Original research article

JVA The Journal of Vascular Access

Long peripheral catheters in neonates: filling the gap between short peripheral catheters and epicutaneous-caval catheters?

The Journal of Vascular Access
1–6

DOI: 10.1177/11297298211057377
journals.sagepub.com/home/jva
SAGE

Maria Grazia Romitti*, Carmen Rodriguez Perez*, Elena Pezzotti, Mario Motta and Francesco Maria Risso

Abstract

Introduction: Non-critically ill neonates at times require venous access to provide peripherally compatible infusions for a limited period (more than 3 days). In such a situation, short peripheral cannulas are not appropriate as their average duration is about 2 days, while—on the other hand—epicutaneous-caval catheters may be too invasive. In these patients, insertion of long peripheral cannulas may be an effective option.

Methods: In this observational retrospective study, we revised all "long" peripheral catheters (4 and 6 cm long) inserted by direct Seldinger technique in our neonatal intensive care unit when peripheral venous access was required for more than 3 days.

Results: We inserted 52 2Fr polyurethane catheters, either 4 cm long ($n = 25$) or 6 cm long ($n = 27$) in 52 patients. Mean dwelling time was 4.17 days (range 1–12). Most devices were inserted in the cephalic vein ($n = 18$, 35%), and the rest in the saphenous vein ($n = 11$, 21%) and other superficial veins. There was no significant correlation between the duration of the device and type of infusion ($p = 0.40$). The main complications were infiltration ($n = 16$, 31%) and phlebitis ($n = 8$, 15%). The rate of removal due to complications was significantly higher ($p < 0.01$) in neonates with bodyweight <2000 g at the time of insertion.

Conclusion: In our experience, 2 Fr 4–6 cm long peripheral catheters may be a valid option for neonates requiring peripherally compatible infusions for more than 3 days. The limits of this study are the necessity of training in the technique of insertion and the small size of our sample. The longest dwell was observed in neonates weighing >2000 g at the time of LPC insertion.

Keywords

Peripheral venous access, long peripheral catheter, direct Seldinger, neonate

Date received: 3 June 2021; accepted: 6 October 2021

Introduction

In every setting, clinicians should always consider selecting the most appropriate vascular access device for each patient, focusing on safety, efficacy, and cost-effectiveness. This is particularly true in the Neonatal Intensive Care Unit (NICU), as neonates are physiologically delicate and non-collaborative patients with small and fragile veins.

In our NICU, we have adopted the DAV-Expert algorithm,[1] proposed by the Italian Group of Venous Access Devices (GAVeCeLT). It is a flexible and practical instrument that provides explicit suggestions for choosing the most appropriate venous access device for each specific

Neonatal Intensive Care Unit, Children's Hospital, ASST Spedali Civili di Brescia, Brescia, Italy

*These authors have contributed equally to this work.

Corresponding author:
Maria Grazia Romitti, Neonatal Intensive Care Unit, Children's Hospital, ASST Spedali Civili di Brescia, Piazzale Spedali Civili, n. 1, Brescia, Lombardia 25123, Italy.
Email: mg.romitti8@gmail.com

clinical situation. Utilizing this instrument, though we realized that when considering the most appropriate venous access device to be placed for a non-critically ill neonate requiring infusions compatible with peripheral access for more than 3 days, there was a gap between the indication for a short peripheral cannula (SPC)—typically lasting less than 48 h in neonates[2]—and the only alternative option, the epicutaneous-caval catheter (ECC). ECCs are central venous devices, quite invasive, suitable for high osmolarity infusion of solutions not compatible with the peripheral route. Between these two devices, there is no middle option, that is nothing covering the clinical situation of a stable neonate requiring peripheral venous access for more than 3 days. This is not an infrequent situation, as many neonates may be non-critical but still in need of intravenous support: they may not tolerate enteral feeding, or they may have unstable blood glycemic levels, or even require fluids, antibiotics, and/or other intravenous drugs. As these patients are not fully eligible for central access, they are often candidates to many repeated procedures for SPC insertion, procedures that are painful for the neonate and stressful for the clinician. This study is about our experience in trying to find an alternative option/device to fill the existing gap between the SPC and the ECC for non-critical neonates requiring peripheral venous access for more than 3 glycemic days.

Materials and methods

We considered the duration of long peripheral catheters (LPCs) in a population of non-critical neonates as well as their performances, complications, and reasons for removal. Data collections represent our 1-year experience with LPCs (January–December 2019). We utilized 2 Fr polyurethane catheters (Leaderflex®, Vygon), available in two lengths, 4 and 6 cm, to be inserted by Seldinger technique (catheter-over-guidewire) in superficial veins. Before starting the actual positioning of devices, we organized some theoretical training sessions for all the NICU staff to understand and learn the direct Seldinger technique, which had never been used before in our unit. Three vascular access team professionals (one nurse and two neonatologists) began at first to position the LPCs and, subsequently started to train other colleagues. We reviewed the following data: gestational age and birthweight and at the time of positioning, diagnosis of admittance to NICU, selected vein for placing the device, type of infusion, catheter-related complications, duration of the device, and reason for the removal (Tables 1 and 2).

All LPCs were inserted in neonates requiring peripheral venous access for a time estimated longer than 3 days. Before insertion, the venous patrimony of the neonate was systematically evaluated following the RaSuVA protocol (Rapid Superficial Vein Assessment) proposed by GAVeCeLT[3] to select the most appropriate insertion site. The length of the device (4 or 6 cm) was chosen based on the measurements taken before the insertion, so to make sure that the tip would still be located inside the veins of the limbs. Ultrasound guidance and near-infrared guidance were never adopted. No clinician was allowed to more than two attempts of venipuncture, to avoid exploitation of the venous patrimony of the neonate. A strict protocol of insertion and maintenance was scheduled and followed,[4] including hand hygiene, surgical aseptic non-touch technique, maximum sterile barriers, skin antisepsis with 2% chlorhexidine in 70% isopropyl alcohol using single-dose single-use applicators, sealing off the exit site with cyanoacrylate glue, securement of the catheter by a skin-adhesive sutureless device (GripLok®), coverage of the exit site with a polyurethane transparent semipermeable membrane. We applied for the LPCs the same bundle in use in our unit for the placement and management of the ECC. A surveillance record was filed for each patient, to monitor the management of the device.

Descriptive statistics tools (percentages and means) were utilized to describe the patient's population, main diagnosis, selected vein, type of infusion, the reason for

Table 1. Patients' and device characteristic.

	Nr (%)	
Total patients/devices	52	
Bodyweight at time of insertion:		
Under 2000 g	14 (27)	
Over 2000 g	38 (73)	
Main diagnosis		
Prematurity	16 (31)	
Respiratory distress	13 (25)	
Infections	9 (17)	
Malformations	6 (12)	
Bronchiolitis	3 (6)	
Surgical conditions	3 (6)	
Hematology	2 (4)	
Vein selected for cannulation:		
Cephalic vein	18 (35)	
Saphenous vein	11 (21)	
Antecubital vein	9 (17)	
Basilic vein	8 (15)	
Dorsal vein of the hand	5 (10)	
Popliteal vein	1 (2)	
Length of the device		
4 cm	25 (48)	
6 cm	27 (52)	
Type of infusion		
Antibiotics and glucose solutions	35 (67)	6 only antibiotics
Glucose solutions	13 (25)	
Other medications	4 (8)	
Life span of the device		
1–3 days	14 (27)	
4–7 days	34 (65)	
8–12 days	4 (8)	

Table 2. Showing the comparison between the reason for removal and mean dwell time in neonates weighing less or more than 2 kg at the time of insertion.

Reason for removal	Weight at insertion <2 kg Tot 14	%	Weight at insertion >2 kg Tot 38	%
Election/end of treatment	0	0	10	26.4
Phlebitis	3	21.4	5	13.2
Infiltration	9	64.4	9	23.6
Accidental removal	2	14.2	6	15.8
Other (transfer of patient, unknown)	0	0	8	21
Mean duration (days)	4.42		5.21	

the removal (Tables 1 and 2). Statistical analysis was performed using the χ^2 test for categorical variables and analysis of variance (ANOVA) for non-normally distributed continuous variables. The effect of weight and gestational age on the duration of the device was evaluated by correlation-regression analysis. The χ^2 test was used to assess the relationship between the indwelling time of the device, type of infusion, weight, gestational age, and reason for removal. Kruskal-Wallis ANOVA was performed to value the duration of the device comparing different types of infusion, gestational age, and weight confronted to the reason for the removal (complications or election). A p-value <0.05 was regarded as significant.

Results

We inserted 52 LPCs in 52 patients either 6 cm long ($n=27$) or 4 cm long ($n=25$). The weight of patients at the time of insertion varied from 1158 to 4259 g. Most neonates involved weighed more than 2000 g ($n=38$, 73%); neonates under 2000 g were a minority ($n=14$, 27%). The success of insertion was 100%. The most frequently cannulated vein was the cephalic vein ($n=18$, 35%), followed by the saphenous vein ($n=11$, 21%). The cephalic vein, being safely sited far from the brachial artery, turned out to be the preferred vein for LPC insertion; in contrast, placement of ECC in this vein is often unsuccessful because of the sharp angle when the cephalic merges into the axillary vein. Mean dwelling time for all devices placed was 4.17 days (range 1–12) and it was not significantly affected by the type of infusion ($p=0.4$). The most frequent complications for all neonates were infiltration ($n=16$, 31%) followed by phlebitis ($n=8$, 15%). Analyzing our data, we realized that the only statistically significant record was the comparison between the weight at the time of insertion and the reason for the removal. The rate of removal because of complication was significantly higher in neonates with bodyweight <2000 g at the time of insertion ($p<0.01$) while elective removal was in favor of neonates weighing more than 2000 g. All devices placed in patients weighing less than 2 kg were removed due to complications, although these patients were the minority group. We found no difference in the two weight groups regarding the length of the device utilized (4 or 6 cm) compared to the reason for removal.

Discussion

Vascular access in neonates is always challenging; it requires a careful evaluation of the available veins and the proactive choice of the safest and most effective device in each clinical situation. In other words, the clinician must choose the device potentially associated with minimal risk of complications, minimal pain, and maximal clinical outcome. Pain and stress are serious issues in neonates, especially for preterm babies since their neurobehavioral development can be easily affected by traumatic experiences.[5] Neonates who are out of critical conditions but still needing intravenous support are particularly exposed to repeated insertions of SPC since these devices have an average duration of 2 days.[2] The LPCs could be an alternative option in this regard. Further elaborating the concepts of the DAV-Expert and after considering the results of our study, we modified and developed two practice-oriented flowcharts for selecting venous access at birth (Figure 1), and after birth (Figure 2) in our NICU. In both flowcharts, we differentiate between unstable and stable neonates, but we also consider other important variables such as body weight, gestational age, as well as the type and approximate duration of intravenous treatment. We tried to close the gap between SCP and ECC by including in our flowchart a new option, the long peripheral venous catheters. Long peripheral catheters (LPC) are widely used in adults and children.[6–11] Searching in the standard databases (Medline, Embase, Emcare), we found only one study about LPC in neonates, written by Chenoweth at al.[12] In this study, the focus was more on the comparison of the performances and costs between LPCs and ECCs (the first is peripheral access while the second is central); furthermore, the LPCs were inserted only at the end of the treatment course after exhausting multiple SPC, not as "first" choice. These authors had used a 6 or 8 cm silicone catheter that they have called "extended peripheral intravenous catheter" (EPIV). The nomenclature of these devices have been quite confusing. In a recent editorial, Qin et al.[13] tried to achieve some level of standardization defining long

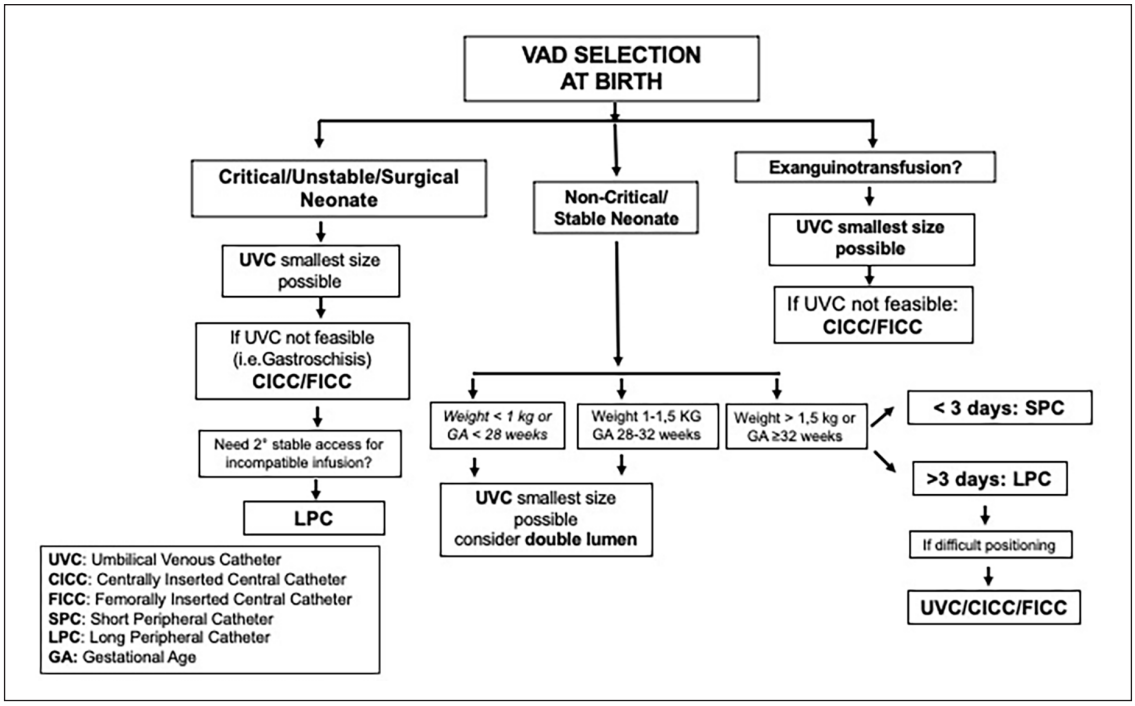

Figure 1. New flowchart of vascular access device (VAD) selection at birth in our NICU.

peripheral catheters as devices long more than 6 and less than 15 cm long, while short peripheral catheters (SPC) are <6 cm, and midline catheters >15 cm. Such definitions and classification can hardly be applied to neonates. We suggest the use of a specific term more suitable for neonates, "nLPC" (neonatal Long Peripheral Catheters), which may include peripheral venous access devices long from 4 to 6 cm.

In our analysis, the mean dwelling time for all nLPCs was more than 4 days with the majority of the devices (65%) lasting from 4 to 7 days. Considering though the dwell time separately in the two-weight group; under 2 kg and above 2 kg, the mean dwell time is greater for the second group, 5,2 days (Table 2). Further training and expertise could improve this outcome, considering that this was our first experience with the Seldinger technique. The rate of complications we detected was not negligible, but not dissimilar from the rates commonly reported in the literature with neonatal peripheral cannulations.[14] The use of ultrasound could improve the success of the procedure. Barone et al.[15] proved that it is feasible and recommended prior specific training, to measure the diameter of the neonatal veins before the selection and positioning of any venous catheter device to reduce the risk of complications. The group of neonates weighing less than 2 kg in our analysis most probably did not have an appropriate "vein to catheter ratio" for positioning a 2 Fr catheter which could explain the higher rate of complications. The complications associated with nLPC insertions, are usually less clinically relevant compared to those potentially associated with ECC placement; the careful monitoring of all nLPC placed was effective in preventing any damage to the vessels and/or to the skin of neonates. Even though we were hoping and expecting to achieve a longer dwell time when placing nLPCs, it is noteworthy to underline two aspects: the first is the 100% success at the first attempt and the second is that, for a minimum of 4 days, the majority of the devices placed (almost three quarters) were fully functioning and no other attempts were made to replace it. From our viewpoint, this could be regarded as relevant progress considering the pain and stress caused to the neonates by multiple attempts to replace venous access, as well as the time, the efforts, and—even more—the frustration of the staff, the waste of materials, and the interruption of treatments in case of failure.

We discovered another potential useful indication for the insertion of nLPCs; as an additional peripheral venous access in critically ill neonates who already have a central line in place (ECC or a centrally inserted central catheter) but require a continuous or intermittent infusion of different incompatible drugs.

In our experience, nLPCs could be a promising device particularly for neonates weighing over 2000 g requiring peripheral access for more than 3 days. The best peripheral venous access device for neonates under 2000 g requiring intravenous treatment for more than 3 days is yet to be defined. SPCs are not suitable, and—in our experience—nLPCs have a higher rate of complications in this population (Table 2).

Limitations of our study are the following: (a) our sample size is small; (b) our training in the Seldinger technique

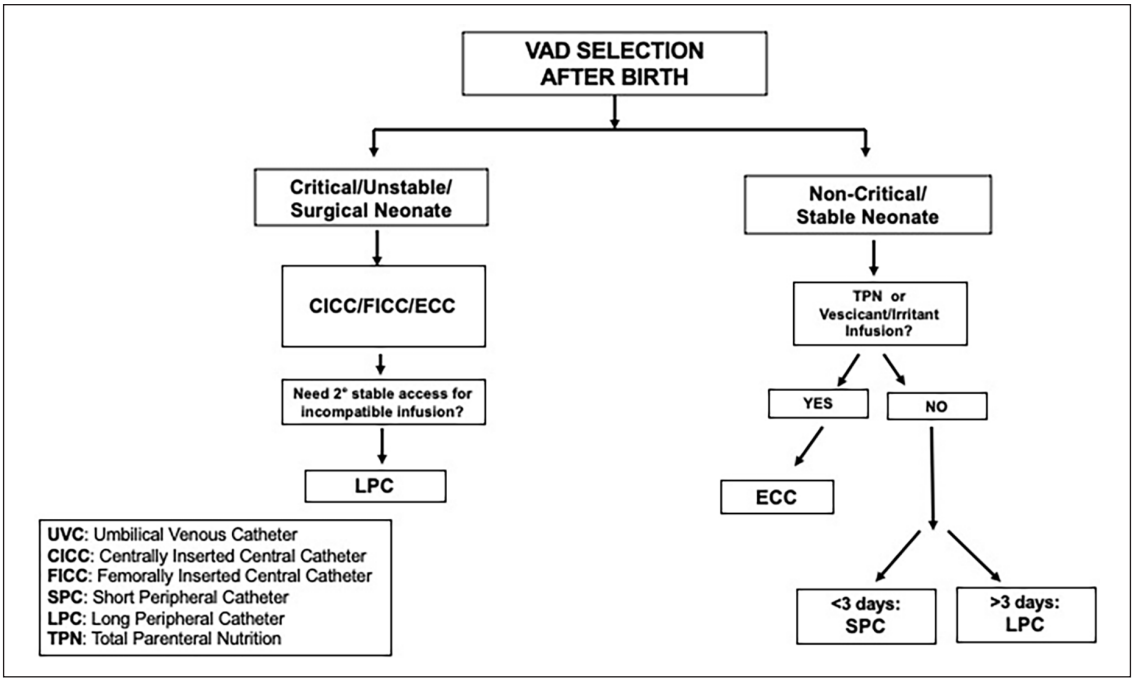

Figure 2. New flowchart of vascular access device (VAD) selection after birth in our NICU.

might have been limited, as no specific simulators are available for mimicking placement in exceedingly small veins; better expertise might have been associated with better clinical outcomes; (c) the population we studied is quite small since we have been using nLPC with a very specific indication; and (d) there was no actual comparison between the outcome of insertion of nLPC versus repeated insertion of SPC; a randomized controlled study is warranted in this regard.

Conclusions

Long peripheral cannulas (2 Fr, 4–6 cm) may be potentially useful in some neonates who require peripheral venous access for more than 3 days since, in this clinical situation, short peripheral cannulas are unsuitable due to their limited dwelling time and, on the other hand, EECs may be inappropriate because too invasive. In our experience, 4–6 cm 2 Fr long cannulas could be a promising device to be positioned particularly for neonates with bodyweight >2000 g. As for the question in the title of our work, we cannot say that the gap is bridged yet, however, we have started to build the bridge.

Author's note

All authors affiliated to GAVeCeLT, GAVePed, SIN.

Author contributions

Conceptualization: Maria Grazia Romitti, Carmen Rodriguez Perez, and Elena Pezzotti. Maria Grazia Romitti collected the data and wrote the first draft of the manuscript. Maria Grazia Romitti, Carmen Rodriguez Perez, Elena Pezzotti, Mario Motta, and Francesco Maria Risso assisted in reviewing and editing the manuscript. Maria Grazia Romitti and Carmen Rodriguez Perez supervised the project and prepared the final version of the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The authors of this study received no funding or sponsorship from Vygon or any other source.

Ethics statement

The authors assert that all procedures contributing to this work comply with the ethical standards of international standards for authors, position statement developed at the second World Conference on Research Integrity (2010), and with the Helsinki Declaration of 1975, as revised in 2008.

ORCID iDs

Maria Grazia Romitti https://orcid.org/0000-0002-8535-8591
Carmen Rodriguez Perez https://orcid.org/0000-0002-1316-9388
Mario Motta https://orcid.org/0000-0002-9579-2455

References

1. Pittiruti M. DAVEXPERT expert system algorithm choice of device for venous access, 2018, http://davexpert.gavecelt.it
2. Legemaat M, Carr PJ, van Rens RM, et al. Peripheral intravenous cannulation: complication rates in the neonatal population a multicenter observational study. *J Vasc Access* 2016; 17: 360–365.
3. GAVeCeLT. RaSuVa rapid superficial vein assessment, 2017, https://gavecelt.it
4. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice. *J Infus Nurs* 2021; 44(Suppl. 1): S1–S224.
5. Roofthooft DW, Simons SH, Anand KJ, et al. Eight years later, are we still hurting newborn infants? *Neonatol* 2014; 105: 218–226.
6. Qin KR, Ensor N, Barnes R, et al. Long peripheral catheters for intravenous access in adults and children: a systematic review of the literature. *J Vasc Access* 2021; 22: 767–777.
7. Pacilli M, Bradshaw CJ and Clarke SA. Use of 8-cm 22G-long peripheral cannulas in pediatric patients. *J Vasc Access* 2018; 19: 496–500.
8. Qian SY, Horn MT, Barnes R, et al. The use of 8-cm 22G Seldinger catheters for intravenous access in children with cystic fibrosis. *J Vasc Access* 2014; 15: 415–417.
9. Scoppettuolo G, Pittiruti M, Pitoni S, et al. Ultrasound-guided "short" midline catheters for difficult venous access in the emergency department: a retrospective analysis. *Internet J Emerg Med* 2016; 9: 3.
10. Morosini I, Lucenti E, Mozzarelli F, et al. Mini-midline a new device for peripheral venous catheterization UN emergency wards. *J Anesth Intensive Care Med* 2018; 6: 555678.
11. Gilardi E, Giannuzzi R, WoldeSellasie K, et al. Mini-midline in difficult intravenous access patients in emergency department: a prospective analysis. *J Vasc Access* 2020; 21: 449–455.
12. Chenoweth KB, Guo JW and Chan B. The extended dwell peripheral intravenous catheter is an alternative method of NICU intravenous access. *Adv Neonatal Care* 2018; 18: 295–301.
13. Qin KR, Nataraja RM and Pacilli M. Long peripheral catheters: is it time to address the confusion? *J Vasc Access* 2019; 20: 457–460.
14. Patel SA, Araujo T, Rodriguez LP, et al. Long peripheral catheters: a retrospective review of major complications. *J Hosp Med* 2019; 14: 758–760.
15. Barone G, D'Andrea V, Vento G, et al. A systematic ultrasound evaluation of the diameter of deep veins in the newborn: results and implications for clinical practice. *Neonatol* 2019; 115: 335–340.