A Bundled Approach to Decrease the Rate of Primary Bloodstream Infections Related to Peripheral Intravenous Catheters

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Abstract

Background: *Peripheral intravenous catheters (PIVs) have been considered as having lower risk of infection than central lines. However, research is limited regarding numbers of primary bloodstream infections related to peripheral lines and prevention of peripheral line-associated bloodstream infections (PLABSI).*

Methods: *Our aim was to create and monitor compliance with a new PIV maintenance bundle using disinfecting caps and tips and to assess whether this bundle would lead to a decrease in PLABSI rates. Weekly audits were conducted to measure compliance with both the new PIV bundle and our existing central line-associated bloodstream infection (CLABSI) bundle. We also audited the disconnection method used for intravenous line tubing (peripheral and central lines) before and during the study intervention period.*

Results: *A compliance rate of close to 90% with the use of the disinfecting caps and tips was attained. Using a PLABSI bundle successfully decreased primary bloodstream infections due to PIVs (from 0.57 infections per 1000 patient-days preintervention to 0.11 infections per 1000 patient-days; $p < 0.001$). We confirmed that improving care for PIVs would decrease primary bloodstream infections associated with these devices.*

Conclusions: *Using a PIV maintenance bundle including disinfecting caps and tips can effectively lower the rate of primary bloodstream infections attributable to PIV lines.*

Keywords: *peripheral IV catheters, bloodstream infections, disinfection caps, quality improvement*

Background

Primary bloodstream infections (BSIs) are a common hospital-acquired infection that can lead to substantial patient morbidity and significantly increased healthcare costs in terms of treatment and length of stay. It is estimated that a primary BSI increases hospital costs by $10,000-$20,000.[1] In the intensive care unit (ICU) settings, it may be closer to $40,000, according to a study in pediatric patients.[2] A significant reduction in central line-associated BSIs in the past decade is a result of more research and standardization around central line care and maintenance.[3-5] However, when it comes to peripheral intravenous lines (PIVs), the research emerged more recently without much standardization in clinical practice. Maki et al[6] were the first to our knowledge to state that although PIVs generally are considered as having a lower risk of infection than central lines, the fact that their use is much more frequent makes them responsible for a large number of infections, and therefore infection control measures should be applied to all types of intravascular devices. They reached this conclusion based on a systematic review of 200 published prospective studies. A year later, a prospective study published by Pujol et al[7] compared cases of peripheral venous catheter-related bloodstream infections to cases of central venous catheter-related bloodstream infections in a group of non-intensive care unit patients over a period of 17 months and found very similar rates (0.19 versus

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0.18 cases/1000 patient-days, respectively). Interestingly, this study showed that the peripheral venous catheters inserted in the emergency department caused the highest number of episodes, and stated that in the emergency department, catheters are used excessively and frequently inserted under poor aseptic conditions. This suggests that these infections could potentially be prevented by following the guidelines[8] every single time (sterile device, skin antisepsis, and aseptic technique). Moureau[9] pointed out in her recent review that the primary cause of infection with peripheral catheters may be as simple as disregarding basic practices such as hand washing and cleaning the access hub each time; she also highlights that this causes "double jeopardy" when a peripheral and a central catheter are present in the same patient. Neglecting a peripheral catheter can cause an infection that will impact the central venous device and may create the impression that the latter was the primary source of bacterial growth.

Recent research implies that BSI risk from PIV catheters may actually exceed central line-related risk.[10] Zhang et al[11] reviewed studies describing the infection risks associated with PIV catheters and summarized the various risk factors. They describe the four possible pathways of infection (migration of microbes down the catheter tract; via the catheter hub; by bacteria circulating in the bloodstream (existing infection); or from contaminated infusate) and mention that the most frequently isolated bacteria from peripheral catheters are coagulase-negative staphylococci and *Staphylococcus aureus* (cutaneous flora). The Zhang[11] article also lists the risk factors for infection in the categories of catheter related, healthcare related, and dressing related, and goes on to describe various infection prevention strategies consisting of education, hand hygiene, skin disinfection, catheter dressing and securement, PVC replacement, and needleless connector decontamination. The latter was a strategy that we had not fully addressed yet for peripheral catheters.

PIV insertion is one of the most common invasive procedures that happen in hospital settings.[12] Almost every admitted patient will have a PIV placed for some type of treatment (eg, fluid administration, medication administration, or blood draw). Although the tip of a catheter is fairly short, it still provides a direct portal of entry into a patient's bloodstream. It is estimated that the risk of a primary BSI from a PIV catheter is 0.1% or 0.5 per 1000 catheter-days.[6] Additionally, between 10% and 50% of *Staphylococcus aureus* BSIs come from PIV catheters.[13]

Practices that place patients in danger of an infection with any vascular access device include failure to cap the tubing when an intermittent IV administration set is removed (disconnected), and failure to properly disinfect the port (needleless connector) when accessing needle-free valves on intravenous (IV) sets. In the first instance, the tip of the IV administration set is exposed to potential contaminants, which could lead to an infection if the nonsterile IV set is reconnected to a patient's IV access, and in the second instance, the port is exposed to potential contamination that can be introduced into the line the next time it is accessed.[14] According to a published survey of nurses on the practices in place for the maintenance of IV sets used for intermittent infusion, there are vast differences regarding the frequency at which such sets are changed and how the ends are cleaned.[15] These variations may explain the differences in infection rates observed, and the growing effort to standardize practices towards the goal of eliminating these mostly preventable infections.[9,12] A recent systematic review article on the disinfection of needleless connector hubs states that 33% to 45% of them are contaminated, and that compliance with disinfection is as low as 10%.[16] Staff education regarding the care and maintenance of vascular access has been shown to significantly decrease catheter-related BSI rates.[17,18]

There are various products developed to protect various critical components for vascular access from contamination. Disinfecting caps can be placed over needleless connectors during disconnection to keep them clean; disinfecting tips are intended to keep the male luers clean and covered during the disconnection and until the next use.

The purpose of this study was to test whether a PIV maintenance bundle that includes use of disinfecting products (caps and tips) could lower the rate of primary BSIs due to peripheral lines at our institution. We also wanted to show that it is safe to change intermittent tubing every 96 hours if the tubing is properly protected. Specifically, the study intervention consisted in using a disinfecting cap on all peripheral IV needleless connectors, and a disinfecting tip on all disconnected IV tubing. Since our institution had already been using the disinfecting cap on central lines for 5 years, we also added as an intervention in this study the use of the disinfecting tip to the IV tubing disconnected from the central lines. We monitored both peripheral and central lines for a side-by-side comparison of compliance with disinfecting caps and tips and infection rates. The primary endpoints of this study were compliance with the use of disinfecting caps on needleless connectors, and compliance with the use of disinfecting tips on disconnected IV tubing on all line types pre-intervention and during the study intervention period. For the disconnected IV tubing (peripheral and central lines), we also audited the method used for maintenance when disconnected. The secondary endpoint was the primary BSI rates associated with PIV lines and with central lines, compared with the rates observed before the study intervention. Other parameters measured pre-intervention and during the study intervention period described the condition of the insertion site (pain, redness and swelling).

About the Hospital

Mercy Hospital is a > 900-bed not-for-profit tertiary care trauma 1 center in a large metropolitan area in the Midwest. The facility has a 37-bed adult medical/surgical ICU; a 16-bed trauma/neuro ICU; a 12-bed burn ICU; multiple medical/surgical units, including oncology; and a heart hospital with a cardiovascular ICU. We also have a labor and birth and mother/baby unit that delivers almost 9000 babies per year. Mercy Hospital has a children's hospital within the hospital with a 98-bed level-III neonatal ICU, a pediatric ICU, and a pediatric unit. The study was exempt from full institutional review board review according to federal regulations because it was a low-risk, quality improvement project that did not include subject identifiers.