



# BLOODSTREAM INFECTIONS (BSI)

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EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND PREVENTION

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## Disclosures

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***No Conflicts of Interest Relevant to Bloodstream Infections***

UptoDate Royalties (Pelvic Osteomyelitis)

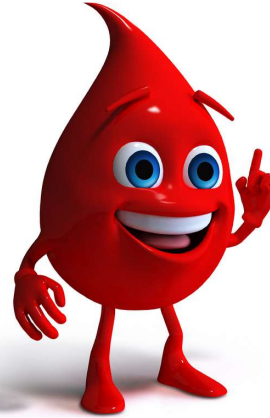
Consultant: DLA Piper, Osteal Therapeutics, Nichol & Associates, Bendin, Sumrall, & Ladner LLC, Ambrecht Jackson LLP, Richardson Plowden

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# Objectives

- Understand the impact of bloodstream infections
- Understand the incidence and causative pathogens of bloodstream infections
- Understand the risk factors for healthcare-associated bloodstream infections
- Understand how we define bloodstream infection, both clinically and epidemiologically
- Understand the prevention and control of bloodstream infections



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## BSI Epidemiology

1. The Factors Associated With the Trend in Incidence of Bacteremia and Associated Mortality Over 30 years. BMC Infectious Diseases. 2023. Garcia-Rodriguez JF, Manfio-Calleo A.

2. Incidence, Aetiology and Temporal Trend of Bloodstream Infections in Southern Sweden from 2008 to 2019: A Population-Based Study. Euro Surveillance. Bulletin European Soc. Les Maladies Transmissibles + European Communicable Disease Bulletin. 2023. Ljungquist O, Blomstergren A, Merkel A, et al.

3. Trends in the Prevalence of Bloodstream Infections in Spanish Hospitals (2013-2023). Antimicrobial Resistance and Infection Control. 2026. Parra LM, Escarotio R, Carrero M, et al. [View here](#)



### Incidence trends show increasing rates globally:

- Spanish Cohort: **43.8 to 205** per 100,000 population per year (1991-2020).
- Swedish population-based study: overall incidence of **307 per 100,000 person-years with an average annual increase of 3.0%**,
- Spanish Cohort: increased from 18.0% to 24.3%, **□ 3.5% yearly increase in infection odds (2013-2023)**

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## CLABSI Epidemiology

10% decrease in U.S. from 2023-2024

BUT...

Estimated 18,100 CLABSIs per year still occur!

Non-ICU inpatient CLABSIs > ICU CLABSIs.

**CLABSI incidence rates: 4.8 per 1,000 catheter-days** (95% CrI, 3.4-6.6) across 48 studies examining 549,246.8 catheter-days.

CDC National and State Healthcare-Associated Infections Progress Report, published April 2024, available at <https://www.cdc.gov/healthcare-associated-infections/php/data/progressreport.html>  
Prevention of Central Line-Associated Bloodstream Infections. The New England Journal of Medicine. 2023. O'Grady NP, Teja B, Bosch NA, Diep C, et al. Complication Rates of Central Venous Catheters: A Systematic Review and Meta-Analysis. JAMA Intern Med. 2024;184(5):474-482. doi:10.1001/jamainternmed.2023.8232

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## COVID-19's Impact

CLABSI incidence increased, particularly coagulase-negative staphylococci

Stabilized ~2021

Potential etiologies

- Many placed emergently


- Multiple central lines present

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# BSI: Impact on Healthcare

Magill SS, et al. *New Engl J Med* 2014;370:1198; Marschall J, et al. *ICHE* 2014;35:753-771

iData Research. Central Venous Catheter Market Size, Share & Trends Analysis, Global, 2020-2026. 2020. Accessed October 26, 2023. <https://idataresearch.com/product/vascular-access-devices-market/>



Approximately 72,000 primary bloodstream infections per year

- Accounts for ~10% of healthcare-associated infections (rank = 5)

Rate of BSIs varies by:

- Hospital size, unit, and service
- Population served (elderly/infants, acute/chronic)
- Use and type of intravascular access device
- Time-trends
- Endemic/Epidemic



Major risk = central venous catheter (CVC)


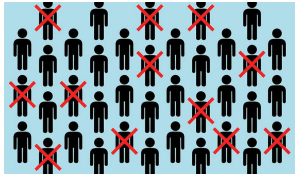
- 27 million CVCs are inserted annually worldwide
- From 2008-2013, an estimated 30,100 central line-associated bloodstream infections (CLABSI) still occur in intensive care units and wards of U.S. acute care facilities each year.

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# CLABSI: Impact on Healthcare

Alshahrani et al. Clinical Impacts and Risk Factors for Central Line-Associated Bloodstream Infection: A Systematic Review. *Cureus*. 2023 Jun 25;15(6):e40954. Yousif A, Jamal MA, Raad I. Biofilm-based central line-associated bloodstream infections. *Adv Exp Med Biol*. 2015;830:157-79. doi: 10.1007/978-3-319-11038-7\_10. PMID: 25366227.



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**Table 2. Distribution of 504 Health Care–Associated Infections.\***

Type of Infection	Rank	No. of Infections	Percentage of All Health Care–Associated Infections (95% CI)
Pneumonia†	1 (tie)	110	21.8 (18.4–25.6)
Surgical-site infection	1 (tie)	110	21.8 (18.4–25.6)
Gastrointestinal infection	3	86	17.1 (14.0–20.5)
Urinary tract infection‡	4	65	12.9 (10.2–16.0)
<b>Primary bloodstream infection§</b>	<b>5</b>	<b>50</b>	<b>9.9 (7.5–12.8)</b>
Eye, ear, nose, throat, or mouth infection	6	28	5.6 (3.8–7.8)
Lower respiratory tract infection	7	20	4.0 (2.5–6.0)
Skin and soft-tissue infection	8	16	3.2 (1.9–5.0)
Cardiovascular system infection	9	6	1.2 (0.5–2.5)
Bone and joint infection	10	5	1.0 (0.4–2.2)
Central nervous system infection	11	4	0.8 (0.3–1.9)
Reproductive tract infection	12	3	0.6 (0.2–1.6)
Systemic infection	13	1	0.2 (0.01–1.0)

50 Primary BSI  
42 (82%) CLABSI  
37 Secondary BSI

Magill SS, et al. New Engl J Med 2014;370:1198

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## Central Lines: Utilization

Characteristic	All Patients (N=11,282)	Patients without Health Care–Associated Infections (N=10,830)	Patients with Health Care–Associated Infections (N=452)	P Value†
Central catheter in place on survey date — no. (%)				
Any	2,121 (18.8)	<b>1,862 (17.2)</b>	<b>259 (57.3)</b>	<b>&lt;0.001</b>
Femoral	54 (0.5)	44 (0.4)	10 (2.2)	
Peripherally inserted	1,037 (9.2)	878 (8.1)	159 (35.2)	
Other known type	1,057 (9.4)	958 (8.8)	99 (21.9)	
Unknown type	32 (0.3)	29 (0.3)	3 (0.7)	
None	9,140 (81.0)	8,948 (82.6)	192 (42.5)	
Missing data	21 (0.2)	20 (0.2)	1 (0.2)	

Magill SS, et al. New Engl J Med 2014;370:1198

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# Central Line Utilization by Unit

High: ICUs (Medical and Surgical)

Low: Psych, L&D/Postpartum, Ortho

Central line utilization ratio <sup>a</sup>				Percentile					
Type of acute care hospital location	No. of locations <sup>b</sup>	Central line days	Patient days	Pooled mean	10%	25%	50% (median)	75%	90%
Medical/surgical: major teaching	358 (356)	800,019	1,482,658	0.54	0.28	0.39	0.53	0.65	0.71
Medical/surgical: all other, ≤15 beds	1,647 (1,627)	1,260,781	3,453,458	0.37	0.11	0.19	0.34	0.50	0.62
Medical/surgical: all other, >15 beds	807	2,132,226	4,391,341	0.49	0.30	0.40	0.51	0.60	0.69
Neurologic	59 (58)	80,894	171,989	0.47	0.22	0.32	0.46	0.55	0.67
Neurosurgical	181	317,745	731,728	0.43	0.24	0.34	0.43	0.54	0.60
Pediatric cardiothoracic	43	146,328	202,899	0.72	0.49	0.59	0.75	0.86	0.91
Pediatric medical	31 (29)	23,719	63,391	0.37	0.10	0.14	0.25	0.34	0.47
Pediatric medical/surgical	315 (307)	389,069	866,418	0.45	0.14	0.22	0.35	0.50	0.62
Pediatric surgical	6	3,105	9,609	0.32					
Prenatal	8	710	9,153	0.08					
Respiratory	6	9,842	26,288	0.37					
Surgical: major teaching	197	470,884	819,943	0.57	0.38	0.46	0.57	0.67	0.75
Surgical: all other	190 (188)	345,261	614,414	0.56	0.37	0.45	0.56	0.67	0.75
Surgical cardiothoracic	455 (454)	955,534	1,414,414	0.68	0.48	0.57	0.68	0.78	0.85
Trauma	147	329,688	570,866	0.58	0.39	0.48	0.59	0.69	0.77
Step-down units									
Adult step-down (postcritical care)	700 (699)	818,478	3,533,742	0.23	0.06	0.07	0.07	0.09	0.11
Step-down NICU (level II)	47 (44)	4,886	57,086	0.31					
Pediatric step-down (postcritical care)	17	17,416							
Mixed acuity units <sup>c</sup>									
Adult mixed acuity	83 (82)	83,286	336,340	0.25	0.04	0.10	0.19	0.35	0.49
Mixed age mixed acuity	49	28,758	204,837	0.14	0.03	0.06	0.10	0.20	0.32
Pediatric mixed acuity	16	29,140	125,440	0.23					
Inpatient wards	---	---	---	---	---	---	---	---	---

$$\text{Device utilization ratio} = \frac{\text{No. of device days}}{\text{No. of patient days}}$$



Dudeck et al. AJIC 2015; 43: 206-221

# Central Line Associated BSI (CLABSI) Rate by Unit

High: Burn, ICUs (Medical and Surgical), Trauma, Vent Unit

Low: Ortho, GYN, Psych

Table 3 Pooled means and key percentiles of the distribution of laboratory-confirmed central line-associated BSI rates and central line utilization ratios, by type of location, acute care hospitals, DA Module, 2013

Central line-associated BSI rate <sup>a</sup>				Percentile					
Type of acute care hospital location	No. of locations <sup>b</sup>	No. of CLABSI	Central line days	Pooled mean	10%	25%	50% (median)	75%	90%
Critical care									
Burn	71 (69)	219	74,949	2.9	0.0	0.0	2.2	4.4	7.3
Medical: major teaching	251 (250)	812	669,976	1.2	0.0	0.4	1.0	1.8	2.8
Medical: all other	452 (432)	660	611,514	1.1	0.0	0.0	0.5	1.4	2.5
Medical cardiac	387 (381)	565	557,944	1.0	0.0	0.0	0.8	1.6	2.6
Medical/surgical: major teaching	358 (354)	908	800,019	1.1	0.0	0.0	0.9	1.6	2.4
Medical/surgical: all other, ≤15 beds	1,647 (1,510)	1,032	1,260,781	0.8	0.0	0.0	0.0	1.0	2.4
Medical/surgical: all other, >15 beds	807 (804)	1,752	2,132,226	0.8	0.0	0.0	0.6	1.2	2.0
Neurologic	59 (58)	91	80,894	1.1	0.0	0.0	0.9	1.6	2.8
Neurosurgical	181 (178)	300	317,745	0.9	0.0	0.0	0.7	1.4	2.2
Pediatric cardiothoracic	43	146,328	202,899	1.3	0.0	0.0	1.2	2.4	3.2
Pediatric medical	31 (29)	23,719	63,391	0.37					
Pediatric medical/surgical	315 (307)	389,069	866,418	0.45					
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Surgical cardiothoracic	455 (454)	777	955,534	0.8	0.0	0.0	0.5	1.2	2.1
Trauma	147	470	329,688	1.4	0.0	0.5	1.2	2.1	3.4

$$\text{Device-associated infection rate} = \frac{\text{No. of device-associated infections for an infection site}}{\text{No. of device days}} \times 1,000$$



Dudeck et al. AJIC 2015; 43: 206-221

## Definitions: IMPORTANT!

CLINICAL  
DEFINITION

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SURVEILLANCE  
DEFINITION

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## Definitions: IMPORTANT!

Category	Clinical Definition	Surveillance Definition (NHSN/CDC)
Primary BSI	No identifiable source	Lab-confirmed bloodstream infection (LCBI)
Secondary BSI	Linked to another infection (UTI, pneumonia, etc.)	Requires site-specific infection definition met
Contaminant	Single positive culture without clinical symptoms	Excluded if not meeting LCBI criteria

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CLINICAL DEFINITION

# What is BSI?





Bloodstream infection or Bacteremia:

Positive blood culture(s) +/- systemic signs of infection

Other terms:

- Septicemia: positive blood cultures + systemic signs of infection
- Sepsis and Septic Shock
- Pseudobacteremia or “contaminated” blood cultures: positive blood cultures resulting from contamination during the collection procedure or during laboratory processing





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CLINICAL DEFINITION

# What is BSI?





*Primary BSI:* NO identifiable originating source on clinical exam and/or diagnostic testing

*Secondary BSI:* Identifiable, localized infection at a specific site on clinical exam and/or diagnostic testing

Ex: Group B Streptococcus BSI

GBS BSI Source in Non-pregnant adults	%
Unknown (Primary)	30-40%
Skin and Soft Tissue	15-40%
Urinary Tract	5-15%
Upper Respiratory Tract	6-12%
Bone and Joint	2-15%
Cardiac/Endocarditis	2-9%
Central Nervous System	<4%

Source: UpToDate.

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## How do pathogens enter the bloodstream?

Many potential points/mechanisms of entry.

Disruption of skin or mucosal barriers:

- Localized infection advances to become systemic (Secondary BSI)
- Skin disruption, scratches, bug bites
- IV drug abuse
- Invasive devices (central venous catheter)
- Invasive procedures (surgical, dental, scopes)

Transient bacteremic episodes may happen all the time but are usually cleared by the liver/spleen

Host considerations

- Implants/prostheses
- Impaired immunity

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CLINICAL  
DEFINITION

## Signs and symptoms

Systemic: Fever, chills, rigors, fatigue → hypotension, shock

Respiratory: hyperventilation → respiratory failure

Neurologic: Confusion → seizure, coma

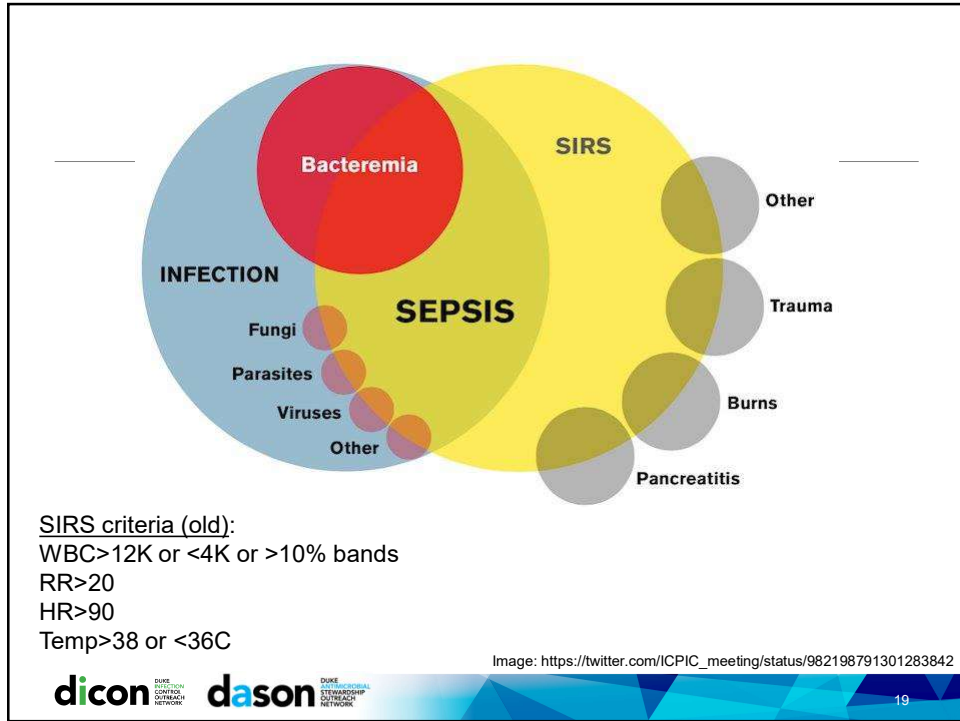
Secondary: Other localized infection symptoms

**Localized infection**

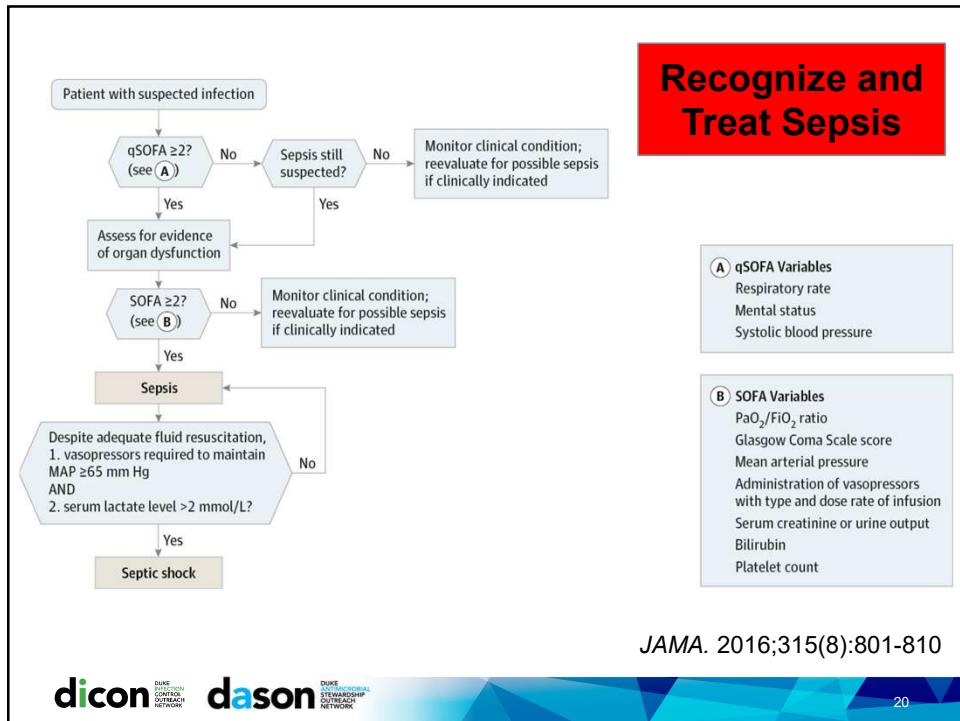
**Fever**

**Septic Shock  
+ Organ Failure**

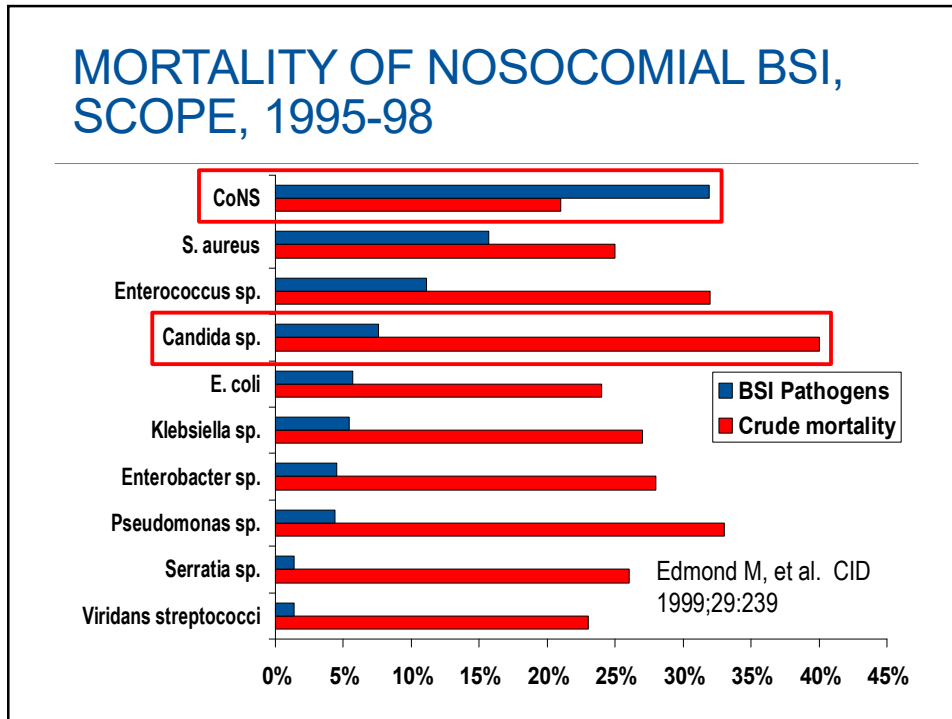
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## Clinical management: Go to the Source


1. Source control
  - Incision and Drainage for abscesses
  - Remove necrotic material
  - Remove foreign material
  - Contain bowel/bladder contents
  - Wash out joints
2. Antibiotics and/or antifungals
  - Initially IV
  - May be able to transition to oral depending on: clinical progress, culture clearance, primary source, and organism/susceptibilities
3. Supportive Care
  - Fluids, oxygen, ICU (pressors, vent)

































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**CLINICAL  
DEFINITION**

# Central Venous Catheter Infections

Infection	Definition
Catheter colonization	Significant growth of $\geq 1$ microorganism in a quantitative or semiquantitative culture of the catheter tip, subcutaneous catheter segment, or catheter hub
Phlebitis	Induration or erythema, warmth, and pain or tenderness along the tract of a catheterized or recently catheterized vein
Exit site infection	
Microbiological	Exudate at catheter exit site yields a microorganism with or without concomitant bloodstream infection
Clinical	Erythema, induration, and/or tenderness within 2 cm of the catheter exit site; may be associated with other signs and symptoms of infection, such as fever or purulent drainage emerging from the exit site, with or without concomitant bloodstream infection <sup>a</sup>
Tunnel infection	Tenderness, erythema, and/or induration $>2$ cm from the catheter exit site, along the subcutaneous tract of a tunneled catheter (e.g., Hickman or Broviac catheter), with or without concomitant bloodstream infection <sup>a</sup>
Pocket infection	Infected fluid in the subcutaneous pocket of a totally implanted intravascular device; often associated with tenderness, erythema, and/or induration over the pocket; spontaneous rupture and drainage, or necrosis of the overlying skin, with or without concomitant bloodstream infection <sup>a</sup>
Bloodstream infection	
Infusate related	Concordant growth of a microorganism from infusate and cultures of percutaneously obtained blood cultures with no other identifiable source of infection
Catheter related	Bacteremia or fungemia in a patient who has an intravascular device and $>1$ positive blood culture result obtained from the peripheral vein, clinical manifestations of infection (e.g., fever, chills, and/or hypotension), and no apparent source for bloodstream infection (with the exception of the catheter). One of the following should be present: a positive result of semiquantitative ( $>15$ cfu per catheter segment) or quantitative ( $>10^2$ cfu per catheter segment) catheter culture, whereby the same organism (species) is isolated from a catheter segment and a peripheral blood culture; simultaneous quantitative cultures of blood with a ratio of $>3:1$ cfu/mL of blood (catheter vs. peripheral blood); differential time to positivity (growth in a culture of blood obtained through a catheter hub is detected by an automated blood culture system at least 2 h earlier than a culture of simultaneously drawn peripheral blood of equal volume). Note that this definition differs from the definition of central line-associated bloodstream infection used for infection-control surveillance activities.

Mermel L, et al. CID 2009;49:1-45

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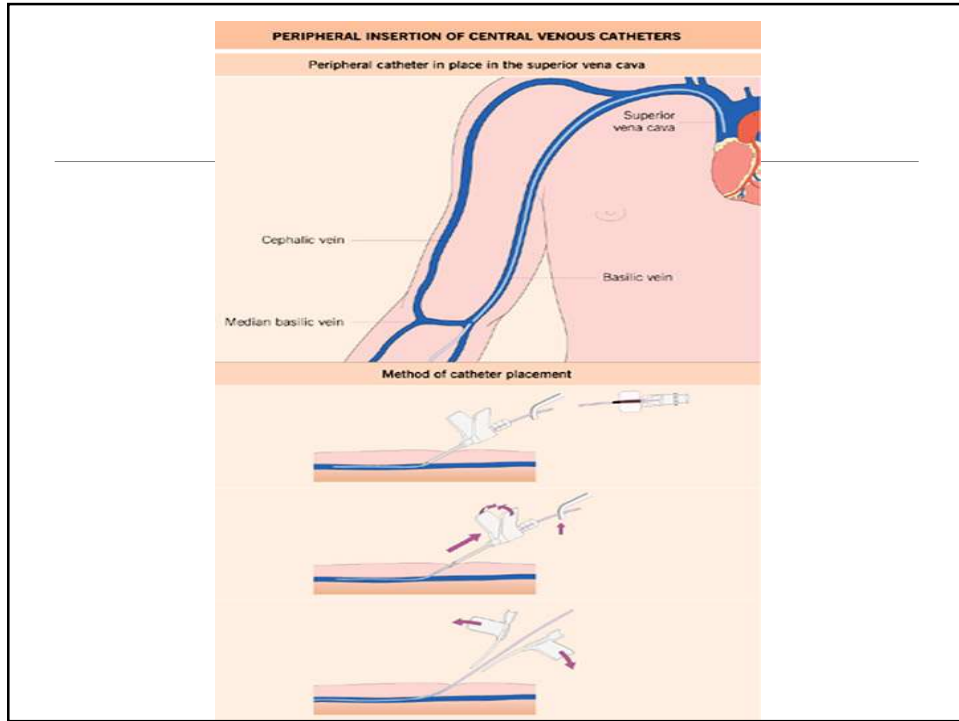
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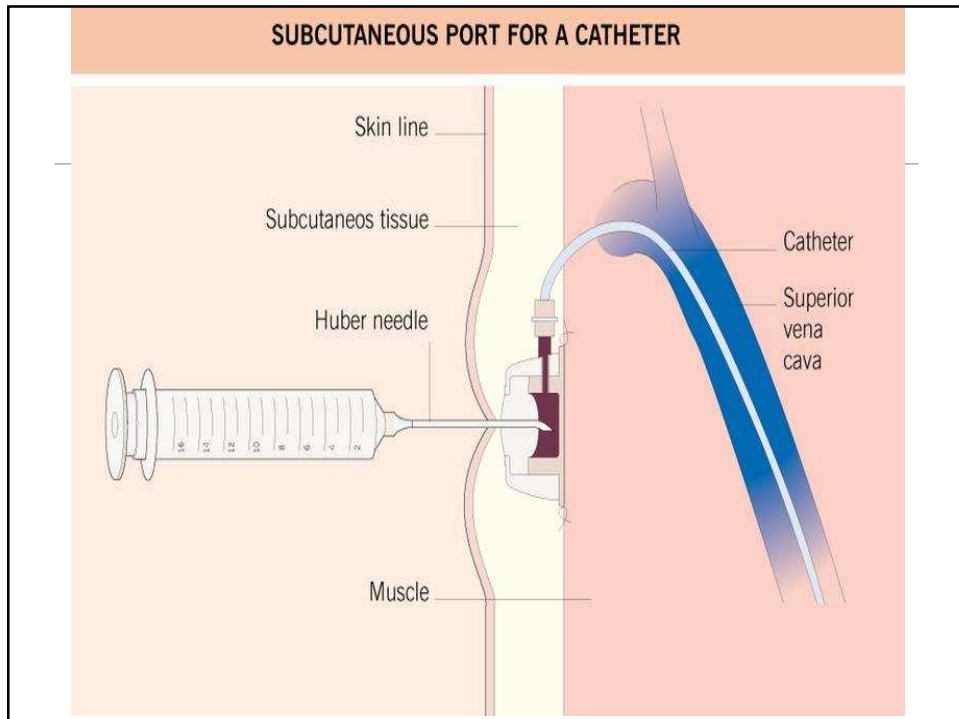
**Table 3. Types of intravascular devices and comments on their use.**

Type of intravascular device	Comment
Peripheral venous catheter	Usually inserted into the veins of the forearm or the hand; the most commonly used short-term intravascular device
Peripheral arterial catheter	For short-term use; commonly used to monitor hemodynamic status and to determine blood gas levels of critically ill patients; risk of bloodstream infection may approach that of CVCs
Midline catheter	Peripheral catheter (size, 7.6–20.3 cm) is inserted via the antecubital fossa into the proximal basilic or cephalic veins, but it does not enter central veins; it is associated with lower rates of infection, compared with CVCs
Short-term CVC	Most commonly used CVC; accounts for the majority of all catheter-related bloodstream infections
Pulmonary artery catheter	Inserted through a teflon introducer and typically remains in place for an average duration of only 3 days
Pressure-monitoring system	Used in conjunction with arterial catheter; associated with both epidemic and endemic nosocomial bloodstream infections
Peripherally inserted central catheter	Provides an alternative to subclavian or jugular vein catheterization; is inserted via the peripheral vein into the superior vena cava, usually by way of cephalic and basilic veins; similar risk of infection as CVCs in patients hospitalized in intensive care units
Long-term CVC	Surgically implanted CVC (e.g., Hickman, Broviac, or Groshong catheter) with the tunneled portion exiting the skin and a dacron cuff just inside the exit site; used to provide vascular access to patients who require prolonged chemotherapy, home-infusion therapy, or hemodialysis
Totally implantable device	A subcutaneous port or reservoir with self-sealing septum is tunneled beneath the skin and is accessed by a needle through intact skin; associated with low rates of infection

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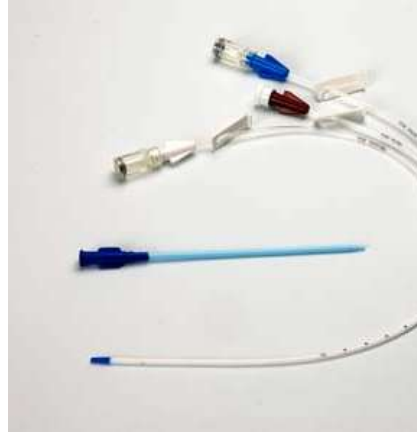
## PATHOGENESIS Central Line Infection

Multifactorial and complex

Most catheter-related infections appear to result from **migration of skin organisms** at insertion site into the cutaneous tract with eventual colonization of the catheter tip

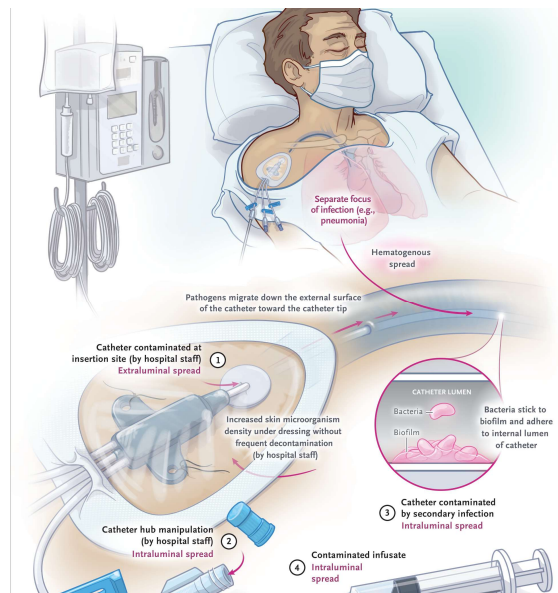
Catheter hub also important contributor to intraluminal colonization (especially in long-term catheters)

Less common = hematogenous seeding of catheter tip from distant focus of infection or contaminated infusate



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### CLABSI Pathophysiology

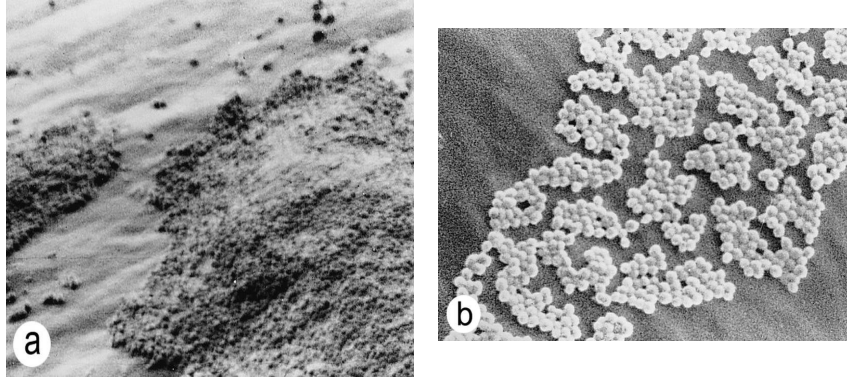


O'Grady, N. P. (2023). Prevention of central line-associated bloodstream infections. *New England Journal of Medicine*, 389(12), 1121-1131.

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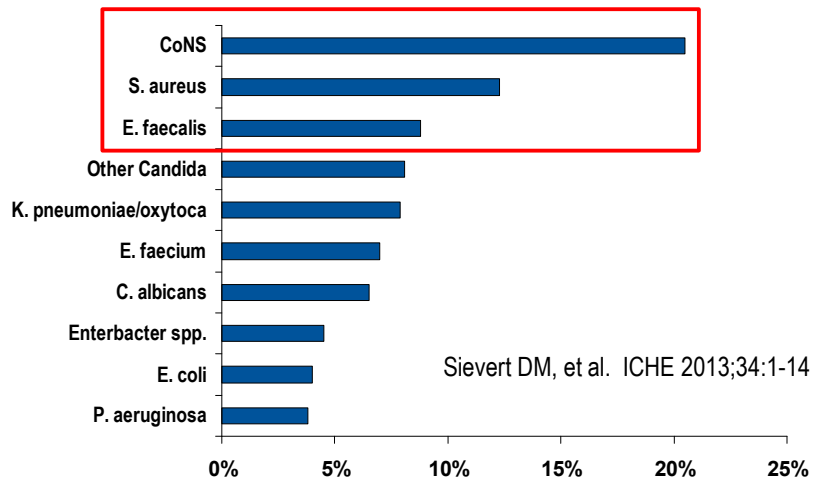
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# BIOFILM



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# TOP 10 PATHOGENS ASSOCIATED WITH CLABSIs: NHSN, 2009-2010



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# Pathogen Evolution

## Swiss study of 1 tertiary hospital 2016-2023

- Coagulase-negative staphylococci ( $N = 207$ , 23.4%) and *Enterococcus* spp. ( $N = 134$ , 15.2%) were the most frequent causative pathogens.
- Proportion of *Enterococcus* spp. ( $z = 3.4$ ,  $P < 0.001$ ), driven by an increase of *E. faecium* ( $z = 3.2$ ,  $P = 0.001$ ), and yeast ( $z = 2.3$ ,  $P = 0.020$ ) **increased**
- Coagulase-negative staphylococci **decreased** ( $z = -6.1$ ,  $P < 0.001$ ).

Obenhuber T, Pfister M, Reiber C, Dunic M, Falk C, Zingg W, Schreiber PW. Trends in surveillance indicators for central-catheter-associated bloodstream infections in a tertiary hospital in Switzerland. *J Hosp Infect.* 2024 Dec;154:64-69. doi: 10.1016/j.jhin.2024.09.019. Epub 2024 Oct 10. PMID: 39395465.

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## Pathogens Depend on Setting

Novosad SA, Fike L, Dudeck MA, Allen-Bridson K, Edwards JR, Edens C, Sinkowitz-Cochran R, Powell K, Kuhar D. Pathogens causing central-line-associated bloodstream infections in acute-care hospitals—United States, 2011–2017. *Infect Control Hosp Epidemiol.* 2020 Mar;41(3):313–319. doi: 10.1017/ice.2019.303. Epub 2020 Jan 9. PMID: 31915083.

Hsu HE, Mathew R, Wang R, et al. Health Care-Associated Infections Among Critically Ill Children in the US, 2013–2018. *JAMA Pediatr.* 2020;174(12):1176–1183. doi:10.1001/jamapediatrics.2020.3223

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- ICU: *Candida*
- Pediatric:
  - Neonatal ICUs: *Staphylococcus aureus* and coagulase-negative staphylococci most frequent
  - Pediatric ICUs: *Enterococcus* spp, coagulase-negative staphylococci, *Staphylococcus aureus*, *Enterobacter cloacae*, yeast, *K. pneumoniae*, and *Serratia marcescens*

# Populations at Higher Risk for CLABSI

## ICU patients

- High CL utilization (often multiple CL at once and specialized lines)
- Catheters placed in emergencies circumstances
- Need for repeated access daily
- Often need CL for extended time periods

## Vulnerable populations

- Hemodialysis
- Peri-operative
- Hem/Onc

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# CLABSI Risk Factors

## Patient

- Hematologic malignancy
- Neutropenia
- Malnutrition
- Prolonged LOS
- Severe burns
- BMI >40
- Prematurity

## Provider

- Emergency insertion
- Incomplete sterile technique
- Multiple catheter manipulations
- Low nurse-to-patient ratios

## Device

- Insertion site: **Femoral (worst), Internal jugular, compared to Subclavian (best)**
- Number of lumens
- Indication for use e.g. TPN

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Decreased Risk/Protective Factors

- Female sex
- Antibiotic administration
- Minocycline-rifampin impregnated catheters

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## CLINICAL CLUES of CVC INFECTIONS

- CVC: Exit site infection (erythema, tenderness, purulence) or tunnel infection (erythema, tenderness, purulence, induration)
- High grade bacteremia/fungemia (multiple positive cultures)
- Abrupt onset, associated with shock
- Symptoms/signs of sepsis (i.e., fever/ hypotension) without obvious source (no identifiable local infection)
- Evidence of septic thrombophlebitis of great vein
- Continued bacteremia/fungemia despite appropriate therapy
- Symptoms/signs of sepsis plus catheter malfunction
- Bacteremia with CoNS, *Candida*, *Bacillus*, *Corynebacterium*

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## COMPLICATIONS OF CLABSIs

### Local infection

- Tunnel infection, pocket infection

### Sepsis

### Remote site infection

- Osteomyelitis
- Meningitis

### Endovascular infection

- Endocarditis
- Mycotic aneurysms
- Septic thrombophlebitis



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## Identifying Complicated SAB

### Clinical Context Matters

### ***S. aureus* Bacteremia + Prosthesis = Trouble**



SAB + Arthroplasty = 28% Joint Infection

Murdoch et al *Clin Infect Dis* 2001; 32:647-9.



SAB + Prosthetic Valve = 51% Valve Infection

El-Adhab *Am J Med* 2005; 118:225-9.



SAB + Pacemaker/ICD = 45% Device Infection

Chamis *Circulation* 2001; 104: 1029



SAB + Central Catheter = 71% Thrombophlebitis

Crowley *Crit Care Med* 2008;36:385-90



Slide: Thomas Holland MD, Duke Univ

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## Goals of Infection Surveillance: Improve Understanding

Estimate disease incidence:

- Assess program impact, detect outbreaks or problem areas to focus prevention efforts, understand and describe disease burden

Reliability, reproducibility

- Trend over time
- Valid and standardized to the degree possible among practice areas (internal validity)
- Compare to benchmarks (external validity)

The definitions are designed to reflect clinical "truth," but there is NO method of measurement that is perfect.

Abiding by NHSN definitions improves validity AND provides protection when faced with external review or challenges to the data.

NHSN definitions must be adjusted with time due to the dynamic nature of medicine.



39

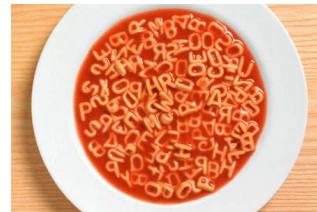
39

SURVEILLANCE  
DEFINITION

## What is BSI?

There are multiple surveillance definitions to be familiar with for BSI:

- LCBI (1 to 3)
- Secondary BSI due to other site-specific infection
- MBI LCBI (1 to 3)
- CLABSI



[https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc\\_clabscurrent.pdf](https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf)



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SURVEILLANCE  
DEFINITION

## Healthcare Associated Infection (HAI)

There are multiple “timing” related definitions:

- Date of Event (DOE)
- Healthcare associated infection (HAI)
- Infection window period (IWP)
- Present on admission (POA)
- Repeat infection timeframe (RIT)
- Secondary BSI attribution period (SBAP) = IWP + RIT

An infection is considered an HAI if:

- ALL elements of a CDC/NHSN site-specific infection criterion were *NOT present on admission* but were **ALL present on or after the 3rd calendar day of admission** to the facility.

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SURVEILLANCE  
DEFINITION

## Laboratory Confirmed BSI (LCBI)

Must meet 1 of 3 LCBI criteria:

- Recognized pathogen (1+ cx)
- Common skin commensal (≥2 separate +cx with ≤1 day gap between)
- Neonates + common skin commensal

For all: organism cultured from blood is *not related to infection at another site*

Most closely reflects a clinical Primary BSI.

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SURVEILLANCE  
DEFINITION

## LCBI 1

1

Patient of any age has a **recognized pathogen**, which is an organism NOT included on the NHSN common commensal list, identified from **one or more blood specimens obtained** by a culture or non-culture based microbiologic testing method

AND

organism cultured from blood is *not related to an infection at another site*

Recognized Pathogen  
(Examples)

*S. aureus*  
*P. aeruginosa*  
*E. coli*  
*K. pneumoniae*  
*S. marcescens*  
*C. albicans*  
*Enterococcus sp.*

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SURVEILLANCE  
DEFINITION

## LCBI 2

2

Patient of any age has at least one of the following **signs or symptoms**: fever (>38.0C), chills, or hypotension

AND

Organism(s) identified from blood is *not related to an infection at another site*

AND

The same NHSN common commensal is identified by a culture or non-culture based microbiologic testing method, from **two or more** blood specimens collected on separate occasions.

Criterion elements must occur within the Infection Window Period (**IWP**), the 7-day time period which includes the date the positive blood culture was collected, the 3 calendar days before and the 3 calendar days after

Common Commensals  
(Partial List)

*Diphtheroids [Corynebacterium spp. not C. diphtheriae]*  
*Bacillus spp. [not B. anthracis]*  
*Propionibacterium spp.*  
*Coagulase-negative staphylococci [including S. epidermidis]*  
*Viridans group streptococci*  
*Aerococcus spp.*  
*Micrococcus spp.*  
*Rhodococcus spp.*


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SURVEILLANCE DEFINITION

LCBI 3



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Patient **≤ 1 year of age** has at least one of the following signs or symptoms: fever (>38.0C), hypothermia (<36.0C), apnea, or bradycardia


AND

Organism(s) identified from blood is *not related to an infection at another site*

AND




The same NHSN common commensal is identified by a culture or non-culture based microbiologic testing method, from **two or more** blood specimens collected on separate occasions.

Criterion elements must occur within the Infection Window Period (IWP), the 7-day time period which includes the collection date of the positive blood, the 3 calendar days before and the 3 calendar days after.



**Common Commensals (Partial List)**

*Diphtheroids*  
*[Corynebacterium spp. not C. diphtheriae]*  
*Bacillus spp. [not B. anthracis]*  
*Propionibacterium spp.*  
*Coagulase-negative staphylococci [including S. epidermidis]*  
*Viridans group streptococci*  
*Aerococcus spp.*  
*Micrococcus spp.*  
*Rhodococcus spp.*




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SURVEILLANCE DEFINITION

Secondary BSI

---

An NHSN site-specific definition must be met; either one of the CDC/NHSN Surveillance Definitions for Specific Types of Infections (defined in Chapter 17), or UTI, PNEU or SSI definitions.




AND

One of the following scenarios must be met:

Scenario 1	Scenario 2
A positive blood specimen must contain at least <b>one eligible matching organism</b> to the site-specific specimen	Positive blood specimen must be an <b>element</b> of the <b>site-specific definition</b>
And the blood specimen is collected in the site-specific <b>secondary BSI attribution period</b>	And blood specimen is collected in the site-specific <b>infection window period</b>
And an eligible organism <b>identified from the site-specific specimen</b> is used as an element to meet the site-specific definition	And an eligible organism <b>identified in a blood specimen</b> is used as an element to meet the site-specific definition

Scenario 1  
"Match"

Scenario 2  
"Element"

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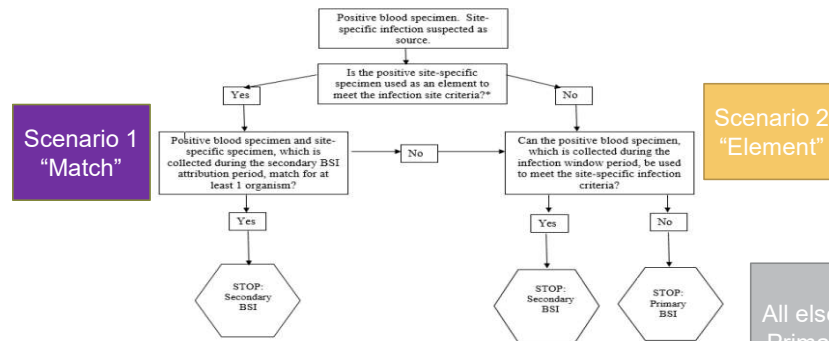
Table B1: Secondary BSI Guide: List of all NHSN primary site-specific definitions available for making secondary BSI determinations using Scenario 1 or Scenario 2

Scenario 1		Scenario 2	
A positive blood specimen must contain at least one eligible matching organism to the site-specific specimen		Positive blood specimen must be an element of the site-specific definition	
And the blood specimen is collected in the site-specific secondary BSI attribution period		And blood specimen is collected in the site-specific infection window period	
And an eligible organism identified from the site-specific specimen is used as an element to meet the site-specific definition		And an eligible organism identified in a blood specimen is used as an element to meet the site-specific definition	
Site	Criterion	Site	Criterion
ABUTI	ABUTI	ABUTI	ABUTI
BONE	1	BONE	3a
BRST	1	BURN	1
CARD	1	DISC	3a
CIRC	2 or 3	ENDO	4a, 4b, 5a or 5b (specific organisms) 6e or 7e plus other criteria as listed
CONJ	1a	GIT	1b or 2c
DECU	1	IAB	2b or 3b
DISC	1	JNT	3c
EAR	1, 3, 5 or 7	MEN	2c or 3c
EMET	1	OREP	3a
ENDO	1	PNEU	2 or 3
EYE	1	SA	3a
GE	2a	UMB	1b
GIT	2a, 2b (only yeast)	USI	3b or 4b
IAB	1 or 3a		
IC	1		
JNT	1		
LUNG	1		
MED	1		
MEN	1		
ORAL	1, 3a, 3d (only yeast)		
OREP	1		
PJI	1 or 3e		
PNEU	2 or 3		
SA	1		
SINU	1		
SSI	SI, DI or OS		
SKIN	2a		
ST	1		
UMB	1a		
UR	1a or 3a		
USI	1		
SUTI	1a, 1b or 2		
VASC only as SSI	1		
VCUS	3		



## SECONDARY BSI GUIDE FOR ELIGIBLE ORGANISMS (not applicable to VAE)

Figure B1: Secondary BSI Guide for eligible organisms\*‡  
(Not applicable to Ventilator-associated Events [VAE], See Figure B2)



**Exception:** The necrotizing enterocolitis (NEC) definition does not include criteria for a matching site-specific specimen, nor an organism identified from a blood specimen, however an exception for assigning a BSI secondary to NEC is provided. A BSI is considered secondary to NEC if the patient meets one of the two NEC criteria AND an organism identified from a blood specimen, collected during the secondary BSI attribution period, is an LCBI pathogen or the same common commensal is identified from 2 or more blood specimens drawn on separate occasions but on the same or consecutive days.



All else= Primary LCBI

SURVEILLANCE  
DEFINITION

## Laboratory Confirmed BSI (LCBI)

---

**LCBI Hierarchy: Types of LCBI (see Table 1 and Table 2):**

```

graph TD
    BSI[BSIs] --> LCBI1[LCBI 1]
    BSI --> LCBI2[LCBI 2]
    BSI --> LCBI3[LCBI 3]
    LCBI1 --> MBI1[MBI-LCBI 1]
    LCBI2 --> MBI2[MBI-LCBI 2]
    LCBI3 --> MBI3[MBI-LCBI 3]
    
```

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## Hem/Onc/BMT a “special population” for surveillance

Complex patient population	<ul style="list-style-type: none"> <li>Highly toxic treatments</li> <li>ICU stays</li> <li>Complications (infection, bleeding, ADEs)</li> </ul>
Device utilization	<ul style="list-style-type: none"> <li>True need for central line</li> </ul>
Culturing practices	<ul style="list-style-type: none"> <li>Bad veins</li> <li>Thrombocytopenia</li> </ul>
Antimicrobial utilization	<ul style="list-style-type: none"> <li>Like water</li> <li>Usually appropriate for severity of illness</li> </ul>
Surveillance practices	<ul style="list-style-type: none"> <li>Variable?</li> </ul>
Administrative pressure	<ul style="list-style-type: none"> <li>“Protective” of program and reputation</li> </ul>
Adjudication	<ul style="list-style-type: none"> <li>Clinicians don’t consider many “CLABSI” to be preventable</li> <li>Definitions don’t apply well to patient population and leads to rejection of data</li> </ul>

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SURVEILLANCE  
DEFINITIONMucosal Barrier Injury Laboratory  
Confirmed Bloodstream Infection  
(MBI-LCBI)

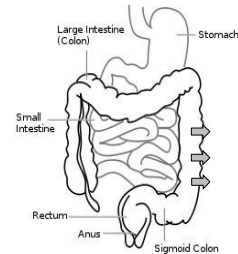
A subset of the LCBI criteria

Aim to identify the “special population” of patients who have BSI due to hematogenous spread from the gut/oral flora due to immune compromise

Must meet one of the 3 LCBI criteria

AND

Must meet one of the two MBI criteria

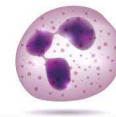
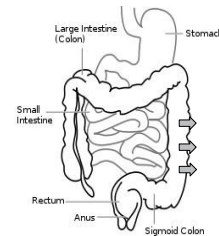


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SURVEILLANCE  
DEFINITIONMucosal Barrier Injury Laboratory  
Confirmed Bloodstream Infection  
(MBI-LCBI)

One of two MBI criteria:

1. Is an allogeneic hematopoietic **stem cell transplant recipient** within the past year with one of the following documented during same hospitalization as positive blood specimen:
  - a) Grade III or IV **gastrointestinal graft versus host disease** [GI GVHD]
  - b)  $\geq 1$ -liter **diarrhea** in a 24-hour period (or  $\geq 20$  mL/kg in a 24-hour period for patients  $< 18$  years of age) with onset on or within the 7 calendar days before the date the positive blood specimen was collected.
2. Is **neutropenic**, defined as at least two separate days with ANC and/or WBC values  $< 500$  cells/mm<sup>3</sup> collected within a 7-day time period which includes the collection date of the positive blood specimen, the 3 calendar days before and the 3 calendar days after.



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SURVEILLANCE  
DEFINITION

# MBI-LCBI 1

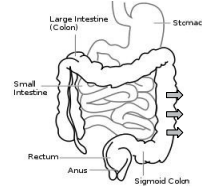
1

LCBI 1 = at least 1 culture positive for “recognized pathogen”

from the intestines

Plus

One of the MBI criteria



Intestinal pathogens  
(partial list)

*Bacteroides spp.*  
*Candida spp.*  
*Clostridium spp.*  
*Enterococcus spp.*  
*Fusobacterium spp.*  
*Peptostreptococcus spp.*  
*Prevotella spp.*  
*Veillonella spp.*  
*Enterobacteriaceae*

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SURVEILLANCE  
DEFINITION

# MBI-LCBI 2

2

LCBI 2 = signs and symptoms AND at least 2 separate cultures with “common commensals”

Only **viridans group Streptococci** and/or **Rothia spp.** and no other organisms.

Plus

One of the two MBI criteria



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SURVEILLANCE  
DEFINITION

## MBI-LCBI 3



LCBI 3 = Patient  $\leq 1$  year of age,  
AND at least 2 separate cultures  
with “common commensals”



Only **viridans group streptococci**  
**and/or Rothia spp** and no other  
organisms.

Plus

One of the MBI criteria

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SURVEILLANCE  
DEFINITION

## Central Line



Central line: terminates at or close to the heart or in one of the great vessels, used for infusions, withdrawal of blood, or hemodynamic monitoring.

- Catheter must terminate in aorta, pulmonary artery, superior or inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac or common iliac veins, femoral veins, umbilical artery/vein (neonates)

The following are NOT considered central lines:

- Extracorporeal membrane oxygenation (ECMO)
- Arterial catheters
- Intra-aortic balloon pump (IABP) devices
- Hemodialysis reliable outflow (HeRO) dialysis catheters
- Non-accessed central line (not accessed nor inserted during the hospitalization)
- Peripheral IV or Midlines
- Ventricular Assist Device (VAD)
- Total Artificial Heart (TAH)

Infusion: Introduction of a solution through a blood vessel via a catheter lumen

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SURVEILLANCE  
DEFINITION

## Central Line: Temporary, Permanent

Temporary central line: A non-tunneled, non-implanted catheter

Permanent central line:

- Tunneled catheters, including dialysis catheters
- Implanted catheters (including ports)

Umbilical catheter: A vascular catheter inserted through the umbilical artery or vein in a neonate.

SURVEILLANCE  
DEFINITION

## Central Line: Excluded Pathogens

LCBI Criterion → Any non-commensal

Exclusion criteria (can be secondary BSIs)

- Parasites and viruses
- Salmonella, Shigella, Yersinia, Campylobacter, Listeria, Vibrio, STEC, ETEC, EPEC, EIEC, EAEC, DAEC, C. difficile, or Giardia
- Vector-borne bacteria and Fungi (can't meet secondary BSI)

SURVEILLANCE  
DEFINITIONCENTRAL LINE-ASSOCIATED  
BLOODSTREAM INFECTION (CLABSI)  
EVENT

Eligible Central Line: A CL that has been in place for **more than two** consecutive calendar days (on or after CL day 3), following the **first access** of the central line, in an inpatient location, during the current admission. Such lines are eligible for CLABSI events and remain eligible for CLABSI events **until the day after removal from the body or patient discharge**, whichever comes first.

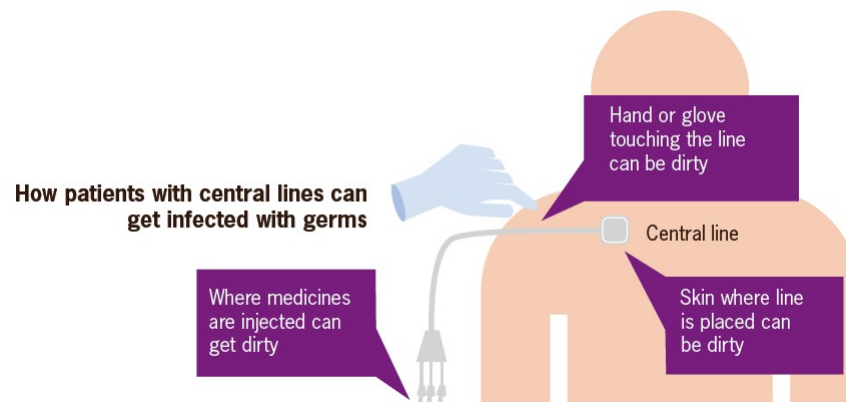
Central line-associated BSI (CLABSI): A laboratory confirmed bloodstream infection (LCBI) where an eligible BSI organism is identified and an eligible central line is present on the LCBI date of event or the day before.

[https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc\\_clabscurrent.pdf](https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf)

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## How does CLABSI happen?



CDC VitalSigns March  
2011;60(8):243–248.

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OUTREACH  
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## Contamination occurs...

### Insertion:

- Patient's Skin
- Operator (Spit, Hair, Hands)
- Environment

### Maintenance:

- Cap is frequently accessed, inadequately cleaned during access, or poorly functioning
- Operator (Spit, Hair, Hands) during assessments + routine dressing changes
- Bacterial migration along catheter tract from skin

## What's a Bundle?



“Care bundles are small, straightforward, sets of evidence-based practices... that, when implemented collectively, improve the reliability of their delivery and improve patient outcomes.”



An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU

Peter Pronovost, M.D., Ph.D., Dale Needham, M.D., Ph.D., Sean Berenholtz, M.D., David Sinopoli, M.P.H., M.B.A., Hester Chou, M.D., Ph.D., Sara Cosgrove, M.D., Bryan Sexton, Ph.D., Robert Hays, M.D., Robert Welsh, M.D., Gary Roth, M.D., Joseph Bander, M.D., John Kepros, M.D., and Christine Goeschel, R.N., M.P.A.



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<http://www.ihl.org/resources/Pages/ImprovementStories/WhatIsaBundle.aspx>

# IHI Bundle: PREVENTION OF CENTRAL LINE INFECTIONS

## During insertion:

- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis (now CHG-alcohol)
- Optimal catheter site selection, with subclavian vein as the preferred site for nontunneled catheters

## During maintenance:

- Daily review of line necessity, with prompt removal of unnecessary lines

Buetti N et al Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update. *Infect Control Hosp Epidemiol.* 2022 May;43(5):553-569. doi: 10.1017/ice.2022.87. Epub 2022 Apr 19.



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OUTREACH  
NETWORK **dason** DATA-DRIVEN  
EVIDENCE  
OUTREACH  
NETWORK

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*Infection Control & Hospital Epidemiology* (2022), 1–17  
doi:10.1017/ice.2022.87



## SHEA/IDSA/APIC Practice Recommendation

### Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update

Niccolò Buetti MD, MSc, PhD<sup>1,2,a</sup> , Jonas Marschall MD, MSc<sup>3,4,a</sup> , Marci Drees MD, MS<sup>5,6</sup> ,  
Mohamad G. Fakih MD, MPH<sup>7</sup> , Lynn Hadaway MEd, RN, NPD-BC, CRNI<sup>8</sup>, Lisa L. Maragakis MD, MPH<sup>9</sup>,  
Elizabeth Monsees PhD, MBA, RN, CIC<sup>10,11</sup> , Shannon Novosad MD MPH<sup>12</sup>, Naomi P. O'Grady MD<sup>13</sup>,  
Mark E. Rupp MD<sup>14</sup> , Joshua Wolf MBBS, PhD, FRACP<sup>15,16</sup> , Deborah Yokoe MD, MPH<sup>17</sup> and  
Leonard A. Mermel DO, ScM<sup>18,19</sup> 

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# GRADING THE QUALITY OF EVIDENCE

Category	Definition
HIGH	Highly confident that the true effect lies close to that of the estimated size and direction of the effect. Evidence is rated as high quality when there are a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.
MODERATE	The true effect is likely to be close to the estimated size and direction of the effect, but there is a possibility that it is substantially different. Evidence is rated as moderate quality when there are only a few studies and some have limitations but not major flaws, there is some variation between studies, and/or the confidence interval of the summary estimate is wide.
LOW	The true effect may be substantially different from the estimated size and direction of the effect. Evidence is rated as low quality when supporting studies have major flaws, there is important variation between studies, the confidence interval of the summary estimate is very wide, and/or there are no rigorous studies.

\*Based on the CDC Healthcare Infection Control Practices Advisory Committee (HICPAC) "Update to the Centers for Disease Control and Prevention and the Healthcare Infection Control Practices Advisory Committee Recommendations Categorization Scheme for Infection Control and Prevention Guideline Recommendations" (October 2019), the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE),<sup>265</sup> and the Canadian Task Force on Preventive Health Care.<sup>266</sup>

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## Essential Practices

### Before insertion

1. Provide easy access to an evidence-based list of indications for CVC use to minimize unnecessary CVC placement (Quality of Evidence: LOW)
2. Require education and competency assessment of HCP involved in insertion, care, and maintenance of CVCs about CLABSI prevention (Quality of Evidence: MODERATE)<sup>74-75</sup>

3. Bathe ICU patients aged >2 months with a chlorhexidine preparation on a daily basis (Quality of Evidence: HIGH)<sup>88-90</sup>

### At insertion

1. In ICU and non-ICU settings, a facility should have a process in place, such as a checklist, to ensure adherence to infection prevention practices at the time of CVC insertion (Quality of Evidence: MODERATE)<sup>105</sup>

2. Perform hand hygiene prior to catheter insertion or manipulation (Quality of Evidence: MODERATE)<sup>103-107</sup>

3. The subclavian site is preferred to reduce infectious complications when the catheter is placed in the ICU setting (Quality of Evidence: HIGH)<sup>93,172,198-199</sup>

4. Use an all-inclusive catheter cart or kit (Quality of Evidence: MODERATE)<sup>118</sup>

5. Use ultrasound guidance for catheter insertion (Quality of Evidence: HIGH)<sup>115,120</sup>

6. Use maximum sterile barrier precautions during CVC insertion (Quality of Evidence: MODERATE)<sup>123-128</sup>

7. Use an alcoholic chlorhexidine antiseptic for skin preparation (Quality of Evidence: HIGH)<sup>94,129-134</sup>

### After insertion

1. Ensure appropriate nurse-to-patient ratio and limit use of float nurses in ICUs (Quality of Evidence: HIGH)<sup>14,35</sup>

2. Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (Quality of Evidence: HIGH)<sup>65,136-142</sup>

3. For non-tunneled CVCs in adults and children, change transparent dressings and perform site care with a chlorhexidine-based antiseptic at least every 7 days or immediately if the dressing is soiled, loose, or damp. Change gauze dressings every 2 days or earlier if the dressing is soiled, loose, or damp (Quality of Evidence: MODERATE)<sup>45-148</sup>

4. Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter (Quality of Evidence: MODERATE)<sup>150-154</sup>

5. Remove nonessential catheters (Quality of Evidence: MODERATE)

6. Routine replacement of administration sets not used for blood, blood products, or lipid formulations can be performed at intervals up to 7 days (Quality of Evidence: HIGH)<sup>164</sup>

7. Perform surveillance for CLABSI in ICU and non-ICU settings (Quality of Evidence: HIGH)<sup>1,160,166</sup>

## Additional Approaches

1. Use antiseptic- or antimicrobial-impregnated CVCs (Quality of Evidence: HIGH in adult patients<sup>24,38,169-171</sup> and Quality of Evidence: MODERATE in pediatric patients)<sup>172,173</sup>

2. Use antimicrobial lock therapy for long-term CVCs (Quality of Evidence: HIGH)<sup>177-184</sup>

3. Use recombinant tissue plasminogen activating factor (rt-PA) once weekly after hemodialysis in patients undergoing hemodialysis through a CVC (Quality of Evidence: HIGH)<sup>192</sup>

4. Utilize infusion or vascular access teams for reducing CLABSI rates (Quality of Evidence: LOW)<sup>193,194</sup>

5. Use antimicrobial ointments for hemodialysis catheter insertion sites (Quality of Evidence: HIGH)<sup>195-200</sup>

6. Use an antiseptic-containing hub/connector cap/port protector to cover connectors (Quality of Evidence: MODERATE)<sup>200-206</sup>

## Approaches that Should Not Be Considered a Routine Part of CLABSI Prevention

1. Do not use antimicrobial prophylaxis for short-term or tunneled catheter insertion or while catheters are *in situ* (Quality of Evidence: HIGH)<sup>209-213</sup>

2. Do not routinely replace CVCs or arterial catheters (Quality of Evidence: HIGH)<sup>164</sup>

## Unresolved Issues

1. Routine use of needleless connectors as a CLABSI prevention strategy before an assessment of risks, benefits, and education regarding proper use<sup>110-209</sup>

2. Surveillance of other types of catheters (eg, peripheral arterial or peripheral venous catheters)<sup>1,171-173</sup>

3. Standard, nonantimicrobial transparent dressings and CLABSI risk

4. The impact of using chlorhexidine-based products on bacterial resistance to chlorhexidine

5. Sutureless securement

6. Impact of silver zeolite-impregnated umbilical catheters in preterm infants (applicable in countries where it is approved for use in children)<sup>227</sup>

7. Necessity of mechanical disinfection of a catheter hub, needleless connector, and injection port before accessing the catheter when antiseptic-containing caps are being used

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# PREVENTING CLABSI: BEFORE INSERTION

Provide easy access to an evidence-based list of indications for CVC {Low}

Require education of HCP involved in insertion, care, and maintenance of CVCs about CLABSI prevention {Moderate}

Bathe ICU patients over 2 mo of age with a CHG preparation on a daily basis {High}



# CDC EDUCATIONAL MATERIAL

## Checklist for Prevention of Central Line Associated Blood Stream Infections

Based on 2011 CDC guideline for prevention of intravascular catheter-associated bloodstream infections: <http://www.cdc.gov/infectioncontrol/guidelines/bsi-prevention-2011.pdf>

- For Clinicians:**
- Remove daily audits to assess whether each central line is still needed
- Follow proper insertion practices**
- Perform hand hygiene before insertion
  - Adhere to aseptic technique
  - Use maximal sterile barrier precautions (i.e., mask, cap, gloves, sterile gown, and sterile full-body drape)
  - Perform skin antisepsis with 70% alcohol/water with alcohol
  - Change the site of the insertion site and mechanical components
    - Avoid removal site in adult patients
  - Connect site with aseptic glove or sterile, non-sterile, non-sterile device
- Handle and maintain central lines appropriately**
- Comply with hand hygiene requirements
  - Use the aseptic point-of-care methodology prior to each use with an appropriate antiseptic (e.g., chlorhexine, povidone iodine, or alcohol)
  - Remove catheters only with aseptic devices
  - Replace dressings that are wet, soiled, or dislodged
  - Perform dressing changes under aseptic technique every 48 hours or sooner if needed
- For Facilities:**
- Ensure staff have non-emergent insertion (proper) procedures are not followed
  - Ensure the aseptic point-of-care methodology is followed
  - Ensure aseptic access to hand hygiene
  - Monitor and provide prompt feedback to adherence to hand hygiene
  - Provide ongoing education on central line insertion, handling and maintenance
- Supplemental strategies for consideration:**
- 2% Chlorhexidine bathing
  - Antimicrobial-coated intravascular catheters
  - Chlorhexidine impregnated dressings

Revised Credit for Emergency and Disaster Infection Diseases  
© 2011 by American Society for Infection Control



## FAQs about "Catheter-Associated Bloodstream Infections"

**What is a catheter-associated bloodstream infection (CLABSI)?**

A "central line" or "tunnel catheter" is a tube that is placed into a patient's vein, usually in the neck, chest, or arm. The catheter is often used to draw blood or give fluids or medications. It may be left in place for a short or long time. A bloodstream infection can occur when bacteria or other germs travel down a "tunnel line" and enter the blood. CLABSI is a leading cause of hospital-associated bloodstream infections that may become life-threatening and costly.

**Can a catheter-related bloodstream infection be avoided?**

A catheter-associated bloodstream infection is preventable, but often can be difficult to prevent with antibiotics. The antibiotic might lead to the removal of your drainage catheter.

**What is the cause of the CLABSI and how can you avoid it?**

To prevent catheter-associated bloodstream infections, doctors and nurses will:

- Check to see where the catheter can be safely inserted and where the risk for infection is least.
- Clean their hands with soap and water or an alcohol-based hand rub before putting in the catheter.
- Wash a mask, cap, sterile gown, and sterile gloves when putting in the catheter to keep it sterile. The patient will be covered with a sterile drape.
- Change the patient's site with an aseptic device before putting in the catheter.
- Clean their hands, wear gloves, and cover the catheter opening with an aseptic barrier device using the aseptic device to keep hands and water gloves when changing the barrier that covers the site when the catheter enters the site.
- Replace every day if the patient still needs to have the catheter. The catheter will be removed as soon as it is no longer needed.
- Use sterile, handle medications and fluids that are given through the catheter.

**What can you do to help prevent a catheter-associated bloodstream infection?**

- Ask your doctor and nurse to explain why you need the catheter and how long you will have it.

**For more information, please see your doctor or nurse.**

**Additional resources:**

- Centers for Disease Control and Prevention (CDC)
- Agency for Healthcare Research and Quality (AHRQ)
- Association for Professionals in Infection Control and Epidemiology (APIC)
- World Health Organization (WHO)
- U.S. Food and Drug Administration (FDA)
- U.S. Department of Health and Human Services (HHS)

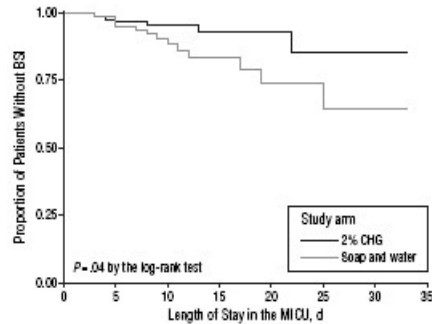
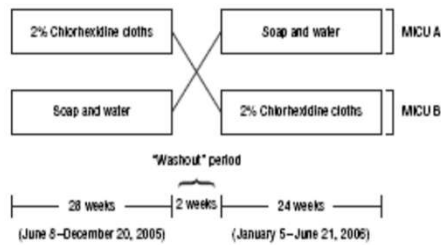
<http://www.cdc.gov/HAI/bsi/bsi.html>

## BATHE ICU PATIENTS >2 MONTHS OF AGE WITH A CHG PREPARATION DAILY

Intervention = Daily bathing with 2% CHG impregnated washcloth

Design & setting : Cross-over study in MICU

Result: CHG associated with decreased rate (per 1,000 pt-days) of CLABSI (4.1 vs 10.4)



Bleasdale S, et al. Arch Intern Med 2007;167:2073

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## REDUCE MRSA

Cluster-randomized trial in 74 ICUs

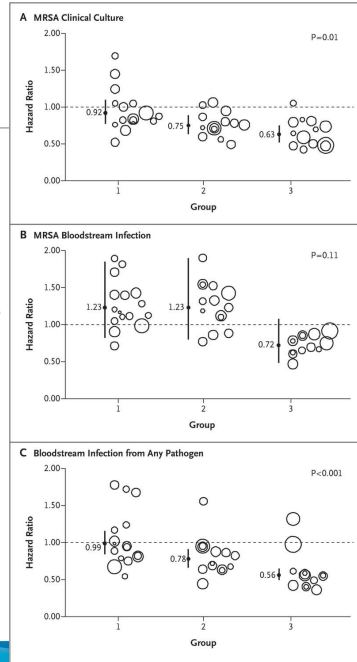
MRSA screening and isolation vs. targeted decolonization of MRSA carriers vs. universal decolonization

Decolonization: CHG daily bathing + nasal mupirocin

Result: Universal decolonization reduced rate of all Primary BSI significantly. Decreased MRSA BSI also, but NS.

1 BSI prevented per 99 patients decolonized.

Huang SS et al. N Engl J Med 2013;368:2255-2265.



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# PREVENTING CLABSI: AT INSERTION

- Have a process in place to ensure adherence to infection prevention practices (e.g., checklist) {Moderate}
- Perform hand hygiene prior to catheter insertion or manipulation {Moderate}
- **Subclavian site is preferred in the ICU setting**/Avoid using the femoral artery for central venous access in obese patients {High}
  - Consider risks and benefits of different insertion sites
  - Do not use peripherally inserted CVCs (PICCs) as a strategy to reduce CLABSI
- Use an all-inclusive catheter cart or kit {Moderate}
- Use ultrasound guidance for internal jugular insertion {High}
- Use maximum sterile barrier precautions during CVC insertion (mask, cap, sterile gown, and sterile gloves; patient covered with full body sterile drape) {Moderate}
- **Use alcohol-chlorhexidine for skin antisepsis {High}**

**CVC Bundle Checklist:**

- Hand Hygiene
- Mask, cap, gown, sterile gloves, full body drape
- CHG-alcohol skin antisepsis
- Optimal line site selection



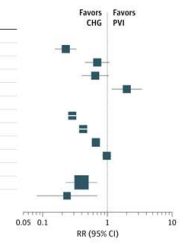
## CHG > PI for CLABSI prevention

high-concentration chlorhexidine (≥1%) in isopropyl alcohol is superior to povidone-iodine for preventing catheter-related infections.



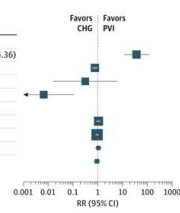
**A) Antiseptic solution type and risk of CRBSI, catheter tip colonization, and local infection**

Comparison	CHG		PVI		RR (95% CI)
	Events, No.	Patients, No.	Events, No.	Patients, No.	
<b>CRBSI</b>					
Alcoholic CHG vs aqueous PVI	40	4918	79	2205	0.23 (0.16-0.33)
Alcoholic CHG vs alcoholic PVI	40	4918	39	3344	0.70 (0.45-1.08)
Aqueous CHG vs aqueous PVI	20	861	79	2205	0.65 (0.40-1.05)
Aqueous CHG vs alcoholic PVI	20	861	39	3344	1.99 (1.17-3.40)
<b>Colonization</b>					
Alcoholic CHG vs aqueous PVI	318	4604	497	2062	0.29 (0.25-0.33)
Alcoholic CHG vs alcoholic PVI	318	4604	547	3346	0.42 (0.37-0.48)
Aqueous CHG vs aqueous PVI	185	1158	497	2062	0.66 (0.57-0.77)
Aqueous CHG vs alcoholic PVI	185	1158	547	3346	0.98 (0.84-1.14)
<b>Local infection</b>					
Alcoholic CHG vs alcoholic PVI	17	3236	41	3105	0.40 (0.23-0.70)
Alcoholic CHG vs aqueous PVI	17	3236	4	181	0.24 (0.08-0.70)



**B) Antiseptic solution time and risk of local adverse effects and mortality**

Comparison	CHG		PVI		RR (95% CI)
	Events, No.	Patients, No.	Events, No.	Patients, No.	
<b>Local adverse effects</b>					
Alcoholic CHG vs aqueous PVI	195	2875	3	1620	36.63 (11.73-114.36)
Alcoholic CHG vs alcoholic PVI	195	2875	153	1743	0.77 (0.63-0.95)
Aqueous CHG vs aqueous PVI	0	861	3	1620	0.31 (0.02-6.25)
Aqueous CHG vs alcoholic PVI	0	861	153	1743	0.01 (0.00-0.11)
<b>Mortality</b>					
Alcoholic CHG vs aqueous PVI	568	2072	158	621	1.08 (0.93-1.25)
Alcoholic CHG vs alcoholic PVI	568	2072	339	1168	0.94 (0.84-1.04)
Aqueous CHG vs aqueous PVI	29	107	158	621	1.07 (0.76-1.49)
Aqueous CHG vs alcoholic PVI	29	107	339	1168	0.93 (0.68-1.29)



Druegon B, Mihala G, Schults J, et al. Chlorhexidine vs Povidone-Iodine and Incidence of Catheter-Related Infections: A Systematic Review and Meta-Analysis. JAMA Netw Open. 2026;9(2):e2558954. doi:10.1001/jamanetworkopen.2025.58954

## CLABSI: MAINTENANCE



<http://allnurses.com/general-nursing-discussion/scrub-the-hub-926648-page5.html>

- Ensure appropriate nurse-to-patient ratio and limit the use of float nurses in the ICU {High}
- Use CHG-containing dressings for CVCs in patients > 2 months {High}
- Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter {Moderate}
- Remove nonessential catheters {Moderate}
- For non-tunneled CVCs, change dressings and performs site care with CHG-based antiseptic q7d or prn damp/loose/soiled dressing. Gauze q2 days or prn damp/loose/soiled dressing {Moderate}
- Replace administration sets not used for blood, blood products, or lipids at intervals not longer than 96 hours {High}

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## PREVENTING CLABSI: SPECIAL APPROACHES

Use antiseptic or antimicrobial-impregnated CVCs in adult patients {High/Moderate} in specific situations:

- Higher than desired CLABSI rate
- Patients with recurrent CLABSI
- Patients at higher risk of severe sequelae from a CLABSI (e.g. prosthetic valves)

Use an antiseptic-containing hub/connector cap/port protector to cover connectors {Moderate}

Use recombinant tPA for HD through CVC {High}

Use vascular access teams {Low}

Use antimicrobial locks for CVCs {High} in specific situations:

- HD catheters
- Limited access and history of recurrent CLABSI
- Patients at higher risk of severe sequelae from a CLABSI

AVOID:

- Antimicrobial prophylaxis
- Routine replacement of CVCs

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## PREVENTING CLABSI: UNRESOLVED ISSUES

- Routine use of needleless connectors
- Silver-coated catheters
- Standard transparent dressings (nonantimicrobial)
- Impact of CHG-containing products on CHG-resistance
- Sutureless securement
- Necessity of manual disinfection of hub/needleless connector when antiseptic-caps used

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## Central Line Associated BSI: High Stakes

CLABSI is a **rare event**. Every case is examined for root cause.

**Public reporting** is the rule

- <https://www.medicare.gov/hospitalcompare/>

**Financial penalties** for CLABSI are a reality (since 2008) and increasing with VBP.

**Reputation** may be affected.

2015: Required CLABSI reporting is house-wide (adult and pediatric ICUs, medical, surgical wards)

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# Standardized Infection Ratio (SIR)

Observed N CLABSI / Predicted N CLABSI

SIR >1 rate is higher than comparator

SIR <1 rate is lower than comparator

If predicted <1 then no SIR is calculated

Regression modeling used to calculate “Predicted” based on NHSN reference population

- 2015 SIRs based on 2006-2008 NHSN baseline
- 2016 SIR “re-baseline” based on 2015 NHSN population

Adjustment factors for CLABSI SIR: location/unit type, bed size, medical school affiliation, facility type (e.g. children/women’s hospital), birthweight if NICU

$$SIR = \frac{\text{Observed (O) HAIs}}{\text{Predicted (P) HAIs}}$$

<https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf>



### North Carolina 2024 CLABSI Highlights in Adult/Pediatric Medical, Surgical, and Medical/Surgical Wards & ICUs

- North Carolina hospitals reported 242 infections, significantly lower than the 309.50 infections predicted by the national experience.
- The most identified organisms from adult and pediatric CLABSI patients were *Candida* and other yeasts/fungi, followed by *Enterococcus*.

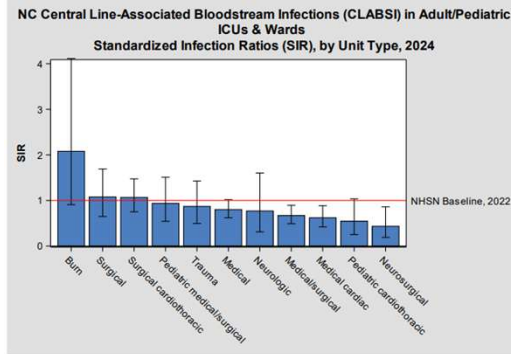
Table 1. NC Central Line Associated Bloodstream Infections (CLABSI) in Adult/Pediatric Medical, Surgical and Medical/Surgical Wards & ICUs, 2024

Year	# Observed Infections	# Predicted Infections	How Does North Carolina compare to the National Experience?
2024	242	309.50	BETTER: less than the number of infections predicted (better than the national experience)

<https://www.dph.ncdohhs.gov/epidemiology/communicable-disease/2024annualreportfinalpdf/open>



Figure 7.



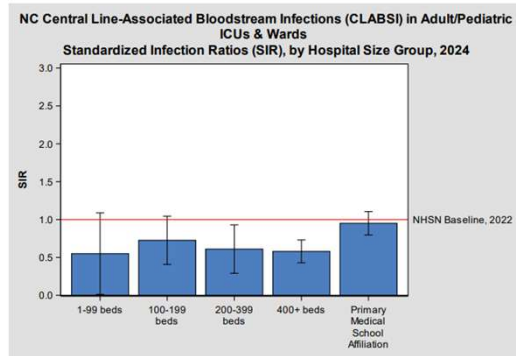
**Interpreting Figure 7:**

- In 2024, medical/surgical, medical/cardiac, and neurosurgical units reported fewer infections than predicted, performing BETTER than the national experience.
- All other unit types performed about the SAME as expected.

<https://www.dph.ncdhhs.gov/epidemiology/communicable-disease/2024annualreportfinalpdf/open>



Figure 8.



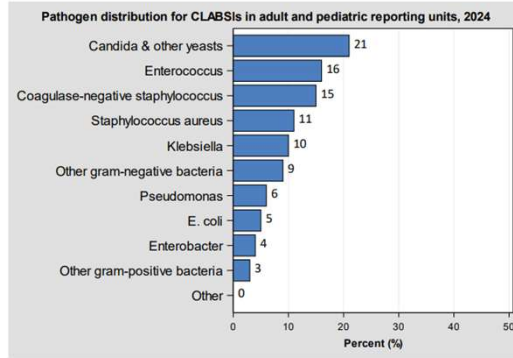
**Interpreting Figure 8:**

- In 2024, hospitals with 200-399 and 400+ beds had fewer CLABSIs than predicted, performing BETTER than the national experience.
- In 2024, hospitals with 1-99, 100-199, and primary medical school affiliation had about the same number of CLABSIs as predicted performing the SAME as the national experience.

<https://www.dph.ncdhhs.gov/epidemiology/communicable-disease/2024annualreportfinalpdf/open>



Figure 9.



**Interpreting Figure 9:**

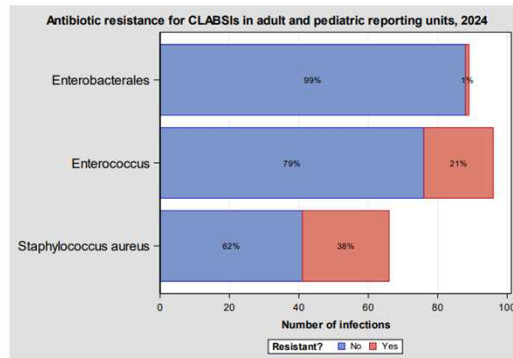
- In 2024, the most commonly identified organisms from adult and pediatric CLABSIs patients were *Candida* spp. and other yeasts/fungi (21%), followed by *Enterococcus* (16%) and coagulase-negative *Staphylococcus* (15%).

<https://www.dph.ncdhhs.gov/epidemiology/communicable-disease/2024annualreportfinalpdf/open>



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Figure 10.



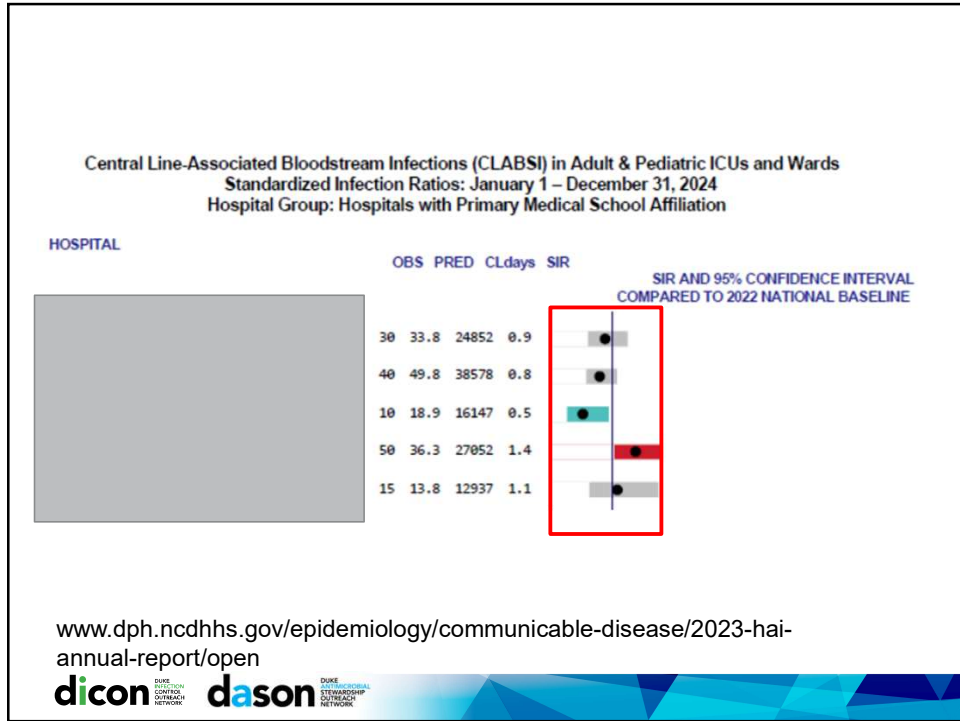
**Interpreting Figure 10:**

- In 2024, 38% of *Staphylococcus aureus* identified among adult/pediatric CLABSIs were resistant to methicillin.
- 21% of *Enterococcus* identified among adult/pediatric CLABSIs were resistant to vancomycin.
- The percentage of Enterobacteriales identified among adult/pediatric CLABSIs resistant to carbapenems was low (1%).

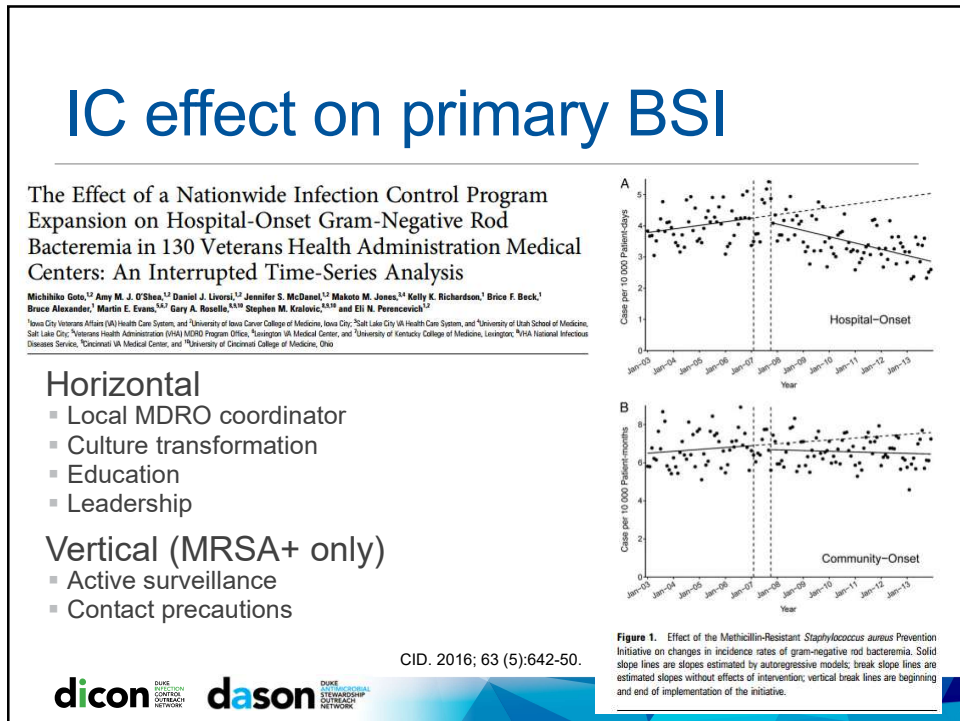
<https://www.dph.ncdhhs.gov/epidemiology/communicable-disease/2024annualreportfinalpdf/open>



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## CLABSI Prevention Success!

In 2017, there were 24,265 CLABSIs reported by 3576 United States acute care hospitals to the United States Centers for Disease Control and Prevention's National Healthcare Safety Network

**-19%**

Prevention efforts have saved ~ 3,000-6,000 lives and ~\$414 million in extra medical costs (2009 compared with 2001)

United States Centers for Disease Control and Prevention. Current HAI Progress Report.  
<https://www.cdc.gov/hai/data/portal/progress-report.html>  
 MMWR Morb Mortal Wkly Rep. 2011;60(8):243.

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But, CLABSIs still occur: ~18,000 per year

### Data highlights

Nationally, among acute care hospitals, the 2024 highlights in this report include:

Overall, **most** HAI SIRs decreased in 2024 compared to 2023:

- 9% decrease in CLABSI
  - Decreases observed across ICU locations ICUs (10%) and Ward locations (9%)

<https://www.cdc.gov/healthcare-associated-infections/php/data/progress-report.html>

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# CONCLUSIONS

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- Healthcare-associated bloodstream (BSI) cause significant morbidity and mortality
- The most important risk factor for BSI is presence of a central venous catheter
- Clinical definition and surveillance definition of catheter-related BSI are NOT the same
- A near 0 rate of CLABSI is possible using existing technology and appropriate practice strategies
- Current guidelines should be followed for the prevention of CLABSI