BMJ Open

Central venous catheter insertion profile and complications among neonates in Saudi Arabia: a cross-sectional study

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To cite: Elabbasy A, Alkorbi HA, Padua I, *et al*. Central venous catheter insertion profile and complications among neonates in Saudi Arabia: a cross-sectional study. *BMJ Open* 2024;**14**:e089554. doi:10.1136/bmjopen-2024-089554

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-089554).

Received 05 June 2024
Accepted 14 October 2024

Check for updates

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ABSTRACT

Objectives To compare complications in neonates who had umbilical venous catheter (UVC) versus peripherally inserted central catheter (PICC), percentage of non-elective removal of central catheters, and to compare complications of PICC in the upper limb compared with the lower limb.

Design A prospective cross-sectional cohort study.

Setting Neonatal intensive care unit (NICU) in Prince Sultan Military Medical City in Riyadh, Saudi Arabia.

Participants All infants who are admitted to the unit requiring central catheter insertion were included in the study.

Primary outcome measure Complications of central catheters in infants admitted to the NICU.

Results A total of 415 central catheters were involved in this study (206 UVCs and 209 PICCs (85 in the lower limb, 99 in the upper limb and 25 in the head and neck). The median birth weight of the neonates was 1470 grams (1000–2215). Low birth weight was the most common reason for central catheter insertion, which accounted for 59.8%. Neonatologists were the main insertor for the majority of the cases. The median dwell days for the study sample were 11.00 (7.00–16.50) days. Complications were more common across PICC cases compared with UVC cases (p=0.001). There was non-elective removal of PICC (32.1%) compared with UVC (22.8%) (p=0.035). Phlebitis, occlusion, local infiltrate and leakage were more common in PICC compared with UVC (p<0.05). However, malposition was more commonly associated with the use of UVC (mainly to the liver) (p<0.01). Central line-associated bloodstream infection (CLABSI) rate in 1000.00 dwell days was higher in the upper limb 4.6 compared with the lower limb 2.72 but was not statistically significant (p=0.63), and there was no statistically significant difference in the proportion of other complications between the upper limb and the lower limb (p>0.05).

Conclusion Close monitoring during extended dwell times is crucial. Our findings underscore the importance of raising awareness of CLABSI risk factors and adhering to best practices for central catheter maintenance. Healthcare professionals should be vigilant about the differences in complication rates between PICC and UVC, tailoring their approach accordingly.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is a single-centre study, which might have affected the generalisability of our study findings.
⇒ The use of cross-sectional study design restricted the ability to examine causality among the study variables.
⇒ Excluding neonates with no follow-up might lead to selection bias as they might have different outcomes profile.

INTRODUCTION

Central venous access refers to the insertion of a catheter into a large vein for different medical purposes.[1] Central catheter insertion should be recommended in neonatal intensive care units (NICU) based on patient characteristics, fluid characteristics or the duration of the required therapy.[2]

Central catheters encompass several types of catheters. First is the umbilical venous catheter (UVC), where the tip is located at the junction between the inferior vena cava (IVC) and right atrium (RA). Second is the epicutaneo-caval catheter (ECC) or neonatal-peripherally inserted central catheter (n-PICC). For ECC/n-PICC coming through the superior vena cava (SVC), the tip may be located (a) in the lower third of the SVC, (b) at the junction between the SVC and RA or (c) in the upper third of the RA. For ECC/n–PICC coming through the IVC, the tip may be located (a) in the subdiaphragmatic IVC (below the hepatic vein but above the renal vein) or (b) at the junction between IVC and RA. Third is the centrally inserted central catheter which is inserted by an ultrasound-guided venipuncture of deep veins of the supra-clavicular area (mainly the internal jugular vein or the brachiocephalic vein). The tip is located (a) at the junction between SVC and RA or (b) in the upper third of the RA. Last is the femorally inserted central catheter which is inserted by an ultrasound-guided venipuncture of deep veins of the groin (common femoral vein). The tip may be located (a) in the subdiaphragmatic IVC (below the hepatic vein but above the renal

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veins) or (b) at the junction between IVC and RA.[3–6] Complications associated with central catheter insertion are frequently encountered, and although certain complications are fewer compared with peripheral catheters, they possess the potential to be life-threatening, such as cardiac tamponade and pleural effusion.[7–10] A previous study by van Rens *et al* reported that for patients who received a peripheral catheter, the complication rate was significantly higher when compared with infants receiving a central venous access devices (CVAD) (407.00/1000.00 and 13.00/1000.00 catheter days, respectively).[10]

Clinicians such as neonatologists typically insert the majority of central catheters in the NICU. The interventional radiologist employs either fluoroscopy or ultrasound guidance 'as an insertion methods' to guide the placement of the catheter and to facilitate the positioning.[11] Additionally, there are instances where an anaesthetist may also provide assistance.

Prior research has elucidated various risk factors associated with problems arising from PICCs in neonates.[10 12] These factors encompass young age, severity of disease, duration of catheter stay, placement of catheter tip and site of catheter insertion.[10 12–14] The identification of modifiable risk factors for complications holds significant importance in the efforts of the healthcare providers to prevent catheter-related challenges. Prior research examining modifiable risk variables, including the duration of catheter dwell time, the site of catheter insertion and the position of the catheter tip, has yielded inconclusive findings.[9 15 16] The objectives of this study are to compare complications in neonates who had UVC versus PICC, percentage of non-elective removal of PICC catheters, and to compare complications of PICC in the upper limb compared with the lower limb.

METHODS

Study design

This is a prospective cross-sectional cohort study that examined the complications of central catheters in infants admitted to the NICU in Prince Sultan Military Medical City in Riyadh, Saudi Arabia from July 2022 to July 2023.

Study population

All infants who are admitted to the unit requiring central catheter insertion were included in the study. Neonates who lost the follow-up or transferred to other centre before removal of the central catheter were excluded.

Data collection

Data were collected from the neonates' electronic medical records for demographic information, details of the central catheter and date and age at insertion. Other recorded data were the indication for its insertion, total dwell days, type of removal (elective or non-elective), reason for non-elective removal and any complication developed, such as malposition, phlebitis (any sign of inflammation at the course of the vein where the catheter is inserted may be chemical, mechanical or infectious and in UVC is diagnosed based on the presence of redness at the site of insertion of UVC), leakage, local infiltrate 'any collection of fluid either superficial or deep, related to the catheter and is diagnosed in case the UVC is in the liver and there is abnormal translucency in the liver', central line-associated bloodstream infection (CLABSI), occlusion, accidental pulling, migration, pleural effusion and mortality. The length of stay in the hospital was also recorded.

Statistical analysis

The Statistical Package for Social Science software V.28 was used to analyse the data for this study. Continuous variables were presented as median (IQR) as the data were non-normally distributed. The normality of the data was checked using skewness and kurtosis measures and the histogram. Categorical data were presented as frequencies and percentages. The χ^2 was applied to compare the outcomes between PICC group and the UVC group. Binary logistic regression analysis was used to identify the OR of developing complications comparing UVC to PICC and the upper limb to the lower limb. The significance level was assigned as a p-value of less than 0.05.

Patient and public involvement

None.

RESULTS

Neonates' baseline characteristics

Table 1 presents neonates' baseline characteristics. Around 53.5% of the neonates were females. The median birth weight of the neonates was 1470 grams (1000–2215). The median insertion age of the neonates was 2.00 (1.00–8.00) days. Patient characteristic such as low birth weight was the most common reason for central catheter insertion, which accounted for 59.8%.

Table 1 Neonates' baseline characteristics

Variable	Frequency	Percentage
Gender		
Females	222	53.5%
Median birth weight (in grams) (IQR)	1470 (1000–2215)	
Median insertion age (days) (IQR)	2.00 (1.00–8.00)	
Reason for insertion		
Low birth weight	248	59.8%
GIT pathology/surgery	58	14.0%
Cardiac	16	3.9%
Other	119	28.7%
Median length of stay (days) (IQR)	43.00 (25.80–79.30)	

GIT, gastrointestinal.

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Table 2 Central catheters' baseline characteristics

Variable	Frequency	Percentage
Type of central catheter used		
Peripherally inserted central catheter	209	50.4%
Umbilical vein catheter	206	49.6%
Central catheter insertion sites		
Umbilical	206	49.6%
Lower limb	86	20.7%
Upper limb	100	24.1%
Head and neck	49	11.8%
Insertion side		
Umbilical	206	49.6%
Right	141	34.0%
Left	94	22.7%
Type of catheter		
Umbilical	207	49.9%
Polyurethane PICC	195	47.0%
Silicone PICC	9	2.2%
Other	30	7.2%
Number of lumen		
Single	402	96.9%
Multiple	39	9.4%
Median total dwell days (IQR)	11.00 (7.00–16.50)	
Insertor		
Dedicated neonatal team*	247	59.5%
Non-dedicated neonatologist*	168	40.5%
Radiologist	13	3.1%
Anaesthetist	8	1.9%
Surgeon	5	1.2%

*Dedicated team is assigned a team for central catheter insertion (neonatal intensive care unit doctors who are expert in inserting catheters and all consultants in the unit approve them for central catheter insertion). Non-dedicated persons should be encouraged to insert the catheter but under supervision from a dedicated person.
PICC, peripherally inserted central catheter.

Table 2 presents central catheters' baseline characteristics. A total of 415 catheters were involved in this study. Peripherally inserted central catheter and UVC accounted for 50.4% and 49.6%, respectively (figure 1). Single lumen catheters contributed for the vast majority (96.9%). Neonatologists (dedicated and non-dedicated) were the main insertors for the majority of the cases. The median dwell days for the catheters were 11.00 (7.00–16.50) days.

Characteristics of umbilical venous catheters compared with peripherally inserted catheters

Table 3 presents the characteristics of neonates received UVCs compared with peripherally inserted catheters.

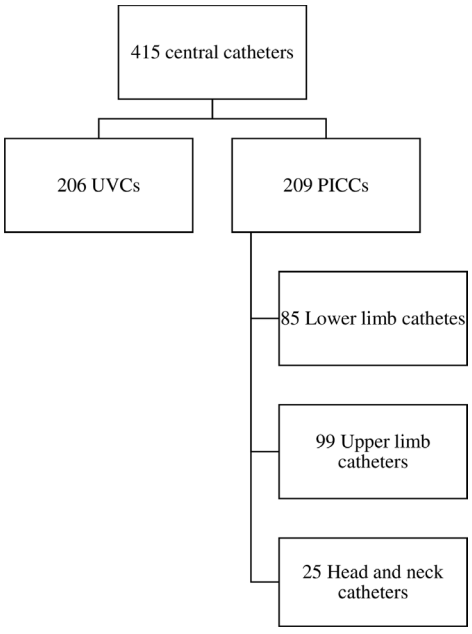

Figure 1 Flow chart for the study cohort. PICCs, peripherally inserted central catheters; UVCs, umbilical venous catheters.

There was a statistically significant difference in the median gestational age, birth weight, age of insertion, dwell days, length of stay, number of lumens, reason of insertion and insertor between neonates who received UVCs compared with peripherally inserted catheters (p<0.01).

Complications of peripherally inserted central catheter compared with umbilical venous catheter

Complications were more common across PICC cases (37.8%) compared with UVC cases (23.3%) (p value =0.001). The non-elective removal type for PICC (32.1%) and UVC (22.8%). Phlebitis, occlusion and local infiltrate were more commonly associated with PICC compared with UVC (p<0.05). However, malposition (mainly to the liver) was more commonly associated with the use of UVC compared with PICC (p value =0.002). There is no significant difference in CLABSI rate between both groups (table 4). In our practice, catheter tip migration typically occurs after the initial insertion and securement of the catheter, whereas tip malposition is the result of suboptimal positioning during the initial placement. To confirm precise tip location, we use both anteroposterior and lateral abdominal X-rays.

Characteristics of the upper limb versus lower limb peripherally inserted central catheter

Online supplemental table 1 presents the characteristics of neonates received in the upper limb versus lower limb PICC. There was a statistically significant difference in the median gestational age, dwell days, single number of lumens and assistant between neonates received in the upper limb versus lower limb PICC (p<0.05).

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Table 3 Characteristics of neonates received umbilical venous catheters compared with peripherally inserted catheters

		UVC (n=206)	PICC (n=209)	P value
The median gestational age (weeks)		32	31	0.008
Sex	Male	105 (51.0%)	100 (47.8%)	0.524
	Female	101 (49.0%)	109 (52.2%)	
The median birth weight (grams)		1480	1390	0.009
The median age of insertion (days)		1.00	6.00	<0.001
The median dwell days		8.00	15.00	<0.001
The medina length of stay (days)		34.00	54.00	<0.001
Number of lumens	Single	206 (100.0%)	188 (90.0%)	<0.001
	Multiple	0 (0.0%)	21 (10%)	
Reason of insertion	Low birth weight	128 (62.1%)	119 (56.9%)	<0.001
	Others	80 (38.8)	90 (43%)	
Assistant*		80 (38.8%)	77 (36.8%)	0.676
Insertor (dedicated neonatologist)		165 (80.1%)	79 (37.8%)	<0.001

*Assistant is a healthcare provider who is helping the insertor by holding the limb and cleaning the site of insertion.
PICC, peripherally inserted central catheter; UVC, umbilical venous catheter.

Complications of the upper limb versus lower limb peripherally inserted central catheters

Online supplemental table 2 presents the complications of the upper limb versus lower limb PICC. The study found a higher rate of CLABSI in upper limb catheters (4.6) compared with lower limb catheters (2.72); however, this difference did not reach statistical significance (p=0.63). There was no statistically significant difference in the proportion of other complications between the upper limb and the lower limb (p>0.05).

Table 4 Complications of peripherally inserted central catheters (PICCs) compared with umbilical vein catheters (UVCs)

	UVC (n=206)	PICC (n=209)	P value
Non-elective removal	47 (22.8%)	67 (32.1%)	0.035
Any complication	48 (23.3)	79 (37.8%)	0.001
Malposition	37 (18.0%)	16 (7.7%)	0.002
Migration	0 (0.0%)	4 (1.9%)	0.123
Accidental removal	1 (0.5%)	3 (1.4%)	0.623
CLABSI events	9	17	0.114
CLABSI rate in 1000.00 dwell days	5.25	4.33	0.216
Phlebitis	0 (0.0%)	6 (2.9%)	0.030
Occlusion	0 (0.0%)	8 (3.8%)	0.007
Local infiltrate	0 (0.0%)	9 (4.3)	0.004
Pleural effusion	0 (0.0%)	1 (0.5)	1
Breakage	0 (0.0%)	1 (0.5%)	1
Leakage	0 (0.0%)	13 (6.2%)	<0.001

CLABSI, central line-associated bloodstream infection.

Predictors of complications

Table 5 presents the findings of binary logistic regression analysis. The likelihood of non-elective removal was lower among users of UVC compared with PICC (OR 0.60; 95% CI 0.39 to 0.91) (p<0.05). On the other hand, the likelihood of malposition was three-fold higher among UVC users compared with PICC (OR 3.00; 95% CI 1.61 to 5.56) (p<0.001). The OR of malposition was 72% lower in the upper limb compared with the lower limb PICC (OR 0.28; 95% CI 0.11 to 0.73) (p<0.01). The likelihood of developing laboratory-confirmed bloodstream infection was higher among neonates with non-elective removal (OR 4.17; 95% CI 2.38 to 7.31), those who developed any complications (OR 5.30; 95% CI 3.00 to 9.38) and those who developed breakage (OR 4.12; 95% CI 1.44 to 11.80) (p<0.01).

DISCUSSION

Central catheters are commonly employed in NICUs, playing a crucial role in the care of premature infants and neonates with critical cardiac, respiratory and gastrointestinal diseases requiring surgical intervention by providing secure intravascular access for the administration of fluids, medications and parenteral nutrition, ensuring the safe delivery of substantial volumes and hypertonic solutions.[17–22] Therefore, this study aimed to compare the complications between UVC and PICC, determining the percentage of non-elective PICC catheter removal and its causes and assessing complications in PICC placements in the upper limb versus the lower limb.

In neonates who require long-term or complex therapy, central vascular access devices are generally regarded as more reliable and safer than peripheral devices. Central catheters offer secure and enduring access for

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Table 5 Predictors of complications comparing umbilical vein catheter (UVC) to peripherally inserted central catheter (PICC) and the upper limb to the lower limb

	OR of developing complications using UVC compared with PICC (95% CI)	OR of developing complications in the upper limb compared with lower limb (95% CI)	OR of developing laboratory-confirmed bloodstream infection (95% CI)
Non-elective removal	0.60 (0.39 to 0.91)*	0.67 (0.53 to 1.50)	4.17 (2.38 to 7.31)***
Any complication	0.69 (0.45 to 1.05)	0.83 (0.48 to 1.45)	5.30 (3.00 to 9.38)***
Malposition	3.00 (1.61 to 5.557)***	0.28 (0.11 to 0.73)**	0.48 (0.17 to 1.39)
Migration	–	–	–
Accidental removal	0.23 (0.03 to 1.94)	0.75 (0.08 to 6.80)	1.27 (0.15 to 11.07)
Phlebitis	–	2.04 (0.34 to 12.42)	2.16 (0.43 to 10.93)
Occlusion	–	0.28 (2.31 to 0.51)	–
Breakage	–	2.62 (0.78 to 8.80)	4.12 (1.44 to 11.80)**

*p<0.05; **p<0.01; ***p<0.001.

the administration of parenteral nutrition, medications and hydration. Short peripheral catheters are frequently unable to facilitate the safe infusion of hypertonic solutions and larger volumes due to a higher risk of complications, including extravasation, phlebitis and catheter dislodgment, which these devices enable. In their retrospective study, van Rens *et al* found that central vascular access was associated with superior outcomes in neonatal populations when contrasted with peripheral devices.[10] The significance of selecting the most suitable device for a patient's requirements and treatment duration is underscored by the study, which emphasises the elevated risks of complications associated with short peripheral catheters. In critically ill neonates, reliable administration of life-saving therapies is of the utmost importance, and central vascular access devices, despite the fact that they necessitate more expertise for insertion, provide a higher level of safety and stability.[10]

PICC and UVC are both considered the most common types of central catheters used in NICU.[7 23 24] Its use differs in regards to the function and the need for each type, where UVCs are often used initially to provide a quick and convenient access in neonate during their early days of life.[19 24] However, when there is a continued need for continuous intravenous therapy or total parenteral nutrition, it is advisable to replace the UVC with PICC.[7 23]

The study results found that central catheter insertion was predominantly performed in two primary sites, with the umbilical vein and saphenous vein being the most prevalent, accounting for 46.7% and 17.9%, respectively. Notably, the umbilical site was the most frequently used insertion location, representing 46.7% of the cases, where these findings are similar to other studies where the most commonly used site for insertion was the umbilical location.[25 26]

In our study, the median age for neonatal central catheter insertion was 2.00 days (with a range of 1.00–8.00 days). Median age for neonatal central catheter insertion may vary in relation to the reason, where the median age for percutaneous central venous cannulation in neonates was found to be 21.00 days[27] and a median age of 7.00 days for PICC placement in neonates with congenital cardiac disease.[28] The primary reason for insertion was low birth weight, constituting 59.8% of cases, where low birth weight infants had a high perinatal mortality rate.[29] In addition, low birth weight contributes to a range of poor health outcomes.[30] Additionally, in our study, the median dwell days for the study sample was 11.00 (7.00–16.50) days, and it was found similarly that a mean dwell day for neonates in the NICU is 8.70 days.[31] However, the increased length of stay may increase the risk of central catheter-associated bloodstream infections during the first 2 weeks after PICC insertion.[32]

Removal of central catheters may be non-elective where our study result revealed that 32.1% of PICCs were removed due to complications (non-elective removal). This was consistent with the findings of Costa *et al* who found that 39.3% of PICCs were removed non-electively.[33] However, this was different from the findings of a previous study in Qatar, which reported lower non-removal rate.[10] Previous literature reported the effectiveness of the use of an approved medical grade adhesive for catheter securement and demonstrated that it is significantly associated with lower rate therapy failures.[34] Cyanoacrylate glue was found to be safe and effective for securement of UVCs and particularly effective in decreasing early catheter dislodgments.[35]

In our study, approximately 37.8% of PICCs encountered complications, where these findings are higher than other studies findings where complications accounted for 31.7% of the catheters.[36] Malposition may lead to a serious course of events and grave consequences like extravasations and sepsis.[37] Besides, malposition found to have an increased incidence in the upper extremities with an increased risk of complications associated to it.[38] Our study results did not show difference between upper and lower limb rate of malposition and migration complications related to PICC. A meta-analysis study revealed that

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lower limb insertion did not lead to poorer outcomes compared with upper limb insertion, and in certain aspects, it was linked to even improved outcomes.[38] Meanwhile, insertion operators tend to use the upper limb, and this is due to that it easy to the operator to use the upper limb for peripheral cannulation as well as PICC.[39] On the other hand, CLABSIs have multiple risk factors with an increased incidence rate, where the number of central venous catheter lumens and place of catheter insertion were significant risk factors among neonates in a tertiary NICU.[40] Also, CLABSI in other studies was considered the most frequent healthcare-associated infection reported in NICU,[41] where multi-drug resistance coagulase-negative staphylococci cause CLABSIs in neonates with very low birth weight.[42] Therefore, understanding the microbiology and risk factors of CLABSI in neonates is crucial for developing targeted prevention strategies in NICUs,[41] and attention to the insertion and maintenance of central catheters can minimise CLABSI rates.[43]

Additionally, this study result found that complications were more common across PICC (37.8%) cases compared with UVC (23.3%) cases. This was comparable to a previous study by van Rens *et al* who reported that for patients who received a peripheral catheter, the complication rate was significantly higher when compared with infants receiving a CVAD (407.00/1000.00 and 13.00/1000.00 catheter days, respectively).[10] Besides, the incidence rate of peripheral line-associated bloodstream infection was 1.19/1000.00 catheter days observed for all peripheral intravenous access devices (Peripheral Intravenous Catheter (PIVC) and Emergency Department Peripheral Intravenous Catheter (ED-PIVC)), whereas a CLABSI incidence rate of 0.34/1000.00 catheter days was observed after CVAD insertion (p<0.001).

Similarly, PICC catheters have been found to have a greater number of complications and are statistically significant when compared with UVCs.[44] While our study findings reveal that the removal type for the majority of PICC (67.9%) and UVC (77.2%) was elective type, the non-elective type of removal comes with complications that affect neonatal well-being, where phlebitis, occlusion and local infiltrate were reasons more commonly associated with PICC compared with UVC. It was found that phlebitis incidence is more related to PICC than to UVC,[45] and factors such as site selection and maintenance measures play a vital role in preventing phlebitis and infection associated with PICC use in premature and low birth weight infants.[46] However, in our study, malposition (mainly to the liver) was more commonly associated with the use of UVC compared with PICC. In fact, while UVC is a common procedure for intravenous access in NICU and associated with major complications,[47] the non-elective removal type of UVCs is the malposition of UVCs, and it was found to have a significant complication including hepatic lesions and suboptimal positioning.[48]

A previous study by Bayoumi *et al* assessed the effectiveness of implementing an ECC team in NICU and found that it is a promising intervention to increase success rates and significantly decrease catheter-related complications in NICU.[49] Besides, it emphasised on standardising catheter maintenance in order to improve CLABSI rates.[49] Another initiative that demonstrated its effectiveness is the application of neonatal simulation programme which proved its effectiveness in protecting neonates from potential harm and improving the overall neonatal outcome including insertion success rate and mean duration of insertion.[50]

The results of this study underlined some of the modifiable factors that can enhance the outcomes of neonatal central venous catheter (CVC) insertions, mainly regarding the reduction of complications and optimisation of care. One of the important features is the use of Point of Care Ultrasound (POCUS) and intracavitary ECG for real-time tip navigation and placement verification. According to Natile *et al*, these technologies enhance CVC placement precision through the capability for real-time visualisation that would result in reduced risks of malposition, especially in neonates, where liver malposition might occur in UVCs due to improper placement and may lead to serious complications.[51] The integration of such tools in routine practice could significantly reduce the occurrence rates of malposition and related complications. Another modifiable factor is the use of cyanoacrylate glue for catheter securement. Van Rens *et al* also noted that cyanoacrylate glue reduces dislodgement and increases the stability of the catheter.[52] This prevents complications such as phlebitis and occlusion of peripheral intravenous catheters. In neonates, this may reduce the number of replacements required and thus reduce overall infection rates.[52] Another advancement in improving outcomes has been the development of dedicated vascular access teams. Bayoumi *et al* indicated that an ECC team instituted in a NICU was associated with the advancement of catheter care and a reduction in complications.[49] This is explained to mean that well-trained vascular access teams in neonatal catheter placement and maintenance can give the necessary expertise needed in reducing mechanical complications while ensuring that optimum care is accorded to the catheters.[49] Taken together, all these modifiable factors—POCUS, intracavitary ECG, cyanoacrylate glue and vascular access teams—represent the key areas for improvement regarding catheter care and decreasing complications in neonates. These interventions can significantly impact healthcare providers' ability to improve short- and long-term outcomes for neonates requiring central venous access.[49 51 52]

Based on the study findings, it is recommended that healthcare professionals in NICUs carefully assess the specific needs of each infant when choosing between PICC and UVC for central catheter insertion. Additionally, careful consideration should be given to the selection of insertion sites, with a focus on reducing complications and infection risk. And to minimise complications, particularly in the case of non-elective removal, healthcare providers should prioritise proper central catheter positioning and infection control measures.

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Implications for practice

This study outlines various suboptimal practices regarding CVC insertion among neonates that demand attention. First, complications were significantly higher in PICC compared with UVC, notably phlebitis, occlusion and local infiltrate, suggesting potential problems with the conditions of insertion and maintenance. This will require advanced training in insertion techniques and post-insertion care for neonatologists, along with a dedicated PICC team to ensure higher levels of competence. It was associated with an increased risk of infection of the bloodstream—likely related to a lack of structured protocols concerning removal of the catheter. Standardised protocols for the timely and elective removal of catheters serve to minimise infection risk. Malposition, particularly migration to the liver, was more frequent with the UVC, indicating poor confirmation of appropriate positioning. The verification of precise catheter placement should be coupled with routine imaging. Checklists related to post-insertion surveillance should also be developed. The significant differences in gestational age, birth weight and dwell days among the groups reflected the fragility of premature neonates and the prolonged use of the catheters. Wherever possible, the type of catheter and insertion site should be individualised based on clinical condition, with dwell times minimised. Further, complications were fewer for the upper limb PICC insertions compared with those of the lower limbs, indicating also that the site of insertion adds to catheter-related complications. Guidelines on upper limb insertion sites where appropriate and criteria for the best site selection may mitigate such risks. Lastly, the high phlebitis rate, occlusion and local infiltrate point towards vascular trauma with long dwell times in PICCs or poor technique. Therefore, monitoring for early signs of phlebitis and occlusion should be enhanced to prevent further complications.

This study has limitations. This is a single-centre study, which might have affected the generalisability of our study findings as other institutions might have different clinical practices. Besides, the use of cross-sectional study design restricted the ability to examine causality among the study variables. Therefore, this type of studies has limited ability to examine cause-and-effect relationships among the study variables. Longitudinal study designs (such as cohort studies) are recommended to address this point in order to assess changes over time. Excluding neonates with no follow-up might lead to selection bias as they might have different outcomes profile.

CONCLUSION

Our study showed that complications and non-elective removal were less in UVCs compared with PICCs; however, the rate of malposition (mainly to the liver) in UVCs was higher. There is no significant difference between the upper limb and lower limb PICCs in terms of non-elective removal and complications; however, the implementation of rigorous surveillance for prolonged periods of residence is of utmost importance. The results of our study emphasise the significance of increasing awareness regarding risk factors associated with CLABSI and adhering to optimal practices for the maintenance of central catheters. Healthcare providers should exercise vigilance in recognising and addressing the variations in complication rates associated with PICC and UVC, adapting their strategies accordingly. Moreover, optimised catheter selection, insertion site and management practices are all necessary to help reduce risks and thus improve neonatal outcomes.

Contributors AE, HAA, IP, AIA, AAA and HA-S made a significant contribution to the work reported, whether that is in the conception; study design; execution; acquisition of data; analysis and interpretation; and drafting, revising or critically reviewing the article, and gave the final approval of the version to be published. AE and HA supervised this research. All researchers have agreed on the journal to which the article has been submitted and agreed to be accountable for all aspects of the work. HA-S is responsible for the overall content as guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants and was approved by the Institutional Review Board (IRB) at Prince Sultan Military Medical City, Riyadh, Saudi Arabia (IRB approval number 1623). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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