

Prevention of Central Line-Associated Bloodstream Infections: Aseptic Insertion and Site Selection



Presenter

Vineet Chopra, MD, MSc

Associate Professor of Medicine
Chief of the Division of Hospital Medicine
University of Michigan

Contributions by

Kristi Felix, RN, BSN, CRRN, CIC, FAPIC
Madonna Rehabilitation Hospital

Karen Jones, RN, MPH, CIC
University of Michigan

Len Mermel, DO, ScM, AM (Hon)
Medical School of Brown University

Russ Olmsted, MPH, CIC, FAPIC
Trinity Health, Livonia MI

Payal Patel, MD, MPH
University of Michigan



Learning Objectives

- Explain the importance of preparing the site for central venous catheter (CVC) insertion
- Recognize the role of various antiseptics in preventing central line-associated bloodstream infections (CLABSI)
- Describe the considerations for choosing a site for CVC insertion



Preparing the Site for CVC Insertion

- Skin antisepsis is a cornerstone of CLABSI prevention
- Skin pathogens are a common cause of CLABSIs
 - Especially for CLABSIs that occur within seven days of insertion
 - Preparing the site appropriately can reduce risk of catheter-related infection
 - Prevent transmission during insertion
 - Reduce burden of bacteria on exit site



Which Skin Preparation is Best?

Available skin preparations include

- Chlorhexidine-gluconate (CHG)
 - Aqueous
 - Alcohol-containing
- Povidone-iodine
- Alcohol preparation without iodine or CHG



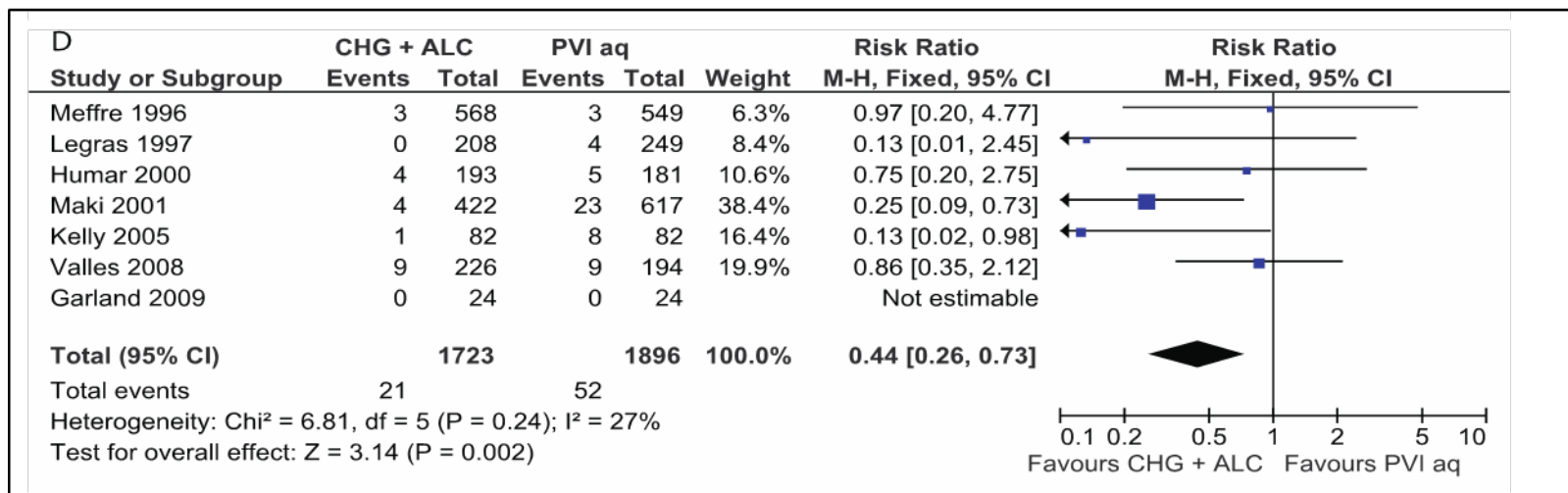
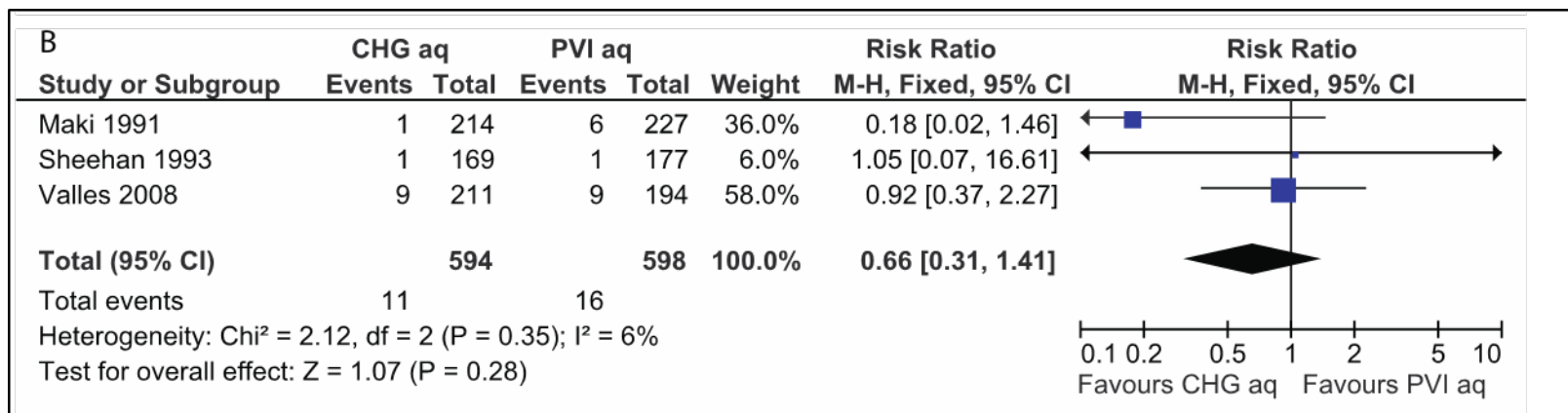
Chlorhexidine-Gluconate as a Skin Antiseptic

**Compared to povidone iodine,
chlorhexidine use for skin antisepsis
significantly reduced risk of CLABSIs**

Risk Ratio 0.51 (95%CI 0.27-0.97%)



The Role of Alcohol



What is the Active Ingredient?

- Is it the alcohol or the chlorhexidine that matters most?
 - In identical concentrations of alcohol, does CHG outperform povidone iodine?
- Does cleaning the skin with soap before catheter insertion make a difference?
- What concentration of chlorhexidine is best?



The CLEAN Trial

Skin antisepsis with chlorhexidine–alcohol versus povidone iodine–alcohol, with and without skin scrubbing, for prevention of intravascular-catheter-related infection (CLEAN): an open-label, multicentre, randomised, controlled, two-by-two factorial trial



*Olivier Mimoz, Jean-Christophe Lucet, Thomas Kerforne, Julien Pascal, Bertrand Souweine, Véronique Goudet, Alain Mercat, Lila Bouadma, Sigismond Lasocki, Serge Alfandari, Arnaud Friggeri, Florent Wallet, Nicolas Allou, Stéphane Ruckly, Dorothée Balayn, Alain Lepape, Jean-François Timsit, for the CLEAN trial investigators**

Randomized controlled trial, n=2,546

11 ICUs, six different hospitals in France

Two-by-two factorial design, four treatment groups:

- CHG or povidone iodine for antisepsis
- Scrubbing with detergent versus no scrubbing

(Mimoz O, Lancet, 2015)



The CLEAN Trial: Product Used

2% CHG to 70% isopropyl alcohol (Chloraprep)

5% povidone iodine (PI) to 69% ethanol

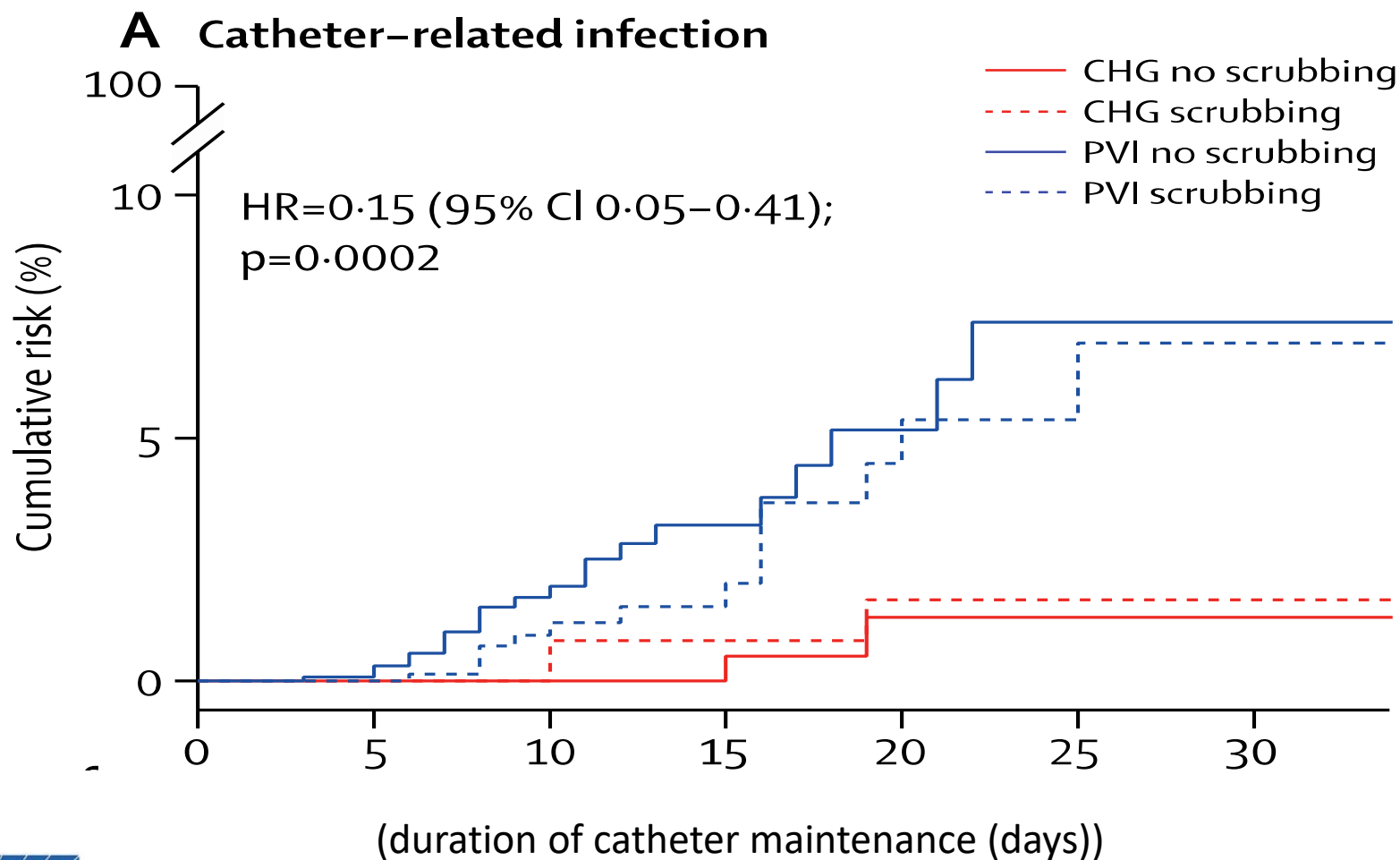
Applied either as:

- 1 step: skin agent only
- 2 step: clean with detergent first, then apply agent

Because products looked different, unable to blind clinicians, but assessors were masked



The CLEAN Trial: Results



The CLEAN Trial: Summary

CHG is superior to PI when administered in the same alcohol concentration

Skin scrubbing is a relic of the past

- No longer necessary in an era of modern antiseptics and CHG use

Alcohol-containing CHG should be standard for skin antisepsis prior to CVC insertion

- If the patient is allergic or under two months of age, PI is a reasonable alternative



Traditional Thinking About Site

Avoid the femoral site

- Higher bacterial density
- Harder to keep clean
 - Core component of Keystone study, CLABSI Bundle

What about the jugular site?

- Problematic to keep site clean, dry, intact
 - Dressing, oral secretions, weight of catheter/tubing

How do femoral and jugular vein placement compare to subclavian placement?



Is the Femoral Site Really Worse?

 CARING FOR THE
CRITICALLY ILL PATIENT

Femoral vs Jugular Venous Catheterization and Risk of Nosocomial Events in Adults Requiring Acute Renal Replacement Therapy A Randomized Controlled Trial

Randomized controlled trial with 750 adult patients requiring acute renal replacement therapy

From 12 hospitals in France

Randomized to jugular or femoral catheter site placement

Results:

- More hematomas in the jugular group
- No difference in rate of catheter-related bloodstream infection

(Parienti JJ, JAMA, 2008)



More Data Questioning Site

Meta-analysis of subclavian insertion and nontunneled central venous catheter-associated infection risk reduction in critically ill adults*

Parienti, Jean-Jacques MD, PhD; du Cheyron, Damien MD, PhD; Timsit, Jean-François MD, PhD; Traoré, Ousmane MD; Kalfon, Pierre MD; Mimoz, Olivier MD, PhD; Mermel, Leonard A. DO, ScM, AM (Hon)

Systematic review of randomized or prospective cohort studies

Reviewed 19 studies and 10 were included in the meta-analysis

- Only one randomized site of insertion

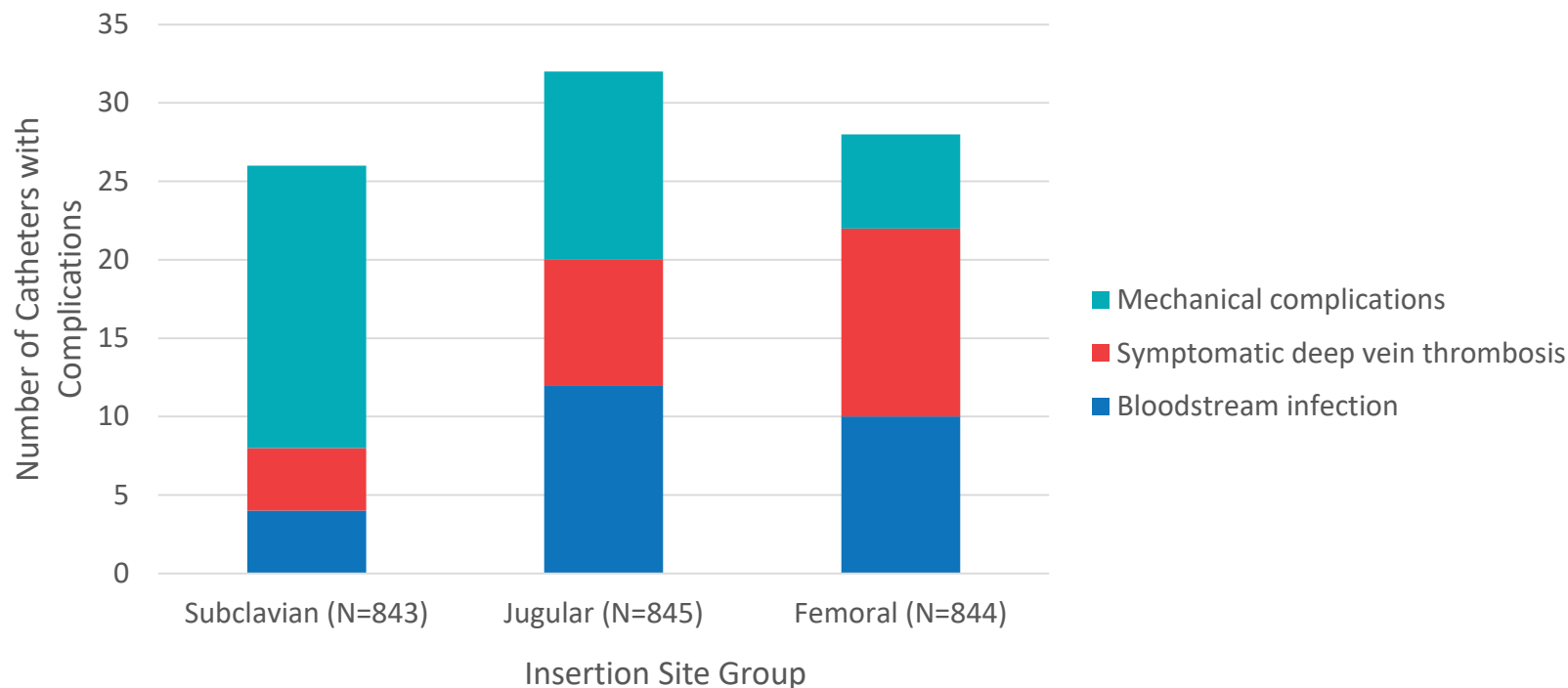
Results:

- Risk of infection lower for subclavian site versus jugular and femoral sites
 - RR 0.47 [95%CI=0.27-0.82]
- When one large study was excluded, no difference in risk between femoral and subclavian site

(Parienti JJ, Crit Care Med, 2012)



Definitive Data



Subclavian site associated with lower risk of catheter-related bloodstream infection and deep vein thrombosis, but higher risk of pneumothorax.

(Parienti JJ, *N Engl J Med*, 2015)



What About Skin Asepsis and Site for Peripherally Inserted Central Catheters (PICCs)?

Limited data available

Avoid antecubital site or sites around elbow

- Increase kink of catheter, which increases failure
- Higher bacterial density on skin, aka the “groin of arm”

Upper arm placement under ultrasound guidance associated with reduction in CLABSI

Placement of PICCs in ICU settings – same risk of CLABSI as traditional CVCs



Summary

Alcohol-containing chlorhexidine-gluconate is the most effective skin antisepsis at reducing CLABSI

For patients allergic to CHG, povidone iodine is a suitable alternative

Weigh the risk of infection against the risk of mechanical complications when placing central venous devices

- Subclavian placement has the lowest risk of infection but highest risk for insertion-related complications
- No clear difference in infection risk between jugular and femoral sites

PICCs have similar rates of infection as CVCs

- Avoid the antecubital fossa
- Use ultrasound guidance for insertion



References

Chaiyakunapruk N, Veenstra DL, Lipsky BA, et al. Chlorhexidine compared with povidone-iodine solution for vascular catheter-site care: a meta analysis. *Ann Intern Med*. 2002; 136(11): 792-801.

Harnage SA. Achieving zero catheter related blood stream infections: 15 months success in a community based medical center. *JAVA*. 2007; 12(4): 218-25.

Maiwald M, Chan ES. The forgotten role of alcohol: a systematic review and meta-analysis of the clinical efficacy and perceived role of chlorhexidine in skin antisepsis. *PLoS One*. 2012; 7(9): e44277.

McNeil CR, Rezaie SR, Adams BD. Central Venous Catheterization and Central Venous Pressure Monitoring. *Clinical Procedures in Emergency Medicine*. 2014; 6: 397-431.

Mimoz O, Chopra V, Timsit JF. What's new in catheter-related infection: skin cleansing and skin antisepsis. *Intensive Care Med*. 2016; 42(11):1784-6.



References (cont'd)

Mimoz O, Lucet JC, Kerforne T, et al. Skin antisepsis with chlorhexidine-alcohol versus povidone iodine-alcohol, with and without skin scrubbing for prevention of intravascular-catheter-related infection (CLEAN): an open-label, multicenter, randomized, controlled, two-by-two factorial trial. *Lancet*. 2015; 386(10008): 2069-77.

Parienti JJ, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med*. 2015; 373: 1220-1229.

Parienti JJ, duCheyron D, Timsit JF, et al. Meta-analysis of subclavian insertion and nontunneled central venous catheter-associated infection risk reduction in critically ill adults. *Crit Care Med*. 2012; 40(5): 1627-34.

Parienti JJ, Thirion M, Mégarbane B, et al. Femoral vs jugular venous catheterization and risk of nosocomial events in adults requiring acute renal replacement therapy: a randomized controlled trial. *JAMA*. 2008; 299(2): 2413-22.

Yokoe DS, Anderson DJ, Berenholtz SM, et al. A compendium of strategies to prevent healthcare-associated infections in acute care hospitals: 2014 Updates. *Am J Infect Control*. 2014; 42(8): 820-8.



Speaker Notes



Speaker Notes: Slide 1

This module, titled “Prevention of Central Line-Associated Bloodstream Infections: Aseptic Insertion and Site Selection,” will provide background information on the importance of asepsis during catheter insertion and site selection as a means to prevent CLABSI.



Speaker Notes: Slide 2

This module was developed by national infection prevention experts devoted to improving patient safety and infection prevention efforts.



Speaker Notes: Slide 3

After completing this module, you will be able to:

- Explain the importance of preparing the site for central venous catheter, or CVC, insertion,
- Recognize the role of various antiseptics in preventing central line-associated bloodstream infections, or CLABSI, and
- Describe the considerations for choosing a site for CVC insertion.



Speaker Notes: Slide 4

Skin antisepsis is a cornerstone of CLABSI prevention. If the skin is not cleaned properly, pathogens can migrate along the external surface of the catheter from the skin entry site. Thus, skin pathogens are a common cause of CLABSI, especially within the first seven days of CVC insertion.

Appropriately preparing the insertion site can dramatically reduce the risk of catheter-related infections. This antisepsis both prevents transmission during insertion and reduces the burden of bacteria on the exit site.



Speaker Notes: Slide 5

Available skin preparations include: chlorhexidine-gluconate, both aqueous and alcohol-containing, povidone-iodine and alcohol preparation without iodine or chlorhexidine.

So, which skin preparation is the best to prevent CLABSI?



Speaker Notes: Slide 6

An important meta-analysis by Chaiyakunapruk and colleagues in 2002 compared the use of povidone iodine solution with the use of CHG for skin antisepsis in the prevention of CLABSI.

This systematic review found that compared to povidone iodine, skin disinfection with CHG reduced the risk of CLABSI by almost 50 percent.



Speaker Notes: Slide 7

Alcohol plays a special role in combination with chlorhexidine. Data on this slide are from a review and meta-analysis of the clinical efficacy of chlorhexidine for skin antisepsis for prevention of intravascular catheter-associated infections.

The top panel shows three studies comparing chlorhexidine without alcohol to povidone iodine. There was no statistically significant difference in the risk of CLABSI between those two solutions.



Speaker Notes: Slide 7 Continued

The bottom panel shows studies comparing alcohol-containing chlorhexidine and povidone iodine. Here, the overall effect estimate (depicted as the black diamond) is significantly in favor of the chlorhexidine-alcohol combination. This study suggests that its not just chlorhexidine, but alcohol that also matters.



Speaker Notes: Slide 8

But which element of the bundle is the “active ingredient?”

Is it the alcohol or chlorhexidine component that matters most? Similarly, does skin cleaning with soap before inserting a catheter make a difference? And what concentration of chlorhexidine is best for preventing infection?

The next few slides will explore these three critical questions.



Speaker Notes: Slide 9

The CLEAN trial, published in 2015, helps answer these questions.

This randomized controlled trial examined whether skin antisepsis with chlorhexidine-alcohol, versus povidone iodine-alcohol, with or without skin scrubbing, was effective in preventing catheter-related infection.

The study enrolled 2,546 patients and was conducted in 11 intensive care units in France. The study used a two-by-two factorial design – so there were actually four treatment groups that received either chlorhexidine or povidone iodine either with or without scrubbing of the skin before catheter insertion.



Speaker Notes: Slide 10

The study used commercially available products:

- a two percent chlorhexidine and 70 percent isopropyl alcohol solution, commonly known as Chloraprep, and
- a five percent povidone iodine with 69 percent ethanol solution.

Both groups had a similar concentration of alcohol.

These products were applied either as a one-step process that involved skin prep only, or two-step process in which one cleans with detergent first and then applies skin prep.

Because it's impossible to blind people when doing this, clinicians were not masked, but assessors, or those that determined study outcomes, did not know which group was allocated to which treatment.



Speaker Notes: Slide 11

These are the outcomes from the trial. The lines in red represent the chlorhexidine-alcohol group and the lines in the blue represent the povidone-alcohol group. Solid lines represent groups with skin scrubbing and dashed lines represent groups without skin scrubbing. The group that received chlorhexidine had much lower cumulative risk of infection than the group that received povidone iodine. Skin scrubbing before antiseptic application was not associated with a further decrease.



Speaker Notes: Slide 12

The CLEAN Trial tells us the following:

- First, chlorhexidine-gluconate is superior to povidone iodine when combined with similar concentrations of alcohol.
- Second, skin scrubbing before antiseptic application is not necessary before catheter insertion, in the absence of soiled sites.
- Third, alcohol-containing chlorhexidine-gluconate should be considered standard of care for skin antisepsis. Povidone iodine, on the other hand, should be reserved for instances when chlorhexidine-gluconate in alcohol cannot be used, such as when a patient is allergic to chlorhexidine or under two months of age.



Speaker Notes: Slide 13

Sites for central venous catheter placement include the internal jugular, or the IJ vein, the subclavian vein or the femoral vein. It was traditionally thought that the femoral site should be avoided because the skin around the site of catheter placement has a greater bacterial density and is harder to keep clean. This view was incorporated into the keystone recommendations to prevent catheter-related bloodstream infections. Use of the internal jugular site has also been debated. For example, frontline clinicians recognized that this site is also difficult to keep clean, dry and intact, especially in patients who are mechanically ventilated. Yet – little data guiding how the femoral site compares to the internal jugular (IJ) site was available to determine which is better.



Speaker Notes: Slide 14

This randomized controlled trial, published in JAMA in 2008, aimed to determine if the femoral site was really a higher risk than the internal jugular (IJ) vein. The trial enrolled 750 patients who were randomized either to IJ or femoral vein placement for renal replacement therapy. The study was conducted in nine university hospitals and three general hospitals.

The authors found more hematomas in the group that underwent internal jugular vein placement, but no statistically significant difference in rates of catheter-related bloodstream infection between sites.



Speaker Notes: Slide 15

A subsequent meta-analysis by the same authors reviewed 10 studies and found that central venous catheter-associated infection rates were lower for subclavian-inserted catheters when compared to IJ or femoral sites. Interestingly, when one large study was excluded, no difference in risk between femoral or subclavian site was observed. But because this one large study was removed concerns regarding the conclusions of this meta-analysis were raised



Speaker Notes: Slide 16

This slide describes the results from a more recent large randomized controlled trial that looked at subclavian versus femoral versus internal jugular sites for CVC placement and measured catheter related bloodstream infections, deep vein thrombosis and mechanical complications like pneumothorax.

As you look at this graph, focus on the red portion of each pie chart, which indicates catheter-related bloodstream infection. The results here confirmed that the subclavian site was associated with a lower risk of catheter-related bloodstream infection, but had an increased risk of mechanical complications, primarily pneumothorax, which is the gray part of the bar chart. The orange portion is symptomatic DVT or deep vein thrombosis which is more common in the femoral group.



Speaker Notes: Slide 17

Finally – what does this mean for PICCs, or peripherally inserted central catheters? The fact is that there are limited data available regarding these devices. But what we do know is the following:

First, PICCs should always be placed above the elbow, avoiding the antecubital fossa, which many refer to as the “groin of the arm.” Studies have shown that the skin of this site, just like that of the femoral site, has a higher bacterial load than other areas of the arm.



Speaker Notes: Slide 17 Continued

Second, PICCs should be placed using ultrasound guidance. The use of ultrasound guidance has been linked to lower rates of complications when placing PICCs, including CLABSI and deep vein thrombosis.

Third, and most importantly, PICCs should **NOT** be used as a strategy to reduce CLABSI in hospitals. Systematic reviews and meta-analyses demonstrate that the risk of CLABSI from PICCs is similar to that from other more traditional central venous catheters.



Speaker Notes: Slide 18

In summary, we've learned the following:

1. Alcohol containing chlorhexidine should represent standard of care for skin antisepsis when placing central venous catheters. Povidone iodine should be reserved for patients who are allergic to or otherwise cannot tolerate chlorhexidine.
2. The site of placement of catheters matters. The subclavian site has the lowest risk of infection but the greatest risk of insertion complications. Available data suggest that the risk of infection between internal jugular and femoral veins are actually similar.
3. PICCs have the same rate of infection as typical central venous catheters. Placement in the upper arm and ultrasound guidance are recommended to avoid infectious and non-infectious complications.



Speaker Notes: Slide 19

No notes.



Speaker Notes: Slide 20

No notes.

