Reducing Risk in Vascular Access: A Review of Best Practice

Why are we here tonight?
Majority of CLABSI occurs outside the ICU

A significant opportunity exists to reduce CRBSI incidence in non-ICU settings.¹ ²

Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals: 2014 Update

The intent of this document is to highlight practical recommendations in a concise format designed to assist acute care hospitals in implementing and prioritizing their central line–associated bloodstream infection (CLABSI) prevention efforts. This document updates “Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals,” originally published in 2008*.

Independent risk factors for CLABSI

1. Prolonged hospitalization before catheterization
2. Prolonged duration of catheterization
3. Heavy microbial colonization at the insertion site
4. Heavy microbial colonization of the catheter hub
5. High internal jugular catheterization
6. Femoral catheterization in adults
7. Neutropenia
8. Prematurity (i.e. early gestational age)
9. Reduced nurse-to-patient ratio in the ICU
10. Total parenteral nutrition
11. Substandard catheter care
12. Transfusion of blood products (in children)
In 2009 alone, an estimated 25,000 fewer CLABSI occurred in U.S. ICUs than in 2001, a 58% reduction. This represents up to 6,000 lives saved and $414 million in potential excess health-care costs in 2009 and approximately $1.8 billion in cumulative excess health-care costs since 2001. A substantial number of CLABSI continue to occur, especially in outpatient hemodialysis centers and inpatient wards.
Australian CLABSI Data ~2008

- At a rate of 23 per 1000 catheter days
- It has an 11% mortality rate = 392 deaths PA in Australia from a preventable adverse event-
- Cost of CRBSI in Australia is estimated to be between $25.7 million AUD & $95.3 million pa.

Australian CLABSI Surveillance

- In 2008, the Australian Commission on Safety and Quality in Healthcare (ACSQHC) recommended and endorsed “a mandatory continuous national surveillance to collect and report on an agreed minimum dataset for central line associated blood stream infections in all ICUs”.

- In early 2010, the Australian and New Zealand Intensive Care Society (ANZICS) initiated the ANZICS CLABSI Prevention Project.
NSW CLAB-ICU Project (38 ICUs >15 months of data): CLABSI rate decreased from 3 to 1.2 per 1,000 line days.

Perth: (all WA public ICUs): CLABSI rate (2009-2010): 0.55/1,000 line-days.

Victoria: Since 2003, CLABSI surveillance had been coordinated by the Victorian Healthcare Associated Infection Surveillance System (VicNISS; 36 ICUs).

Adelaide: (Feb 2012): 12 ICUs. No specific CLABSI surveillance.

New South Wales (April 2012): Only private hospitals invited to the meeting - 3/16 ICUs attended.

Queensland (May 2012): No CLABSI surveillance had been performed in ICUs.

Lots of guidelines!
Guidelines

CDC HICPAC 2011 Guideline

CDC major emphasis areas are:

1. Education and training healthcare personnel who insert and maintain catheters

2. Using maximal sterile barrier precautions during central venous catheter (CVC) insertion

3. Using a >0.5% chlorhexidine (CHG) preparation with 70% alcohol for skin antisepsis

4. Avoiding routine replacement of CVCs as a strategy to prevent infection
CDC major emphasis areas are:

5. Using antiseptic/antibiotic impregnated short-term CVCs and chlorhexidine impregnated-style dressings, if the rate of infection is not decreasing despite adherence to other strategies;

(i.e. education and training, maximum barrier precautions, and >0.5% CHG preparations with alcohol for skin antisepsis)

6. Performance improvement by implementing bundled strategies, and documenting and reporting rates of compliance with all components of the bundle as benchmarks for quality assurance and performance improvement.
Australian Guidelines
Australian Guidelines;

• Australian Commission on Safety and Quality in Healthcare (ACSQHC), Australian Guidelines for the Prevention and Control of Infection in Healthcare, 2012:

  “There is strong evidence (Grade B) that the use of chlorhexidine-impregnated (CHG) sponges at the catheter insertion site significantly reduces IVD-related bloodstream infections and device colonisation rates compared to other types of dressings for peripheral arterial devices, short-term or long-term central venous devices.”

• Standard 3: Preventing and Controlling Healthcare Associated Infections.
SHEA Guideline

- Society for Hospital Epidemiology of America (SHEA)
- Infectious Diseases Society of America (IDSA)
- American Hospital Association (AHA)
- Association for Professionals in Infection Control and Epidemiology (APIC)
- The Joint Commission
## SHEA Level of Evidence

### TABLE 1. Grading of the Quality of Evidence

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. High</td>
<td>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 is a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.</td>
</tr>
<tr>
<td>II. Moderate</td>
<td>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, or the confidence interval of the summary estimate is wide.</td>
</tr>
<tr>
<td>III. Low</td>
<td>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, or there are no rigorous studies, only expert consensus.</td>
</tr>
</tbody>
</table>

**Note.** Based on Grades of Recommendation, Assessment, Development, and Evaluation (GRADE)\(^{257}\) and the Canadian Task Force on Preventive Health Care.\(^{258}\)

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http://journals.cambridge.org/abstract_S0195941700093528
SHEA recommendations

Basic Practices
• Catheter Checklist - II
• Hand Hygiene - II
• Insertion site - Femoral - I
• Cart Kit - II
• Maximal Barrier Precautions - I
• Chlorhexidine (CHG) Skin Prep - I
• Scrub the Hub – I

Special Approaches
• CHG Baths (ICU patients) - I
• Impregnated Catheters - I
• CHG Impregnated Disc - I
• Antimicrobial Locks - I

http://journals.cambridge.org/abstract_S0195941700093528
Factors Known To Influence CLABSI Rates

• Types of patients with catheters (gastrointestinal, neonatal, cancer, immune-deficient, ICU);
• Type, number, site of insertion, and duration of catheters (impregnated or not, number of lumens);
• Types of connectors (needleless—split septum vs. mechanical valve, stopcocks);
• What is infused through the catheter (esp., blood, lipid, TPN);
• Who inserts/manipulates the catheter (IV team or not);
• Method of documenting BSI (central line cultures—number of lumens and number of catheters cultured, only peripheral culture);
• Interpretation and application of the CDC or other CLABSI definitions and protocols;
• Infection control practices, hand hygiene, etc.
5 Evidence Based Strategies to Prevent CLABSIs

Prevention of CLBSI revolves around 5 best practices. When these interventions are bundled together, they significantly decrease CLBSI. These practices are:

1. Good Hand Hygiene
2. Use of Maximal Barrier Precautions For Catheter Insertion
3. Use of Chlorhexidine & Alcohol to Prepare Skin
4. Optimal Catheter Site Selection, with Avoidance of the Femoral Vein for Central Venous Access in Adult Patients
5. Daily Surveillance of Lines with Prompt Removal of Unnecessary Catheters

Warren et al. ICHE 2006:27;662-7
Marschall et al. ICHE 2008:29; 22S-30S
New to the INS Standards in 2016

- Infusion Team (I, IV, V) – education, training and competency
- Standard Precautions (III-V) – regulatory requirements
- Vascular Visualization (I-V) – US/nIR technologies
- Central Vascular Access Device Tip Location (II, IV, V) – ECG/EKG
- Nerve Injury (I A/P, IV, V) – clear documentation of avoidable sites
The bacterial route of all evil...

<table>
<thead>
<tr>
<th>Extraduodenal</th>
<th>Intraluminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%*</td>
<td>20-30%*</td>
</tr>
</tbody>
</table>

Contamination Sources
- Hands of Medical Personnel
- Hub Colonization
- Patients' Skin Microflora
- Hematogenous Spread
- Contaminated on Insertion
## The Impact of Hand Hygiene – 2014 (AU)

### Compliance Rate Overall

<table>
<thead>
<tr>
<th></th>
<th>Correct Moments</th>
<th>Total Moments</th>
<th>Compliance Rate</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Rate</td>
<td>439,856</td>
<td>537,154</td>
<td>81.9%</td>
<td>81.8%</td>
<td>82%</td>
</tr>
</tbody>
</table>

### Compliance Rate by Moment

<table>
<thead>
<tr>
<th>Moment</th>
<th>Correct Moments</th>
<th>Total Moments</th>
<th>Compliance Rate</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Before Touching A Patient</td>
<td>119,708</td>
<td>153,277</td>
<td>78.1%</td>
<td>77.9%</td>
<td>78.3%</td>
</tr>
<tr>
<td>2 - Before Procedure</td>
<td>43,217</td>
<td>50,925</td>
<td>84.9%</td>
<td>84.6%</td>
<td>85.2%</td>
</tr>
<tr>
<td>3 - After a Procedure or Body Fluid Exposure Risk</td>
<td>54,940</td>
<td>61,513</td>
<td>89.3%</td>
<td>89.1%</td>
<td>89.6%</td>
</tr>
<tr>
<td>4 - After Touching a Patient</td>
<td>133,336</td>
<td>154,069</td>
<td>86.5%</td>
<td>86.4%</td>
<td>86.7%</td>
</tr>
<tr>
<td>5 - After Touching A Patient’s Surroundings</td>
<td>88,655</td>
<td>117,370</td>
<td>75.5%</td>
<td>75.3%</td>
<td>75.8%</td>
</tr>
</tbody>
</table>

Joint facility of UTS and UNSW Faculties of Law

• New South Wales Consolidated Regulations (Jan 2010)
  HEALTH PRACTITIONER REGULATION (NEW SOUTH WALES) REGULATION 2010 - SCHEDULE 1
  – Infection control standard

• **Part 2 - General standards applying to relevant health practitioners**

  **2 General precautions and aseptic techniques**
  
  (1) Precautions must be taken to avoid direct exposure to a patient’s blood or body substance.
  
  (2) The requirement in subclause (1) applies regardless of whether there is any perceived risk of infection.
  
  (3) Aseptic techniques must be used in the course of complying with the requirements of this Schedule.

CHG/Alcohol Skin Prep Is Best

Skin prep with CHG/alcohol is more effective than with povidone iodine (Betadine) in preventing CLABSI.

This meta-analysis found that use of CHG reduced the risk of CLABSI by 49%.

Skin Antisepsis – adults and 2 months +

- Use an alcoholic chlorhexidine antiseptic for skin preparation (quality of evidence: I)

- Bathe ICU patients over 2 months of age with a chlorhexidine preparation on a daily basis (quality of evidence: I)

- In long-term acute care hospitals, daily chlorhexidine bathing may also be considered as a preventive measure*

- The role of chlorhexidine bathing in non-ICU patients remains to be determined#

# Medina A J Nurs Care Qual 2014;29(2):133–140.
Skin Antisepsis: under 2 months

- The optimal choice of antiseptic agents is unresolved for children under 2 months of age. However, chlorhexidine is widely used in children under 2 months of age*

- FDA recommends “use with care in premature infants or infants under 2 months of age; these products may cause irritation or chemical burns.”

- Some institutions have used chlorhexidine-containing sponge dressings for CVCs$ and chlorhexidine for cleaning CVC insertion sites in children in this age group with minimal risk of such reactions#

CHG Resistance

- Widespread use of chlorhexidine-based products (eg, use of chlorhexidine bathing, antisepsis, and dressings) may promote reduced chlorhexidine susceptibility in bacterial strains*

- However, testing for chlorhexidine susceptibility is not standardized. The clinical impact of reduced chlorhexidine susceptibility in gram-negative bacteria is unknown

- The benefits of chlorhexidine outweigh the risks of not using it.

CHG Allergy

• CHG impregnated CVCs are widely used, because CHG 2% has demonstrated to reduce significantly intravascular catheter-related infections [Maki 1991], but CHG-coated CVC may be an important unrecognized source of CHG exposure.
• Importantly, CHG is not documented as a drug administered by anaesthesiologists because skin disinfection and catheter insertion performed by nurse staffs are considered as routinely preoperative activities.
• Contemporary double exposure to CHG-coated catheters may be possible: through central venous line plus the urethral pathway – in ICU and OT.
• Always have non-CHG impregnated devices and skin antiseptics available for patients with known or suspected CHG Ax.
Maximal Barrier Precautions

- Full-Body Drapes
- Chloraprep Applicators
- Bouffants & Caps
- Masks
- Hospital Forms & Educational Materials
- Gloves
- Gowns
This picture does **NOT** show Maximal Barrier Protection
3 studies:

1) Mermel 1991 Am J Med 91(3B):197S-205S. Prospective, Cross-sectional Study (Swan-Ganz Catheters) demonstrated that the risk of infection was **2.2 fold higher when MBP were not used (p=0.03)**

2) Raad 1994 Infect Control Hosp Epidemiol 15:231-8. Prospective, Randomized Study (Central Venous Catheters) demonstrated that the risk of infection was **3.3 fold higher when MBP were not used (p=0.03)**

3) Lee 2008 Infect Control Hosp Epidemiol 2008;29:947-950 demonstrated that the risk for infection was **5.2 higher when MBP were not used (p=0.02)**

Maximum barrier precautions - the drape covers the patient from head to foot
# Maximal Barrier Precautions

<table>
<thead>
<tr>
<th>Operator &amp; supervisor (or anyone at risk for crossing the sterile field)</th>
<th>For the Patient</th>
<th>For the Assistant (if required)</th>
</tr>
</thead>
</table>
| • Hand hygiene  
• Non-sterile cap and mask  
  • All hair should be under cap (includes beard and mustache)  
  • Mask should cover nose and mouth tightly  
• Sterile gown  
• Sterile gloves | • Cover patient’s head and body with a large sterile drape | • Hand hygiene  
• Non-sterile cap and mask  
  • All hair should be under cap (includes beard and mustache)  
  • Mask should cover nose and mouth tightly  
• Sterile gown  
• Sterile gloves |

Note: **people in the same room** who are not involved with the procedure (and who are not at risk for crossing the sterile field) do not need to wear maximal barrier precautions – but cap and mask is required.
Two-Dimensional Ultrasound (US)

(Note: This picture shows assistants without the best practice PPE, consisting of cap, mask with eye protection and gown (within operating field)
US-guided versus Anatomical Landmark

- Meta-analysis of 18 RCTs
  - Failed placement: RR 86%
  - Complications: RR 57%
  - First attempt failure: RR 41%
  - Attempts: 1.5
  - Time: 69.3 (sec)

## Ultrasound? Since when?

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC (2002)</td>
<td>Use of ultrasound guidance for catheter insertion substantially reduces mechanical complications</td>
</tr>
<tr>
<td>NICE (2002)</td>
<td>Use ultrasound guidance for catheter insertion substantially reduced mechanical complications</td>
</tr>
<tr>
<td>CNSA (2007)</td>
<td>Recommends use that patient safety could be improved by combining ultrasound guided puncture and ECG-guided positioning.</td>
</tr>
<tr>
<td>APIC (2009)</td>
<td>Use ultrasound guidance for internal jugular catheter insertion.</td>
</tr>
<tr>
<td>CDC/HICPAC (2011)</td>
<td>Use US guidance to reduce number of cannulation attempts and mechanical complications if technology is available (Level of evidence: 1B)</td>
</tr>
<tr>
<td>ANZICS (2011)</td>
<td><strong>No recommendations</strong> on ultrasound guidance for CVC insertion.</td>
</tr>
<tr>
<td>EPIC 3 (2013)</td>
<td>US use may indirectly reduce the risk of infection by facilitating mechanically uncomplicated subclavian placement.</td>
</tr>
<tr>
<td>SHEA (2014)</td>
<td>Use ultrasound guidance for internal jugular catheter insertion (quality of evidence: II)</td>
</tr>
</tbody>
</table>
Choice of Site

- The femoral site should be avoided.

- In a clinical trial of ICU patients randomized to femoral or subclavian lines there were:
  - Higher rate of **infectious** complications (colonization and BSI combined) in femoral grp: 19.8% vs 4.5% (p < .001)
  - Higher rate of **thrombotic** complications in femoral grp: 21.5% vs. 1.9% (p < .001); complete thrombosis 6% vs 0%

- The preferred order of preference:
  1) Subclavian  
  2) Internal Jugular  
  3) Femoral

Merrer J et al. 2001, Complications of femoral and subclavian venous catheterization in critically ill patients: a randomized controlled trial JAMA; 286:700-7
Special Considerations for Site Selection

Other factors to consider in site choice include:

Anatomic deformity

Presence of coagulopathy

- Use a compressible site (e.g., IJ/AxV, not SC)

Hemodialysis patients:

National Kidney Foundation 2006 Guidelines recommended against the use of the subclavian vein for any central line, unless use of the IJ vein is absolutely contraindicated, due to the risk of subclavian vein stenosis.

If the IJ vein is chosen, use the right side to reduce risk of mechanical complications.
Other Special Considerations

1. Use antiseptic or antimicrobial-impregnated CVCs in adult patients (quality of evidence: I)
2. Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (quality of evidence: I).
   a. It is unclear whether there is additional benefit to using a chlorhexidine-containing dressing if daily chlorhexidine bathing is already established and vice versa.
3. Use an antiseptic-containing hub/connector cap/port protector to cover connectors (quality of evidence: I)
4. Use silver zeolite–impregnated umbilical catheters in preterm infants (in countries where it is approved for use in children; quality of evidence: II)
5. Use antimicrobial locks for CVCs (quality of evidence: I)

Cleared Indication to reduce local infections, catheter-related bloodstream infections (CRBSI), and skin colonization of microorganisms commonly related to CRBSI in patients with central venous and arterial catheters
Many options available

Not all antimicrobials are the same..
Not all dressing materials are the same..
Not all designs are the same..
Post Insertion Care

- Antimicrobial ointments do not reduce the incidence of CLABSI except HD catheters
- Apply a sterile dressing to the insertion site before the sterile barriers are removed.
- Transparent dressings are preferred to allow visualization of the site.
- If the insertion site is oozing, apply a gauze dressing instead of a transparent dressing.
- Replace dressings when the dressing becomes damp, loosened, soiled or after lifting the dressing to inspect the site.
Daily Review of Device Necessity

- Evaluate necessity of intravenous catheters daily with the patient care team.
- The care team understands and communicates the reason for the central catheter.
- Remove intravenous catheters as soon as possible to reduce the risk of catheter related bloodstream infections.
In Summary

“When does the Opportunity to be a healthcare provider become an Obligation to provide the best healthcare?”