

Short Peripheral Intravenous Catheters and Infections

ABSTRACT

The rate of infections associated with short peripheral intravenous catheters is thought to be very low, even rare. Approximately 330 million peripheral catheters are sold annually in the United States. Although the rate may be low, the actual number of infections could be relatively high, with most going undetected because of short dwell times and early patient discharges. A recent estimate reported as many as 10000 *Staphylococcus aureus* bacteremias from peripheral catheters annually in the United States. This integrative literature review identified soft tissue, bone, and bloodstream infections. Analysis of 45 studies revealed significant knowledge gaps and inadequate clinical practices associated with one of the most common devices used in all health care settings.

Intravenous (IV) catheters are now reported to be the single most common source of bacteremia and fungemia,¹ yet infections associated with short peripheral catheters receive very little attention. Infections associated with central vascular access devices (CVADs) are thought to present a greater risk from bloodstream infections (BSIs). CVADs have larger diameters and lengths, are longer-dwelling catheters,

and have become the focus of many rate-reduction campaigns within American hospitals. The total number of patients receiving short peripheral catheters, however, is far larger than those exposed to CVADs. Data on infection rates with short peripheral catheters are quite limited; however, a Spanish study on infection rates from peripheral venous catheters reported infection rates to be about the same as the rates from CVADs.² In addition, the current author's personal experience as an expert witness has involved review of lawsuits regarding infections associated with peripheral catheters—cases with serious outcomes such as complex regional pain syndrome and septicemia leading to the patient's death.

US governmental agencies have conflicting approaches to the issue of catheter-related infections. The National Healthcare Safety Network (NHSN), a voluntary data collection system from the Centers for Disease Control and Prevention (CDC), offers many benefits over the old system by addressing both patient and health care worker safety. The patient safety component of this system includes surveillance methods to identify and track device-related infections. Central line-associated bloodstream infection (CLABSI) is the only type of vascular access device (VAD)-associated infection addressed with surveillance processes providing a specific definition for tip location within a great thoracic vessel and strict ways to count the number of line-days. There is no mention of surveillance on VADs with tip location in peripheral vessels. Consequently, health care organizations participating in this process would not be reporting infections associated with short peripheral catheters.

Another change relates to terms being used. *Catheter-related bloodstream infection (CRBSI)* is often interchanged with *CLABSI*. *CRBSI* would encompass all types of catheters and is a clinical term used for diagnostic and treatment purposes. *CLABSI* is a surveillance term used by the NHSN. The definition is simpler and only requires that a CVAD be present within 48 hours of the signs and symptoms and that the infection not be related to any other infected site. This definition of *CLA-BSI* may easily produce an overestimate of the true incidence of *CR-BSI*.³ *CLA-BSI* rates would not include any infection from a short peripheral catheter.

Author Affiliation: Lynn Hadaway Associates, Inc.

Lynn Hadaway, MEd, RN, BC, CRNI®, has more than 35 years of experience as an infusion nurse, educator, and consultant. She holds a master's degree in education, is certified in professional staff development and infusion nursing, and has published extensively on infusion topics in numerous journals

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Corresponding Author: Lynn Hadaway, MEd, RN, BC, CRNI® (lynn@hadawayassociates.com).

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In 2008, the Centers for Medicare & Medicaid Services began its program of disallowing payment for treatment of certain hospital-acquired conditions. The current list includes *vascular catheter-associated infection* without any modifiers about the type or location of the catheter or the type of infection. To receive payment for treatment of these infections, the hospital must have adequate documentation that the infection was *present on admission* and, thus, not acquired while in the hospital. *Vascular catheter-related infections* would encompass all devices used to access the vasculature without regard to the specific tip location or limiting this to only BSIs.

Nosocomial BSIs are reported to be the eighth-leading cause of death in the United States, with costs calculated to be \$23 242 ± \$5184 (2005 dollars).⁴ Although CLA-BSI gets the most attention from researchers and clinicians, BSI and other types of infections can occur with short peripheral catheters. For hospitals participating in the NHSN system, there would be no formal way to document infections associated with short peripheral catheters. Moreover, these infections would be regarded as hospital-acquired conditions, with no payment to the hospital for their treatment.

The 2011 CDC *Guidelines for the Prevention of Intravascular Catheter-Related Infection* includes recommendations on short peripheral catheters; however, the discussion section only addresses CVADs. These guidelines include a table of catheters used for venous and arterial access and state that both peripheral venous and arterial catheters are “rarely associated with bloodstream infection.”^{3(p22)}

The published rates, causes, and prevention of infections associated with short peripheral catheters need more clarity. To assess the published information about infections associated with short peripheral catheters, this author performed a systematic literature review, using an integrative approach to evaluate studies of all designs. The process attempted to answer this question: For patients of all ages and in all health care settings, what are the possible causes, outcomes, and prevention methods for all infectious complications associated with short peripheral catheters?

SEARCH METHODOLOGY

A search of English-language literature published between January 2000 through June 2011 was conducted without limiting the research study design. The following search terms and combinations were used:

- Peripheral catheter
- Peripheral IV catheter
- Peripheral venous catheter
- Peripheral IV catheter insertion
- Peripheral venous catheter insertion

- Venipuncture
- Peripheral catheter complication
- Peripheral catheter and infection
- Peripheral catheter and phlebitis
- Suppurative thrombophlebitis and catheter
- Bacteremia and catheter
- Bloodstream infection and catheter

The author searched the following databases:

- Medline, through the Internet-based PubMed
- Ingenta
- CINAHL
- Google Scholar

The search produced approximately 1400 abstracts, with 588 publications retained for more careful assessment. All studies that included data or discussion of any type of infection associated with short peripheral catheters were included in the final report. Articles that only included data on mechanical and chemical causes of phlebitis were excluded along with articles only including CVAD data.

RESULTS

Each study is listed in the Appendix with the author, year, country of origin, and purpose of the study. The studies have been categorized by their design, including the appropriate ranking from the INS *Standards of Practice*. The entire table with abstracted outcome data can be downloaded from www.hadawayassociates.com/OutcomeData.pdf. The major themes, issues, and trends are discussed; however, further data analysis becomes extremely difficult because of the wide variety of study purposes, designs, and patient populations.

TYPES OF INFECTIONS

The literature includes many types of infections associated with short peripheral catheters, including the following:

- Local infection such as cellulitis, soft tissue infection, and osteomyelitis
- Phlebitis or thrombophlebitis; some studies acknowledge the 3 known causes of phlebitis—mechanical, chemical, and infectious—but few make any attempt to distinguish among these 3 causes
- Suppurative thrombophlebitis—the presence of purulent drainage from the insertion site
- BSIs, also known as bacteremia

The clinical signs and symptoms for each of these may overlap, making it difficult to correctly identify the specific problem without additional diagnostic tools, such as ultrasound and cultures.

The pathophysiology of peripheral catheter-associated BSI is not well understood. Zingg and Pittet^{5(pS39)} state: “The most likely mechanism of PVC [peripheral venous catheter]-BSI is colonization of the vascular catheter tract followed by biofilm formation. Such colonization may occur during catheter insertion and when manipulating the catheter for drug administration or blood sampling.” These authors also speculate on the correlation between thrombophlebitis and BSI; however, no explicit evidence demonstrating the connection between these 2 complications was included.^{5(pS39)}

The standard definition for *phlebitis* has always been simply “inflammation of the vein.”⁶ Nursing and medical literature have clearly described 3 causes of phlebitis:

- Chemical phlebitis is associated with the infusion of hyperosmolar fluids greater than 600 mOsm per liter and/or solutions and medications with a pH less than 5 and greater than 9.
- Mechanical phlebitis is associated with the catheter size, insertion site, insertion technique, and methods of catheter and joint stabilization.
- Bacterial phlebitis is associated with deficits in skin antisepsis, catheter handling, dressing, and stabilization.

Postinfusion phlebitis is also reported to occur after the infusion has stopped and the catheter has been removed.⁷

Tagalakis et al,⁸ citing data from studies conducted in the 1970s, reported that peripheral vein thrombus could become infected and produce BSI, then added data from ~30-year-old studies supporting the idea that catheter-related infection produces peripheral vein thrombophlebitis. This still leaves confusion about whether the inflammation allows for the infection or whether the infection creates the inflammation.

In studies reporting culture results, the most prevalent pathogen in peripheral catheter BSI is *Staphylococcus aureus*.⁹⁻¹¹ Data from 2 large studies indicated that *S. aureus* is the most common cause of all BSIs.^{1,12} A retrospective case-controlled study from England assessed the recurrence of *S. aureus* bacteremia and reported that, when the condition was caused by a peripheral venous catheter, recurrence was less likely than from any other source. This study of only 66 patients included 7 patients with *S. aureus* bacteremia from peripheral catheters and 35 from central venous catheters.¹³ Trinh et al¹⁴ used a retrospective approach to review adult patients with *S. aureus* bacteremia across a 3-year period to identify factors associated with peripheral catheters. Twenty-four definite and probable cases were identified. An additional analysis of all US hospital admissions produced an estimate of more than 10 000 *S. aureus* bacteremias from peripheral catheters occurring annually.

Additional research has established that *S. aureus* cell walls produce a protein causing them to adhere firmly to endothelial cells. Animal studies demonstrate that venous endothelium, rather than arterial endothelium, is a primary site for the attachment of and recruitment of other bacterial cells.^{15,16}

More research is needed to identify the exact interaction between the immune system producing the inflammatory response and the invasion of bacterial cells that can produce both a local or systemic infection and to determine how this is related to peripheral venous cannulation.

RATES OF EACH TYPE OF INFECTION

Given the prevalence of skin organisms, especially *S. aureus*, and the extremely high numbers of short peripheral catheters inserted, it is surprising that the published rates are so low. The strongest evidence for rates of BSI comes from another systematic literature review. The review assessed all English-language studies on adults published from January 1966 through July 1, 2005. All studies described the type of catheter(s) being used, reported BSI data prospectively, met specific criteria for device-related BSI, and included the duration of device use.¹⁷

This review divided peripheral IV catheters into 3 groups—plastic catheters, steel needles, and venous cut-down. For plastic catheters, there were 110 studies with 10 910 catheters and 28 720 device-days. These studies reported 13 BSIs, producing a pooled mean rate of 0.1 events per 100 devices (0.1-0.2, 95% confidence interval [CI]). The pooled mean was 0.5 infections per 1000 device-days (0.2-0.7, 95% CI). Plastic peripheral catheters produced the lowest BSI rates of all catheter types. When assessing by device-days, the only device with a lower rate was subcutaneous venous ports.¹⁷

The retrospective analysis by Trinh et al reported a calculated incidence rate based on the total number of adult inpatient days and the number of patients with a peripheral catheter during a point-prevalence study conducted in 2008. The calculated rate was 0.06 bacteremias per 1000 catheter-days. This represents a rate dramatically lower than what was reported by Maki et al¹⁷ of 0.2 to 0.7 bacteremias per 1000 catheter-days.

According to Zingg and Pittet,⁵ rates of thrombophlebitis range from 2% to 80%. These rates are taken from 21 studies dating back to 1973. Many factors related to the catheter, drug(s), patient, and health care personnel contribute to thrombophlebitis. Data from the above literature review were used to report rates of BSI. Zingg and Pittet also state that there is a widely held assumption that thrombophlebitis can become BSI. The connection between thrombophlebitis and BSI and the burden of BSI from short peripheral catheters has not

been convincingly established through the available studies. The authors included 10 studies, dating back to 1975, to report that an estimated 5% to 25% of peripheral catheters were colonized with bacteria at the time of removal. Reasons given for the very low BSI rates with relatively high rates of colonization include the short dwell time and fewer manipulations of the peripheral catheter and lack of appropriate surveillance.

The rate of local infection associated with peripheral catheters was reported to be 2.3% (9 out of 390 catheters) in an Italian study¹⁸—a study that was also included in the work by Zingg and Pittet. No description of these infections was provided. There are several case reports of other local infections caused by short peripheral catheter insertion, including 3 children with osteomyelitis.¹⁹

England, Wales, Northern Ireland, and the Republic of Ireland participated in a point-prevalence study on all health care-acquired infections (HCAIs) in 2004. The overall prevalence was 7.6% in 75 694 patients. Primary BSIs were reported in 264 out of 28 987 (0.9%) patients with a current peripheral catheter; patients who had a peripheral catheter within the previous 7 days produced 48 out of 17 595 (0.3%) BSIs. Patients with a CVC revealed the highest BSI rates of 5%, and those having a CVC within the previous 7 days showed a rate of 2.3%.²⁰

ISSUES IDENTIFIED

This literature review revealed several issues that have a decided impact on the risk of BSI from peripheral catheter insertion and use.

Catheter Design

Ported catheters are peripheral catheters with an additional port or opening built onto the top of the catheter hub with closure from a tethered, nonreplaceable cap. Such catheters are frequently used in countries other than the United States. A descriptive study reported on significant practice changes aimed at reducing rates of HCAI. An audit within an acute care hospital in London found that peripheral line-related infections needed to be reduced because of high rates of methicillin-resistant *S. aureus* (MRSA) and identified poor practices with short peripheral catheters. The original system included a ported catheter with a 3-way “tap” or stopcock added to the port. During the first 8-month period, there were 30 reported MRSA bacteremias, with 17 classified as HCAI and 9 judged to be related to the catheter, although no culture data were provided. After the change to a closed-system catheter without the ported design, there were 14 MRSA bacteremias, with 11 classified as HCAIs, 4 definitely and 2 possibly related

to the catheter. The audit question was worded to equate phlebitis and infection. This facility also introduced a split-septum needleless connector and chlorhexidine gluconate (CHG) 2% in 70% isopropyl alcohol for skin antisepsis, along with other policy changes and auditing at the same time as the new catheter. Because of the need for very large-gauge catheters in some specialty units, the ported catheters were still available in clinical areas. This was a cultural change along with many product changes, and it is therefore difficult to isolate the impact of the catheter on the BSI rates.²¹ A catheter with an open port would be difficult to maintain as a sterile fluid pathway and could not be easily cleaned before each use. The attachment of stopcocks is also a known risk for infection.

Another German study using ported peripheral catheters reported on phlebitis from 4 hospitals. In 2495 peripheral catheters in 1582 patients, there were 27 cases per 100 patients and 104 events per 1000 catheter-days. Fever and other local symptoms were seen in 11 patients (1.5%), although no data on infections or cultures of any kind were included. With 27% of patients experiencing possible infections, there is much doubt about the risks associated with injection ports built onto these catheters.²²

Skin Antisepsis

The prevailing evidence points to the skin as a primary source of organisms colonizing all types of IV catheters, with the majority of these organisms residing in the layers of the epidermis. This would indicate a need for careful attention to the skin antiseptic agent, the method of application of this agent, and the total contact time to include application and drying time. For many years, the standard of care has been to apply the agent using concentric circles, beginning with the point of insertion and working outward; however, there is no scientific evidence to support this practice. In addition, this technique results in merely painting the agent on the skin rather than using friction to allow the agent to penetrate the layers of the epidermis. Standards and guidelines now include CHG for skin antisepsis. Application in the back-and-forth scrubbing method, however, is specified in the manufacturer’s instructions for use. Health care professionals are left to assume that the science supporting the back-and-forth technique was submitted to the Food and Drug Administration for review and product clearance. Only 1 published study is available on the application technique.²³

Very few studies in this review provided information about the agent(s) used for skin antisepsis. A Brazilian study in children reported use of 70% alcohol followed by nonsterile tape only in the control group and tape and sterile gauze in the experimental group. No infection data were reported, and virtually the same rates of

phlebitis were seen in both groups; 98.8% of all catheters, however, became infiltrated.²⁴ A Taiwanese study of adults reported using 75% alcohol followed by 10% povidone-iodine and 2 minutes' drying time. Those with phlebitis did not produce any microbiological evidence of infection; no purulent drainage was seen, and no BSIs were documented.²⁵ The study by Easterlow et al incorporated CHG as part of its organizational change and documented a reduction in MRSA-BSIs.²¹

Skin antisepsis has been identified as a major cause of contamination in 2 other venipuncture procedures—obtaining a sample for blood culture, and collection of blood donation. Several studies have found that CHG produces better outcomes for both procedures.²⁶⁻²⁹ Recently updated standards and guidelines, however, have different approaches to the issue of skin preparation.

The 2011 *Infusion Nursing Standards of Practice*⁶ states that chlorhexidine is preferred for skin antisepsis except for infants less than 2 months of age. Tincture of iodine, iodophor, and 70% alcohol are also acceptable for use. All types of VADs are included with this statement based on the guidelines published by the Society for Healthcare Epidemiology of America in 2008, which only addressed CVCs. The *CDC Guidelines for Prevention of Intravascular Catheter-Related Infections* list 70% alcohol, tincture of iodine, iodophor, and chlorhexidine for insertion of short peripheral catheters.³ Moreover, both documents state that the agent should be applied to clean skin.

Peripheral skin preparation is addressed in the guidelines from the Infectious Diseases Society of America (IDSA) regarding drawing blood cultures. Alcohol, tincture of iodine, or alcoholic chlorhexidine is acceptable, but the IDSA guidelines state that povidone-iodine is not adequate. This document also emphasizes the need for adequate skin contact and drying time.³⁰

Inserters' Skill Level

Two studies assessed the skill of inserters in relation to peripheral catheter outcomes. Lee et al²⁵ reported that peripheral catheters inserted by the emergency department nurses had a greater rate of phlebitis than those inserted by IV therapists: 3.7% vs 2.1%, with an odds ratio of 1.6 (1.003-2.5, 95% CI, $P = .048$). The language in this study indicates that the authors equate phlebitis to infection because 160 of 162 phlebitis cases had microbiological evidence of infection. No site purulence or BSIs were reported.

Palefski and Stoddard³¹ assessed complications in 776 peripheral catheters—639 inserted by infusion nurses and 137 by generalist nurses. Thirty-six percent (36%) of catheters inserted by the generalists and 20% inserted by infusion nurses were removed for complications ($P \leq .001$). Cellulitis, infection, and sepsis were tracked by clinical signs and symptoms, but none were reported in either group.

Predisposition to Phlebitis

Another trend revealed in several studies was the tendency for repeated cases of phlebitis with subsequent catheters after the first episode. Patients experiencing phlebitis with the first catheter were 5.1 times more likely to have phlebitis with subsequent catheters. Patients with pain during infusion with the first catheter were 11.7 times more likely to have pain with subsequent catheters. No other complication exhibited this same predisposition.³¹

Another study reported phlebitis rates of 2.7% in patients with 1 peripheral catheter; among patients with 2 or more catheters, the rate was 13.4%. In 35 patients with phlebitis, 29 (83%, odds ratio 4.9) developed phlebitis in a subsequent catheter site. This study also reported that there was 1 blood culture obtained with negative results in these patients, and no infections were found.³²

Use of Vein Visualization Technology

Vein visualization technology includes both infrared light and ultrasound devices. The use of infrared light has not yet gained wide clinical acceptance, and there are very few published studies available. All infrared light devices are hands-free, allowing for the use of current catheter-insertion procedures. Infrared light devices also do not require anything to touch the patient's skin for the device to function properly.

Ultrasound use requires 1 hand to hold the probe and the use of coupling gel to produce the image. For CVC insertion, sterile probe covers and sterile coupling gel are required. However, short peripheral catheter insertion is not considered to be a sterile procedure.

Two studies addressed this issue. Dargin et al³³ reported on peripheral catheter outcomes in 75 patients when ultrasound was used to assist with insertion. Emergency department physicians inserted 18-gauge peripheral catheters into deep basilic or brachial veins. Chlorhexidine was used for skin preparation; sterile coupling gel was used, and the probe was covered with a sterile transparent membrane dressing. Local infections, suppurative thrombophlebitis, and BSIs were tracked, but none were reported. Infiltration caused the failure of 47% of these catheters within 24 hours of insertion and was the most prevalent complication. Adhikari et al³⁴ collected data retrospectively on emergency patients, comparing outcomes in 402 patients using ultrasound and 402 patients using traditional methods. Skin preparation information was not included; the probe was covered with a nonsterile glove, and nonsterile bacteriostatic lubricant gel was used. Using the CDC definitions for skin and soft tissue infection, the researchers reported 2 infections in the ultrasound group and 3 in the traditional-method group.

Attention to Catheter Stabilization

Catheter stabilization has gained much attention over the past 15 years since the first product designed for that purpose was introduced. Descriptive studies on short peripheral catheters have addressed avoidance of unplanned restarts due to complications such as phlebitis or infiltration; however, none have reported on infectious outcomes.³⁵⁻³⁷ A recent randomized trial addressing catheter stabilization did not include any information about infectious complications, focusing only on the mechanical and chemical causes of phlebitis.³⁸

One randomized, controlled trial of stabilization for peripherally inserted central venous catheters (PICCs)³⁹ reported on infections and stabilization. Systemic infections were confirmed in 8 patients and suspected in 2 patients when the PICC was secured with sutures. With the stabilization device, there was 1 confirmed systemic infection and 1 suspected infection. Cellulitis occurred in 5 secured with suture versus 3 secured with a stabilization device. There were 85 patients in each group of this study.³⁹ This study is included because the insertion sites are on the upper extremity, and the burden of organisms on the skin would be very similar to those for peripheral catheter insertion. The differences would be a sterile procedure for PICC insertion versus a “clean” procedure for peripheral catheter insertion. Peripheral catheters are not sutured, which would add to skin disruption. These are the only available data on infectious complications and stabilization for any type of VAD.

Age Differences

Several studies included neonatal and pediatric patients. Norberg et al⁴⁰ assessed rates of false-positive blood cultures when samples taken during peripheral catheter insertion were compared with blood samples obtained from a separate venipuncture. They reported a 70% reduction in the false-positive rates when a separate, direct venipuncture site was used. This study did not report details of the skin antisepsis procedures and simply stated that they were “standardized.” The authors speculated that the differences were related to the ease of drawing the sample when the peripheral catheter was inserted, leading to indiscriminate prescribing of blood cultures.

A study from Uganda cultured hubs and tips on removal of 391 peripheral catheters in hospitalized pediatric patients. Tips were colonized in 20.7%, hubs were colonized in 11.25%, and 4.86% had the same organisms growing in both the hub and tip. *S. aureus* was the most prevalent organism, followed by *S. epidermidis*. The study provided no information on skin antisepsis, catheter stabilization, dressing, or experience of personnel performing the insertions.⁴¹

Two studies in low-birth-weight/preterm neonates compared outcomes of peripheral catheters with those of PICCs; 1 of these studies reported more infectious

episodes and deaths from infection in the patients with peripheral catheters, and the other found more infections with PICCs.^{42,43}

Health Care Setting Differences

Only 2 studies were found with some infection information on peripheral catheters from alternative health care settings. Palefski and Stoddard³¹ compared outcome data from peripheral catheters inserted by infusion nurses in hospitals and home infusion agencies versus those inserted by generalist nurses. Complications were fewer in those inserted by infusion nurses; however, the data were not reported by type of health care setting.

A small, retrospective study assessed outcomes associated with the frequency of flushing peripheral catheters in hospitalized patients and those in an ambulatory infusion center. Although the complications were fewer in those flushed less often, the small numbers did not allow for enough statistical power to draw conclusions.⁴⁴

Changes in Standards and Guidelines

Before 2011, all documents recommended the routine removal of short peripheral catheters after a specific dwell time. Since the mid-1970s, this length of time has been extended from 48 hours to 96 hours. The 2011 *Infusion Nursing Standards of Practice* removed the recommendation for routine change of peripheral catheters at a specific time interval, stating:

The nurse should consider replacement of the short peripheral catheter when clinically indicated and when infusion treatment does not include peripheral parenteral nutrition. The decision to replace the short peripheral catheter should be based on assessment of the patient's condition; access site; skin and vein integrity; length and type of prescribed therapy; venue of care; integrity and patency of the VAD; dressing and stabilization device.^{6(p557)}

The CDC's *Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011*³ include revised wording that states there is no need to replace peripheral catheters more frequently than every 72 to 96 hours for the purpose of reducing infection and states that changing the catheter in adults based only on clinical indication is an unresolved issue. The CDC states the following: “Remove peripheral venous catheters if the patients develops [*sic*] signs of phlebitis (warmth, tenderness, erythema, or palpable venous cord), infection, or a malfunctioning catheter.”^{3(p10)}

DISCUSSION

On the surface, the impression could be that these 45 studies would provide an adequate amount of data to properly assess the original research question. However,

the many variables and research design issues leave numerous unaddressed issues and unanswered questions.

Other literature reviews included studies from more than 30 years ago, yet there have been numerous practice changes during this period. Patient populations now include many more patients living with chronic diseases that both impact the immune system and require more frequent and long-term infusion therapy. Since CHG skin antiseptic agents were first introduced in the United States about 10 years ago, this agent has virtually replaced other skin antiseptics for all catheter insertions. CHG solutions are applied in a manner different from older solutions and are thought to be more effective than other agents. Responsibility for insertion of short peripheral catheters has shifted from highly skilled infusion nurses to primary care generalist nurses. These differences could alter current clinical outcomes compared with outcomes seen many years ago.

Clinical practice differences between countries can vary greatly. Peripheral catheters built with an injection port are not used in the United States, but they are commonly used in European countries. Several studies report greater risk associated with these ported catheters, probably due to the inability to adequately clean the injection port.

Insertion techniques influencing infection risks vary greatly among inserters. Application of skin antiseptic agents in a circular motion that simply painted the agent on the skin are being replaced by back-and-forth scrubbing techniques that create greater friction and allow for deeper penetration of the lower layers of the epidermis. The inserter's skill level influences the perceived need to repeat vein palpation after applying the skin antiseptic. Many studies do not include information about skin antiseptics and certainly do not address these technique differences.

Conventional wisdom dictates that phlebitis may have an infectious cause, but all episodes of infection may not display visible signs and symptoms of phlebitis. Much more information is needed about the pathophysiology of phlebitis and thrombophlebitis of superficial veins and all types of infections associated with peripheral catheters. The finding of increased rates of phlebitis and pain with subsequent peripheral catheters drives the need for much more information about the pathophysiology of peripheral catheter-associated phlebitis and its connection to all types of infection.

New technology has also changed our approach to peripheral catheter insertion and maintenance. Use of vein visualization devices is relatively new, and the standards of care for their application to this procedure are still evolving. There will likely be differences between the standards for use of ultrasound and infrared light devices.

Engineered catheter-stabilization devices have shown trends toward reduction of peripheral catheter complications, but no studies have identified a reduced risk of infection. Joint stabilization is another important aspect that has been overlooked. Movement of the catheter

and nearby joint containing a peripheral catheter may result in more skin organisms being forced into the subcutaneous tissue and/or bloodstream.

Finally, the most recent documents guiding clinical practice with peripheral catheters now include the idea of changing peripheral catheters only when clinically indicated rather than at a specific time interval. This practice change could alter the incidence of all types of infections associated with peripheral catheters; however, this may require many years to quantify. Currently, the CDC guidelines state that a PICC or midline catheter is indicated when therapy is required for more than a week.³ When the site of a peripheral catheter is free of signs or symptoms of complications, will clinicians allow them to dwell longer than a week? If so, how will and/or should this affect practices for skin antiseptics, insertion-site assessment, maintenance of dressing integrity, and the need for adequate catheter stabilization? These issues are yet to be addressed through clinical research along with the incidence of all infections in these longer-dwelling peripheral catheters.

This literature review, along with others, has produced evidence that rates of infection with short peripheral catheters are low. The deficits in these studies are numerous, however, and must be considered when using the data. Additionally, infection rates must be compared against the number of catheters used. Approximately 330 million short peripheral catheters are sold annually in the United States alone. Studies show venipuncture proficiency rates of 2.18 attempts⁴⁵ and 2.35 attempts⁴⁶ to establish 1 catheter site. If we consider that half of the catheters sold are successfully inserted, a rate of 0.1% of these catheters producing a BSI¹⁶ would result in 165 000 patients becoming infected annually.

Clearly, the health care community needs more research on this issue to enhance its knowledge of these infection rates, the pathophysiology, and most appropriate prevention methods.

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PIV Infection Studies Meeting the Inclusion Criteria

Author	Year	Country of Origin	Study Purpose
4 Case Studies, SOP Ranking V			
Vidal et al ⁴⁷	2001	Spain	Cutaneous TB infection and reactivation of systemic TB
Straussberg et al ¹⁹	2001	Israel	3 children with osteomyelitis from PIV sites
Hong et al ⁴⁸	2008	Korea	Suppurative thrombophlebitis from <i>Candida albicans</i> and fungal spondylitis
Katz et al ⁴⁹	2005	USA	Suppurative thrombophlebitis from <i>E. coli</i>
23 Descriptive Studies, SOP Ranking V			
Siegman-Igra et al ⁹	2005	Israel	Retrospective report of bacteremic episodes in adults from 1995–1998 in a 1150-bed university hospital
Vandenbos et al ¹⁸	2003	Italy	Prospective study of ED patients to assess inappropriate insertion of PIV based on patient needs over a 14-day period in May–June 2000
Kagel & Rayan ⁵⁰	2004	USA	Retrospective report of minor and major PIV complications seen in patients from the ED of a teaching hospital in Oklahoma City from 1997–1999
Foster et al ¹⁰	2002	Australia	Prospective convenience sample of 496 peripheral catheters in neonates and pediatric patients, June to October 2000 in an Australian hospital
Norberg et al ⁴⁰	2003	USA	Compare contamination rates in blood cultures taken from a separate venipuncture site or from a new peripheral catheter insertion; observational study in patients 18 years and younger in the ED of a tertiary care children's hospital in Ohio
Palefski & Stoddard ³¹	2001	USA	Assess complication rates for PIV catheters in adults inserted by generalist nurses compared to infusion nurses at 2 hospitals and 1 home infusion agency over 3-month period
Catney et al ⁵¹	2001	USA	Evaluate extending peripheral catheter dwell time beyond 72 hours and the associated increase in phlebitis and infiltration Surgical male patients age 33–88 years with stay greater than 48 hours, at teaching VA facility in Iowa
Bhananker et al ⁵²	2009	USA	Outcome analysis of malpractice claims for peripheral catheterization from anesthesia practice; data from 35 professional liability insurance companies
Grune et al ²²	2004	Germany	Prospective observational study of phlebitis in PIV catheters with injection ports; reported phlebitis based on signs and symptoms including presence of fever, no cultures taken
Dargin et al ³³	2010	USA	Assessed survival and complications of peripheral catheters inserted with ultrasound guidance in emergency patients
Easterlow et al ²¹	2010	England	Change initiative with peripheral catheters to reduce the high rates of MRSA bacteremia at a large hospital
Ritchie et al ⁵³	2007	New Zealand	Point prevalence study of all patients with IV device and urinary catheters to assess infectious complications with each device and report quality assurance information
Adhikari et al ³⁴	2010	USA	Retrospective data collection to compare infection rates in peripheral catheters inserted with ultrasound to those inserted with traditional methods; adults in a level 1 academic urban ED
Campbell et al ⁴⁴	2005	Canada	Retrospective audit of records from patients with peripheral catheter from May 1, 2002–June 30, 2003 in a teaching facility inpatient and ambulatory infusion center Compared rates of complications based on flushing frequency
Boyd et al ¹¹	2010	Scotland	To assess compliance with a new bundle for insertion and care of short peripheral catheters
Malach et al ⁵⁴	2005	Israel	Series of 9 point prevalence studies on PIVs and phlebitis in adults and pediatrics
Nahiryia et al ⁴¹	2008	Uganda	Assess the prevalence of infections from peripheral catheters in hospitalized pediatric patients
Geffers et al ⁵⁵	2010	Germany	Reported on the relationship between central and peripheral catheters and the risk of BSI in very low birth weight infants from 22 NICUs
Humphreys et al ²⁰	2008	UK—data from England, Wales, Northern Ireland, and Republic of Ireland	A prevalence survey in 2006 of HCAs
Pujol et al ⁵⁶	2007	Spain	Assessed clinical outcome data on peripheral catheter BSI in non-ICU patients over 18 months
Aygun et al ⁵⁷	2006	Turkey	Prospective study to culture all peripheral catheters removed from November 2001 to April 2002

(continues)

PIV Infection Studies Meeting the Inclusion Criteria

Author	Year	Country of Origin	Study Purpose
Hirschmann et al ⁵⁸	2001	Austria	Prospective multicenter study to compare the impact of hand hygiene on frequency of peripheral catheter complications
Trinh et al ¹⁴	2001	USA	Retrospective analysis of adult patients with <i>S. aureus</i> bacteremia from July 2005 to March 2008, correlated with clinical documentation of the PVC site condition
1 Cohort Study, SOP Ranking IV			
Hirai et al ⁵⁹	2009	Japan	Retrospective analysis of 41 gastrectomy patients receiving TPN compared with 41 receiving PPN
3 Case Controlled Studies, SOP Ranking IV			
Liossis et al ⁴²	2003	Canada	Two groups of extremely low birth weight infants comparing outcomes from peripheral central venous catheters (PCVC) to short peripheral catheters
Nasser et al ⁶⁰	2004	Lebanon	Infectious outbreak investigation using matched case-control and a retrospective cohort
Lee et al ⁶¹	2010	Taiwan	Investigate soft tissue infections associated with short peripheral venous catheters in hospitalized patients at 2 hospitals
1 Correlational Study, SOP Ranking IV			
Gallant & Schultz ³²	2006	USA	Assess phlebitis rates at 96 hours of dwell and beyond; to assess the phlebitis rates based on bacterial, mechanical, and chemical factors in a 14-bed cardiac surgery critical unit and 42-bed cardiothoracic step-down unit
9 Randomized Controlled Trials, SOP Ranking III			
Barria et al ⁶²	2007	Chile	Comparison of outcomes with a 2 F silicone PICC vs 24-gauge polyurethane catheters or 27-gauge winged needle
Wilson et al ⁴³	2007	USA	Comparison of outcomes with 2 Fr PICCs and peripheral catheters in preterm neonates less than or equal to 1250 g birth weight or 30 weeks' gestation
Webster et al ⁶³	2008	Australiz	Comparison of routine 72-hour replacement of peripheral catheters with replacement only when clinically indicated in an adult population
Van Donk et al ⁶⁴	2009	Australia	Compare routine replacement (72–96 h) of peripheral catheters to replacement when clinically indicated in home care patients with catheters inserted by MD and RNs not part of an IV Team
Machado et al ²⁴	2008	Brazil	Compared use of only adhesive tape over puncture site to use of sterile gauze dressing and sterile TSM dressing in children mostly of preschool age with Teflon catheters
Lee et al ²⁵	2009	Taiwan	Comparison of peripheral catheters in adults indwelling for 48 to 72 hours versus those dwelling for 72 to 96 hours; in medical & surgical units
Rickard et al ⁶⁵	2010	Australia	Comparison of routine rotation of peripheral catheters every 3 days to removal only when clinically indicated in adults in hospital without an IV Team
Periard et al ⁶⁶	2008	Switzerland	Compared use of PICCs to peripheral catheters in an adult hospitalized population
Small et al ⁶⁷	2008	England	Comparison of organisms on peripheral catheter tips when skin prep was done with 2% chlorhexidine in alcohol versus 70% alcohol alone
4 Systematic Literature Reviews, SOP Ranking II			
Tagalakis et al ⁸	2002	Canada	Review of literature on peripheral vein infusion thrombophlebitis using randomized controlled trials, case-controlled studies, and cohort studies from 1966 to 2001, English language; data for CVCs, steel needles, and PICCs excluded
Maki et al ¹⁷	2006	USA	Assessed risk of BSI in adults with different types of intravascular devices Studies were English language, prospective from January 1, 1966 through July 1, 2005
Zingg & Pittet ⁵	2009	Switzerland	Determine if complications arising from peripheral venous catheters are underevaluated and whether the peer-reviewed literature appropriately reflects the wide use of this device, whether potential harmful complications are well addressed, and the type of prevention and intervention measures proposed
Webster et al ⁶⁸	2010	Australia	Assess the effect of removing peripheral catheters when clinically indicated compared with removing and re-siting routinely; randomized controlled trials only
1 Meta-Analysis, SOP Ranking I			
Niel-Weise et al ⁶⁹	2010	Netherlands	Assess the effect of inline filters on infusion-related phlebitis associated with PIV catheters

Abbreviations: BSI, bloodstream infection; CHG, chlorhexidine gluconate; CVC, central venous catheter; ED, emergency department; HCAI, health care-acquired infection; IPA, isopropyl alcohol; IV, intravenous; IVD, intravenous device; MRSA, methicillin-resistant *Staphylococcus aureus*; NICU, neonatal intensive care unit; NNIS, National Nosocomial Infection Surveillance System (currently known as the National Healthcare Safety Network); PICC, peripherally inserted central catheter; PIV, peripheral intravenous; PPN, peripheral parenteral nutrition; PVC, peripheral venous catheter; SOP, Standards of Practice; TB, tuberculosis; TPN, total parenteral nutrition; TSM, transparent membrane dressing; UK, United Kingdom; VA, Veterans Affairs.