Bacteremia is a life-threatening condition associated with significant morbidity and mortality. Common sources of bacteremia include the genitourinary and respiratory tracts and surgical wounds/abscesses, although there are less common causes. Therefore, rapid detection, identification, and susceptibility testing of blood culture isolates are of utmost diagnostic importance. Most bacteremias are intermittent and require multiple culture sets to be obtained. Although it may be convenient to obtain blood samples for culture from central catheters, expert opinion and clinical guidelines discourage this practice because of concerns of contamination that increases false-positive rates, as well as catheter-related bloodstream infection that may lead to greater (and sometimes unnecessary) use of antibiotics, longer hospital stays, and higher costs associated with the longer stays.

Thus, the following PICO question (patient/problem, intervention, comparison, outcome) was raised by our clinical team: Among hospitalized patients, are samples obtained via peripheral venipuncture or central catheters, as well as single or paired blood culture sets, associated with the greatest sensitivity and specificity in detecting bacteremia? In examining the literature on this original question, other best-practice pearls related to timing, preparing, obtaining samples, and labeling were uncovered.

Methods

The strategy included searching MEDLINE, CINAHL, and the Cochrane databases, as well as publications of professional societies (American Society for Microbiology, Clinical Laboratory and Standards Institute, Infectious Diseases Society of America) for clinical practice guidelines. Key words included blood cultures, catheter-associated sepsis, central line, and peripheral venipuncture. An additional strategy included hand-searching bibliographies.

Results

Peripheral vs Central Catheter Sampling

In 3 studies, researchers investigated the sensitivity/specificity of blood cultures of central versus peripheral blood samples. Sensitivity refers to the probability that the culture will show growth if bacteremia is present ("true-positives"). On the other hand, specificity is the probability that the culture will show no growth if bacteremia is absent ("true-negatives"). Blood samples obtained from central catheters have higher sensitivity but lower specificity than blood samples obtained via peripheral venipuncture (Table 1). Thus, cultures of samples obtained from central catheters are more likely to show true bacteremia but at the expense of a lower accuracy when bacteremia is truly not present.

Similar results were found in another investigation on contaminated blood cultures. In that study of more than 1400 catheter and venipuncture samples, samples obtained from catheters were significantly more likely to be contaminated and thus had lower specificity. Contaminating organisms in central-catheter samples were more diverse than those in venipuncture samples. Contamination rates for catheter types were highest for noncuffed and nontunneled catheters (6.5%), peripherally inserted catheters (5.3%), arterial catheters (4.9%), implantable ports (4.2%), and tunneled and cuffed...
catheters (2.7%). Although researchers in a large trial found that discarding the initial 10 mL of blood obtained does not reduce contamination rates for samples obtained from central catheters and can contribute to nosocomial anemia, obtaining samples from old caps has been associated with higher false-positive rates.7

**Single vs Paired Sets**

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.8 For instance, coagulase-negative *Staphylococcus* may be either a contaminant or an offending pathogen in single sets; however, if isolated from only 1 bottle of 2 sets it is most likely a contaminant rather than a pathogen.9 Therefore, cultures of lone samples may cause false-positive results that lead to unnecessary or increased duration of antibiotic therapy and potentially prolonged hospital stays.8,10

Optimally, 3 or 4 blood sets with adequate volume (20-30 mL) obtained within the first 24 hours of suspected bacteremia will have the greatest cumulative yield of pathogens.10 (Four or more sets may be recommended when it is likely that the anticipated pathogens are common contaminants.1) Thus, additional blood from 2 sets or more increases the likelihood that a pathogen will grow if present, maximizing diagnostic utility with true-positive results. When offending pathogens grow in all cultures, bacteremia exists and is due to the organism isolated. Additional culture sets should be obtained thereafter when continuing or recurrent bacteremia is clinically suspected or to test for cure 48 to 96 hours after initiation of appropriate therapy.13

**Timing of Cultures**

Shortly after administration, intravenous antibiotics are highly concentrated in the blood before they have a chance to distribute into peripheral tissue. Blood samples obtained during or just after an antibiotic infusion may have sufficient quantities of antibiotic to kill any viable bacteria in the sample. Therefore, samples must be obtained before administration of antibiotics to maximize the likelihood of a true-positive result.8,10

Although older literature recommended separating collection of samples by 15- to 30-minute intervals, evidence has not borne this out. This practice does not enhance microbial yield and may delay antibiotic therapy in critically ill patients.9,10 Rather, blood samples for culture may be obtained “back to back” as quickly as 2 sites can be prepared to obtain necessary blood for specimens.

**Site Preparation**

Greater than 0.5% alcoholic chlorhexidine, tincture of iodine (if the patient is allergic to chlorhexidine), or 70% isopropyl alcohol (patients <2 months old) should be used to prepare the venipuncture site to reduce the presence of skin contaminants. Adequate drying time as follows must be allowed to reduce the likelihood of contamination: isopropyl alcohol, 0 seconds; tincture of iodine, 30 seconds; chlorhexidine gluconate, 60 seconds; and povidone iodine, 2 minutes.

### Table 1

<table>
<thead>
<tr>
<th>Reference, year</th>
<th>No. of blood cultures</th>
<th>Design/population</th>
<th>Peripheral venipuncture</th>
<th>Central catheter</th>
<th>Sensitivity, % (actual positives correctly identified)</th>
<th>Specificity, % (actual negatives correctly identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DesJardin et al,2 1999</td>
<td>551</td>
<td>Retrospective cohort/oncology</td>
<td>78</td>
<td>89</td>
<td>97</td>
<td>95</td>
</tr>
<tr>
<td>Beutz et al,3 2003</td>
<td>300</td>
<td>Prospective cohort/medical intensive care unit</td>
<td>65</td>
<td>82</td>
<td>96</td>
<td>93</td>
</tr>
<tr>
<td>Falagas et al,4 2008</td>
<td>2677</td>
<td>Systematic review of 6 studies</td>
<td>64-95</td>
<td>78-95</td>
<td>96-98</td>
<td>81-96</td>
</tr>
</tbody>
</table>

**About the Authors**

Margo A. Halm is a clinical nurse specialist and director of nursing quality and research at Salem Hospital in Salem, Oregon, where she leads and mentors staff in the principles of clinical research and evidence-based practice. Tracy Hickson is supervisor of microbiology, cytology, and molecular diagnostics, Deanna Stein is the nurse manager for infusion and wound care, Matthew Tanner is intensive care unit and antimicrobial stewardship pharmacist, and Sheila VandeGraaf is the laboratory support service supervisor at Salem Hospital.

Corresponding author: Margo A. Halm, RN, PhD, ACNS-BC, Salem Hospital, Salem, OR 97301 (e-mail: margo.halm@salemhealth.org).
Table 2
Age considerations in volumes of blood samples collected for culture

<table>
<thead>
<tr>
<th>Population</th>
<th>Age</th>
<th>Site</th>
<th>Minimum volume</th>
<th>Bottles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonates</td>
<td>0-28 days (or admitted to neonatal intensive care unit)</td>
<td>One peripheral stick&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;8 kg: 1 mL</td>
<td>Single pediatric aerobic</td>
</tr>
<tr>
<td>Children</td>
<td>1-3 months</td>
<td>One peripheral stick&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;8 kg: 1 mL</td>
<td>Single pediatric aerobic</td>
</tr>
<tr>
<td></td>
<td>3-36 months</td>
<td>One peripheral stick&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8-13 kg: 3 mL</td>
<td>Pediatric aerobic if volume &gt;0.5-4 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13-27 kg: 5 mL</td>
<td>Adult aerobic if volume &gt;4.0 mL</td>
</tr>
<tr>
<td></td>
<td>4-11 years</td>
<td>One peripheral stick&lt;sup&gt;c&lt;/sup&gt;</td>
<td>27-40 kg: 10 mL</td>
<td>Pediatric aerobic if volume &gt;0.5-4 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;40 kg: 10 mL</td>
<td>Adult aerobic if volume &gt;4.0 mL</td>
</tr>
<tr>
<td>12-17 years</td>
<td>One peripheral stick; consider 2 sticks from separate sites for 2 cultures&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td>27-40 kg: 10 mL</td>
<td>Pediatric aerobic if volume &gt;0.5-4 mL</td>
</tr>
<tr>
<td>Adults</td>
<td>≥18 years</td>
<td>2 peripheral sticks&lt;sup&gt;c&lt;/sup&gt; from separate sites if possible; may reprepare and restick same site if second site not readily obtainable</td>
<td>10-mL ideal/bottle</td>
<td>Adult aerobic and anaerobic If unable to obtain &gt;5 mL, place entire volume in adult aerobic bottle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(absolute minimum = 5 mL per bottle)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Based on information from Dellinger et al<sup>8</sup>, O’Grady et al<sup>10</sup>, and Kaditis et al<sup>16</sup>.

<sup>b</sup>Based on weight.

<sup>c</sup>Central catheter may be used to obtain a second sample to rule out suspected catheter-related bloodstream infection.

Antiseptics with more rapid drying time are preferred over povidone-iodine to allow samples to be obtained more quickly. In 1 study, use of blood culture sampling kits significantly reduced contamination rates from 24% to 8%. The kit included sample bottles, an instruction sheet, and a large wipe impregnated with 62% ethyl alcohol for cleansing the skin before venipuncture.

Volume of Samples

Although the volume of blood is the most important factor in the recovery of bacteria, recovery rates do not improve beyond a total volume of 30 mL per culture. In adults, 20 mL is the preferred volume (10 mL divided between aerobic and anaerobic bottles) obtained at one time from a single site. Anaerobic bottles should be inoculated first (except in the case of inadequate sample volume) to ensure that no air, which may be trapped in the top of a syringe, enters the bottle and alters the anaerobic environment within. Caution should also be exercised to avoid overfilling as this may cause false-positive results.

Pediatric bottles should not be used for adult blood samples as smaller volumes diminish the yield of pathogens. If less than 5 mL of blood is obtained, it is reasonable to put all of the blood into the aerobic bottle. Table 2 outlines considerations for neonatal, pediatric, and adult blood culture specimens.

Labeling Specimens

The location from which the blood sample was obtained and the exact time when it was withdrawn can be critical in determining if a central catheter is infected (or difference in time to generate a positive result can be used as a diagnostic criterion), as many patients have multiple central catheters that can be accessed. The label must include the time the sample was obtained, the volume of blood added to each bottle, and the source (ie, specific anatomic location or catheter name). This information aids in interpretation of laboratory data and enables clinicians to identify the specific catheter of concern.

Recommendations for Practice

According to the best available evidence, blood cultures should be obtained peripherally by specially trained phlebotomists. Unless a sample for culture is specifically ordered from a central catheter or a peripherally inserted central catheter, phlebotomists should collect all blood samples for ordered cultures. Each sample should be obtained in paired sets by a separate venipuncture at an intact and noninfected site before administration of antibiotics.
Sites should be prepared with appropriate antiseptics (chlorhexidine, tincture of iodine, or 70% isopropyl alcohol in patients <2 months old) followed by the recommended drying time. Volumes of blood samples should follow age-appropriate recommendations. In patients with extremely limited peripheral access, it may be necessary to obtain 2 blood samples from the same site. The site must be prepared again before the second sample is obtained from the same general location.

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.8-10 Another exception to collecting blood samples for culture via venipuncture is patients with central catheters who have no obvious source of infection and thus may have a catheter-related bloodstream infection. In these cases, 1 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 (as determined by catheter duration, especially >48 hours, or the presence of purulence or cellulitis at the insertion site).8,10 by using the steps outlined in Table 3. By following these steps to obtain blood samples for culture from central catheters, clinicians will implement evidence-based practice that yields more reliable results to guide good clinical care.

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None reported.

REFERENCES

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