



Infants central line-associated bloodstream infection risk influenced by catheter dwell time

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Abstract

A central venous catheter is associated with significant morbidity and mortality in the NICU because of the risks of central line-associated bloodstream infections (CLABSI). Study participants were asked to determine whether dwell time affected the incidence of CLABSI. ICR studies retrospectively collected data on 6663 infants with 7783 catheters and 128044 catheter-connected days across 70 neonatal intensive care units. Based on the National Health Surveillance Network definition, CLABSI was developed. The dwell time defined is the number of days between the day of line insertion and the removal of the line or the day of CLABSI. In our analysis, we used a Cox proportional hazards frailty model to estimate survival curves for CLABSI at the end of each week of dwell time. Separate models were generated by line type, controlling including the effects of facility on postmenstrual age and year, and incorporating postmenstrual age. A median of 29 weeks was found to be the postmenstrual age. Across 500 catheter days, 0.93 cases of CLABSI occurred. CLABSI risk for PICCs was not higher with longer dwell times. There was a significantly higher infection rate in weeks 7 and 9 for tunneled catheters than in week 1. The conclusion of this study is that clinicians should not replace PICCs simply because they are uninfected, but may if tunneled catheters are no longer necessary, remove them before week 7. There is a need for further research to determine what daily maintenance practices, especially for tunneled catheters, may help reduce infection risks.

Keywords: Associated Bloodstream Infections with Central Lines in Infants

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Introduction

It is common for patients in the NICU to receive central catheters, which are crucial to their survival. Stable intravascular access provides fluid, nutrition, and medication administration

via these catheters. It is especially helpful to ensure long-term vascular access with peripherally inserted central catheters (PICCs) that a trained provider can implant the device at the bedside without any surgical intervention



requiring any surgery. For example, are tunneled catheters which require a surgical procedure to install but are able to stay in place for a long time. Even though central catheters are life-saving devices, they can lead to neonatal central line-associated bloodstream infections (CLABSI). CLABSI is a significant risk for NICU infants, particularly those who are low birth weight. If they are at risk for CLABSI, they are at significantly greater risk than older children and adults. It is crucial to develop strategies aimed at preventing these infections since a CLABSI increases the risk of death in an infant.

A central line in an infant may be left in place for an optimal difference in days between inserting and removing a catheter. It is unclear if the daily risk of infection increases over time with longer dwell times (accessing of the line). The number of catheter dwell times has been linked to CLABSI risk in several studies [3,5,6-8,9] but others report increased dwell time does not increase the risk of CLABSI. In addition to balancing infection risks and frequent catheter replacement risks, researchers have examined the risks of frequently replacing catheters, including PICCs. Knowing the optimal dwell time for central lines would be beneficial for neonatologists, allowing them to provide safer care. The National Central Line Associated Blood Stream Infection Prevention Project (NCLABSI), which is the largest registry of neonatal central lines to date, is where we tested the hypothesis that longer dwell times are associated with an increased risk of bloodstream infections.

Methods

Data Source

A retrospective cohort study was conducted from September 2019 to August 2020 on a cohort of infants with PICCs or tunneled catheters. A note of note is that on the data collection form, tunneled catheters were called "Broviacs" because this is the trade name that clinicians are generally familiar with. 70 NICUs from 6 different places participated in the NCLABSI. As part of a quality improvement effort intended to reduce CLABSIs by 75%,

state-level leaders Individual sites recruited teams to report on all central lines placed, removed, and infected. A central catheter insertion and maintenance bundle was developed by participating sites, which included guidelines for sterile dressing changes and catheter access, a daily assessment of line need, and recommendations for removing central lines when infants reached 100mL/kg of enteral feedings per day. There was no standardization of antibiotic practices between the sites. The first two days of central lines insertion and removal were excluded from analysis. Local institutional review boards reviewed this project when requested by the participating institutions and granted permission to conduct this investigation.

Definitions

It was not considered an indication that a patient was infected elsewhere by the National Health Surveillance Network if a pathogenic organism was found in a blood culture. Streptococci from the viridans group, Aerococcus species, and Micrococcus species are compound-negative staphylococci. are among the commensal organisms that can cause CLABSI, with the diagnosis requiring systemic signs and symptoms of infection, as well as the isolation of the same organism from two different blood cultures. During the first two days following the insertion, positive blood cultures were deemed to be associated with the insertion and excluded. In the analysis, only the first positive blood culture was considered if multiple positive blood cultures were associated with a single catheter. A CLABSI occurred three times when multiple catheters were present, so both catheters were blamed for the incident. From the time a line is inserted until its removal or until CLABSI, the dwell time is considered. During dwell time, seven-day segments began Line days.

Statistical Analysis

A median and interquartile range (IQR) or a percentage will be shown when it is appropriate. The incidence of CLABSIs and the dwell times based on line type were compared using Fisher's exact test and Wilcoxon rank-sum



test, respectively. The Spearman's rank correlation coefficient was calculated to determine if dwell time contributed to infection incidence. For weeks 2 to 10, we compared the frequency of CLABSI in Cox proportional hazards model with week 1. Our model also included a random effect related to facility and a model for each type of catheter, in addition to the postmenstrual age (PMA) and year of insertion (September 2018-August 2019 versus Sept 2019-August 2020). Our calculation of the incidence of CLABSI at every facility is based on the number of CLABSIs reported per 500 catheter days. The data analysis was conducted

using Stata 13. Statistical significance was determined by the P value of .05.

Results

Study participants included 6663 infants who received 7783 catheters and 128044 catheter days. PICC catheters accounted for the majority (7225/7783). It took PICCs a median of 11 days versus 25 days for tunneled catheters to reach the median dwell time (Table 1). A PICC stayed in the patient's body for more than 10 weeks, two of which were infected; a tunneled catheter stayed in the patient for more than 10 weeks.

TABLE 1: Duration of catheterization

Dwell Time, d	(IQR) for PICCS	Tubular Catheters	P
Generally	5	12.2 (6–22)	<0.002
Sept. 2018-Sept.	5 (3–8)	12 (6–23)	
Between September 2019 and August 2020	5 (3-8)	12 (6–20)	

PICCs had a 1.4% incidence of CLABSI compared to tunneled catheters (99/7225). 33 (47%) A CLABSI occurred in 0.93 cases out of the 70 NICUs for every 500 catheter days. Among the 500 catheter days on average in the median center, 17 of those were CLABSIs. One facility had 30.3 infection cases per 500 catheter days when only two catheters were reported infected. Increasing median dwell time did not result in an increase in infection rates overall at a center (P = 0.88).CLABSI risk for PICCs was not increased during any week compared with week 1 (Table 2). In weeks 7 and 9, infection rates for

tunneled catheters were significantly higher than week 1. PICCs and tunneled catheters did not display significant differences in CLABSI by catheter insertion year (P =0.35 and P =0.08, respectively). The risk of CLABSI for Compared to those born with PICCs between 26- and 29-weeks PMA, those born between 26- and 29-weeks PMA were significantly more infants born prematurely compared to adjusted term infants. CLABSI was not significantly more common in premature infants with tunneled catheters.

TABLE 2: A comparison of CLABSI with Dwell Time

Week of Dwell Time	(PICCAs)	N %Cont.	PICCs, HR ^a (95% CI)	Tubular Catheters	No (%)	HRa (95% CI) Tubular Catheters
1	7226	40 (0.5)	Reference	557	2 (0.4)	Reference
2	4125	27(0.6)	1.1 (0.9–1.7)	484	2 (0.5)	1.2 (0.4–4.4)
3	2031	15 (0.7)	1.2 (0.8–1.9)	373	1 (0.4)	0.9 (0.2–4.4)
4	1104	2 (0.2)	0.3 (0.1–0.9)	290	1(0.3)	0.8 (0.2–4.7)
5	645	3 (0.5)	0.8 (0.4–1.9)	225	1 (0.7)	1.7 (0.4–7.6)
6	382	3 (0.9)	1.4 (0.7–3.2)	177	2 (1.1)	3.1 (0.8–12.0)
7	226	2 (0.9)	1.3(0.5–4.0)	140	2 (1.4)	3.9 (1.1–15.4)



Week of Dwell Time	(PICCAs)	N %Cont.	PICCs, HR ^a (95% CI)	Tubular Catheters	No (%)	HRa (95% CI) Tubular Catheters
8	138	1 (1.1)	0.8 (0.5–5.2)	113	1 (0.4)	1.2 (0.1–11.4)
9	91	1(1.1)	1.4 (0.4–6.3)	88	1 (1.7)	4.6 (1.1–20.3)
10	62	0		76	1 (0.7)	1.9 (0.2–17.7)

HR, hazard ratio; CI, confidence interval. ^aIn addition to PMA, site, and year, aHRs are adjusted.

TABLE 3
CLABSI and PMA

PMA, wk	NPICCs	(95% confidence interval)	Narrow-bore catheters	- TRa (95% CI)
≥36	917	Bibliography	157	Bibliography
33–35	670	1.0 (0.2–3.7)	96	0.4 (0.2–2.7)
31–32	1657	1.1 (0.3–3.5)	65	0.1 (0.03–3.1)
27–28	2625	3.7 (1.5–9.6)	101	1.3 (0.4–5.1)
<25	1353	5.9 (2.4–15.1)	136	1.1 (0.3–3.7)

The size of samples is indicative of the Patient data for each PMA with regard to the type of catheter used. Confidence intervals and hazards ratios refer to patient treatment. In addition to the line week, year, and location of insertion, aHRs are adjusted for

DISCUSSION

In the case of neonatal central lines, this study represents the most comprehensive analysis so far of how dwell time affects infection risk. Clinical staff would benefit greatly from knowing when it is time to replace catheters, as this would allow them to replace them before the infection risk increases. An increased risk of infection was not associated with longer PICC dwell time Across multiple states, we have infants in this cohort. In prior single-center studies [8, 9] the same findings were observed. Each of those studies had a significantly higher infection rate than this one (1.5%). Different definitions of catheter-associated infections may have contributed to differences in infection incidence. Multivariable logistic regression analysis with Smith *et al* [9] revealed that longer dwell times decreased the risk of infection. It is our hypothesis that the rapid maturation of the immune system in the early neonatal period,

particularly for premature infants, will decrease the risk of infection as the infant ages, even with the central line in place. With more enteral feeds and decreased medical acuity, the line may be accessed less frequently and therefore less often, resulting in fewer chances for infection. Additionally, a mature gastrointestinal system may lead to a reduced risk of infection in older infants as a result of less bacteria moving throughout the digestive tract. Our findings regarding PICCs differ from those of several previous studies. There was an association between longer overall catheter dwell times and an increased risk of late-onset sepsis in Researchers examined 6215 very low birth weight infants treated at Neonatal Research Network centers [3] but were unable to determine when infectious late-onset disease began. An infection developed on the 14th day after catheter placement in a previous study would seem to indicate a longer catheter dwell time among patients whose catheters were in place for 35 days, when it was in fact the second week of catheterization that caused the infection. Because the results of such an examination would not likely affect management, we decided not to test CLABSI



risk within the first week following PICC implantation. For PICCs with a dwell time of up to 7 days, we observed increased infection risks for 1105 central lines in 562 infants. The patient is typically expected to have a PICC for at least one week before the doctor inserts it. A clinician would not replace a PICC within the first week of dwell time if they were aware infections tend to occur on days 5 and 4 respectively. Our study found that the risk of CLABSI did not increase after 7 days, which is in agreement with their findings. There was a single-center study that demonstrated increased risks of CLABSI after day 35 in 341 infants with 341 PICCs, however, the size of the sample was small, and infection rates were higher than those observed in the current study.[7]According to the multicenter cohort study from Milstone et al [6], 4797 PICCs were implanted in 3967 infants. During the first 2 weeks following PICC insertion, the anticipated risk of CLABSI increased and remained elevated until the catheter was removed. In this study, infection was detected at a higher rate (3.11 %) than in the current one. A different population of infants was studied in the previous study; the median birth weight of the infants was 2000 grams. The median PMA in our cohort Most likely, the population was smaller and more premature at 29 weeks. Birth weights are unknown. A higher infection rate may also be attributed to the fact that our cohort represents NICU infants who have undergone specific catheter maintenance interventions to prevent CLABSI. Also, the two studies applied different analytical approaches, which may explain the difference in results.According to our knowledge, this is the first comprehensive study to examine the association between dwell time and CLABSI in infants with tunneled catheters. Previous studies have suggested that babies with surgical lines and those with PICCs have similar risk of CLABSI [1,11,12]. In a multicenter study of 1354 neonates, Brodie *et al* [13] reported that neonates with Broviacs (n = 54) had higher risk of CLABSI. The duration of catheter use was not addressed in this study. A significant increase in CLABSI risks was noted

after week 7 and 9 A study involving 1116 tunneled catheters in 1037 infants was conducted. Flow rate was similar in all 376 infants (36 with tunneled catheters), according to a different study done by Beck-Sagueet *al*[14 an increase in the risk of sepsis with prolonged tunneled catheter use.In the NICU, surgically placed catheters serve a unique purpose and are cared for in a unique way. Tunneled catheters are often placed in infants with complex gastrointestinal surgery conditions in anticipation of prolonged intravenous feeding before adequate enteral feeding can take place. PICC lines are more risky than surgical catheters because general anesthesia may be required for replacement and access may be severely limited. Due to this, clinicians, even if the tunneled catheter is no longer needed, may decide to leave the catheter in the infant longer than PICCs, out of concern that the infant may need nutritional access in the future. Tunneled catheters need to be flushed regularly even if they are heparin-locked and can be used to collect blood. In tunneled catheters with prolonged dwell times, these practices may increase the risk of infection. We found that the risk of tunneled catheter infections was 2.5 times higher than the risk for PICC lines and these risks increased after the sixth week. However, despite the compelling reasons for leaving a tunneled catheter in place, decision-makers need to consider the increased risk for infection when weighing this against the necessity of continuing the catheter.Tunneled catheters are found to have a lower infection rate than PICC lines despite dwell time being an important factor. First, the Despite the fact that tunneled catheters have unique characteristics, the quality initiative used standard recommendations for central line maintenance bundles. To reduce infection rates, tunneled catheters may need special attention. Despite the recommendation to remove PICCs when infants achieved 120 mL/kg per day of enteral feeding, we did not see a reduction in tunneled catheter dwell time over the course of the initiative. We also didn't discuss optimal techniques related to tunneled catheter entry



or flushing, nor the use of tunneled catheters for blood sampling. There were significant differences CLABSI rates across facilities have increased. Previously, it has been shown that infection risks differ between NICUs, [1,15,16] but since the NHS implemented a universal vaccination scheme, the findings seem to invalidate those conclusions infection numbers at each center were too small, we were not able to examine whether dwell time was related to CLABSI risk within a particular facility. At the collaborative level, the risk for infection does not appear to be associated with dwell time. Some centers can protect against infection despite long stays if they integrate maintenance-line care practices into their treatment plans. In fact, we chose to include facility as a random variable in a frailty model specifically for this reason. Based on these findings, good central line maintenance practices should be identified and adhered to vigorously. A central line should be more resistant to infection if staff training, catheter maintenance practices, antibiotic practices, and hand hygiene protocols are varied. In spite of the fact that all facilities in this analysis participated in the initiative, a number of factors - namely, the architecture of the unit and environmental factors - were immutable or could not be changed (antibiotic practices). More research is needed to determine which components of maintenance bundles and other factors have most influence on infection prevention. Moreover, we were able to compare infection risk week by week, confirming previous findings that infections are higher in smaller infants with PICCs. [5,6,9]

CONCLUSIONS

Despite their importance in administering vital in the NICU, sick infants receive medication and nutrition, central venous catheters carry a high risk of infection. It is dangerous to replace catheters that are not necessary. The data suggest clinicians shouldn't replace uninfected PICCs on a routine basis to avoid infection. However, given our finding that infection risk increases the closer we get to week 7, we should strongly consider removing tunneled

catheters before that point. The lack of association between CLABSIs and dwell time suggests clinicians should work on the two factors of maintaining the line properly and removing the line as soon as it is no longer needed in order to reduce the rates of CLABSIs. It would be worthwhile to conduct additional studies to identify and describe individual Central line infection prevention practices.

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