Device Associated Infections

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Objectives

- At the end of this lecture the student will be able to
- Describe what is a central line associated blood stream infection using NHSN criteria
- Describe what is a catheter associated urinary tract infection using NHSN criteria
- Describe what is a ventilator associated event using NHSN criteria
- Identify best practices for prevention of device associated infections

Why is CLABSI Prevention Important?

- 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.*

- Increased costs, LOS, mortality

*CDC National and State Healthcare-Associated Infections Progress Report, published March 2014, available at www.cdc.gov/HAI/pdfs/progress-report/hai-progress-report.pdf

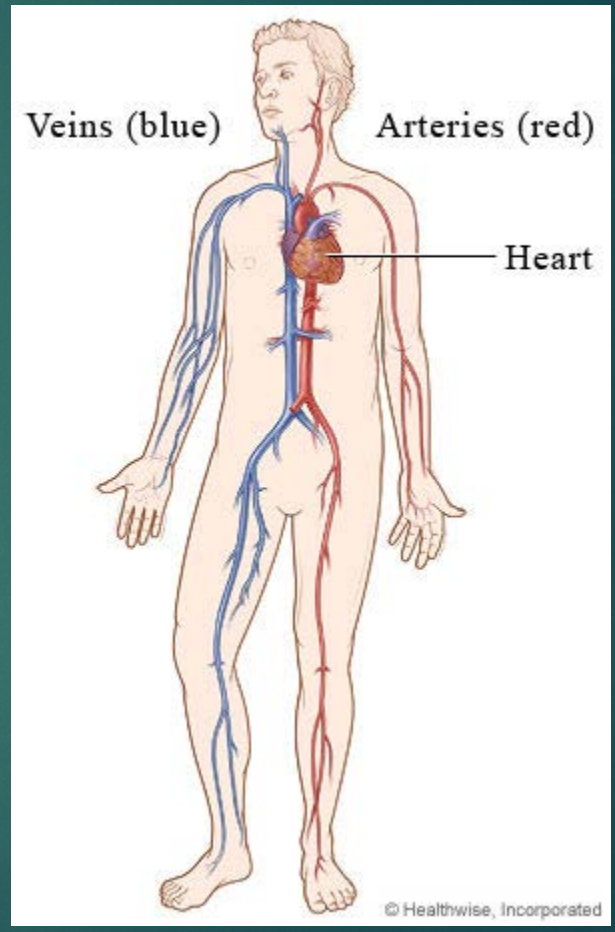
What is a Central Line?

What is a central line (also known as a central venous catheter)?

- a catheter placed in a one of the great vessels neck, chest, or groin to give medication or fluids or to collect blood for medical tests.

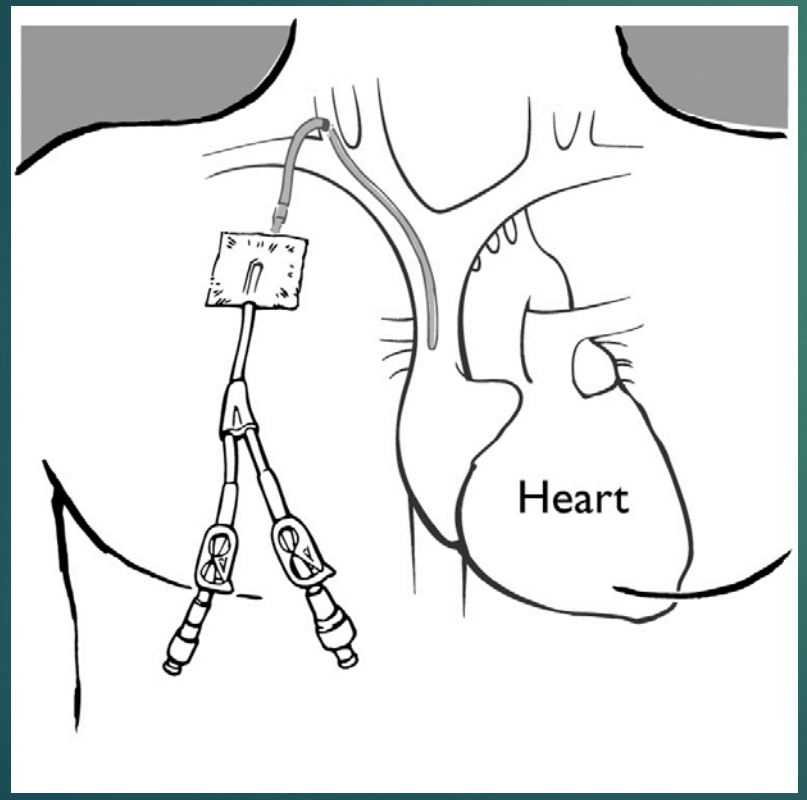
What are the Great Vessels?

- Aorta,
- Pulmonary artery
- Superior vena cava,
- Inferior vena cava,
- Brachiocephalic veins,
- Internal jugular veins,
- Subclavian veins,
- External iliac veins
- Common femoral veins
- And in neonates, the umbilical artery/vein.

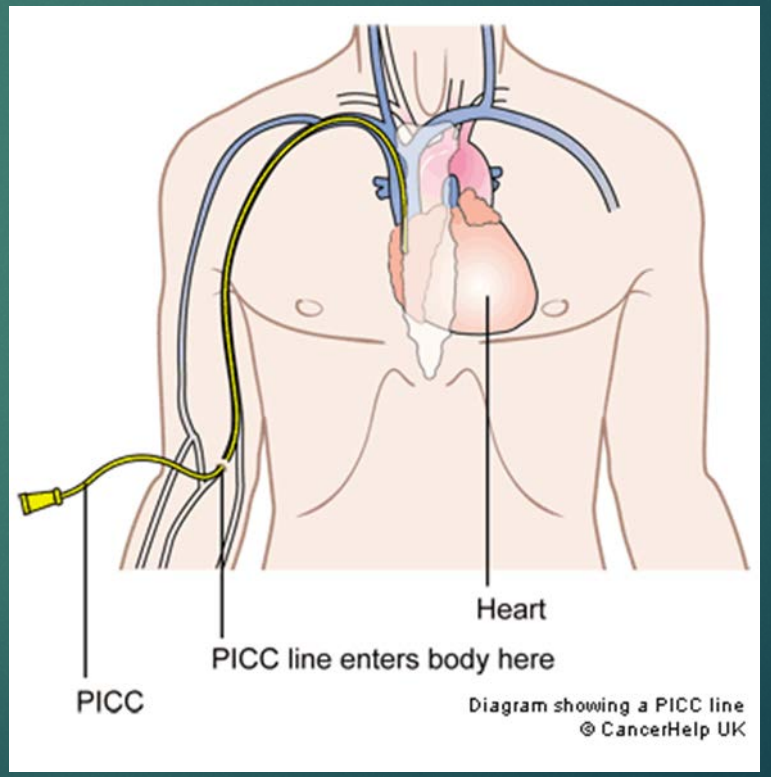


Permanent vs. Temporary Central Lines

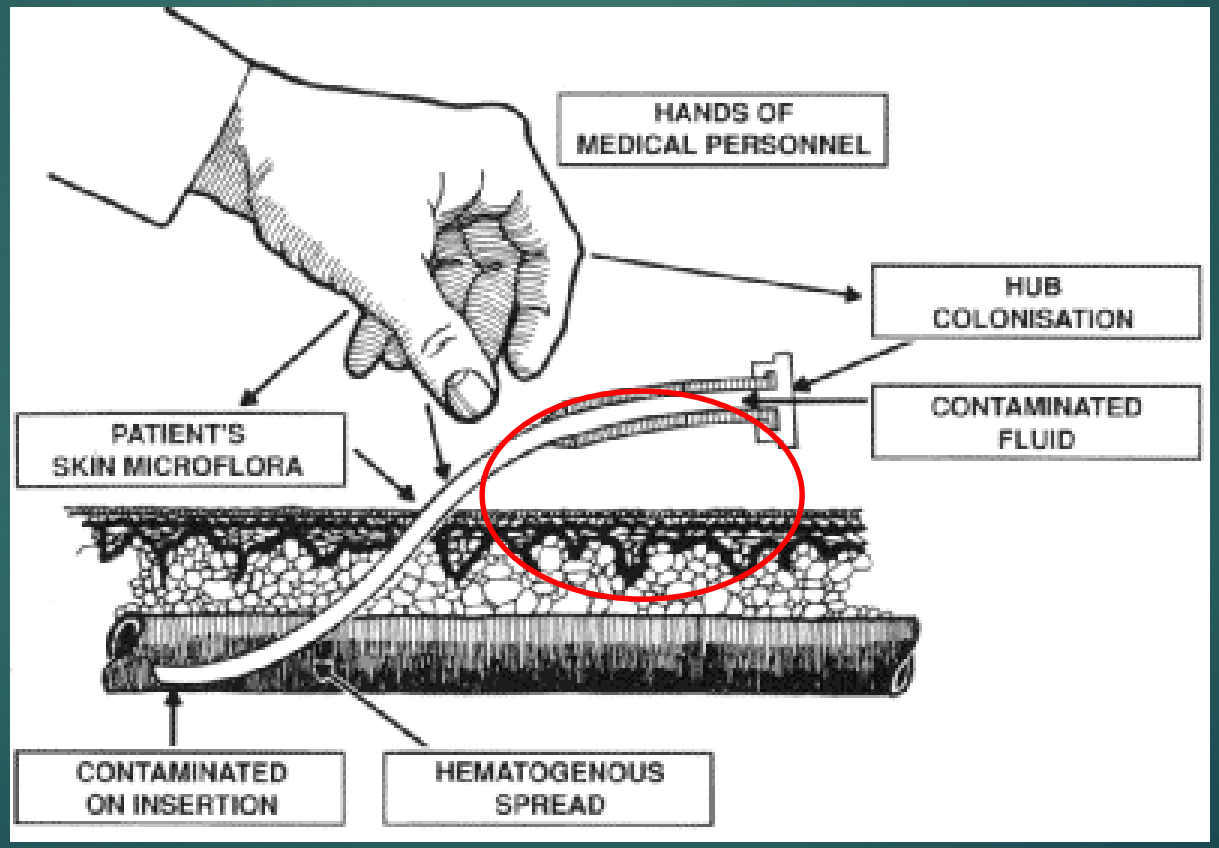
Tunneled



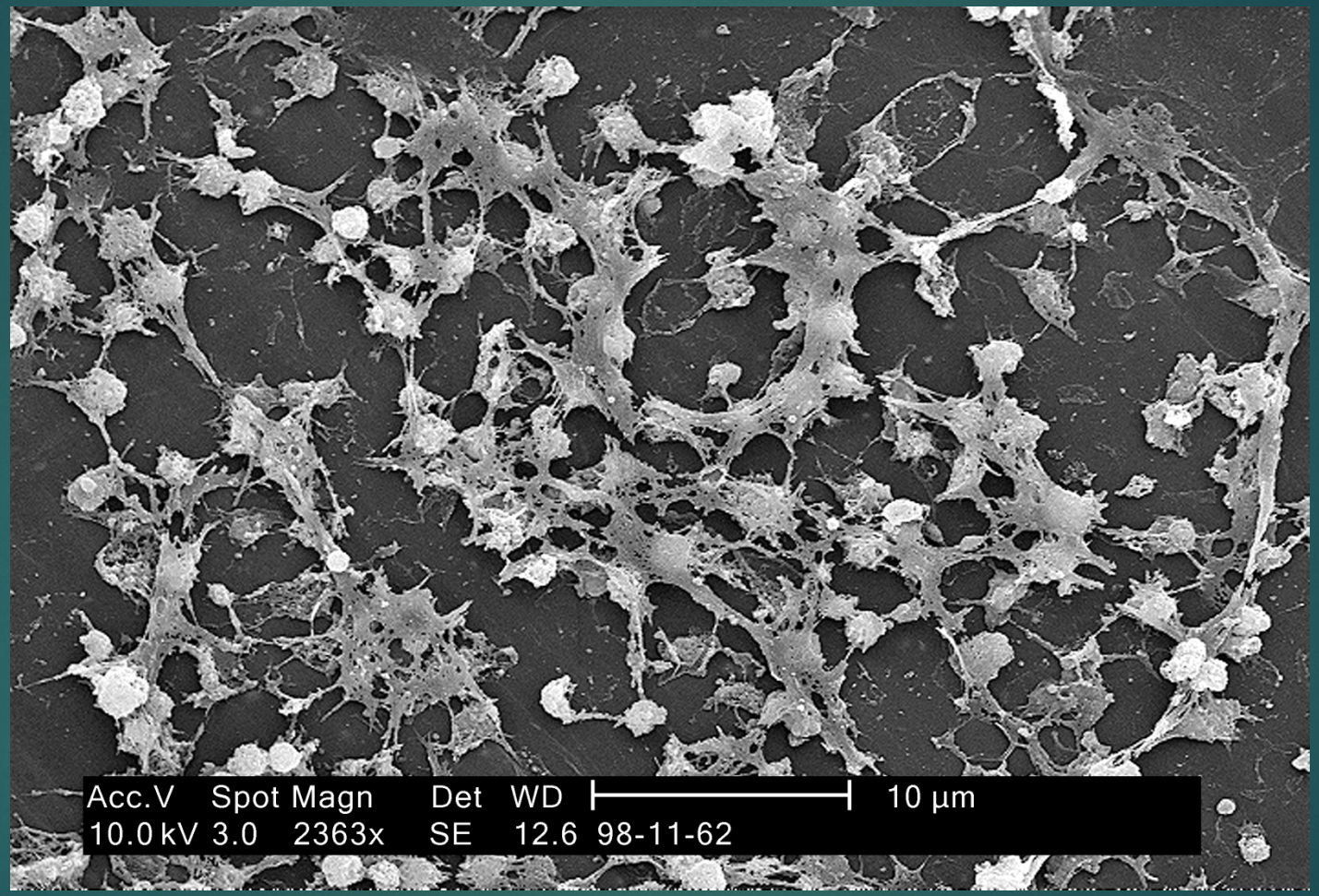
Non Tunneled



Potential Portals of Entry Leading to CLABSI



Staphylococcus aureus Biofilm



Source: Public Health Images Library

CVC Insertion Bundle

- **full-body drape**
- **caps and masks**
- **sterile gloves and gown**
- **2% CHG and alcohol**
- 4 to 6 sterile towels
- 1% lidocaine with epinephrine
- 3 ml syringe with 25 gauge needle for local injection
- sterile gauze
- transparent dressing
- heparin flush 100 u/ml
- 10 ml syringe
- J-tipped wire

Maximal Barrier Tray

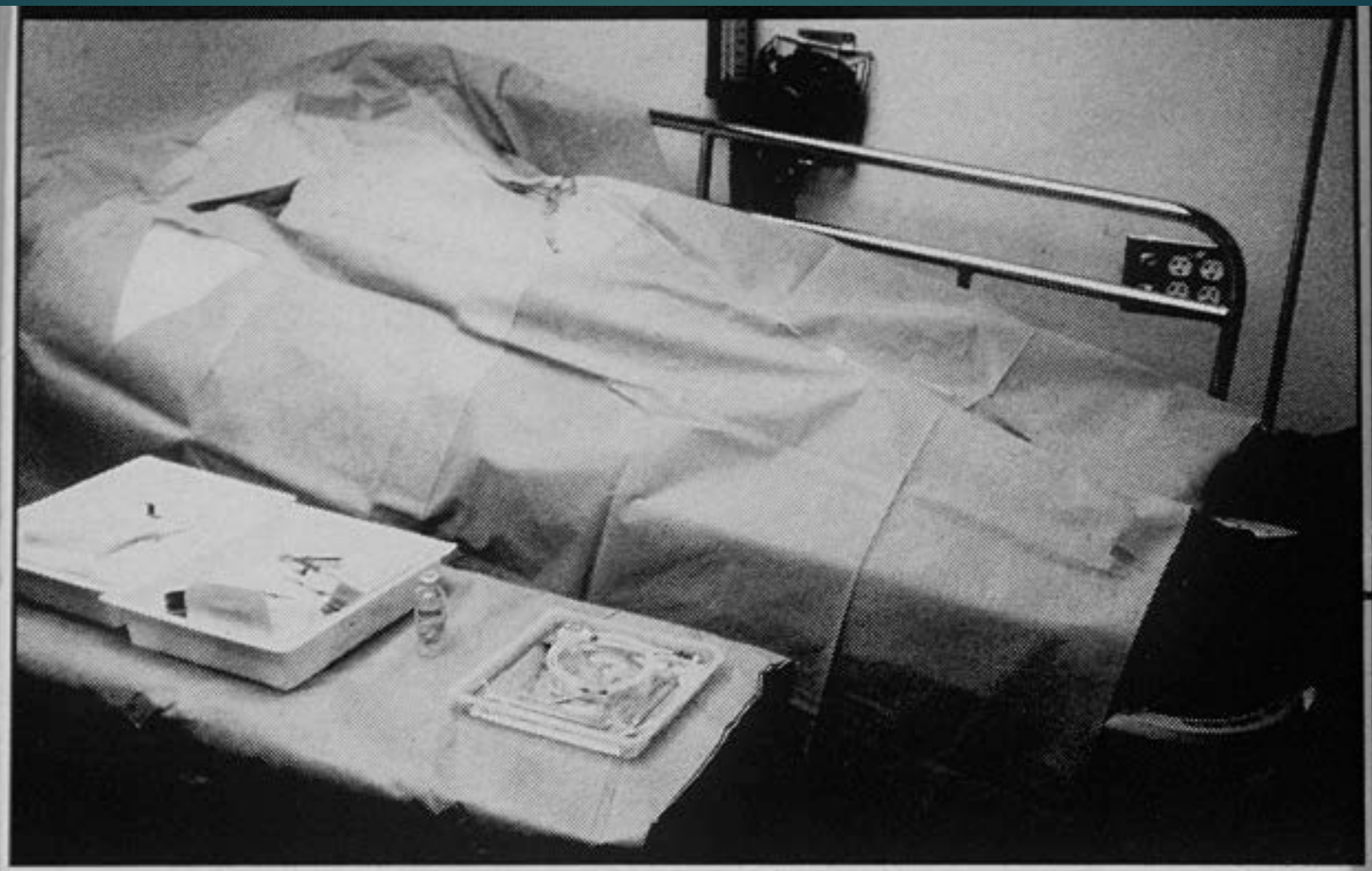


FIGURE 1A. The large drape used in the maximal barrier arm consisted of a full body drape that covered the patient's head and body.

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Central Line Insertion Practices Adherence Monitoring

Page 1 of 2
*required for saving

Facility ID: _____ Event #: _____

*Patient ID: _____ Social Security #: __ __ __ - __ __ - __ __ __ __

Secondary ID: _____ Medicare #: _____

Patient Name, Last: _____ First: _____ Middle: _____

*Gender: ☐ F ☐ M ☐ Other *Date of Birth: ___ /___ /_____ (mm/dd/yyyy)

Ethnicity (specify): _____ Race (specify): _____

*Event Type: CLIP *Location: _____ *Date of Insertion: ___ /___ /_____ (mm/dd/yyyy)

*Person recording insertion practice data: ☐ Inserter ☐ Observer

Central line inserter ID: _____ Name, Last: _____ First: _____

*Occupation of inserter:

☐ Fellow ☐ Medical student ☐ Other student ☐ Other medical staff

☐ Physician assistant ☐ Attending physician ☐ Intern/resident ☐ Registered nurse

☐ Advanced practice nurse ☐ Other (specify): _____

*Was inserter a member of PICC/IV Team? ☐ Y ☐ N

*Reason for insertion:

☐ New indication for central line (e.g., hemodynamic monitoring, fluid/medication administration, etc.)

☐ Replace malfunctioning central line

☐ Suspected central line-associated infection

☐ Other (specify): _____

If Suspected central line-associated infection, was the central line exchanged over a guidewire? ☐ Y ☐ N

*Inserter performed hand hygiene prior to central line insertion: ☐ Y ☐ N (if not observed directly, ask inserter)

*Maximal sterile barriers used: Mask ☐ Y ☐ N Sterile gown ☐ Y ☐ N

Large sterile drape ☐ Y ☐ N Sterile gloves ☐ Y ☐ N Cap ☐ Y ☐ N

*Skin preparation (check all that apply) ☐ Chlorhexidine gluconate ☐ Povidone iodine ☐ Alcohol

☐ Other (specify): _____

If skin prep choice was <u>not</u> chlorhexidine, was there a contraindication to chlorhexidine? ☐ Y ☐ N ☐ U

If there was a contraindication to chlorhexidine, indicate the type of contraindication:

☐ Patient is less than 2 months of age - chlorhexidine is to be used with caution in patients less than 2 months of age

☐ Patient has a documented/known allergy/reaction to CHG based products that would preclude its use

☐ Facility restrictions or safety concerns for CHG use in premature infants precludes its use

*Was skin prep agent completely dry at time of first skin puncture? ☐ Y ☐ N (if not observed directly, ask inserter)

*Insertion site: ☐ Femoral ☐ Jugular ☐ Lower extremity ☐ Scalp ☐ Subclavian ☐ Umbilical ☐ Upper extremity

Antimicrobial coated catheter used: ☐ Y ☐ N

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Central Line Insertion Practices Adherence Monitoring

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*Central line catheter type:

☐ Non-tunneled (other than dialysis) ☐ PICC

☐ Tunneled (other than dialysis) ☐ Umbilical

☐ Dialysis non-tunneled ☐ Other (specify): _____

☐ Dialysis tunneled

("Other" should not specify brand names or number of lumens; most lines can be categorized accurately by selecting from options provided.)

*Did this insertion attempt result in a successful central line placement? ☐ Y ☐ N

Custom Fields

Label		Label	
_____	___/___/_____	_____	___/___/_____
_____	_____	_____	_____
_____	_____	_____	_____
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_____	_____	_____	_____

Comments

Handle and maintain central lines appropriately

- Comply with hand hygiene requirements.
- Interventional daily hygiene
- Scrub the hub with appropriate antiseptic.
- Use only sterile devices to access catheters.
- Perform routine dressing changes using aseptic technique with clean or sterile gloves.
  - Change gauze dressings at least every two days or semipermeable dressings at least every seven days.
- Immediately replace dressings that are wet, soiled, or dislodged.

- https://www.cdc.gov/hai/pdfs/bsi/checklist-for-CLABSI.pdf

Handle and Maintain Central lines appropriately continued:

- For patients 18 years of age or older, use a chlorhexidine impregnated dressing with an FDA cleared label that specifies a clinical indication for reducing CLABSI for short-term non-tunneled catheters unless the facility is demonstrating success at preventing CLABSI with baseline prevention practices.
- Change administrations sets for continuous infusions no more frequently than every 4 days, but at least every 7 days. • If blood or blood products or fat emulsions are administered change tubing every 24 hours.
- If propofol is administered, change tubing every 6-12 hours or when the vial is changed

Definitions:

- Primary bloodstream infections (BSI): Laboratory-confirmed bloodstream infections (LCBI) that are not secondary to an infection at another body site
- Central line-associated BSI (CLABSI): A laboratory-confirmed bloodstream infection (LCBI) where central line (CL) or umbilical catheter (UC) was in place for >2 calendar days on the date of event, with day of device placement being Day 1,

AND

- the line was also in place on the date of event or the day before.

Appendix B: 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 definition.**

AND

- **One of the following scenarios must be met:**
- **Scenario 1:** At least one organism from the blood specimen matches an organism identified from the site-specific infection that is used as an element to meet the NHSN site-specific infection criterion AND the blood specimen is collected during the secondary BSI attribution period (infection window period + repeat infection timeframe).

OR

- **Scenario 2:** An organism identified in the blood specimen is an element that is used to meet the NHSN site-specific infection criterion, and therefore is collected during the site-specific infection window period.

Chapter 17:

CDC/NHSN Surveillance Definitions for Specific Types of Infections

INTRODUCTION

This chapter contains the CDC/NHSN surveillance definitions and criteria for all specific types of infections. This chapter also provides additional required criteria for the specific infection types that constitute organ space surgical site infections (SSI) (e.g., mediastinitis [MED] that may follow a coronary artery bypass graft, intra-abdominal abscess [IAB] after colon surgery, etc.). **Comments and reporting instructions that follow the site-specific criteria provide further explanation and are integral to the correct application of the criteria**. Refer to Chapter 2 (Identifying HAIs in NHSN) for specific guidance for making HAI determinations.

Infection criteria contained in this chapter may be necessary for determining whether a positive blood specimen represents a primary bloodstream infection (BSI) or is secondary to a different type of infection (see Appendix B Secondary Bloodstream Infection (BSI) Guide). A BSI that is identified as secondary to another site of infection must meet one of the infection criteria detailed in this chapter and meet other requirements. Secondary BSIs are not reported as Laboratory Confirmed Bloodstream Infections in NHSN, nor can they be associated with the use of a central line.

NOTES:

- Criteria for urinary tract infections (UTI), bloodstream infection (BSI), pneumonia (PNEU) infections, ventilator-associated events (VAE) and surgical site infections (SSI) are no longer included in this chapter. For those criteria, see individual protocol chapters.

Laboratory-Confirmed Bloodstream Infection Criteria :LCBI 1

- Patient of any age has a recognized pathogen identified (i.e., an organism which is not on the NHSN common commensal list) from one or more blood specimens by a culture or non-culture based microbiologic testing method
- **AND**
- Organism(s) identified in blood is not related to an infection at another site

Laboratory-Confirmed Bloodstream Infection Criteria : LCBI 2

- Patient of any age has at least one of the following signs or symptoms: fever (>38.0oC), chills, or hypotension
- **AND**
- Organism(s) identified from blood is not related to an infection at another site (See Appendix B: Secondary BSI Guide)
- **AND**
- the same NHSN common commensal is identified from two or more blood specimens drawn on separate occasions by a culture or non-culture based microbiologic testing method.

Laboratory-Confirmed Bloodstream Infection Criteria : LCBI 3

- Patient ≤ 1 year of age has at least ***one*** of the following signs or symptoms: fever (>38.0oC), hypothermia (<36.0oC), apnea, or bradycardia
- **AND**
- Organism(s) identified from blood is not related to an infection at another site (See Appendix B Secondary BSI Guide)
- **AND**
- the same NHSN common commensal is identified from two or more blood specimens drawn on separate occasions (see Comment 4 below), by a culture or non-culture based microbiologic testing method.

Mucosal Barrier Injury: Subset of CLABSI

MBI-BSI 1

Patient of any age meets criterion 1 for LCBI with at least one blood specimen identified by a culture or non-culture based microbiologic testing method, with ONLY intestinal organisms from the MBI-LCBI organisms list.

A partial list of MBI-LCBI organisms is provided in Appendix A See MBI organism tab on the NHSN organisms list for the full list of MBI-LCBI organisms

NOTE: If a patient meets MBI-LCBI 1 and MBI LCBI 2 criteria, report organisms as MBI-LCBI 1.

And patient meets at least *one* of the following:

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 7 calendar days before the date the positive blood specimen was collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm3 within a 7-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before *and* the 3 calendar days after (See Table 5 for example).

MBI-BSI 2

Patient of any age meets criterion 2 for LCBI with at least two blood specimens identified by a culture or non-culture based microbiologic testing method, with only viridans group streptococci but no other organisms.

And patient meets at least *one* of the following:

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 7 calendar days before the date the first positive blood specimen was collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm3 within a seven-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before *and* the 3 calendar days after

MBI-BSI 3

Patient ≤1 year of age meets criterion 3 for LCBI with at least two blood specimens identified by a culture or non-culture based microbiologic testing method, with only viridans group streptococci but no other organisms.

And patient meets at least *one* of the following:

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. ≥20 mL/kg diarrhea in a 24-hour period with onset on or within 7 calendar days before the date the first positive blood specimen is collected.

2. Is neutropenic, defined as at least two separate days with values of absolute neutrophil count (ANC) or total white blood cell count (WBC) <500 cells/mm3 on or within a seven-day time period which includes the date the positive blood specimen was collected (Day 1), the 3 calendar days before *and* the 3 calendar days after.

Transfer Rule for CLABSI

- If the date of event for a CLABSI is on the date of transfer or discharge, or the next day, the infection is attributed to the transferring/discharging location.

HAI Calculator

- https://nhsn.cdc.gov/nhsntraining/calculator/workgen.html

CAUTI

- Urinary tract infections (UTIs) are the fourth most common type of healthcare-associated infection, with an estimated 93,300 UTIs in acute care hospitals in 2011[1].
- UTIs account for more than 12% of infections reported by acute care hospitals. Virtually all healthcare-associated UTIs are caused by instrumentation of the urinary tract[1].
  - 12%-16% of adult hospital inpatients will have an indwelling urinary catheter at some time during their hospitalization
  - Each day the indwelling urinary catheter remains, a patient has a 3%-7% increased risk of acquiring a catheter-associated urinary tract infection (CAUTI).2-3

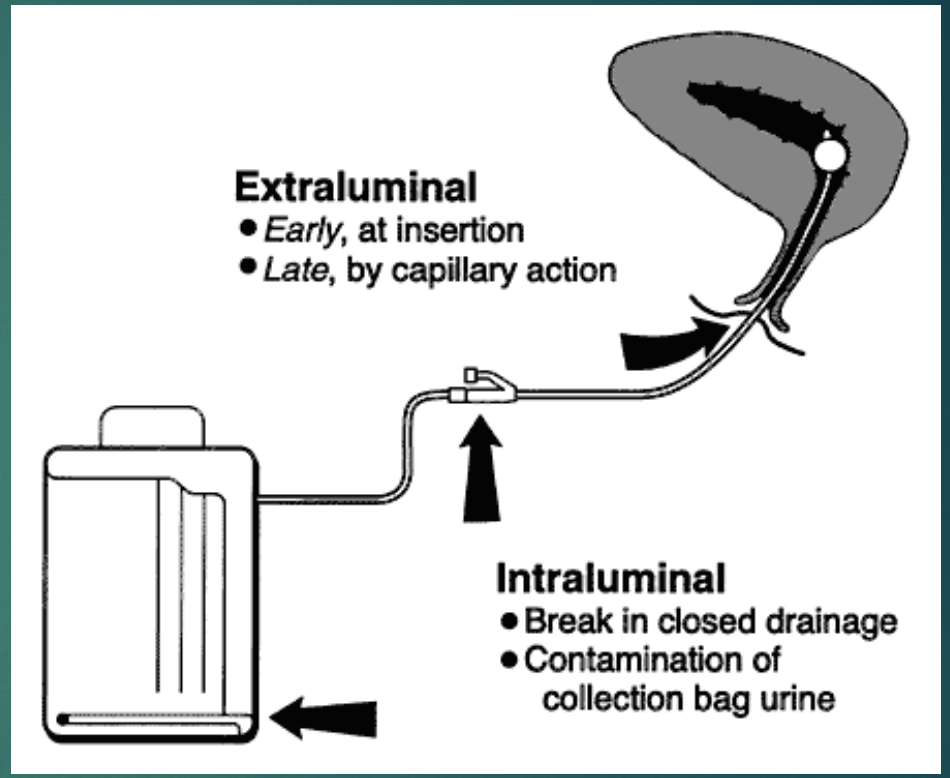
1Magill SS., Edwards, JR., Bamberg, W., et al. "Multistate Point-Prevalence Survey of Health Care- Associated Infections, 2011". New England Journal of Medicine. 370: (2014): 1198-1208.

2McGuckin M. The patient survival guide: 8 simple solutions to prevent hospital and healthcare-associated infections. New York, NY: Demos Medical Publishing; 2012.

3Lo E, Nicolle LE, Coffin SE, Gould C, Maragakis LL, Meddings J, et al. Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35:464-79

Etiology of CAUTI

- Source
  - Patient's colonic or perineal flora
  - Bacteria on hands of personnel
- Microbes enter bladder via one of 2 routes
  - Extraluminal - around the external surface
  - Intraluminal - inside the catheter
- Daily risk of bacteriuria with catheterization 3% to 10%
  - By day 30, 100%



Maki D, TambyahP. Engineering out risk of infection with urinary catheters. Emerg Infect Dis, 2001

CAUTI Core Prevention Strategies

- Insert catheters only for appropriate indications
- Leave in place only as long as needed
- Only properly trained persons insert and maintain
- Hand hygiene
- Aseptic technique and sterile equipment for insertion
- Maintain closed drainage system and unobstructed urine flow
- Implement improvement program to achieve appropriate use of catheters

http://www.cdc.gov/hicpac/pdf/CAUTI/CAUTIguideline2009final.pdf

Use Indwelling Urinary Catheters *ONLY* for Appropriate Indications

1. Acute urinary retention or obstruction
2. Peri-operative use in selected surgeries
3. Assist healing of perineal and sacral wounds in incontinent patients
4. Hospice, comfort care, palliative care
5. Required immobilization for trauma or surgery
6. Chronic indwelling urinary catheter on admission
7. Accurate measurement of urinary output in critically ill patients (intensive care)

http://www.cdc.gov/hicpac/pdf/CAUTI/CAUTIguideline2009final.pdf

CAUTI Supplemental Prevention Strategies

- Alternatives to indwelling urinary catheters
- Portable ultrasound devices to assess urinary retention, reduce unnecessary catheterizations
- Antimicrobial/antiseptic impregnated catheters

http://www.cdc.gov/hicpac/pdf/CAUTI/CAUTIguideline2009final.pdf

CAUTI Prevention Bundle Example

- CAUTI Insertion Bundle
  - Verification of need prior to insertion
  - Insert urinary catheter using aseptic technique.
  - Maintain urinary catheter based on recommended guidelines

- CAUTI Maintenance Bundle

- Daily documented assessment of need
- Tamper evident seal is intact
- Catheter secured with securement device
- Hand hygiene performed before patient contact
- Daily meatal hygiene with soap and water
- Drainage bag emptied using a clean container
- Unobstructed flow maintained
- Daily assessment of catheter necessity

Preventing CAUTI: A patient-centered approach; (Autumn 2012) APIC Prevention *strategist*: apic.org/Resource_/TinyMceFileManager/epublications/CAUTI_feature_PS_fall_12.pdf

Definitions

- Catheter-associated UTI (CAUTI): A UTI where an indwelling urinary catheter was in place for >2 calendar days on the date of event, with day of device placement being Day 1,
- ***AND***
- an indwelling urinary catheter was in place on the date of event or the day before. If an indwelling urinary catheter was in place for > 2 calendar days and then removed
- The following excluded organisms cannot be used to meet the UTI definition:
  - *Candida* species or yeast not otherwise specified
  - mold
  - dimorphic fungi or
  - parasites

Symptomatic Urinary Tract Infection 1 A

Patient must meet 1, 2, and 3 below:

1. Patient had an indwelling urinary catheter that had been in place for > 2 days on the date of event (day of device placement = Day 1) AND was either:

Present for any portion of the calendar day on the date of event

OR

Removed the day before the date of event‡

2. Patient has at least ***one*** of the following signs or symptoms:

- fever (>38.0°C)
- suprapubic tenderness*****
- costovertebral angle pain or tenderness*
- urinary urgency
- urinary frequency
- dysuria ^

3. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of ≥10^5 CFU/ml

Symptomatic Urinary Tract Infection 1B

Patient must meet 1, 2, and 3 below:

1. One of the following is true:

Patient has/had an indwelling urinary catheter but it has/had not been in place >2 calendar days on the date of event

OR

Patient did not have a urinary catheter in place on the date of event nor the day before the date of event

2. Patient has at least ***one*** of the following signs or symptoms:

- fever (>38°C) in a patient that is ≤ 65 years of age
- suprapubic tenderness*****
- costovertebral angle pain or tenderness*****
- urinary frequency
- urinary urgency
- dysuria

3. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml.

Symptomatic Urinary Tract Infection 2

Patient must meet 1, 2, and 3 below:

1. Patient is ≤1 year of age (with or without an indwelling urinary catheter)

2. Patient has at least ***one*** of the following signs or symptoms:

- fever (>38.0°C)
- hypothermia (<36.0°C)
- apnea
- bradycardia
- lethargy
- vomiting

- suprapubic tenderness

3. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of ≥10^5 CFU/ml

Asymptomatic Urinary Tract Infection

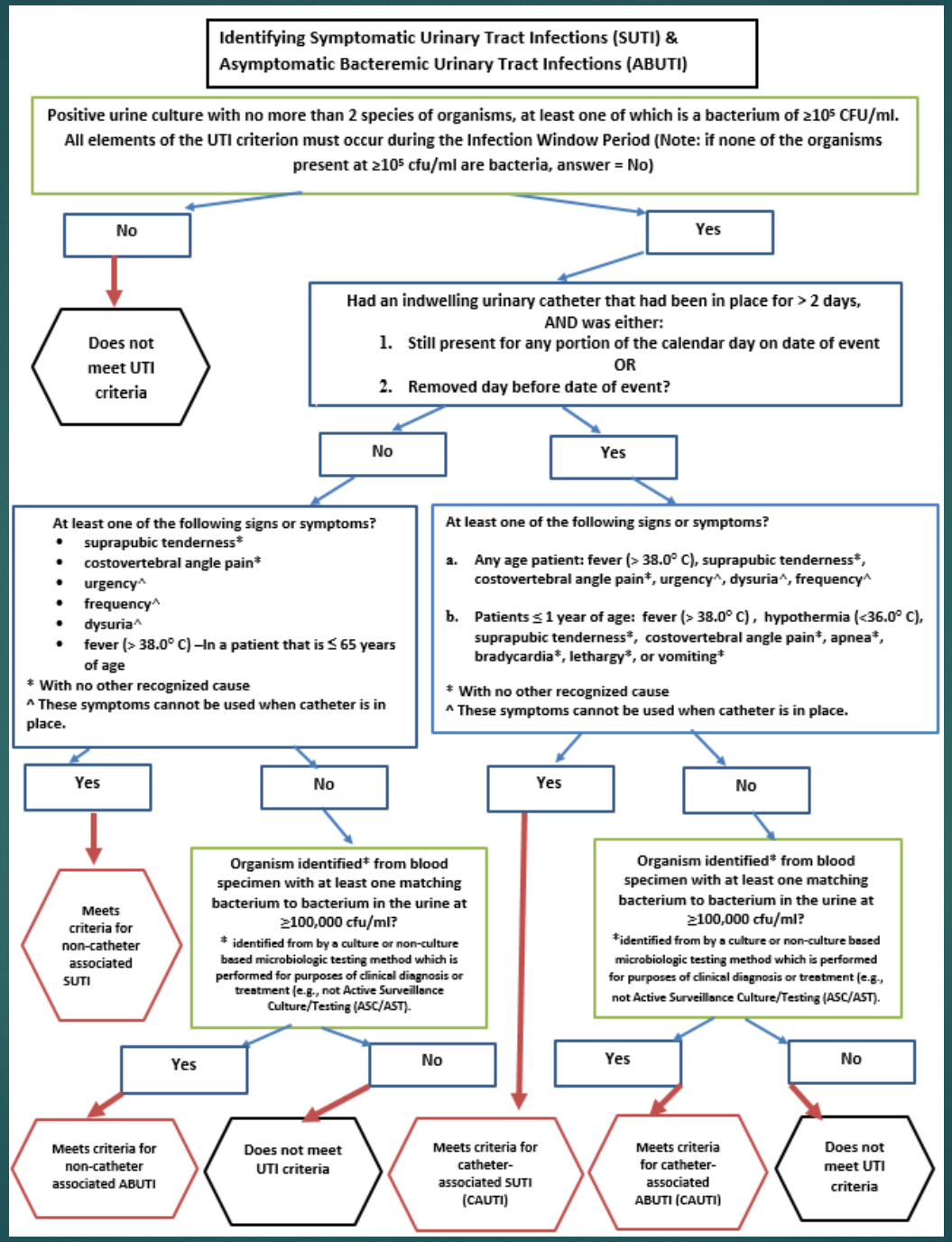
Patient must meet 1, 2, and 3 below:

1. Patient with* or without an indwelling urinary catheter has no signs or symptoms of SUTI 1 or 2 according to age (**Note**: Patients > 65 years of age with a non-catheter-associated ABUTI **may** have a fever and still meet the ABUTI criterion)

2. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of ≥105 CFU/ml (see Comment section below)

3. Patient has organism identified** from blood specimen with at least ***one*** matching bacterium to the bacterium identified in the urine specimen, or meets LCBI criterion 2 (without fever) and matching common commensal(s) in the urine. All elements of the ABUTI criterion must occur during the Infection Window Period (See Definition Chapter 2 Identifying HAIs in NHSN).

*Patient had an indwelling urinary catheter in place for >2 calendar days on the date of event, with day of device placement being Day 1, and catheter was in place on the date of event or the day before.


Identifying Symptomatic Urinary Tract Infections (SUTI) & Asymptomatic Bacteremic Urinary Tract Infections (ABUTI)
Positive urine culture with no more than 2 species of organisms, at least one of which is a bacterium of ≥10⁵ CFU/ml. All elements of the UTI criterion must occur during the Infection Window Period (Note: if none of the organisms present at ≥10⁵ cfu/ml are bacteria, answer = No)
No
Does not meet UTI criteria
Yes
Had an indwelling urinary catheter that had been in place for > 2 days, AND was either:
1. Still present for any portion of the calendar day on date of event OR
2. Removed day before date of event?
No
At least one of the following signs or symptoms?
• suprapubic tenderness*
• costovertebral angle pain*
• urgency^
• frequency^
• dysuria^
• fever (> 38.0° C) –In a patient that is ≤ 65 years of age
* With no other recognized cause
^ These symptoms cannot be used when catheter is in place.
Yes
At least one of the following signs or symptoms?
a. Any age patient: fever (> 38.0° C), suprapubic tenderness*, costovertebral angle pain*, urgency^, dysuria^, frequency^
b. Patients ≤ 1 year of age: fever (> 38.0° C) , hypothermia (<36.0° C), suprapubic tenderness*, costovertebral angle pain*, apnea*, bradycardia*, lethargy*, or vomiting*
* With no other recognized cause
^ These symptoms cannot be used when catheter is in place.
Yes
Meets criteria for non-catheter associated SUTI
No
Organism identified* from blood specimen with at least one matching bacterium to bacterium in the urine at ≥100,000 cfu/ml?
* identified from by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing (ASC/AST).
Yes
Meets criteria for non-catheter associated ABUTI
No
Does not meet UTI criteria
Yes
Meets criteria for catheter-associated SUTI (CAUTI)
No
Organism identified* from blood specimen with at least one matching bacterium to bacterium in the urine at ≥100,000 cfu/ml?
*identified from by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing (ASC/AST).
Yes
Meets criteria for catheter-associated ABUTI (CAUTI)
No
Does not meet UTI criteria

Transfer Rule for CAUTI

- If the date of event for a UTI is on the date of transfer or discharge, or the next day, the infection is attributed to the transferring/discharging location.

Ventilator Associated Events

- Mechanical ventilation is an essential, life-saving therapy for patients with critical illness and respiratory failure.
- About 300,000 patients receive mechanical ventilation in the United States each year [1-3].
- These patients are at high risk for complications and poor outcomes, including death [1-5].
- Mortality in patients with acute lung injury on mechanical ventilation has been estimated to range from 24% in persons 15-19 years of age to 60% for patients 85 years and older [4].

1) Behrendt CE. Acute respiratory failure in the United States: incidence and 31-day survival. Chest 2000;118:1100-5.
2) Kahn JM, Goss CH, Heagerty PJ, et al. Hospital volume and the outcomes of mechanical ventilation. N Engl J Med 2006;355:41-50.
3) Wunsch H, Linde-Zwirble WT, Angus DC, Hartman ME, Milbrandt EB, Kahn JM. The epidemiology of mechanical ventilation use in the United States. Crit Care Med 2010;38:1947-53.
4) Rubenfeld GD, Caldwell E, Peabody E, et al. Incidence and outcomes of acute lung injury. N Engl J Med 2005;353:1685-93.
5) Esteban A, Anzueto A, Frutos F, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. JAMA 2002;287:345-55.

History of the VAE Algorithm

- NHSN implemented The VAE surveillance definition algorithm was implemented in 2013
- Objective, Streamlined, Potential for Automation developed by the
- identify a broad range of conditions and complications occurring in mechanically-ventilated adult patients
- NOTE: The VAE definition algorithm is for use in surveillance; it is not a clinical definition algorithm and is not intended for use in the clinical management of patients
- Adults only definition

Adapted from the CDC Guidelines for Preventing Healthcare-Associated Pneumonia, 2003.
www.cdc.gov

Preventing Ventilator Associated Pneumonia

APIC
ASSOCIATION FOR PROFESSIONALS IN INFECTION CONTROL AND EPIDEMIOLOGY, INC.

Basic Practices to Eliminate VAP

- Use noninvasive positive pressure ventilation in selected populations
- Manage patients without sedation whenever possible
- Interrupt sedation daily
- Assess readiness to extubate daily
- Perform spontaneous breathing trials with sedatives turned off
- Facilitate early mobilization
- Utilize endotracheal tubes with subglottic secretion drainage ports for patients expected to require greater than 48 or 72 hours of mechanical ventilation50
- Change the ventilator circuit only if visibly soiled or malfunctioning
- Elevate the head of the bed to 30°-45°

Definitions

- Patients must be mechanically ventilated for at least 4 calendar days to fulfill VAE criteria (where the day of intubation and initiation of mechanical ventilation is day 1). The earliest date of event for VAE (the date of onset of worsening oxygenation) is day 3 of mechanical ventilation
- The baseline period of stability or improvement on the ventilator is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO2, and must be characterized by ≥ 2 calendar days of stable or decreasing daily minimum FiO2 or PEEP values
- PEEP values between 0 cmH2O and 5 cmH2O will be considered equivalent.

Ventilator Associated Events: Baseline Period

- Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum* FiO2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO2.
- *Daily minimum defined by lowest value of FiO2 or PEEP during a calendar day that is maintained for at least 1 hour.

Ventilator Associated Condition

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:

1) Increase in daily minimum* FiO2 of ≥ 0.20 (20 points) over the daily minimum FiO2 in the baseline period, sustained for ≥ 2 calendar days.

2) Increase in daily minimum* PEEP values of ≥ 3 cmH2O over the daily minimum PEEP in the baseline period†, sustained for ≥ 2 calendar days.

*Daily minimum defined by lowest value of FiO2 or PEEP during a calendar day that is maintained for at least 1 hour.

†Daily minimum PEEP values of 0-5 cmH2O are considered equivalent for the purposes of VAE surveillance.

Infection-related Ventilator-Associated Complication (IVAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:

1) Temperature > 38 °C or < 36°C, **OR** white blood cell count ≥ 12,000 cells/mm3 or ≤ 4,000 cells/mm3.

AND

2) A new antimicrobial agent(s) (see Appendix for eligible antimicrobial agents) is started, and is continued for ≥ 4 calendar days.

Possible Ventilator-Associated Pneumonia (PVAP): Criterion1

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (**taking into account organism exclusions specified in the protocol**)*:

1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, without requirement for purulent respiratory secretions:

- ☐ Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
- ☐ Bronchoalveolar lavage, ≥ 104 CFU/ml or corresponding semi-quantitative result
- ☐ Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
- ☐ Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result

***Candida* species or yeast not otherwise specified; coagulase-negative *Staphylococcus* species; and *Enterococcus* species, when identified from sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings specimens.**
These organisms can be reported as PVAP pathogens if identified from lung tissue or pleural fluid specimens

Possible Ventilator-Associated Pneumonia (PVAP): Criterion 2

Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field [lpf, x100])† plus organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):

- ☐ Sputum
- ☐ Endotracheal aspirate
- ☐ Bronchoalveolar lavage
- ☐ Lung tissue
- ☐ Protected specimen brush

† If the laboratory reports semi-quantitative results, those results must correspond to the above quantitative thresholds.

Possible Ventilator-Associated Pneumonia (PVAP): Criterion 3

- ☐Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- ☐Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- ☐Diagnostic test for *Legionella* species
- ☐Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

Figure 1: Ventilator-Associated Events (VAE) Surveillance Algorithm

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum* FiO_2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2.

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for at least 1 hour.

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After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
1) Increase in daily minimum* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP in the baseline period†, sustained for ≥ 2 calendar days.

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for at least 1 hour.
†Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance.

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Ventilator-Associated Condition (VAC)

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On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:

1) Temperature > 38 °C or < 36°C, **OR** white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3.
AND
2) A new antimicrobial agent(s) (see Appendix for eligible antimicrobial agents) is started, and is continued for ≥ 4 calendar days.

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Infection-related Ventilator-Associated Complication (IVAC)

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On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (**taking into account organism exclusions specified in the protocol**):

1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, without requirement for purulent respiratory secretions:
   - Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
   - Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
   - Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
   - Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result
2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain ≥25 neutrophils and ≤10 squamous epithelial cells per low power field [lpf, ⨯100])† plus organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):
   - Sputum
   - Endotracheal aspirate
   - Bronchoalveolar lavage
   - Lung tissue
   - Protected specimen brush

   † If the laboratory reports semi-quantitative results, those results must correspond to the above quantitative thresholds. See additional instructions for using the purulent respiratory secretions criterion in the VAE Protocol.
3) Criterion 3: One of the following positive tests:
   - Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
   - Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
   - Diagnostic test for *Legionella* species
   - Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

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Possible Ventilator-Associated Pneumonia (PVAP)

VAE Calculator

- https://www.cdc.gov/nhsn/vae-calculator/index.html

Transfer Rule for VAE

- If the date of event for a VAE is on the date of transfer or discharge, or the next day, the infection is attributed to the transferring/discharging location.

Resources

- Lo, E., Nicolle, L., Coffin, S., Gould, C., Maragakis, L., Meddings, J., . . . Yokoe, D. (2014). Strategies to Prevent Catheter-Associated Urinary Tract Infections in Acute Care Hospitals: 2014 Update. *Infection Control & Hospital Epidemiology, 35*(S2), S32-S47. doi:10.1017/S0899823X00193845
- Klompas, M., Branson, R., Eichenwald, E., Greene, L., Howell, M., Lee, G., . . . M. Berenholtz, S. (2014). Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals: 2014 Update. *Infection Control & Hospital Epidemiology, 35*(S2), S133-S154. doi:10.1017/S0899823X00193894
- Yokoe, D. S., Anderson, D. J., Berenholtz, S. M., Calfee, D. P., Dubberke, E. R., Ellingson, K. D., ... & Lo, E. (2014). A compendium of strategies to prevent healthcare-associated infections in acute care hospitals: 2014 updates. *American journal of infection control*, *42*(8), 820-828.

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