%, and 15% of cases respectively causing some confusion in diagnosis. CoNS deserve special mention, because they are ubiquitous as blood culture contaminants, yet are important pathogens in patients with intravascular devices and implanted prosthetic materials.

Choosing the Antibiotic from the Culture Report

This is not very straight forward as it would sound, and require in-depth understanding of the general or acceptable sensitivity pattern for the particular organism and the suspected site of infection. Thus, the decision is made on comparing the sensitivity pattern of the organism and assessing the degree of penetration of antibiotic in the site of infection. E.g. for a UTI caused by E.coli susceptible to fluoroquinolones, moxifloxacin would be a wrong choice as it has very poor urinary concentrations. Similarly, if the E.coli is resistant to ceftazidime but susceptible to cefotaxim, the report would be a suspect.

Rapid Methods for Identification of Organisms in Blood Cultures: What goes the future hold?

It is difficult to anticipate whether culture-based blood culture systems will remain important diagnostic tests for detection of bloodstream infections in the future. Nucleic acid amplification and detection methods developed in the past decade are useful for the diagnosis of a variety of infectious diseases also. Molecular amplification assays may have their greatest value in the detection of microorganisms that are difficult to detect or require prolonged incubation periods using current methods.

CONLUSION

Blood culture is a very valuable tool for the physician in diagnosis & treatment of infections. Every care should be taken to collect & transport the blood samples in an ideal fashion to make a full utilization of this very important investigation. Special care should be given regarding the volume of blood drawn and number of samples. This should precede empiric antibiotic therapy in all possible situations. All efforts must be made to differentiate contaminants from true pathogens before taking any treatment decisions. Appropriate antibiotics should be chosen as per the blood culture results.

END NOTE

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