BLOODSTREAM INFECTIONS (BSI)

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND PREVENTION

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Disclosures

No Conflicts of Interest Relevant to Bloodstream Infections

UptoDate Royalties (Pelvic Osteomyelitis)

Consultant: 3M, Osteal Therapeutics, Nichol & Associates

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

BSI: Impact on Healthcare

Approximately 72,000 primary bloodstream infections per year

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

Rate of BSIs varies by:

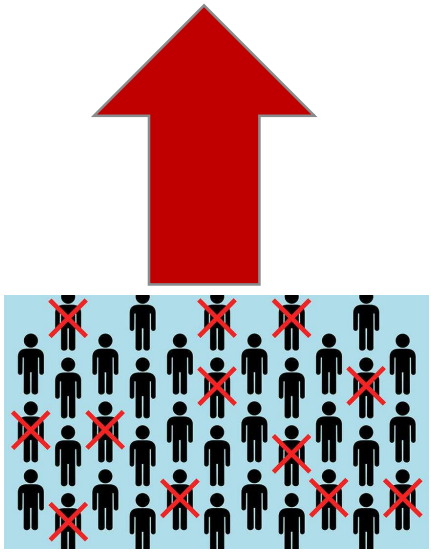
- Hospital size, unit, and service
- Population served (elderly/infants, acute/chronic)
- Use and type of intravascular access device
- Time-trends
- Endemic/Epidemic

Major risk = central venous catheter

- 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.

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

BSI: 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.

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)
Primary bloodstream infection§	5	50	9.9 (7.5–12.8)
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)	1,862 (17.2)	259 (57.3)	<0.001
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

Central Line Utilization by Unit

High: ICUs (Medical and Surgical)

Low: Psych, L&D/Postpartum, Ortho

Central line utilization ratio[¶]					Percentile				
Type of acute care hospital location	No. of locations[†]	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							
Surgical cardiothoracic	455 (454)	955,534	1,						
Trauma	147	329,688							
Step-down units									
Adult step-down (postcritical care)	700 (699)	818,478	3,						
Step-down NICU (level II)	47 (44)	4,886	83,342	0.06	0.01	0.02	0.04	0.07	0.11
Pediatric step-down (postcritical care)	17	17,416	57,086	0.31					
Mixed acuity units[‡]									
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									

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

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

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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*					Percentile				
Type of acute care hospital location	No. of locations†	No. of CLABSIs	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	185	146,238	1.3	0.0	0.6	1.2	2.0	2.7
Pediatric m									
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Pediatric s									
Prenatal									
Respiratory									
Surgical: m									
Surgical: all other	190 (186)	295	345,261	0.9	0.0	0.0	0.7	1.4	2.3
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
Step-down units									

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

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

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Definitions: IMPORTANT!

CLINICAL DEFINITION ≠ SURVEILLANCE DEFINITION

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

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

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.

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

CLINICAL DEFINITION

Signs and symptoms

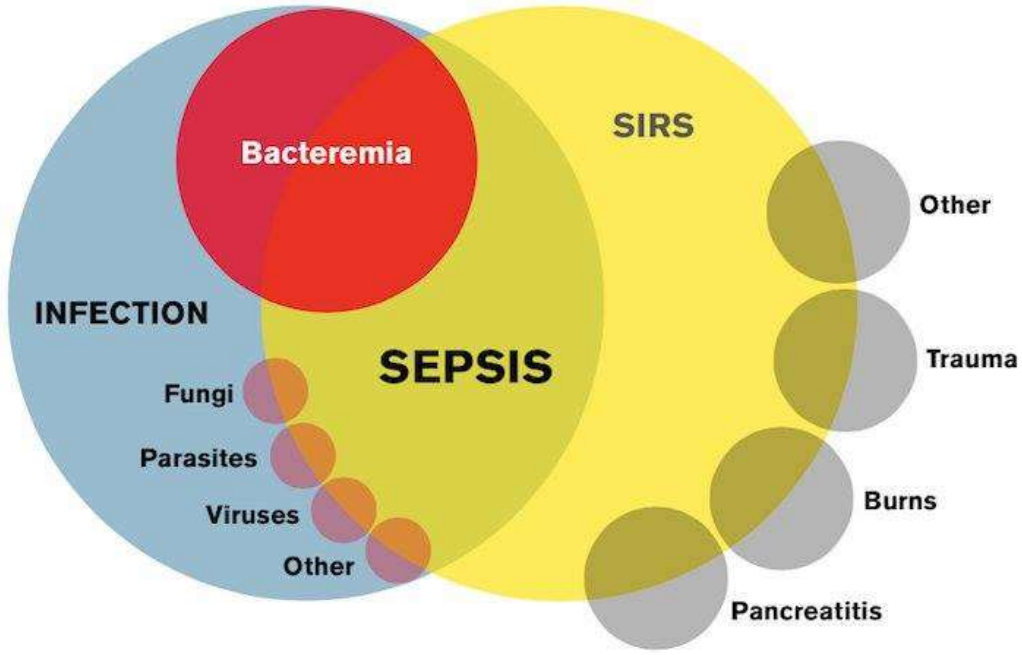
Systemic: Fever, chills, rigors, fatigue → hypotension, shock

Respiratory: hyperventilation → respiratory failure

Neurologic: Confusion → seizure, coma

Secondary: Other localized infection symptoms

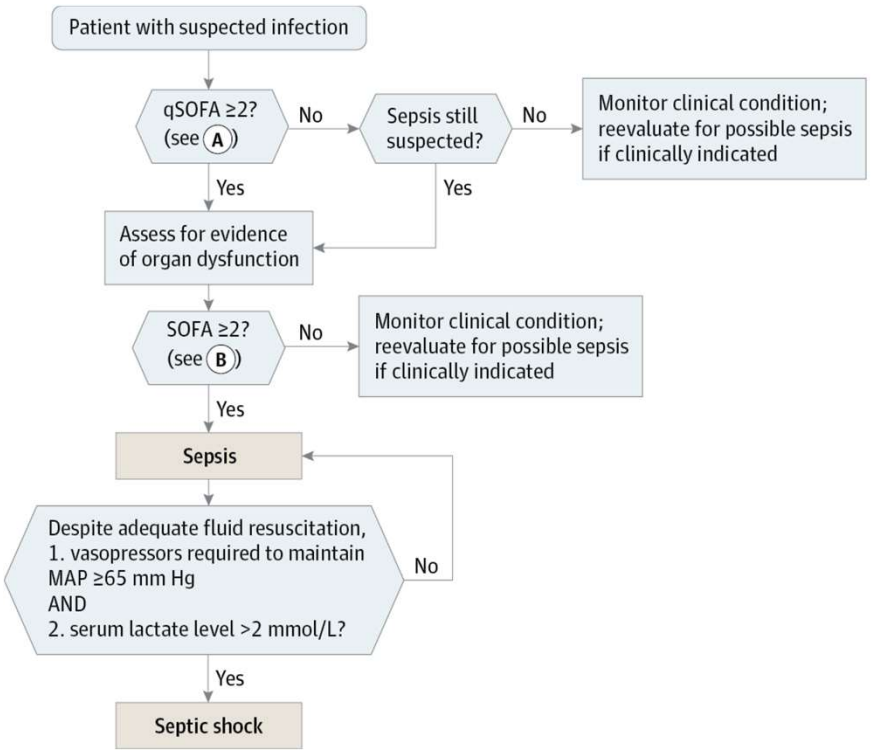
Localized infection **Fever** **Septic Shock + Organ Failure**



SIRS criteria (old):
WBC>12K or <4K or >10% bands
RR>20
HR>90
Temp>38 or <36C

Image: https://twitter.com/ICPIC_meeting/status/982198791301283842

Recognize and Treat Sepsis



A qSOFA Variables
- Respiratory rate
- Mental status
- Systolic blood pressure

B SOFA Variables
- PaO_2/FiO_2 ratio
- Glasgow Coma Scale score
- Mean arterial pressure
- Administration of vasopressors with type and dose rate of infusion
- Serum creatinine or urine output
- Bilirubin
- Platelet count

JAMA. 2016;315(8):801-810

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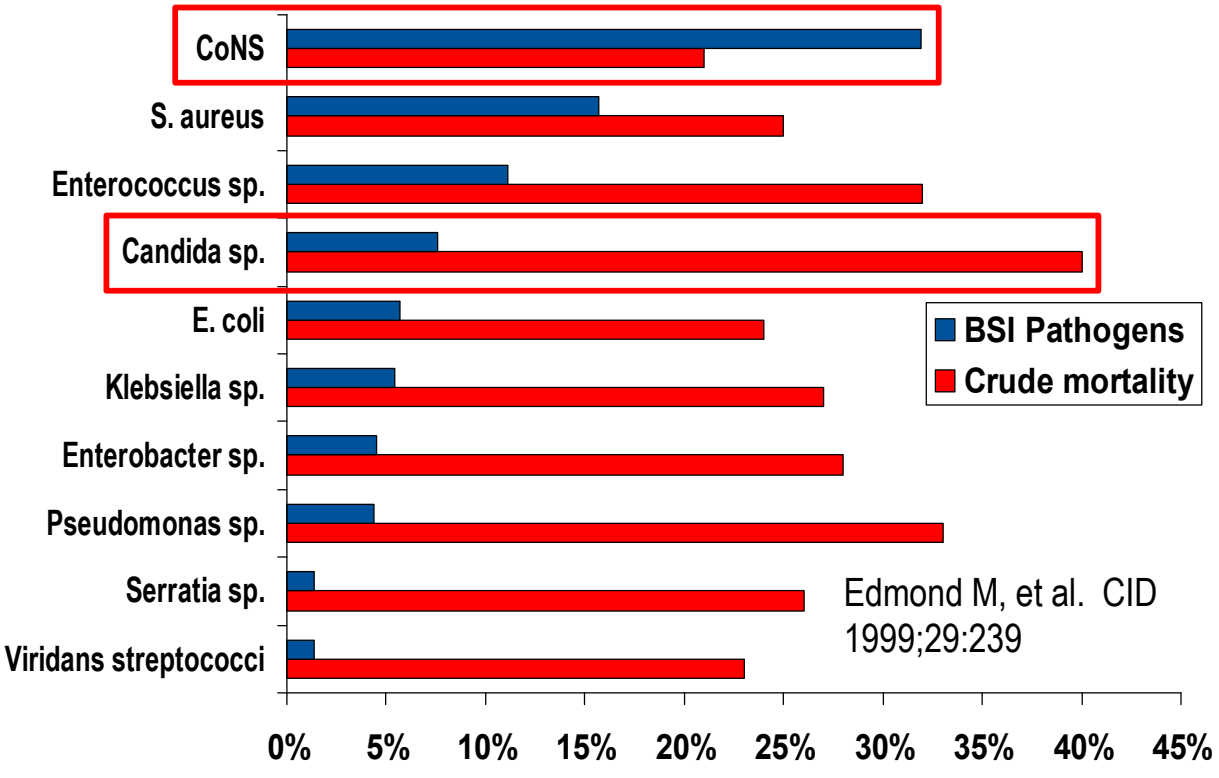
MORTALITY OF NOSOCOMIAL BSI, SCOPE, 1995-98



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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)

CLINICAL DEFINITION

Central Venous Catheter Infections

Infection	Definition
Catheter colonization	Significant growth of ⩾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[a]
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[a]
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[a]
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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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 basilar 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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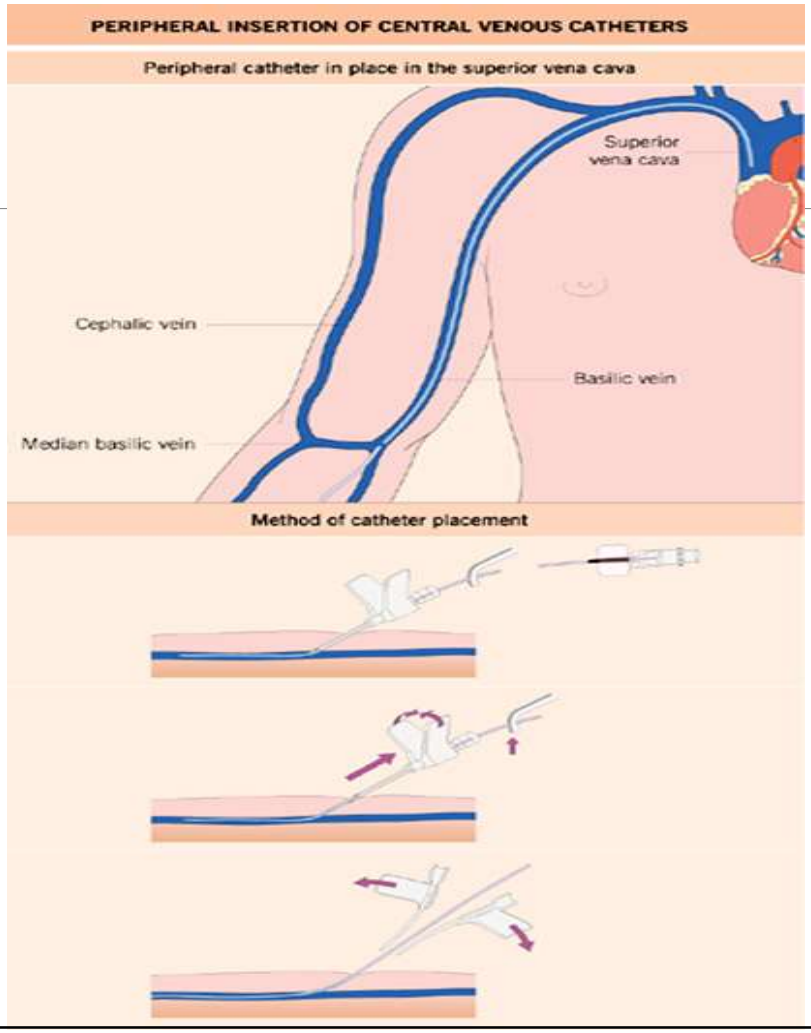
PERIPHERAL INSERTION OF CENTRAL VENOUS CATHETERS
Peripheral catheter in place in the superior vena cava
Superior vena cava
Cephalic vein
Basilic vein
Median basilic vein
Method of catheter placement

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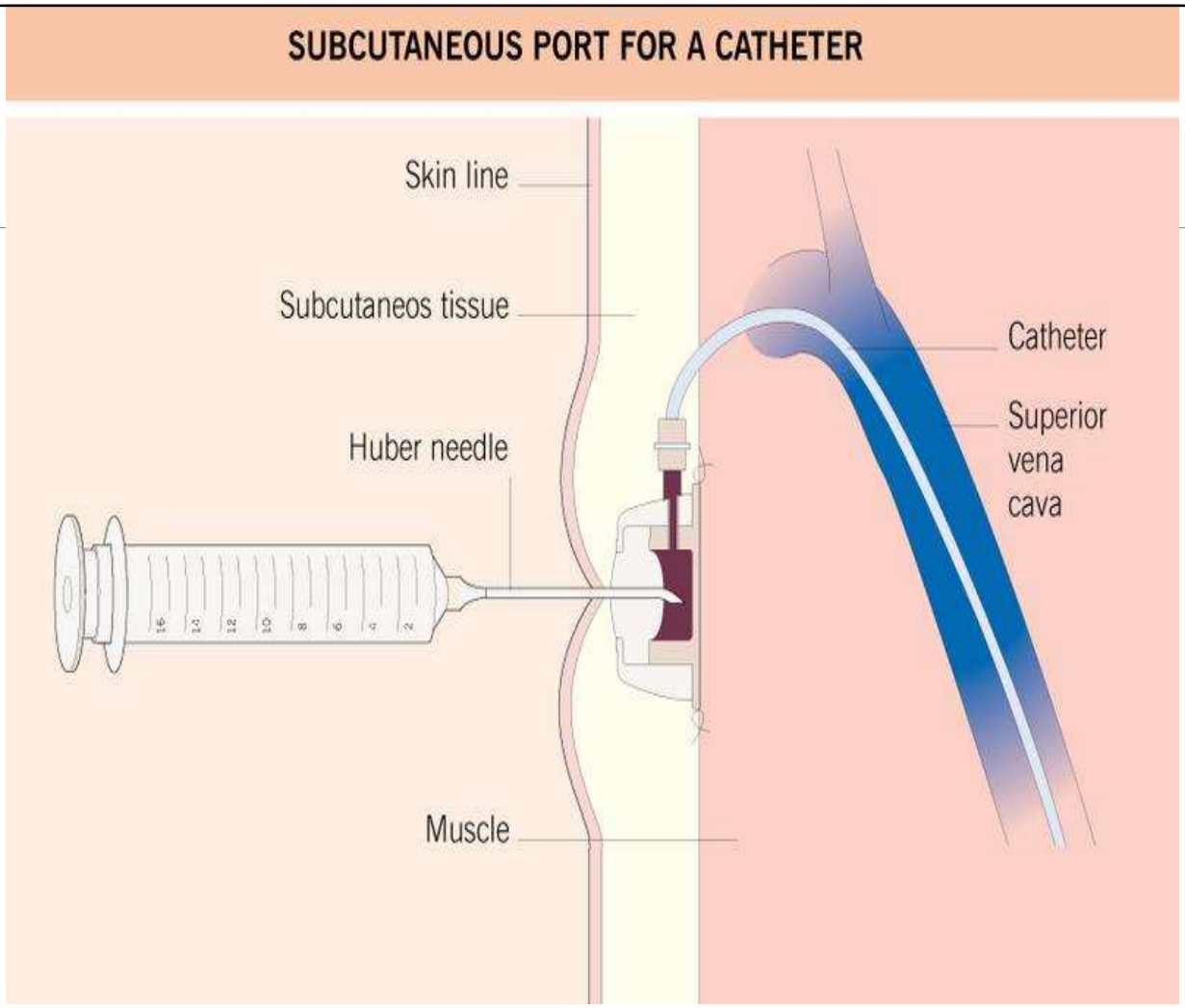
SUBCUTANEOUS PORT FOR A CATHETER
Skin line
Subcutaneos tissue
Huber needle
Muscle
Catheter
Superior
vena
cava

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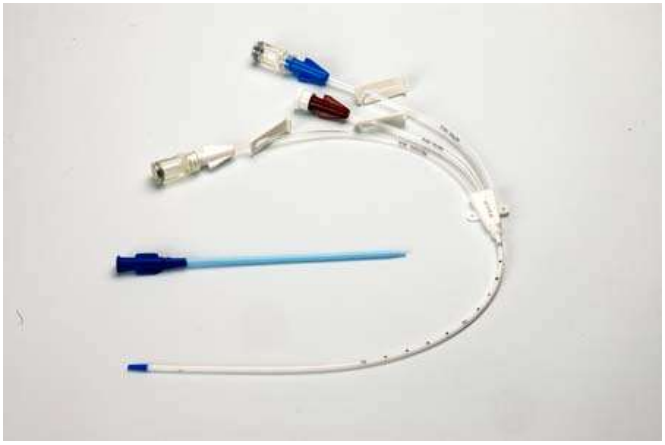
PATHOGENESIS Central Line Infection

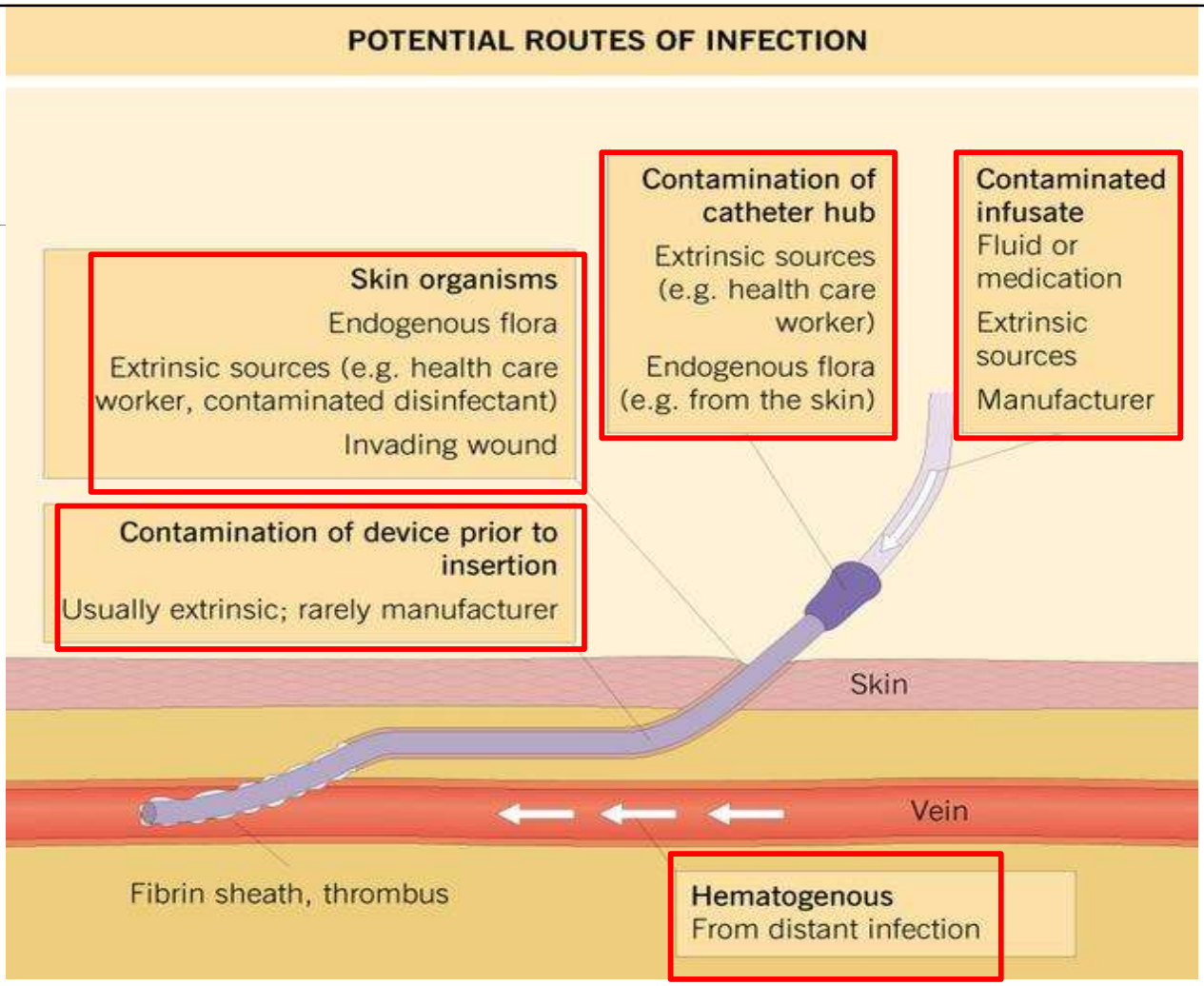
Multifactorial and complex

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 intralumenal colonization (especially in long-term catheters)

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




POTENTIAL ROUTES OF INFECTION
Contamination of catheter hub
Extrinsic sources (e.g. health care worker)
Endogenous flora (e.g. from the skin)
Contaminated infusate
Fluid or medication
Extrinsic sources
Manufacturer
Skin organisms
Endogenous flora
Extrinsic sources (e.g. health care worker, contaminated disinfectant)
Invading wound
Contamination of device prior to insertion
Usually extrinsic; rarely manufacturer
Skin
Vein
Fibrin sheath, thrombus
Hematogenous
From distant infection

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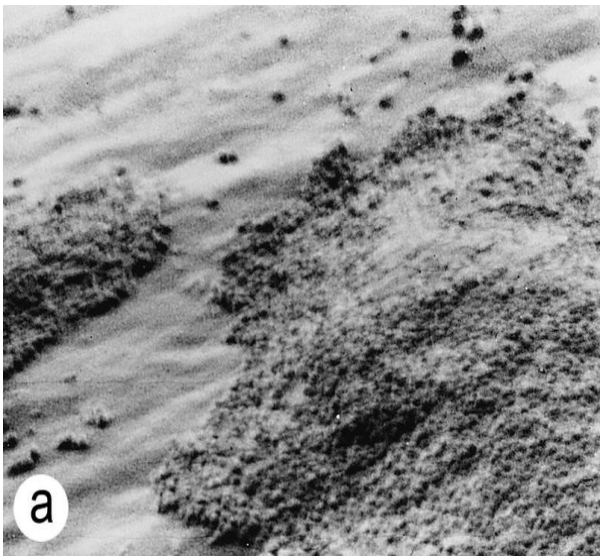
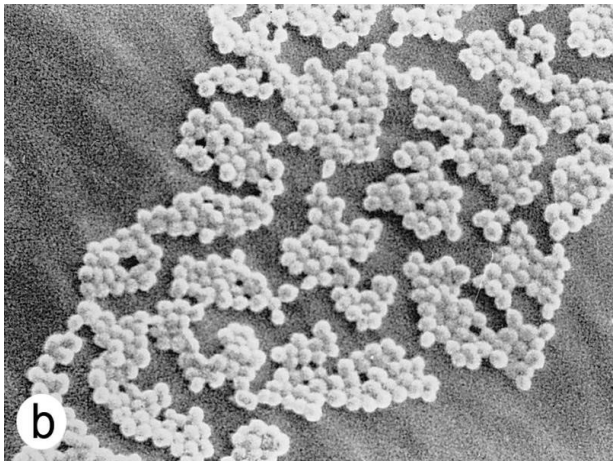
BIOFILM





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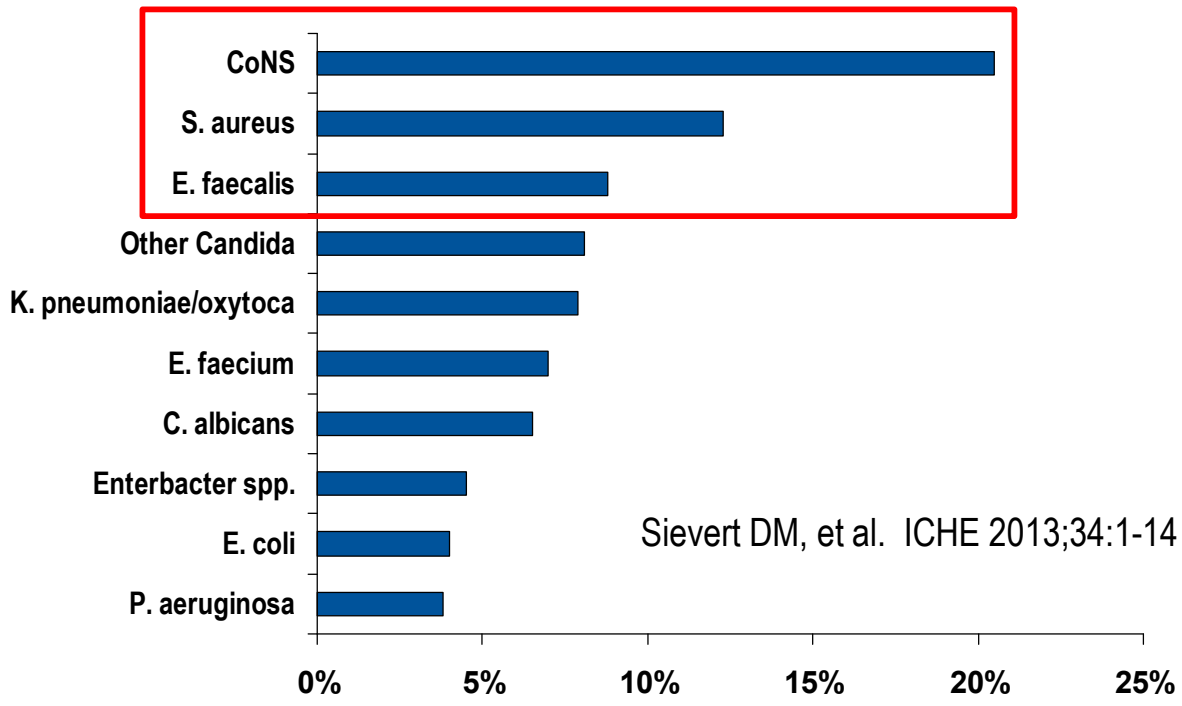
TOP 10 PATHOGENS ASSOCIATED WITH CLABSIs: NHSN, 2009-2010



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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

Risk Factors for CLABSI*

- Prolonged hospitalization prior to catheterization
- Prolonged duration of catheterization
- Heavy microbial colonization at the insertion site
- Heavy microbial colonization of the catheter hub
- **Site of catheter (adults): Femoral (worst), Internal jugular, compared to Subclavian (best)**
- Multilumen or concurrent catheters
- Substandard catheter care
- Neutropenia
- BMA >40
- Prematurity
- Host Immunity: Neutropenia, neonate prematurity
- Reduced Nurse: Patient Ratios (ICU)
- **TPN**
- Substandard catheter care (e.g. excessive manipulation)
- Blood products (children)

*In at least 2 observational studies *ICHE* 2014; 35: 753-771.

Decreased Risk/Protective Factors

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

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*

COMPLICATIONS OF CLABSIs

Local infection
- Tunnel infection, pocket infection

Sepsis

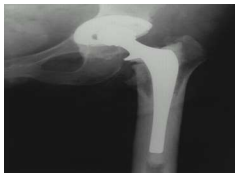
Remote site infection
- Osteomyelitis
- Meningitis

Endovascular infection
- Endocarditis
- Mycotic aneurysms
- Septic thrombophlebitis

Identifying Complicated SAB

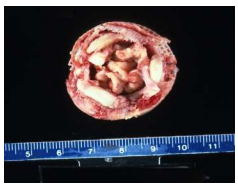
Clinical Context Matters

S. aureus Bacteremia + Prosthesis = Trouble



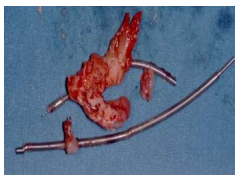
SAB + Arthroplasty = 28% Joint Infection

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



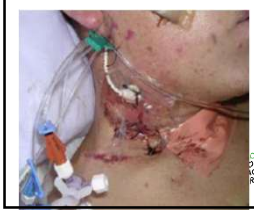
SAB + Prosthetic Valve = 51% Valve Infection

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

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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.

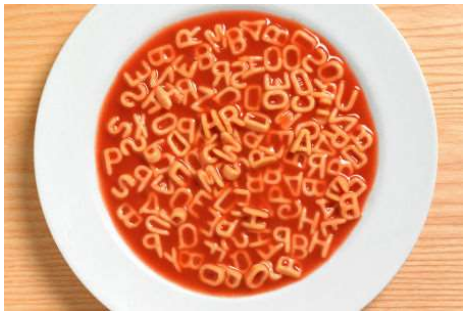
NHSN definitions must be adjusted with time due to the dynamic nature of medicine.

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

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.

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.

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.

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

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 **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

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

Scenario 1

Site	Criterion
ABUTI	ABUTI
BONE	1
BRST	1
CARD	1
CIRC	2 or 3
CONJ	1a
DECU	1
DISC	1
EAR	1, 3, 5 or 7
EMET	1
ENDO	1
EYE	1
GE	2a
GIT	2a, 2b (only yeast)
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
VCUF	3

Scenario 2

Site	Criterion
ABUTI	ABUTI
BONE	3a
BURN	1
DISC	3a
ENDO	4a, 4b, 5a or 5b (specific organisms) 6e or 7e plus other criteria as listed
GIT	1b or 2c
IAB	2b or 3b
JNT	3c
MEN	2c or 3c
OREP	3a
PNEU	2 or 3
SA	3a
UMB	1b
USI	3b or 4b

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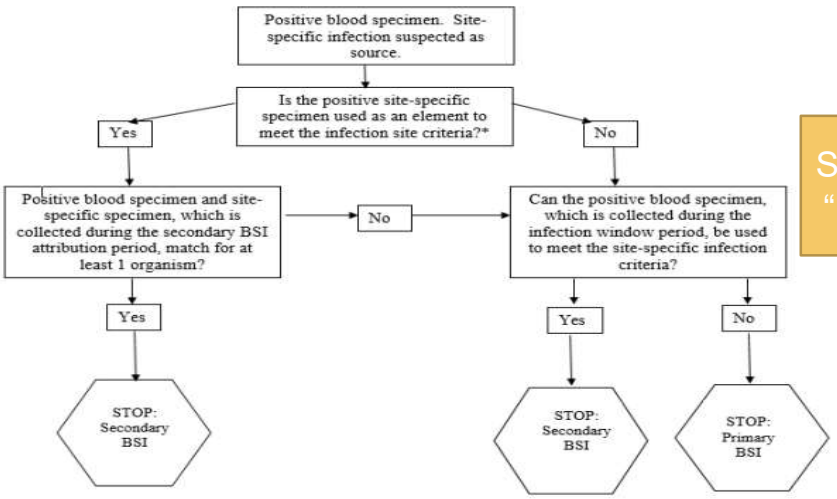
SECONDARY BSI GUIDE FOR ELIGIBLE ORGANISMS (not applicable to VAE)

Figure B1: Secondary BSI Guide for eligible organisms*‡

(Not applicable to Ventilator-associated Events [VAE], See Figure B2)



Scenario 1 "Match"

Scenario 2 "Element"

All else= Primary LCBI

*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.

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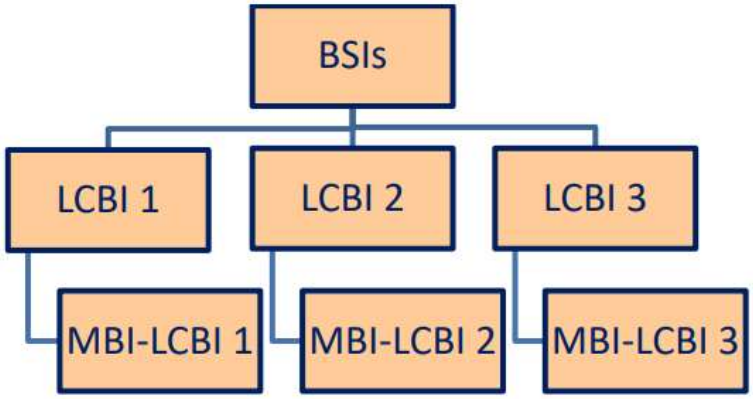
SURVEILLANCE DEFINITION

Laboratory Confirmed BSI (LCBI)

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



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

Complex patient population	• Highly toxic treatments • ICU stays • Complications (infection, bleeding, ADEs)
Device utilization	• True need for central line
Culturing practices	• Bad veins • Thrombocytopenia
Antimicrobial utilization	• Like water • Usually appropriate for severity of illness
Surveillance practices	• Variable?
Administrative pressure	• “Protective” of program and reputation
Adjudication	• Clinicians don’t consider many “CLABSI” to be preventable • Definitions don’t apply well to patient population and leads to rejection of data

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SURVEILLANCE DEFINITION

Mucosal Barrier Injury Laboratory Confirmed Bloodstream Infection (MBI-LCBI)

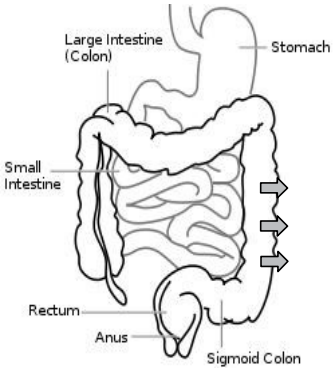
A subset of the LCBI criteria

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

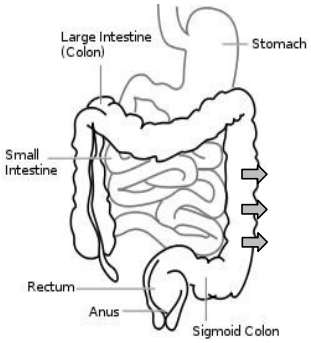


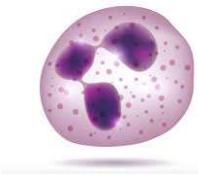
SURVEILLANCE DEFINITION

Mucosal 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) ≥1-liter diarrhea in a 24-hour period (or ≥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/mm3 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.





SURVEILLANCE DEFINITION

MBI-LCBI 1

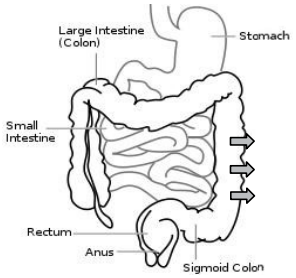
1

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

SURVEILLANCE DEFINITION

MBI-LCBI 3

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

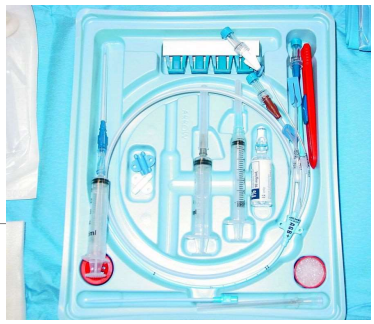
Only viridans group streptococci and/or Rothia spp and no other organisms.

Plus

One of the MBI criteria

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)

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-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

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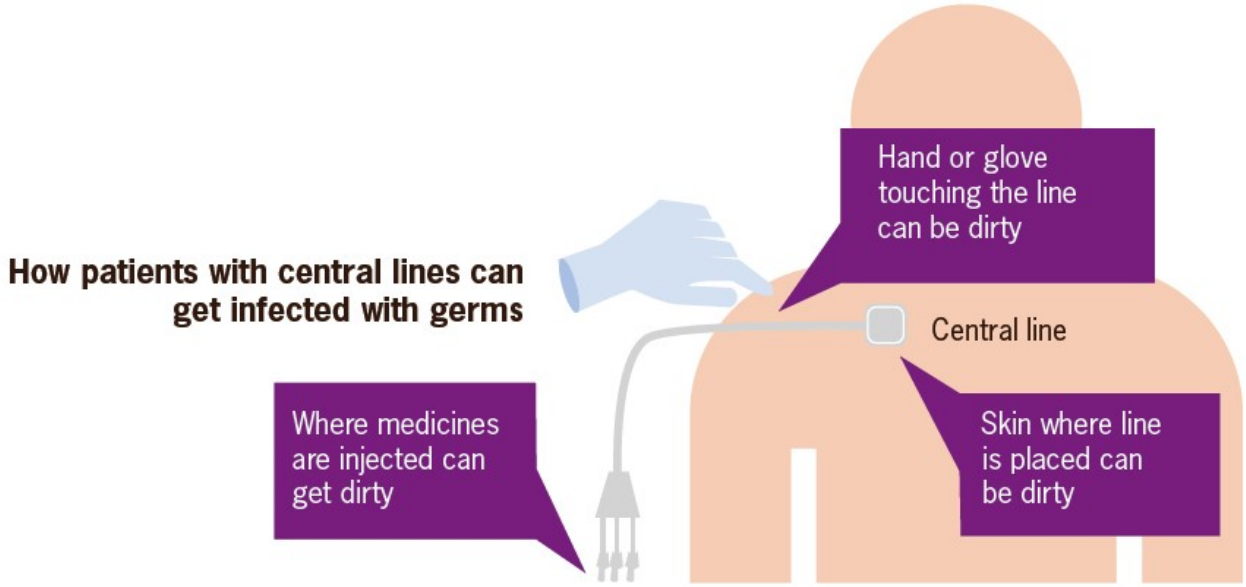
How does CLABSI happen?



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

Contamination occurs…

Insertion:

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

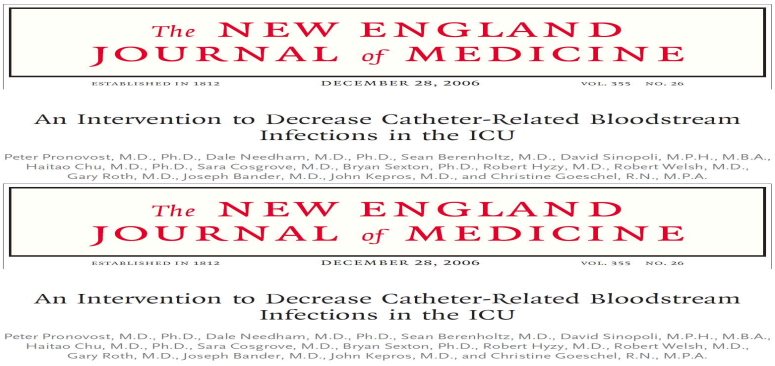
Maintenance:

- 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?

Institute for Healthcare Improvement

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



The NEW ENGLAND JOURNAL of MEDICINE

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

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http://www.ihi.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.

Institute for Healthcare Improvement

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

SHEA

SHEA/IDSA/APIC Practice Recommendation

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

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

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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.

[a]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),[265] and the Canadian Task Force on Preventive Health Care.[266]

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)[74–78]
3. Bathe ICU patients aged >2 months with a chlorhexidine preparation on a daily basis (Quality of Evidence: HIGH)[86–90]

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)[101]
2. Perform hand hygiene prior to catheter insertion or manipulation (Quality of Evidence: MODERATE)[102–107]
3. The subclavian site is preferred to reduce infectious complications when the catheter is placed in the ICU setting (Quality of Evidence: HIGH)[33,37,108–110]
4. Use an all-inclusive catheter cart or kit (Quality of Evidence: MODERATE)[118]
5. Use ultrasound guidance for catheter insertion (Quality of Evidence: HIGH)[119,120]
6. Use maximum sterile barrier precautions during CVC insertion (Quality of Evidence: MODERATE)[123–128]
7. Use an alcoholic chlorhexidine antiseptic for skin preparation (Quality of Evidence: HIGH)[42,129–134]

After insertion

1. Ensure appropriate nurse-to-patient ratio and limit use of float nurses in ICUs (Quality of Evidence: HIGH)[34,35]
2. Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (Quality of Evidence: HIGH)[45,135–142]
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)[145–148]
4. Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter (Quality of Evidence: MODERATE)[150–154]
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)[164]
7. Perform surveillance for CLABSI in ICU and non-ICU settings (Quality of Evidence: HIGH)[13,165,166]

Additional Approaches

1. Use antiseptic- or antimicrobial-impregnated CVCs (Quality of Evidence: HIGH in adult patients[38,39,169–171] and Quality of Evidence: MODERATE in pediatric patients)[172,173]
2. Use antimicrobial lock therapy for long-term CVCs (Quality of Evidence: HIGH)[177–184]
3. Use recombinant tissue plasminogen activating factor (rt-PA) once weekly after hemodialysis in patients undergoing hemodialysis through a CVC (Quality of Evidence: HIGH)[192]
4. Utilize infusion or vascular access teams for reducing CLABSI rates (Quality of Evidence: LOW)[193,194]
5. Use antimicrobial ointments for hemodialysis catheter insertion sites (Quality of Evidence: HIGH)[197–201]
6. Use an antiseptic-containing hub/connector cap/port protector to cover connectors (Quality of Evidence: MODERATE)[202–208]

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)[209–213]
2. Do not routinely replace CVCs or arterial catheters (Quality of Evidence: HIGH)[214]

Unresolved Issues

1. Routine use of needleless connectors as a CLABSI prevention strategy before an assessment of risks, benefits, and education regarding proper use[215–219]
2. Surveillance of other types of catheters (eg, peripheral arterial or peripheral venous catheters)[11,21,22]
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)[227]
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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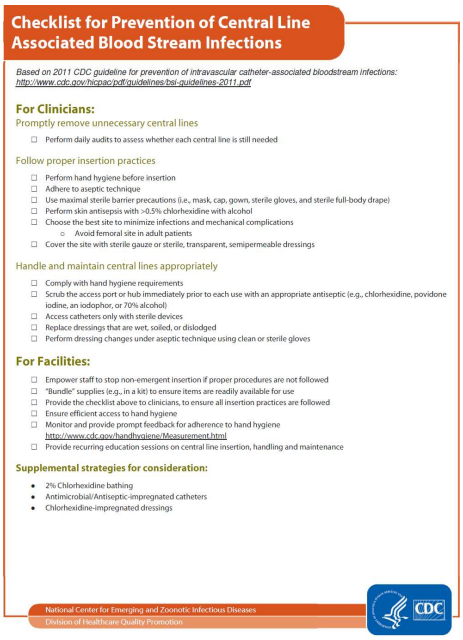
PREVENTING CLABSI: BEFORE INSERTION

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/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf

For Clinicians:

Promptly remove unnecessary central lines

- ☐ Perform 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, gown, sterile gloves, and sterile full-body drape)
- ☐ Perform skin antisepsis with >0.5% chlorhexidine with alcohol
- ☐ Choose the best site to minimize infections and mechanical complications
  - ○ Avoid femoral site in adult patients
- ☐ Cover the site with sterile gauze or sterile, transparent, semipermeable dressings

Handle and maintain central lines appropriately

- ☐ Comply with hand hygiene requirements
- ☐ Scrub the access port or hub immediately prior to each use with an appropriate antiseptic (e.g., chlorhexidine, povidone iodine, an iodophor, or 70% alcohol)
- ☐ Access catheters only with sterile devices
- ☐ Replace dressings that are wet, soiled, or dislodged
- ☐ Perform dressing changes under aseptic technique using clean or sterile gloves

For Facilities:

- ☐ Empower staff to stop non-emergent insertion if proper procedures are not followed
- ☐ "Bundle" supplies (e.g., in a kit) to ensure items are readily available for use
- ☐ Provide the checklist above to clinicians, to ensure all insertion practices are followed
- ☐ Ensure efficient access to hand hygiene
- ☐ Monitor and provide prompt feedback for adherence to hand hygiene http://www.cdc.gov/handhygiene/Measurement.html
- ☐ Provide recurring education sessions on central line insertion, handling and maintenance

Supplemental strategies for consideration:

- 2% Chlorhexidine bathing
- Antimicrobial/Antiseptic-impregnated catheters
- Chlorhexidine-impregnated dressings

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion

FAQs (frequently asked questions) about **"Catheter-Associated Bloodstream Infections"** (also known as "Central Line-Associated Bloodstream Infections")

What is a catheter-associated bloodstream infection?

A "central line" or "central catheter" is a tube that is placed into a patient's large vein, usually in the neck, chest, arm, or groin. The catheter is often used to draw blood, or give fluids or medications. It may be left in place for several weeks. A bloodstream infection can occur when bacteria or other germs travel down a "central line" and enter the blood. If you develop a catheter-associated bloodstream infection you may become ill with fevers and chills or the skin around the catheter may become sore and red.

Can a catheter-related bloodstream infection be treated?

A catheter-associated bloodstream infection is serious, but often can be successfully treated with antibiotics. The catheter might need to be removed if you develop an infection.

What are some of the things that hospitals are doing to prevent catheter-associated bloodstream infections?

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

- Choose a vein where the catheter can be safely inserted and where the risk for infection is small.
- Clean their hands with soap and water or an alcohol-based hand rub before putting in the catheter.
- Wear 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 sheet.
- Clean the patient's skin with an antiseptic cleanser before putting in the catheter.
- Clean their hands, wear gloves, and clean the catheter opening with an antiseptic solution before using the catheter to draw blood or give medications. Healthcare providers also clean their hands and wear gloves when changing the bandage that covers the area where the catheter enters the skin.
- Decide every day if the patient still needs to have the catheter. The catheter will be removed as soon as it is no longer needed.
- Carefully handle medications and fluids that are given through the catheter.

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

- Ask your doctors and nurses to explain why you need the catheter and how long you will have it.
- Ask your doctors and nurses if they will be using all of the prevention methods discussed above.
- Make sure that all doctors and nurses caring for you clean their hands with soap and water or an alcohol-based hand rub before and after caring for you.

If you do not see your providers clean their hands, please ask them to do so.

- If the bandage comes off or becomes wet or dirty, tell your nurse or doctor immediately.
- Inform your nurse or doctor if the area around your catheter is sore or red.
- Do not let family and friends who visit touch the catheter or the tubing.
- Make sure family and friends clean their hands with soap and water or an alcohol-based hand rub before and after visiting you.

What do I need to do when I go home from the hospital?

Some patients are sent home from the hospital with a catheter in order to continue their treatment. If you go home with a catheter, your doctors and nurses will explain everything you need to know about taking care of your catheter.

- Make sure you understand how to care for the catheter before leaving the hospital. For example, ask for instructions on showering or bathing with the catheter and how to change the catheter dressing.
- Make sure you know who to contact if you have questions or problems after you get home.
- Make sure you wash your hands with soap and water or an alcohol-based hand rub before handling your catheter.
- Watch for the signs and symptoms of catheter-associated bloodstream infection, such as soreness or redness at the catheter site or fever, and call your healthcare provider immediately if any occur.

If you have additional questions, please ask your doctor or nurse.

Co-sponsored by: SHEA, IDSA, American Hospital Association, APIC, CDC, The Joint Commission

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

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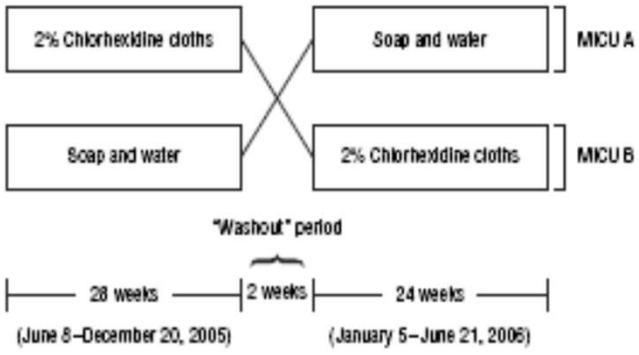
BATHE ICU PATIENTS >2 MONTHS OF AGE WITH A CHG PREPARATION DAILY

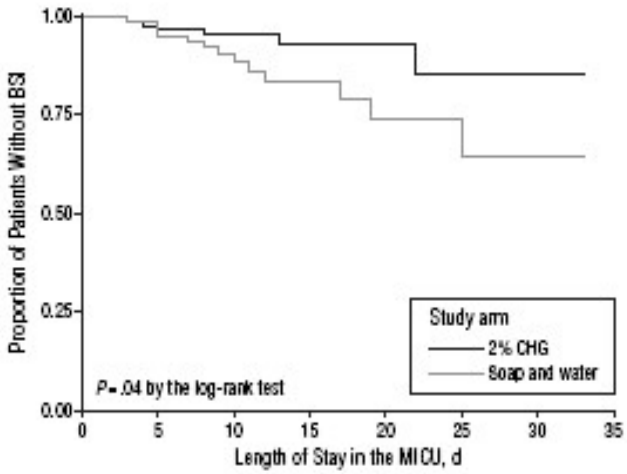
Intervention = Daily bathing with 2% CHG impregnated washcloth

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)

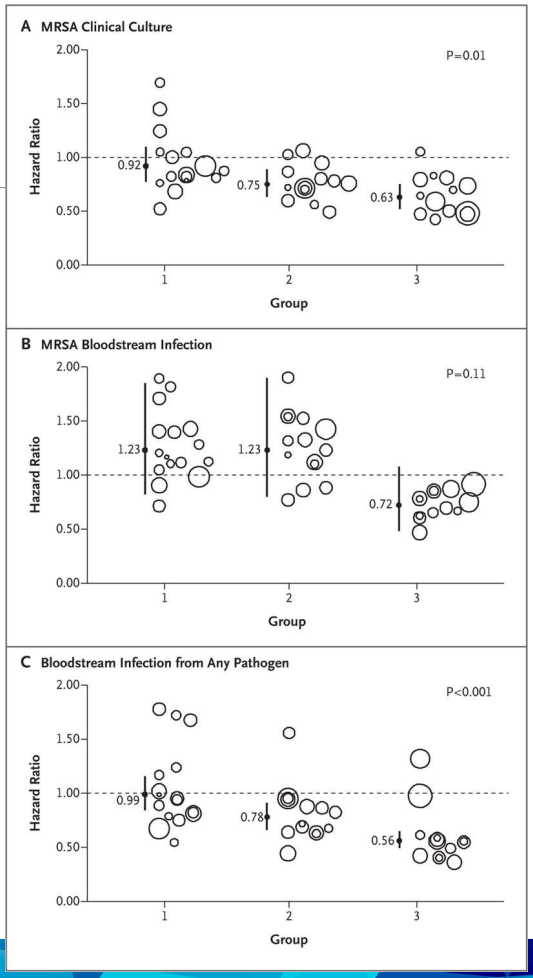




Bleasdale S, et al. Arch Intern Med 2007;167:2073

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 used 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

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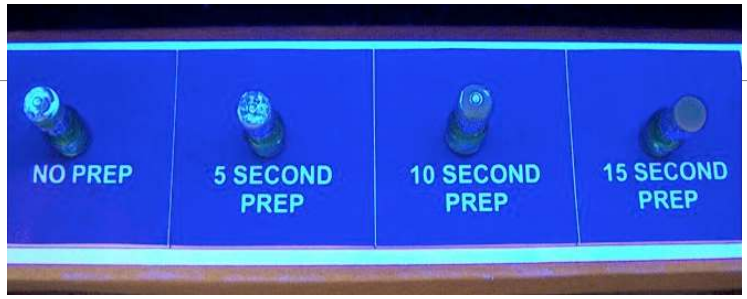
CLABSI: MAINTENANCE



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/needless connector when antiseptic-caps used

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

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

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

North Carolina 2023 CLABSI Highlights in Adult/Pediatric Medical, Surgical, and Medical/Surgical Wards & ICUs

- North Carolina hospitals reported 480 infections, compared to the 563.72 infections predicted by the 2015 national experience; this was better than the 2015 national experience.
- The most frequently identified organisms from adult and pediatric CLABSI patients were *Candida* spp and other yeasts/fungi, followed by coagulase-negative *Staphylococcus*.

Table 1. NC Central Line Associated Bloodstream Infections (CLABSI) in Adult/Pediatric Medical, Surgical and Medical/Surgical Wards & ICUs, 2023

Division of Public Health, SHARPPS Program NC HAI Annual Report – November 2024 12

Year	# Observed Infections	# Predicted Infections	How does North Carolina compare to the 2015 National Experience?
2023	480	563.72	BETTER: less than the number of infections predicted (better than the 2015 national experience)

www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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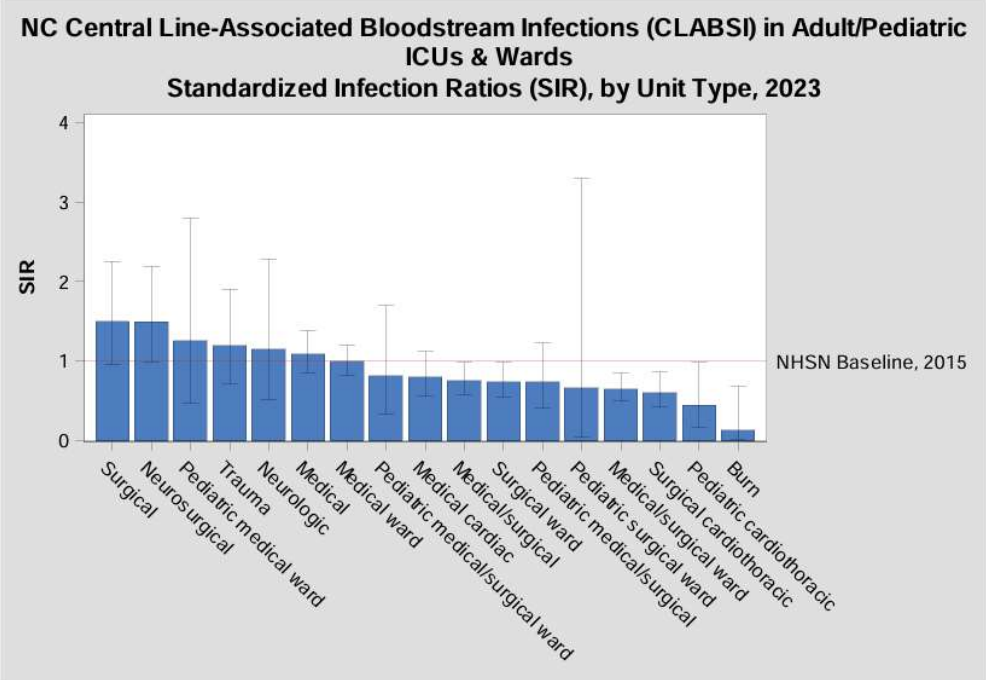
Figure 7.



Interpreting Figure 7:

- In 2023, medical/surgical, surgical cardiothoracic, pediatric, and burn units reported fewer infections than predicted, performing BETTER than the 2015 national experience. All other unit types performed about the SAME as expected.

www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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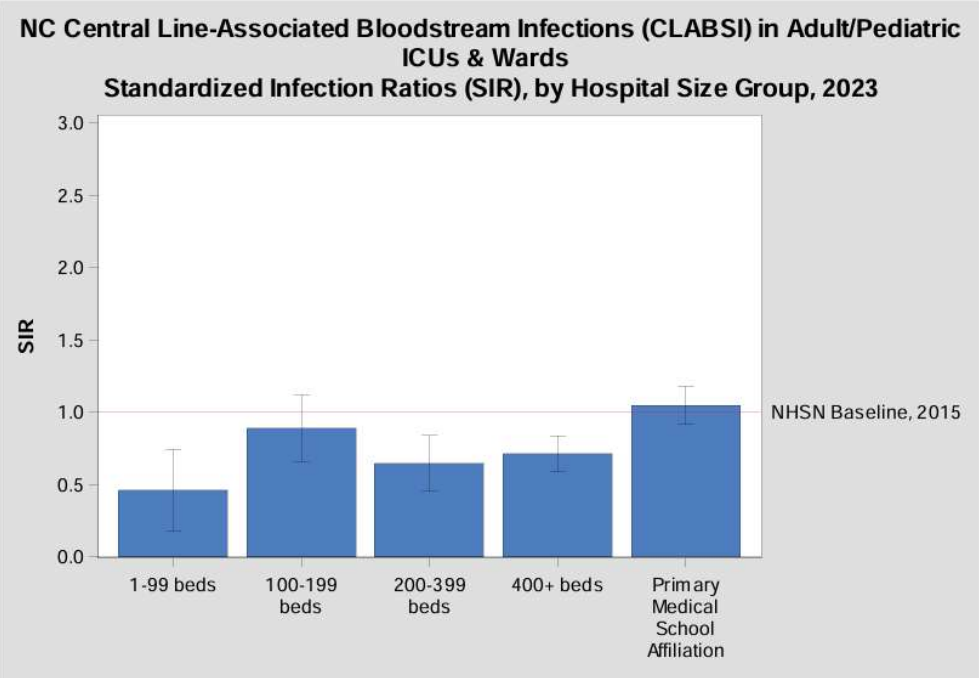

Interpreting Figure 8:

- In 2023, hospitals with 1-99, 200-399, and 400+ beds had fewer CLABSIs than predicted, performing BETTER than the 2015 national experience.
- In 2023, hospital sizes with 100-199 beds and Primary Medical School affiliation had about the same number of CLABSIs as predicted, preforming the SAME as the 2015 national experience.

www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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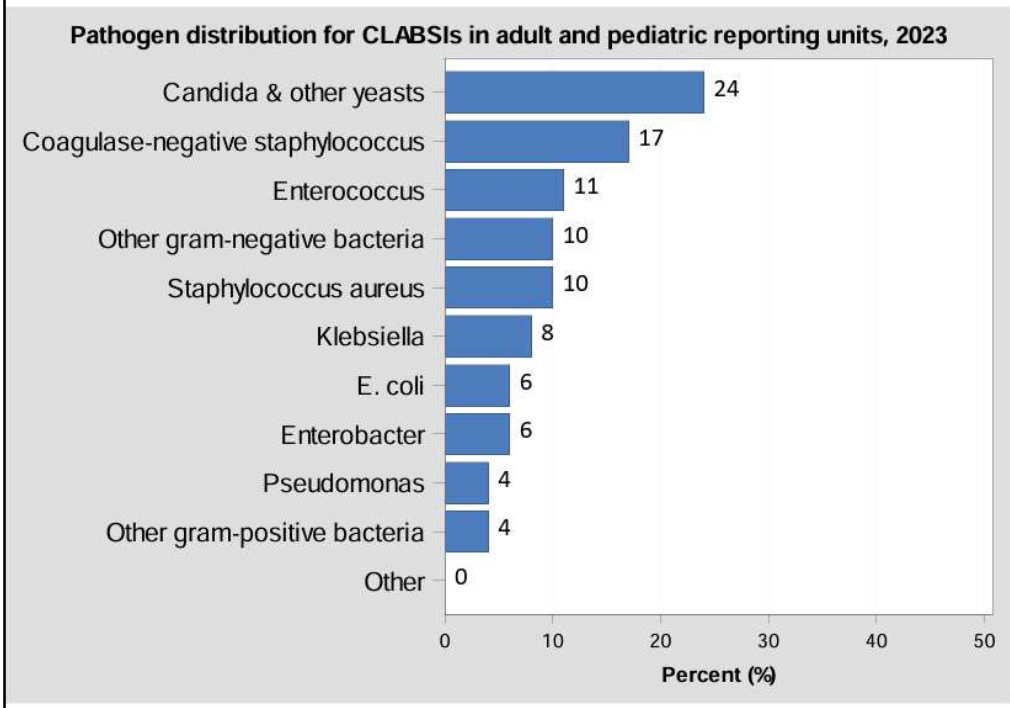

Interpreting Figure 9:

- In 2023, the most commonly identified organisms from adult and pediatric CLABSI patients were *Candida* spp. and other yeasts/fungi (24%), followed by coagulase-negative *Staphylococci* (17%).

www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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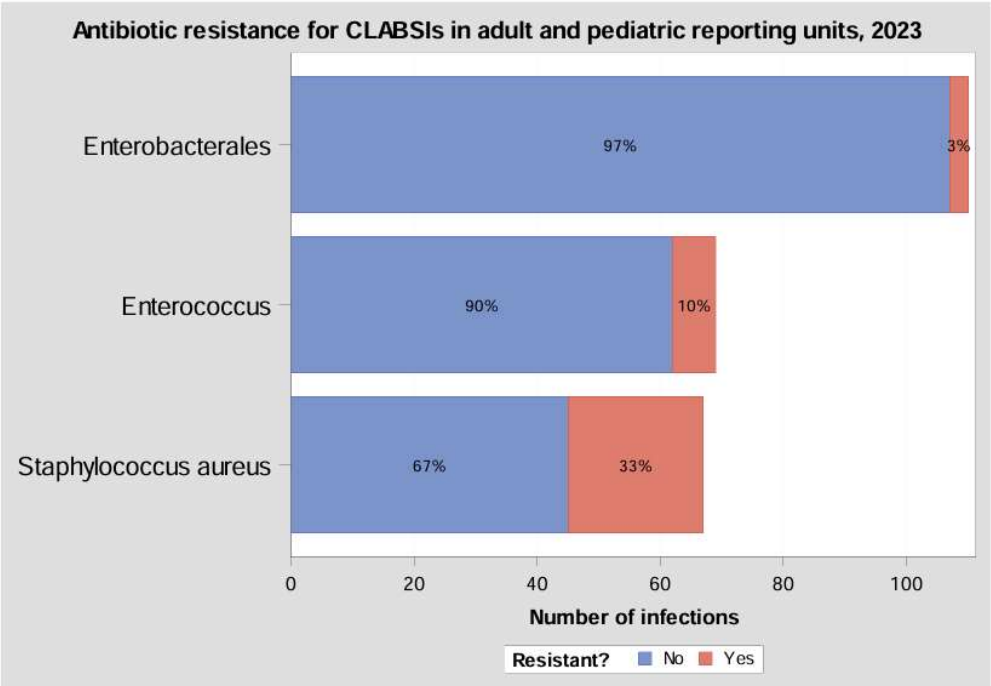

Interpreting Figure 10:

- The percentage of Enterobacterales identified among adult/pediatric CLABSIs resistant to carbapenems was low (3%).
- 10% of *Enterococcus* identified among adult/pediatric CLABSIs were resistant to vancomycin.
- In 2023, 33% of *Staphylococcus aureus* identified among adult/pediatric CLABSIs were resistant to methicillin.

www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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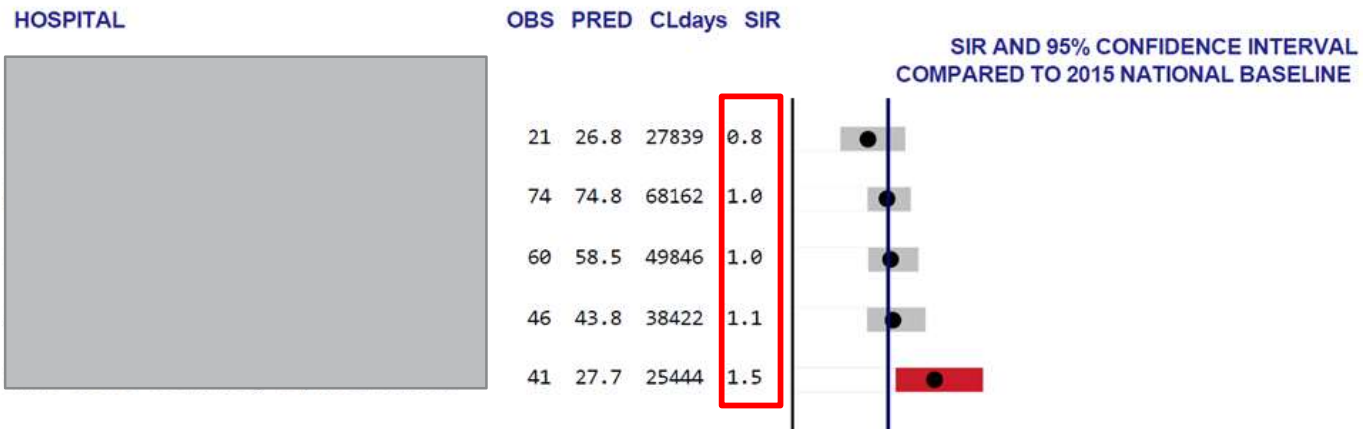
Central Line-Associated Bloodstream Infections (CLABSI) in Adult & Pediatric ICUs and Wards
Standardized Infection Ratios: January 1 – December 31, 2023
Hospital Group: Hospitals with Primary Medical School Affiliation



www.dph.ncdhhs.gov/epidemiology/communicable-disease/2023-hai-annual-report/open

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IC effect on primary BSI

The Effect of a Nationwide Infection Control Program Expansion on Hospital-Onset Gram-Negative Rod Bacteremia in 130 Veterans Health Administration Medical Centers: An Interrupted Time-Series Analysis

Michihiko Goto,[1,2] Amy M. J. O'Shea,[1,2] Daniel J. Livorsi,[1,2] Jennifer S. McDanel,[1,2] Makoto M. Jones,[3,4] Kelly K. Richardson,[1] Brice F. Beck,[1] Bruce Alexander,[1] Martin E. Evans,[5,6,7] Gary A. Roselle,[8,9,10] Stephen M. Kralovic,[8,9,10] and Eli N. Perencevich[1,2]

[1]Iowa City Veterans Affairs (VA) Health Care System, and [2]University of Iowa Carver College of Medicine, Iowa City; [3]Salt Lake City VA Health Care System, and [4]University of Utah School of Medicine, Salt Lake City; [5]Veterans Health Administration (VHA) MDRO Program Office, [6]Lexington VA Medical Center, and [7]University of Kentucky College of Medicine, Lexington; [8]VHA National Infectious Diseases Service, [9]Cincinnati VA Medical Center, and [10]University of Cincinnati College of Medicine, Ohio

Horizontal

- Local MDRO coordinator
- Culture transformation
- Education
- Leadership

Vertical (MRSA+ only)

- Active surveillance
- Contact precautions

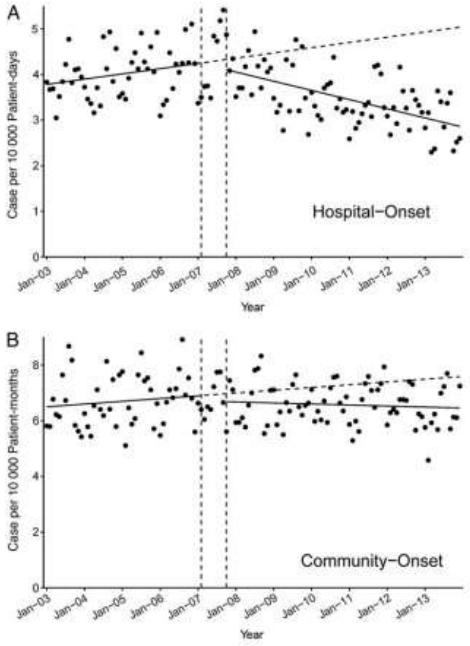

Figure 1. Effect of the Methicillin-Resistant *Staphylococcus aureus* Prevention Initiative on changes in incidence rates of gram-negative rod bacteremia. Solid slope lines are slopes estimated by autoregressive models; break slope lines are estimated slopes without effects of intervention; vertical break lines are beginning and end of implementation of the initiative.

CID. 2016; 63 (5):642-50.

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CLABSI Prevention Success!

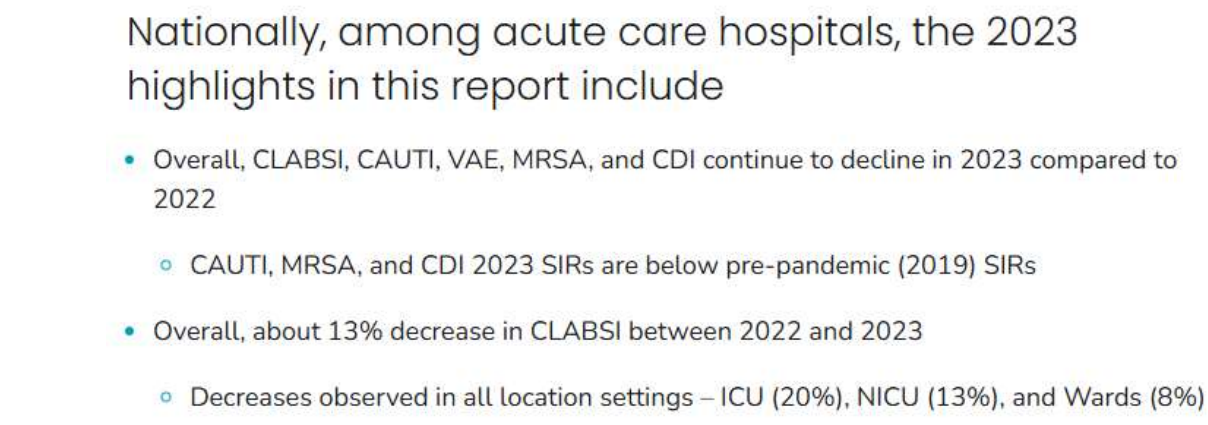
In 2017, there were 24,265 CLABSIs reported by 3576 United States acute care hospitals to the United States Centers for Disease Control and Prevention's National Healthcare Safety Network

-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.

But, CLABSIs still occur: ~30,000 per year



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

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CONCLUSIONS

- 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

Key References

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