# BLOOD CULTURE COLLECTION

## PRACTICE GUIDELINE ©

## DOCUMENT SUMMARY/KEY POINTS

- When deciding to collect blood cultures, attention must be paid to aseptic collection technique, selection of peripheral (vein) or central (line) site of collection, type, and number of culture bottles. These depend on underlying patient factors and this procedure should be used as a guide along with clinical judgement and other relevant policies and procedures.
- Discards should be avoided where possible.
- All staff are to read the complete Infection Control policies to inform themselves of all the relevant areas prior to obtaining peripheral blood cultures from a patient. Hand Hygiene Practice Guideline, Personal Protective Equipment for Infection Control Policy and NSW Health Infection Prevention and Control Policy Directive.
- The selection of blood culture bottle(s) should include consideration of the patient's age and weight, pre-existing conditions, existing IV access and/or optimal volume to collect in the case of difficult blood draw.
- Likelihood of detecting bacteraemia is more closely correlated with blood volume collected than degree of fever, method of collection or any other factor. As a general rule, the minimum volume of blood inoculated into a blood culture should be the child's age in mL (2mL for a child aged 2 years, 5mL for a child aged 5 years, etc.), ensuring the volume collected is always <4% total blood volume, aiming for at least 0.5 – 1mL for children <1 year of age.
- In most cases, a blood culture set comprises at least 1 paediatric bottle in a child ≤12 years of age or 2 bottles (aerobic and anaerobic) in a child >12 years of age.





| | | |
|---|---|---|
| **Approved by:** | SCHN, Policy, Procedure and Guideline Committee | |
| **Date Effective:** | 1st May 2023 | **Review Period**: 3 years |
| **Team Leader:** | Physician and Microbiologist | **Area/Dept**: Infectious Diseases |

Date of Publishing: 7 June 2023 9:51 AM Date of Printing: 7 June 2023


K:\CHW P&P\ePolicy\Jun 23\Blood Culture Collection.docx

# CHANGE SUMMARY

- Change in practice – the use of discards should be avoided where possible.
- References updated.
- Protocol broadened to include more clinical teams and situations, outside of CICU.
  - Previous title - *Peripheral Blood Cultures in CICU – SCH (2014-1002 v2)*
- **07/06/23**: minor review. Updated table 3 and footnote for maximum volume to collect per bottle.

# READ ACKNOWLEDGEMENT

- Medical and nursing staff who obtain peripheral or central blood cultures are required to read and acknowledge they understand the contents of this document.

# TABLE OF CONTENTS

# 1 Standard practice for blood culture collection

Blood cultures should be considered whenever bloodstream infection is suspected. [1] In clinical practice this is often considered if a patient develops a new fever of >38.5°C, although studies have shown significant proportions of bacteraemic children had a maximal temperature below 38.5°C [2] and there is no reliable correlation between onset or degree of fever and bacteraemia. [3] Using discards should be avoided where possible. Clinicians should refer to specific policy indications for blood culture collection for specific patient groups, e.g., oncology patients. Collection of blood cultures should not be delayed in a patient showing signs of sepsis without fever. [3] The patient's presenting condition and/or the presence of any signs of localised infection should be considered in deciding on blood culture collection and empiric antimicrobial therapy.

- Hand hygiene must be undertaken by the collector as outlined in the SCHN Hand Hygiene Policy.
- Standard Precautions to be used when collecting blood cultures include gloves, an impervious gown, and eye protection as outlined in the Personal Protective equipment for Infection Control Policy.
- Collection using aseptic non-touch technique (ANTT) is important in order to avoid contamination and to ensure sensitivity. Re-palpation should be avoided. If re-palpation is required after skin sterilisation, a sterile glove should be used. [4, 5] Please refer to the Aseptic Non-Touch Technique Policy. If blood is collected from a central venous access device (CVAD), refer to the SCHN CVAD policy.

# 2 Indications to collect blood cultures

Blood culture collection should be completed for those at significant risk of bloodstream infection based on clinician judgement.

Children are especially vulnerable to serious bacterial infection for several reasons, including immaturity of the immune system. Other factors which influence risk include altered host defences in the case of concurrent disease or postoperative disposition.

The presence of fever or other factors suggesting possibility of bloodstream infection should prompt clinical history-taking, examination and potentially laboratory investigations. In the general paediatric hospital population, only about 2% of blood cultures ever grow pathogens, and most of these are in young children or those with complex needs and co-morbidities. [6,7]

Some conditions are associated with a higher risk of bloodstream infection and should prompt blood culture collection, including bone and joint infections, [8] bacterial meningitis, vertebral discitis, ventriculoperitoneal (VP) shunt infection and central venous access line site infection. Skin and soft tissue infections are less likely to be associated with bloodstream infection in paediatric patients, but clinical judgement should be used to determine whether bloodstream infection should be suspected. [9]

# 3 Detection of bloodstream infection

Early detection of bloodstream infection is crucial to establish a bacterial cause for fever and direct appropriate antimicrobial therapy. Blood cultures are among the most common laboratory tests performed in the diagnosis of serious infection. Due to the increased risk and associated mortality with bloodstream infection, a low threshold exists for blood culture, which is considered the gold standard for diagnosing bloodstream infection. [10]

Administration of antibiotics prior to blood culture collection can lead to false negative results; collection should be prior to the commencement of antibiotic therapy wherever possible but antibiotic therapy **should not be delayed** in children with sepsis or those otherwise critically unwell.

Paediatric blood culture bottles are formulated to support the growth of both common pathogens and fastidious paediatric pathogens such as *Haemophilus influenzae* and *Neisseria meningitidis.* [7] Where only one sample will be collected for blood culture in children, a paediatric blood culture bottle should be used. [11]

## 3.1 Volume of blood collected

The optimal yield of microorganisms from a bloodstream infection is more dependent on volume of blood collected than any other factor. Frequently, the volume of blood collected is inadequate to detect bacteraemia in paediatric patients. [6] This needs to be balanced against the risk of inducing anaemia, avoiding collection more than 4% of total blood volume (see Table 1). [12] This is particularly important in young infants who have small blood volumes and for patients who receive regular blood culture collection (e.g., patients with febrile neutropenia).

- Children (≤12 years old) generally have a higher number of bacteria per unit blood volume compared to adults, [13] but yield of blood culture collection **remains proportional to the volume of blood collected** (see Tables 2-4).
- A paediatric bottle should be inoculated with **a minimum of 0.5 – 1 mL and a maximum of 4 mL of blood (Table 2)**.
- In children aged >12 years, the set (adult aerobic and anaerobic) should be inoculated with a minimum of **5mL in each bottle and a maximum of 5 – 10mL of blood (as indicated on the individual bottle, as this varies by bottle type – see Table 2)**.
- In general, **the minimum volume of blood inoculated into a blood culture should be the child's age in mL** (i.e., 2mL for a child aged 2 years, 5mL for a child aged 5 years, etc.), ensuring the volume collected does not exceed 4% of the total blood volume. [1] For children aged <1 year, 0.5 – 1mL should be collected depending on their weight, if possible (Table 3).

**Table 1. Approximate blood volumes per age group.** [14]

| Age group | Total blood volume (mL/kg) |
|---|---|
| Neonates | 85-90 |
| Infants | 75-80 |
| Children | 70-75 |
| Adults | 65-70 |

**Note**: sometimes patient factors render it impossible to collect recommended minimum volumes, in which case bloodstream infection may still be detected, although the yield of blood culture collection will not be optimal.

**Table 2. Minimum and maximum volume for blood cultures per bottle.** [1, 11, 15, 16]

| Blood Culture Bottles | Recommended minimum volume per bottle* | Recommended maximum volume per bottle* |
|---|---|---|
| Paediatric Bottles | 0.5 – 1 mL | 4 mL |
| Adult Aerobic Bottles | 5 mL | 10 mL |
| Adult anaerobic Bottles | 5 mL | 10 mL |

*Recommended volume depends on the bottle type – refer to individual bottles for maximum volumes.

**Table 3. Blood culture volume to inoculate per bottle based on patient age and weight.**

| Patient group | | Recommended blood volume to collect per bottle |
|---|---|---|
| Age <1 year | Weight 0 – 1 kg | 0.5 mL |
| | Weight 1 – 5 kg | 0.5 – 1 mL |
| Age 1 – 15 years | | 1 mL for each year of life, up to the recommended maximum in Table 2* |

* i.e., 1 mL for a child aged 1 year, 2 mL for a child aged 2 years, 3 mL for a child aged 3 years, and so on. See Section 3.2, Table 4 (CHW) and Table 5 (SCH) for suggested distribution of blood into blood culture bottles.

## 3.2 Distribution of blood collected.

Blood taken for culture should be distributed in bottles for maximal yield of suspected pathogens. This will depend on the volume of blood taken, the types of bottles available, which differ in CHW and SCH, and whether there are clinical indications to suspect anaerobic infection. The following tables provide detailed advice on maximal yield distribution of blood into blood culture bottles: Table 4 provides recommendations for the Children's Hospital at Westmead and Table 5 applies at Sydney Children's Hospital, Randwick.

***The following TABLE applies to the Children's Hospital at Westmead***

**Table 4. Recommended distribution of blood for culture when only paediatric bottles and adult anaerobic bottles are available (i.e., adult aerobic bottles are NOT available).**

| Total volume of blood available for culture (mL) | There is NO clinical indication for anaerobic culture | There is clinical indication for anaerobic culture |
|---|---|---|
| <0.5 | Inadequate volume for blood culture, recollect at least 0.5 mL. | Inadequate volume for blood culture, recollect at least 0.5 mL |
| 0.5 – 4 | Place up to 4 mL into paediatric bottle. | Place 4 mL into paediatric bottle (*anaerobic culture is not possible*) |
| 5 – 7 | Place up to 4 mL into paediatric bottle.<br>(Can inoculate second paediatric bottle with equal volume; second venepuncture preferred, if possible) | Place up to 4 mL into paediatric bottle.<br>(*anaerobic culture not possible*) |
| 8 – 9 | Place 4 mL into paediatric bottle.<br>(Can inoculate second paediatric bottle with similar volume; second venepuncture preferred, if possible). | Place 5 mL into anaerobic bottle and remainder (2 – 4 mL) into paediatric bottle. |
| 10 – 14 | Place 4 mL into paediatric bottle and remainder (up to 10 mL) into anaerobic bottle. | Place 4 mL into paediatric bottle and remainder (up to 10 mL) into anaerobic bottle |

***The following Table applies to Sydney Children's Hospital, Randwick***

**Table 5: Recommended distribution of blood for culture when paediatric bottles, adult aerobic bottles, and adult anaerobic bottles are all available.**

| Total volume of blood available for culture (mL) | There is NO clinical indication for anaerobic culture | There is clinical indication for anaerobic culture |
|---|---|---|
| <0.5 | Inadequate volume for blood culture, recollect at least 0.5 mL | Inadequate volume for blood culture, recollect at least 0.5 mL |
| 0.5 – 4 | Place up to 4 mL into paediatric bottle | Place up to 4 mL into paediatric bottle (*anaerobic culture not possible*) |
| 5 – 6 | Place all blood into adult aerobic bottle | Place all into adult aerobic bottle (*anaerobic culture not possible*) |
| 7 – 9 | Place all blood into adult aerobic bottle | Place 5 mL into anaerobic bottle and remainder (2 – 4 mL) into paediatric bottle |
| 10 – 14 | Place 5 mL into adult anaerobic bottle and remainder (up to 10 mL) into adult aerobic bottle | Place 4 mL into paediatric bottle and remainder (up to 10 mL) into anaerobic bottle |
| 15 – 20 | Place 10 mL into adult aerobic bottle and remainder (up to 10 mL) into adult anaerobic bottle | Place half into adult aerobic bottle and half into adult anaerobic bottle |

# 4 Preparation for procedure

It is important to prepare all equipment prior to initiation of the procedure, to minimise risk of contamination.

## 4.1 Blood culture bottle selection:

Anaerobic bottle collection is not necessary in children <12 years except as part of diagnostic evaluation for bacteraemia/sepsis in patients at greater risk of anaerobic infection, for example:

- Patients with signs or symptoms of intra-abdominal infection.
- Debilitated patients with pressure ulcers.
- Patients with suspected bacteraemia after human or animal bite wounds or crushing trauma.
- Oncology patients as recommended in Oncology- Fever – Low Risk Management Guideline.
- Necrosis, myositis, or deep tissue abscesses.

## 4.2 Site of venepuncture/ blood collection

Where possible, blood cultures should be obtained by peripheral venepuncture, given the lower risk of contamination compared to a CVAD (even if collected at time of CVAD insertion) and the risk of catheter lumen colonisation. [17, 18] It is acceptable, however for children with long-term CVADs and frequent blood collection to have only central line cultures collected, in accordance with locally endorsed practice, to avoid discomfort and distress associated with peripheral cultures. This should be discussed with the patient's admitting team.

- Venous and arterial blood cultures have comparable yield. [19]
- Do not use any blood from blood gas syringe for blood cultures.
- Never force blood into a bottle. If vacuum is not present, the bottle should not be used.
- Always label the site of blood culture collection (e.g., peripheral, white lumen of CVAD, red lumen of CVAD).
- If a central line culture is positive, a peripheral culture should be collected, where possible, in addition to repeat CVAD collection to assist interpretation of bacteraemia and document clearance of bacteraemia.
- Repeat blood cultures should generally only be taken to confirm a positive culture result, document clearance of pathogens, or in setting of a second fever or clinical instability. [20-22] Exceptions to this rule should be in accordance with endorsed policies only (e.g., Fever in Oncology).
- No more than **two** unsuccessful attempts are to be made before contacting a more senior staff member for assistance in obtaining blood culture samples.

## 4.3 Analgesia for sampling procedure

**In children with sepsis or who are unwell with suspected bloodstream infection, do NOT delay venepuncture, blood culture collection or antimicrobial therapy to wait for analgesia.**

- Nonetheless, it is important to consider the emotional and psychological support of younger children undergoing medical procedures. The Child Life Therapy: Procedure Support Guideline provides advice.
- Where possible, infants <3 months of age undergoing venepuncture for blood culture sampling may be given to the use of ORAL SUCROSE and non-nutritive sucking.
    - Oral sucrose should be administered as outlined in Sucrose – Management of Short Duration Procedural Pain in Infants Nurse Initiated Medication, noting contraindications.
- Where possible, LMX4® or EMLA® 5% creams (topical local anaesthetics) may be used to relieve the pain associated with venepuncture:
    - If used, cream or patch should be in contact with the skin for at least 30 – 60 mins before sampling.
    - Application of LMX4® or EMLA® 5% should be undertaken as outlined in Nurse Initiated Medication documents. Note special precautions.
    - Topical Anaesthesia – Lignocaine, Prilocaine 5% Cream (EMLA)
    - Topical Anaesthesia – Lignocaine 4% Cream (LMX4)

# 5 Procedure: peripheral blood culture collection

1. Check patient identification and inform the parent or carer of the procedure.
2. Order each set of blood cultures collected on eMR and sign the request form, making sure the date, time, and location (CVAD lumen/peripheral site) is clearly marked. If multiple sets of cultures are collected (e.g., one from each lumen of a central line and/or peripheral cultures), each should have a separate order through eMR.
3. **KEY POINT:** a brief clinical history must be included on the request form as this is vital to ensure that relevant organisms are sought – e.g., 'blood culture – febrile neutropenia'
4. Inspect the bottle surface, the media and expiry date. Blood culture bottles must have more than 7 days before their expiry date to be used. DO NOT use bottles past their expiry date.
5. Perform hand hygiene and apply PPE. Personal Protective Equipment for Infection Control.
6. **The top of culture bottle is not sterile and must be disinfected**. Remove the caps off all culture bottles and wipe the membrane with alcohol wipes (DO NOT USE IODINE). Discard wipes and leave to dry whilst venepuncture is in progress.

7. Apply a tourniquet briefly and select a suitable blood vessel for sampling. Release tourniquet.
8. Before selecting the solution for skin antisepsis, the patient's age and skin integrity must be assessed.
    - 0.1% Aqueous Chlorhexidine is recommended for skin antisepsis in neonates and infants up to 8 weeks of age due to risks of skin irritation and chemical burns if a stronger skin preparation is used.
    - 2% Chlorhexidine Gluconate in 70% alcohol is used for skin preparation in children greater than 8 weeks of age.
    - Disinfect the skin site for a minimum of 20 seconds using appropriate solution from the site of venepuncture outwards on concentric circles covering a circular area 2 – 4 cm in diameter. Repeat once and then allow the skin to dry allowing antiseptic action to complete.
9. Re-apply the tourniquet.
10. Wash hands.
11. Apply gloves. [9, 10]
12. Perform venepuncture.
13. Draw amount of blood appropriate for patient's size and volume required for test from patient (see Table 1).
14. Inoculate the bottle using syringe markings as a guide for correct volume (do not overfill bottles as this may cause false positive results). A blood transfer device should be used, if possible, to minimise the risk of needle stick injury. Stand the bottle upright and use the graduated scale on the side of the bottle to determine when filling is complete (the vacuum is strong). Avoid overfilling bottles – refer to Table 1.
15. If using two bottles (e.g., patient ≥ 12 years or high risk of anaerobic infection) place at least 4 – 5mL in each bottle, with up to 10mL in the anaerobic bottle. Refer to individual bottles for maximum recommended volume and see Table 1.
16. Mix the blood in the bottles (do not shake).
17. Label the bottles with patient's name, date of birth, and medical record number, as well as the date and time of collection. If multiple sets are collected or the sample is from a CVAD, record the collection site on the bottles. If sticky labels are used DO NOT COVER THE BARCODE on the bottle.
18. When labelling the bottles, do not cover the peel-off section of the barcode labels or the lot numbers.
19. Transport inoculated blood cultures at room temperature to the laboratory as soon as possible for incubation in appropriate specimen bags, along with any request forms – this may be via the specimen chute system. **Never refrigerate blood cultures**.

# 6 Interpretation of results

Most episodes of clinically significant bacteremia are detected within 24 hours. [23, 24, 25, 26, 27]

Detection of fungaemia, which is much less common, may require an additional 24 to 72 hours of incubation [26]. Empiric treatment should be re-evaluated after no more than 48 hours following blood culture collection and initiation of antibiotic therapy. Since some rarely encountered organisms require more than 48 hours to grow, blood cultures are routinely monitored for 5 days.

False positive blood cultures may occur because of contamination of cultures at the time of collection [6]. Most blood culture contaminants emanate from the skin plug through which the collection needle traverses during phlebotomy. Avoidance of skin flora by appropriate decontamination of the skin is thus important to avoid contamination. Blood culture contamination may be interpreted as true bacteraemia prompting unnecessary antibiotic treatment and an increased potential for antimicrobial resistance [28, 29].

The interpretation of bacteria or fungi isolated from a blood culture can be difficult, [1] and should be discussed with the Infectious Diseases service (on call 24 hours, 7 days) if uncertain. Examples of organisms which are usually pathogens or contaminants are given in Table 6.

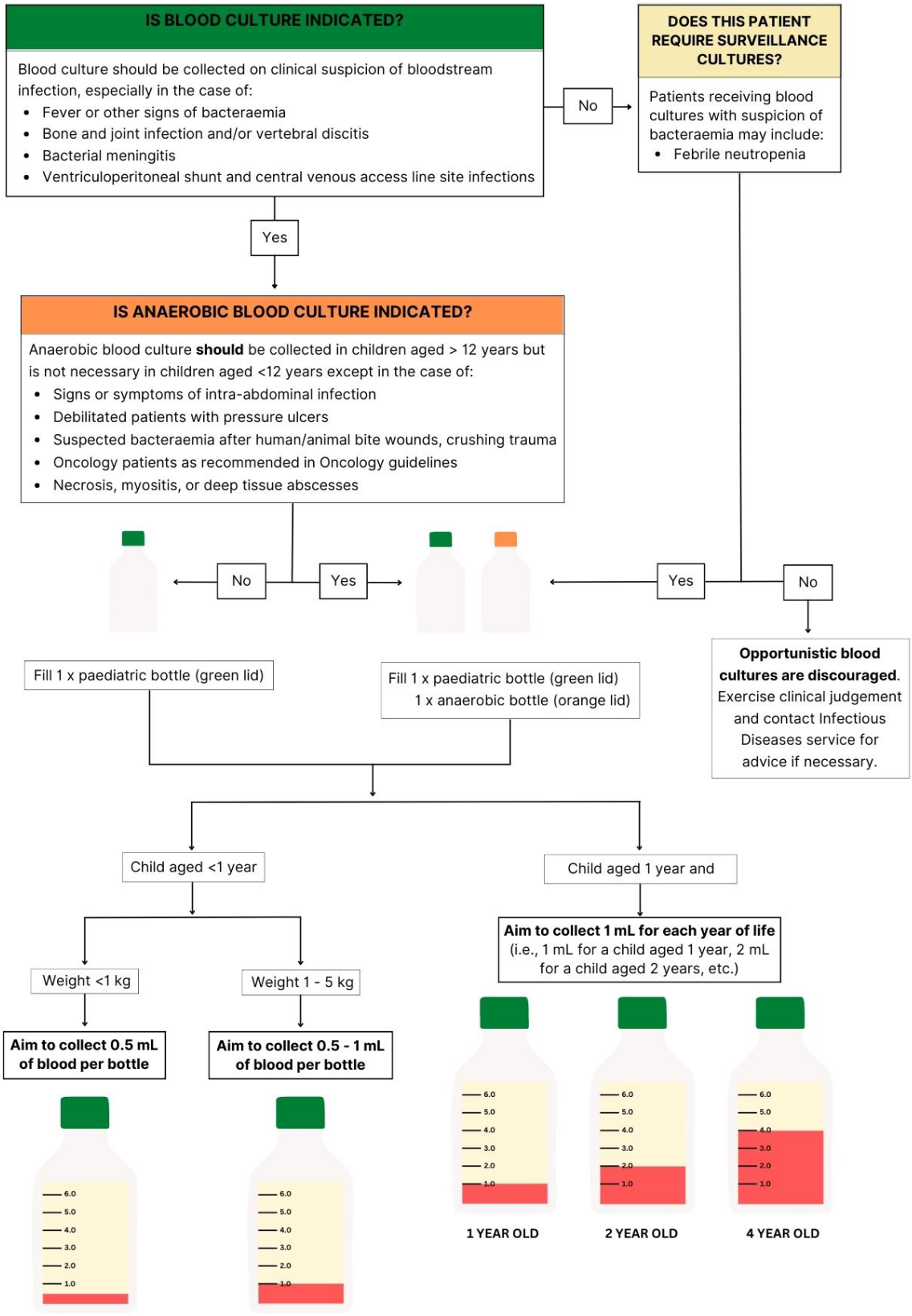
**Table 6: Clinical significance of common bacteria isolated from a blood culture.** [1, 27]

| | Common or important causes of bloodstream infection | Common contaminants* |
|---|---|---|
| **Organisms** | *Staphylococcus aureus*<br>*Streptococcus pneumoniae*<br>*Streptococcus pyogenes*<br>*Escherichia coli*<br>*Klebsiella pneumoniae*<br>*Enterobacter* species<br>*Neisseria meningitidis*<br>*Pseudomonas aeruginosa*<br>*Haemophilus influenzae*<br>*Candida albicans* | *Staphylococcus epidermidis*<br>*Staphylococcus hominis*<br>*Streptococcus mitis/oralis*<br>*Micrococcus* species<br>*Corynebacterium* species<br>*Bacillus* species<br>*Paenibacillus* species<br>*Moraxella* species<br>*Cutibacterium* species |
| **Recommended actions** | Discuss with Admitting Medical Officer (AMO).<br><br>Infectious diseases consultation recommended.<br><br>Check antimicrobial agent and dose appropriate (infectious diseases physician, microbiologist, or antimicrobial stewardship pharmacist can assist).<br><br>Consider removal of central lines, indwelling devices or foreign bodies. | Reassess patient for risk factors (e.g., for central line infection or endocarditis).<br><br>Repeat blood culture if clinically indicated.<br><br>Discuss with microbiologist or Infectious Diseases physician if concerns exist about significance of result. |

*Can be pathogenic in higher risk groups. If uncertain, discuss with Infectious Diseases.

***Figure 1. Blood culture practice recommendations for children***

**Please note** that this only summarises the information and should not replace detailed review of these Practice Guidelines.



# 7 References

1. O'Hagan S, Nelson P, Speirs L, Moriarty P, Mallett P. How to interpret a paediatric blood culture. Arch Dis Child Educ Pract Ed. 2021;106(4):244-50.
2. Michelson KA, Neuman MI, Pruitt CM, Desai S, Wang ME, DePorre AG, et al. Height of fever and invasive bacterial infection. Arch Dis Child. 2021;106(6):594-6.
3. Kee PP, Chinnappan M, Nair A, Yeak D, Chen A, Starr M, et al. Diagnostic Yield of Timing Blood Culture Collection Relative to Fever. Pediatr Infect Dis J. 2016;35(8):846-50.
4. Chatterjee J, El Feghaly RE, Morgan S, Dowdy K, Stempak L. A quality improvement project: Decreasing blood culture contamination in a Children's Hospital. Pediatrics. 2018;142(1 MeetingAbstract):353-.
5. Kim NH, Kim M, Lee S, Yun NR, Kim KH, Park SW, et al. Effect of routine sterile gloving on contamination rates in blood culture: a cluster randomized trial. Annals of internal medicine. 2011;154(3):145-51.
6. Connell TG, Rele M, Cowley D, Buttery JP, Curtis N. How Reliable Is a Negative Blood Culture Result? Volume of Blood Submitted for Culture in Routine Practice in a Children's Hospital. Pediatrics. 2007;119(5):891-6.
7. Le Doare K, Nichols A-L, Payne H, Wells R, Navidnia S, Appleby G, et al. Very low rates of culture-confirmed invasive bacterial infections in a prospective 3-year population-based surveillance in Southwest London. Archives of Disease in Childhood. 2014;99(6):526-31.
8. Roger PM, Cua E, Courjon J, Landraud L, Carles M, Bernard E. The impact of bacteremia on the outcome of bone infections. Médecine et Maladies Infectieuses. 2014;44(8):380-6.
9. Stephens JR, Hall M, Markham JL, Zwemer EK, Cotter J, Shah SS, et al. Variation in Proportion of Blood Cultures Obtained for Children With Skin and Soft Tissue Infections. Hospital Pediatrics. 2020:hpeds.2019-0317.
10. Weiss SL, Peters MJ, Alhazzani W, Agus MSD, Flori HR, Inwald DP, et al. Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children. Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies. 2020;21(2):e52-e106.
11. Novak-Weekley SaD, WMJ. Blood culture: A key investigation for diagnosis of bloodstream infections. In: BIOMERIEUX, editor. Biomerieux, Inc. 100 Rodolphe Street, Durham, NC USA: Pioneering Diagnostics; 2018.
12. Steffen K, Doctor A, Hoerr J, Gill J, Markham C, Brown SM, et al. Controlling Phlebotomy Volume Diminishes PICU Transfusion: Implementation Processes and Impact. Pediatrics. 2017;140(2):e20162480.
13. Riedel S, Carroll KC. Blood cultures: key elements for best practices and future directions. J Infect Chemother. 2010;16(5):301-16.
14. Hazinski MF. Nursing care of the critically ill child. Elsevier Health Sciences; 2012 May 4.
15. Huber S, Hetzer B, Crazzolara R, Orth-Höller D. The correct blood volume for paediatric blood cultures: a conundrum? Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases. 2020;26(2):168-73.
16. SHPN CEC. SEPSIS KILLS NEONATAL Blood Culture Guideline. 2016.
17. Snyder SR, Favoretto AM, Baetz RA, Derzon JH, Madison BM, Mass D, et al. Effectiveness of practices to reduce blood culture contamination: a Laboratory Medicine Best Practices systematic review and meta-analysis. Clinical biochemistry. 2012;45(13-14):999-1011.
18. Kelly A-M, Klim S. Taking blood cultures from a newly established intravenous catheter in the emergency department does not increase the rate of contaminated blood cultures. Emergency Medicine Australasia. 2013;25(5):435-8.
19. Levin P, Hersch M, Rudensky B, Yinnon A. The use of the arterial line as a source for blood cultures. Intensive Care Med. 2000;26:1350-4.
20. Cockerill FR, 3rd, Wilson JW, Vetter EA, Goodman KM, Torgerson CA, Harmsen WS, et al. Optimal testing parameters for blood cultures. Clin Infect Dis. 2004;38(12):1724-30.
21. Petty LA, Sokol EA, Bartlett AH, McNeer JL, Alexander KA, Pisano J. Repeated Blood Cultures in Pediatric Febrile Neutropenia: Would Following the Guidelines Alter the Outcome? Pediatric blood & cancer. 2016;63(7):1244-9.
22. Haeusler GM, De Abreu Lourenco R, Clark H, Thursky KA, Slavin MA, Babl FE, et al. Diagnostic Yield of Initial and Consecutive Blood Cultures in Children With Cancer and Febrile Neutropenia. J Pediatric Infect Dis Soc. 2021;10(2):125-30.

23. Biondi EA, Mischler M, Jerardi KE, Statile AM, French J, Evans R, et al. Blood Culture Time to Positivity in Febrile Infants With Bacteremia. JAMA Pediatrics. 2014;168(9):844-9.
24. Singh MP, Balegar V KK, Angiti RR. The practice of blood volume submitted for culture in a neonatal intensive care unit. Archives of Disease in Childhood - Fetal and Neonatal Edition. 2020;105(6):600-4.
25. Dierig A, Berger C, Agyeman PKA, Bernhard-Stirnemann S, Giannoni E, Stocker M, et al. Time-to-Positivity of Blood Cultures in Children With Sepsis. Frontiers in pediatrics. 2018;6:222-.
26. Doern GV, Brueggemann AB, Dunne WM, Jenkins SG, Halstead DC, McLaughlin JC. Four-day incubation period for blood culture bottles processed with the Difco ESP blood culture system. J Clin Microbiol. 1997;35(5):1290-2.
27. Ransom EM, Alipour Z, Wallace MA, Burnham CD. Evaluation of optimal blood culture incubation time to maximize clinically relevant results from a contemporary blood culture instrument and media system. J Clin Microbiol 2021; 59(3) e02459-20.
28. Doern GV, Carroll KC, Diekema DJ, Garey KW, Rupp ME, Weinstein MP, et al. Practical Guidance for Clinical Microbiology Laboratories: A Comprehensive Update on the Problem of Blood Culture Contamination and a Discussion of Methods for Addressing the Problem. Clin Microbiol Rev. 2019;33(1).
29. Souvenir D, Anderson DE, Jr., Palpant S, Mroch H, Askin S, Anderson J, et al. Blood cultures positive for coagulase-negative staphylococci: antisepsis, pseudobacteremia, and therapy of patients. J Clin Microbiol. 1998;36(7):1923-6.