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Blood Culture Collection:

Greiner Bio-One contributes to assure Best Practice

Gabriele Castelo-Rose

Greiner Bio-One GmbH | Bad Haller Straße 32 | A-4550 Kremsmünster
Phone: (+43) 75 83 67 91-0 | Fax: (+43) 75 83 63 18 | E-mail: office@at.gbo.com

Introduction: Blood Culture Determination Saves Lives

"Blood is one of the most important specimens received by the microbiology laboratory for culture, and culture of blood is the most sensitive method for detection of bacteremia or fungemia."

This statement by Gary V Doern, MD, outlines the importance of blood culture determination. Each year, there are over 18 million cases of severe sepsis worldwide. Sepsis is a major cause of mortality throughout the world, killing approximately 1,400 people each day.[1] USA estimates exist which state that approximately 750,000 patients suffer from sepsis annually. The death rate lies between 30 and 50%. This makes sepsis the 10th leading cause of death in the United States.[2] Therefore, it is critical for patient survival to timely identify any infection.

There are certain recognised symptoms which indicate a possible systemic infection. They include for example a sudden temperature spike or core temperature which is out of normal range, focal signs of infection, an abnormal heart rate (raised), blood pressure (low or raised) or respiratory rate (raised), chills or rigors, raised or very low white blood cell count, or a new or worsening confusion.[3] These symptoms point to the possibility of an infection. A blood culture test can verify that an infection is in fact present.

The presence of an infectious agent is confirmed by way of a positive blood culture. Undetected, the organism causing the infection can result in sepsis, resulting in systemic inflammatory response, potential organ failure and death. A blood culture test will help to identify the microorganism which is responsible for the infection and an appropriate antibiotic therapy can be chosen. Lives can be saved.

This is the one side of the coin.

The Costly Effect of Wrong Results

However, picture the following situation as described by Dennis J. Ernst[4]: The only thing standing between Mr. Lee and his release from the hospital after 15 days is his signature on the discharge form. Even though he had a low-grade fever this morning, his doctor is sending him home because his recovery from endocarditis appears otherwise complete. All other discharge orders are finished, and he's at the nurses station ready to sign out.

Then comes a call from the lab. One of the three blood cultures drawn earlier was positive for grampositive cocci in clusters. The physician cancels the discharge and orders the patient back on IV antibiotics. Mr. Lee will need four more days of IV therapy to treat the bacteremia.

But Mr. Lee may not have bacteremia. Based on the Gram's stain, Mr. Lee's blood culture could have been contaminated by skin flora when the sample was drawn—the gram-positive cocci in clusters is indicative of Staphylococcus aureus, a common skin

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2. Alan E. Jones, Alan C. Heffner, James M. Horton, and Michael R. Marchick; Etiology of Illness in Patients with Severe Sepsis Admitted to the Hospital from the Emergency Department; Clinical Infectious Diseases (2010); Volume 50, Issue 6Pp. 814-820
3. NHS UK (2007), Saving Lives: reducing infection, delivering clean and safe care; Taking blood cultures; accessed and downloaded February 2015;
4. Ernst, Dennis, MT(ASCP) (2001); The right way to do blood cultures; Modern Medicine Network online; RN/MCPHU Home Study Program; accessed and downloaded February 2015;

contaminant. That's even more likely since only one of three specimens was positive.

The cost of cases like Mr. Lee's is staggering: Studies undertaken show that in the USA contaminated blood culture (pseudobacteremia) can increase a patient's hospital stay as much as 4.5 days. It can add $4,100 or more to the cost of treatment and $8,000 to the patient's bill.[5, 6] Tainted cultures have also been shown to increase microbiology department overtime expenses by 30% or more.[7]

More important, they keep patients from getting back to their families, jobs, and other activities. And they put people in the hospital who otherwise wouldn't be there: In one study, 26% of pediatric outpatients with false-positive blood cultures were hospitalized.[8]

This is the other side of the coin.

> "Few collection errors are as costly to the hospital, the laboratory, and the patient as blood cultures that are compromised by inattentive specimen-collection practices."

When faced with uncertainty and the possibility of an actual positive result, doctors are put in a difficult spot: They must decide whether to ignore a result that could be life threatening, or to use valuable hospital resources fighting an non-existing infection. Posed with this paradox, many still choose the conservative approach. As a result, contaminated blood cultures can lead to inappropriate antibiotic therapy, which results in a significant waste of healthcare resources and in addition exposes the patient to the side effects of antimicrobial therapy.[9] Antimicrobial resistance due to unnecessary exposure has been reported widely. Few collection errors are as costly to the hospital, the laboratory, and the patient as blood cultures that are compromised by inattentive specimen-collection practices.[10]

According to research, this very common problem of contaminated blood culture accounts for up to 50% of all positive cultures.[11, 12]

Reducing Errors – Reaching a Realistic Goal

There will never be a situation of 0% false positive results. According to standards published by the American Society for Microbiology, the rate of blood-culture contamination should not exceed 3%, but a complete elimination of false positive is unrealistic.[13] However, when a hospital finds its rate rising above 3%, it is an indication that blood cultures are not done with best practice. As a company, we at Greiner Bio-One aim to assist with this objective to reduce false positive blood culture results to an absolute minimum, thereby helping health systems around the world to save costs, and allowing patients to receive the best possible treatment and be spared unnecessary treatments and delays.

This is why we offer to our customers our new **VACUETTE®** Blood Culture Holder + Luer Adapter.

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12. Weinstein MP. Blood culture contamination: persisting problems and partial progress. J Clin Microbiol 2003; 41 (6): 2275-8
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Factors affecting blood-culture collection

There are some factors which have an absolutely critical bearing on drawing a blood-culture specimen and achieving the best outcome.

They include:

- Proper training of blood-collection personnel
- The location of the collection site
- The right preparation of a puncture site
- An optimal choice of blood-collection equipment; and
- A sufficient collection volume

Where best practice in regards to the above is compromised, it can lead to false positive results due to contamination. Contamination may occur at any stage between the taking of blood and processing in the laboratory.[14] Blood cultures may be contaminated with skin commensals or environmental organisms. Pseudobacteraemia occurs when isolates originate from outside the patient's bloodstream. A range of possible sources of contamination exists, including: the skin of the patient; the fingers or even mouth of the practitioner; the environment; from laboratory contamination of vented systems, and contamination from other blood collection tubes.[15, 16]

Greiner Bio-One assists its customers to achieve the optimal outcome for any medical procedure by providing products which are best suited for the given purpose. With the provision of this new **VACUETTE®** Blood Culture Holder + Luer Adapter, which is a single-packaged, sterile blood culture holder with a male luer adapter, we have taken the next step to assist medical personnel in eliminating any external source of contamination during blood culture collection. The single-package and ensured sterility supports this aim, whether the product is attached to a sterile butterfly set, or to a central catheter.

14. Schifman RB, Strand CL, Meier FA, Howanitz PJ. Blood culture contamination: a College of American Pathologists Q-Probes study involving 640 institutions and 479,134 specimens from adult patients. Arch Pathol Lab Med 1998; 122 (3): 216-21
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Best practice of Blood Culture Sample Collection

Detailed information concerning the before-mentioned critical factors can be found in literature (refer for example to the reference list below). However, following are the basic recommendations:

Personnel / Competence

Studies clearly show that proper training can radically reduce false positive blood culture results. As a general rule, blood cultures should only be collected by members of staff (medical, nursing, healthcare assistant, phlebotomist or technician) who have been trained in the collection procedure and whose competence in blood culture collection has been assessed. An optimal situation has been found to be the use of a specifically designated phlebotomy team. In a Q-Probe study released by the College of American Pathologists (CAP) in 1998 it was shown that the lowest contamination rates were associated with facilities in which 90% or more of the blood cultures were collected by a trained phlebotomy staff.[17] Another approach which has proven successful is to monitor the contamination rates of each collector and to inform them about their results.

Site Selection

Venipuncture remains the method of choice for obtaining blood for culture; arterial blood cultures are not associated with a better diagnostic result than are venous blood cultures.[18] Studies have been carried out to check the contamination rates for blood cultures obtained from intravascular devices vs. those obtained by venipuncture. The results are conflicting. Bryant and Strand however note that contamination rates are significantly increased when blood for culture was obtained from intravenous catheters.[19] The American College of Physicians guidelines also recommend that blood for culture not be obtained from intravascular devices.[20] If blood is collected from intravenous lines, a culture from such a device should be paired with another culture of blood obtained by peripheral venipuncture.

Obtaining blood samples from central catheters may be indicated in 2 circumstances: First, if peripheral access is not possible, 2 blood samples may be collected through different lumens (when available) of the same central catheter, although this technique may be associated with higher false-positive rates.[21, 22, 23] The second exception are patients with central catheters who have no obvious source of infection and therefore may have a catheter-related bloodstream infection. In these cases, one set of samples should be obtained peripherally and the second set should be obtained through the distal lumen of the catheter suspected to be infected.[24, 25]

17. Schifman RB, Strand CL, Meier FA, Howanitz PJ. Blood culture contamination: a College of American Pathologists Q-Probes study involving 640 institutions and 479,134 specimens from adult patients. Arch Pathol Lab Med 1998;
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Single vs Paired Sets / Timing of Cultures

Recommendations state that in patients with suspected bacteraemia, blood samples should be obtained in pairs (2 sets) from different peripheral sites rather than singly (1 set) because cultures of single samples are difficult to interpret.[26] The optimal situation will be 3-4 collections with adequate volume (obtained within the first 24 hours of suspected bacteremia).[27, 28]

The cultures should be taken from separate sites at intact and noninfected sites before administration of antibiotics. There are conflicting views concerning the timing, with older literature suggesting a waiting time of 15 to 30 min prior to a second or further collection, but evidence shows that there is no real necessity for that.[29, 30] Provided that the blood can be drawn from another site, it is possible to collect it immediately after the first one.[31]

Preparation of Puncture Site

The patient's skin must be thoroughly cleansed before venepuncture. Soap and water shall be used to clean visibly soiled skin, then the medical attendant shall clean his / her own hands. The patient's skin must then be disinfected. Iodine-based antiseptics, sometimes used along with isopropyl alcohol, have become the industry standard for preparing puncture sites.[32] Care shall be taken not to palpate the collection site again after disinfection. The bacteriostatic effect of antiseptic compounds is directly proportional to the length of time they are allowed to remain in contact with the skin. According to Dennis Ernst, at least 30 seconds of contact is necessary before the puncture to assure proper site preparation.[33]

Blood Collection Equipment

Depending on the type of blood-culture bottles in use, they can be filled either by way of a winged infusion (butterfly) set and a suitable adapter, or by drawing blood directly into a syringe through a needle or butterfly set.

"Using proper equipment and technique can minimize contamination rates at any facility."

24. Dellinger R, Levy MM, Carlet JM, et al. Surviving sepsis campaign: internation guidelines for management of severe sepsis and septic shock. Crit Care Med. 2008; 36:296-327.
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The use of any components which may introduce contaminants should be avoided. Using proper equipment and technique can minimize contamination rates at any facility.[34]

The equipment should ensure that as little manipulation as possible is necessary, thereby reducing any necessary handling to an absolute minimum. Various options are offered on the market. With our new product **VACUETTE®** Blood Culture Holder + Luer Adapter, it provides a user with a sterile holder which is suitable for all common blood collection bottles, whether wide-necked or narrow-necked, and which also allows a subsequent filling of evacuated blood collection tubes without the necessity of a separate special adapter. The sterile **VACUETTE®** Blood Culture Holder + Luer Adapter can be easily assembled with a sterile Safety Blood Collection Set, thereby minimising any risk of contamination. At the same time, the sterile Blood Culture Holder + Luer Adapter can be used in those particular cases in which collection from an in-dwelling line is a necessity or the only option to obtain a blood culture sample. Collections from catheters carry generally a higher risk of contamination. By using the sterile **VACUETTE®** Blood Culture Holder + Luer Adapter, one possible source of contamination can be eliminated.

Collection Procedure

The correct procedure depends on the equipment and the collection site used. For correct procedures using Greiner Bio-One **VACUETTE®** Blood Culture Holder + Luer Adapter, refer to the complete Instructions for Use at www.gbo.com.

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