Clinical Practice
Review
Venous-access devices

Keywords Cannulation/Medicine administration/Vein assessment

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In this article...

- The appropriateness of different venous-access devices for individual patients
- What is covered by the UK Vessel Health and Preservation framework
- Findings of recent studies into the use of venous-access devices

Vessel health and preservation 1: minimising the risks of vascular access

Nursing Times Journal Club

Key points

Most inpatients require cannulation, and some can be identified as having difficult intravenous access

Peripheral intravenous cannulas are most common, despite their high complication and failure rates

A framework was developed to help staff with assessment and decision making around venous-access devices

The framework has been updated to reflect recent research into the selection and management of devices

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Abstract A high proportion of patients require cannulation for vascular access. Peripheral intravenous cannulas are most often used, which can cause complications and fail before treatment is completed. Other devices are available, and a framework was developed to help health professionals to choose, insert and assess the most appropriate for each patient. As research continues, the framework is being revised to reflect the latest recommendations. This is the first article in a two-part series, which outlines a framework designed to aid assessment, decision making and management of devices for individual patients. Part 2 explains the procedure for inserting a peripheral intravenous cannula.

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Vascular access is an important process for the delivery of many treatments in patients who are hospitalised: >80% receive a peripheral intravenous cannula (PIVC) during their hospital stay to deliver essential intravenous (IV) fluids, blood transfusions, analgesics, antimicrobials and other medications (Van Loon et al, 2019a). However, PIVCs remain associated with high rates of complications – including phlebitis (inflammation of the vein), thrombosis and infection – as well as discomfort to the patient (Loveday et al, 2014).

Vascular-access devices

The One Million Global catheters study, carried out in 2014-15, aimed to compare insertion practices, management practices and outcomes of PIVCs with best practice (Alexandrou et al, 2018). The study analysed data about more than 40,000 PIVCs from 51 countries and found that 10% of the PIVCs caused signs of phlebitis and pain, and a further 10% showed signs of malfunction. It concluded that a stronger focus was needed on PIVC insertion, management and surveillance, as well as improved assessment and decision making, to reduce the risks associated with PIVCs (Alexandrou et al, 2018).

Research has shown that when vascular access is required, limited assessment is performed of the most appropriate device to use; PIVCs are often used as the default, despite not being the best device for some patients (Hallam et al, 2016). They are the most commonly used vascular-access device (VAD) and insertion is often delegated to staff who have the least experience, who may be unclear of when to escalate issues (and to whom) and when to consider an alternative VAD (Jackson et al, 2013).

There is a high failure rate of PIVCs: up to 50% fail before completion of the intended treatment (Helm et al, 2015). After insertion, there is often little consideration of the survival of the PIVC, and when the antecubital fossa (elbow pit) is used for cannulation, there is a high risk of dislodgement (Carr et al, 2016). The failure of the PIVC:

- Can result in delayed treatments, including of analgesia, antibiotics and IV fluids (Alexandrou, 2014);
- Starts a negative cycle of numerous PIVCs being inserted into fragile veins, resulting in frustration for busy staff and, most importantly, a poor patient experience (Oliver, 2015).

Sharing a personal experience, Horsfield (2014) described how in this negative cycle of cannulations she was given 14 PIVCs over 21 days during a hospital stay; she subsequently developed a needle phobia.

Recent evidence suggests there is a group of patients with difficult IV access (DIVA) (Van Loon et al, 2019a; Ehrhardt et al, 2018). Van Loon et al (2019a) found that even the most experienced health professionals, who regularly perform cannulation, experience difficulty with this group – there is a failure rate of up to 19% for first-attempt cannulation. Traditionally, patients with DIVA are identified after numerous failed PIVC insertion attempts, but prospectively identifying these patients can reduce the cannulation failure rate and improve their care experience (Van Loon et al, 2019a).

The use of ultrasound-guided (USG) PIVC insertion is increasing and offers health professionals the opportunity to select veins that are not easily seen or palpated (Blanco, 2019). Although the use of ultrasounds to insert a PIVC requires additional skills, training and competency assessment, it increases the first-attempt success rate at cannulation significantly, thereby providing a better patient experience and reducing wastage of time and resources (Van Loon et al, 2019b). The use of USG PIVC is particularly important in patients with DIVA; it increases the first-attempt success rate from 25-30% without ultrasound to 90% with it (Blanco, 2019).

There is a direct link between the length of the PIVC and its survival time; standard PIVC length is usually no more than 4.78cm, while extended-length PIVCs are up to 7cm (Bahl et al, 2019). The benefit of selecting a longer-length PIVC is that it allows at least two-thirds of the catheter length to reside in the vein, making it less likely to irritate the vessel wall, which can cause chemical phlebitis and infiltration (Chopra el al, 2015). In a study of 255 patients, Bahl et al (2019) found the extended-length PIVC had an average dwell time of 132 hours, compared with a 96-hour average for the standard PIVC.

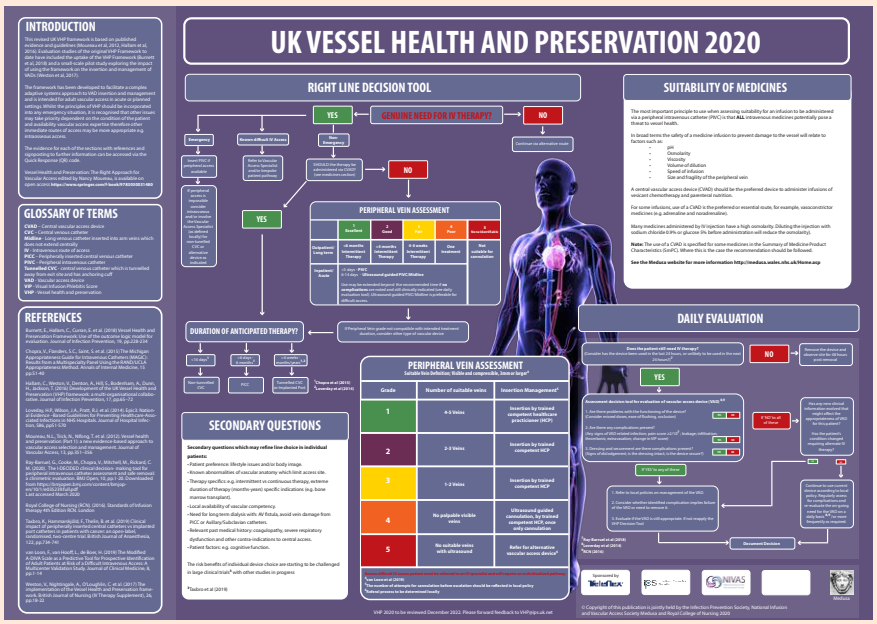
An alternative peripheral vein device is a midline; with a length range of 8-20cm, this is longer than a PIVC and is usually inserted into the upper arm (Gorski et al, 2017). The midline is advantageous over the PIVC in that it is located in a larger and faster-flowing vessel of the upper arm (Simonov et al, 2015). As midlines do not reach the central veins, they should only be used for injectable medicines suitable for peripheral administration (Royal College of Nursing, 2016). Midlines can be used for the administration of medications such as antimicrobials, analgesics and fluid replacements that are normally tolerated by peripheral veins (Gorski et al, 2017); guidance suggests they are suitable to administer treatment for up to 14 days (Chopra et al, 2015).

PIVCs and midlines should not be used to administer vesicant drugs, parenteral nutrition or infusates with an osmolarity of >900mOsm/L, due to the potential damage to the vessel (Gorski et al, 2017; Royal College of Nursing, 2016). Guidance relating to osmolarity levels that was published by both the Infusion Nurses Society (Gorski et al, 2017) and the RCN (2016) changed during 2016, increasing from 600mOsm/L to 900mOsm/L.

More than 300 injectable medicines are listed on the Medusa injectable medicines guide website, hosted by NHS Wales Informatics Service (medusa.wales.nhs.uk); all of which have the potential to cause damage to the vessel used for administration. The Medusa website provides information on each of the injectable medicines, including pH and osmolarity levels.

Central venous-access devices (CVADs) are used to facilitate the delivery of medications and solutions into the large central veins and include peripherally inserted central catheters (PICCs), non-tunnelled central venous catheters, tunnelled central venous catheters and implanted ports (RCN, 2016). The advantage of CVADs is that they can be used to administer all injectable medicines, due to the central vessels being larger than peripheral veins, providing greater haemodilution, reducing the risk of chemical phlebitis and ensuring fast distribution of medication and fluids with rapid clinical effect (Moureau and Alexandrou, 2019).

Fig 1. **UK Vessel Health and Preservation 2020 framework***



*Available for download at Bit.ly/IPSVesselHealth2020
Source: Infection Prevention Society et al (2020)

Guidance for use

To ensure vessel health and preservation, a proactive approach to vascular access is required, rather than a reactive one that can cause pain and damage to vessels, and limit further vascular-access options (Moureau et al, 2012). Assessing patients who require vascular access in a proactive, timely way results in intentional placement of the right device to reduce vessel damage and preserve vessels for future use (Moureau et al, 2012). This has the potential to improve patient experience, reduce complications, and reduce costs in consumables and health professionals' time (Hallam et al, 2016).

Developing a framework

In 2016, the UK Vessel Health and Preservation (VHP) framework was developed to

Table 1. **Comparison of recommended device duration**

Device	epic3 guidance (Loveday et al, 2014)	MAGIC study (Chopra et al, 2015)
PIVC	Up to 7-10 days	Up to 5 days
Midline	1-4 weeks	6-14 days
USG PIVC	n/a	Up to 14 days
PICC	4 weeks – 6 months	>6 days
Non-tunnelled CVAD	Up to 7-10 days	Up to 14 days
Tunnelled CVAD	Months or years	>15 days
Implanted port	Months or years	>30 days

CVAD = central venous-access device; MAGIC = Michigan Appropriateness Guide for Intravenous Catheters PICC = peripherally inserted central catheter; PIVC = peripheral intravenous cannula; USG = ultrasoundguided.

help address the need for assessment and decision making around VADs (Hallam et al, 2016). Adapting a concept published by Moureau et al (2012) to provide a patient-centred assessment for the most appropriate device to deliver the course of treatment, its development was led by the Infection Prevention Society, in collaboration with the National Infusion and Vascular Access Society and the RCN.

The VHP framework was designed as a poster providing visual and straightforward guidance to help frontline staff with assessment and decision making regarding suitable VADs for patients needing vascular access (Hallam et al, 2016). The first and most important question in the VHP framework is whether there is a "genuine need for vascular access", prompting consideration of alternative routes for administering medication, such as oral, nasal or rectal. These alternative routes may provide options with a much lower risk of complications.

The VHP framework comprises:

- A vein-assessment tool featuring a scale (1-5) to assess peripheral vein quality;
- A medication suitability section on the safety of the drugs to be given and consideration of central vein administration;
- An algorithm for VAD choice, based on vein quality, drug choice and treatment duration;
- An evaluation section to assess the VAD daily and monitor any complications.

In a small-scale study that explored the impact of using the framework on the insertion and management of VADs on a haematology ward, Weston at al (2017) found an increase in the placement of appropriate alternative devices, with reduced time from patient admission to insertion of the most appropriate VAD. The study also showed a significant (approximately 30%) decrease in PIVC placement and found the framework had empowered frontline staff to escalate issues so patients could receive an alternative device (Weston et al, 2017).

Revising the framework

The original VHP framework was evaluated within the first year by Burnett et al (2018), who used an outcome logic model to measure its short- and medium-term impact and success. The evaluation found that many respondents were aware of the framework and they were using it in a range of different ways. Participants also reported that the framework was most beneficial in helping them decide what device to use, assessing peripheral veins and improving clinical practice (Burnett et al, 2018).

The VHP framework was revised in 2020 (Fig 1) to incorporate study findings published after it was originally finalised. Of these studies, three were paramount in its development. The first, the Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) study by Chopra et al (2015), assessed the appropriateness of over 600 scenarios of patients given PICCs and found that 43% were inappropriate. It provided a matrix for preferred alternatives, including USG PIVCs; the matrix also lists appropriate VAD duration, taking account of proposed infusion duration. This has altered the suggested VAD duration from the original VHP framework, which was guided by Loveday et al's (2014) epic3 guidance on infection prevention and control; Table 1 outlines the differences.

The second study of note highlighted the importance of recognising adult patients with DIVA and developed a scale to identify them, called the adult DIVA (A-DIVA) scale (Van Loon et al, 2019a). It concluded that five variables contribute to difficult vascular access:

- Failed peripheral IV cannulation on the first attempt;
- Previous history of difficult IV cannulation;
- Difficult IV access as expected by the practitioner;
- Inability to detect a dilated vein by palpating and/or visualising the extremity;
- A diameter of the selected vein <3mm.

The study used a multicentre approach and over 3,500 adult participants to validate the A-DIVA scale.

The third study included in the review of the VHP framework was the development of Ray-Barruel et al's (2020) I-DECIDED tool. This is an evidence-based PIVC-assessment and decision-making tool to aid assessment and prompt removal of the device if needed. I-DECIDED is used as an acronym for:

- **I**dentifying if there is a VAD in situ;
- **D**oes the patient need the device;
- **E**ffective function, following local policy for flushing and locking;
- **C**omplications check,
- **I**nfection prevention, including hand hygiene and scrubbing the hub of the VAD;
- **D**ressings and securement;
- **E**valuate and educate;
- **D**ocument and record the decision.

The I-DECIDED tool was tested in three different hospitals using an interrupted time-series study and concluded that a pain score of ≥2/10 was a valid complication of PIVCs (Ray-Barruel et al, 2020).

In addition, the VHP framework's 2020 update says USG PIVCs for therapy are suitable for peripheral administration for a duration of 6-14 days and suggests a combination of a USG PIVC or midline is preferable for DIVA patients. The suggested duration of midlines has changed from up to 28 days in the original VHP framework to up to 14 days in the revised version, following Chopra et al's (2015) MAGIC guidelines. However, the revised framework states that use may be extended beyond the recommended time if no complications are noted and it remains clinically indicated with, at least, a daily review.

The revised VHP framework continues to provide a vein assessment tool using a scale of 1-5. Additionally, it recognises patients with DIVA, suggesting they are referred to a vascular access specialist and will require an individualised pathway.

Further changes are seen in the revised framework's section on suitability of medicines. It states that when assessing the suitability of an infusion to be administered via a PIVC, it is important to consider that all IV medicines potentially pose a threat to vessel health. The safety of a medicine infusate and the prevention of damage to a vessel relate to factors such as pH and osmolarity.

The updated framework does not provide specific levels for a CVAD, stating only than a CVAD should be the preferred device to administer infusions of vesicant chemotherapy and parenteral nutrition. Instead, it states that some medicines given by IV injection will have a high osmolarity, which can be reduced by diluting the injection with sodium chloride 0.9% or glucose 5% before administration. The VHP framework continues to reference the Medusa injectable medicines guide for further information. The following statement has also been added: "The use of a CVAD is specified for some medicines in the Summary of Medicine Product Characteristics, which is available for all medicines. Where this is the case, the recommendation to use a CVAD should be followed."

Daily inspection of all VADs is recommended to assess for any complications (Gorski et al, 2017; Loveday et al, 2014) and to evaluate whether the device is still needed and is the most appropriate one for the patient at that time (Hallam et al, 2016). This is reflected by the evaluation section of the revised VHP framework, which starts with the question "Does the patient still need IV therapy?" and asks health professionals: "Has the device been used in the last 24 hours, or [is it] unlikely to be used in the next 24 hours?" It then lists the following three questions to assess the VAD:

- Are there problems with the functioning of the device?
- Are there any complications present?
- Dressings and securement – are there any complications present?

Following the work of Ray-Barruel et al (2020), the revised VPN framework includes pain as a complication indicator when it is reported as a score of ≥2/10 in the daily evaluation. Complications or problems with the functioning of the VAD may indicate that it is not the most appropriate device to deliver the intended treatment for the patient. This signals that evaluation is required to determine whether the VAD is still appropriate and, if necessary, the framework's decision tool should be reapplied.

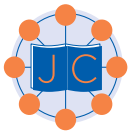
The framework includes a list of secondary questions to consider individual patient factors when selecting the most appropriate VAD. These include the need to avoid vein damage from PICC or axillary/subclavian catheters for patients who might need long-term dialysis with an arteriovenous fistula.

Conclusion

The original and revised VHP frameworks were developed to be used by frontline staff and IV teams, either as a whole framework or in parts, to aid assessment and decision making in selecting and maintaining the right VAD for individual patients. Updating the framework is necessary to make sure it continues to provide up-to-date evidence to help maintain best practice in vascular access now and in the future.

Vascular access will continue to be common practice in the administration of medicines and essential fluids to patients. It is important that vessel health is assessed for each individual patient requiring such access to protect their veins, minimise damage and complications, and give the optimum experience.

The VHP working group is aware of large studies being conducted at present, including a large randomised control trial to determine which VAD offers the best outcome for safety, clinical effectiveness and cost effectiveness. As before, these studies may lead to further changes to the framework. **NT**



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References

Alexandrou E (2014) The one million global catheters PIVC worldwide prevalence study. *British Journal of Nursing;* 23: 8, S16-S17.

Alexandrou E et al (2018) Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *Journal of Hospital Medicine;* 13: 5.

Bahl A et al (2019) Standard long IV catheters versus extended dwell catheters: a randomized comparison of ultrasound-guided catheter survival. *American Journal of Emergency Medicine;* 37: 4, 715-721.

Blanco P (2019) Ultrasound-guided peripheral venous cannulation in critically ill patients: a practical guideline. *The Ultrasound Journal;* 11: 1, 27.

Burnett E et al (2018) Vessel health and preservation framework: use of the outcome logic model for evaluation. *Journal of Infection Prevention;* 19: 5, 228-234.

Carr PJ et al (2016) Development of a clinical prediction rule to improve peripheral intravenous cannulae first attempt success in the emergency department and reduce post insertion failure rates: the Vascular Access Decisions in the Emergency Room (VADER) study protocol. *BMJ Open;* 6: 2, e009196.

Chopra V et al (2015) The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Annals of Internal Medicine;* 163: 6Suppl, S1-S40.

Ehrhardt BS et al (2018) Making it stick: developing and testing the Difficult Intravenous Access (DIVA) tool. *American Journal of Nursing;* 118: 7, 56-62.

Gorski LA et al (2017) The 2016 infusion therapy standards of practice. *Home Healthcare Now;* 35: 1, 10-18.

Hallam C et al (2016) Development of the UK vessel health and preservation (VHP) framework: a multi-organisational collaborative. *Journal of Infection Prevention;* 17: 2, 65-72.

Helm RE et al (2015) Accepted but unacceptable: peripheral IV catheter failure. Journal of Infusion Nursing; 38: 3, 189-203.

Horsfield C (2014) A personal experience of care and the lack of it. *Journal of Infection Prevention;* 15: 3, 82-83.

Infection Prevention Society et al (2020) *UK Vessel Health and Preservation 2020.* Seafield: IPS.

Jackson T et al (2013) Right line, right patient, right time: every choice matters. *British Journal of Nursing;* 22: 8, S24-S28.

Loveday HP et al (2014) epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in Englans. Journal of Hospital Infection; 86: S1, S1-S70.

Moureau NL, Alexandrou E (2019) Device selection. In: Moureau N (ed) *Vessel Health and Preservation: The Right Approach for Vascular Access.* Springer.

Moureau NL et al (2012) Vessel health and preservation (part 1): a new evidence-based approach to vascular access selection and management. *Journal of Vascular Access;* 13: 3, 351-356.

Oliver G (2015) Whose line is it anyway? *British Journal of Nursing;* 24: 2, S2.

Ray-Barruel G et al (2020) The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. *BMJ Open;* 10: e035239.

Royal College of Nursing (2016) *Standards for Infusion Therapy.* London: RCN.

Simonov M et al (2015) Navigating venous access: a guide for hospitalists. *Journal of Hospital Medicine;* 10: 7: 471-478.

Van Loon F et al (2019a) The modified A-DIVA scale as a predictive tool for prospective identification of adult patients at risk of a difficult intravenous access: a multicenter validation study. *Journal of Clinical Medicine;* 8: 2, 144.

Van Loon F et al (2019b) Establishing the required components for training in ultrasoundguided peripheral intravenous cannulation: a systematic review of available evidence. *Medical Ultrasound;* 21: 4, 464-473.

Weston V et al (2017) The implementation of the vessel health and preservation framework. *British Journal of Nursing;* 26: 8, S18-S22.