of patients with COBAS-confirmed SARS-CoV-2. Sensitivity was higher (85%) for patients admitted with clinical suspicion of COVID-19 and lower (56.4%) for those without. These results align with prior studies demonstrating lower accuracy of IDNOW compared with other platforms.[5,6] Many reasons for this have been postulated, including sample collection modality, symptom onset, user variability, and lag between sample collection and testing.[7] Despite these limitations, IDNOW played an important role in identifying cases early and improving throughput in combination with robust infection prevention protocols and engineering controls. The attack rate of COVID-19 in double-occupancy rooms is high. One report showed that 39% of exposed roommates converted within 5 days after exposure.[8] Nosocomial transmission risk has increased with new highly contagious variants.[9] At our facility, patients with negative IDNOW results and suspected COVID-19 were placed in single-occupancy rooms pending COBAS results. Patients without symptoms of COVID-19 and negative IDNOW results were placed in cohorts using a zoned double-occupancy strategy that involved floor-to-ceiling plexiglass barriers, face masks for source control, and the use of a commode to defer sharing a bathroom pending COBAS results.[10] With a median time difference of 33.8 hours between IDNOW and COBAS, significant exposure and nosocomial transmission pose a risk in dual occupancy rooms. Despite this risk, no nosocomial cases were identified in our study period, highlighting the importance of engineering controls and infection prevention protocols.

This study had several limitations. It was conducted before the emergence of highly infectious variants such as SARS-CoV-1 o (omicron), and it was conducted at a single site, potentially limiting generalizability. Nevertheless, these results contribute a valuable assessment of the diagnostic accuracy of IDNOW in symptomatic and asymptomatic individuals. We have also provided real-world data on pragmatic implementation of rapid testing and infection prevention strategies. Our hospital is representative of many safety-net hospitals with double-occupancy rooms, and our approach may provide a valuable model for testing, infection prevention protocols, and engineering controls.

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Peripheral venous catheters: An underrecognized source of *Staphylococcus aureus* bacteremia

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Healthcare-associated *Stapyhlococcus aureus* bacteremia (SAB) has traditionally been caused by surgical-site infections or central-line–associated bloodstream infections. However, peripheral venous catheters (PVCs) are responsible for many cases of healthcare-associated SAB.

Previous authors have evaluated the impact of PVC bacteremia infections in case series[1–3] or case–control studies.[4] These researchers reported that PVC infections were more common in the antecubital site, in PVC present for ≥4 days, and in PVC placed in the emergency department or outside the institution. We assessed baseline rates of healthcare-associated SAB due to PVC and performed a case–control study to determine the risk factors for SAB due to PVC. We hypothesized that we would identify modifiable risk factors to improve the safety of patients with PVCs.

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Methods

Setting and population

This retrospective, case–control study of adult patients was conducted at Denver Health Medical Center (DHMC). DHMC is a level 1 trauma center and an academic safety-net hospital with ~500 beds. The study period spanned April 9, 2016, to March 31, 2021.

Data acquisition

Cases of SAB were identified by query of the electronic medical record data warehouse. Cases were classified as either community-onset SAB (≤2 days after hospitalization) or healthcare-associated SAB (ie ≥3 days after hospitalization or community-onset attributed to PVC removed in the 7 days prior). An infectious diseases physician reviewed cases of healthcare-associated SAB to determine the source using National Healthcare Safety Network definitions.[5] PVC-associated bacteremia was defined as an arterial or venous infection (VASC) with presence of PVC in that body site within the previous 7 days. Three controls were matched to each PVC-related SAB case based on the age of the patient (±5 years) and the date the PVC was placed (±3 days). Patients who were admitted for elective procedures, those who were admitted to psychiatry or obstetrics departments, and those who died within 2 days of PVC placement were excluded from the control set.

Data regarding the variables of interest were abstracted by a single reviewer via retrospective chart review. These data included age, sex, race, ethnicity, substance abuse, length of hospital stay, reason for hospital admission, and comorbid conditions (ie, diabetes mellitus, cirrhosis, end-stage renal disease, and an immunocompromised state defined as severe malnutrition, untreated cancer, or the current use of chemotherapy agents, biological modulators, or prednisone ≥20 mg per day for at least 1 month). Additional variables included the location of PVC insertion, body location of the PVC, size of PVC, skin antisepsis product, number of insertion attempts, days PVC was present, and phlebitis scale.

Peripheral IV standard of care

At DHMC, the Medical Action Industries IV Start Kit (Medical Action Industries, Arden, NC) is utilized. It contains a single chlorhexidine/isopropyl alcohol (CHG/IPA) swab. The DHMC vascular access team is a resource for difficult PVC placement, but most PVCs are placed by staff or supervised students. A maximum of 4 insertion attempts are permitted per individual, and ultrasound is available to trained personnel. The institutional policy is to remove a PVC placed by emergency medical services (EMS) and by outside facilities within 24 hours of hospitalization; the PVC site is not routinely changed if it was placed within the hospital.

Statistical analyses

Descriptive statistics were used to characterize the population. The χ^2 test, Fisher exact test, or Wilcoxon rank-sum test was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) based on a significance level of $P \leq .05$. The logistic regression model included variables with $P \leq .05$ in the univariate analysis and those deemed to be potential confounders. The Hosmer-Lemeshow test and C-statistic were used to determine appropriateness of the model; adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were used to report the effect of each variable on the outcome. This study was approved by the Colorado Multiple Institutions Review Board.

Results

Overall, 598 episodes of SAB in 559 patients occurred during the study period, and 542 cases were eligible for inclusion (17 were excluded due to age <18 years). Among these, 80 were hospital-onset SAB and 514 were community-onset SAB (Table 1). Of the community-onset SAB cases, 65 had accessed healthcare in the previous 7 days. SAB was more common in men (n = 274, 72.9%), and median patient age was 53.0 years (SD, 17.5). MRSA accounted for 31.9% of all SAB cases.

Of the 80 hospital-onset SAB cases, PVC was the most common cause SAB (n = 24, 30.0%). Other common causes were pneumonia or lung infection (n = 18, 22.5%) and unknown source (n = 12, 15.0%). An additional 3 cases of PVC-associated SAB were detected among those who had accessed healthcare in the prior 7 days, and these were added to the case counts.

Table 1. Demographic Data

Variable	No. (%)[a]
Total episodes of *Staphylococcus aureus* bacteremia	598
Unique episodes of *S. aureus* bacteremia	559
Exclusion to due to age <18 y	17 (3.0)
Community-onset	514 (86.0)
Methicillin-resistant *S. aureus*	164 (31.9)
Age, median y (SD)	53.0 (17.5)
Sex, male	362 (70.4)
Healthcare within 7 d of *S. aureus* bacteremia	60 (11.7)
Infection attributable to prior peripheral venous catheter	3 (0.6)
Hospital-onset	80 (13.4)
Methicillin-resistant *S. aureus*	20 (25.0)
Age, median y (SD)	52.5 (19.5)
Sex, male	57 (71.3)
Source of infection[b]	
Arterial or venous infection	23 (28.8)
Lung or pneumonia	18 (22.5)
Unknown, no definition met	12 (15.0)
Laboratory-confirmed bloodstream infection	8 (10.0)
Skin or soft tissue	7 (8.8)
Surgical-site infection	3 (3.8)
Symptomatic urinary tract infection	2 (2.5)
Bone or joint	2 (2.5)
Endovascular	2 (2.5)
Multiple categories	3 (3.8)
Soft tissue and joint	1 (1.3)
Soft tissue and arterial or venous infection	1 (1.3)
Arterial or venous infection and pneumonia	1 (1.3)

[a]Units unless otherwise specified.[b]Adjudicated using the National Healthcare Safety Network definitions.

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Table 2. Risk Factors Associated With Peripheral Venous Catheter-Associated Bacteremia: Univariate and Multivariate Analyses

Variable	Case (N = 27), No. (%)[a]	Control (N = 81), No. (%)[a]	Crude OR (95% CI)	Adjusted OR (95% CI)
Length of stay, median d (SD)	20.0 (34.8)	5 (8.2)	1.14 (1.07–1.21)	1.1 (1.1–1.2)
Sex, male	20 (74.1)	54 (66.7)	1.4 (0.5–3.9)	. . .
Alcoholism	7 (25.9)	22 (27.2)	0.9 (0.4–2.6)	. . .
Immunocompromised	7 (25.9)	4 (4.9)	6.7 (1.8–25.3)	8.2 (2.0–34.2)
Diabetes	4 (14.8)	17 (21.0)	1.5 (0.5–5.0)	. . .
Intravenous drug use	1 (3.7)	4 (4.9)	1.4 (0.1–12.6)	. . .
Cirrhosis	2 (7.4)	2 (2.5)	0.3 (0.0–2.4)	. . .
End stage renal disease	2 (7.4)	2 (2.5)	0.3 (0.0–2.4)	. . .
Setting where peripheral venous catheter was placed			2.6 (1.0–7.1)	5.3 (1.4–19.4)
Emergency medical services	9 (33.3)	13 (16.0)		
In hospital	17 (65.4)	66 (84.6)		
Body site where peripheral venous catheter located				
Upper arm	18 (66.7)	43 (53.1)	1.54 (0.61–3.85)	. . .
Lower arm	9 (33.3)	33 (40.7)		
Duration of peripheral venous catheter, median d (SD)	5.0 (2.6)	3.0 (3.5)	1.14 (1.01–1.29)	1.1 (0.9–1.2)

Note. OR, odds ratio; CI, confidence interval; SD, standard deviation.
[a]Units unless otherwise specified.

Compared to controls, the following factors caused PVC patients to be more likely to become infected: immunocompromised individuals (OR, 8.2; 95% CI, 2.0–34.2), PVCs placed by emergence medical services personnel (OR, 5.3, 95% CI, 1.4–19.4), and longer lengths of stay (OR, 1.1; 95% CI 1.1–1.2) (Table 2). Sex, PVC site, and duration of PVC were not associated with infection in multivariate analysis.

Discussion

Based on these findings, we focused initial quality efforts on EMS-placed PVCs and found opportunities for improvement. Nursing staff did not routinely remove externally placed PVCs because PVC placement location was not readily apparent. Nursing informatics modified the manager and bedside nurse dashboards to highlight externally placed PVCs. Additionally, PVCs in place for ≥24 hours became a standard metric that infection preventionists reported on the daily safety call.

We also evaluated EMS PVC placement technique. EMS PVC supplies included an alcohol swab, clear adhesive tape, tourniquet, macro/micro drip set or blood pump, 1,000-mL normal saline bag, and a PVC. The tape and tourniquets were stored in an open area and were used on multiple patients. Quality improvement efforts included introduction of sterile, single-use packages of CHG/IPA, semipermeable dressing, clear tape, tourniquet, extension tubing, and PVC.

Our initial evaluation of the postintervention data showed no infections in EMS-placed PVC, but there has been no decrease in overall PVC-related SAB. Previous researchers have described 4 mechanisms contributing to PVC infection: contamination along the catheter line where it inserts into the skin, contamination via the catheter hub, inoculation from a bloodstream infection, and inoculation from a contaminated infusate.[6] Next, researchers at our institution will investigate these factors as we strive for better quality and safety for patients.

Our findings suggest that longer length of hospital stay, but not individual PVC durations, are associated with a higher risk of infection. Although PVC duration has been shown to be a risk factor for infection in other studies, the routine removal of PVC has not been associated with better outcomes. In fact, a randomized-controlled trial found that clinically indicated replacement of PVC has an equivalent infection risk to routine replacement.[7] Clinically indicated replacement also has patient satisfaction benefits such as fewer needle sticks to patients in the hospital.

This study had several limitations. It had a single-center design and relatively small number of bloodstream infections. We focused our attention on SAB because it is a common, serious bloodstream infection often due to a break in the skin, but we did not evaluate bacteremia due to other pathogens because it would have been very difficult to determine the source of infection in many cases. The strengths of the study included a case–control design and the use of standardized NHSN definitions to determine the source of bacteremia.

In summary, our analyses identified EMS-related PVC and longer hospital durations as being associated with SAB. In addition to our EMS-specific interventions, we will address hand hygiene, hub-cleansing procedures, and catheter securement in the near future.

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