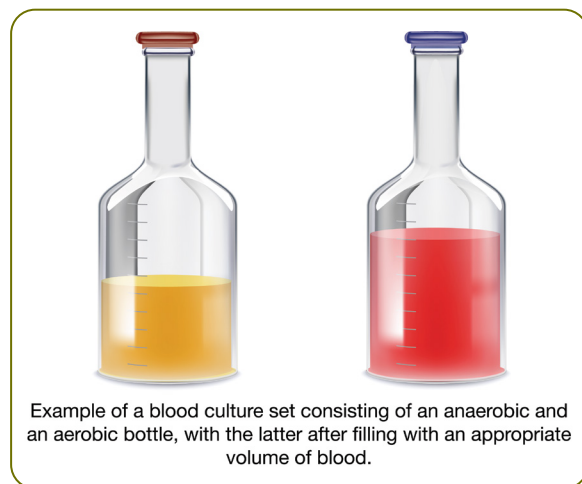# Blood Culture Contamination: An Overview for Infection Control and Antibiotic Stewardship Programs Working with the Clinical Laboratory

Purpose

Blood culture contamination can compromise quality of care and lead to unnecessary antibiotic exposure and prolonged length of hospitalization. Microbiology laboratories typically track blood culture contamination rates and can provide data to assist in reducing contamination rates. Infection control programs and microbiology laboratories might participate in designing and implementing interventions to decrease contamination rates, and antibiotic stewardship programs could also be engaged to optimize multidisciplinary quality improvement efforts to decrease blood culture contamination and improve the collection of blood culture specimens.

Background

Blood cultures are important diagnostic tools for identifying the pathogen(s) responsible for a patient's infection. This is especially true of patients with suspected sepsis or septic shock and for patients with suspected infective endocarditis[1, 2]. When indicated, blood cultures should be obtained prior to starting antimicrobial therapy[1, 2]. A conventional blood culture set consists of an aerobic and an anaerobic bottle. For adults, 20-30 mL of blood per venipuncture (depending on the instrument manufacturer) is recommended and may require >2 bottles depending on the system[2]. At least two blood culture sets should be obtained within a few hours of each other via peripheral venipuncture when obtaining blood cultures for a total volume of 40-60 mL of blood to optimize detection of pathogens[2]. The College of American Pathologists laboratory accreditation program states that clinical laboratories have a written policy and procedure for monitoring

Example of a blood culture set consisting of an anaerobic and an aerobic bottle, with the latter after filling with an appropriate volume of blood.

blood cultures from adults for adequate volume and provide feedback on the results to the collectors[3]. Moreover, the monitoring and reporting of blood culture contamination rates is a laboratory quality best practice[4].

Because blood is a normally sterile body site, positive blood cultures with a known pathogen have a generally overall high positive predictive value for infection. However, blood culture contamination is a significant problem. In the era of modern blood culturing techniques, virtually all blood culture contamination occurs during collection; the source of contaminants is usually the patient's skin or the hub or cannula of an indwelling catheter (i.e., when an existing catheter is used to obtain the specimen). Frequent causes include poor collection technique and insufficient skin disinfection. Typical organisms include coagulase-negative staphylococci, *Corynebacterium* spp., *Bacillus* spp. other than *Bacillus anthracis, Micrococcus* spp., and *Cutibacterium acnes* among others. Consequences include unnecessary antibiotic exposure with the potential for downstream unintended consequences (e.g., possible allergic reactions and *Clostridioides difficile* infection)[5]. Other possible consequences include the unnecessary removal of intravenous catheters or other devices, an increased length of stay, and increased costs[5]. One study found that the average length of stay was 2 days longer in patients with contaminated blood cultures compared to patients with negative cultures[6]. That same study found that direct and indirect hospital costs of a contaminated blood culture were $12,824 compared to $8,286 for a negative blood culture (savings of $4,538 for preventing a contaminated blood culture)[6].

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Tracking and Reporting

It can be useful to track the blood culture contamination rate to ensure high quality blood culture collection techniques are in place and effective. The College of American Pathologists recommends that the laboratory director should regularly review blood culture contamination rates as tracking the contamination rate and providing feedback to units and persons drawing blood cultures is one method that has been shown to reduce contamination rates[3]. Regularly reporting the rate to facility committees and leaders (e.g., infection prevention and control committee or an antimicrobial stewardship committee) can help ensure broad engagement. The American Society for Microbiology (ASM) and the Clinical Laboratory Standards Institute (CLSI) have recommended that an overall blood culture contamination rate should not exceed 3%[5]. However, many facilities have been able to drive this to less than 1%. Therefore, it should be possible to achieve blood culture contamination rates substantially lower than 3% even if 0% is not reached; when best practices are followed, a target contamination rate of 1% is achievable. Such thresholds can provide a method to benchmark within or between facilities[4].

Tracking the Blood Culture Contamination Rate

Blood culture contamination rates should be monitored by the laboratory. A contaminated blood culture is generally defined by one set out of multiple sets being positive for a commensal organism. A list of skin commensals can be found here. An example of calculating a blood culture contamination rate includes dividing the total number of contaminated blood culture sets by the total number of blood culture sets collected during the evaluation period.

$$\frac{\text{Number of blood culture sets with growth of skin commensals without the same organism in other sets collected within 24 hours}}{\text{Total number of all eligible blood culture sets collected}}$$

Exclusion criteria could include a lack of two blood culture sets drawn within a 24-hour period.

As an example of the above calculation, if an institution has 200 blood culture sets drawn on 100 patients (each patient has 2 sets drawn within 5 minutes of each other) in one month, and one set grows *Staphylococcus epidermidis* and the patient's other set drawn within 24 hours of the positive one is negative, then the institution's contamination rate is 0.5%.

Using Blood Culture Contamination Rate for Quality Improvement

Many clinical laboratories routinely calculate and report the blood culture contamination rate as a quality metric at the beginning of the month to evaluate the previous month's rate. In addition to reporting rates regularly to infection prevention and antibiotic stewardship teams, specialized reporting of rates stratified by patient care locations and collection staff (e.g., nursing or phlebotomy teams), can be undertaken to better target improvement efforts.

Prevention/Actions[5]

An in-depth discussion of the ways to address the problem of the blood culture contamination can be found in the review article by Doern *et al*.[5]. A summary of the article follows.

Full article here.

1. **Diagnostic Stewardship**
   Clinicians should strive to obtain blood cultures for the right patients, in the right settings, and at the right time. Blood cultures can be both underused and overused. An example of underuse would be not obtaining blood cultures prior to starting antibiotics for a patient with suspected sepsis. Without a blood culture collected before starting antibiotics, it can be more difficult to appropriately de-escalate antibiotic therapy given that the causative organism is more likely to remain unknown. Also, blood cultures can be underused if the appropriate volume is less than recommended (i.e., two to three 20 mL volumes of blood during initial evaluation of the patient for bacteremia) as this can decrease the sensitivity for pathogen detection. Cultures can also be overused; for example, obtaining repeat cultures in a patient with fever for whom an alternative diagnosis other than bloodstream infection is much more likely. In patients with a very low pretest probability of bloodstream infection, a positive culture is more likely to represent contamination than infection.

2. **Proper Skin Antisepsis**
   Improper skin antisepsis can lead to increases in blood culture contamination rates. It is recommended that the skin be disinfected with an alcohol containing disinfectant and allowed to dry prior to drawing blood cultures[5].

3. **Blood Culture Bottle Disinfection**
   It is standard blood culture practice to disinfect the blood culture bottle tops prior to inoculation[5].

4. **Blood Culture Collection Site**
   Peripheral venipuncture has consistently been associated with lower rates of blood culture contamination than draws collected through existing central venous catheters[7]. Thus, peripherally drawn blood cultures are preferred over catheter drawn cultures except when the diagnosis of catheter-associated bloodstream infection is suspected[2]. In these cases, both peripheral and catheter draws are indicated.

5. **Hand Hygiene**
   Hand hygiene is recommended prior to interacting with patients and donning gloves prior to drawing blood cultures[8].

6. **Phlebotomy Teams and Education on Proper Technique**
   Blood cultures drawn by phlebotomy teams are less likely to be contaminated compared with blood cultures collected by non-phlebotomy staff in hospital settings[7].

7. **Surveillance and Feedback**
   Studies have demonstrated that providing feedback to those performing blood cultures regarding their contamination rates can decrease blood culture contamination rates[9, 10]. Antibiotic stewardship programs can also consider tracking and evaluating the impact of contamination rates on unnecessary vancomycin use.

8. **Initial Specimen Diversion Devices**
   There are devices that are commercially available that have shown promise in further reducing blood culture contamination rates. These devices divert the initial 1 to 2 mL of potentially contaminated blood and then collect blood for the blood culture[5].

Next Step Considerations for Tracking and Preventing Blood Culture Contamination Events

- Antibiotic stewardship and infection prevention personnel should meet with laboratory personnel to learn how tracking and reporting of blood culture contamination events is being performed at their facility

- Understand locations in the facility where blood culture contamination events occur more commonly, the type of staff who collect blood cultures, and how the collector is identified in the laboratory information system

- Review with the laboratory staff the blood culture collection procedures used in the facility and the training received by those responsible for collecting blood cultures

- Explore with laboratory staff how the site where blood cultures are collected is labeled (e.g., venipuncture or central venous catheter) and consider how to encourage collecting blood cultures from preferred sites

- Think about future tracking and facility benchmarking of blood culture utilization (e.g., blood cultures per admissions and patient days) as further data and guidance becomes available

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