Preventing Peripheral Intravenous Line Infections: Recommendations for Healthcare Facilities

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Abstract

Intravascular catheters are indispensable tools in acute care, but with the benefits come the risk of local or systemic Healthcare Acquired Infections (HAIs). In fact, more than 250,000-500,000 intravascular-related bloodstream infections occur in the United States each year with resulting mortality rates of 12%–25%. (Maki, Kluger & Crnich, 2006; CDC, 2002). While bloodstream infections related to the use of peripheral lines may not occur as often as they do with central lines, they do occur.

Although most studies focus on central catheter-related bloodstream infections due to their greater documented prevalence and severity, some studies have evaluated the prevalence of peripheral intravenous catheter-associated bloodstream infections. In 2006 Maki reviewed 200 studies that prospectively examined the risk of Bloodstream Infections (BSIs) associated with intravascular devices over a forty year period. The infection rate with peripheral intravenous catheters was 0.5 per 1000 catheter days.

Though the frequency of peripheral intravenous catheter-associated infections is lower than with other intravascular devices, absolute numbers of patients affected can be significant with more than 330 million peripheral catheters sold each year in the United States (Millennium Research Group, 2006). Some doctors are stressing the need to use a peripheral line versus early placement of a central line with the rationale to reduce infection rates.

Multiple national and international guidelines advocate a number of simple, yet highly effective procedures to reduce risk of central venous catheter infections. Some of these same guidelines should be applied as standards for peripheral catheters. By standardizing protocols across all types of catheter insertions, safety is ensured in reducing infections and ultimately improving patient care.

Introduction

Healthcare-associated infections (HAIs) are a major public health concern (Centers for Disease Control, [CDC], 2009) with nearly half of all HAIs classified as either surgical site infections or catheter-related bloodstream infections. These infections occur when bacteria and other microorganisms that naturally exist on the skin's surface enter the body through a puncture through the skin such as the insertion of a catheter, surgical incision or through the use of a contaminated device (Safdar & Maiki, 2004 ; Emori & Gaynes, 1993).

Intravascular catheters are indispensable tools in medical settings. However, with the benefit of their use comes the risk of local or systemic HAIs. In fact, more than 250,000-500,000 intravascular-related bloodstream infections occur in the United States each year with resulting mortality rates of 12%–25% (Maki, Kluger & Crnich, 2006 ; CDC, 2002).

Bloodstream infections (BSIs) are not only dangerous for patients; they can be costly for hospitals. As of October 2008, the Centers for Medicare & Medicaid Services (CMS) is no longer reimbursing for certain catheter-related bloodstream infections (CMS, 2008). A catheter-related bloodstream infection can prolong a stay in the intensive care unit by an extra 20 days and in the hospital by 22 days (Dimick et al., 2001 ; Maki, Kluger & Crnich, 2006). Furthermore, the mean cost of treating a single bloodstream infection is approximately $36,000, but can go as high as $107,000 (Stone, Braccia & Larson, 2005). It is estimated that the annual cost of treating patients with catheter-related bloodstream infections may be as high as $2.3-$28 billion (Mermel, 2000; Maki, Kluger & Crnich, 2006).

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The risk of a bloodstream infection with a central venous catheter is widely recognized among nurses and other healthcare professionals; however, there is a common misconception that bloodstream infections with peripheral lines are not a concern since they are placed for a shorter period of time. Based on experience as an educator and consultant, most facilities do not track infections resulting from peripheral catheters Additionally, the infection prevention protocols that are in place for vascular catheter insertions are often not translated to peripheral line insertions such as with the central line bundle. While bloodstream infections related to the use of peripheral lines may not occur as often as they do with central lines (occurrence of 0.5 for peripheral verses 2.7 with central nontunneled catheters) (Maki, Kluger & Crnich, 2006), there are serious complications associated with these infections including mortality. Therefore, clinicians should consider and implement strategies to prevent them.

Rate of Bloodstream Infections with Peripheral Intravenous Catheters

Peripheral intravenous catheters are the most commonly used means for vascular access with more than 330 million peripheral catheters sold each year in the United States (Millennium Research Group, 2006). Furthermore, the use of peripheral lines may be increasing. In certain situations, clinicians are opting for a peripheral line versus early placement of a central line in an attempt to reduce infection rates.

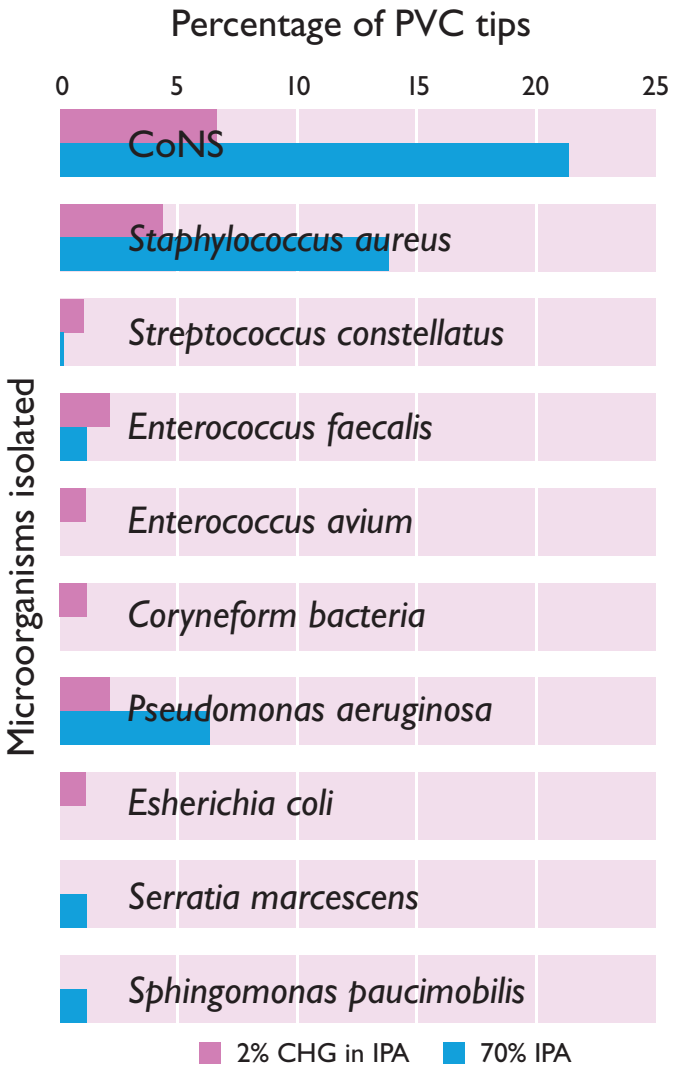
Although much of the literature focuses on central catheter-related bloodstream infections, some studies have evaluated the prevalence of peripheral intravenous catheter-associated bloodstream infections as is seen in the meta-analysis by Drs Maki, Kluger and Crnich. In 2006, Dennis Maki, MD, and colleagues reviewed 200 studies that prospectively examined the risk of BSIs associated with intravascular devices over a forty year period (Maki, Kluger & Crnich, 2006). The authors found that the infection rate with peripheral intravenous catheters was 0.5 per 1000 intravascular device days. While the frequency of peripheral intravenous catheter-associated infections is lower than that noted with other intravascular devices, absolute numbers of patients affected can be significant given the widespread use of peripheral intravenous catheters (O'Grady et al., 2002).

In another review conducted between 1997 and 2001 by Coello and colleagues, 73 hospitals in the United Kingdom surveyed the rate of hospital-acquired bacteraemia (infections) (Coello et al., 2003). Almost 7,000 cases were identified and characterized in this study. While central intravascular catheters were the most common source of infection, peripheral intravenous catheters were responsible for a sizeable percentage of the infections: between 3.9% and 8.4%, depending on type of hospital (Coello et al., 2003).

Skin is the Source of Infection

The naturally occurring bacteria that exist on the skin of a patient or on the hands of a healthcare worker are not dangerous on the surface of the skin but can become life-threatening if they enter the body. Intravenous catheter infections happen when microorganisms from the skin attach to the catheter tip during insertion and grow in sufficient numbers to result in infection. For peripherally inserted catheters, dangerous bloodstream infections are typically caused when bacteria from the skin at the catheter insertion site migrate into the insertion site (Maki, Kluger & Crnich, 2006).

Figure 1: Comparison of microorganisms isolated from peripheral intravenous catheter tips following removal from patients who received skin disinfection prior to catheter insertion with either 2% CHG/70% IPA or 70% IPA alone.



The body's own immune response also plays a role in promoting infection. At the time of catheter insertion, the patient undergoes a normal and localized immune response. This response results in plasma protein adhesion to the catheter surface and the formation of a biofilm – a layer of immune cells covering the catheter (Ryder, 2005).

This immune reaction occurs regardless of whether bacteria have entered the body via adhesion to the catheter tip or migration through the puncture wound. However, in the event that bacteria

Table 1: Summary of CDC Guidelines for Preventing Intravascular Device-Related Infections

- Educating and training healthcare providers who insert and maintain catheters
- Upper body vs. lower body insertion site selection
- Teflon-coated catheters vs. polyvinylchloride or polyethylene
- Hand hygiene and aseptic technique
- Skin antisepsis with 2% chlorhexidine
- Catheter-site dressing (e.g. some evidence supports transparent dressings over gauze) and securing (some evidence suggests sutureless devices can be advantageous over sutures in preventing catheter-related bloodstream infections)
- Antimicrobial/antiseptic-impregnated catheters, dressings and cuffs
- Regularly scheduled catheter replacement (e.g. every 72-96 hours for peripheral intravenous catheters)

are attached to the catheter tip, they become embedded and sheltered by the biofilm which provides an optimal environment for the bacteria to multiply. Eventually, the bacteria are released into the bloodstream as a function of growth of the colonies. When catheters are removed, the fibrin layer slides off and is released into the bloodstream becoming free-floating bacteria (Ryder, 2005). Biofilm associated bacteria behave differently than freely suspended bacteria and are notoriously difficult to treat as they exhibit antimicrobial resistance and are often resistant to immune defenses.

By increasing sterility through maximum sterile barriers and ensuring proper skin antisepsis upon catheter insertion, the potential for infection can be reduced. If the bacteria on the skin can be eliminated, bacterial adhesion to the catheter is also reduced on insertion. An effective skin prep that keeps fighting bacteria with residual action for at least 48 hours results in the reduction of bacterial regrowth that could potentially migrate to the catheter tip.

The Importance of Skin Antisepsis

Since the infection danger resides primarily on the patient's skin, skin antisepsis efforts are especially important. The 2002 CDC guidelines on preventing intravascular device-related infections include the recommendation to use a 2% chlorhexidine gluconate (CHG) preparation for antisepsis (Adams, Quayum, Worthington, Lambert & Elliott, 2005). Consistent with CDC guidelines, a skin prep containing 2% CHG should be applied with an applicator using a gentle back and forth frictional scrub to eliminate direct hand-to-patient contact and help prevent cross-contamination.

Recent studies also provide direct evidence suggesting better outcomes related to peripheral intravenous catheter insertion, by using a skin preparation containing 2% CHG/70% IPA (ChloraPrep; CareFusion, San Diego, CA). A study comparing use of 2% CHG/70% IPA with 70% IPA alone as a skin antiseptic in 170 elective cardiology patients showed an overall reduction of 60% in microorganisms present on peripheral intravenous catheter tips in patients in the 2% CHG/70% IPA group, compared to patients in the IPA group ($P < 0.001$) (Small et al., 2008). The findings suggest that use of the combination of 2% CHG/70% IPA for skin decontamination prior to peripheral intravenous catheter insertion may reduce the risk of subsequent peripheral intravenous catheter tip contamination or colonization, compared with the use of 70% IPA alone (Small et al., 2008).

In addition to the CDC, several other organizations including the National Institutes of Health (NIH), Infectious Diseases Society of America (IDSA) and American Association of Critical-Care Nurses (AACN) have issued guidance related to skin prepping including use of a 2% CHG solution.

Importance of Infection Prevention Protocols

While skin preparation is a critical component of infection prevention, it is only one part of the puzzle. Following a proven infection prevention protocol is critical for preventing dangerous and costly infections. In the United States, the CDC guidelines for the prevention of intravascular device-related infections are considered a standard of care (see Table 1) (O'Grady et al., 2002).

Currently, there are no infection prevention guidelines in the United States created specifically for the actual insertion of a peripheral intravenous catheter. For this, we can utilize the reported expertise and experience of approximately 250 hospitals in the United Kingdom that have adopted the Aseptic No Touch Technique (ANTT™). ANTT is based on a collection of peer reviewed and tested clinical guidelines and standardizes aseptic technique for a range of clinical procedures including peripheral catheter insertion (Coello et al., 2003).

In recognizing the potential risk of infection with peripheral intravenous catheters, the group has developed a simple, stepwise approach that has been customized for peripheral line insertion (see Table 2). This guide serves as a checklist for healthcare professionals to standardize techniques across large hospitals and optimize effectiveness of infection prevention measures.

Conclusion

While the proportion of catheter-related bloodstream infections associated with the use of peripheral intravenous catheters is relatively small compared to use of other intravascular devices, the overall number of infections is significant and therefore, so is the risk of increased hospital stays and the high cost of treatment for infections. Multiple guidelines advocate a number of simple, yet highly effective procedures to reduce the risk of infections associated with the use of central venous catheters and these should be used as a standard for peripheral catheters. Additionally, the ANTT guidelines for peripheral catheter insertion are being widely adopted in the UK and offer a simple stepwise approach including hand washing and the use of a skin prep with a 2% CHG/70% alcohol solution. The effort as healthcare professionals, is to put the same emphasis

Table 2: Checklist for Healthcare Professionals: Peripheral Intravenous Catheter Insertion

1. Have patient wash hand and arm with soap and water or alcohol gel.
2. Clean hands with soap and water or alcohol gel.
3. Clean tray creating an aseptic field.
4. Gather equipment.
5. Prepare flushes and equipment.
6. Don non-sterile gloves.
7. Position patient's hand on drape and apply disposable tourniquet; locate vein and release tourniquet.
8. Tighten tourniquet.
9. Clean insertion site for 30 seconds with a 2% chlorhexidine/70% alcohol solution using back and forth frictional scrub. Re-prep skin each time you palpate.
10. Insert catheter; secure and dress.
11. Dispose of sharps and equipment.
12. Clean tray; dispose of gloves; then immediately clean hands with soap and water or alcohol gel.

on infection prevention for peripheral catheters as is done for central lines. By standardizing protocols across all types of catheter insertions, it may be possible to further reduce infections and ultimately improve patient care.

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