Prevalence and Factors Associated With Indwelling Non-Utilized (Idle) Central Vascular Access Devices Across All Age Groups

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ABSTRACT

A retrospective study was conducted in a large, urban, pediatric/adult hospital to investigate the extent of idle central vascular access devices (CVADs) across all age groups and to identify factors that contribute to an in situ nonutilized CVAD. Patients who were hospitalized for >4 days between January 2015 and December 2019 were included. Implanted ports, tunneled catheters, and umbilical lines were excluded. *Idle time* was defined as a calendar day in which no intravenous medication was administered. A total of 6054 CVADs (59% nontunneled CVADs, 41% peripherally inserted central catheters [PICCs]; 73% adults, 27% children) were analyzed. Among these, 1263 (21%) had at least 1 idle day, with a median idle time and proportion of 3 days and 25%, respectively. Up to 51% and 64% of lines placed in infants/neonatal intensive care unit had idle time compared with 13% and 12% in adults/medical intensive care units (ICUs). The median idle time for PICCs was longer than that of nontunneled CVADs. CVADs with dwell duration greater than the median (duration for their respective departments) had 5.0 (95% CI, 4.2–5.9) odds of being idle. CVADs in the neonatal ICU had 14.2 (95% CI, 10.8–18.6) odds of having idle time compared with those in the medical ICU. This study found that 1 of every 5 CVADs had at least 1 day of idle time, with one fourth of their total dwell duration idle. CVADs with longer dwell duration, those placed in children, and PICCs were more likely to be idle.

Key words: central catheterization, central vascular access device, CVAD, hospitalization, idle, intensive care unit, NICU, non-utilized, peripherally inserted central catheter insertion, PICU

Hospitalized patients often require intravascular access, and short peripheral intravenous catheters (PIVCs) are the most common form of intravascular access.[1] PIVCs, however, have high failure rates (35%–50%[2]), and challenges in obtaining PIVC access impact the patient's hospital experience.[2] Placement of a central vascular access device (CVAD), either a nontunneled CVAD or a peripherally inserted central catheter (PICC), is recommended for intravascular therapy that is estimated to last for >8, 8 to 15, and >15 days for neonates, infants/children, and adults, respectively.[1,3] CVADs are life-saving interventions, despite a significant associated risk of complications, including CVAD infections and mechanical complications, such as deep vein thrombosis and venous thromboembolism. Each central line-associated bloodstream infection (CLABSI) is estimated to cost up to $32,000[4] and confers a 2.2-fold higher mortality risk.[4] Because of their smaller vasculature, children have a more substantial risk of CVAD-associated venous thromboembolism (~103/100 000 pediatric intensive care unit [PICU]

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patients) and approximately 4 times higher odds of deep vein thrombosis.[5]

CVAD-related complications increase with the duration of catheterization; therefore, daily assessment of the CVAD requirement and removal of unnecessary catheters are crucial components of most care bundles that are implemented to reduce CLABSI.[6] Despite the awareness of the risk of infection with a longer duration of CVAD placement, occasionally they are left in situ even when not used for intravascular therapy. The rate of presence of an idle CVAD is reported to be 1.8%[7] to 63.0%,[8] depending on the patient population, hospital unit, and the type of catheter. Current literature on idle CVADs is mainly from small studies (sample size, 74–876[9])[7,9] and is limited to specific age groups (adult[7-11]/neonatal[12,13]). A 2016 integrative review found 13 studies on idle intravascular devices and only 4 studies on idle CVADs,[14] reflecting the paucity of research on this topic.

The primary objective of this study was to describe the prevalence of non-utilized but indwelling (ie, idle) CVADs in a large, urban, pediatric/adult hospital across all age groups and departments, with a hypothesis that different specialties have different practices with regard to CVAD removal. The authors assert that quantifying and comparing the extent of the idleness may raise awareness and generate further ideas for best practices. The secondary objective of the study was to identify factors associated with CVADs that contribute to a higher likelihood of idleness.

MATERIALS AND METHODS

Design and Setting

This retrospective study was conducted at OSF Saint Francis Medical Center, a 616-bed teaching hospital affiliated with the University of Illinois College of Medicine at Peoria (UICOMP). Data from January 1, 2015, to December 31, 2019, were extracted through a chart review of the hospital electronic medical records. The study protocol was reviewed and approved by the institutional review board of the UICOMP. The requirement of informed consent was waived (Institutional Review Board No. 1603765, 06/08/2020).

Inclusion and Exclusion Criteria

Patients hospitalized for at least 4 nights without indwelling CVADs at the time of admission were included. Out of a total 123 841 vascular access devices (VADs) screened, implanted VADs/ports, tunneled CVADs, highly unit-specific devices (eg, umbilical venous catheters that are only placed in the neonatal intensive care unit [NICU]), and non-CVADs (eg, PIVCs, midline catheters, and intraosseous lines) were excluded (n = 117 787). A total of 6054 CVADs were included in the analysis (Figure 1). The inclusion unit was a CVAD (if patients received >1 CVAD during hospitalization, each was counted separately).

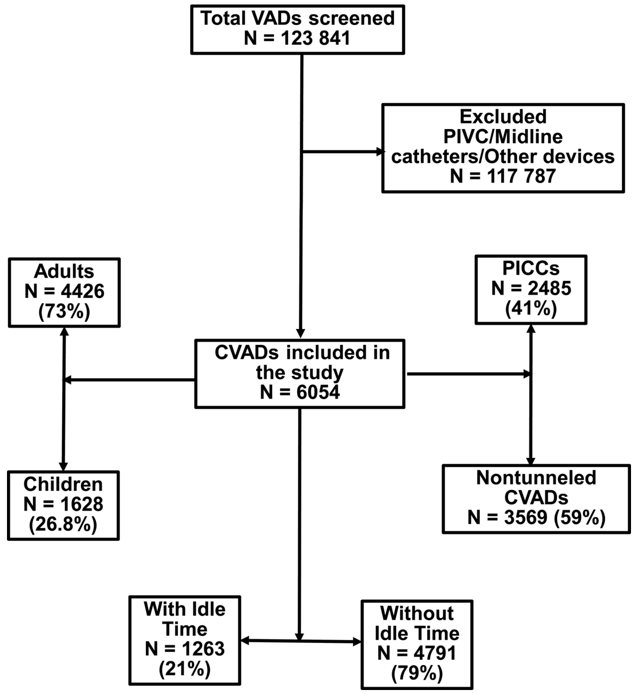

Figure 1 Study flow diagram. *Abbreviations: CVADs, central vascular access devices; PIVC, peripheral intravenous catheter; VADs, vascular access devices.*

Variables and Definitions

Patient-specific demographics including age (in years), sex, race, and body mass index (BMI) were collected. Adult patients (age ≥18 years) were classified as obese, overweight, healthy, and underweight based on established BMI cutoff points.[15] The BMI percentiles for children aged 2 to 17 years were calculated based on the Centers for Disease Control and Prevention (CDC) growth chart using R package *Childsds*.[16] Age-related data were available in years only; thus, BMI percentiles for patients <2 years could not be calculated. Patients (age range: 2–17 years) were subcategorized as obese, overweight, healthy, and underweight (>95th, 85th–94th, 5th–84th, and <5th percentile) based on the CDC criteria.[17] The study population was stratified by age: infant, small child, child and adolescent, adult, and seniors (<2, 3–6, 7–17, 18–65, and >65 years, respectively). Patients were grouped based on their discharge department into NICU, PICU, pediatric floor, adult ICU (including the medical, surgical, and neuro ICUs), adult floor, and adult procedural floors (eg, labor and delivery or endoscopy suites).

For each CVAD, the number of days of any intravenous (IV) medication administration (within the CVAD dwell duration) was calculated. An *idle CVAD* was defined as a CVAD with indwelling calendar day without IV medication administration. It was identified by subtracting the IV therapy days from the CVAD day. The proportion of idle days was calculated as a percentage of the total CVAD days for each catheter with idle time. The total duration of patient hospitalization and the number of PIVCs placed during hospitalization were also calculated.

Statistical Analysis

Data are presented as number (percentage) or median (interquartile range [IQR]). Categorical and continuous variables were compared using the χ^2 or Fisher exact test and nonparametric Wilcoxon signed-rank test, respectively. Multivariate nominal logistic regression analysis, including all factors with a potential clinical association with idleness, was conducted to identify independent risk factors for idle time. Missing data were assumed to be missing at random, and a complete case analysis was performed. Complete data were available for 4238 catheters (missing data, obesity [n =1261] and number of PIVCs in the encounter [n = 372]); the remaining variables had no missing data. Variables with a large proportion of missing data (>5%) were excluded from the multivariate logistic regression (ie, obesity). Factors with a potential colinear relationship to other factors in the model (eg, age and discharge department) were analyzed separately. Continuous variables in the model (hospital length of stay [LOS] and CVAD days) were converted into dichotomous groups based on the LOS and CVAD duration of more than or less than the median duration for their respective discharge departments. Adjusted odds ratios (ORs) with 95% CIs were calculated for categorical variables, and $P < .05$ was considered significant. All of the statistical analyses were conducted using JMP Pro version 14.2 (SAS Institute, Cary, NC).

RESULTS

Of the 6054 CVADs analyzed, 73% were placed in adults (≥18 years), and 27% were placed in children (<18 years); 59% and 41% of the CVADs were nontunneled CVADs and PICCs, respectively. Of all CVADs, 1263 (21%) had at least 1 day of idle time (Figure 1). The cumulative idle CVAD time during the study period was 5690 days.

Comparison of the Proportion of Idle CVADs

Infants, adults, and seniors composed 19.3%, 37.3%, and 35.7% of the total cohort. There was a significant difference in the age-stratified proportion of catheters with idle times. Approximately 51% of all CVADs in infants (598/1172) had idle time, as compared with 9.7% (26/268) in children and adolescents and 13.3% (301/2262) in adults ($P < .01$). The majority of the study population was White (82.5%), and a statistically significant difference in idle CVAD time based on race was noted: 27.3% (221/809) of Blacks had idle CVAD time compared with 19.2% (961/4998) of Whites. There was a significant difference in the proportion of patients who had idle CVADs based on their discharge departments: 64.3% (398/619) of all CVADs placed in the NICU had idle time as compared with 12% (233/1929) in the medical ICU ($P < .01$). A significant difference in the proportion of idle time based on catheter type was also noted: up to 32.8% (815/2485) of all PICCs had idle time as compared with only 12.5% of nontunneled CVADs (448/2569; $P < .01$; Table 1).

The median hospital LOS was 15 days (IQR, 8–28 days). Patients with idle CVADs had a significantly longer hospital LOS (25 days [IQR, 12–57 days]) than patients without an idle CVAD (13 days [IQR, 8–24 days]; $P < .01$). CVADs with an idle time had significantly longer dwell duration than those without an idle time (median = 10 [IQR, 6–18 days] vs 4 days [IQR, 2–9 days]; $P < .01$). Patients with an idle CVAD received significantly fewer PIVCs per week compared with patients without an idle CVAD (median = 0.8 [IQR, 0.3–1.4] vs 1.75 [IQR, 0.8–2.6]; $P < .01$; Table 1).

Comparison of Idle CVAD Duration

The median idle catheter duration and median proportion for the total study cohort were 3 days (IQR, 1–5 days) and 25% (IQR, 14%–50%), respectively (data not shown in tables). There was a significant difference in the total idle catheter duration between the different age groups, with the most prolonged median idle catheter duration of 3.5 days (IQR, 1.7–6.0 days) in children and adolescents compared with that of 2.0 days (IQR, 1.0–3.0 days) in adults ($P < .01$). The proportion of idle time compared with total catheter duration was longest for the infant population (28.5%) and shortest for children aged 2 to 5 years (18.1%). Overall, children had a longer idle catheter duration than adults (median, 3 [IQR, 2–6 days] vs 2 days [IQR, 1–3 days]); however, the proportion of idle time did not differ significantly between children and adults. There was a significant difference in the idle catheter duration based on the discharge department; the PICU had the longest median idle time of 5 days (IQR, 2–11 days), whereas the adult ICU and the adult floor had the shortest idle catheter time of 2 (IQR, 1–3 days) and 2 days (IQR, 1–4 days), respectively. The proportion of idle time, however, was highest for the NICU (median = 33.3% [IQR, 16.6%–59.4%]) and lowest for the pediatric floor (20.8% [IQR, 11.1%–33.3%]; $P < .01$). PICCs had an additional day of idle catheter duration as compared with nontunneled CVADs (median, 3 [IQR, 2–6 days] vs 2 days [IQR, 1–3 days], $P < .01$); however, there was no significant difference in the proportion of idle time between the 2 types of CVADs (Table 2).

Factors Associated With Idleness of CVADs

Multivariable logistic regression was performed to identify the factors associated with non-utilized indwelling CVADs, including patient age, sex, race, catheter type, discharge department, hospital LOS, and catheter duration (greater than median for the respective department) in the model. Because of the collinearity of age with the discharge department, logistic regression analysis was done with and without including age categories. Age was significantly associated with the risk of an idle catheter on univariate regression. However, the impact of age on idle CVAD time was not significant after accounting for the discharge department ($P = .54$). The OR for idle catheters in obese patients compared with that in nonobese patients in univariate analysis was 1.16 (95% CI, 0.98–1.37, $P = .08$).

TABLE 1

Proportion of Idle Central Vascular Access Devices

Category	Subcategory	Total cohort (N = 6054)	Nonidle CVADs (n = 4791, 79%)	Idle CVADs (n = 1263, 21%)	*P* value
Categorical variables, n (%)					
Age[a]	Infant	1172 (19.3)	574 (49.9)	598 (51.0)	<.01
	Small child	188 (3.1)	153 (81.3)	35 (18.6)	
	Child and adolescent	268 (4.4)	242 (90.3)	26 (9.7)	
	Adult	2262 (37.3)	1961 (86.6)	301 (13.3)	
	Senior	2164 (35.7)	1861 (86.0)	303 (14.0)	
Sex	Male	3460 (57.1)	2750 (79.4)	710 (20.5)	.44
	Female	2594 (42.8)	2041 (78.6)	553 (21.3)	
Race	Asian	47 (0.8)	33 (70.2)	14 (29.7)	<.01
	Black	809 (13.3)	588 (72.6)	221 (27.3)	
	White	4998 (82.5)	4037 (80.7)	961 (19.2)	
	Other	200 (3.3)	133 (66.5)	67 (33.5)	
Obesity[b]	No	2578 (55.9)	2241 (86.9)	337 (13.0)	.08
	Yes	2032 (44.0)	1730 (85.1)	302 (14.8)	
Discharge department	NICU	619 (10.2)	221 (35.7)	398 (64.3)	<.01
	PICU	540 (8.9)	357 (66.1)	183 (33.8)	
	MICU	1929 (31.8)	1696 (87.9)	233 (12.0)	
	Pediatric floor	479 (7.9)	396 (82.6)	83 (17.3)	
	Adult floor	2030 (33.5)	1718 (84.6)	312 (15.3)	
	Adult surgical floor	457 (7.5)	403 (88.1)	54 (11.8)	
Catheter type	Nontunneled CVAD	3569 (58.9)	3121 (87.4)	448 (12.5)	<.01
	PICC	2485 (41.0)	1670 (67.2)	815 (32.8)	
Continuous variables, median (IQR)					
Length of stay	Days	15 (8–28)	13 (8–24)	25 (12–57)	<.01
CVAD/days	Days	6 (2–10)	4 (2–9)	10 (6–18)	<.01
PIVC/week	No. of insertions	[n = 5499]	[n = 4390]	[n = 1109]	<.01
		1.4 (0.7–2.3)	1.75 (0.8–2.6)	0.8 (0.3–1.4)	

Abbreviations: CVAD, central vascular access device; IQR, interquartile range; MICU, medical intensive care unit (ie, all adult intensive care units); NICU, neonatal intensive care unit; PICC, peripherally inserted central catheter; PICU, pediatric intensive care unit; PIVC, peripheral intravenous catheter.
[a]Infant (<2 years), small child (3–6 years), child and adolescents (7–17 years), adults (18–65 years), senior (>65 years)
[b]Missing data, n = 1444

Obesity was not included in the model because of a large number of missing values. The data presented herein did not include age and obesity in the regression model.

Among the variables included in the model, only catheter type, LOS greater than the median, CVAD days greater than the median, and discharge department were independently associated with the risk of an idle CVAD. PICCs had a higher OR of being left idle than nontunneled CVADs (OR = 1.35 [95% CI, 1.10–1.50]). CVADs with longer dwell time, as defined by a dwell duration greater than the median dwell duration for their respective departments, had an OR of 5.04 (95% CI, 4.20–5.90) for having an idle time. Significant association of hospital units with CVADs having an idle time was also observed. The highest OR of having an idle time was for CVADs placed in the NICU compared with those placed in the medical ICU (OR = 14.2 [95% CI, 10.8–18.6]), whereas the OR for the PICU compared with the medical ICU was 3.62 (95% CI, 2.80–4.60). There were lower ORs of idle time for CVADs in the adult ICU (OR = 0.83 [95% CI, 0.68–1.01]) compared with adult floors, although there were higher ORs of an idle CVAD in the PICU compared with the pediatric floor (OR = 2.56 [95% CI, 1.87–3.50]; Table 3).

DISCUSSION

Results of this large cross-sectional study of 6054 CVADs across all age groups showed that 21% of all CVADs had at least 1 idle day, with a median of 3 idle days per idle catheter. Compared with the adult ICU, the NICU and PICU

TABLE 2

Comparison of the Median Duration and Proportion of Idleness (Out of Total Duration) Among Different Subcategories

Category		N	Hospital length of stay (days) Median (IQR)	Total catheter duration (days) Median (IQR)	Idle catheter duration (days) Median (IQR)	*P* value	Proportion of idle catheter duration (%) Idle duration (IQR) %	*P* value
Age[a]	Infant	598	54 (30–89)	13 (8–25)	3 (2–6)	<.01	28.5 (15.7–50)	<.01
	Small child	35	31 (17–58)	16 (12–29)	3 (2–4)		18.1 (8.6–25)	
	Child/adolescent	26	25 (15–53.2)	15.5 (10–41)	3.5 (1.7–6)		19.6 (10–34.3)	
	Adult	301	13 (7–24.5)	8 (5–14)	2 (1–3)		25 (14.2–42.1)	
	Senior	303	13 (9–19)	8 (5–12)	2 (1–4)		25 (14.2–44.4)	
Child vs adult	Child	659	52 (27–87)	13 (8–25)	3 (2–6)	<.01	27.2 (14.6–50)	.15
	Adult	604	13 (8–20.7)	8 (5–13)	2 (1–3)		25 (14.2–43.2)	
Sex	Male	710	26 (12–61.2)	11 (6–20)	3 (1–5)	.42	25 (14.2–42.9)	.22
	Female	553	23 (12–52)	9 (6–17)	3 (1–5)		25 (15.3–50)	
Race	White	961	21 (11–50)	9 (6–18)	3 (1–5)	.09	25 (14.2–50)	.60
	Black	221	41 (15–76.5)	11 (7–19.5)	3 (1–5)		25 (14.2–46.8)	
	Asian	14	50.5 (30.2–90)	11.5 (9–20.5)	4 (3–6.2)		36.9 (16.4–46.5)	
	Other	67	37 (13–77)	12 (7–27)	3 (1–6)		25 (14.2–44.4)	
Department	NICU	398	54 (31–86)	10 (7–18)	3 (2–5)	<.01	33.3 (16.6–59.4)	<.01
	PICU	183	57 (30–151)	24 (13–43)	5 (2–11)		25 (12.5–39.4)	
	Adult ICU	233	12 (7–20)	8 (5–12)	2 (1–3)		23.0 (14.2–40)	
	Pediatric floor	83	24 (15–54)	16 (10–29)	3 (2–5)		20.8 (11.1–33.3)	
	Adult floor	312	14 (8–21)	8 (5–13)	2 (1–4)		25 (14.2–45.4)	
	Adult procedure	54	13.5 (7.7–22.5)	7 (5–13)	2 (1–4.2)		29.6 (17.5–55.9)	
Obesity[b]	Yes	302	12 (7–20)	8 (5.7–12)	2 (1–4)	.50	25 (15.3–50)	.12
	No	337	15 (10–25)	9 (6–15)	2 (1–4)		25 (2.7–40)	
Type	Nontunneled CVAD	448	12 (7–20)	8 (5–12)	2 (1–3)	<.01	25 (14.3–40)	.20
	PICC	815	41 (19–76)	12 (7–23)	3 (2–6)		26.6 (14.2–50)	

Abbreviations: CVAD central vascular access device; ICU, intensive care unit; IQR, interquartile range; NICU, neonatal intensive care unit; PICC, peripherally inserted central catheter; PICU, pediatric intensive care unit.

[a]Infant (<2 years), small child (3–6 years), child and adolescents (7–17 years), adults (18–65 years), senior (>65 years).

[b]Missing data, n = 624.

are more likely to have an idle CVAD. PICCs were left idle more often than other CVADs, although the proportion of idle times did not differ between these 2 types of temporary CVADs. CVADs with a dwell duration longer than the median dwell duration for their respective departments had significantly higher odds of idleness.

The overall proportion of idle catheters of 21% is lower than the 63% and 50% reported by Tejedor et al[8] and Burdeu et al,[11] respectively. However, other studies have reported a much lower prevalence of idle catheters (4.8%[10] and 4.6%[7]). The reported rate of this study is cumulative across all populations, whereas most other studies have reported rates in specific populations. Neonates and children had a higher proportion of idle CVADs, contributing to our higher overall rate. However, the idle rates for the NICU (64.3%) were much higher than the reported idle rates of 25.2% for tunneled CVADs and 5.1% for PICCs[12] in a previous study on neonates.

An *idle CVAD* was defined as a CVAD with indwelling calendar day without IV medication administration. The definition of an idle CVAD is not uniform. Some studies define an *idle CVAD* as a CVAD that does not receive any medication that cannot be administered from PIVCs. The latter definition is more clinically appropriate, although defining *need* always has an element of subjectivity and thus a possibility of investigator bias. In general, a lower rate of idleness has been shown in studies utilizing subjective assessment of necessity[10]

TABLE 3

Adjusted Odds Ratio of an Idle Central Vascular Access Device Based on Multivariable Logistic Regression

Variable	OR (95% CI)	*P* value
PICU vs adult ICU	3.62 (2.83–4.63)	<.01
NICU vs PICU	3.92 (2.98–5.16)	<.01
NICU vs adult ICU	14.2 (10.8–18.6)	<.01
PICU vs pediatric floor	2.56 (1.87–3.50)	<.01
Adult ICU vs adult floor	0.83 (0.68–1.01)	.07
CVAD day > median yes vs no	5.04 (4.25–5.99)	<.01
LOS > median yes vs no	0.68 (0.59–0.80)	<.01
PICC vs nontunneled CVAD	1.35 (1.14–1.59)	<.01
Black vs White race	1.16 (0.95–1.42)	.12
Female vs male gender	1.03 (0.89–1.19)	.65

Abbreviations: CVAD, central vascular access device; ICU, intensive care unit; LOS, length of stay; NICU, neonatal intensive care unit; PICC, peripherally inserted central catheter; PICU, pediatric intensive care unit.

or justification[7] rather than nonutilization,[8] as in the current study.

More idle CVADs were found in the PICU than on the pediatric floor, whereas fewer idle catheters were found in the medical ICU versus the adult floor. No previous studies on this topic are available in the pediatric literature. Studies in adults have shown more unjustified CVADs in non-ICU (8.5%) patients than in ICU patients (1.8%).[7] Another study showed a 26.2% idle rate for CVADs on patients on the hospital floor who were discharged from the ICU.[11] This study supports the notion that more effort is needed in the non-ICU adult settings to generate awareness of daily catheter necessity.

The prolonged duration of CVADs in this study was associated with 5.04 odds of idle catheter time. This is similar to the results obtained by Tiwari et al.[9] The risk of the idle catheter time being higher in catheters with more extended catheter days is significant because the risk of developing CLABSI is not linearly proportional with catheter days but increases nonlinearly with time. Milstone and Sengupta[13] showed a 33% increase in the incidence of CLABSIs per day after 36 days of PICCs in neonates. Recent theoretical analysis also showed that the CLABSI risk increases in quadratic fashion with increased catheter dwell time.[18] Routine replacement of catheters after a specific time, however, has not been shown to demonstrate a reduction in CLABSI rates,[19] and at least 1 study has shown that the rate of CLABSI is lower in idle catheters compared with the ones in use.[12] Nevertheless, there should be a careful selection of patients who need CVADs, and prompt catheter removal should be emphasized when they are not required.

LIMITATIONS

The study has limitations inherent to a retrospective automated chart review. The dwell times of CVADs depend on the accuracy of charting by the nursing staff with regard to the insertion and removal times; this may vary based on practices in different nursing units. The idle time was determined based on not receiving any IV medication and does not differentiate if the catheter was left for critical lifesaving access or whether the medications could be given through a PIVC (justified vs nonjustified idle CVAD). Many catheters, particularly in children, are also left indwelling because of the need for frequent blood draws. This factor was also not included in the analysis. Different populations and units have unique characteristics and risks; therefore, the comparison across units should be interpreted with these differences in mind. A large proportion of the difference between units is probably due to their unique patient population. However, at least some of the differences may be due to culture and ingrained practices.

CONCLUSIONS

This study provides comparative information on idle CVADs across all age groups, hospital units, and specialties. It shows that all hospital units have idle CVADs with varying prevalence. Children, notably neonates, are more likely to have an idle CVAD. Additional research is recommended to evaluate any association of infection with an indwelling non-utilized CVAD and to separate justified from nonjustified idle CVAD. A quality improvement project on the implementation of an electronic medical record alert with required documentation of justification every day for an unutilized CVAD may possibly lead to a significant reduction of idle catheters.

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