Blood Culture Stewardship Tool

Background

In the setting of the blood culture bottle shortage, HMS has obtained permission to share a blood culture stewardship resource from Johns Hopkins Medicine. The purpose of this algorithm is to safely reduce the use of blood cultures in low-risk bacteremia cases. Additionally, it can be used to promote blood culture stewardship.

Important Notes

- This was developed with the support of the CDC through the Johns Hopkins Prevention Epicenter Blood Culture Stewardship Collaborative
- Any investigational studies utilizing this algorithm cannot be published until Johns Hopkins University has published their manuscript

Blood Culture Stewardship – Johns Hopkins Medicine (JHM)

July 2024

Context: BD Diagnostics, Inc. has reported an interruption in the production of BACTEC pediatric and adult aerobic and anaerobic blood culture bottles. While blood cultures are the gold standard to diagnose bacteremia, many are ordered in situations with low risk of bacteremia. Infectious Disease faculty at JHM have worked to advance Blood Culture Stewardship for several years.

Supporting evidence: We have shown that blood cultures can be reduced safely in adult and pediatric patients using evidence-based recommendations for when to obtain blood cultures. In addition to reducing overall blood culture use, our blood culture stewardship program has resulted in a reduction of single blood cultures, increase in blood culture positivity, and a reduction in broad spectrum antibiotic use, and central line-associated bloodstream infection (CLABSI) rates without affecting adversely mortality, length of stay, readmission, or compliance with the CMS SEP-1 Core Measure.

Next steps: Below, we share considerations to optimize blood culture use based on our experience.

SUGGESTED STRATEGIES TO CONSERVE BLOOD CULTURE BOTTLES

- ✓ **Determine the magnitude of the problem**
  - Meet with the Clinical Microbiology Laboratory to discuss current and expected blood culture bottle supplies
  - Identify clinical areas/units with highest blood culture utilization (usually inpatient medicine, ICU, surgery, and Oncology units) using electronic health record data
  - Develop a plan for ongoing monitoring of blood culture bottle availability and blood culture use
- ✓ **Implement an action plan**
  - Target high-use areas for education and implementation
  - Use a graded approach to conserve blood culture bottles based on anticipated supply reduction
    - Work on reducing low yield blood cultures first. This alone may lead to reduction in ~40% of blood cultures (can be higher depending on local practices). See **Table** on next page.
    - Use more restrictive conservation strategies in non-critically ill patients to ensure access to blood cultures for patients most likely to benefit from blood cultures such as those with severe sepsis/septic shock and endovascular infections. If above strategies are insufficient, consider reducing blood cultures in infections with intermediate risk of bacteremia where a culture can be obtained from another source (e.g., pyelonephritis)
    - If supply allows, continue to encourage 2 sets of blood cultures given the lower sensitivity of blood cultures when only one set is obtained

Blood cultures are **NOT recommended** in the following situations due to low yield:
Isolated fever (i.e., without other signs or symptoms of infection)
Isolated leukocytosis (i.e., without other signs or symptoms of infection)
Repeat blood cultures for ongoing fever and/or leukocytosis and negative blood cultures ≤72 hours without clinical change
Repeat blood cultures to document clearance of bacteremia caused by organisms other than *S. aureus*, *S. lugdunensis*, or Candida unless there is suspected or proven endovascular infection or suspected persistent bacteremia
Repeat blood cultures to rule out blood culture contamination in immunocompetent patients without prosthetic implants
Community acquired pneumonia not requiring ICU care
Cellulitis not requiring ICU care
Post-operative fever within 48 hours after surgery
Lower UTI (i.e., cystitis, prostatitis)
Surveillance blood cultures in patients without suspicion for bacteremia (e.g., prior to TPN initiation/central line placement/procedures, patients withdrawing from sedation weans, ECMO, CRRT)

- ✓ **Meet with the EHR IT group to discuss implementation of electronic decision support tools to optimize blood culture ordering, including:**
  - Make most recent blood culture results available upon clicking on new blood culture order so providers can see recent results
  - Include link to BCx algorithm or list low-yield indications to deter clinicians from ordering unnecessary blood cultures
  - Hard stop to repeat blood cultures for positive blood cultures due to organisms other than *S. aureus*, *S. lugdunensis*, Candida (in which BCx are always indicated) with need for review of the need for repeat BCx in other circumstances
  - Space out to 48hs repeat blood cultures to document clearance of S. aureus bacteremia and every 72 hs thereafter
  - Critically review order sets that have blood cultures on them
- ✓ **Review optimal blood culture collection techniques with groups that draw blood cultures to reduce risk of contamination and need for additional blood cultures to evaluate likely contamination**

TIPS FOR IMPLEMENTING THE BLOOD CULTURE ALGORITHM

- ✓ Review your data to assess drivers of unnecessary blood cultures
- ✓ Review the content of the algorithm with ordering providers, especially residents, hospitalists, and advanced practice practitioners
- ✓ Educate consultants who are more likely to recommend blood cultures such as Infectious Diseases and Nephrology
- ✓ Engage unit director and bedside nurses in applying the Blood Culture Algorithm
- ✓ Highlight common infections where blood cultures are low yield (e.g., non-severe CAP, uncomplicated cellulitis, lower UTIs, isolated fever +/- leukocytosis, post-operative fever first 48 hours)
- ✓ Highlight infections with low risk of bacteremia in which blood culture are low yield
- ✓ Highlight infections in which is important to get 2 sets of blood cultures (e.g., severe sepsis, endovascular infection)
- ✓ Monitor appropriateness of use and feedback data to units (could be a random sample of cases)

For further information about the content of this document	
Adult algorithm	Pediatric algorithm
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References

Adult Blood Culture Stewardship from JHH:

Fabre V, Sharara SL, Salinas AB, Carroll KC, Desai S, Cosgrove SE. Does This Patient Need Blood Cultures? A Scoping Review of Indications for Blood Cultures in Adult Nonneutropenic Inpatients. Clin Infect Dis. 2020, PMID: 31942949.

Fabre V, Klein E, Salinas AB, Jones G, Carroll KC, Milstone AM, Amoah J, Hsu YJ, Gadala A, Desai S, Goyal A, Furfaro D, Zimmerman J, Lin S, Cosgrove SE. A Diagnostic Stewardship Intervention To Improve Blood Culture Use among Adult Nonneutropenic Inpatients: the DISTRIBUTE Study. J Clin Microbiol. 2020 Sep 22;58(10):e01053-20. doi: 10.1128/JCM.01053-20. PMID: 32759354; PMCID: PMC7512168.

Fabre V, Carroll KC, Cosgrove SE. Blood Culture Utilization in the Hospital Setting: a Call for Diagnostic Stewardship. J Clin Microbiol. 2022 Mar 16;60(3):e0100521. doi: 10.1128/JCM.01005-21. Epub 2021 Jul 14. PMID: 34260274; PMCID: PMC8925908:

Adult Blood Culture Algorithm adopted by other institutions:

Seidelman JL, Moehring R, Gettler E, et al. Implementation of a diagnostic stewardship intervention to improve blood-culture utilization in 2 surgical ICUs: Time for a blood-culture change. *Infection Control & Hospital Epidemiology*. 2024;45(4):452-458. doi:10.1017/ice.2023.249

Wang MC, Zhou KJ, Shay SL, et al. The impact of a blood-culture diagnostic stewardship intervention on utilization rates and antimicrobial stewardship. *Infection Control & Hospital Epidemiology*. 2024;45(5):670-673. doi:10.1017/ice.2023.265

Pediatric Blood Culture Stewardship published from JHH:

Safety and Effectiveness of Multicenter Blood Culture Stewardship in PICU setting:

Woods-Hill CZ, Colantuoni EA, Koontz DW, Voskertchian A, Xie A, Thurm C, Miller MR, Fackler JC, Milstone AM; Bright STAR Authorship Group; Agulnik A, Albert JE, Auth MJ, Bradley E, Clayton JA, Coffin SE, Dallefeld S, Ezetendu CP, Fainberg NA, Flaherty BF, Foster CB, Hauger SB, Hong SJ, Hysmith ND, Kirby AL, Kociolek LK, Larsen GY, Lin JC, Linam WM, Newland JG, Nolt D, Priebe GP, Sandora TJ, Schwenk HT, Smith CM, Steffen KM, Tadphale SD, Toltzis P, Wolf J, Zerr DM. Association of Diagnostic Stewardship for Blood Cultures in Critically Ill Children With Culture Rates, Antibiotic Use, and Patient Outcomes: Results of the Bright STAR Collaborative. JAMA Pediatr. 2022 Jul 1;176(7):690-698. https://pubmed.ncbi.nlm.nih.gov/35499841/

Consensus Recommendations for Pediatric Blood Culture Stewardship:

Woods-Hill CZ, Koontz DW, Voskertchian A, Xie A, Shea J, Miller MR, Fackler JC, Milstone AM; BrighT STAR Consensus Authorship Group. Consensus Recommendations for Blood Culture Use in Critically Ill Children Using a Modified Delphi Approach. Pediatr Crit Care Med. 2021 Apr 23. https://pubmed.ncbi.nlm.nih.gov/33899804/

Charts developed by our team.

List of conditions in which blood cultures would be recommended based on their value (yield or potential impact on patient management).

Indications for INITIAL Blood Cultures (BCx) in Non-Neutropenic Adult Patients	
BCx Not Indicated	**BCx Indicated**

• Syndromes with low risk of bacteremia (<10%):
  ○ Non-severe cellulitis
  ○ Lower UTI (e.g., cystitis, prostatitis)
  ○ Non-severe CAP, HCAP
  ○ Diabetic foot infection
  ○ Colitis (including *C. difficile*)
  ○ Aspiration pneumonitis
  ○ Uncomplicated cholecystitis
  ○ Uncomplicated diverticulitis
  ○ Uncomplicated pancreatitis
• Blood cultures in patients without suspicion of bacteremia (e.g., patient with central line needing TPN, before central line placement)
• Fever or leukocytosis explained by a non-infectious cause (e.g., drug withdrawal)
• Isolated fever without chills
• Isolated post-operative fever within 48 hours
• Isolated leukocytosis
• Persistent fever or leukocytosis in patient with prior negative BCx in past 48-72 hours without new localizing signs of infection
  ○ Other cultures or imaging might be more appropriate than BCx
	• Syndromes with high risk of bacteremia (≥50%):
	  ○ Septic shock
	  ○ IE/endovascular infection (septic thrombophlebitis, infected endovascular thrombi, implantable cardioverter defibrillator (ICD)/pacemaker lead infections, intravascular catheter infections, and vascular graft infections.)
	  ○ Catheter-related bloodstream infection
	  ○ Discitis/native VO
	  ○ Epidural abscess
	  ○ Non-traumatic native septic arthritis
	  ○ Meningitis
	  ○ Venticuloatrial shunt infections
	• Syndromes with intermediate risk of bacteremia (>10% - <50%)
	  ○ Cholangitis
	  ○ Pyelonephritis
	  ○ Severe pneumonia
	  ○ Prosthetic vertebral OM
	  ○ Severe cellulitis
	• Systemic signs of infection AND asplenia

The algorithm is not a substitute for clinical judgment. **Peripheral BCx are preferred over central lines blood cultures due to lower false positive results.** **Always draw 2 peripheral sets (i.e., 4 bottles with 8-10cc/bottle).** **Developed by the Johns Hopkins Department of Antimicrobial Stewardship**	

Indications for FOLLOW-UP Blood Cultures (BCx) in Non-Neutropenic Adult Patients with Positive BCx	
BCx Not Indicated	**BCx Indicated**

• **When all have met:**
  ○ Clinical response after starting antibiotics
  ○ Source control achieved
  ○ Bacteremia not due to *S. aureus, S. lugdunensis*, and *Candida*
  ○ No concern for endovascular infection
  - Septic thrombophlebitis
  - Infected endovascular thrombi
  - Implantable cardioverter defibrillator (ICD)/pacemaker lead infections
  - Intravascular catheter infections
  - Vascular graft infections
 	
• Examples:
  ○ *Enterococcus* bacteremia from urinary or biliary source
  ○ *S. pneumoniae* bacteremia from pulmonary source
  ○ Gram-negative bacteremia from urinary/abdominal source
  ○ Cases likely to represent contamination (e.g., single BCX with coagulase-negative *staphylococci*)
 	
• ***Note:*** *Strep* other than *S. pneumoniae or* GAS remain major infective endocarditis pathogens. Must assess patient risk factors for endovascular infection and clinical presentation to determine significance of *streptococci* in blood.
	• All bacteremia cases due to:
	  ○ *S. aureus*
	  ○ *S. lugdunensis*
	  ○ *Candida spp.*
	
	• All cases with suspected endovascular infection
	  ○ Infective endocarditis
	  ○ Septic thrombophlebitis
	  ○ Implantable cardioverter defibrillator (ICD)/pacemaker lead infections
	  ○ LVAD line infections
	  ○ Vascular graft infections
	
	• All cases in patients at risk of endovascular infection
	  ○ ICD/pacemaker
	  ○ Vascular graft
	  ○ Prosthetic valves
	  ○ History of infective endocarditis
	  ○ Valvulopathy in heart transplant recipient
	
	• Catheter related bloodstream infection with catheter retention
	
	• Concern for persistent bacteremia (lack of source control, lack of clinical improvement, ineffective therapy)
	
	• Single positive BCx with skin flora organisms in patients with prosthesis (orthopedic or intravascular prosthesis)

The algorithm is not a substitute for clinical judgment. **Peripheral BCx are preferred over central lines blood cultures due to lower false positive results.** **Always draw 2 peripheral sets (i.e., 4 bottles with 8-10cc/bottle).** **Developed by the Johns Hopkins Department of Antimicrobial Stewardship**	

Published:
In *Fabre V, Carroll KC, Cosgrove SE. Blood Culture Utilization in the Hospital Setting: a Call for Diagnostic Stewardship. J Clin Microbiol. 2022 Mar 16;60(3):e0100521. doi: 10.1128/JCM.01005-21. Epub 2021 Jul 14. PMID: 34260274; PMCID: PMC8925908*:

TABLE 1 Examples of common scenarios when initial blood cultures have high and low diagnostic utility for immunocompetent hosts[a] (Table view)

Diagnostic value of initial blood cultures	Exception
High diagnostic value	
Severe sepsis/septic shock	NA
Infections associated with high or intermediate risk of bacteremia	NA
Low diagnostic value	
Fever ± leukocytosis in stable patients without suspicion for endovascular infection	Patients with splenectomy
Postoperative fever within 48 h	Presence of severe sepsis/ septic shock
Infections with low risk of bacteremia (e.g., cystitis, prostatitis, cellulitis, non-severe pneumonia, prosthetic joint infection)	Endovascular infection suspected Presence of severe sepsis/ septic shock
Persistent febrile neutropenia in hemodynamically stable patients with 2 negative sets	NA

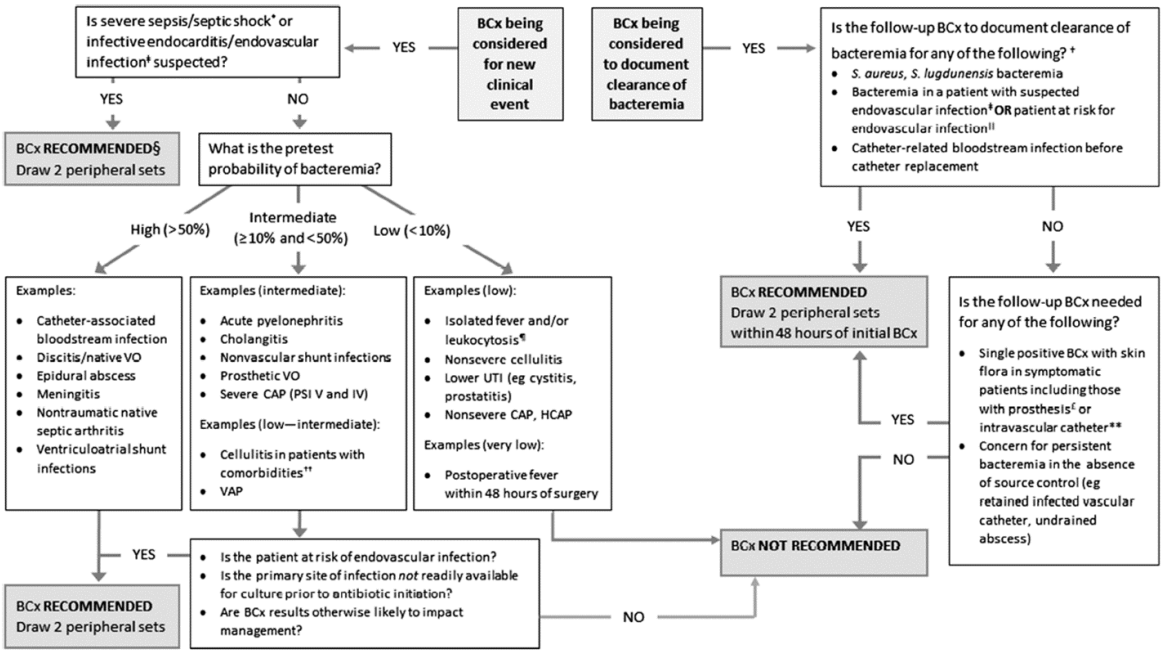
TABLE 2 Examples of common scenarios when repeat blood cultures have high and low diagnostic utility[a] (Table view)

Diagnostic value of repeat blood cultures	Exception
High diagnostic value	
To document clearance of *S. aureus* bacteremia	NA
To document clearance of *S. lugdunensis* bacteremia	NA
Any organism suspected to be causing infective endocarditis/endovascular infection	NA
Concern for persistent bacteremia	NA
To distinguish contamination from true bacteremia	NA
Low diagnostic value	
S. pneumoniae or β-hemolytic streptococcus bacteremia from pulmonary source	Infective endocarditis/endovascular infection suspected
Gram-negative organisms from urinary/abdominal source	Infective endocarditis/endovascular infection suspected
Enterococcus bacteremia from urinary or biliary source	Inadequate clinical response
Cases likely to represent contamination[b]	Absence of source control

[a] See references 8 and 50 for more details. NA, not applicable.

[b] For example, single blood culture with diphtheroids, *Cutibacterium* spp., coagulase-negative staphylococci (CoNS), and micrococci in immunocompetent hosts and those without prosthetic material. Careful interpretation of clinical context is needed (e.g., a single positive blood culture for CoNS in a patient with a prosthetic hip without any clinical changes may not need repeating blood cultures).

In *Fabre V, Sharara SL, Salinas AB, Carroll KC, Desai S, Cosgrove SE. Does This Patient Need Blood Cultures? A Scoping Review of Indications for Blood Cultures in Adult Nonneutropenic Inpatients. Clin Infect Dis. 2020 Aug 22;71(5):1339-1347. doi: 10.1093/cid/ciaa039. PMID: 31942949*:



Algorithm for bacterial blood cultures recommendations in nonneutropenic patients. The algorithm is not a substitute for clinical judgment.

* Blood culture (BCx) required by US Centers for Medicare and Medicaid Services severe sepsis criteria of the Severe Sepsis and Septic Shock Early Management Bundle.

† BCx positive for *Candida* species require routine follow-up blood culture (FUBCx).

‡ Septic thrombophlebitis, infected endovascular thrombi, implantable cardioverter defibrillator (ICD)/pacemaker lead infections, intravascular catheter infections, and vascular graft infections.

§ Consider > 2 sets for suspected endocarditis.

|| Patients at risk of endovascular infection: ICD/pacemaker, vascular graft, prosthetic valves and prosthetic material used for cardiac valve repair, history of infective endocarditis, valvulopathy in heart transplant recipient, unrepaired congenital heart disease, repaired congenital heart disease with residual shunt or valvular regurgitation, or within the first 6 months post repair.

¶ Before ordering BCx, assess the patient's clinical history and perform a physical examination to identify infectious and noninfectious sources for the isolated fever episode and review the potential benefit added by BCx.

£ Prosthesis: joint or intravascular prosthesis.

****** Routine additional FUBCx for a single BCx with skin flora (e.g., coagulase-negative staphylococci) in an immunocompetent patient are not necessary unless bacteremia is suspected or a prosthesis is present.

†† Cellulitis in patients with comorbidities: immunocompromised hosts or those at risk of poor outcomes from sequelae from missed *Staphylococcus aureus* bacteremia.

Abbreviations: BCx, blood culture; CAP, community-acquired pneumonia; HCAP, healthcare-associated pneumonia; PSI, Pneumonia Severity Index; *S. aureus*, *Staphylococcus aureus*; *S. lugdunensis*, *Staphylococcus lugdunensis*; UTI, urinary tract infection; VAP, ventilator-associated pneumonia; VO, vertebral osteomyelitis.