



Peripheral Vascular Catheter–Related Infection: Dwelling on Dwell Time

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ABSTRACT

In the United States, almost 200 million peripheral intravenous catheters are used each year. Recommendations for the prevention of vascular catheter–related infection in adults seem to allow the clinician to leave a peripheral catheter in place for more than 72 hours and allow clinicians to use clinical judgment for leaving peripheral intravenous catheters in place until clinical indications for removal are manifested. From an infection prevention standpoint, once the patient shows clinical indications of infection, bacteremia may not be far off. Authority analysts searched the Pennsylvania Patient Safety Reporting System and the National Healthcare Safety Network for evidence related to the prevalence of peripheral intravenous catheter infection–related bacteremia and the related time frame of infection development. Focusing on *Staphylococcus aureus* primary bloodstream infection (BSI) as a surrogate for the detection of peripheral intravenous catheter–related infection, there was an impressive increase in primary BSIs 72 hours post-admission. Due to the high incidence in which peripheral catheters are used when caring for inpatients, complications like bacteremia may contribute substantially to yearly hospital-acquired infections. (*Pa Patient Saf Advis* 2014 Mar;11[1]:30-5.)

INTRODUCTION

The Centers for Disease Control and Prevention (CDC) guidelines for prevention of peripheral vascular catheter–related infection (PVCRI) state the following:¹

1. There is no need to replace peripheral catheters more frequently than every 72–96 hours. . . . Category IB*
2. No recommendation is made regarding replacement of peripheral catheters in adults only when clinically indicated. Unresolved issue†
3. Replace peripheral catheters in children only when clinically indicated. Category IB*

The above recommendations for the prevention of PVCRI could be interpreted to allow the clinician to leave a peripheral catheter in adults in place for more than 72 hours. In certain populations, the peripheral vascular catheter (PVC) can be changed when clinically indicated. Furthermore, the CDC guidelines state that “some studies have suggested that planned removal at 72 hours vs. removing as needed resulted in similar rates of phlebitis and catheter failure. However, these studies did not address the issue of [PVCRI], and the risk of [PVCRI] with this strategy is not well studied.”¹

The Infusion Nurses Society’s (INS) 2011 standards of practice recommend that site rotation of the short peripheral catheter be based on clinical indication, which is a change from the 2006 recommendation of rotation at least every 72 hours.^{2,3} INS underlines the importance of site inspection for the identification of complications of catheter use, including signs and symptoms of phlebitis, infiltration, extravasation, nerve damage, and infection (mainly by way of fever development).⁴ However, from an infection prevention standpoint, once the patient develops a fever or other indicators of infection, bacteremia may not be far off.

INS has identified the primary reference for the change in recommendations to be a meta-analysis of five trials that showed changing the catheter every three days did not reduce the risk of infection.⁵ Another review of seven trials showed no evidence to support changing catheters every 72 to 96 hours.⁶ In contrast, a survey conducted by Collignon found that in 90% of all PVC sepsis cases, the catheter was in place for three days or more.⁷ Furthermore, it has been observed that there is a linear relationship between *in situ* time and PVCRI complications.⁸ Trinh et al., studying PVC-related *Staphylococcus aureus* bacteremia, noted the impact of prolonged dwell time on infection development and stressed that PVC-related bacteremia due to *S. aureus* is an unrecognized complication of PVC use.⁹ Maki points out that “although abandoning scheduled replacements may not greatly increase the incidence of infusion phlebitis and infiltration in the average hospital that currently replaces peripheral catheters at 72 hour intervals, it would probably increase the risk of catheter related bacteremia with *Staphylococcus aureus*.”¹⁰

The evidence is conflicted related to how to best manage PVC dwell time, and recommendations are being based on that evidence. Two essential questions remain regarding management of PVCs in the acute care adult population:

1. From an infection prevention standpoint, is it safe to leave a PVC in place until there is a clinical indication for removal?

* “Category IB. Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and a strong theoretical rationale; or an accepted practice (e.g., aseptic technique) supported by limited evidence.”¹

† “Unresolved issue. Represents an unresolved issue for which evidence is insufficient or no consensus regarding efficacy exists.”¹

- Is there a time in hours that a PVC could be re-sited that would likely reduce the risk of PVCRI?

METHODS

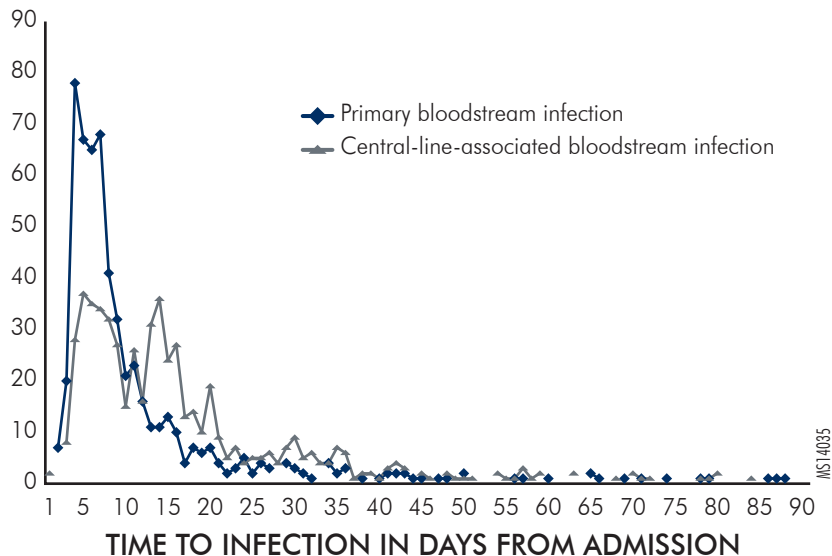
Health Protection Scotland places PVCRI as the third leading cause of device-related bacteremia.¹¹ In the United States, almost 200 million PVCs are used each year.¹² Due to the high utilization of peripheral catheters in the inpatient setting, complications like bacteremia may contribute substantially to hospital-acquired infections. Furthermore, it has been demonstrated that PVCRI related to *S. aureus* may be as high as 23.5% and that 45.2% of PVCRI related to *S. aureus* were found in patients for which the PVC had a dwell time of ≥ 4 days.¹³

Because of the probable impact of PVCRI and PVC use as highlighted in previous sections, Pennsylvania Patient Safety Authority analysts searched the National Healthcare Safety Network (NHSN) for primary bloodstream infection (BSI) data for the years of 2011 and 2012. Primary BSI is an infection of the bloodstream not related to an infection at another site. One of the challenges with identifying evidence for a PVCRI aggregate is that there is currently no way to isolate an event related to a peripheral catheter within the NHSN database. Therefore, unlike central venous catheters, there needs to be other levels of epidemiological evidence applied in order to identify the perceived occurrence of PVCRI. When looking specifically at *S. aureus*, there seems to be external validity in assuming a relationship between *S. aureus* and PVC infection prevalence evidenced by similar findings in the literature related to *S. aureus* and PVC infection development.^{7,9} *S. aureus* is the second most common cause of hospital-acquired BSI, and it has been estimated that as many as 76% of hospitalized adult inpatients have a PVC.^{9,14}

In order to understand the impact of PVCRI on Pennsylvania patients, Authority

Figure. Time to Infection: *Staphylococcus aureus* Primary Bloodstream Infections and Central-Line-Associated Bloodstream Infections in Pennsylvania Acute Care Facilities, 2011 to 2012

NO. OF STAPHYLOCOCCUS AUREUS BACTEREMIA EVENTS



Data as identified from the Centers for Disease Control and Prevention's National Healthcare Safety Network.

analysts queried the Pennsylvania Patient Safety Reporting System (PA-PSRS) database for events associated with PVC use. The search was conducted for calendar year 2012. Examples from the PA-PSRS database related to that search are presented in the following section.

RESULTS

Events of primary BSI (those not related to a central line) from NHSN for 2011 and 2012 in Pennsylvania (N = 1,890) were analyzed and categorized by time from presumed catheter insertion (typically on admission) to infection and type of pathogen. The Figure focuses on *S. aureus* bacteremia and shows an impressive increase in primary *S. aureus* BSI after the 72-hour mark. The data aligns with

published studies on PVCRI prevalence at and beyond the 72-hour mark.^{7,9}

The Table lists the top 10 pathogens causing bacteremia for primary BSI and central-line-associated infection (CLABSI). Of particular interest are the percentages of reported *S. aureus* bacteremia in both populations of patients, likely due to the similarities of how both device types enter the skin and bloodstream, insertion and maintenance procedures, and the potential for endogenous colonization of patients. Furthermore, in the primary BSI population, the percentage of *Escherichia coli* may implicate poor hand hygiene and/or general hygiene of the patient, translocation of bacteria, catheter contamination, and unidentified source infections being confirmed early and reported as primary BSIs.



Table. Top 10 Pathogens Causing Primary BSI and CLABSI in Pennsylvania, 2011 to 2012

| PRIMARY BLOODSTREAM INFECTION (BSI) | | |
|--|-------------------|------------|
| PATHOGEN | NO. OF INFECTIONS | PERCENTAGE |
| <i>Staphylococcus aureus</i> | 584 | 30.9 |
| <i>Escherichia coli</i> | 197 | 10.4 |
| <i>Klebsiella pneumoniae</i> | 140 | 7.4 |
| <i>Enterococcus faecalis</i> | 130 | 6.9 |
| <i>Enterococcus faecium</i> | 81 | 4.3 |
| <i>Pseudomonas aeruginosa</i> | 72 | 3.8 |
| <i>Candida albicans</i> | 63 | 3.3 |
| Coagulase-negative staphylococci | 46 | 2.4 |
| <i>Enterobacter cloacae</i> | 45 | 2.4 |
| <i>Serratia marcescens</i> | 43 | 2.3 |
| CENTRAL-LINE-ASSOCIATED BLOODSTREAM INFECTION (CLABSI) | | |
| PATHOGEN | NO. OF INFECTIONS | PERCENTAGE |
| <i>Staphylococcus aureus</i> | 598 | 19.9 |
| <i>Klebsiella pneumoniae</i> | 250 | 8.3 |
| <i>Enterococcus faecalis</i> | 247 | 8.2 |
| Coagulase-negative staphylococci | 197 | 6.5 |
| <i>Candida albicans</i> | 193 | 6.4 |
| <i>Staphylococcus epidermidis</i> | 159 | 5.3 |
| <i>Enterococcus faecium</i> | 152 | 5.1 |
| <i>Pseudomonas aeruginosa</i> | 147 | 4.9 |
| <i>Escherichia coli</i> | 125 | 4.2 |
| <i>Enterobacter cloacae</i> | 86 | 2.9 |

Note: Data as identified from the Centers for Disease Control and Prevention’s National Healthcare Safety Network.

The PA-PSRS database houses Serious Event and Incident reports; however, within those event reports are narratives authored by the individual reporter, usually a bedside clinician. The narratives are plainly worded accounts of what the clinician or the patient had experienced. Following are excerpts from actual PA-PSRS event report narratives related to complications of PVCRI:

A patient was admitted with a diagnosis of inflammatory bowel disease

and an IV [intravenous] catheter inserted into the left antecubital. Routine restart of the IV line was waived per physician order. The patient developed a fever. The IV line was discontinued, and the catheter tip was cultured and was positive.

Blood cultures were identified with Staphylococcus epidermidis and Staphylococcus aureus. Phlebitis was noted on left forearm from old IV catheters.

Forearm IV line was in for five days; [when it was] removed, [there were] no signs of infection at that time. The next day, the site was red and had a small pocket of pus. Site and blood cultures were positive for staph.

A patient was admitted with acute MI [myocardial infarction]. Cardiac catheterization was performed. The patient with chronic ESRD [end-stage renal disease] was on hemodialysis. The patient developed respiratory failure prior to cardiac catheterization and was febrile with positive blood cultures. [The patient was] diagnosed with peripheral IV catheter bacteremia.

A patient was admitted with an A-Fib [atrial fibrillation]. IV catheter #18 inserted at left antecubital space. Four days later, the site was found to be red and tender. The IV line was removed. The patient was started on antibiotics. The IV catheter tip was sent for culture. The culture tip and blood were positive for Staphylococcus sp. Patient was for pacemaker insertion. The infectious-disease physician was consulted. Antibiotics were started, and pacemaker insertion was put on hold for three days.

DISCUSSION

The primary BSI criteria within NHSN does not specifically ask if the infection is a result of a PVC (unlike CLABSI); therefore, this is a limitation in the data set that was used, meaning that it is unclear exactly how many PVCRI are represented by the primary BSI events. As described herein, when the epidemiologic links of time to infection and the pathogen profile are combined with the definition of primary BSI, and when the sheer prevalence of the PVC is considered, it is likely that the majority of acute care adult primary BSIs in Pennsylvania are due to PVCRI.

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INFECTION REDUCTION STRATEGIES FOR THE ADULT PATIENT WITH A PERIPHERAL INTRAVENOUS CATHETER

Selected Strategies for Insertion

Evaluate the patient's care plan and condition in order to select the appropriate intravenous access device.

Avoid placing catheters in the antecubital space.

Use sterile tape or sterile securement devices for catheter securement.

Place a sterile occlusive dressing as soon as possible after establishing intravenous access.

Train and credential those staff who are responsible for establishing intravenous access.

Consider the use of an insertion checklist.

Use an intravenous start kit that contains at least all supplies necessary for proper skin preparation, catheter securement, and insertion site dressing, as well as personal protective equipment for staff.

Consider a product containing chlorhexidine-alcohol for skin preparation prior to insertion.

Flush catheters postinsertion until clear.

Infection Risk Reduction

Selected Strategies for Maintenance

Remove catheters that were placed in suboptimal conditions.

Limit dwell time to 72 hours in adults.

Label dressing with insertion date to establish dwell time start.

Avoid traction on intravenous tubing.

Review catheter necessity daily.

Remove unneeded or unused catheters.

Consider a product containing chlorhexidine-alcohol for scrubbing the hubs of intravenous tubing and catheter ports prior to access.

Scrub hubs and ports for at least 10 to 15 seconds prior to access.

Access the catheter function and the insertion site/vein per Infusion Nurses Society guidelines.

Train and credential those staff who are responsible for intravenous catheter care and maintenance.

Ensure intravenous tubing and fluid or medication bags or bottles are changed per Centers for Disease Control and Prevention or manufacturer's guidelines.

Label tubing, bags, or bottles to ensure proper changing intervals.

Create workflows or practices of care that limit translocation of pathogens to the intravenous catheter or tubing.

Notes

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From an infection control standpoint, waiting for a clinical indication of infection to re-site may place the patient in a position for the development of bacteremia due to prolonged dwell times. Re-siting at 72 hours may reduce PVCRI risk, and a comprehensive approach to PVC care (including use of best practices for insertion, maintenance, and monitoring) is fundamental for the development of a PVC care program.^{1,2,15} Furthermore, re-siting of PVCs inserted in the field or emergency department, avoiding the antecubital fossa, and limiting dwell time (daily review of necessity) may help prevent PVCRI even further.⁹ Refer to “Infection Reduction Strategies for the Adult Patient with a Peripheral Intravenous Catheter” for selected strategies for the reduction of risk for infection due to PVC use in the adult population.

It has been suggested that re-siting when clinically indicated versus scheduled re-siting of PVCs may result in a cost savings due to equipment and device cost and professional time spent during the insertion process.⁶ For example, an acute care hospital admitting 10,000 patients per year with 76%⁹ of those patients receiving a PVC (N = 7,600) at a cost of \$40.00 per insertion with an average venipuncture proficiency rate of 2.18 would result in an estimated cost of \$87.20 (2.18 x \$40.00) per patient in operational costs of inserting one PVC.¹⁶ This would result

in an annual cost of \$662,720 for initial insertion for that hospital. However, the average length of stay for a patient in acute care in 2011 was 5.4 days,¹⁷ meaning the average patient has the potential to receive two PVCs following the 72-hour scheduled replacement rule. Consequently, the proposed savings from re-siting when clinically indicated would theoretically avoid the second PVC insertion associated with re-siting at 72 hours based on the average length of stay, which is the basis for the cost savings. However, the reimbursement based on Current Procedural Terminology code 36000 defined as “insertion of needle or catheter into a vein” results in an estimated charge of \$125.00 and an estimated reimbursement of \$87.50 per insertion.¹⁸ The previously referenced example hospital could bill \$950,000 and expect \$665,000 in reimbursement. Essentially, the cost of inserting a PVC is a break-even scenario (if the hospital had a venipuncture proficiency rate <2.18, it could save money). If the same hospital had experienced a single PVCRI related to *S. aureus* because of increased dwell time, treatment costs could conservatively reach \$19,212 to \$26,424.¹⁹ The argument of cost savings related to abandoning scheduled replacement of PVCs does not add up.

CONCLUSION

Events reported by Pennsylvania health-care facilities suggests that *facilities may*

want to conduct focused surveillance for PVCRI in order to consider the practice of re-siting peripheral catheters in adult patients every 72 hours, as opposed to re-siting when clinically indicated. The Authority proposes, in the absence of a true NHSN data field for PVCRI identification, that the number of primary *S. aureus* BSIs can be a surrogate for estimation of PVCRI in the adult acute care population. For the benefit of future research and identification of PVCRI nationally, it would be helpful if NHSN would develop criteria that specifically asks for the relationship between hospital-acquired bacteremia development and short PVC use.

Furthermore, national metrics are needed to allow for surveillance of best practices related to PVC insertion and maintenance. When there is related national rate surveillance data that is adequately captured and combined with best-practice compliance data, then it will be possible to make decisions related to increasing PVC dwell time safely. Until then, the data, at least in Pennsylvania, seems to indicate that patients are at risk for PVC-related bacteremia after a PVC is in place past the 72-hour mark.

Acknowledgments

Edward Finley, BS, data analyst, Pennsylvania Patient Safety Authority, contributed to data acquisition and validity in this article.

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