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Abstract

We compared the risk of Peripheral Venous Catheter Bloodstream Infection (PVC-BSI) to Central Line Associated BSI (CLABSI) at UC San Diego Health (UCSDH). The rates of PVC-BSI and CLABSI were comparable outside of the ICU setting and the risk of *Staphylococcus aureus* bacteremia were greater in PVC-BSI.

Keywords: Catheter, Bloodstream Infection, Peripheral Venous Catheter, Bacteremia

Introduction

Peripheral venous catheters (PVCs) are among the most widely used medical devices in hospitals[1,2]. Approximately 200 million PVC devices are used each year on adults in the United States[3]. The incidence of PVC related bloodstream infections (BSIs) is estimated to be 0.18%. Overall, the risk of catheter-related BSIs has been reported to be greater in central venous catheters (CVCs) than PVCs[3], but CVCs are used less frequently in acute care settings compared to PVCs[1]. Since PVC use greatly exceeds central lines, the prevalence of PVC-BSIs may be significant[3]. Most studies and clinical guidelines, however, have focused on reducing CVC related BSIs[4]. The Infusion Nurses Society guidelines recommend surveillance for PVC related BSIs[5], but few facilities in the U.S. report compliance. The intent of this study was to compare the risk of PVC-BSI to Central Line Associated BSI (CLABSI) at University of California San Diego Health (UCSDH) and to identify any opportunities for improvement.

Methods

A case control study was conducted at UCSDH, a two-hospital, 808-bed quaternary care academic health system in San Diego, CA. A patient line list was generated from EPIC electronic medical records (EMR) with an abnormal blood culture result and an eligible PVC without the presence of a central line between December 2020 and August 2021. Monthly line lists included data from the patients' Line/Drains/Airways flowsheet consisting of patient admission, disposition, location during line insertion, PVC insertion time, site location, line removal time, and daily assessment. Patients were classified as cases if they were determined to have a PVC-BSI according to the inclusion criteria below.

Inclusion Criteria

PVC-BSIs were identified using the National Healthcare Safety Network (NHSN) criteria for a Bloodstream Infection Event[6]. The NHSN CLABSI criteria consists of an eligible central line and an eligible BSI organism. PVC-BSIs were identified using the same definition. An

eligible PVC line was defined as one that had been in place for more than two consecutive calendar days, in an inpatient location, during the current admission. PVC-BSIs were only considered if they were Healthcare Associated Infections (HAI), on or after day 3 from hospital admission (hospital onset). An HAI PVC-BSI is possibly associated if a positive blood culture was identified more than two days after admission (day 1 being day of admission). The association of device was considered if (1) a recognized bacterial pathogen, not included on the NHSN common commensal list, was identified from a blood culture, and the organism was not related to infection at another site, or (2) the same common commensal was identified in two or more blood cultures collected on separate occasions and the patient had at least one of the following symptoms of fever, chills, or hypotension.

Exclusion Criteria

Patients who had both CVCs and PVCs were excluded. Patients whose positive blood culture were within two days of admission according to the NHSN definition of present on admission (POA). Patients who did not have an eligible PVC line nor an eligible BSI organism (i.e., only one common commensal) according to the previously mentioned definitions.

Statistical Analysis

A case control comparison was designed using a three-to-one ratio of controls (n=36) to cases (n=12). A table of odds ratios and 95% confidence intervals was calculated for risk of extended dwell time and anatomical PVC locations including antecubital, wrist, forearm, and overall flexure. Analyses were conducted in R 4.1.3 using the Epidemiology Tools package, version 0.5-10.1.

Results

Case Characteristics

A total of 703 patients with bacteremia were identified during the study period: 480 community onset and 158 either secondary BSIs or with only one common skin commensal. Of the

65 hospital-onset bacteremias, 12 (1.7%) PVC-BSI cases were identified. The plurality of PVC-BSI cases was due to *Staphylococcus aureus* (5), two of which were methicillin- resistant (Table 1). Of the CLABSI group, the plurality of cases was due to *Staphylococcus epidermidis* (5). Risk factors for PVC-BSI were investigated using a case control methodology (Table 2).

The PVC-BSI rate was 0.115 per 1000-line days, compared to 0.588 per 1000 line-days for CLABSI (n=31). All Intensive Care Unit (ICU) patients had both PVCs and central lines. The rate of CLABSI per 1000-line days in the non-ICUs during the study period was 0.199 (n=10). The rates of CLABSI house-wide were significantly higher than PVC-BSIs ($p < 0.001$). However, given that almost all patients with central lines also had PVCs, it would be reasonable to assume that the rate of CLABSIs and PVC-BSIs were statistically similar in non-ICU patients because some CLABSIs were likely due to the PVCs alone. Using a crude method of subtracting the rates of PVC-BSI from CLABSI, the rate of non-ICU CLABSI was 0.084 per 1000 line-days, below that of PVC-BSIs.

Discussion

Using a case control design, we compared the risk of PVC-BSI to CLABSI. All of the patients with CLABSI also had a PVC at some point during their hospital encounter. It is possible that some BSIs were due to PVCs rather than central lines. If a central line was present, we excluded the PVC line-days and BSIs. If only 20% of the CLABSI cases were actually attributable to the PVC and not the central line, a plausible assumption given the PVC-BSI rate, then the majority of non-ICU vascular access associated BSIs would be due to PVCs.

PVCs are likely an underrecognized source of *Staphylococcus aureus* BSIs[7]. These are associated with significantly worse outcomes than bacteremias due to *Staphylococcus epidermidis.* During the study period, the majority of vascular access associated BSIs due to *Staphylococcus aureus* were associated with PVCs. Of the twelve hospital onset MRSA bacteremia reported to CMS during the study period, 4 were PVC related (2 PVC-BSI and 2 CLABSI with PVCs in place). Therefore, the high use of PVCs in healthcare combined with the

severity of *Staphylococcus aureus* infections demands active surveillance.

Recently, CMS suggested that they are considering focusing on hospital onset bacteremias[8]. If this were to occur, institutions will be forced to look at all causes of bacteremia, including CLABSI, post-operative sepsis, and PVC-BSI. Our data suggests that PVC-BSIs would be identified as a significant source of infections and therefore national risk adjusted baseline rates should be established now so that institutions can begin to assess their needs around PVC-BSI prevention.

This study has three limitations. Our institution used extended dwell times and CHG impregnated sponges on PVCs in place greater than 24 hours. Patients with PVC dwell times of greater than 96 hours were 5.48 times more likely to develop a PVC-BSI ($p = 0.02$). The PVC length was short, making placement of the CHG impregnated sponge around the PVC suboptimal. Thus, our results may not be applicable to facilities with other practices. Lastly, the study timeline was limited to 9-months resulting in a small number of cases.

In conclusion, PVC-BSIs were responsible for the majority of vascular access-associated *Staphylococcus aureus* bacteremias. Developing an EMR-based PVC-BSI active surveillance program is achievable in most hospitals. Data obtained could be used for performance improvement and to implement best practices. Adopting the SHEA/IDSA/APIC Practice Recommendations[9] and Infusion Therapy Standards of Practice[5] could result in a significant reduction of hospital onset bacteremias with highly pathogenic organisms.

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References

1. Tatsuno K, Ikeda M, Wakabayashi Y, Yanagimoto S, Okugawa S, Moriya K. Clinical Features of Bloodstream Infections Associated with Peripheral Versus Central Venous Catheters. *Infect Dis Ther*. 2019;8(3):343-352.

2. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. *Int J Antimicrob Agents*. 2009;34 Suppl 4:S38-42.

3. Mermel LA. Short-term Peripheral Venous Catheter-Related Bloodstream Infections: A Systematic Review. *Clin Infect Dis*. 2017;65(10):1757-1762.

4. Ruiz-Giardin JM, Ochoa Chamorro I, Velázquez Ríos L, et al. Blood stream infections associated with central and peripheral venous catheters. *BMC Infect Dis*. 2019;19(1):841.

5. Gorski L, Ms RN, Hhcns-Bc C, et al. Infusion Therapy Standards of Practice, 8th Edition. *J Infus Nurs*. 2021;44(1S):S1-S224.

6. *Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-Central Line Associated Bloodstream Infection)*. National Healthcare Safety Network (NHSN) https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf

7. Austin ED, Sullivan SB, Whittier S, Lowy FD, Uhlemann AC. Peripheral Intravenous Catheter Placement Is an Underrecognized Source of Staphylococcus aureus Bloodstream Infection. *Open Forum Infect Dis*. 2016;3(2):ofw072.

8. Centers for Medicare & Medicaid Services (CMS). Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long-Term Care Hospital Prospective Payment System and Proposed Policy Changes and Fiscal Year 2023. *Federal Register*. 2022;87:28108-28746. https://www.federalregister.gov/d/2022-08268

9. Buetti N, Marschall J, Drees M, et al. Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 Update. *Infect Control Hosp Epidemiol*. 2022;43(5):1-17.