Blood cultures are important laboratory investigations in sick children. The detection of a pathogenic organism in the blood of an ill infant or child guides the further management and appropriate antimicrobial selection for the patient.\(^1\)

Contaminated (non-pathogenic) blood culture specimens lead to inappropriate use of antimicrobials and increased hospital stay. The internationally accepted contamination rate ranges between 2 and 3 \(\%\)^2. The following are examples of organisms that are generally considered non-pathogenic organisms if isolated from a single blood culture: coagulase negative staphylococci, \textit{Corynebacterium} species, \textit{Bacillus} species, \textit{Micrococcus} species, viridans group streptococci. These organisms may cause true bloodstream infections in certain situations eg. in patients with prosthetic devices or indwelling central venous catheters.\(^3\)

**INDICATIONS FOR BLOOD CULTURES**

Blood culture(s) should be considered in children in any of the following circumstances:

(1) If suspected on clinical and/or laboratory grounds of having serious invasive bacterial infection i.e. sepsicaemia/sepsis, meningitis, meningococcaemia, pyelonephritis, osteomyelitis, septic arthritis, infective endocarditis, mastoiditis or cellulitis

(2) Fever without a source (FWS) >38°C if:
   - less than 2 months of age
   - more than 2 months of age and toxic / ill-looking
   - HIV-infected – particularly if ART naïve or recently initiated on ART (<6 months)
   - severe acute malnutrition is present
   - another immunosuppressive condition is present e.g. immunosuppressive therapy, chemotherapy, malignancy, or primary immunodeficiencies.

Blood culture(s) should not be routinely performed in children with otitis media, acute pharyngitis, suspected viral infection, gastroenteritis, sinusitis, mild urinary tract infection (UTI), pneumonia, superficial skin sepsis, FWS in children >2 months of age with non-toxic clinical appearance.

**Ideally, blood cultures should be obtained before antimicrobial therapy is commenced**
FEATURES SUGGESTIVE OF SEPTICAEMIA

- In infants <2 months septicaemia may manifest with, but is not limited to:
  inability to suck or breastfeed (not feeding well), drowsiness or unconsciousness, convulsions, movement only when stimulated or no movement at all, respiratory rate (RR)<20 breaths/min or apnoea, tachypnoea (RR >60 breaths/min) ± other signs of respiratory distress (grunting, severe chest indrawing, central cyanosis), raised temperature >38°C, hypothermia <35.5°C, mottled skin, poor perfusion (capillary refill time ≥2 seconds) and/or severe abdominal distension. Presentation may be subtle with non-specific features predominating.

- In infants & children >2 months septicaemia may present with, but is not limited to:
  fever without a source in an ill looking/toxic child, pale, mottled or scleraemic skin, no response to stimulation, confusion or lethargy, weak, high-pitched or continuous cry, signs of a systemic upset (inability to breastfeed, drink, or eat, vomiting), sinus tachycardia, respiratory distress, poor perfusion (capillary refill time ≥2 seconds) and/or severe abdominal distension.

INTERNATIONAL CONSENSUS DEFINITIONS

To guide the recognition of the sepsis continuum in children, consensus definitions have been published. Although mainly employed for standardisation in research studies, these definitions are being used in clinical practice. However, several limitations are associated with these definitions. In particular their diagnostic usefulness has not been formally evaluated in our setting.

The **systemic inflammatory response syndrome (SIRS)** is a non-specific inflammatory process that occurs in response to an infection or other injury. At least 2 of the following should be present, one of which must be an abnormal temperature or leucocyte count:

- Core temperature of > 38.5°C or < 36°C§
- Tachycardia - mean heart rate > 2 SD above the normal for age or a bradycardia (< 10th centile for age in infants under 1 year of age*)
- Respiratory rate > 2 SD above the normal for age*
- White cell count elevated (> 13.5 - 34 x 10³/mm) or depressed (<4.5 – 6 x 10³/mm) for age or > 10% immature neutrophils (band cells).*

**Sepsis** is SIRS in the presence of or resulting from a suspected or proven infection.4

<table>
<thead>
<tr>
<th>Age</th>
<th>Tachypnoea (rate/min)</th>
<th>Tachycardia (beats/min)</th>
<th>Bradycardia (beats/min)</th>
<th>Hypotension (SBP mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn – 3 months</td>
<td>&gt; 60</td>
<td>&gt; 180</td>
<td>&lt; 100</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>4 – 12 months</td>
<td>&gt; 50</td>
<td>&gt; 180</td>
<td>&lt; 100</td>
<td>&lt; 60</td>
</tr>
<tr>
<td>1 – 4 years</td>
<td>&gt; 40</td>
<td>&gt; 160</td>
<td>N/A</td>
<td>&lt; 70</td>
</tr>
<tr>
<td>5 – 12 years</td>
<td>&gt; 30</td>
<td>&gt; 140</td>
<td>N/A</td>
<td>&lt; 80</td>
</tr>
<tr>
<td>12 + years</td>
<td>&gt; 30</td>
<td>&gt; 130</td>
<td>N/A</td>
<td>&lt; 90</td>
</tr>
</tbody>
</table>

§ At RCWMCH, temperature is measured using an infrared tympanic thermometer or an electronic thermometer in the axilla
Severe sepsis is sepsis and organ hypoperfusion (prolonged CRT (> 5 secs), increased lactate, oliguria (<0.5ml/kg/hr of urine), reduced mental state) or dysfunction (acute respiratory distress syndrome, DIC, acute renal failure) or hypotension (systolic BP < 2 SD for age or the need for inotropic support to maintain a normal BP).

BLOOD CULTURE PROCEDURE

BLOOD CULTURE FROM PERIPHERAL VENIPUNCTURE

1. Identify the patient for the procedure – ID band, ask the parent the name of the child.
2. Blood for blood culture should be obtained before other samples.
3. Assemble the necessary equipment
   - A sharps disposal container within easy access
   - A sterile dressing pack containing a waste bag, sterile gauze, sterile sheet and cover sheet with a window
   - Sterile gloves
   - Cleaning solution - Chlorhexidine Gluconate (0.5% Biotaine in 70% alcohol)
   - Blood culture bottle(s) (BacT/Alert Paediatric (yellow top) or BacT/Alert Standard Aerobic (green top))
   - An appropriate size syringe for obtaining the blood culture (5, 10 or 20 ml)
   - Butterfly or straight needle (24 gauge in a neonate, 22 gauge or more in an older infant)
4. Open the dressing pack on a trolley creating a sterile field, empty the syringe and needle, and cleaning solution into the holding vessel.
5. An assistant should be available to help with the procedure as children may not be cooperative.
6. Wash hands with soap and water and don sterile gloves.
7. The assistant should remove the dust cap from the blood culture bottle. Disinfect the septum of the blood culture bottle with a chlorhexidine soaked gauze. Allow to dry.
8. Clean the phlebotomy site e.g. the antecubital fossa or dorsal aspect of the hand, using the gauze soaked in chlorhexidine. Start cleaning from the phlebotomy site outwards in a circular motion. Allow the site to dry for at least 30 seconds before phlebotomy. The vein should not be palpated after the skin has been decontaminated without sterile gloves on.
9. Place the sterile sheet with the opening over the site for the blood culture.
10. Attach the needle being used to the syringe.
11. Insert the needle into the vein, drawing an appropriate volume of blood for inoculation into the blood culture medium (refer below: VOLUME OF BLOOD).
12. Withdraw the needle insuring that the needle-point does not touch any surfaces. Apply pressure with dry gauze to the phlebotomy site to prevent further bleeding.
13. Insert the blood drawn into the blood culture bottle without changing the needle.
14. Dispose of the needle in the sharps container.
15. Rotate (not shake) the blood culture to mix the blood with the culture medium.

BLOOD CULTURE FROM A CENTRAL VENOUS CATHETER LINE or ARTERIAL LINE

More than one blood culture specimen may be needed if infective endocarditis is suspected.
For suspected bloodstream infections in patients with indwelling central venous or arterial lines, **blood cultures should be obtained from both the central line and a peripheral venipuncture.**

1. Identify the patient for the procedure (ID band) and ask the parent the name of the child.
2. Blood for blood culture should be obtained before other samples.
3. Assemble the necessary equipment
   - A sharps disposal container within easy access
   - A sterile dressing pack containing a waste bag, sterile gauze, sterile sheet
   - Sterile gloves
   - Cleaning solution - Chlorhexidine Gluconate (0.5% Biotaine in 70% alcohol)
   - Blood culture bottle(s) (BacT/Alert Paediatric (yellow top) or BacT/Alert Standard Aerobic (green top))
   - Needle 22g or more
   - 1x 5ml syringe and 1 appropriate size syringe for obtaining the blood culture (5, 10 or 20 ml)
   - 5ml syringe with saline flush or heparinised saline
4. Open the dressing pack on a trolley creating a sterile field, empty the syringe and needle, and cleaning solution into holding vessel.
5. Pause the infusion pump and clamp the catheter.
6. Wash hands with soap and water and don sterile gloves.
7. The assistant should remove the dust cap from the blood culture bottle. Disinfect the septum of the blood culture bottle with a chlorhexidine soaked gauze. Allow to dry.
8. Create a sterile field by placing the sterile sheet under the catheter line.
9. Hold the catheter with the non-dominant hand and using the dominant hand scrub the port of the catheter for at least 15 seconds with the cleaning solution.
10. Disconnect the infusion line from the catheter line. Place on the sterile sheet.
11. Withdraw at least 5ml of blood via the catheter line and place the syringe on the sterile field to prevent any contamination of the tip. Clamp the catheter if necessary.
12. Using an appropriate size syringe withdraw the required volume of blood for inoculation into the blood culture medium (refer below: VOLUME OF BLOOD).
13. Reinject the first 5ml of blood withdrawn into the central venous catheter or discard the blood.
14. Flush the catheter line with the saline and reconnect the infusion line OR flush the catheter line with the heparinised saline.
15. Attach a needle to the syringe with the blood and insert into the blood culture bottle.
16. Discard the needle in the sharps container.
17. Restart the infusion pump.
18. Rotate (not shake) the blood culture to mix the blood with the culture medium.

**LABELLING AND TRANSPORT OF SPECIMENS**

- The patient label should be placed lengthwise on the bottle ensuring that that barcode is not obscured. Do not remove any part of the barcode – this is required in the laboratory during processing.
• Provide sufficient information on the laboratory request form including name, age and diagnosis of the patient, the site from which the blood culture was taken and any prior antibiotics administered.

• Blood cultures should be transported to the lab as soon as possible. Do not store in the fridge while awaiting transport. Blood cultures taken at Red Cross War Memorial Children’s Hospital are processed at the NHLS based at Groote Schuur Hospital.

**PROCESSING OF SAMPLES**

Blood cultures are processed at the Department of Microbiology at Groote Schuur Hospital. All specimens are routinely incubated for a period of 120 hours (5 days) in automated systems. The majority of pathogenic organisms will be detected within 36-48 hours of incubation. Once a blood culture flags positive in the automated system, an aliquot of the fluid is removed for Gram staining and culture on agar plates. Identification and sensitivity results are generally available 12-24 hours after the Gram stain result (6-8 hours later for Gram negative bacilli), provided a single organism is present.

**VOLUME of BLOOD**

Blood culture yield is related to the volume of blood cultured. Inadequate volumes of blood will be unable to detect true bacteraemia. Volumes should be adequate but not exceed the recommended volume for the blood culture specimen bottle. In the BacT/Alert Paediatric bottle (yellow top) no more than 4ml of blood should be inserted and the BacT/Alert Standard Aerobic bottle (green top), no more than 10ml of blood should be inserted. More than one blood culture specimen may be necessary per septic episode. Table 1 describes the recommended volume of blood to be collected from the patient suspected of having a bloodstream infection.

Table 1: Recommended volumes of blood for culture – adapted from the Infectious Diseases Society of America and the American Society of Microbiology

<table>
<thead>
<tr>
<th>Weight of patient (kg)</th>
<th>Total patient blood volume (mL)</th>
<th>Recommended volume of blood for culture (mL)</th>
<th>Blood culture bottle used</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1 - 2</td>
<td>50 - 200</td>
<td>1 - 2</td>
<td>Paediatric (yellow top)</td>
</tr>
<tr>
<td>2.1 – 13</td>
<td>&gt;200</td>
<td>4</td>
<td>Paediatric (yellow top)</td>
</tr>
<tr>
<td>13 – 36</td>
<td>&gt;800</td>
<td>8 - 10</td>
<td>Adult (green top) or x 2 Paediatric (yellow top) if no adult bottle is available</td>
</tr>
<tr>
<td>&gt;36.1</td>
<td>&gt;2200</td>
<td>20</td>
<td>Adult (green top) x 2</td>
</tr>
</tbody>
</table>

**REDUCING CONTAMINATION**

Decontamination of the skin is one of the most important interventions in reducing blood culture contamination. Skin antiseptic choice is also important. Chlorhexidine gluconate (0.5 – 3%) in 70% alcohol has been shown to decrease the blood culture contamination rate compared to 10% Povidine Iodine solution. Alcohol containing products are better at reducing blood culture contamination rates. The drying time of the skin antiseptic also plays a role. Chlorhexidine solution
needs 15-30 seconds to dry after disinfecting the skin whereas povidine iodine solution will require approximately 2 minutes before venipuncture can occur.9,11 If a needle and syringe are used for the specimen collection, the needle should not be changed between collection and inoculation in the blood culture bottle. This poses an unnecessary risk of a needlestick injury and it has not been shown to reduce the contamination rate.

**SPECIAL CONSIDERATIONS**

There is no longer a need for separate aerobic and anaerobic blood culture specimens.

In cases of suspected disseminated TB, blood specimens for culture need to be inoculated into the **BDBactec Myco/F Lytic** culture bottle. These can be obtained from the laboratory reception at RCWMCH.

Fungal cultures are processed using the same **BacT/Alert Paediatric or BacT/Alert Standard Aerobic bottles**. The majority of Candidal infections will be detected in the standard 5 day period of blood culture incubation. If fungal infections other than Candida are suspected, submit a **BDBactec Myco/F Lytic** culture bottle.

There is no need for extended culture in cases of suspected endocarditis as even fastidious organisms, such as the HACEK group, have been shown to grow adequately within 5 days in modern blood culture systems.

In certain instances, organisms that are usually contaminants (coagulase negative staphylococci, *Corynebacterium* species, *Bacillus* species, *Micrococcus* species, viridans group streptococci), can be considered as a cause of bloodstream infections. These include the isolation of the same organism from two or more separate specimens taken at different times (but within a 24 hour period), and meeting the criteria as listed previously for infection or sepsis.12 If an organism classified as a contaminant is isolated from a central venous catheter or indwelling venous catheter, the same organism should be isolated from a peripheral venipuncture to be considered a cause of bloodstream infection.5

**REFERENCES**