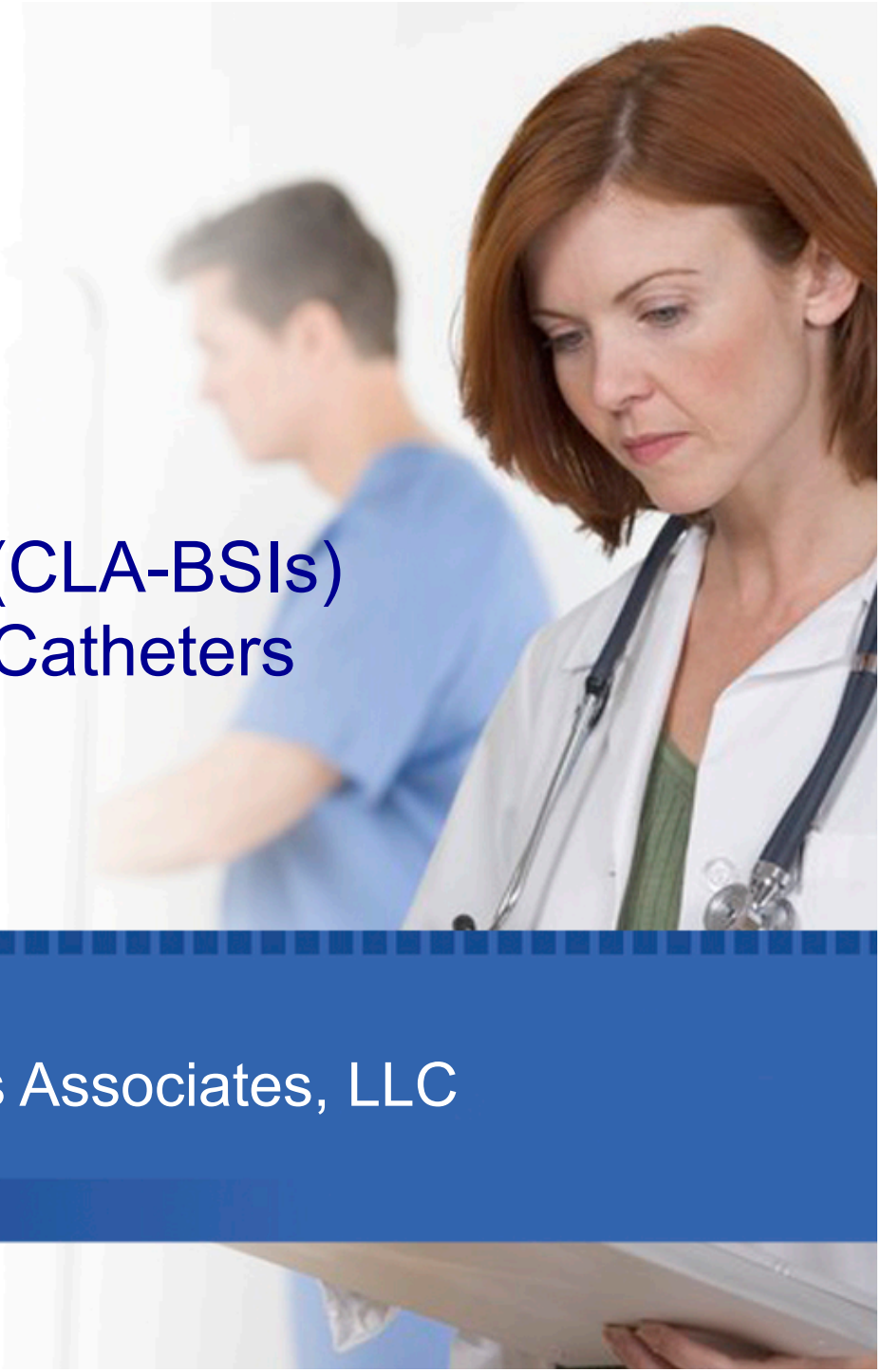
Prevention of Central Line-associated Bloodstream Infections (CLA-BSIs) associated with Arterial Catheters



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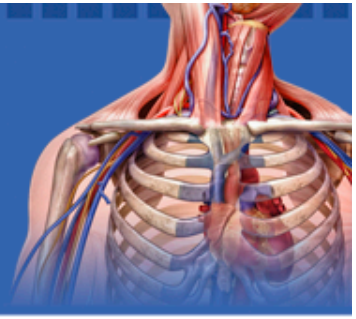

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Prevention of Central Line-associated Bloodstream Infections (CLA-BSIs) associated with Arterial Catheters

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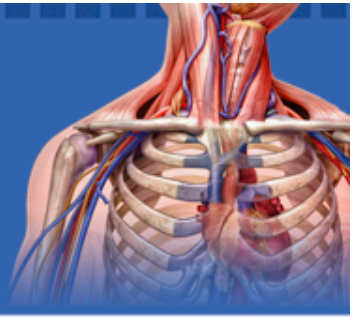
Objectives

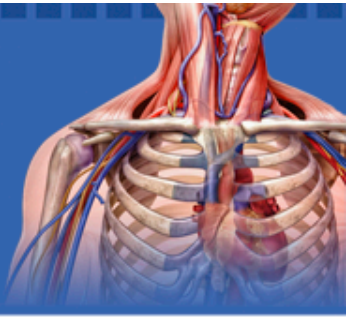


1. To discuss the recent literature comparing infection rates with arterial and central venous catheters.

2. Describe the CDC 2011 recommendations on arterial catheters with special emphasis on catheter-related infection.

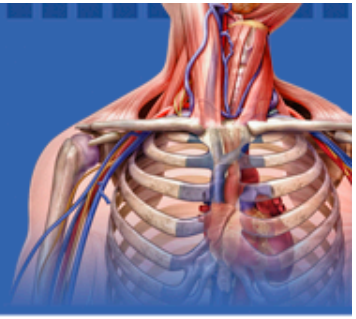
3. Discuss the consequences for clinical practice.

Hierarchy of Medical Evidence



http://library.downstate.edu/ebm/2500.htm

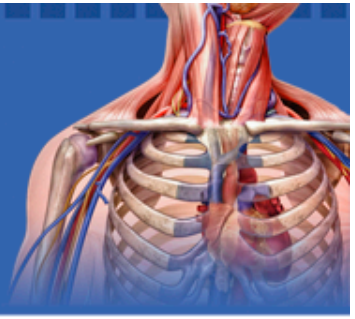
Systematic Review of Intravascular Device Related Bloodstream Infections (IVD-BSIs)



- 200 studies prospectively examining IVD-BSI associated with:
  - Peripheral IV catheters (PIVC)
  - Midline catheters
  - Arterial catheters (ACs)
  - Pulmonary artery catheters
  - Peripherally inserted central catheters (PICCs)
  - Central venous catheters (CVCS)
  - Hemodialysis catheters (cuffed and tunneled)
  - Hickman catheters (cuffed and tunneled)
  - Central venous ports
  - Left ventricular assist devices
  - Intra-aortic balloon pumps

Maki DG et al., Mayo Clinic Proc 2006;81:1159-1171.

IVD-BSI Risk Associated with Arterial Catheters



- Arterial catheters are used in ~6 million patients in U.S. hospitals annually
- Assumed to be low risk because of short duration of insertion
- 2002 CDC IV Guideline did not advocate surveillance of arterial catheter-related BSIs
  ("low infection rates --- rarely associated with BSI")
- Many clinicians consider arterial catheters to pose little BSI risk
- Arterial catheters are among the most heavily manipulated catheters in the ICU or operating room
- Insertion and Maintenance Prevention Bundles deserve to be applied with arterial catheters

Maki DG et al., Mayo Clinic Proc 2006;81:1159-1171.

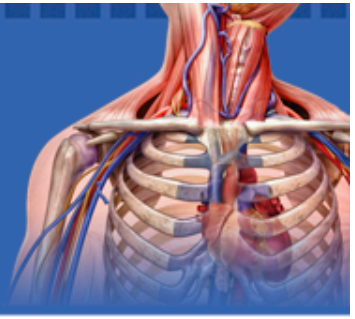
TABLE 3. **Rates of Intravascular Device–Related Bloodstream Infection Caused by Various Types of Devices Used for Vascular Access***

Device	No. of studies	No. of catheters	No. of IVD (d)	No. of BSIs	Rates of IVD-related bloodstream infection			
					Per 100 devices		Per 1000 IVD-days	
					Pooled mean	95% CI	Pooled mean	95% CI
Peripheral IV catheters								
Plastic catheters	110	10,910	28,720	13	0.1	0.1-0.2	0.5	0.2-0.7
Steel needles	1	148	350	3	2.0	0.0-4.3	8.6	0.0-18.2
Venous cutdown	1	27	111	1	3.7	0.0-10.8	9.0	0.0-26.6
Midline catheters	3	514	9251	2	0.4	0.0-0.9	0.2	0.0-0.5
Arterial catheters for hemodynamic monitoring	14	4366	21,397	37	0.8	0.6-1.1	1.7	1.2-2.3
Peripherally inserted central catheters								
Inpatient and outpatient	15	3566	105,839	112	3.1	2.6-3.7	1.1	0.9-1.3
Inpatient	6	625	7137	15	2.4	1.2-3.6	2.1	1.0-3.2
Outpatient	9	2813	98,702	97	3.5	2.8-4.1	1.0	0.8-1.2
Short-term noncuffed central venous catheters								
Nonmedicated								
Nontunneled	79	20,226	322,283	883	4.4	4.1-4.6	2.7	2.6-2.9
Tunneled	9	741	20,065	35	4.7	3.2-6.2	1.7	1.2-2.3
Medicated								
Chlorhexidine-silver-sulfadiazine	18	3367	54,054	89	2.6	2.1-3.2	1.6	1.3-2.0
Minocycline-rifampin	3	690	5797	7	1.0	0.3-1.8	1.2	0.3-2.1
Silver impregnated	2	154	1689	8	5.2	1.7-8.7	4.7	1.5-8.0
Silver iontophoretic	2	396	4796	16	4.0	2.1-6.0	3.3	1.7-5.0
Benzalkonium chloride	1	277	2493	12	4.3	1.9-6.7	4.8	2.1-7.5
Pulmonary artery catheters	13	2057	8143	30	1.5	0.9-2.0	3.7	2.4-5.0
Hemodialysis catheters								
Temporary, noncuffed	16	3066	51,840	246	8.0	7.0-9.0	4.8	4.2-5.3
Long-term, cuffed and tunneled	16	2806	373,563	596	21.2	19.7-22.8	1.6	1.5-1.7
Cuffed and tunneled central venous catheters	29	4512	622,535	1013	22.5	21.2-23.7	1.6	1.5-1.7
Subcutaneous venous ports								
Central	14	3007	983,480	81	3.6	2.9-4.3	0.1	0.0-0.1
Peripheral	3	579	162,203	23	4.0	2.4-5.6	0.1	0.1-0.2
Intra-aortic balloon pumps	1	101	414	3	3.0	0.0-6.3	7.3	0.0-15.4
Left ventricular assist devices	3	157	19,653	41	26.1	19.2-33.0	2.1	1.5-2.7

*BSI = bloodstream infection; CI = confidence interval; IV = intravenous; IVD = intravascular device.

Maki DG et al., Mayo Clinic Proc 2006;81:1159-1171.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection



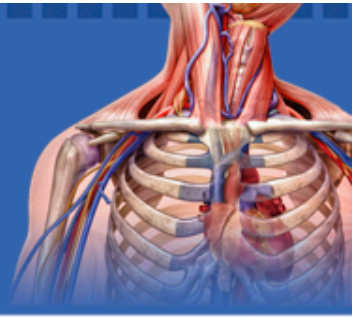
- Objectives: Few studies have assessed the risk of colonization or infection in concurrently used arterial (AC) and central venous (CVCs) catheters. The purpose of this study was to:
  1) prospectively measure AC colonization and bloodstream infection (BSI)
  2) to assess the risk factors for AC colonization
  3) to compare AC colonization and BSI to that of concurrently used CVCs.

- Study design:
  - Prospective 24 month (June 2004-June 2006) cohort study
  - Colonization or infection in peripheral AC or concurrent sited CVCs
  - 8-bed intensive care unit (ICU) 350-bed Australian teaching hospital

- Outcomes measured:
  - Incidence of catheter days of colonization (>15 colonies)
  - Catheter-related bloodstream infections

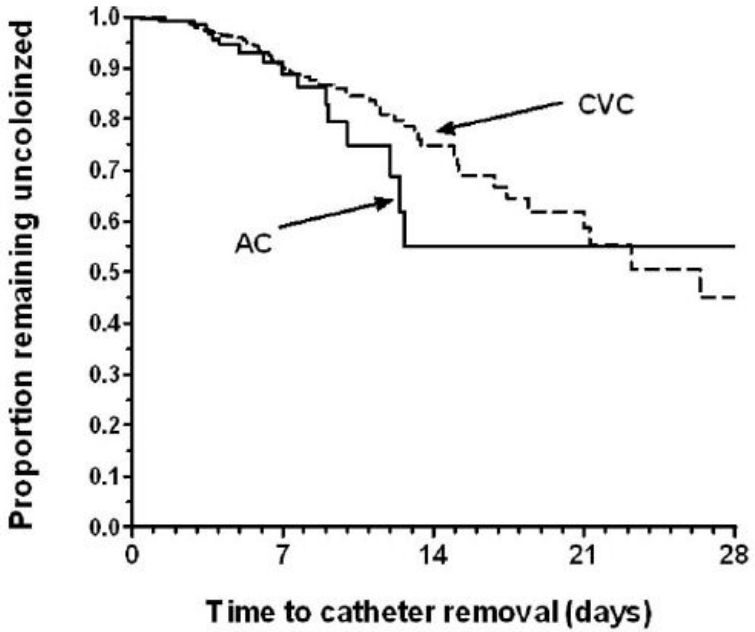
Koh et al. CCM 2008;36:397-402.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection



Results

- 321 arterial catheters (ACs)
  - inserted in 252 patients
  - observed for 1,082 catheter-days
  - Average duration = 3.4 days
- 618 CVCs
  - inserted in 410 patients
  - observed for 4,040 catheter-days
  - Average duration = 6.5 days

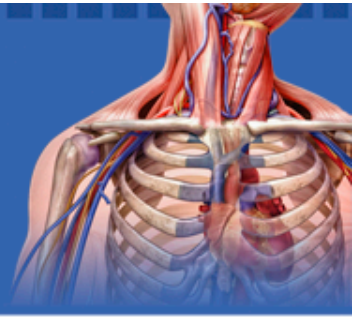


Numbers of catheters remaining in situ on days	0	4	8	12	16	20	24	28
AC —	321	87	30	10	3	2	2	1
CVC --	618	379	183	74	34	23	10	8

Figure 1. Proportion of arterial (*AC*) and central venous catheters (*CVC*) remaining uncolonized on removal. The incidence rate of AC colonization was not different than that of CVCs (hazard ratio, 1.17; 95% confidence interval, 0.41–3.36; $p = .773$).

Koh et al. CCM 2008;36:397–402.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection



Results

Table 1. Colonization and catheter-related bloodstream infection (CR-BSI) associated with arterial and central venous catheters

Catheter Site	No. of Catheters	Total Catheter-Days	Colonization			CR-BSI		
			No.	Rate[a]	%[b]	No.	Rate[a]	%[b]
Arterial catheters	321	1082	17	15.71	5.3	1	0.92	0.31
Central venous catheters	618	4040	68	16.83	11.0	9	2.23	1.46

[a]Unadjusted rate per 1000 catheter days; [b]percentage of catheters.

Koh et al. CCM 2008;36:397-402.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection

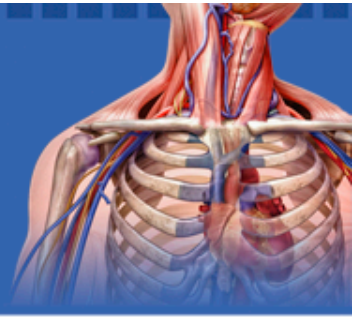


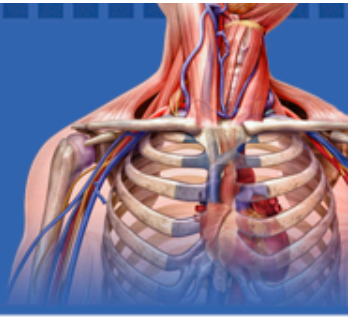
Table 2. Arterial catheter (AC) colonization when catheters were removed at different time periods

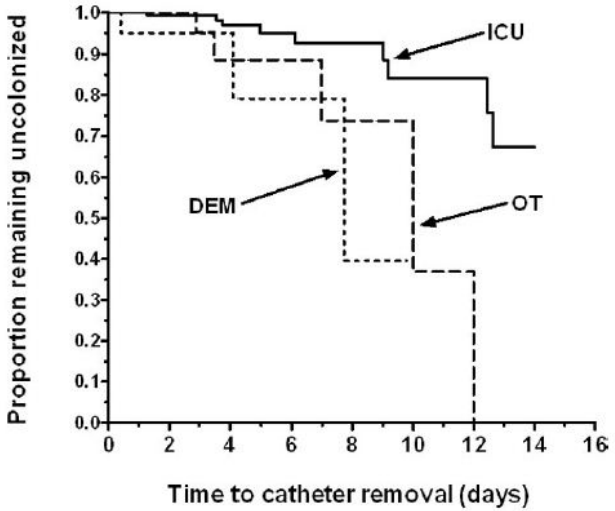
No. of Days	No. of Catheters Removed[a]	No. of Catheters Colonized	%	Mean AC Duration, Days
0–3	193	3	1.6	1.4
3–6	79	5	6.3	4.1
6–9	23	3	13	7.2
9–12	16	4	25	10.2
12–15	4	2	50	12.9

[a]In six catheters, removal time was not documented.

Koh et al. CCM 2008;36:397-402.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection

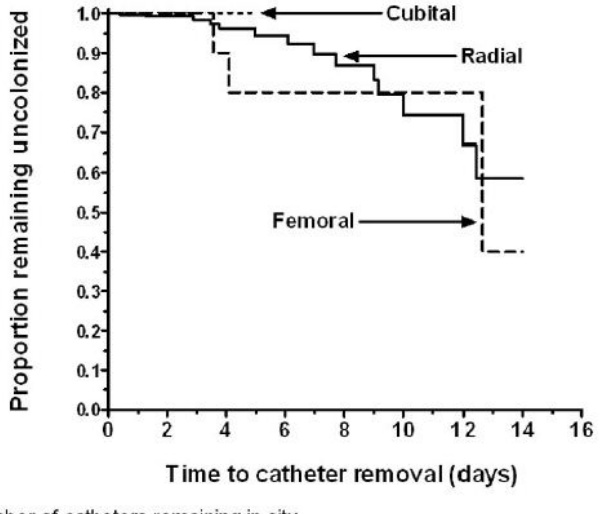




Number of catheters remaining in situ

on days	0	4	8	12	16
ICU ——	202	68	24	10	3
OT – –	99	13	5	0	0
DEM ····	20	6	1	0	0

Figure 2. Proportion of arterial catheters (ACs) remaining uncolonized on removal in relation to insertion in the intensive care unit (*ICU*), operating theater (*OT*), or department of emergency medicine (*DEM*). Colonization of ACs was higher when inserted in the OT and DEM (hazard ratio, 4.45; 95% confidence interval, 1.42–13.9; p = .010) compared with the ICU.



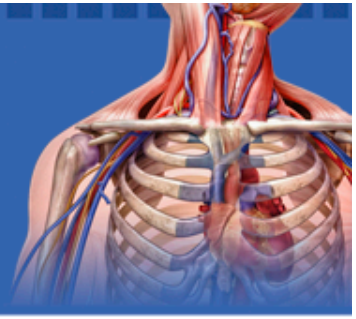
Number of catheters remaining in situ

on days	0	4	8	12	16
Radial ——	265	68	22	7	1
Cubital ····	15	2	0	0	0
Femoral – –	21	9	3	2	1

Figure 3. Proportion of arterial catheters (ACs) remaining uncolonized on removal in relation to anatomical insertion site. The femoral site was more heavily colonized (hazard ratio, 5.08; 95% confidence interval, 0.85–30.3; p = .075) than other sites. (In 20 catheters, the site was not recorded.)

Koh et al. CCM 2008;36:397-402.

Peripheral Artery vs. Central Venous Catheter Colonization and Infection

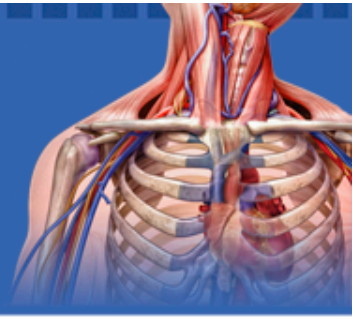


Conclusions

- This study documents that arterial catheters are at equal risk to CVCs of colonization and BSI.
- The risk of colonization is partially dependent upon:
  a) location of catheter insertion [OR, ED, ICU]
  b) site of insertion [IJ, SC, Femoral]
  c) duration of catheterization
- To reduce the risk of arterial catheter colonization and infection, more aggressive infection prevention measures are indicated.

Koh et al. CCM 2008;36:397-402.

Risk of Colonization or Infection in Arterial or Central Venous Catheters

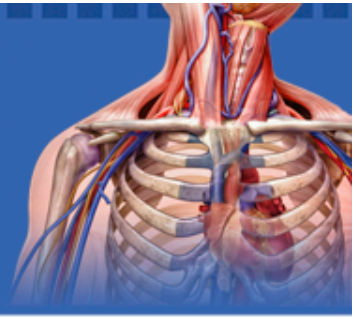


- Objectives: To compare the daily risk and risk factors for colonization and catheter-related infection between arterial catheters and central venous catheters.

- Methods: Data used were from a randomized controlled trial of seven intensive care units evaluating different dressing change intervals and use of CHG-impregnated disk. The daily hazard rate and identified risk factors for colonization were determined using a marginal Cox model for clustered data.

Lucet JC et al., Crit Care Med 2010; 38:1-6.

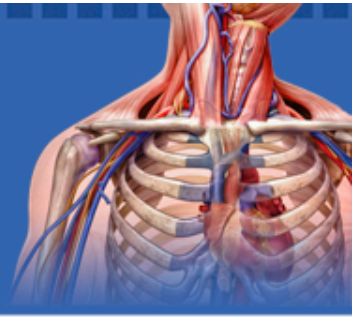
Risk of Colonization or Infection in Arterial or Central Venous Catheters



- 2,095 patients with >1 intravascular catheter, 1,636 were enrolled.
- Of these, 1,525 patients had >1 assessable catheter
  - 1,212 had >1 AC,
  - 1,403 had >1 CVC,
  - 1,090 had >1 AC plus >1 CVC
- A total of 3,532 catheters (1,617 ACs and 1,915 CVCs) with 27,541 catheter-days were cultured and analyzed.

Lucet JC et al., Crit Care Med 2010; 38:1-6.

Risk of Colonization or Infection in Arterial or Central Venous Catheters

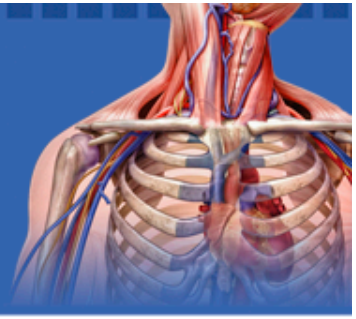


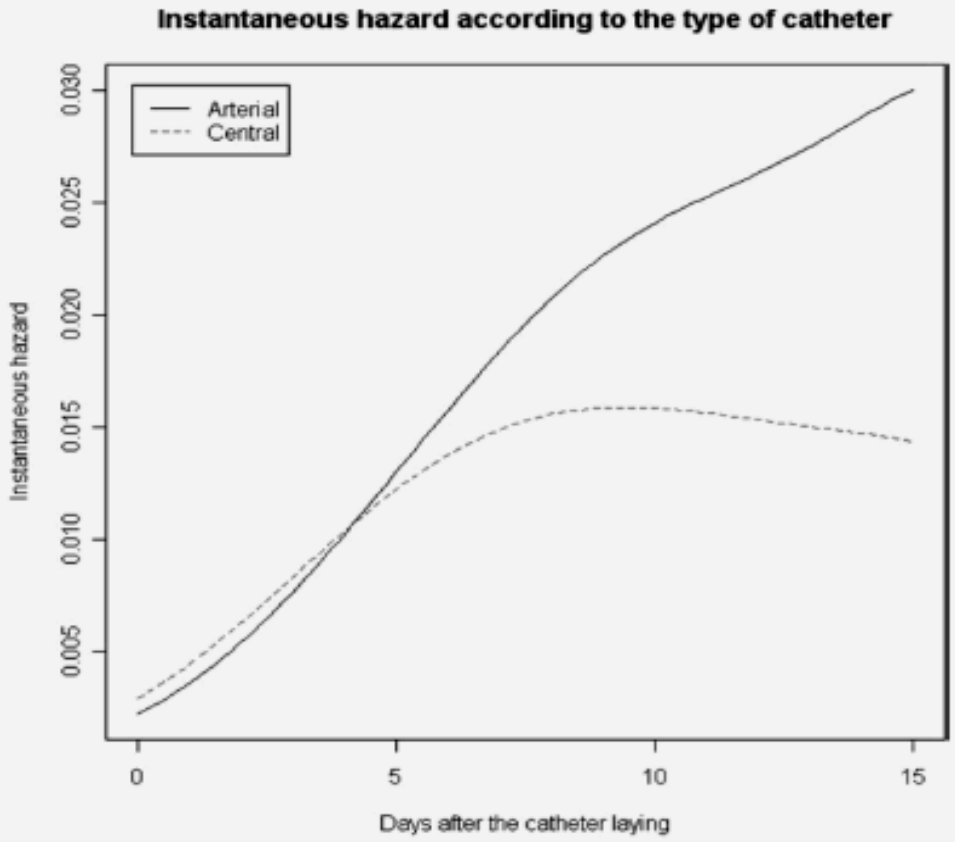
- Colonization rates did not differ between arterial catheters (ACs) and central venous catheters (CVCs)
  - ACs: 7.9% (11.4/1000 catheter-days)
  - CVCs: 9.6% (11.1/1000 catheter-days) respectively

- AC- and CVC-related infection rates were
  - ACs: 0.68% (1.0/1000 catheter-days)
  - CVCs: 0.94% (1.09/1000 catheter-days)

Lucet JC et al., Crit Care Med 2010; 38:1-6.

Risk of Colonization or Infection in Arterial or Central Venous Catheters





Number of catheters at risk

Day	1	3	5	7	9	11	13	15
Arterial:	1617	1314	877	581	387	260	181	118
Central:	1915	1663	1257	944	683	497	355	263

Figure 1. Daily hazard rate for catheter colonization.

Lucet JC et al., Crit Care Med 2010; 38:1-6.

Risk of Colonization or Infection in Arterial or Central Venous Catheters

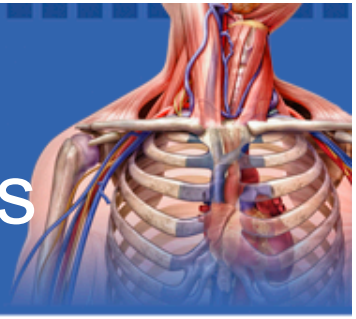


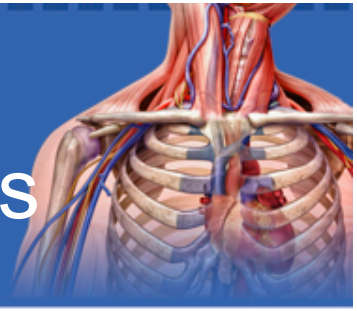
Table 3. Catheter colonization and catheter-related infections according to catheter type

Variable	Arterial Catheters, n = 1617	Central Venous Catheters, n = 1915
Catheter colonization $\geq 10^3$ colony-forming units,[a] n (%)	127 (7.8)	183 (9.6)
Staphylococcus aureus	6 (4.7)	10 (5.5)
Coagulase-negative staphylococci	63 (49.6)	90 (49.2)
Other Gram-positive cocci	16 (12.6)	18 (9.8)
Pseudomonas spp.	19 (15)	34 (18.6)
Enterobacter spp.	33 (26)	49 (26.8)
Escherichia coli	6 (4.7)	9 (4.9)
Acinetobacter baumannii	11 (8.7)	4 (2.2)
Fungi	3 (2.4)	10 (5.5)
Catheter-related bloodstream infection, n (%)	8 (0.5)	15 (0.8)
Major catheter-related infection,[a] n (%)	11 (0.7)	18 (0.9)
Staphylococcus aureus	1 (9.1)	4 (22.2)
Coagulase-negative staphylococci		4 (22.2)
Other Gram-positive cocci		1 (5.6)
Pseudomonas spp.	5 (45.5)	4 (22.2)
Enterobacter spp.	6 (54.5)	8 (44.4)
Escherichia coli	1 (9.1)	
Acinetobacter baumannii	1 (9.1)	
Fungi		1 (5.6)

[a] More than one microorganism was recovered in some cases.

Lucet JC et al., Crit Care Med 2010; 38:1-6.

Risk of Colonization or Infection in Arterial or Central Venous Catheters

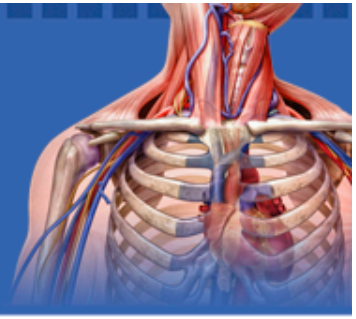


Conclusions:

- Risks of colonization and catheter-related infection did not differ between ACs and CVCs, indicating that AC use should receive the same precautions as CVC use.
- Daily risk was constant over time for CVCs after the fifth catheter day but increased significantly over time after the seventh day for ACs.
- Randomized studies are needed to investigate the impact of scheduled AC replacement.

Lucet JC et al., Crit Care Med 2010; 38:1-6.

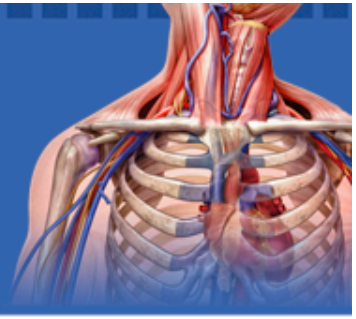
Comparative Risk of Colonization of Bloodstream Infection with Arterial or Central Venous Catheters



Reference	Colonization Rate*	Colonization Rate*	BSI Rate*	BSI Rate*
	ACs	CVCs	ACs	CVCs
Traore O. et al	9.4	12.0		
Koh DB. et al	15.7	16.8		
Maki DG. et al			1.4[a]	2.9
Estrave F. et al			3.7%	4.6%
Lucet JC. et al	11.4	9.6	1.0[b]	1.09

BSI = bloodstream infection; *Rate per 1,000 catheter-days;
AC = arterial catheters; CVC = central venous catheters; a = 0.8%; b = 0.7%

IVD-BSI Risk Associated with Central Venous and Arterial Catheters

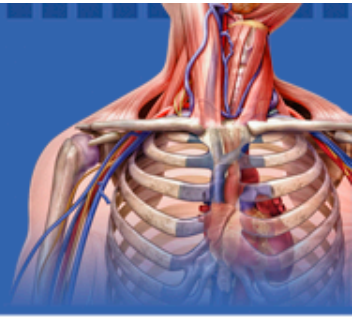


- If 6 million ACs are inserted annually and the risk of CR-BSI ranges from 0.7%-3.7%, then there are

  ~ 42,000 - 222,000 AC-related BSIs annually.

- Despite this, ACs are largely ignored in many guidelines (SHEA, UK, CDC-2002) and prevention bundles have not been applied to ACs.

CDC HICPAC 2011 IV Guideline



http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf

Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011

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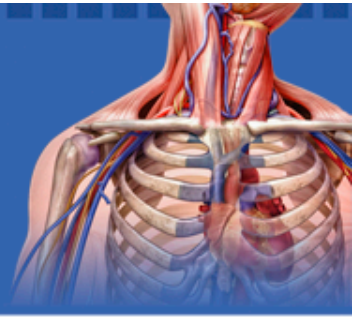
Category 1A Recommendations: Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies



PRESSURE TRANSDUCERS

1. Keep all components of the pressure monitoring system (including calibration devices and flush solution) sterile.

2. When the pressure monitoring system is accessed through a diaphragm, rather than a stopcock, scrub the diaphragm with an appropriate antiseptic before accessing the system.

3. Do not administer dextrose-containing solutions or parenteral nutrition fluids through the pressure monitoring circuit.

4. Sterilize reusable transducers according to the manufacturers' instructions if the use of disposable transducers is not feasible.

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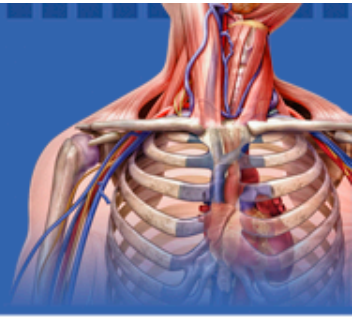
Category 1B Recommendations: Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies, and a strong theoretical rationale



UMBILICAL CATHETERS

1. Cleanse the umbilical insertion site with an antiseptic before catheter insertion. Avoid tincture of iodine because of the potential effect on the neonatal thyroid. Other iodine-containing products (e.g., povidone iodine) can be used.

2. Add low-doses of heparin (0.25-1.0 U/mL) to the fluid infused through umbilical arterial catheters.

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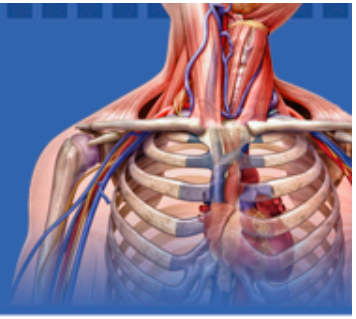

TRANSDUCERS, ADMINISTRATION SETS AND INFUSIONS

1. Use disposable, rather than reusable, transducer assemblies when possible.
2. Replace disposable or reusable transducers at 96-hour intervals. Replace other components of the system (including the tubing, continuous-flush device, and flush solution) at the time the transducer is replaced.
3. Replace tubing used to administer blood, blood products, or fat emulsions (those combined with amino acids and glucose in a 3-in-1 admixture or infused separately) within 24 hours of initiating the infusion.

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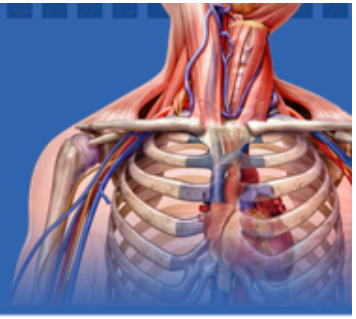

PERIPHERAL ARTERY CATHETERS

1. In adults, use of the radial, brachial or dorsalis pedis sites is preferred over the femoral or axillary sites of insertion to reduce the risk of infection.
2. A minimum of a cap, mask, sterile gloves and a small sterile fenestrated drape should be used during peripheral artery catheter insertion.

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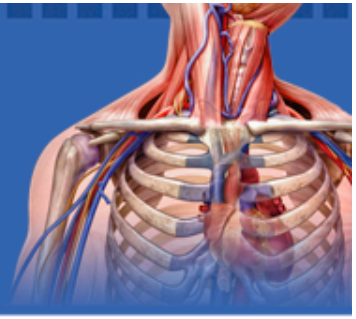
Category II Recommendations: Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale



ARTERIAL CATHETER TRANSDUCER ISSUES

1. In children, the brachial site should not be used. The radial, dorsalis pedis, and posterior tibial sites are preferred over the femoral or axillary sites of insertion.

2. During axillary or femoral artery catheter insertion, maximum barrier precautions should be used.

3. Replace arterial catheters only when there is a clinical indication.

4. Remove the arterial catheter as soon as it is no longer needed.

5. Do not routinely replace arterial catheters to prevent catheter-related infections.

6. Minimize the number of manipulations of and entries into the pressure monitoring system. Use a closed flush system (i.e., continuous flush), rather than an open system (i.e., one that requires a syringe and stopcock), to maintain the patency of the pressure monitoring catheters.

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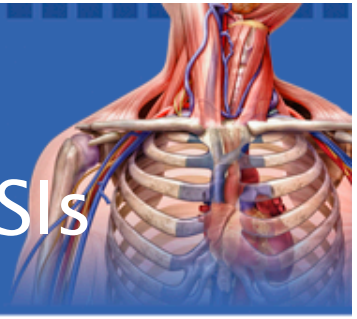
SHEA Recommended Basic and Special Approaches for the Prevention of CLA-BSIs



Basic Practices

Catheter Checklist	B- II
Hand Hygiene	B- II
Insertion site-Femoral	A- I
Cart Kit	B- II
Maximal Barrier Precautions	A- I
Chlorhexidine (CHG) Skin Prep	A- I

Catheter Insertion Bundle

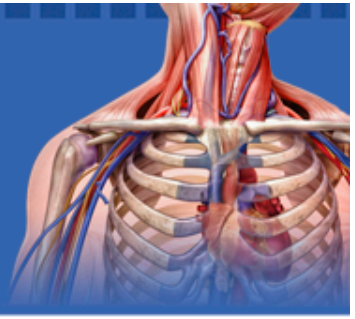
Special Approaches

CHG Baths (ICU patients)	B- II
Impregnated Catheters	A- I
CHG-impregnated (BioPatch) Disk	B- I
Antimicrobial Locks	A- I

Catheter Maintenance Bundle

Marschall J, et al. ICHE 2008;29:S22-30.

Potential Arterial Catheter Insertion and Maintenance Bundles



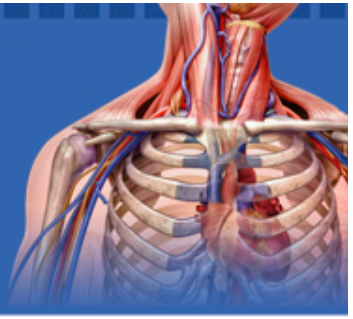
Insertion:

- Catheter kit with gown, gloves, large/small fenestrated drape and mask with eye protection
- Chlorhexidine with alcohol skin antiseptic
- Justification for initial insertion
- Inserter training and competence

Maintenance:

- Manipulator training and competence
- Catheter hub disinfection (alcohol or CHG/alcohol scrub)
- CHG-impregnated disk
- Dressing change asepsis
- Appropriate nurse to patient ratios
- Remove when no longer needed
- Surveillance and infection reporting

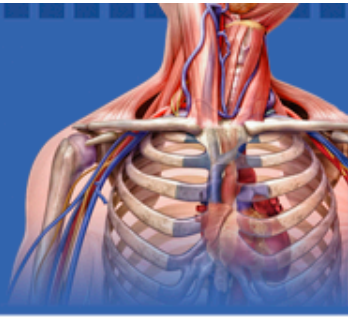
Conclusions



- Catheter (arterial and venous)-related BSIs are a major cause of patient morbidity and mortality.
- Prevention of Catheter-related BSIs requires a multi-factorial approach, including:
- Implementation of CDC Central Line-associated BSI Prevention Guideline Recommendations (2011) and SHEA 2008 Compendium Recommendations.
- Implementing new prevention evidence.
- Implementation of insertion and maintenance bundles.
- Educating staff; Insuring adequate and properly trained staff
- Insuring that policy = practice (clinician accountability)
- Monitoring catheter insertion and maintenance processes (checklists) and Catheter-related BSI rates (outcomes).

A comprehensive catheter-related BSI prevention program—applied to arterial and venous catheters-- can dramatically reduce infection rates and improve patient safety.

Conclusions



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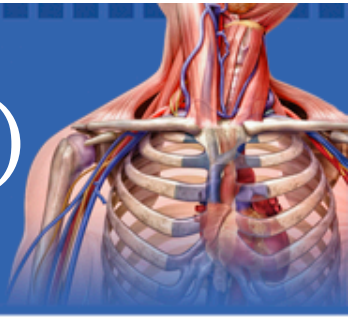
Continuing Education Credit (CE)



1. To obtain 1.0 contact hour, go to www.saxetesting.com/vh
2. Complete the post-test and evaluation form.
3. Certificate of completion will be issued immediately.
4. Provider approved by the California Board of Registered Nursing. Provider # 14477.
5. This program has been approved for 1.0 contact hour of CRCE by the AARC.

Questions ?

Thank you for your attention

This session has been recorded and will be archived on
www.vesselhealth.org