Chapter 9
Peripheral Venous Access in Neonates

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The appropriate type of vascular access device, peripheral or central, is chosen in order to accommodate the needs of the neonate (parenteral nutrition, intravenous medication, etc.). The choice of vascular access is also related to many other factors such as gestational age, birth weight, comorbidities, previous history of infusion therapy, and ability/resources available for inserting and maintaining the device.

As general rule, the vascular access device should be of the smallest outer diameter with the fewest number of lumens and should be the least invasive as possible, still considering the prescribed intravenous therapy.

Peripheral venous access (PVA) is certainly the less invasive venous access device; though, venous cannulation may be a challenging procedure especially in small preterm neonates, even under perfect conditions (i.e., in ventilated and sedated).

9.1 Indication

The key question is: is a venous access really needed? In fact, even in neonates, a large variety of clinical situations can be managed without establishing venous access. If the newborn really needs a venous access, we should consider three issues:

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1. Anticipated duration of intravenous therapy. When the anticipated duration of infusion therapy is less than 6 days, PVA should be preferred as first option unless a central access is needed for other reason.
2. Infusate characteristics. Do not use peripheral catheters for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L.
3. Need of vein preservation for long term access. Every human being is born with a limited number of veins suitable for venous access. Neonates, especially preterm ones, might need repeated venous cannulations, therefore it is crucial to consider the opportunity of preserving the vasculature for future venous accesses.

9.2 Device

We should use peripheral venous catheter of the smallest gauge possible, while still compatible with the prescribed therapy. Peripheral venous cannulas of small caliber (22G–26G) are appropriate for most infusion therapies. Peripheral catheters larger than 20G are likely to cause phlebitis; on the contrary, small gauge catheters minimize the insertion-related trauma, and this aspect is particularly relevant in preterm infants. For this reason, 24G–26G catheters are appropriate for extremely low birth weight infant (< 1000 grams) and 22G–24G for the other neonates. Larger catheters (20G) may be considered when rapid fluid replacement is required.

Steel winged venous access devices should be used only for single-dose administrations and should not be left in place.

9.3 Procedure

Care should be taken when performing invasive procedures in neonates: aseptic precautions and awareness of best practice to avoid nosocomial infection are crucial. Furthermore, the skin of preterm babies is particularly fragile in the first week of life and the bones of chronically ill preterm babies may develop rickets and are vulnerable to fractures.

Equipment needed:

- Gloves
- 22G, 24G or 26G short cannula with safety mechanism, based on infant characteristics; 26G cannulas are preferred for very small neonates.
- Vein visualization device (such as NIR: see Chap. 5), if needed
- 2 ml syringe, pre-filled with normal saline.
- Short extension connected to a needle-free device with neutral displacement (ideally, with straight fluid path design and minimal dead space).
- 2% chlorhexidine in 70% IPA.

- Cyanoacrylate glue.
- Semipermeable transparent dressing with high permeability (i.e., high moisture vapor transmission rate).

Technique:

1. Before starting, choose a suitable vein. Avoid using site such as the antecubital fossa and long saphenous veins, potentially useful for insertion of epicutaneo-cava catheters. If a scalp vein is chosen (Fig. 9.1), hair removal might be necessary. Assess the condition of the skin and evaluate previous site of intravenous access, in order to identify previous venipuncture-related or infusion-related complications (e.g., phlebitis, infiltration), so to avoid these areas. When veins are difficult to visualize, cannulation success may be improved by visible light devices or by NIR technology. If using visible light devices, adopt only cold light sources so to avoid thermal burns. For near-infrared light devices follow the manufacturer's instructions and try to identify bifurcating veins and tortuosity which might make the puncture unsuccessful. Always avoid blind venipuncture: veins should be properly identified either by direct eye visualization or by device-assisted visualization.

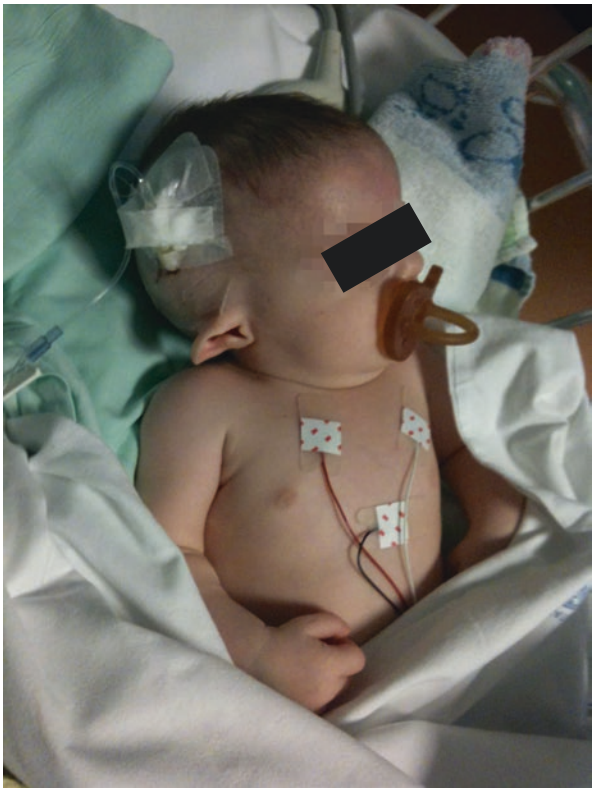

Fig. 9.1 Peripheral venous cannula on the scalp

2. Adjust the height of the incubator and ensure you have adequate lighting.
3. Consider sucrose analgesia and swaddling, when appropriate.
4. Hygiene of the hands (alcohol-based gel rub)
5. Wear non-sterile gloves.
6. Clean site with alcoholic 2% chlorhexidine wipes and let it dry for 30 seconds.
7. Flush the short extension set with normal saline to remove air.
8. Firmly grip the limb using your fingers as a tourniquet whilst stretching the skin, to stabilize the vein. It may be helpful if an assistant holds the limb.
9. With the cannula bevel facing upwards, puncture the skin and vein together at an angle of approximately 35°. Carefully advance the cannula until blood appears in the hub.
10. Withdraw the needle holding it with your thumb and middle finger, while simultaneously advancing the cannula into the vein with your forefinger.
11. Attach the short extension set and the needle-free device.
12. Flush the cannula with normal saline to check patency.
13. Secure the cannula using cyanoacrylate glue. Sterile strips may be used, but they are potentially harmful to the delicate skin of the newborn and far less effective than glue.
14. Cover with semipermeable transparent membrane (Fig. 9.2). Avoid dressings and strapping that obscure the entry site of the line as this can make detection of extravasation difficult. Ensure dressing is not circumferential to the limb.
15. Place a splint only exceptionally, if needed. Cannula in antecubital fossa often require immobilization, but this may cause stress and discomfort to the neonate.
16. Document site, date, time of insertion, number of attempts made, gauge of device and initials of inserter.

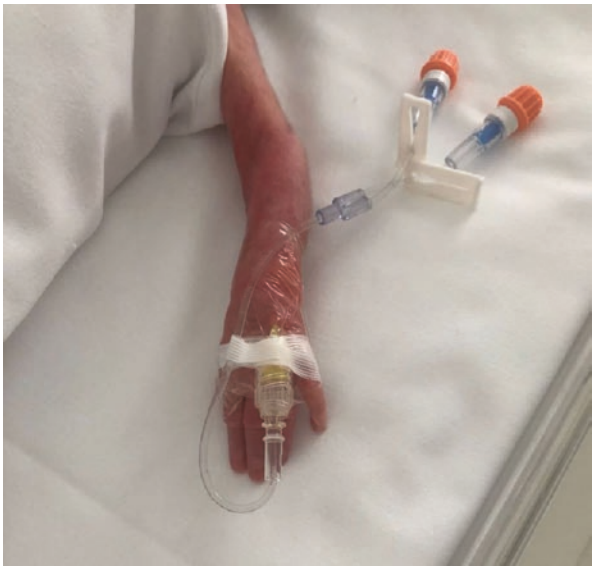

Fig. 9.2 24G cannula placed on the hand and secured with cyanoacrylate glue and semipermeable transparent dressing

It's common sense to avoid multiple punctures in newborns. In most neonatal intensive care units, there is an unspoken rule regarding vein cannulation: "three strikes and you're out". Though, we recommend to ask for help even after your second unsuccessful attempt.

9.4 Complications

Complications related to PVA and infusions include:

1. Infections. Premature neonates are at high risk of infection due to the immaturity of immune system. Local infection of the exit site is common and may be secondary to inappropriate skin antisepsis at time of insertion or to detachment and contamination of the dressing. When exit site infection is suspected at visual inspection, the cannula must be removed. PVA-related blood stream infections are rare.
2. Phlebitis. It can be bacterial (due to contamination of the exit site), mechanical (typically secondary to inappropriate stabilization of the cannula or to excessive caliber of the cannula compared to the vein), or chemical (due to infusion of irritant/vesicant solutions that are not compatible with the peripheral route). Figure 9.3 shows the effect of an extravasation (potassium) after placement of a peripheral cannula on the hand. The risk of phlebitis is related to vesicant or irritant drugs, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L. For this reason, PVA should be used for parenteral nutrition only for short periods (few days).
3. Infiltration/extravasation. Non-irritant solutions cause 'infiltration', which is not harmful but inevitably associated with loss of the venous access. Leakage of irritant/vesicant solutions in the surrounding tissues is named 'extravasation' and may be associated not only with loss of the venous access but also with severe local damage. For example, leakage of parenteral nutrition in the subcutaneous tissue might cause skin ulceration, secondary infection, and scar. Sometimes skin necrosis could happen if the extravasation is not properly managed, and the infusion contained high irritant solutions like calcium.
4. Occlusion of the lumen is frequent for small caliber cannulas and should be prevented by periodic flushing with saline.

9.5 The RaSuVA Protocol (Rapid Superficial Vein Assessment)

As stated earlier, every human being is born with a limited number of veins suitable for venous access. Sometimes neonates—especially preterm ones—need repeated venous cannulations. The puncture and cannulation of these veins is commonly

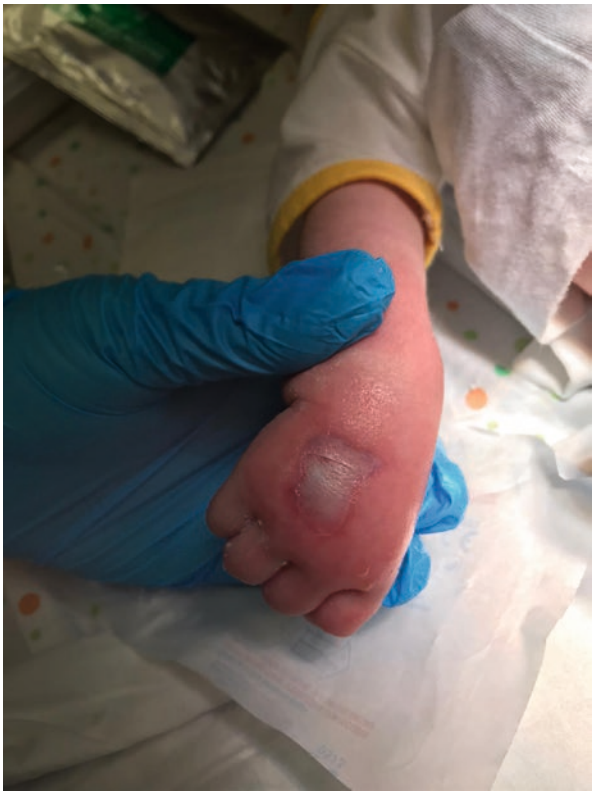

Fig. 9.3 Extravasation (peripheral cannula inappropriately used for potassium-enriched solutions)

performed by direct visualization, though new technologies such as 'Near-Infra-Red' (NIR) technique are very promising.

However, the choice of the vein most suitable for the insertion may be difficult and mainly relies upon an empiric decision, depending usually on the operator's preference and experience, often after a non-systematic assessment of the main superficial veins.

We suggest an easy and repeatable protocol for a rational and systematic evaluation of the superficial veins in neonates, as a potential guide for choosing the most appropriate approach in each situation.

The Rapid Superficial Vein Assessment—RaSuVA—is a sequential assessment of seven sites, systematically explored 'from foot to head', first on the right and then on the left side. The assessment may be performed by direct eye evaluation or also using a device with NIR technology. Each area of the upper and lower limbs is explored with and without tourniquet. The seven sites include (1) medial malleolus, (2) lateral malleolus, (3) popliteal fossa, (4) back of the hand and wrist, (5) antecubital fossa, (6) anterior scalp veins, (7) posterior scalp veins. After RaSuVA, the clinician can build a map of all the suitable veins for venous access. We advise to keep this map in the medical notes of the patient, recording time by time and attempt

by attempt which veins have been used. This easy protocol can help to preserve veins in newborns which might need multiple cannulations and would also help to choose the best intravenous device.

This protocol is also useful to define a list of preferred options in each patient depending on the type of the vascular access device to insert (peripheral or central). Using RaSuVA, each unit can build its own policy. For example, the insertion of PVA may preferably be performed in the lower limbs (excluding the saphenous vein) as a first option or on the back of the hand and at the wrist as a second option. On the other hand, the insertion of a central line may be performed at the antecubital fossa (first option) or at the saphenous vein at the medial malleolus (second option). Even at a teaching institution, it must be accepted that there are patients in whom it is imperative that the most skilled practitioner available must be in charge for the very first attempt of venous cannulation; sometimes in such patients, there is no room for training, and RaSuVA could help to identify such patients.

RaSuVA is a simple and rapid assessment tool designed to optimize and rationalize the use of veins in newborn babies.

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