

# Bacteremia in the Hospitalized Setting

Bacteremia, the presence of bacteria in the bloodstream, is a common and potentially life-threatening condition in hospitalized patients. This pamphlet provides physician assistant (PA) students with a detailed guide to evaluate, diagnose, and treat bacteremia, including when to suspect endocarditis, with case scenarios to apply the knowledge.

## Overview and Types

- **Definition:** Bacteremia is the presence of viable bacteria in the blood, confirmed by positive blood cultures. It can lead to systemic infection (sepsis) or metastatic infections (e.g., endocarditis, osteomyelitis).
- **Types of Bacteremia:**
  - **Primary Bacteremia:**
    - **Definition:** Bacteria enter the bloodstream directly, often via an indwelling device or procedure.
    - **Sources:** Central venous catheters (CVC), hemodialysis catheters, IV drug use, or skin breaches.
    - **Common Pathogens:** Staphylococcus aureus, coagulase-negative staphylococci (CoNS, e.g., *S. epidermidis*), gram-negatives (e.g., *Pseudomonas aeruginosa*).
  - **Secondary Bacteremia:**
    - **Definition:** Bacteria spread to the bloodstream from a focal infection site.
    - **Sources:** Pneumonia, urinary tract infection (UTI), intra-abdominal infection (e.g., abscess, perforated bowel), skin/soft tissue infection (SSTI).
    - **Common Pathogens:** Streptococcus pneumoniae (pneumonia), Escherichia coli (UTI), Bacteroides fragilis (abdominal), *S. aureus* (SSTI).
  - **Transient Bacteremia:**
    - **Definition:** Brief, self-limiting bacterial presence in the blood, often after procedures.
    - **Sources:** Dental procedures (e.g., extraction), GI/GU procedures, brushing teeth.
    - **Common Pathogens:** Viridans group streptococci, Enterococcus, anaerobes.

- **Polymicrobial Bacteremia:**
  - **Definition:** Multiple organisms in the blood, often from a complex source.
  - **Sources:** Intra-abdominal infections (e.g., perforated viscus), necrotizing SSTI, contaminated catheters.
  - **Common Pathogens:** E. coli + Bacteroides (abdominal), S. aureus + gram-negatives (catheter).
- **Key Tips:**
- **Primary bacteremia:** Suspect in patients with indwelling devices (e.g., CVC).
- **Secondary bacteremia:** Identify the source (e.g., pneumonia, UTI) for targeted therapy.

## Causes

- **Device-Related:**
  - **Central Venous Catheters (CVC):** S. aureus, CoNS, gram-negatives (Pseudomonas, Klebsiella).
  - **Hemodialysis Catheters:** S. aureus (MRSA), CoNS, Enterococcus.
  - **Pacemakers/ICD:** CoNS, S. aureus, often with endovascular infection.
- **Infections:**
  - **Pneumonia:** S. pneumoniae, S. aureus, Klebsiella pneumoniae (necrotizing, alcoholics).
  - **UTI:** E. coli, Enterococcus, Proteus mirabilis (often in catheterized patients).
  - **Intra-Abdominal:** E. coli, Bacteroides, Enterococcus (e.g., diverticulitis, appendicitis).
  - **SSTI:** S. aureus, Streptococcus pyogenes (group A strep), polymicrobial in necrotizing fasciitis.
  - **Osteomyelitis:** S. aureus, gram-negatives (e.g., post-surgical, diabetic foot).
  - **Endocarditis:**
    - **Native Valve:** S. aureus, viridans streptococci, Enterococcus.
    - **Prosthetic Valve:** CoNS (early), S. aureus (late).
    - **IV Drug Users:** S. aureus (right-sided, tricuspid valve).
- **Immunocompromised:**
  - **Neutropenia:** Gram-negatives (Pseudomonas, E. coli), S. aureus, CoNS.
  - **HIV:** Salmonella (non-typhoidal), S. pneumoniae, Mycobacterium avium complex (MAC).
  - **Transplant:** Gram-negatives, Listeria monocytogenes, anaerobes.
- **Other Causes:**
  - **IV Drug Use:** S. aureus, Pseudomonas (contaminated needles).
  - **Surgical Site Infections:** S. aureus, gram-negatives (post-op wound infections).

- **Contaminated Infusions:** Enterobacter, Serratia (nosocomial outbreaks).
- **Spontaneous Bacterial Peritonitis (SBP):** E. coli, Klebsiella (cirrhosis, ascites).

## Evaluation and Further Workup

- **Clinical Presentation:**
- **Symptoms:** Fever ( $T \geq 38^{\circ}\text{C}$ ), chills, fatigue, tachycardia, hypotension (sepsis), or focal symptoms (e.g., dysuria in UTI, cough in pneumonia).
- **Exam:** Source identification—lung crackles (pneumonia), costovertebral tenderness (pyelonephritis), skin erythema (SSTI), new murmur (endocarditis).
- **Initial Labs:**
  - **Blood Cultures:**  $\geq 2$  sets (aerobic/anaerobic) before antibiotics, from separate sites, 30 min apart.
  - **CBC:** Leukocytosis/leukopenia, anemia, thrombocytopenia (sepsis, DIC).
  - **Inflammatory Markers:** CRP, procalcitonin (elevated in bacterial infection, guides duration).
  - **Lactate:**  $>2$  mmol/L indicates sepsis;  $>4$  mmol/L suggests septic shock.
  - **Renal/Hepatic Function:** Creatinine, LFTs (organ dysfunction, antibiotic dosing).
- **Further Workup:**
  - **Source Identification:**
    - **Urine Culture/Urinalysis:** Dysuria, pyuria (UTI).
    - **Chest X-ray/CT:** Pneumonia, empyema.
    - **Abdominal Imaging:** CT abdomen/pelvis for abscess, perforation.
    - **Skin/Soft Tissue:** Ultrasound for abscess; MRI for necrotizing fasciitis.
    - **Endocarditis Workup (if suspected):**
      - **Transthoracic Echocardiogram (TTE):** First-line for vegetations.
      - **Transesophageal Echocardiogram (TEE):** If TTE negative, prosthetic valve, or high suspicion.
      - **Blood Cultures:**  $\geq 3$  sets; persistent bacteremia (e.g., S. aureus,  $>72\text{h}$ ) raises concern.
  - **Other Tests:**
    - **HIV Test:** If risk factors (e.g., Salmonella bacteremia).
    - **Bone Scan/MRI:** Osteomyelitis (persistent S. aureus bacteremia).
  - **CT/MRI:** Embolic phenomena (e.g., stroke, splenic abscess).
- **When to Suspect Endocarditis:**
  - Persistent bacteremia ( $>72\text{h}$  despite antibiotics), especially S. aureus, viridans streptococci, or Enterococcus.

- New murmur, embolic phenomena (e.g., Janeway lesions, Roth spots, stroke).
- IV drug use (right-sided, tricuspid valve involvement).
- Prosthetic valve or structural heart disease (e.g., bicuspid aortic valve).
- Fever + risk factors (e.g., recent dental procedure, catheter-related bacteremia).

## Bacteremia Types and Causes Table

Type	Common Sources	Pathogens	Notes
Primary Bacteremia	CVC, IV drug use, hemodialysis catheters	S.aureus, CoNS, Pseudomonas	Remove catheter if source; high endocarditis risk with S. aureus.
Secondary Bacteremia	Pneumonia, UTI, intra-abdominal	S.pneumoniae, E. coli, Bacteroides	Identify source (e.g., CT abdomen for abscess).
Polymicrobial	Intra-abdominal, necrotizing SSTI	E.coli + Bacteroides, S.aureus	Broad-spectrum antibiotics; surgical source control.
Transient	Dental/GI procedures	Viridans streptococci, Enterococcus	Often self-limiting; suspect endocarditis if persistent.

## Treatment and Treatment Durations

- **General Principles:**
  - Start empiric antibiotics within 1 hour of suspected bacteremia (improves outcomes in sepsis).
  - Tailor therapy based on culture/susceptibility results.
- **Source control:** Remove catheters, drain abscesses, debride infected tissue.
- **Empiric Therapy:**
- **Community-Acquired:**
  - Vancomycin 15 mg/kg IV q12h (covers MRSA, streptococci) + ceftriaxone 2 g IV q24h (covers gram-negatives, S. pneumoniae).
- **Nosocomial (Hospital-Acquired):**
  - Vancomycin 15 mg/kg IV q12h OR linezolid 600mg IV q12h + piperacillin-tazobactam 4.5 g IV q6h OR meropenem 1 g IV q8h (broad-spectrum, covers Pseudomonas).
- **Immunocompromised:**
  - Meropenem 1 g IV q8h OR cefepime 2 g IV q8h + vancomycin 15 mg/kg IV q12h (if MRSA risk).
- **Directed Therapy (Based on Culture/Susceptibility):**
  - **S. aureus (MSSA):** Nafcillin 2 g IV q4h OR cefazolin 2 g IV q8h.
  - **S. aureus (MRSA):** Vancomycin 15 mg/kg IV q12h (trough 15-20 µg/mL) OR linezolid 600mg IV q12h

- **S. pneumoniae:** Penicillin G 4 million units IV q4h OR ceftriaxone 2 g IV q24h.
- **E. coli (ESBL-negative):** Ceftriaxone 2 g IV q24h OR ertapenem 1 g IV q24h.
- **Pseudomonas aeruginosa:** Piperacillin-tazobactam 4.5 g IV q6h OR cefepime 2 g IV q8h + aminoglycoside (e.g., tobramycin 5 mg/kg IV q24h) if severe.
- **Enterococcus (ampicillin-susceptible):** Ampicillin 2 g IV q4h + gentamicin 1 mg/kg IV q8h.
- **Anaerobes (e.g., Bacteroides):** Metronidazole 500 mg IV q8h OR piperacillin-tazobactam 4.5 g IV q6h.
- **Treatment Durations:**
  - **Uncomplicated Bacteremia:** 7-14 days (e.g., S. pneumoniae from pneumonia, E. coli from UTI).
  - **Complicated Bacteremia:**
  - **Catheter-Related:** 14 days after catheter removal (S. aureus, gram-negatives).
  - **Persistent Bacteremia (>72h):** 4-6 weeks (e.g., S. aureus, suspect endocarditis).
  - **Endocarditis:** 4-6 weeks (e.g., S. aureus, viridans streptococci).
  - **Osteomyelitis:** 6-8 weeks (e.g., S. aureus, gram-negatives).
  - **Polymicrobial:** 14-21 days, depending on source control (e.g., intra-abdominal abscess).
- **Source Control:**
  - Remove catheters (CVC, dialysis) if source of bacteremia (e.g., S. aureus, CoNS).
  - **Surgical drainage:** Abscess (e.g., intra-abdominal), necrotizing fasciitis.
  - **Debridement:** Infected tissue (e.g., diabetic foot, osteomyelitis).
- **Supportive Care:**
  - **Sepsis:** Fluids (NS 30 mL/kg IV within 3h), vasopressors (norepinephrine 5-20 mcg/min IV) if hypotensive.
  - **Monitor:** Daily CBC, blood cultures (until negative), renal/hepatic function (antibiotic toxicity).

## Treatment Guidelines Table

Pathogen	Treatment Agent/ Dose	Duration	
S.aureus (MRSA)	Vancomycin OR daptomycin OR linezolid	Vancomycin 15 mg/kg IV q12h linezolid 600mg IV q12h	14 days (uncomplicated); 4-6 weeks (endocarditis)
E. coli (ESBL-neg)	Ceftriaxone OR ertapenem	Ceftriaxone 2 g IV q24h	7-14 days (UTI); 14-21 days (complicated)

Pathogen	Treatment Agent/ Dose	Duration	
Pseudomonas	Piperacillin-tazobactam + tobramycin	Piperacillin-tazobactam 4.5 g IV q6h	14-21 days; add aminoglycoside if severe
Polymicrobial	Broad-spectrum + source control	Meropenem 1 g IV q8h	14-21 days; surgical drainage if abscess

## Complications

- **Acute:**
  - **Sepsis/Septic Shock:** 20-30% mortality; multi-organ failure (AKI, ARDS, DIC).
  - **Endocarditis:** Persistent bacteremia (*S. aureus*, >72h), new murmur, embolic phenomena.
  - **Metastatic Infection:** Osteomyelitis (*S. aureus*), septic arthritis, abscess (e.g., spleen, epidural).
- **Chronic:**
  - **Recurrent Bacteremia:** Unresolved source (e.g., retained catheter, undrained abscess).
  - **Antibiotic Resistance:** MRSA, ESBL-producing gram-negatives, VRE (prolonged therapy).
- **Other:**
  - **Antibiotic Toxicity:** AKI (vancomycin, aminoglycosides), ototoxicity (gentamicin), *C. difficile* infection (broad-spectrum antibiotics).

## When to Consult Infectious Disease (ID)

- Persistent bacteremia (>72h despite antibiotics), especially *S. aureus*, Enterococcus.
- Polymicrobial bacteremia (complex source, e.g., intra-abdominal).
- Suspected endocarditis (new murmur, embolic phenomena, IV drug use).
- Immunocompromised patients (e.g., neutropenia, HIV, transplant).
- Antibiotic resistance (e.g., MRSA, VRE, ESBL gram-negatives).
- Culture-negative bacteremia (e.g., prior antibiotics, fastidious organisms).
- Need for prolonged therapy (e.g., osteomyelitis, endocarditis)

## Key Pearls

- **Types:** Primary (catheter-related), secondary (e.g., pneumonia, UTI), transient (post-procedure), polymicrobial (complex source).

- **Blood Cultures:**  $\geq 2$  sets before antibiotics; persistent bacteremia ( $>72\text{h}$ )  $\rightarrow$  Suspect endocarditis, metastatic infection.
- **Endocarditis Risk:** *S. aureus*, viridans streptococci, IV drug use, new murmur—order TTE/TEE.
- **Empiric Therapy:** Vancomycin + ceftriaxone (community-acquired); piperacillin-tazobactam + vancomycin (nosocomial).
- **Source Control:** Remove catheters, drain abscesses, debride tissue—essential for resolution.
- **Duration:** 7-14 days (uncomplicated); 4-6 weeks (endocarditis, osteomyelitis); 14-21 days (polymicrobial).
- **Monitor:** Blood cultures until negative, renal function (antibiotic toxicity), lactate (sepsis).

## References

- **UpToDate:** “Bacteremia: Diagnosis and Management” (2025).
- **IDSA:** “Guidelines for the Management of Bacteremia” (2024).
- **NEJM:** “Staphylococcus aureus Bacteremia: Clinical Outcomes” (2023).
- **Clin Infect Dis:** “Polymicrobial Bacteremia: Management Strategies” (2024).

## Case Scenarios

### Case 1: A 70-Year-Old Male with Fever and Chills

- **Presentation:** A 70-year-old male with a history of diabetes and an indwelling urinary catheter presents with fever ( $38.8^{\circ}\text{C}$ ), chills, and dysuria for 2 days. Exam shows costovertebral angle tenderness, no murmur.
- **Labs/Imaging:** WBC  $14,000/\mu\text{L}$ , 2/2 blood cultures positive for *E. coli* (ESBL-negative). Urinalysis: Pyuria, positive culture (*E. coli*). Creatinine  $1.5\text{ mg/dL}$  (baseline  $1.0$ ).
- **Diagnosis:** Secondary Bacteremia  $\rightarrow$  Source: UTI (pyelonephritis), *E. coli*.
- **Management:** Start ceftriaxone  $2\text{ g IV q24h} \times 14\text{ days}$ . Remove urinary catheter (source control). Monitor blood cultures until negative (day 3). Creatinine improves to  $1.1\text{ mg/dL}$ . No endocarditis workup (no murmur, transient bacteremia resolved). Discharge on oral antibiotics (e.g., cefpodoxime  $400\text{ mg PO BID}$ ) to complete 14 days.

## Case 2: A 40-Year-Old Female with IV Drug Use

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- **Presentation:** A 40-year-old female with IV drug use presents with fever (39°C), dyspnea, and chest pain for 5 days. Exam shows a tricuspid regurgitation murmur, needle tracks, and right lung crackles.
- **Labs/Imaging:** WBC 16,000/ $\mu$ L, 3/3 blood cultures positive for *S. aureus* (MRSA). TTE: 15 mm vegetation on tricuspid valve. Chest X-ray: Pulmonary nodules (septic emboli).
- **Diagnosis:** Primary Bacteremia  $\rightarrow$  *S. aureus* from IV drug use, complicated by endocarditis (tricuspid valve).
- **Management:** ID and cardiology consult. Start vancomycin 15 mg/kg IV q12h (trough 15-20  $\mu$ g/mL) OR linezolid 600mg IV q12h x 6 weeks. Monitor blood cultures (clear by day 4). CT chest confirms pulmonary emboli—no anticoagulation (septic emboli). Surgical evaluation for vegetation size (>10 mm)—patient declines surgery. Monitor for heart failure. Complete therapy via PICC line.

## Case 3: A 55-Year-Old Male Post-Surgery

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- **Presentation:** A 55-year-old male, 7 days post-colectomy for diverticulitis, develops fever (38.5°C) and abdominal pain. Exam shows a tender abdomen, no murmur. He has a CVC in place.
- **Labs/Imaging:** WBC 12,000/ $\mu$ L, 2/2 blood cultures positive for *E. coli* and *Bacteroides fragilis*. CT abdomen: Intra-abdominal abscess. Lactate 2.5 mmol/L.
- **Diagnosis:** Polymicrobial Bacteremia  $\rightarrow$  Source: Intra-abdominal abscess (post-surgical complication).
- **Management:** ID consult. Start meropenem 1 g IV q8h x 21 days. Remove CVC (possible source). Surgical drainage of abscess (source control). Blood cultures clear by day 5. Procalcitonin trends down (guides duration). No endocarditis workup (no murmur, resolved with source control). Transition to oral antibiotics (e.g., amoxicillin-clavulanate 875/125 mg PO BID + metronidazole 500 mg PO TID) to complete 21 days.

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