Vessel Health and Preservation: a model and clinical pathway for using vascular access devices

Nancy L Moureau and Peter J Carr

ABSTRACT

Use of intravenous devices for the delivery of medical treatment spans all healthcare facilities ranging from hospitals to clinics and home care. Clinical pathways are processes used by healthcare providers to integrate and illustrate the best evidence and approach to care for a specific area of practice. The Vessel Health and Preservation (VHP) model is a framework and pathway process, consisting of four quadrants, to guide initiation and management of treatment requiring intravenous access. The pathway is designed to promote preservation of the vasculature of patients from admission through discharge with a focus on acute care. This article describes the model and pathway process. Moving through the quadrants of assessment/selection, insertion, management and evaluation of outcomes the clinician receives vascular access education to establish an understanding of the key principles and is then better able to provide care to the patient. Research on the VHP model has found that patients, clinicians and healthcare facilities benefit from the evidence integrated within the VHP model for improved outcomes, greater success with insertion, time saved through improved efficiency, risk reduced through appropriate device discontinuation, and greater patient satisfaction.

Key words: Clinical pathway ■ Vascular access ■ Model of care ■ Central venous catheters ■ Peripheral catheters

A frequent procedure performed on acute care patients is the insertion of a vascular access device (VAD). Necessary for current medical treatment, a VAD with continued functionality provides a route of administration for intravenous (IV) medications and solutions. The Vessel Health and Preservation® (VHP) model (Teleflex Inc), originally developed through a consensus group in the USA, is a framework and pathway process to guide initiation and management of treatment requiring intravenous access (Moureau et al, 2012). The model was evaluated, modified and tested by a multi-organisational collaborative in the UK (Hallam et al, 2016) involving the Infection Prevention Society, National Infusion Vascular Access Society and the Royal College of Nursing.

The VHP was developed as a means of integrating guidelines and functions for establishing and monitoring intravascular access in a way that promotes patient safety by minimising complications (Moureau, 2017). The biggest challenge is translating a clinical pathway to ensure it is adopted into practice. Multiple clinicians and groups have applied components of the model (Hallam et al, 2016) for VAD selection and vein assessment (Ventura, 2016; Shaw, 2017). As a complete proactive patient-focused model, the process—through selection, insertion, management and evaluation of intravenous treatment with VADs—applies evidence to promote the best outcomes within acute care.

Patients with an ongoing need for IV treatment may also benefit from VHP in home care, oncology, rehabilitation, sub-acute care and other settings. By integrating evidence-based research, the evaluation of outcome data, and education on VAD insertion and management into a model or pathway of care, complications may be minimised, costs reduced, patient satisfaction increased, and treatment completed more efficiently (Panella et al, 2003; Sou et al, 2017).

Evidence points to clinical pathways as management tools to define the best process and procedures to treat patients (Hanchett and Poole, 2001). A clinical pathway is defined as a specific method of patient care management used for a well-defined group of patients and applied during a set period of time (De Bleser et al, 2006). Clinical pathways improve outcomes by reducing variations and medical errors that may result in iatrogenic complications (Rotter et al, 2010). The content of a pathway is based on evidence and expert consensus regarding treatment plans and offers the highest probability of improving the quality of care, increasing efficiency and reducing risk by producing satisfactory health-related outcomes for the specified group of patients (Hanchett and Poole, 2001).

The VHP pathway takes a patient from initiation of the treatment plan through discharge and evaluation of the outcomes. Within the VHP model key actions function together to form

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four practice quadrants during the life of the VAD, integrating education into each of these (*Figure 1*). The quadrants of the VHP model focus on:

- Assessment and selection of the vein and VAD
- Insertion of the device by a trained clinician
- Management with daily assessment of device function and necessity
- Evaluation encompassing audit of patient outcomes, areas of improvement and product review.

Each quadrant of the pathway consists of multiple functions required for the initiation and management of the VAD and treatment process, all supported through evidence and education.

Quadrant 1: assessment and selection

Risks associated with intravenous devices range from low to high, depending on the device selected. Even with the selection of the lowest risk device, commonly the peripheral IV, patients can suffer from multiple attempts at insertion and re-sites, all of which could be avoided if critical thinking was applied to select the most appropriate device for treatment (Carr et al, 2017). Assessment and selection form the evidence-based processes of the first quadrant of the VHP model. The goal of the first quadrant is the timely intentional selection of the most appropriate location and device type for insertion establishing the 'right line, for the right patient, at the right time' (Moureau et al, 2012) (*Figure 2*). Within the first 48 hours of hospital admission patients receive a working diagnosis, placement of a peripheral intravenous (PIV) catheter and initiation of treatment. With reports of 31% of PIVs failing within the first 48 hours and 71% by 72 hours, optimal timing for the first phase of VHP assessment and selection is within the first 2 days of treatment (Helm et al, 2015).

Evidence supports VAD selection by a knowledgeable practitioner as a means to reduce risk and prevent complications, specifically infection, leading to greater patient safety (Maki et al, 2006; Registered Nurses Association of Ontario (RNAO), 2004). The device representing the lowest risk of infection or severe complications is the PIV (Maki et al, 2006). PIVs, as the most often used VAD, have the lowest reported risk, and represent the largest volume of devices used each year (Alexandrou, 2014) but they are subject to concerns with under-reporting of infection (Trinh et al, 2011). The US Centers for Disease Control (CDC) includes selection of the device with the lowest risk as a component in its central line bundle (O'Grady et al, 2011). In one US study, using the CDC's central line bundle, the need to select a device with the lowest risk based on patient-specific risk factors and on device insertion was emphasised to study participants (Pronovost et al, 2006). Adherence to this advice led to fewer catheter-related bloodstream infections (Pronovost et al, 2006).

Central venous access devices (CVADs) represent the highest risk and necessitate evaluation for indication prior to insertion (Marschall et al, 2014). Recommendations included in the Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) consensus document (Chopra et al, 2015) provide guidance for appropriate selection of these devices according to indications of duration, infusate, usage and patient co-morbidities (Chopra et al, 2015; Moureau and Chopra, 2016). When the treatment plan includes the need for a CVAD, additional consideration of inserter availability and skill level are also factored into the equation as components of a selection process that reduces risk. VHP incorporates these guidelines into the first quadrant as recommendations for safe practice with VADs.

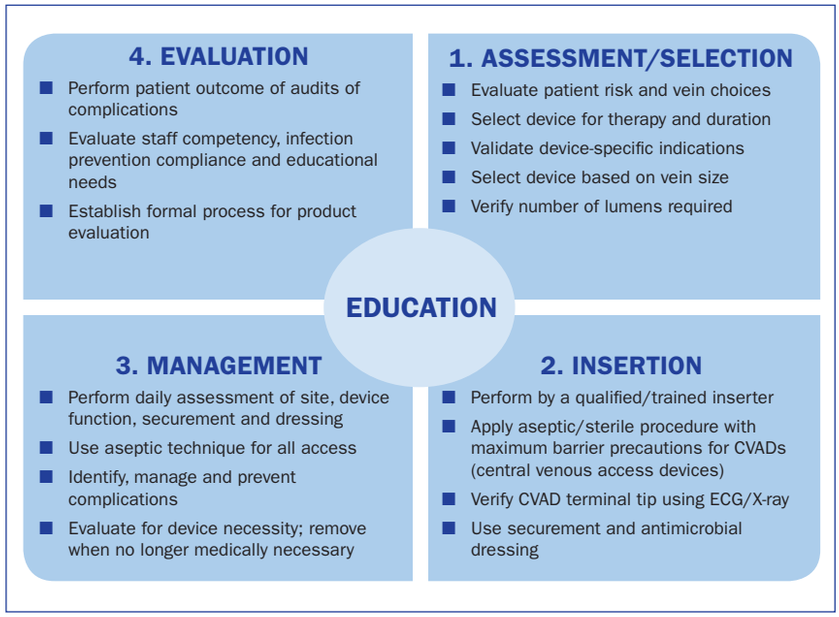

Figure 1. Original USA model of vascular access clinical pathway for patient start of care through discontinuation of device, including evaluation of outcomes
Source: PICC Excellence Inc, Nancy Moureau

Recommendations for assessment and selection quadrant

- Perform assessment of patient condition, factoring in level or risk, co-morbidities and potential contraindications (RNAO, 2004; Shaw, 2017)
- Evaluate vasculature and select an appropriate insertion site and vein based on health and absence of complications to skin or veins (RNAO, 2004). Consider use of visualisation technologies for vein assessment and selection, when peripheral veins are not visible or palpable, and for central vein selection (Gorski et al, 2017)
- Select the most appropriate vein and device that best meets the needs of the patient and therapy (Lorente, 2013)
- Use an intentional process to select the vascular access device based on appropriateness of indications, assessment results and risk-benefit ratio of location and device insertion complications (Chopra et al, 2015)
- Select catheter size not to exceed 45% of vein diameter, with vein measured in the natural state, to avoid complications of thrombosis (Trerotola et al, 2010; Nifong and McDevitt, 2011; Sharp et al, 2015)
- Limit the number of lumens, with preference given to single lumen. Verify need for more than one lumen (Grove and Pevec, 2000; O'Brien et al, 2013).

Quadrant 2: insertion by experienced clinician

The second quadrant of the VHP model is focused on insertion of intravenous devices, emphasising vein selection and insertion by a qualified clinician. Once the type of VAD needed for the treatment is selected a trained clinician can identify the location and vein best suited for insertion and perform this procedure without delay. Qualification and availability of an experienced inserter has a direct bearing on occurrence of complications (Eisen et al, 2006). The knowledge of the inserter, their experience and the number of puncture attempts performed during insertion are factors that affect complication rates of CVADs (Lennon et al, 2012; Mourad et al, 2012). Availability of educated and trained ultrasound inserters for CVADs is rated as one of the top 12 safety measures for reducing risk and minimising complications by the Agency for Healthcare Research and Quality (AHRQ) (Rothschild, 2001; Gayle and Kaye, 2012). Lack of education and experience is linked to a greater number of needle passes necessary to complete the procedure (McGee and Gould, 2003). Minimal training requirements for CVAD inserters include education on the central line bundle and infection prevention practices, simulation and supervision (Moureau et al, 2013). Assessment of insertion competency is a necessary component at the end of training and should be performed periodically to ensure patient safety (Gorski et al, 2017).

CVAD insertion techniques incorporate use of various technologies to position the terminal end of the catheter in the correct location (Baldinelli et al, 2015; Oliver and Jones, 2014). Confirmation of tip placement in the distal portion of the superior vena cava, at or near the caval atrial junction, is a safety requirement prior to use of any non-dialysis CVAD to prevent complications of thrombosis and occlusion (Petersen et al, 1999). Both PIV and CVAD insertions now incorporate ultrasound technology to aid with insertion success and promote safety with insertion and, in some cases, CVAD verification of terminal tip position (Evans et al, 2010). Training for CVAD insertions should integrate technology education with ultrasound simulation and competency assessment, while ensuring qualification prior to insertion of devices as a necessary safeguard for patients (Moureau et al, 2013).

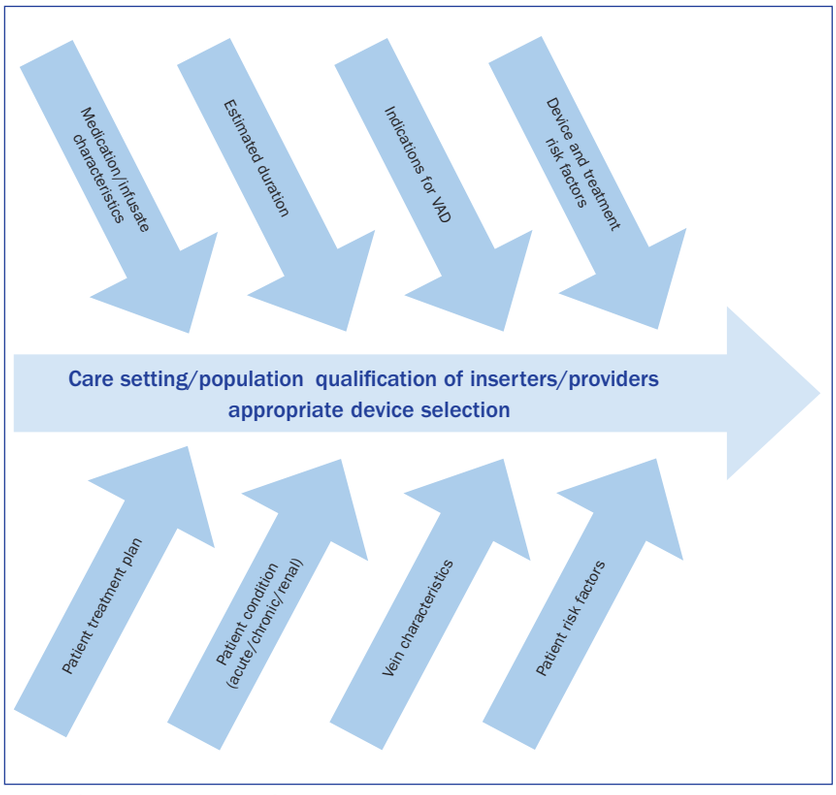

Figure 2. Device selection factors
Source: PICC Excellence Inc

Recommendations for insertion

- Ensure insertion is performed by a trained and qualified inserter, with preference given to insertion by a member of the vascular access team or other vascular access specialist, for greater first-time insertion success (Alexandrou et al, 2012; Carr et al, 2018)
- Apply principles of infection prevention to insertion procedure with the five components of the central line bundle, including maximum barrier precautions for CVADs (Loveday et al, 2014)
- Validate education, training and experience of the inserter prior to insertion; if training is not complete a qualified superviser is necessary (Alexandrou et al, 2014)
- Perform competency assessment of the inserter on a regular basis (Marschall et al, 2014)
- Place device with no more than two attempts per clinician (Eisen et al, 2006; Gorski et al, 2017)
- Use visualisation technology during the insertion procedure of VADs, for peripheral catheters when vessels are not visible or palpable, and for CVADs as a safety measure to reduce insertion-related complications (Pittiruti et al, 2009; Laksonen and Gasiewicz, 2015)
- Verify terminal tip position of CVADs with radiographic, fluoroscopic or electrocardiogram confirmation techniques prior to use; the ideal position of the catheter tip is between the lower third of the superior cava vein and the upper third of the right atrium for non-dialysis catheters or inferior vena cava above the level of the diaphragm for catheters inserted and advanced from the lower extremities (Pittiruti et al, 2011)
- Implement evidence-based securement device strategies for all VADs (Marsh et al, 2015)
- Use antimicrobial devices and dressings for CVADs based on risk assessment, vulnerability of the patient or incidence of central line-associated bloodstream infections (CLABSI) in the facility (Timsit et al, 2009; Thokala et al, 2016)
- Provide education to all clinical staff involved with VAD insertion for infection prevention, sterile technique and procedural training (Loveday et al, 2014).

Quadrant 3: assessment and management

Management of VADs involves maintaining function, securement and dressing coverage, identification of complications and the administration of medications requiring clinician education on aseptic technique and appropriate device usage. Activities

performed within this quadrant include: daily assessment for identification of complications and dressing adherence, aseptic technique with VAD access and determination of device necessity. The goals of this phase are to maintain functionality of the device, avoid complications and, if they occur, quickly identify actions needed, based on recommendations, to avoid more serious complications or reoccurrence.

Recommendations for assessment and management

- Perform a visual inspection for phlebitis of the VAD using the visual infusion phlebitis (VIP) scale with each access (Gallant and Schultz, 2006). Document a complete assessment at least once daily. Assessment includes: evaluation of insertion site, catheter function, securement/dressing and observation for complications (RNAO, 2005)
- Verify date of last dressing change, full adherence and integrity through consistent assessment. Perform VAD aseptic dressing changes every 7 days or as needed if the dressing is loose, dirty, or wet (Timsit et al, 2012)
- Maintain an aseptic non-touch technique (ANNT) for all access and manipulation of VAD (Rowley and Clare, 2009)
- Perform slow pulsatile flushing as per protocol (Conway et al, 2014; Ferroni et al, 2014)
- Apply 'scrub the hub' principles for disinfection prior to each access of VADs (Moureau and Flynn, 2015). If compliance is not achieved consider passive disinfection caps (Gorski et al, 2017)
- Determine the necessity of the VAD each day with prompt removal when treatment is complete (Gowardman et al, 2005; O'Grady et al, 2011). Promote multidisciplinary discussion of an intravenous to oral transitional plan (Chopra et al, 2014)
- Provide consistent and varied education to clinical staff performing access and management of VADs for infection prevention and compliance with policies (Kelly et al, 2015).

Quadrant 4: evaluation and education

Improvement of patient care is impossible without an evaluation and understanding of the outcomes of VAD care. At the completion of the treatment regimen evaluation and outcome measurement processes are needed to review any complications or negative outcomes. Evaluation is used in root-cause analysis when infection occurs (Zastrow, 2015). Other complications associated with VADs also benefit from analysis of causes for improvement of future outcomes and avoidance of complications. Maintaining trained and competent clinical staff requires periodic evaluation of compliance with policies and infection prevention practices (Marschall et al, 2014). Patient outcomes can be used to determine specific educational needs (Cherry et al, 2010). Varied and consistent education on all

KEY POINTS

- Vessel Health and Preservation (VHP) represents a systematic approach to initiating and managing vascular access for the purpose of intravenous patient medication treatments
- The application of VHP quadrant components is designed to improve the quality of acute care and patient outcomes by reducing infection, thrombosis and phlebitis through selection of the most appropriate cannulae, inserter and management through trained staff
- A systematic approach to vascular access incorporates guidelines and recommendations while ensuring that clinical staff receive the education and training necessary to provide the safest level of patient care
- The evaluation quadrant of VHP includes audits and monitoring of outcomes to pinpoint the required education and establish evidence of the need for specialty products that may reduce negative outcomes
- Without intravenous cannulae treatment is impossible in acute care today, and yet vascular access devices carry a high level of risk requiring vigilance in the application of evidence provided to clinicians in the form of updated training and education

aspects of 7VHP provides a basis to understand and apply current guidelines and research to practice.

Improvement in outcomes is also achieved by the incorporation of products aimed at reducing infection, dislodgement and other complications (Jenks et al, 2016). Formal product evaluation is needed to validate product performance and analyse results in the clinical setting.

Recommendations for evaluation and education

- Perform evaluation of process, performance and outcomes with all VADs through audit, surveillance and patient satisfaction measures (Loveday et al, 2014)
- Establish a process for evaluation of staff insertion and management competency with vascular access and institute minimal training requirements (Bishop et al, 2007; Bodenham et al, 2016)
- Provide recurrent and consistent education on aseptic management and infection prevention practices (Marschall et al, 2014)
- Formalise a programme for product review to include value analysis, verification of performance in the clinical setting and education during implementation (Ullman et al, 2015)
- Institute competency measures to maintain staff compliance with patient safety guidelines. Use checklists to ensure compliance with policies of insertion and management (Sacks et al, 2014)
- Provide consistent education to multidisciplinary professionals responsible for vascular access insertion and management on best practices and the consequences of poor technique. Use outcomes to identify continuing educational needs (Frampton et al, 2014)
- After implementing education on foundational aspects of infection prevention identify specific areas of weakness that could benefit from the introduction of products designed to reduce complications. Evaluate and trial products to determine their application in the clinical setting (Keogh et al, 2014)
- Implement a multimodal quality improvement infection prevention programme that applies guidelines and recommendations to all intravascular practices (Loveday et al, 2014; McAlearney and Hefner, 2014).

Conclusion

The VHP model applies evidence to establish the most efficient means of providing safe treatment with intravenous therapies. The pathway represented in the VHP model incorporates patient-focused assessment, device selection, insertion of VADs by qualified inserters, management and evaluation of outcomes. Establishing and maintaining intravenous access is a crucial component of current medical treatment. The expectation that healthcare facilities adopt the VHP model in its entirety is an ambitious undertaking. Application of the principles of VHP are designed to ensure the best outcomes, but may be initially targeted for areas evaluated as at highest need. The subject of VHP is broad, and continued research is necessary to establish the value of the VHP model and recommendations within each quadrant.

Selection of the most appropriate VAD, inserted by a trained and qualified clinician, managed through principles of ANNT and the evaluation of patient outcomes, with the application of education for practices within each quadrant of VHP, are principles necessary to ensure safety of each patient receiving intravenous treatment. Following the VHP model will ensure that a patient receives the application of best practices with the intent to achieve the most positive outcomes. **BJN**

Declaration of interest: Nancy Moureau, the owner of PICC Excellence, Inc. Hartwell, Georgia, is an employee of Greenville Health System, Greenville, South Carolina; serves as a speaker and educational consultant for 3M, Access Scientific, AngioDynamics, Teleflex, BD Carefusion, Chiesi, Linear Sciences, Parker Laboratories, Signostics, Entrotech, and Nexus; as a researcher at Griffith University in Queensland, Australia, research grants were received from 3M, Cook Medical, and Entrotech

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CPD reflective questions

- What can you do to ensure the selection of the best vascular access device for your patient at the onset of treatment?
- Think about whether special training is needed to insert intravenous devices, especially central catheters, and whether that added education improves outcomes
- Considering the four quadrants, which represents the longest period of time? Which would you identify as the most important to patient safety?

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