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ABSTRACT

Peripheral intravenous (IV) cannulas are the quickest and most effective way of gaining venous vascular access and administering IV therapy. Closed-system peripheral IV cannulas have been shown to be safe and more reliable than open, non-valved peripheral cannulas in clinical practice. This article introduces the Smiths Medical DeltaVen closed-system peripheral IV cannula and includes three case studies describing its use in clinical practice and associated patient outcomes.

Key words: Peripheral cannula ■ Complications ■ Length ■ Indications

In the UK, one in three inpatients has at least one peripheral intravenous cannula (PIVC) in situ (Zhang et al, 2016). It is estimated that, worldwide, over a billion PIVCs are inserted in hospitalised patients each year (Alexandrou et al, 2015). Peripheral cannulation is the quickest and most effective way of gaining venous vascular access and administering intravenous (IV) therapy. It is a routine procedure that is mostly undertaken by nurses and, more recently, nurse aids and unregistered health professionals. PIVCs are used in the administration of IV therapy and antibiotics, in emergencies, in diagnostic systems and even in the patient's home. Despite being associated with a high risk of infection and other complications, they are still the most common invasive procedure undertaken in hospitals (Helm et al, 2015). This article describes the factors to consider when selecting a PIVC, with a focus on the benefits of a closed-system safety cannula.

Complications associated with peripheral venous cannulation are well documented. Mechanical, chemical and bacterial phlebitis, bacteraemia, sepsis, extravasation, haematoma and pain are all associated with PIVCs (Sato et al, 2016). Some of these complications can be avoided if the health professional adheres to guidelines and, for example, uses an aseptic non-touch technique, decontaminates the skin before cannulation and secures the device with a transparent IV dressing (Loveday et al, 2014). To avoid mechanical phlebitis, the cannulation site should also be considered. The cubital fossa region is vulnerable to severe phlebitis and so is not recommended as the first site of choice for cannulation (Dunda et al, 2015). PIVC indwell time can be improved by the selection of an appropriate diameter, followed by preferential forearm insertion (Wallis et al, 2014).

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Selection

The theory behind the decision-making process for starting a patient on IV therapy and placing a PIVC is well documented. With the advent of the Vessel Health and Preservation (VHP) framework (Hallam et al, 2016) and the epic 3 guidelines (Loveday et al, 2014), evidence is available on how to select the right IV device at the correct time throughout the duration of treatment. Use of the VHP framework can ensure that, for each patient, the right vein and vascular access device (VAD) are selected when needed (Shaw, 2017a).

Nevertheless, selecting a peripheral cannula can still be confusing. At least 15 different systems are available for purchase via the NHS Supply Chain (NHS Business Authority, 2018). All PIVCs should be sharp safe, in line with the European directive on safe sharps (Council of the European Union, 2010), single use and CE marked. Their design and individual features will, however, vary. These have been influenced by health professionals over the years.

Historically, in the UK, health professionals favoured a ported cannula, as the position of the port plays an important role in how the device is held and its successful insertion. The port allows for drug administration, which is important to anaesthetists. Times have changed, and ported cannulas are sometimes associated with an increased risk of infection due to bacterial colonisation of the dead space within their structure (Easterlow et al, 2010).

Re-education on the use of modern cannulas has been vital in promoting their use. When selecting a PIVC for a healthcare setting, changing hearts and minds can be the biggest barrier. Evidence shows that standardisation can lead to better outcomes and cost efficiencies when embraced by a healthcare institution (Bolton et al, 2015). If the chosen PIVC meets the needs of the majority of patients in a setting, a case can be made to introduce it across the organisation.

Of all the different types of PIVC, those with a closed system have been shown to reduce episodes of phlebitis and the risk of cannula-associated infection most effectively (González López et al, 2014). There is evidence that closed-cannula systems are safer and more cost effective in the long term as they can reduce the time taken to perform the procedure (Shaw, 2017b). A closed-cannula system maintains a closed intraluminal environment.

Table 1. Pressure rated for 330 PSI in DeltaVen gauges 24–16			
IV cannula gauge	**IV cannula length (mm)**	**Maximum flow at 20°C (ml/second)**	**Maximum flow at 37°C (ml/second)**
24G	19	4	5
22G	19	5	6
	25	5	5
20G	25	7	8
	32	6	7
	45	6	7
18G	25	8	9
	32	7	9
	45	7	9
16G	32	>10	>10

Contrast media used: IOMERON 400 featuring 27.5 mPa.s. viscosity at 20°C and 12.6 mPa.s. at 37°C (DeltaMed data on file; for more details, please visit www.smiths-medical.com/customer-support). A measurement unit of viscosity, mPa.s. is millipascals per second

Depending on their level of viscosity, different contrast media can provide different flow-rate results from the same product. It is important, therefore, to ensure that the same contrast media is used when comparing different sets of data

Figure 1. The DeltaVen closed-system PIVC (45 mm length)

It reduces the risk of the operator coming into contact with the patient's blood after the cannula needle has entered the vessel and been retracted into the sharp-safe mechanism. It also provides a safe way of drawing blood samples before the first flush of the newly inserted cannula.

As with other types of PIVCs, a closed-system device allows IV therapy to be administered into the venous system. Cannulas in which an integrated IV extension is attached to a needle-free connector are easier to handle and allow a degree of flexibility in terms of where they are sited.

Another important feature to consider when selecting a PIVC is its ability to reduce backflow into the tip of the cannula (Barton et al, 2017). This can reduce the risk of occlusion and thus the need for repeated insertions.

It is also vital that the device remains stable after insertion, so that micro-movements of the cannula inside the vessel are kept to a minimum. Micro-movements can damage the tunic intima, which can result in mechanical phlebitis. The stability of the cannula and its resting position will also influence how long the cannula remains patent (Marsh et al, 2015).

The material from which the cannula is made will affect how comfortable it feels inside the blood vessel. A material that becomes soft and pliable when warmed up to body temperature will reduce the risk of trauma to the tunica intima and increase the life of the cannula (Zdrahala and Zdrahala, 1999). Studies have demonstrated that polyurethane may be less thrombogenic than other materials such as polyethylene, polyvinyl chloride or silicone elastomere (Gupta et al, 2007).

The DeltaVen

The DeltaVen PIVC (Smiths Medical) (*Figure 1*) is a new closed-system safety cannula that incorporates all the features discussed above. Like most modern cannulas, it can indwell for as long as is required due to its effective stabilisation platform, which reduces micro-movements inside the vessel, and its ability to reduce the backflow of blood to the tip of the cannula. The cannula is power injectable for scanning contrast up to 330 psi and is available in a wide range of gauges and lengths (from 26 gauge to 16 gauge). Full details on the cannula's dimensions and their flow rates are given in *Table 1*.

The DeltaVen is easy to handle; the needle retracts from the cannula very smoothly and the primary flashback chamber can be clearly seen on successful vessel cannulation. The cannula is available in four different distal port configurations, and with one or two high-quality Microclave-passive needle-free connectors, which provide a laminar flow into the device, with no dead space to harbour blood or microbes.

DeltaVen can be used on all patient groups. Its 26 and 24 gauges are suited for the neonatal unit and the more traditional 22-16 gauges are suitable for adults requiring emergency or routine IV access. The longest length is 45 mm, which is available in the 20 and 18 gauges.

The longer lengths are ideally suited for cannulation of deeper peripheral veins. They can be used for ultrasound-guided peripheral cannulation in patients with difficult-to-access veins (Costantino et al, 2005). Unlike some shorter cannulas, longer PIVCs are unlikely to become dislodged. Moy and Keeyapaj (2017) stated that, for ultrasound-guided insertion, longer needles will ensure that a sufficient amount of the cannula remains in the vein for the procedure to be undertaken safely, even if there is significant movement of the underlying skin. This is particularly important when using a PIVC for CT contrast administration under pressure. A shorter cannula, with less than 50% of the device indwelling in the vessel, could be ejected by the pressure of contrast injection. The cannula should be sited in a long portion of the blood vessel, so that the indwelling tip does not extend to a bend or point of flexion, which can increase the risk of mechanical phlebitis.

DeltaVen has a sharp v-point needle, which is designed to minimise the force needed to access vessels. It is made from stainless steel (AISI 304) and complies with the requirements defined in ISO 10555-5 and ISO 9626.

Case studies

The following case studies, undertaken by the IV team in a large acute hospital in the UK, indicate that the DeltaVen is a versatile and effective closed-system PIVC.

Case study 1: venesection

DeltaVen was used to undertake therapeutic venesections in a busy IV outpatient unit. Therapeutic venesection, the withdrawal of up to 450 ml of blood from a patient, is undertaken to treat conditions such as haemochromatosis (excessive iron in the blood) and polycythemia (an abnormally high volume percentage of red blood cells). In the IV unit, a 16-gauge hollow-bore steel needle is usually used, which is attached to a 600-ml blood-collection bag. The system is single use and, once collected, the bag of blood is discarded as clinical waste. Historically, patients found insertion of the 16-gauge needle painful. It could also be difficult as there is no flashback chamber to identify correct placement and the steel needle is left inside the vessel until the blood is collected, which patients can find uncomfortable or painful, even after the venesection has been performed and the needle removed.

In the IV unit, the DeltaVen closed-system cannula green 18-gauge (45 mm) and pink 20-gauge (45 mm) were used for therapeutic venesections over a 5-day period. All the unit staff used the cannula for all of the venesections performed in the unit. The DeltaVen was effective for all of the venesections in both gauges. *Figure 2* illustrates the process relating to the ultrasound-guided insertion of an 18-gauge 45 mm DeltaVen closed-system PIVC.

Not only does DeltaVen have all of the advantages of a closed-system peripheral cannula, but it also can be applied with a standard cannulation technique, is sharp safe and is made from polyurethane, which is more comfortable for the patient (Zdrahala and Zdrahala, 1999). The flow of blood into the venesection bag was comparable in the DeltaVen and the blood collection bag, although it took a little longer with the 20-gauge DeltaVen due to its slightly smaller size. The peripheral cannula was so successful that the IV unit now uses it for all venesections.

Case study 2: administration of CT contrast at high pressure

A 77-year-old surgical patient required an 18-gauge peripheral cannula for a CT scan with contrast administered at high pressure. A scan had been attempted earlier that day, but was

Figure 2. Ultrasound-guided insertion of an 18-gauge 45 mm DeltaVen closed-system peripheral cannula into the anti-cubital fossa. The primary flash back of blood can be clearly seen in the distal part of the cannula. The venesection bag and blood can be seen flowing freely with very light pressure from an unflated arm cuff.

Figure 3. Insertion of an 18-gauge 45 mm DeltaVen closed-system peripheral cannula into the antecubital fossa for the administration of CT contrast at 6 ml/second

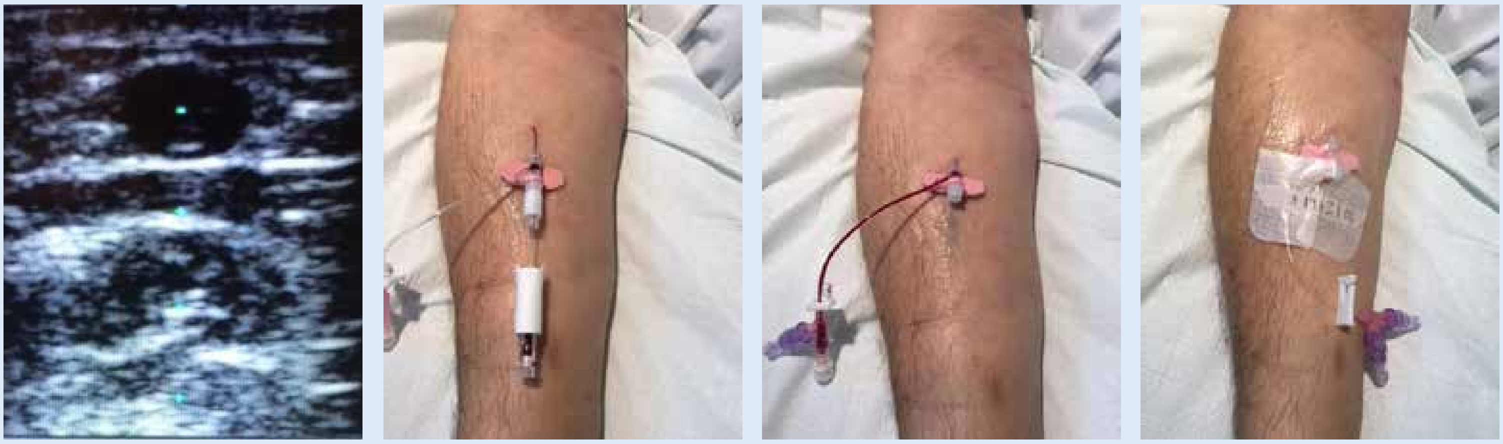

Figure 4. A 20-gauge DeltaVen cannula insertion with ultrasound in a patient with unpalpable deep veins

aborted because the peripheral cannula (which was not a DeltaVen device) became dislodged from the vessel, resulting in infiltration of CT contrast.

The standard cannula length used in the CT scanning unit is an 18-gauge 32 mm, as this allows the contrast to be delivered at high pressure (up to 5 ml/second). The cannula is sometimes not long enough for bariatric patients or those with deep vessels or oedema. In such cases, a longer cannula is often indicated to reach the vein and sit securely inside it. The high pressure can cause the cannula to be ejected if the cannula does not extend far enough into the vein. The position of the patient's arm (bent above the head during the scan) is an exacerbating factor as the cannula will bend in the vessel, causing a degree of occlusion, which can increase the injection pressure. A longer cannula will ensure it stays more securely in place.

A 45 mm DeltaVen was therefore used in the second scan attempt. Using an aseptic non-touch technique, it was successfully inserted into the left antecubital fossa basilic vein. Ultrasound showed that approximately 80% of the cannula was sited inside the vessel. The second contrast injection was successful. The DeltaVen performed well: its stabilisation platform held it securely in place and it was long enough for the patient to be able to bend their arm above their head during the scan without occluding the tip in the vessel.

Figure 3 illustrates the administration of CT contrast at high pressure.

Case study 3: gaining peripheral IV access in an acutely unwell patient

A 68-year-old patient with a high body mass index (BMI) (32) was being treated acutely for congestive heart failure. Vascular access was required to administer IV diuretics. The patient's arms were swollen with oedema, causing him to endure multiple failed cannulation attempts. The vascular access team were called to catheterise the patient.

Ultrasound was used to assess the patient's vessels, and the cephalic vein was identified in the forearm. This is an ideal site for peripheral cannulation as it is located away from the joints and points of flexion, which can cause mechanical phlebitis. The vessel was 6 mm deep and not palpable. Using ultrasound, the DeltaVen 20-gauge 45 mm cannula was easily inserted into it. Care was taken to ensure the puncture site was far enough away from the antecubital fossa for the cannula tip not to extend into it. The sharp tip of the needle aided successful puncture, and the cannula was inserted at a 35-degree angle.

The 45 mm length was used because the patient was struggling to breathe and so was using his arms to prop himself up in the bed. In such circumstances, a standard length cannula could have caused cannula migration.

Figure 4 illustrates use of ultrasound to insert the DeltaVen into a vessel below the antecubital fossa in order to avoid mechanical phlebitis caused by the bend of the arm.

Conclusion

Based on the case studies presented here, the DeltaVen is a reliable and versatile closed-system PIVC. For clinical units that are still using ported or open PIVCs, this cannula would be a much safer alternative. As a general rule, the smallest cannula possible should be used in the biggest vein as far down the arm as possible away from points of flexion and joints. Due to the range of DeltaVen sizes and gauges, health professionals can choose the smallest, shortest cannula, or a longer one with a higher flow rate, depending on the patient's needs and the condition of the vein. **BJN**

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KEY POINTS

- Despite being associated with a high risk of infection and other complications, peripheral cannulation is the most common invasive procedure undertaken in hospitals
- There are at least 15 different peripheral intravenous cannulas (PIVC) to choose from. All are sharp safe and single use, but other features will vary between devices. PIVCs with a closed system have been shown to reduce the risk of phlebitis and infection most effectively
- The DeltaVen is a closed-system PIVC that comes in a range of gauges (16–26 G) and lengths (19–45 mm). As a result, health professionals can select a device from the range that is best suited to individual patient needs in terms of size and flow

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CPD reflective questions

- Is there scope to improve the selection of peripheral intravenous cannulas in your trust?
- How effective is the education provided in your trust on peripheral cannulation?
- Have there been occasions where the patient's experience of peripheral cannulation could have been better? If so, how could this have been achieved?