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Letter to Editor

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Evaluation of Complications and Duration of Central Venous Catheters in Pediatrics

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Dear Editor,

Central venous catheters (CVCs) are essential in pediatric care, especially for neonates and critically ill children, providing reliable access for medications, parenteral nutrition, and monitoring [1,2]. They play a critical role when peripheral veins are inaccessible or when prolonged therapy is required, particularly in neonatal intensive care settings [3–5]. CVCs are commonly inserted via the internal jugular, subclavian, or femoral veins, with site selection based on age, size, and clinical condition. Ultrasound guidance improves success and reduces complications for jugular and subclavian access, whereas femoral access may require surgical exploration [6,7]. Insertion technique, operator experience, and catheter-to-vessel ratio are key determinants of both procedural success and post-insertion complications [8–10].

The use of CVCs, however, is not without risk. Immediate and delayed complications, including mechanical issues (hematoma, pneumothorax, hemothorax), thrombotic events (deep vein thrombosis, venous thrombosis), and catheter-related bloodstream infections, can result in significant morbidity and mortality [8,11]. The prevalence of CVC-related complications varies widely depending on patient characteristics, catheter type, insertion site, and clinical setting. Studies report thrombotic complications in neonates ranging from 0.7% to 67% [12,13]. Such broad variation reflects heterogeneity in patient populations, catheter types, and infection control measures, rather than true epidemiological differences. Most data come from high-income settings with well-established insertion bundles, limiting their applicability to low- and middle-income regions.

In Iran, particularly in northern provinces, such as Guilan, several contextual challenges may influence CVC outcomes, including limited ultrasound-guided access, variable aseptic techniques, and differing levels of staff training. The absence of regional evidence restricts efforts to tailor preventive protocols or evaluate current practices. Additionally, most local studies have focused on adults or short-term mechanical issues, overlooking pediatric-specific factors, such as catheter size relative to vessel diameter, duration of catheterization, and insertion site selection, all of which may influence thrombosis or infection risk [14–16].

Addressing these evidence gaps is crucial for developing context-sensitive guidelines and improving patient outcomes. Therefore, this study was initiated following our preliminary observations suggesting an unexpectedly low rate of CVC-related complications among pediatric patients at 17-Shahrivar Hospital in Rasht, Iran. To verify these initial findings, a descriptive analysis was conducted to determine the true epidemiology, insertion characteristics, and determinants of CVC outcomes

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in this population. Confirmation of these patterns would provide a foundation for future interventional research aimed at identifying the factors contributing to the low complication rates and optimizing catheter care protocols in our setting.

This cross-sectional study was conducted on 41 children (0 month < age ≤ 144 months) with CVCs who were admitted to 17-Shahrivar Hospital in Rasht, Iran, between 2016 and 2020. This study has been confirmed by the Ethics Committee of the Guilan University of the Medical Sciences, Rasht, Iran (IR.GUMS.REC.1400.347). All methods were carried out following relevant guidelines and regulations, such as the Declaration of Helsinki.

The participants were selected using a consecutive sampling method. Pediatrics with major congenital anomalies, severe sepsis, coagulation disorders, hepatic or renal failure, or other systemic conditions likely to affect catheter outcomes were excluded. Routine use of medications, such as antibiotics, inotropes, or parenteral nutrition, was not considered an exclusion criterion. The sample size was estimated using Cochran's formula [$n = \frac{z^2_{1-\frac{\alpha}{2}}\ p(1-p)}{d^2}$] to provide a preliminary institutional estimate of CVC-related complications. Based on a prevalence (p) of 33.3% reported by Torkman et al. [17] and a margin of error (d) of 0.09 at a 95% confidence level, the calculated minimum sample size was 40 participants. Given the limited number of pediatric patients with CVCs during the study period, a census of all eligible cases was conducted

Data were collected through a review of patient medical records. Recorded variables included catheter insertion site, age and weight of the pediatric patient, duration of catheter use, and catheter patency (defined as the period during which the catheter remained functional). Complications associated with central venous catheterization were assessed, including venous thrombosis and deep vein thrombosis (DVT; confirmed by Doppler ultrasonography if limb swelling was observed), hematoma (significant bleeding at the insertion site during or after the procedure), catheter-related infection (confirmed by local signs of infection, such as discharge or cellulitis, or unexplained fever with positive catheter blood cultures), pneumothorax, and hemothorax.

All catheter insertions were performed by a qualified general surgeon experienced in pediatric central venous access. Catheterization of the internal jugular and subclavian veins was performed under real-time ultrasound guidance to improve accuracy and minimize mechanical complications, such as arterial puncture or hematoma formation. Ultrasound guidance allowed precise visualization of vessel size, depth, and patency before needle insertion, which is particularly critical in neonates with small or fragile veins. Catheter sizes of 14–16 French were used for these veins, balancing adequate vascular access with the minimization of vessel trauma and thrombosis.

For femoral vein catheterization, an open surgical exploration technique was employed due to anatomical considerations and limited accessibility of the upper body veins, either because of the neonate's low weight or unsuccessful attempts at jugular or subclavian access. This approach involved direct visualization of the femoral vein to facilitate safe catheter placement, using 22-gauge arterial line catheters.

Both jugular/subclavian and femoral procedures were performed using the "over-the-wire" technique, which involves initial venous puncture with a guidewire followed by sequential dilation and catheter insertion over the wire. This method reduces insertion-related complications and ensures correct catheter positioning. All procedures were performed under local anesthesia, ensuring patient comfort while avoiding the risks associated with general anesthesia in pediatrics. Meticulous aseptic technique was maintained throughout, including skin antisepsis, sterile draping, and use of sterile gloves and instruments, to minimize the risk of catheter-related infections.

The study included 41 pediatric patients with central venous catheters, of whom 29 (70.7%) were males. The age distribution of the study participants showed that 9 (22.0%) patients were aged ≤ 1 month with a mean age of 0.20 ± 0.32 months, 13 (31.7%) patients were between 1 and 12 months old with a mean age of 2.94 ± 1.60 months, 5 (12.2%) patients were between 12 and 60 months old with a mean age of 19.80 ± 5.07 months, and 14 (34.1%) patients were older than 60 months with a mean age of 132.00 ± 20.78 months. The mean weight varied across age categories, with infants aged ≤ 1 month weighing 3.08 ± 0.97 kg, those between 1 and 12 months weighing 4.56 ± 3.54 kg, children between 12 and 60 months weighing 9.76 ± 2.29 kg, and children older than 60 months weighing 18.58 ± 13.36 kg. The most common catheter insertion site was the right femoral vein in 19 (46.3%) patients, followed by the right jugular vein in 13 (31.7%) patients, left femoral vein in 5 (12.2%) patients, left jugular vein in 3 (7.3%) patients, and right

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subclavian vein in 1 (2.4%) patient (Table 1).

Table 1. Catheter duration by gender and site in 40 pediatric patients with central venous catheters.

Variable	Category	N (%)
Gender	Male	29 (70.7)
	Female	12 (29.3)
Age	≤ 1 month	9 (22.0)
	1 < age ≤ 12 months	13 (31.7)
	12 < age ≤ 60 months	5 (12.2)
	60 months <	14 (34.1)
Weight	< 4.5 kg	23 (56.1)
	≥ 4.5 kg	18 (43.9)
Ctheter duration (days)	<10	19 (46.3)
	≥10	22 (53.7)
Cathetersite	Right femoral	19 (46.3)
	Right jugular	13 (31.7)
	Left femoral	5 (12.2)
	Left jugular	3 (7.3)
	Right subclavian	1 (2.4)

Deep vein thrombosis (DVT); Number (n); Not applicable (NA).
$p < 0.05$ as considered a significant level

The mean duration of catheter placement was 11.9 ± 10.9 days for males and 8.8 ± 6.3 days for females. Across age groups, the mean catheter duration was 10.4 ± 6.5 days for infants ≤ 1 month, 9.5 ± 4.3 days for those between 1 and 12 months, 9.0 ± 3.2 days for children between 12 and 60 months, and 10.4 ± 5.8 days for children older than 60 months. Pediatric patients weighing less than 4.5 kg had a mean catheter duration of 9.4 ± 5.1 days, while those weighing 4.5 kg or more had a mean duration of 12.2 ± 12.4 days. Regarding catheter sites, the left jugular site had the longest mean duration of 23.0 ± 24.7 days, followed by the right subclavian at 17.0 days (single case), right jugular at 9.8 ± 6.3 days, right femoral at 9.4 ± 5.6 days, and left femoral at 7.5 ± 5.7 days (Table 2).

The frequency of catheter-related complications, such as thrombosis, DVT, hematoma, infection, pneumothorax, and hemothorax, was zero. Only two cases of local swelling at the catheter site were documented; however, ultrasound examination ruled out DVT in both cases.

Table 2. Catheter duration by sex and site in 40 pediatric patients with central venous catheters.

Variable		Mean ± SD	Median	Min - max	IQR
Gender	Female	8.8 ± 6.3	7.0	3-26	5.0
	Male	11.9 ± 10.9	10.0	1-60	7.0
Age	≤ 1 month	10.4 ± 6.5	14.0	2-20	11.0
	1 < age ≤ 12 months	9.5 ± 4.3	10.0	1-18	5.0
	12 < age ≤ 60 months	9.0 ± 3.2	10.0	5-12	6.0
	>60 months	10.4 ± 5.8	10.0	1-26	7.8
Weight	<4.5 kg	9.4 ± 5.1	10.0	1-20	7.5
	≥4.5 kg	12.2 ± 12.4	10.0	1-60	8.0
Site	Left femoral	7.5 ± 5.7	6.5	2-15	4.0
	Left jugular	23.0 ± 24.7	11.0	10-60	25.0
	Right femoral	9.4 ± 5.6	10.0	1-20	1.0
	Right jugular	9.8 ± 6.3	8.5	1-26	4.5
	Right subclavian	17.0 ± 0.0	17.0	17-17	0.0

$p < 0.05$ as considered as a significant level. Standard deviation (SD); Min (Minimum); Max (Maximum); Interquartile Range (IQR).

In this study, boys comprised the majority of participants, which aligns with previous studies demonstrating male predominance in NICU admissions and interventions. This pattern may reflect sex-related differences in pediatric morbidity and increased vulnerability to critical illnesses among male infants [19,20]. However, evidence on sex differences in catheter duration and complications remains limited, and our findings suggest that while catheter duration tended to be longer in males, this difference was not statistically significant, aligning with prior reports indicating that sex alone does not significantly influence catheter-related outcomes [21,22].

Age and weight are important factors considered when planning vascular access in pediatrics. Our findings illustrated that most pediatric children were aged ≤ 12 months and 60 months, and weighed < 4.5

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kg. A study by Wu et al. [23] found that lower gestational age and birth weight were associated with increased risk of hepatic complications following UVC use. Previous studies reported that catheter dwell time does not depend solely on neonatal age or body weight; rather, careful technique and monitoring, rather than patient size, may be more critical determinants of catheter longevity [24–26]. Importantly, the predominance of older and heavier infants in our study may have biased the observed complication rates downward, since these infants have more mature immune systems, larger vessels, and lower vulnerability compared to preterm pediatric children, a population heavily represented in previous studies reporting high complication rates. This difference in population structure is a key source of potential outcome misclassification when comparing our findings to the other studies.

We observed no major catheter-related complications, including infection, thrombosis, hematoma, pneumothorax, or hemothorax, and only two cases of minor local swelling were documented, which were not associated with deep vein thrombosis. A study by Torkaman et al. reported a 33.3% incidence of CVC-related infection in neonates, with significant associations among infection, catheter duration, and low birth weight, and noted that sepsis and hemothorax contributed to catheter-related mortality [17]. Another study by Liu et al. on central- and peripheral-line-associated bloodstream infections in 581 Victorian neonatal intensive care units reported that infections were most common in neonates ≤750 g [27].

The small sample size in this study may likely contribute to the markedly lower complication rate observed in this study. The absence of infection in the current study may reflect shorter catheter durations, strict adherence to aseptic insertion and maintenance protocols, and careful patient monitoring. More recently, Gibson et al. [28] demonstrated that prolonged indwelling time remained a significant risk factor for complications associated with umbilical vascular catheters. In contrast, despite relatively long dwell times (with 60% of catheters remaining in place ≥10 days), our findings demonstrated no infections. This discrepancy may be partially explained by differences in catheter type, insertion site distribution, and institutional practice patterns.

Another study by Hojsak et al. illustrated that in a 21-year cohort study of pediatric patients receiving prolonged parenteral nutrition, there were 36 episodes of catheter-related sepsis and 11 catheter removals due to infection, despite rigorous hospital protocols. They observed a significantly lower incidence of sepsis in patients receiving parenteral nutrition at home [29], highlighting the role of controlled care practices and environmental factors in infection prevention. The mean duration of catheterization in our study was longer than previously reported ones [23,30]. Buttera et al. described median dwell times of only four to five days following efforts to minimize umbilical venous catheters (UVCs) use [30], while Wu et al. [23] reported a median of around eight days.

In the current study, a mean of approximately 11 days suggests that prolonged catheter use can be achieved safely under well-controlled conditions. However, when comparing vein-specific outcomes, our results differ from those of Yang et al. [31], who found cubital and axillary veins to have longer dwell times. This may reflect differences in population age, catheter type, or institutional expertise, underscoring the importance of contextualizing findings rather than assuming universal applicability. A study by Mashhadi et al. reported that in 18 neonates with prior internal jugular catheterization, Doppler ultrasound 29 months later showed significant rates of stenosis and occlusion [32]. Because we did not perform routine post-removal ultrasonography, subclinical thrombosis or delayed complications may have been missed, further contributing to potential outcome ascertainment bias.

While other studies highlight the risks of infection and thrombosis with prolonged catheter use [11,33], our results demonstrated none. Evidence emphasized that staff training, sterile technique, and standardized catheter care bundles are strongly associated with lower complication rates [34,35]. In this study, while two cases of swelling were evaluated with ultrasound, routine imaging was not used for all patients, which raises the possibility that some subclinical complications could have gone undetected. Thus, both under-ascertainment of outcomes and the inclusion of infants and older pediatrics beyond the strict neonatal period should be considered when interpreting our unexpectedly low complication rates

As a limitation of this study, a single-center design and retrospective cross-sectional nature warrant caution in generalizing our findings. Although we found no complications related to CVC, this cannot be generalized due to the small

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sample size. Future studies should differentiate strictly between age groups in pediatrics to minimize population misclassification and should incorporate systematic imaging-based surveillance to reduce outcome ascertainment bias. Larger, multicenter studies with systematic complication surveillance are needed to better define the safety profile of longer catheter dwell times and evaluate how insertion site, patient characteristics, and catheter care practices interact to influence outcomes.

Our findings demonstrated that the right femoral vein was the most frequently used site for CVC insertion, followed by the right jugular vein. Importantly, no major catheter-related complications were observed, apart from two cases of local swelling without evidence of DVT. However, future studies with a larger sample size are required to confirm the safety of using CVC in pediatric patients.

Conflict of Interest

The authors declare that they have no competing interests.

Declaration of Generative Artificial Intelligence in Scientific Writing

We used AI's tools to improve the manuscript's language and grammar.

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