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# Vascular Access

## Second Edition



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## Declaration of Conflict of Interest

In the context of RNAO best practice guideline development, the term "conflict of interest" (COI) refers to situations in which a RNAO staff member or expert panel member's financial, professional, intellectual, personal, organizational or other relationships may compromise their ability to conduct panel work independently. Declarations of COI that might be construed as constituting a perceived and/or actual conflict were made by all members of the expert panel prior to their participation in guideline development work using a standard form. Expert panel members also updated their COI at the beginning of each expert panel meeting. Any COI declared by an expert panel member was reviewed by the RNAO Best Practice Guideline Development and Research Team and expert panel co-chairs. No limiting conflicts were identified. See "Declarations of Conflicts of Interest Summary" at <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

## Acknowledgements

We acknowledge that the office of the RNAO is located on the traditional and unceded territory of the Huron-Wendat, Haudenosaunee, and most recently, the territory of the Mississaugas of the Credit. This territory was the subject of the Dish With One Spoon Wampum Belt Covenant, an agreement between the Iroquois Confederacy and the Ojibwe and allied nations to peaceably share and care for the resources around the Great Lakes. This land is still the home to many First Nations, Inuit and Métis peoples from across Turtle Island and we are grateful to have the opportunity to work on this territory. By making a land acknowledgement, we are taking part in an act of reconciliation, honouring the land and Indigenous heritage, which dates back over 10,000 years. We encourage you to learn about the land you reside on and the treaties that are attached to it; land acknowledgements are an act of reconciliation and we must all do our part.

## Contact Information

Registered Nurses' Association of Ontario  
500-4211 Yonge Street, Toronto, Ontario, M2P 2A9  
Website: [www.RNAO.ca/bpg](http://www.RNAO.ca/bpg)



# Vascular Access

Second Edition

# Greetings from Doris Grinspun,

## Chief Executive Officer, Registered Nurses' Association of Ontario



The Registered Nurses' Association of Ontario (RNAO) is delighted to present the second edition of the clinical best practice guideline (BPG) *Vascular Access, Second Edition*. Evidence-based practice supports the excellence in service that health providers are committed to delivering every day.

We offer our heartfelt thanks to the many stakeholders who make our vision for BPGs a reality. First, and most important, we thank the Government of Ontario that recognized in 1999 RNAO's capacity to lead a program that has gained worldwide recognition and is committed to funding it. We also thank the co-chairs of the RNAO expert panel, Nancy Moureau, RN, PhD (chief executive officer, PICC

Excellence) and Darlene Murray, RN, MSN (interprofessional education specialist, The Hospital for Sick Children), for their invaluable expertise and stewardship of this BPG. Thanks to RNAO staff Amy Burt (guideline development lead), Christine Buchanan (guideline development methodologist), Verity Scott (guideline development project coordinator), Glynis Gittens (guideline development project coordinator), Nafsin Nizum (senior manager, guideline development and research) and the rest of the RNAO best practice guideline development and research team for their intense and expert work in the production of this BPG. Special thanks to the expert panel for generously providing their time, knowledge and perspectives, especially during these challenging times of the COVID-19 pandemic, to deliver a rigorous and robust evidence-based resource that will guide the education and practice of health providers. We couldn't have done it without you!

Successful uptake of BPGs requires a concerted effort from educators, clinicians, employers, policy-makers, researchers and funders. The nursing and health communities, with their unwavering commitment and passion for excellence in patient care, provide the expertise and countless hours of volunteer work essential to the development of new and next edition BPGs. Employers have responded enthusiastically by becoming Best Practice Spotlight Organizations (BPSO<sup>®</sup>) – with over a 1,000 service and academic institutions in Canada and abroad. BPSO<sup>®</sup> have sponsored best practice champions, implemented BPGs, and evaluated their impact on patient and organizational outcomes. Governments at home and abroad have also joined in this awesome journey. Together, we are building a culture of evidence-based practice that benefits everyone.

We invite you to share this BPG with your colleagues from nursing and other professions, with the patient advisors who are partnering within organizations, and with the government agencies with which you work. We have so much to learn from one another. Together, we must ensure that the public receives the best possible care every time they come in contact with us—making them the real winners of this great effort!

A handwritten signature in black ink that reads "Doris Grinspun". The signature is stylized and includes a long horizontal flourish underneath.

Doris Grinspun, RN, MSN, PhD, LLD (hon), Dr (hc), FAAN, FCAN, O. ONT.  
Chief Executive Officer and Founder Best Practices Guidelines Program  
Registered Nurses' Association of Ontario

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# How to Use This Document

This **best practice guideline**<sup>G\*</sup> (BPG) is a comprehensive document that provides guidance and resources for **evidence-based nursing practice**<sup>G</sup>. It is not intended to be a manual or “how-to” guide; rather, it is a tool to guide best practices and enhance decision making for **nurses**<sup>G</sup>, the **interprofessional team**<sup>G</sup>, educators, **health-service organizations**<sup>G</sup>, academic institutions, and **persons**<sup>G</sup> and their **families**<sup>G</sup> or **caregivers**<sup>G</sup>. This BPG should be reviewed and applied in accordance with the needs of individual health-service organizations, academic institutions or other practice settings, and with the preferences of persons with a **vascular access device**<sup>G</sup> (VAD). This document provides evidence-based **recommendation**<sup>G</sup> statements and descriptions of: (a) practice, education and organizational policy; (b) benefits and harms; (c) values and preferences; and (d) health equity considerations.

Nurses, other members of the interprofessional team, educators and administrators who lead and facilitate practice changes will find this document invaluable for developing policies, procedures, protocols and educational programs to support service delivery. Nurses and other members of the interprofessional team in direct care will benefit from reviewing the recommendations and supporting evidence.

If your health-service organization is adopting this BPG, RNAO recommends that you follow these steps:

1. Assess your existing policies, procedures, protocols and educational programs in relation to the **good practice statement**<sup>G</sup>, recommendations and supporting discussions of evidence in this BPG.
2. Identify existing opportunities or gaps in your policies, procedures, protocols and educational programs.
3. Note the recommendations that are applicable to your setting and that can be used to address your organization’s existing opportunities or gaps.
4. Develop a plan for implementing recommendations, sustaining best practices and evaluating **outcomes**<sup>G</sup>.

**Implementation science**<sup>G</sup> resources, including the *Leading Change Toolkit*<sup>™</sup> (RNAO in partnership with Healthcare Excellence Canada (HEC), 2021), are available online at <https://www.RNAO.ca/leading-change-toolkit>. A description of the *Leading Change Toolkit*<sup>™</sup> can be found in **Appendix Q**. For more information, see **Implementation Strategies**.

All of the RNAO BPGs are available for download, free of charge, on the RNAO website at [RNAO.ca/bpg](https://www.RNAO.ca/bpg). To locate a particular BPG, search by keyword or browse by topic.

We are interested in hearing your feedback on this BPG and how you have implemented it. Please share your story with us at [RNAO.ca/contact](https://www.RNAO.ca/contact).

RNAO Best Practice Guidelines two decade journey can be found in: Grinspun D, Bajnok I, editors. Transforming nursing through knowledge: best practices for guideline development, implementation science, and evaluation Indianapolis (IN): Sigma Theta Tau International; 2018. Available at <https://www.sigmamarketplace.org/transforming-nursing-through-knowledge.html>

\* Throughout this document, terms that are bolded and marked with a superscript G (<sup>G</sup>) can be found in the Glossary of Terms in **Appendix A**.

# Purpose and Scope

## Purpose

RNAO's BPGs are systematically developed, evidence-based documents that include recommendations on specific clinical, healthy work environment and health system topics. They are intended for nurses, other members of the interprofessional team in direct care positions, educators, administrators and executives, policy-makers, researchers and persons with lived experience in health-service and academic organizations. BPGs promote consistency and excellence in clinical care, administrative policies, procedures and education, with the aim of achieving optimal health outcomes for people, communities and the health system as a whole.

This BPG replaces two of RNAO's BPGs *Care and Maintenance to Reduce Vascular Access Complications* (1) and *Assessment and Device Selection for Vascular Access* (2). The purpose of this BPG is to provide nurses (nurse practitioners, registered nurses, registered practical nurses and nursing students) and other members of the interprofessional team with evidence-based recommendations and resources related to the insertion, assessment and maintenance of VADs in the infant (0–1 year), pediatric (1–18 years) and adult populations (18 years and older). This BPG recognizes that persons with a VAD and their families are experts in their health and decision making. Collaboration among the interprofessional team, the person receiving care and their families is therefore essential for achieving improved health outcomes.

The RNAO convened an expert panel to determine the scope of the second edition of this BPG and to develop **recommendation questions**<sup>G</sup> to inform the **systematic reviews**<sup>G</sup>. The expert panel was interprofessional in composition. It was composed of individuals with knowledge and experience in clinical practice, education, research and policy across a range of health-service organizations, academic institutions, practice areas and sectors. These experts shared their insights on supporting and caring for persons with a VAD across the continuum of care (see page 24 for the list of RNAO best practice guideline expert panel members).

A comprehensive review and analysis was completed by the RNAO best practice guideline development and research team and the expert panel to determine the scope and priority recommendation questions for this BPG (see [Appendix C](#)).

## Scope

To determine the scope of this BPG, the RNAO best practice guideline development and research team conducted the following steps:

- reviewed the previously published RNAO BPGs: *Care and Maintenance to Reduce Vascular Access Complications* (1) and *Assessment and Device Selection for Vascular Access* (2);
- conducted an environmental scan of existing guidelines;
- led 11 telephone key informant interviews with **health providers**<sup>G</sup>, administrators, educators and researchers;
- held three telephone discussion groups with nursing students, health providers, managers, administrators and educators; and
- consulted with the expert panel.



This BPG is applicable to all practice settings where care is provided for persons with VADs (such as, but not limited to, primary care, rehabilitation, long-term care, acute care and community care), and it is to be used for all health providers who insert, assess and/or maintain VADs (e.g., registered nurses, nurse practitioners, registered practical nurses, nursing students, physicians, medical laboratory technologists, respiratory therapists, physician assistants, paramedics and child life specialists).



As with all procedures, health providers must be aware of scope of practice and follow regulatory body guidelines. Health providers should only be caring for or inserting VADs for which they have the necessary knowledge, skill and judgement. Health providers should also follow organizational policies and procedures related to VAD insertion and maintenance. This BPG addresses recommendations requiring advanced skill.

The BPG includes recommendations on the following:

- **peripheral vascular access devices<sup>G</sup>** (PVADs), such as short PVADs, or extended dwell, midline catheters;
- **central vascular access devices<sup>G</sup>** (CVADs), such as **peripherally inserted central catheters<sup>G</sup>** (PICCs), **central venous catheters<sup>G</sup>** (CVCs) or **implanted vascular access devices<sup>G</sup>** (IVADs);
- peripheral **arterial catheters<sup>G</sup>**; and
- phlebotomy devices.

**Appendix F** provides an overview of the VADs listed above.

## Key Concepts Used in This Best Practice Guideline

**Vascular access device (VAD):** A catheter (thin tube) inserted into central or peripheral veins or arteries that can be implanted or inserted under the skin, allowing fluids and medications to be delivered. Catheters inserted into arteries can be used to monitor therapy and patient status (i.e., hemodynamics) (adapted from (3)). Examples of VADs include PVADs (e.g., extended dwell, midline catheters); CVADs (e.g., PICCs, tunneled catheters, non-tunneled catheters or IVADs); peripheral arterial catheters; and phlebotomy devices.

**Interprofessional team:** A team composed of multiple health providers (regulated and unregulated) who work collaboratively to deliver comprehensive and quality health services to people within, between and across health settings (4). Key interprofessional team members supporting persons with vascular devices may include nurses, nurse practitioners, physicians, medical laboratory technologists, respiratory therapists, physician assistants, paramedics and child life specialists. It is important to emphasize that persons with a VAD and their chosen family are at the centre as active participants of the team.

**Health provider:** Refers to both regulated workers (e.g., nurses, physicians, and respiratory therapists) and unregulated workers (e.g., physician assistants and paramedics) who are part of the interprofessional team.

**Regulated health provider:** In Ontario, the *Regulated Health Professions Act, 1991* (RHPA) provides a framework for regulating 23 health professions, outlining the scope of practice and profession-specific controlled or authorized acts that each regulated professional is authorized to perform when providing health services (5).

**Unregulated health provider:** These providers fulfill a variety of roles in areas that are not subject to the RHPA. They are accountable to their employers but not to an external regulating professional body (e.g., the College of Nurses of Ontario). Unregulated health providers fulfill a variety of roles and perform tasks that are determined by their employer and employment setting. Unregulated health providers only have the authority to perform a controlled act as set out in the RHPA if the procedure falls under one of the exemptions set out in the Act (6).

## Topics Outside the Scope of This Best Practice Guideline

The following topics are not covered within the scope of this BPG:

- Certain VADs, including: pulmonary arterial catheters, implanted pumps, intra-articular devices, large bore introducer sheaths, arteriovenous fistulas, hemodialysis catheters, subcutaneous catheters, epidural, intrathecal and intraosseous devices.
- Pain management strategies for pre-term infants and those in the neonatal intensive care unit, or persons of any age undergoing surgery or in the operating room.

## Recommendation Questions

Recommendation questions are priority areas of care identified by the expert panel that require a synthesis of the evidence to answer. These recommendation questions inform the **PICO research questions**<sup>G</sup> (population, intervention, comparison, outcomes), which guide the systematic reviews and subsequently inform recommendations. The following were the priority recommendation questions and outcomes developed by the expert panel that informed the development of this BPG.

- **Recommendation Question #1:** Should providing education to persons and their families about their vascular access device be recommended?  
**Outcomes:** Hospital re-admission rate and complications.
- **Recommendation Question #2:** Should practical education for the insertion and management of vascular access devices for health providers be recommended?  
**Outcomes:** Complications (including insertion-related complications), number of successful observed attempts and provider attitude/confidence.
- **Recommendation Question #3:** Should vascular access specialist teams be recommended?  
**Outcomes:** Complications (including insertion-related complications), and number of successful observed attempts.
- **Recommendation Question #4:** Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?  
**Outcomes:** Specimen rejection, patient satisfaction, contamination rate (specific to blood cultures) and dwell time.
- **Recommendation Question #5:** Should the daily review of peripheral vascular access devices by health providers be recommended?  
**Outcomes:** Complications.

- **Recommendation Question #6:** Should the use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?

**Outcomes:** Success rate on the first attempt/number of failed attempts, patient satisfaction and complications.

- **Recommendation Question #7:** Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?

**Outcomes:** Patient's rating of pain, patient comfort, fear/anxiety (related to poke/needle phobia) and patient satisfaction.

**Note:** These priority recommendation questions are condensed versions of the more comprehensive PICO research questions developed by the expert panel to guide the systematic reviews and development of this BPG. For the PICO research questions and the detailed process of how the expert panel determined the priority recommendation questions and outcomes, see [Appendix C](#).

## Good Practice Statement and Recommendations

The recommendations and resources in this BPG address topics such as the insertion, assessment, maintenance and management of VADs. Specifically, the guideline focuses on the following areas:

- person and family education about VADs;
- specialized training requirements for health providers;
- daily review of PVADs;
- the use of visualization technologies to insert PVADs and peripheral arterial catheters;
- the use of VADs for obtaining blood samples; and
- pain management strategies during the insertion of a VAD.

The evidence-based recommendations in this BPG are applicable to all practice settings where persons with a VAD are accessing services (e.g., acute care, long-term care, rehabilitation, primary care and community settings).

In this BPG, no recommendation questions were identified that addressed the need for conducting an assessment of persons prior to initiating vascular access. Please refer to the good practice statement on assessment that nurses and other members of the interprofessional team can use in their practice. The good practice statement is believed to be so beneficial that conducting a systematic review to prove its efficacy would be unreasonable. The resulting statement is not based on a systematic review, and it does not receive a rating of the certainty or confidence in the evidence or strength (i.e., a rating of conditional or strong) (7).

## RNAO BPGs and Other Resources That Align with This BPG

Other RNAO BPGs and evidence-based resources may support implementation of this BPG. See [Appendix B](#) for RNAO BPGs and other evidence-based resources on the following related topics:

- client-centred learning;
- pain management;
- strategies to support self-management in chronic conditions;
- implementation science, implementation frameworks and resources;
- interprofessional collaboration; and
- **person- and family-centred care<sup>G</sup>**.

# Interpretation of Evidence and Recommendation Statements

RNAO BPGs are developed using the **Grading of Recommendations Assessment, Development and Evaluation (GRADE)**<sup>6</sup> methods. For more information about the guideline development process, including the use of GRADE methods, refer to [Appendix C](#).

## Certainty of Evidence

The certainty of evidence (i.e., the level of confidence we have that an estimate of effect is true) for quantitative research is determined using GRADE methods (8). After synthesizing the evidence for each prioritized outcome, the certainty of evidence is assessed. The overall certainty of evidence is determined by considering the certainty of evidence across all prioritized outcomes per recommendation. GRADE categorizes the overall certainty of evidence as *high*, *moderate*, *low* or *very low* (see [Table 1](#) for the definition of these categories).

**Table 1: Certainty of Evidence**

CERTAINTY OF EVIDENCE	DEFINITION
<b>High</b>	We are very confident that the true effect lies close to that of the estimate of the effect.
<b>Moderate</b>	We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
<b>Low</b>	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
<b>Very Low</b>	We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Source: Reprinted from: The GRADE Working Group. Quality of evidence. In: Schunemann H, Brozek J, Guyatt G, et al., editors. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach [Internet]. [place unknown: publisher unknown]; 2013 [cited 2018 Aug 31]. Table 5.1, Quality of evidence grades. Available from: <https://gdt.gradeapro.org/app/handbook/handbook.html#h.wsfivfhuxv4r>. Reprinted with permission.

**Note:** The assigned certainty of evidence can be found directly below each recommendation statement. For more information on the process of determining the certainty of the evidence and the documented decisions made by RNAO guideline development methodologists, please see [Appendix C](#).

## Strength of Recommendations

Recommendations are formulated as *strong* or *conditional* by considering the *certainty of evidence* and the following key criteria (see Discussion of Evidence, below, for definitions):

- balance of benefits and harms,
- values and preferences, and
- health equity.

According to Schunemann et al., “a strong recommendation reflects the expert panel’s confidence that the desirable effects of an intervention outweigh its undesirable effects (strong recommendation *for* an intervention) or that the undesirable effects of an intervention outweigh its desirable effects (strong recommendation *against* an intervention)” (8). In contrast, “a conditional recommendation reflects the expert panel’s confidence that the desirable effects probably outweigh the undesirable effects (conditional recommendation for an intervention) or undesirable effects probably outweigh desirable effects (conditional recommendation against an intervention), but some uncertainty exists” (8). **Table 2** outlines the implications of strong and conditional recommendations.

**Table 2: Implications of Strong and Conditional Recommendations**

POPULATION	STRONG RECOMMENDATION	CONDITIONAL RECOMMENDATION
<b>For health providers</b>	<ul style="list-style-type: none"> <li>■ The benefits of a recommended action outweigh the harms. Therefore, most persons should receive the recommended course of action.</li> <li>■ There is little variability in values and preferences among persons in this situation.</li> <li>■ There is a need to consider the person’s circumstances, preferences and values.</li> </ul>	<ul style="list-style-type: none"> <li>■ The benefits of a recommended course of action probably outweigh the harms. Therefore, some persons could receive the recommended course of action.</li> <li>■ There is greater variability in values and preferences, or there is uncertainty about typical values and preferences among persons in this situation.</li> <li>■ There is a need to consider the person’s circumstances, preferences and values more carefully than usual.</li> </ul>
<b>For persons receiving care</b>	<ul style="list-style-type: none"> <li>■ Most persons would want the recommended course of action, and a small portion would not.</li> </ul>	<ul style="list-style-type: none"> <li>■ The majority of persons in this situation would want the suggested course of action, but many would not.</li> </ul>
<b>For policy-makers</b>	<ul style="list-style-type: none"> <li>■ The recommendation can be adapted as policy in most situations</li> </ul>	<ul style="list-style-type: none"> <li>■ Policy-making will require substantial debate and involvement of many stakeholders. Policies are also more likely to vary between regions.</li> </ul>

Source: Adapted from: The GRADE Working Group. Quality of evidence. In: Schunemann H, Brozek J, Guyatt G, et al., editors. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach [Internet]. [place unknown: publisher unknown]; 2013 [cited 2020 May 11]. Table 6.1, Implications of strong and weak recommendations for different users of guidelines. Available from: <https://gdt.gradeapro.org/app/handbook/handbook.html#h.wsfvfhuxv4r>

**Note:** The strength of each recommendation statement is detailed directly below it and in the **Summary of Recommendations** (page 13). For more information on the process used by the expert panel to determine the strength of each recommendation, please see [Appendix C](#).

## Discussion of Evidence

The Discussion of Evidence that follows each recommendation includes the following main sections:

1. **Benefits and Harms:** Identifies the potential desirable and undesirable outcomes reported in the literature when the recommended practice is used. Content in this section solely includes research from the systematic review.
2. **Values and Preferences:** Denotes the relative importance or worth placed on health outcomes derived from following a particular clinical action from a person-centered perspective. Content for this section may include research from the systematic reviews and, when applicable, observations and/or considerations from the expert panel.
3. **Health Equity:** Identifies the potential impact that the recommended practice could have on health across different populations or settings and/or the barriers to implementing the recommended practice in particular settings. This section may include research from the systematic reviews and, when applicable, observations and/or considerations from the expert panel.
4. **Expert Panel Justification of Recommendation:** Provides a rationale for why the expert panel made the decision to rate a recommendation as strong or conditional.
5. **Practice Notes:** Highlights pragmatic information for nurses and other members of the interprofessional team. This section may include supporting evidence from the systematic review and/or from other sources (e.g., the expert panel).

**Supporting Resources:** Includes a list of relevant resources (e.g., websites, books and organizations) that support the recommendations. Content listed in this section was assessed based on five criteria: relevancy, credibility, quality, accessibility and timeliness of publication (i.e., published within the last 10 years). Further details about this process and the five criteria are outlined in [Appendix C](#). The list is not exhaustive and the inclusion of a resource in one of these lists does not imply an endorsement from RNAO. Some recommendations may not have any identified supporting resources. **Note:** all supporting resources are freely available or open access unless otherwise noted.



# Summary of Recommendations

## GOOD PRACTICE STATEMENT

The expert panel recommends health providers complete a systematic assessment of the person prior to inserting a vascular access device.

*As a good practice, this statement does not require application of the GRADE system. For more information on the good practice statement in this BPG, please see page 37.*

RECOMMENDATIONS	STRENGTH OF THE RECOMMENDATION
<p><b>Recommendation Question #1:</b> Should providing education to persons and their families about their vascular access device be recommended?</p> <p><b>Outcomes:</b> Hospital re-admission rate and complications.</p>	
<p><b>Recommendation 1.1:</b> The expert panel recommends that health providers provide comprehensive health teaching to persons and their families/caregivers about their vascular access device.</p>	<p>Strong</p>
<p><b>Recommendation Question #2:</b> Should practical education for the insertion and management of vascular access devices for health providers be recommended?</p> <p><b>Outcomes:</b> Complications (including insertion-related complications), number of successful observed attempts and provider attitude/confidence.</p>	
<p><b>Recommendation 2.1:</b> The expert panel recommends health-service organizations implement practical education on the insertion and/or management of vascular access devices for health providers.</p>	<p>Strong</p>
<p><b>Recommendation Question #3:</b> Should vascular access specialist teams be recommended?</p> <p><b>Outcomes:</b> Complications (including insertion-related complications) and number of successful observed attempts.</p>	
<p><b>Recommendation 3.1:</b> The expert panel suggests that acute care health-service organizations implement vascular access specialists or vascular access specialist teams to support the insertion and management of vascular access devices.</p>	<p>Conditional</p>

<p><b>Recommendation Question #4:</b> Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?</p> <p><b>Outcomes:</b> Specimen rejection, patient satisfaction, contamination rate (specific to blood cultures) and dwell time.</p>	
<p><b>Recommendation 4.1:</b> The expert panel suggests health providers perform venipuncture when drawing blood samples to maintain specimen integrity.</p>	<p>Conditional</p>
<p><b>Recommendation Question #5:</b> Should the daily review of peripheral vascular access devices by health providers be recommended?</p> <p><b>Outcomes:</b> Complications.</p>	
<p><b>Recommendation 5.1:</b> The expert panel recommends that acute care health-service organizations implement a multi-component peripheral vascular access device care protocol. This protocol includes a minimum of a daily review by health providers, in collaboration with persons and their families.</p>	<p>Strong</p>
<p><b>Recommendation Question #6:</b> Should the use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?</p> <p><b>Outcomes:</b> Success rate on the first attempt/number of failed attempts, patient satisfaction and complications.</p>	
<p><b>Recommendation 6.1:</b> The expert panel recommends that health providers use ultrasound-guided technique for the insertion of peripheral arterial catheters.</p>	<p>Strong</p>
<p><b>Recommendation 6.2:</b> The expert panel suggests that health providers use ultrasound-guided technique for the insertion of peripheral vascular access devices in persons with difficult intravenous access.</p>	<p>Conditional</p>

**Recommendation Question #7:**

Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?

**Outcomes:** Patient’s rating of pain, patient comfort, fear/anxiety (related to poke/needle phobia) and patient satisfaction.

**Recommendation 7.1:**

The expert panel recommends that health providers offer adults non-pharmacological and pharmacological pain management strategies during the insertion of a vascular access device.

Strong

**Recommendation 7.2:**

The expert panel recommends that health providers offer non-pharmacological and pharmacological pain management strategies during the insertion of a vascular access device to infants and children, tailored to their age and developmental stage.

Strong



## Best Practice Guideline Evaluation

As you implement the recommendations in this BPG, we ask you to consider how you will monitor and evaluate its implementation and impact.

The Donabedian model, which informs the development of indicators for evaluating quality health care, includes three categories: structure, process and outcome (9).

- **Structure** describes the required attributes of the health system or health-service organization to ensure quality care. It includes physical resources, human resources, and information and financial resources.
- **Process** examines the health-care activities being provided to, for and with persons or populations as part of the provision of quality care.
- **Outcome** analyzes the effect of quality care on the health status of persons and populations, health workforce, health-service organizations or health systems (9).

For additional information, please refer to the RNAO, in partnership with Healthcare Excellence Canada (HEC), *Leading Change Toolkit*<sup>™</sup> (10).

The following indicators have been developed to support evaluation and quality improvement. Consider **Tables 3, 4** and **5**, which provide a list of structure, process and outcome indicators to assess the impact of BPG implementation and are derived from BPG recommendations. Each table also identifies if the indicator aligns with other indicators in local, provincial, national and/or international data repositories and/or instruments. Alignment with data repositories/instruments is determined by comparing the following criteria with the developed indicators: the operational definition; if the indicator is nursing sensitive; and the inclusion/exclusion criteria. Depending upon the level of alignment, an indicator may be described to have full, partial or no alignment with external data repositories/instruments.

The following indicators will support quality improvement and evaluation. Select the indicators most relevant to the changes being made in practice, education and/or policy based on BPG recommendations that are prioritized for implementation.

**Table 3** provides structure indicators associated with specific recommendation statements that are related to human resources, educational recommendations and/or other organizational factors.

**Table 3: Structure Indicators**

RECOMMENDATION	STRUCTURE INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/ INSTRUMENTS
2.1	<p>Percentage of health providers who received practical education on the insertion and/or management of vascular access devices</p> <p><i><b>Numerator:</b> Number of health providers who received practical education on the insertion and/or management of vascular access devices</i></p> <p><i><b>Denominator:</b> Total number of health providers</i></p>	New

**Table 4** supports the evaluation of practice changes during implementation. The indicators are directly associated with specific recommendation statements and support process improvement.

**Table 4: Process Indicators**

RECOMMENDATION	PROCESS INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/ INSTRUMENTS
<b>Good Practice Statement</b>	<p>Percentage of persons who received a systematic assessment prior to having a vascular access device inserted</p> <p><i><b>Numerator:</b> Number of persons who received a systematic assessment prior to having a vascular access device inserted</i></p> <p><i><b>Denominator:</b> Total number of persons requiring a vascular access device for therapy</i></p>	New

RECOMMENDATION	PROCESS INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/ INSTRUMENTS
1.1	<p>Percentage of persons who received comprehensive health teaching from a health provider about their vascular access device</p> <p><i><b>Numerator:</b> Number of persons who received comprehensive health teaching from a health provider about their vascular access device</i></p> <p><i><b>Denominator:</b> Total number of persons with a vascular access device</i></p>	New
5.1	<p>Percentage of persons with a peripheral vascular access device who received care according to a multi-component peripheral vascular access device care protocol, which includes a minimum of a daily review of the peripheral vascular access device and site</p> <p><i><b>Numerator:</b> Number of persons with a peripheral vascular access device who received care according to a multi-component peripheral vascular access device care protocol, which includes a minimum of a daily review of the peripheral vascular access device and site</i></p> <p><i><b>Denominator:</b> Total number of persons with a peripheral vascular access device</i></p>	<p>Partial Alignment with National Quality Forum (NQF)</p> <p>Partial Alignment with Healthcare Excellence Canada (HEC)</p>
6.1	<p>Percentage of persons who received ultrasound-guided technique for the insertion of peripheral arterial catheters</p> <p><i><b>Numerator:</b> Number of persons who received ultrasound-guided technique for the insertion of peripheral arterial catheters</i></p> <p><i><b>Denominator:</b> Total number of persons with a peripheral arterial catheter inserted</i></p>	Partial Alignment with NQF



RECOMMENDATION	PROCESS INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/ INSTRUMENTS
7.1	<p>Percentage of adults who received non-pharmacological and/or pharmacological pain management strategies during the insertion of a vascular access device</p> <p><i><b>Numerator:</b> Number of adults who received non-pharmacological and/or pharmacological pain management strategies during the insertion of a vascular access device</i></p> <p><i><b>Denominator:</b> Total number of adults who had a vascular access device inserted</i></p>	<p>Partial Alignment with Collaborative Alliance for Nursing Outcomes (CALNOC)</p>
7.2	<p>Percentage of infants and children who received non-pharmacological and/or pharmacological pain management strategies during the insertion of a vascular access device, tailored to their age and developmental stage</p> <p><i><b>Numerator:</b> Number of infants and children who received non-pharmacological and/or pharmacological pain management strategies during the insertion of a vascular access device, tailored to their age and developmental stage</i></p> <p><i><b>Denominator:</b> Total number of infants and children who had a vascular access device inserted</i></p>	<p>Partial Alignment with CALNOC</p> <p>Partial Alignment with National Database of Nursing Quality Indicators (NDNQI)</p>

**Table 5** provides outcome indicators to assess the impact of implementing evidence-based practice changes.

**Table 5: Outcome Indicators**

OUTCOME INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/INSTRUMENTS
<p>Percentage of persons who experience peripheral vascular access device related complication(s)</p> <p><i><b>Numerator:</b> Number of persons who experience peripheral vascular access device related complication(s)</i></p> <p><i><b>Denominator:</b> Total number of persons with a peripheral vascular access device</i></p>	<p>Partial Alignment with National Database of Nursing Quality Indicators (NDNQI)</p>
<p>Percentage of persons who experience central vascular access device related complication(s)</p> <p><i><b>Numerator:</b> Number of persons who experience central vascular access device related complication(s)</i></p> <p><i><b>Denominator:</b> Total number of persons with a central vascular access device</i></p>	<p>New</p>
<p>Percentage of persons who experience one or more central line-associated blood stream infection(s) (CLABSI)</p> <p><i><b>Numerator:</b> Number of persons who experience one or more central line-associated blood stream infection(s) (CLABSI)</i></p> <p><i><b>Denominator:</b> Total number of persons with a central vascular access device</i></p>	<p>Full Alignment with Agency for Healthcare Research and Quality (AHRQ)</p> <p>Full Alignment with NDNQI</p> <p>Full Alignment with National Quality Forum (NQF)</p> <p>Full Alignment with Healthcare Excellence Canada (HEC)</p> <p>Full Alignment with Ontario Health</p>

OUTCOME INDICATORS	ALIGNMENT WITH INDICATORS IN DATA REPOSITORIES/INSTRUMENTS
<p>Percentage of persons who experience moderate or severe pain related to insertion of a vascular access device as determined by the use of an appropriate, validated pain scale</p> <p><i><b>Numerator:</b> Number of persons who experience moderate or severe pain related to insertion of a vascular access device</i></p> <p><i><b>Denominator:</b> Total number of persons who had a vascular access device inserted</i></p>	New
<p>Rate of documented successful vascular access device insertions on the first attempt of insertion per 1000 care-days/care-visits</p> <p><i><b>Numerator:</b> Number of documented successful vascular access device insertions on the first attempt of insertion</i></p> <p><i><b>Denominator:</b> Total number of care-days/care-visits during the measurement period</i></p>	New

Other RNAO resources for the evaluation and monitoring of BPGs:

- Nursing Quality Indicators for Reporting and Evaluation® (NQuIRE®), a unique international data system housed in the International Affairs and Best Practice Guidelines Centre, allows Best Practice Spotlight Organizations® (BPSOs®) to measure the impact of BPG implementation. The NQuIRE data system collects, compares and reports data on human resource structure indicators as well as guideline-based, nursing-sensitive structure, process and outcome indicators. NQuIRE indicator definitions are aligned with available administrative data and existing performance measures wherever possible, adhering to a “collect once, use many times” principle. By complementing other established and emerging performance measurement systems, NQuIRE strives to leverage reliable and valid measures, minimize reporting burden and align evaluation measures to enable comparative analyses. The international NQuIRE data system was launched in August 2012 to create and sustain evidence-based practice cultures, optimize safety of persons, improve health outcomes and engage staff in identifying relationships between practice and outcomes to advance quality and advocate for resources and policy that support best practice changes (11). Please visit [RNAO.ca/bpg/initiatives/nquire](http://RNAO.ca/bpg/initiatives/nquire) for more information.
- **BPG Order Sets**<sup>TMG</sup> embedded within electronic records are technology-enabled implementation tools that provide a mechanism for electronic data capture of process and outcome measures. The ability to link structure and process measures with specific client outcome measures aids in determining the impact of BPG implementation on specific health outcomes. Please visit <http://RNAO.ca/ehealth/bpgordersets> for more information.

# RNAO Best Practice Guideline Development and Research Team

## Amy Burt, RN, MSc

Guideline Development Lead

(March 2019–June 2021)

Guideline Development Methodologist  
International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Christine Buchanan, RN, MN

Guideline Development Methodologist

(September 2019–June 2021)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Glynis Gittens, BA (Hons)

Guideline Development Project Coordinator

(May 2018–August 2019, October 2020–June 2021)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Verity Scott, BSc

Guideline Development Project Coordinator

(September 2019–July 2020)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Nafsin Nizum, RN, MN

Senior Manager, Guideline Development and Research

(November 2019– June 2021)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Giulia Zucal, RN, BScN, MA

Former Senior Manager, Guideline Development and Research (May 2018–October 2019)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Megan Bamford, RN, MScN

Former Associate Director, Guideline Development and Evaluation (May 2018–September 2020)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Yonda Lai, RN, MN

Former Guideline Development Methodologist

(May 2018– March 2019)

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Stephanie Voong, RN, MHI

Senior Manager, Quality Improvement and BPG Order Sets™

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Christina Medeiros, RN, BScN, BPHE, BEd, MN, PhD Candidate

Senior Manager, Evaluation and Monitoring

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Shanoja Naik, PhD, MPhil, MSc, BEd, BSc

Data Scientist/Statistician, Health Outcomes Research, NQuIRE®

International Affairs and Best Practice Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

## Beverly Faubert, RN, BScN, GNC(C), CHPCN(C), CPMHN(C)

Long-Term Care Best Practices Coordinator

Long-Term Care Best Practices Program

Registered Nurses' Association of Ontario  
Toronto, ON

**Heather Woodbeck, RN, HBScN, MHSA**

Long-Term Care Best Practice Coordinator  
Long-Term Care Best Practices Program  
Registered Nurses' Association of Ontario  
Toronto, ON

**Heather McConnell, RN, BScN, MA(Ed)**

Director  
International Affairs and Best Practice  
Guidelines Centre  
Registered Nurses' Association of Ontario  
Toronto, ON

**Doris Grinspun, RN, MSN, PhD, LLD (hon), Dr (hc), FAAN, FCAN, O. ONT.**

Chief Executive Officer  
Registered Nurses' Association of Ontario  
Toronto, ON

**Acknowledgements**

External review provided by:

**Nancy Santesso, RD, MLIS, PhD**

Assistant Professor  
Department of Health Research Methods, Evidence  
and Impact, McMaster University  
Deputy Director, Cochrane Canada

Systematic search completed by:

**UHN HealthSearch**



# RNAO Best Practice Guideline Expert Panel

## Nancy Moureau, RN, PhD

Expert Panel Co-chair  
Chief Executive Officer  
PICC Excellence  
Hartwell, GA

## Darlene Murray, RN, MSN

Expert Panel Co-chair  
Interprofessional Education Specialist, Diagnostic  
Imaging and Vascular Access  
The Hospital for Sick Children  
Toronto, ON

## Carmen Cernusca, RN, BScN, MScN, GCIN, CVAA(c) (January 2020-June 2021)

Nurse Educator, Medicine and Surgery programs  
Niagara Health  
St. Catharines, ON

## Sandra Dragic, RN

Care Facilitator, Vascular Access Team  
Children's Hospital of Eastern Ontario  
Ottawa, ON

## Leslie Graham, RN, MN, PhD Candidate, CNCC, CHSE, CCSNE

Coordinator RPN to BScN Nursing Program  
Professor Nursing, Durham College  
Adjunct Professor, Ontario Tech University  
Oshawa, ON

## Lisa Honeyford, RN, MN, CPHON

Interprofessional Education Specialist  
Hematology/Oncology/Blood and Marrow Transplant,  
Medication Safety  
The Hospital for Sick Children  
Toronto, ON

## Brigid Hughes-Tippett, RN, BScN, MA (Ed)

Manager/Clinical Practice Leader, Professional Practice  
Scarborough Health Network  
Toronto, ON

## Stefanie Irish, BScN, RN, RPN

Clinical Supervisor, Niagara College  
Emergency Department Nurse, Niagara Health  
Niagara Falls, ON

## Andrea Kay, RN

Senior Executive Labour Relations  
Ontario Nurses' Association  
Toronto, ON

## Karen Laforet, RN, BA, MCISc, VA-BC™, CCHN(C), CVAA(c) (January 2020-June 2021)

Manager, Clinical Excellence-Nursing for CBI Health  
Faculty, York University  
Mississauga, ON

## Marie MacDonnell, RN, BScN, CVAA(c) (September 2018-January 2019)

Nurse Clinician, Infection Control  
Humber River Hospital  
Toronto, ON

## Larissa Matukas, MSc, MD, FRCPC

Head, Division of Microbiology and Infectious Disease  
Consultant, Department of Laboratory Medicine  
St. Michael's Hospital, Unity Health Toronto  
Associate Professor, Department of Laboratory  
Medicine and Pathobiology, University of Toronto  
Toronto, ON

## Sheryl McDiarmid, RN, BScN, MEd, MBA, AOCN, ACNP, CRNI, CVAA

(September 2018-December 2019)  
Advanced Practice Nurse, Vascular Access, Apheresis  
and Blood and Marrow Transplant Programs  
President, Corporate Vascular Access Program  
The Ottawa Hospital  
Ottawa, ON



**Natasha Mills, RN, MN, NP**

Nurse Practitioner, Pediatric Anesthesia, Department of Anesthesia and Pain Medicine, Perioperative Care Unit  
The Hospital for Sick Children  
Toronto, ON

**Emily Quantz, RN, BScN**

Patient Safety and Quality Lead  
Cambridge Memorial Hospital  
Cambridge, ON

**Nigel Ruse, RN, MN, CRNI**

Clinical Instructor, Vascular Access Team  
The Hospital for Sick Children  
Toronto, ON

**Krista Shea, RN, BScN CNCC(C)**

Nursing Professional Practice Consultant  
London Health Sciences Center  
London, ON

**Shafqat Tahir**

Manager, Laboratory Quality and Risk Management  
St. Michael's Hospital  
Toronto, ON

**Debra White, RN**

Georgian College/Innomar Strategies  
Faculty Health Sciences/Specialty Field Nurse  
Barrie, ON



# Stakeholder Acknowledgment

As a component of the guideline development process, feedback was obtained from participants across a wide range of health-service organizations, academic institutions, practice areas and sectors. Participants include nurses and other members of the interprofessional team, educators, students, individuals with lived experience and knowledgeable administrators. **Stakeholders**<sup>G</sup> representing diverse perspectives were also solicited for their feedback (see [Appendix C](#)). RNAO wishes to acknowledge the following individuals for their contribution in reviewing this BPG.

Stakeholder reviewers have given consent to the publication of their names and relevant information they provided, as noted below, in this BPG.

## Jeff Andrews, RPN

Registered Practical Nurse  
Hamilton Health Sciences  
Hamilton, ON

## Nicole Baker, RN, BScN (Hons), HBSc

Registered Nurse  
St. Michael's Hospital, Unity Health Toronto  
Toronto, ON

## Kaitlyn Beaulieu, RN, BScN

Registered Nurse  
Windsor, ON

## Clara Bendito Barber, RN, MScN

Research Nurse  
Mateu Orfila Hospital  
Menorca, Balearic Island, Spain

## Kimberley Bowen, RN, CNS

Clinical Nurse Specialist — Medication  
Management and Safety  
Niagara Health  
Welland, ON

## Daphne Broadhurst, RN, MN, CVAA(c)

Clinical Nurse Specialist  
Infusion Excellence Consulting  
Ottawa, ON

## Mariquilange (Mary) Aubin Cadet, RN, BScN, CHPCN

Nursing Supervisor  
VHA Home HealthCare  
Whitby, ON

## Victoria Cameron, RN, BScN

Registered Nurse  
Health Sciences North  
Sudbury, ON

## Aimee Campbell, RN, MScN

Nurse Educator  
Niagara Health  
Niagara Falls, ON

## Anastasia Carron, RN, MSN

Professional Practice Supervisor  
Bluewater Health  
Sarnia, ON

## Sonia Chahal, RN

Registered Nurse/Joint Quality and Education Lead  
in the Cardiac Critical Care Unit (CCCU)  
The Hospital for Sick Children  
Toronto, ON

## Marecar Joanne Chan, RN, MN

Advance Practice Nurse Educator  
University Health Network  
Toronto, ON

**Elizabeth Chapman, RN, MN (student)**

Registered Nurse—Emergency Services  
North York General Hospital  
Toronto, ON

**Angela Cheeseman, RPN**

Outpost Nurse  
Canadian Health Care Agency Ltd.  
Pikangikum, ON

**Nan Cleator, RN, CCHN**

Practice Consultant  
Victorian Order of Nurses for Canada  
Bracebridge, ON

**Teresa Compton, RN, BScN**

Clinical Nurse Educator  
Southlake Regional Health Center  
Newmarket, ON

**Tia Cooney, RN, BScN, MScN, DNP**

Professor  
Confederation College  
Thunder Bay, ON

**Stephanie Crump, RN, BSocSci, BScN, MScN**

Registered Nurse  
Unity Health Toronto and University Health Network  
Toronto, ON

**Amanda Cybulski, RN**

Registered Nurse  
London Health Sciences Center  
London, ON

**Jessica Dolinski, RN, BScH, BN**

Nurse Educator  
Niagara Health  
St. Catharines, ON

**Pamela Elwood, RN, BScN, CVAA(c)**

Toronto, ON

**Eliana Evenaar, RPN, IIVCC, CAPCE, RN (student)**

Registered Practical Nurse  
Peterborough Regional Health Centre  
Peterborough, ON

**Christina Lubinsky Fossella, RN**

Registered Nurse  
St. Michael's Hospital, Unity Health Toronto  
Toronto, ON

**Jacqueline Foster, RN**

Registered Nurse  
Children's Hospital of Eastern Ontario  
Ottawa, ON

**Sarah Gallie, RN, BScN, BSc**

Registered Nurse, Central HAC Audit Nurse  
The Hospital for Sick Children  
Toronto, ON

**Amy Gargal, RN, BScN, MN**

Clinical Nurse Educator  
Muskoka Algonquin Healthcare  
Bracebridge, ON

**Erin Gisborne, RN, BScN**

Clinical Nurse Educator  
Royal Victoria Regional Health Centre  
Barrie, ON

**Beth Gore, PhD**

Operations Manager, Association for Vascular Access  
(AVA) Foundation for Patient Safety  
United States

**Colleen Heywood, RN**

Registered Nurse  
University of Ottawa Heart Institute  
Ottawa, ON

**Brennah Holley, RN, BScN, CPHON**

Clinical Nurse Educator  
Children's Hospital of Eastern Ontario  
Ottawa, ON

**Courtney Houldsworth, RN, BScN**

Clinical Nurse Educator  
Royal Victoria Regional Health Centre  
Barrie, ON

**Lorrie Hudd, RN(EC), MN, NP-Adult**

Professor of Nursing  
Niagara College  
Grimsby, ON

**Janet Hunt, RN, MScN**

London, ON

**Mark Kocsis, RN, BScN**

Clinical Educator—Nursing  
St. Joseph's Health Centre, Unity Health Toronto  
Toronto, ON

**Shelly Philip LaForest, RN, BN, MN, CVAA(c)**

Registered Nurse, Vascular Access Team  
The Hospital for Sick Children  
Toronto, ON

**Amanda Lévesque, RN, BScN, CMSN(C)**

Registered Nurse  
The Ottawa Hospital  
Ottawa, ON

**Richard Lusombe, RN, BSN**

Vascular Access Clinical Nurse Leader (Nephrology)  
Providence Health Care  
Vancouver, BC

**Caitlin Lynch, RN**

Staff Nurse  
Toronto, ON

**Chanda MacDonald, RN**

Clinical Educator  
Nova Scotia Health Authority  
New Glasgow, NS

**Sasha Mazzarello, RN, MSc, BSc, BScN**

Pediatric Emergency Department Registered Nurse  
Children's Hospital of Eastern Ontario  
Ottawa, ON

**Kerry McDonald, RN, CVAA(c)**

CVAD Specialist  
Pembroke Regional Hospital  
Pembroke, ON

**Nicole McGrath, RN, BScN, MScN, IIWCC-CAN**

Clinical Nurse Specialist  
Toronto Central LHIN  
Toronto, ON

**Lindsay McLean, RN, BScN, MScN**

Professional Practice Supervisor  
Bluewater Health  
Sarnia, ON

**Yeshika Meirno, PhD**

Nurse Supervisor  
Donostia University Hospital  
San Sebastián, Gipuzkoa, Spain

**José Miguel Mendes, RN**

Pediatric Nurse  
IPO-Porto  
Porto, Portugal

**Tawnya Norton, RPN**

Registered Practical Nurse  
St. Joseph's Healthcare Hamilton  
Hamilton, ON

**Roseline Oladipo, RN**

Registered Nurse (Community/Visiting)  
CarePartners  
St. Catharines, ON

**Melika Onat, RN, BScN**

Toronto, ON

**Janet Patch, RN, BA, BScN**

Visit Nursing Program  
Carefor Health and Community Services  
Ottawa, ON

**Sapna Patel, RN, MN**

Advanced Practice Leader—Nurse  
Baycrest Health Sciences  
Toronto, ON

**Melissa Pelletier, RN, BScN, CNeph(C)**

Clinical Educator  
Professional Practice and Regional Renal Program  
Royal Victoria Regional Health Centre  
Barrie, ON

**Joana Aintzane Ubierna Prieto, RN**

Staff Nurse  
Osakidetza–HUB  
Bilbao, Biscay, Spain

**Jenna Puk, RN, BScN, BSc (Hons)**

Registered Nurse  
Royal Victoria Regional Health Centre  
Barrie, ON

**Julianna Pullano, RN**

Registered Nurse  
The Hospital for Sick Children  
Toronto, ON

**Timea Raduly, RN, MEd**

Pelham, ON

**Vanesa Regulez**

Nurse  
Teaching Department of Cruces' University Hospital  
(OSI Ezkerraldea–Enkarterri–Cruces)  
Osakidetza  
Baracaldo, Biscay, Spain

**Noemi Cortés Rey, RN**

Nurse Supervisor  
University Hospital Complex A Coruña  
A Coruña, Spain

**Sabeena Felicia Roberts, RN**

Labour Nurse  
Toronto, ON

**Sabeena Santhirakumaran, RN, HBScN,  
HBSc**

Registered Nurse  
Princess Margaret Cancer Centre,  
University Health Network  
Toronto, ON

**Andrew Sieminski, RPN**

Medical Floor Nurse  
St. Mary's Hospital  
Waterloo, ON

**Sarah Smees, MN, BScN, VA-BC, CVAA, OCN**

Advanced Practice Nurse Educator  
Elora, ON

**Alexis Smith, RN, MScN**

Professional Practice Consultant  
St. Joseph's Healthcare London  
London, ON

**Stephanie Swailes, RN, BScN, MN**

Registered Nurse  
Toronto General Hospital, University Health Network  
Toronto, ON

**Rehnuma Tabassum, RN, MGMT**

Critical Care Registered Nurse  
Newmarket, ON

**Dr. Melissa Tawiah, RN, MD, BNSc**

University Health Network  
Toronto, ON

**Grace Terry, RN, BScN, MSc**

Registered Nurse  
Muskoka Algonquin Healthcare  
Huntsville, ON

**Leyla Teymouri, RN**

Nurse Clinician, Infusion Therapy  
Mount Sinai Hospital  
Toronto, ON

**Jennifer Theis, RN, BScN**

Clinical Educator Facilitator  
Cambridge Memorial Hospital  
Cambridge, ON

**Thirisangi Thiruparanathan, RN, BSc,  
BScN, MN (student)**

Registered Nurse  
University Health Network  
Toronto, ON

**Natasha Valentine, RN, BScN, MN Candidate**

Registered Nurse  
Hillsdale Terraces  
Oshawa, ON

**Lisa VanderWees, RN**

Registered Nurse  
Brampton, ON

**Shawna Watt, RN**

Float Nurse/Vascular Access Team  
Children's Hospital of Eastern Ontario  
Ottawa, ON

**Alexandra Wells, RN**

Clinical Nurse Educator  
Royal Victoria Regional Health Centre  
Barrie, ON

**Tim Wharton, RN, BScN**

Professor, School of Practical Nursing and PSW  
Niagara College  
Welland, ON

**Sherry Witmer, RN**

Registered Nurse, Secondary Stroke Prevention Clinical  
(SSPC)  
Grand River Hospital  
Kitchener, ON

**Lidia Yanchuk, RN, BScN**

Registered Nurse  
London Health Sciences Centre  
London, ON

**May Zaw, RN**

Registered Nurse  
Children's Hospital of Eastern Ontario  
Ottawa, ON

**Kerry Zimmer, RN, BScN**

Georgian College  
Penetanguishene, ON



# Background Context

## Vascular Access and Vascular Access Devices

Vascular access is the most common invasive procedure undergone by persons in the health system (12). Vascular access devices (VADs) are catheters inserted into central or peripheral veins or arteries that can be implanted or inserted under the skin (3). Catheters inserted into veins can be used to deliver fluids and medicines directly into the bloodstream of a person (3). Catheters inserted into arteries can be used to monitor therapy and patient status (i.e., hemodynamics) (3). There are different types of VADs that are used depending on the person's need. This includes devices such as:

- peripheral vascular access devices (PVADs), such as short peripheral intravenous catheters (PIVs) and extended dwell, midline catheters;
- central vascular access devices (CVADs), such as peripherally inserted central catheters (PICCs), tunneled catheters, non-tunneled catheters and implanted vascular access devices (IVADs);
- peripheral arterial catheters; and
- phlebotomy devices.

**Appendix F** provides an overview of the VADs listed above.

In the simplest sense, a VAD consists of a hub, a hollow tube divided into one or multiple sections (lumens) and a tip that may terminate within a peripheral or central blood vessel (13). VADs can be classified differently based on the insertion site and location of the device (13). PVADs remain in the periphery, with the terminal tip below the level of the axillary vein for upper extremity placement (14). CVADs are inserted with the terminal tip entering central circulation and advancing towards the heart. Except for haemodialysis catheters, terminal tip placement of all CVADs is in the vena cava (14).

Infusion therapy using VADs has historically been delivered in a hospital setting. However, infusion therapy and use of VADs increasingly is expanding into alternative health settings, including community care, infusion clinics and self-administration in the home (15). With wider use of VADs and a changing health landscape, it is important to recognize and support nurses, other members of the interprofessional team, and persons with vascular devices and their families with the administration of therapies involving VADs (15).

## Complications

Reliable vascular access is fundamental for safe and effective care (13). Ensuring safe insertion and management of VADs should be a priority for all health providers. Despite their important role, VADs are often the source of hospital-acquired infections and other types of **complications**<sup>G</sup> (13). In the United States, approximately 250,000 catheter-related blood stream infections occur each year, with an associated increase in length of stay and hospital costs (16).

**Central line-associated blood stream infections (CLABSI)**<sup>G</sup> are associated with particularly high morbidity and mortality: mortality is estimated to be between 4% and 20% (17). One CLABSI case prolongs hospitalization by an average of seven days and costs an estimated \$3,700 USD to \$29,000 USD (17). Other complications that can occur during the insertion or management of CVADs include catheter occlusion, catheter breakage/leakage, bleeding,

thrombosis or thrombo-embolism, perforation of vessels, pneumothorax, cardiac arrhythmias, air embolisms and central venous stenosis (12). Safe vascular access and management is integral to ensure low risk and better outcomes for persons receiving care: care bundles or **multi-component care protocols**<sup>G</sup> have been widely used to address these complications in CVADs.

Common complications associated with PVADs include **phlebitis**<sup>G</sup>, **infiltration**<sup>G</sup> and **extravasation**<sup>G</sup> (18). Phlebitis is the most common complication of PVADs, occurring when there is acute inflammation of a vein in the presence of intravenous therapy (19). Infiltration occurs when infusing fluids leak into the surrounding tissue, caused by dislodgment of the VAD catheter, improper placement or damage to the vessel (18). Finally, extravasation occurs when there is infiltration of a **vesicant**<sup>G</sup> medication or other agent that can cause tissue damage, pain, inflammation, irritation, blistering or necrosis (18).

## Holistic and Person- and Family-centred Care

Person- and family-centred care means that the health provider is attentive to the emotional needs of the person with a VAD and their family or caregiver(s) (15). The nurse and other members of the interprofessional team play a large role in delivering care that is holistic and person- and family-centered. The selection, insertion and management of VADs by health providers have important implications for the person receiving care and their family. A person's preferences of VADs are unique and will depend on their diagnosis and intended treatment (12), their reasons for requiring a VAD, their health care context and their prior experience. As such, a person's preferences regarding infusion therapy may differ from those of health providers (15).

It is important to consider a variety of factors when choosing which VAD is most appropriate for a person. This consideration should be based on their condition as well as principles of person- and family-centred care. The use of only one device may not meet the vascular access needs of the person, necessitating the use of several devices throughout therapy (20). Considerations about preserving and minimizing vessel trauma, such as protocols that limit the number of VAD insertion attempts by a health provider, are also important (20).

VAD considerations are also likely to change across a person's lifespan. PVAD insertion can be more difficult in children due to their thin blood vessels, the deepness of the vessels, the cooperation level of the child (21), and because young children such as infants and toddlers have more subcutaneous tissue than older children and adults (22). Additionally, the type and frequency of complications in pediatric populations may differ from adults. These complications may be influenced by the smaller vessel size inherent in children and the length of therapy, and they most commonly include occlusion, migration, thrombosis and infection of CVADs (20).

Establishing and maintaining vascular access in older adults can also be challenging (23). Aging causes changes to the skin, vein walls and circulation; the skin loses tone and elasticity, and it becomes more fragile and prone to bruising (23). This can create problems when trying to establish VADs. In addition, older adults are more likely to have comorbidities and a weakened immune system, putting them at greater risk for infection (23). Finally, certain populations may require increased considerations when choosing and maintaining VADs. Some conditions associated with **difficult intravenous access**<sup>G</sup> (DiVA) include obesity, chronic illness, hypovolemia, substance use and vasculopathy (24).

## Vascular Access Specialization

A **vascular access specialist team (VAST)**<sup>G</sup> refers to a grouping of health providers who have advanced knowledge and skills in the assessment, insertion, care and management of VADs, such as intravenous therapy teams and individual **vascular access specialists (VAS)**<sup>G</sup> (nurses, physicians, respiratory therapists, technicians and physician assistants) (3). Some organizations may implement VASTs or VAS to assist the interprofessional team in caring for persons with VADs. It is important that both nurses and the other members of the interprofessional team have the critical thinking skills to perform comprehensive vascular access assessments, and that they collaborate on necessary comprehensive assessments related to appropriate VAD selection. This includes prescribed therapy, person preference, language barriers and other variables (1). These specialist health providers or individual health providers can also be leaders of excellence and quality of care in vascular access within an organization (25).

## Conclusion

There is a need for up-to-date evidence to guide health provider practices regarding safe vascular access. This guideline aims to provide nurses (e.g., nurse practitioners, registered nurses, registered practical nurses and nursing students) and other members of the interprofessional team with evidence-based recommendations and resources related to the insertion, assessment and maintenance of VADs across the lifespan of individuals.

## Guiding Framework and Principles

### Guiding Frameworks

Acquisition of training and skills for VAD insertions and management is necessary to establish and maintain competence and ensure the safety of the person with a VAD. The supervisor or trainer is responsible for identifying the level of clinical competence of the learner as they guide them to higher levels of competence. Global rating scales are a helpful tool to document competence for certain procedures (such as ultrasound-guided peripheral catheter insertions). These scales are used as formal evaluation instruments to determine competence and may be used for annual assessment of competence (26). Benner's Stages of Clinical Competence may also be used to assess the learner or for education planning purposes. Benner (27) notes that health providers, specifically nurses, can advance through five levels of clinical competence during the acquisition and development of a new skill: novice, advanced beginner, competent, proficient and expert. This framework is foundational for recommendations and research questions on health provider education.

### Guiding Principles

The following principles provide fundamental prerequisite knowledge for each of the recommendations included in this BPG. It is expected that the recommendations are applied within the context of these guiding principles. It is recommended that nurses and other health providers receive adequate education and training with respect to these principles and apply them in their clinical practice.

## Routine Practices and Additional Precautions

Routine practices and additional precautions are the expected processes and practices of care to be used in all health settings. Microorganisms have been transmitted from both symptomatic and asymptomatic people, so routine practices are expected in the care of all persons, at all times, across the continuum of care (28). Routine practices include the following:

- point-of-care risk assessment;
- hand hygiene;
- source control (triage, early diagnosis and treatment, respiratory hygiene and spatial separation);
- patient placement, accommodation and flow;
- aseptic technique (e.g., **Aseptic Non Touch Technique**<sup>®G</sup> [ANTT<sup>®</sup>]) (29);
- use of personal protective equipment (PPE);
- sharps safety and prevention of blood-borne pathogen transmission;
- management of the patient care environment (including cleaning and handling of waste and linen);
- education of patients, families and visitors on infection prevention and control; and
- visitor management (28).

Similarly, as stated by Infection Prevention and Control (IPAC) Canada, health providers require IPAC core competencies (30). These competencies include, but are not limited to:

- an understanding of point-of-care risk assessment;
- an understanding that routine infection prevention and control practices are the key to preventing transmission of organisms among health-care providers, persons and visitors/family members;
- an understanding and demonstrated use of appropriate PPE; and
- an understanding of how to prevent and manage occupational exposures to sharps and blood/bodily fluids in an appropriate way (30).

For a full list of infection prevention and control competencies, please refer to IPAC Canada guidelines and standards available at <https://ipac-canada.org/evidence-based-guidelines.php> (30).

Additional precautions should be used for patients with suspected or known infections or **colonization**<sup>G</sup> with microorganisms (28). Additional precautions are conventionally divided into the following categories (28):

- Contact precautions for microorganisms of very low infective dose or situations where heavy **contamination**<sup>G</sup> of the person's environment is anticipated.
- Droplet precautions for microorganisms primarily transmitted by the large droplet route.
- Airborne precautions for microorganisms transmitted through the air over extended time and distance by small particles.

For further details, please see the Public Health Agency of Canada (PHAC) guideline *Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Healthcare Setting* (28) and the IPAC Canada *Infection Prevention and Control Core Competencies for Health Care Workers* (30), or consult an infection control professional. Additional details of four components of routine practices—hand hygiene, aseptic technique, use of PPE and sharps safety—are considered below, as they are particularly relevant to vascular access.

## Hand Hygiene

Hand hygiene is a comprehensive term that refers to handwashing, hand antisepsis and actions taken to maintain healthy hands and fingernails (31). Hand hygiene plays a central role in infection prevention and control, especially in relation to hospital-acquired infections.

Public Health Ontario defines four key moments for hygiene (32). It recommends that health workers clean their hands at the following times:

1. Before initial contact with patient environment.
2. Before an aseptic procedure.
3. After body fluid exposure.
4. After patient/patient environment contact (32).

For details on supporting evidence, techniques (including choice of hand hygiene product) and other considerations, see the guidelines on hand hygiene from the World Health Organization (WHO) or PHAC (31-33), or the Canadian Vascular Access Association (CVAA) guideline for hand hygiene related to vascular access (25). [Appendix M](#) also provides further resources and details on infection control specifically for CVAD care.

## Aseptic Technique

Aseptic technique is the purposeful prevention of the transfer of microorganisms from the patient's body surface to a normally sterile body site, or from one person to another, by keeping the microbe count to an irreducible minimum (28). Aseptic techniques are used when performing procedures that expose the patient's normally sterile sites, such as the intravascular system, to keep them free from microorganisms.

One approach to standardizing aseptic practices is ANTT<sup>®</sup>. ANTT has been shown to support the reduction of health care-acquired infection (29, 34). Given the high potential for patient harm from poorly applied aseptic technique, assurance that all staff are compliant with safe aseptic technique for all clinical procedures should be a priority for all health-care organizations (34).

## Use of Personal Protective Equipment

PPE is part of routine practices and additional precautions, and it is required to prevent exposure of infectious or harmful agents to patients, health-care workers and other staff (28). PPE may include gloves, gowns, masks and facial protection (face shields or eye protection) (28).

## Sharps Safety

VADs pose a risk to health providers through needlestick injuries and potential exposure to blood-borne pathogens (35). The United States Centers for Disease Control and Prevention (US CDC) estimates that 385,000 needlestick and other sharps-related injuries are sustained by hospital-based health workers each year (35). To prevent these injuries, PHAC recommends the following (28):

- Safety engineered devices or needle-free systems be used wherever possible.
- Needles should not be recapped. Used items should be placed immediately in a designated puncture-resistant container that is easily accessible at the point-of-care.

- Health providers should cover open skin areas or lesions on hands and arms with a dry dressing at all times. Hand hygiene is still essential, so consultation is necessary if the dressing interferes with this procedure.
- Eyes, nose and mouth should be protected if splashes with blood or body fluids are anticipated.
- Immediately perform first aid if someone has been exposed to blood or body fluids. First aid should include:
  - thoroughly rinsing the injury site with running water, and gently cleaning with soap and water (if possible);
  - flushing the eyes, nose or mouth with running water if they have been exposed; and
  - rinsing broken skin thoroughly.
- Follow established organization policies and procedures for needlestick injuries, including reporting the incident and exposure immediately to your employer.
- Follow instructions for further treatment and follow-up from medical professionals, where necessary.



# Recommendations

## GOOD PRACTICE STATEMENT:

The expert panel recommends health providers complete a systematic assessment of the person prior to inserting a vascular access device.

This is a good practice statement that does not require application of the GRADE system (7). Conducting an initial assessment of a person before developing a plan of care or any intervention is a standard of professional practice (36). As such, completing a systematic assessment of persons prior to having a VAD inserted is good clinical practice and a pre-requisite for providing other clinical interventions.

The use of VADs, especially PVADs, is common throughout the health system. Any time a VAD is used as part of a care plan, it increases a person's risk for infection and other complications. Therefore, it is important that all persons requiring vascular access, regardless of duration of therapy, have a systematic assessment completed prior to the initiation of therapy (25, 37). This systematic approach will include a vascular assessment, including determination of clinical indication, psychosocial assessment, site selection and device selection. See the “Practice Notes” below for the suggested components of a systematic assessment before initiating vascular access.

Assessment is necessary in all settings where a VAD may be inserted. It is especially important in home-care settings, where persons are sent home with a VAD. Furthermore, for persons in a hospital setting, assessing persons for the most appropriate device upon admission or early in their hospital stay leads to improved person-centred outcomes and is more cost-effective (20). Certain factors—such as age and diagnosis of the person—also need to be considered when choosing to initiate vascular access. For example, pediatric and elderly populations will have different VAD care considerations due to their smaller or more fragile veins; a systematic assessment and choosing the appropriate device are essential for optimizing person-centred outcomes in these specific populations. Health providers will need to consult with the interprofessional team when advocating for the best device for the person, based on a systematic assessment of the person.

## Practice Notes

### Considerations from the expert panel

It may not be possible to complete all components of a systematic assessment of persons needing vascular access in an emergency care situation. Health providers should not delay life-saving vascular access interventions.

**Table 6: Practice Notes from the Expert Panel**

COMPONENTS OF ASSESSMENT	DETAILS OF ASSESSMENT
<p><b>Vascular assessment</b></p>	<ul style="list-style-type: none"> <li>■ Determine the clinical indication for the device.</li> <li>■ Vascular assessment, including determination of clinical indication, is to include (25):                             <ul style="list-style-type: none"> <li>□ intended frequency and duration of therapy;</li> <li>□ prescribed therapy (e.g., <b>osmolality</b><sup>G</sup>, pH, and vesicant and irritant properties);</li> <li>□ history of vascular access, including previous history of vascular access complications;</li> <li>□ comorbidities (e.g., renal status);</li> <li>□ age and developmental stage;</li> <li>□ anatomy;</li> <li>□ activity level;</li> <li>□ skin integrity;</li> <li>□ patient’s preference and lifestyle; and</li> <li>□ available resources for VAD care and maintenance.</li> </ul> </li> <li>■ Vascular assessment is to include an assessment of current medications, including those that may increase complication risk, such as anticoagulants and immunosuppressant medications.</li> <li>■ VAD assessment and planning is an ongoing process through the person’s course of treatment (25).</li> <li>■ Depending on the planned therapy and person receiving the VAD, the assessment may be more focused or more comprehensive.</li> </ul>
<p><b>Psychosocial assessment</b></p>	<ul style="list-style-type: none"> <li>■ Psychosocial assessment is to include:                             <ul style="list-style-type: none"> <li>□ age and developmental stage;</li> <li>□ mental health status (including substance use);</li> <li>□ presence of needle phobia;</li> <li>□ presence of family or caregiver support;</li> <li>□ cognition; and</li> <li>□ need for pain management strategies (see <b>Recommendations 7.1 and 7.2</b>).</li> </ul> </li> </ul>

RECOMMENDATIONS



COMPONENTS OF ASSESSMENT	DETAILS OF ASSESSMENT
<b>Device selection and vesicant medications</b>	<ul style="list-style-type: none"> <li>■ Determine if the planned therapy poses an infusate risk or if the medication is a vesicant. <ul style="list-style-type: none"> <li>□ Do not use peripheral catheters for continuous vesicant therapy or infusates with an osmolality greater than 900 mOsm/L (37). Use caution with parenteral nutrition.</li> <li>□ Consultation with a pharmacist may be required for high risk or vesicant medications.</li> </ul> </li> <li>■ See <b>Appendix H</b> for a list of vesicant medications.</li> <li>■ It is important to select the least invasive device for the duration and type of treatment, and one that promotes vessel preservation (25). When selecting a VAD (25): <ul style="list-style-type: none"> <li>□ Use a device with the minimum number of lumens.</li> <li>□ Select the smallest gauge catheter that will accommodate the prescribed therapy.</li> <li>□ See further details in <b>Appendix F</b> for considerations for different types of VADs and <b>Appendix G</b> for the right line decision tool (as included in the UK Vessel Health Preservation Framework) (38).</li> </ul> </li> </ul>
<b>Site selection</b>	<ul style="list-style-type: none"> <li>■ To select the site for VAD insertion, assess the person's vascular structure and integrity at and above the insertion site (25).</li> <li>■ The following sites should be avoided for vascular access (25): <ul style="list-style-type: none"> <li>□ area of flexion [except where this is not possible in trauma or emergency cases];</li> <li>□ chest wall, digits or breast;</li> <li>□ lower legs, except in a non-walking child;</li> <li>□ insertion area that is painful on palpation;</li> <li>□ vein that is obviously compromised (e.g., thrombosis, redness, cording, bruising, infiltration, phlebitis or engorgement);</li> <li>□ extremity with a planned or actual arteriovenous fistula/graft site; and</li> <li>□ extremity affected by lymphedema, paralysis, extravasation, acute infection, tissue injury or acute trauma.</li> </ul> </li> <li>■ When selecting sites, health providers also must consider any previous history of breast cancer surgery and any potential sites for tissue donation.</li> <li>■ If a short PVAD is deemed appropriate based on a comprehensive assessment of the person—and the health provider has the knowledge, skill and judgement to perform PVAD insertions—the health provider will select an insertion site appropriate for the required therapy that has the least risk of complication.</li> </ul>

## Supporting Resources

RESOURCE	DESCRIPTION
<p>Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.</p>	<ul style="list-style-type: none"> <li>■ Canadian Vascular Access Association guideline.</li> <li>■ Includes details on assessment and device selection.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
<p>Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th Edition. J Infus Nurs. 2021; 44(1S), S1–S224. doi: 10.1097/NAN.0000000000000396</p>	<ul style="list-style-type: none"> <li>■ Infusion Nurses Society standards of practice.</li> <li>■ Includes details on assessment and device selection.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
<p>Paterson RS, Chopra V, Brown E, et al. Selection and insertion of vascular access devices in pediatrics: a systematic review. Pediatrics. 2020 Jun;145(Suppl 3):S243-68. doi: 10.1542/peds.2019-3474H</p>	<ul style="list-style-type: none"> <li>■ Systematic review of selection and insertion of VADs in pediatrics.</li> <li>■ Provides an overview of guidelines in children and infants.</li> <li>■ Includes considerations for special populations (e.g., those who are critically ill or with congenital cardiac conditions or DiVA).</li> </ul>
<p>Ullman AJ, Bernstein SJ, Brown E, et al. The Michigan Appropriateness Guide for Intravenous Catheters in pediatrics: miniMAGIC. Pediatrics. 2020;145(s3):e20193474I.</p>	<ul style="list-style-type: none"> <li>■ Provides further details and considerations for device selection in children.</li> <li>■ Provides a detailed device selection algorithm for use in neonates, infants and children/adolescents.</li> </ul>

## RECOMMENDATION QUESTION #1:

**Should providing education to persons and their families about their vascular access device be recommended?**

**Outcomes:** Hospital re-admission rate and complications.

### RECOMMENDATION 1.1:

The expert panel recommends that health providers provide comprehensive health teaching to persons and their families/caregivers about their vascular access device.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Very low

## Discussion of Evidence:

### Benefits and Harms

**Comprehensive health teaching<sup>G</sup>** involves a combination of learning experiences designed to help improve knowledge and skills related to self-management in persons and their families or caregivers (39-42). The evidence was focused on comprehensive health teaching for CVAD care in particular. Two studies focused on self-management education (39, 40), while seven studies focused on family or caregiver education (41-47), with the majority of these focused on parents or caregivers providing care for children.

Evidence suggests that comprehensive health teaching may reduce complications and hospital re-admission rate (39-49). However, the evidence is very uncertain.

Most studies reported a decrease in complications in persons who received health teaching when compared to either baseline or control groups (39, 40, 42-49). For instance, CLABSI rates decreased in three studies (43-45), and incidence of occlusion decreased in three studies (39, 40, 47). In one study, clotting was lower in the group that received education than in the control group (46). One study compared hospital readmission rates due to CLABSI before and after implementing a CVAD care class to family members: there were no hospital re-admissions related to CLABSI in one month of follow-up (42).

The studies did not report harms as a result of persons and families receiving health teaching about their VAD.

The certainty of the evidence was rated as very low due to serious limitations in how individual studies were conducted, serious imprecision related to the small number of total events or participants, and inconsistency in how outcomes were measured. For more detailed information on the impact of health teaching on the prioritized outcomes (hospital readmission rate and complications), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Further details of the intervention noted in the literature are outlined below, under “Practice Notes.”

## Values and Preferences

Three studies gathered data on patient satisfaction (39, 41, 46). Where this information was collected, persons and families reported improved satisfaction with the health teaching (39, 41), including feeling more comfortable with their care (46).

## Health Equity

No evidence was identified in the systematic review that directly assessed the impact of comprehensive health teaching on health equity. More research is required on this topic.

## Expert Panel Justification of Recommendation

This recommendation could have been a good practice statement however, the expert panel agreed that it was important to pose a recommendation question to examine the evidence on providing comprehensive health teaching to persons about their VAD. In addition, this evidence can support health providers by providing detailed information on the content and delivery of this education outlined in the evidence. There may be benefits to providing comprehensive health teaching to persons with a VAD and their families or caregivers. There were no harms reported. The expert panel felt that persons and their families or caregivers would value comprehensive health teaching, and that it would align with principles of informed consent, person- and family-centred care, self-management and autonomy. The expert panel also noted the potential for harms if health teaching was not completed. This included device failure or catheter-associated infection. Therefore, despite the very low certainty of the evidence, the expert panel determined the recommendation to be strong due to the potential for harms without health teaching. Although the literature was only on CVADs, the expert panel felt that health teaching on all types of VADs would be beneficial and determined the recommendation to be inclusive of all types of VADs.

## Practice Notes

### Considerations from the expert panel

- At the very least, health teaching is to include signs and symptoms of complications. This should also include details about where, how and with whom to follow up and seek assistance if complications arise when discharged home with a VAD.
- The amount of and formalization of health teaching will be dependent on the type of device and the discharge plan. For example, a person with a PVAD that is to be removed prior to discharge will have lower learning needs than a person discharged with a PICC line for a defined amount of time or a person with a long-term CVAD, who will require an in-depth understanding of the device.
- Health teaching is to be tailored to the following (for further details, refer to “Supporting Resources,” below):
  - type of device;
  - type and duration of treatment (including type of infusion or medication);
  - discharge plan;
  - person’s age and developmental stage (including tailoring to children, adolescents and the needs of older adults);
  - person and family/caregiver’s individual learning needs and preferences; and
  - person or family/caregiver capability for self-care.

- For more complex health teaching (if available and appropriate), consider referral to a VAS or VAST.
- Health teaching is to be documented and included in the health record.
- Comprehensive health teaching is to follow a teaching plan or checklist. See [Appendix I](#) for an example of a PICC health teaching guide.

**Table 7: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<b>Health teaching content</b>	<ul style="list-style-type: none"> <li>■ Health teaching content included the following:               <ul style="list-style-type: none"> <li>□ aseptic principles (40, 43, 44, 46),</li> <li>□ catheter flushing (39, 40, 44, 46),</li> <li>□ cap and dressing changes (40, 44, 46),</li> <li>□ care checklists (41, 43-45),</li> <li>□ common complications (41, 43, 45), and</li> <li>□ emergency care (44).</li> </ul> </li> </ul>
<b>Health provider providing the health teaching</b>	<ul style="list-style-type: none"> <li>■ In all but one study, health teaching was completed by a nurse (39, 40, 42-46). This was further described in the studies as one of the following:               <ul style="list-style-type: none"> <li>□ nurse educator (44),</li> <li>□ infusion nurse (39), or</li> <li>□ classes taught by specially trained registered nurses and reinforced by a bedside nurse (42).</li> </ul> </li> <li>■ In one study, health teaching was completing by the study investigator (41).</li> </ul>
<b>Use of technology</b>	<ul style="list-style-type: none"> <li>■ Several studies used audiovisual demonstration through DVDs or videos to enhance education (39, 41, 44, 46, 47).</li> <li>■ One study used video calling technology to enhance coaching and accessibility of the education through one-on-one video chatting (39).</li> </ul>
<b>Individualized or tailored approach</b>	<ul style="list-style-type: none"> <li>■ Most of the health teaching interventions tailored the teaching to the individual needs of the learner through various strategies (39-41, 43, 44). In the evidence these strategies included the following:               <ul style="list-style-type: none"> <li>□ providing one-on-one health teaching (39, 41),</li> <li>□ asking persons to express emotions and fears related to CVAD management and give opportunities to ask questions and receive feedback (40), and</li> <li>□ promoting family member autonomy in providing care (43).</li> </ul> </li> </ul>

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<b>Practical component</b>	<ul style="list-style-type: none"> <li>■ Skill development: Most studies employed a practical component, including skills-based demonstration (39, 40, 42-44).</li> <li>■ Models: Three education programs offered a chance to practise on mannequins or models (40, 43).</li> <li>■ Evaluation or assessment:                             <ul style="list-style-type: none"> <li>□ In one study, the family member undergoing training was required to “room in” and provide total care for 24 hours to demonstrate their competency (44).</li> <li>□ On the day before discharge, persons with a VAD were evaluated on how well they could perform the self-management tasks and were provided with feedback (40).</li> <li>□ Another study assessed learner understanding through “teach back” strategies (42).</li> <li>□ Finally, caregivers in one study were asked to demonstrate skills based on a checklist, and to re-demonstrate skills when the person they were caring for was re-admitted (45).</li> </ul> </li> </ul>

### Supporting Resources

RESOURCE	DESCRIPTION
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>■ Canadian Vascular Access Association guideline.</li> <li>■ Includes patient education as a core practice principle.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th Edition. J Infus Nurs. 2021; 44(1S), S1-S224. doi: 10.1097/NAN.0000000000000396	<ul style="list-style-type: none"> <li>■ Infusion Nurses Society standards of practice.</li> <li>■ Includes a standard and criteria on patient education (beginning on page S35).</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Mills SL, Brady TJ, Jayanthan J, et al. Toward consensus on self-management support: the international chronic condition self-management support framework. Health Promot Int. 2017 Dec;32(6):942-52. <a href="https://doi.org/10.1093/heapro/daw030">https://doi.org/10.1093/heapro/daw030</a>	<ul style="list-style-type: none"> <li>■ Details a self-management support framework and principles.</li> <li>■ In particular, see Table 2 and Figure 1 within the document for self-management strategies.</li> </ul>

## RECOMMENDATION QUESTION #2:

**Should practical education for the insertion and management of vascular access devices for health providers be recommended?**

**Outcomes:** Complications (including insertion-related complications), number of successful observed attempts and provider attitude/confidence.

### RECOMMENDATION 2.1:

The expert panel recommends health-service organizations implement practical education on the insertion and/or management of vascular access devices for health providers.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Low

## Discussion of Evidence:

### Benefits and Harms

For the purposes of this BPG, **practical education**<sup>G</sup> refers to skills practice, supervised insertion and management of VADs, hands-on training or one-on-one training for health providers. It also includes (but is not limited to) high-fidelity **simulation**<sup>G</sup> training. Practical or skills lab training follows a structured teaching concept: it takes place under supervision and in consideration of foundational concepts, and it ideally creates an atmosphere that allows the repeated, risk-free practice of targeted clinical skills (50). The types of practical education provided varied across the evidence. Programs included a didactic theory session followed by simulation component (51-70), an online or video component followed by in-class group simulation or a practical component (67, 71-83), a simulation experience alone (84) or individualized mentoring or supervision (57, 85).

The evidence suggests that practical education for health providers improves the number of successful attempts, probably reduces complications in persons with a VAD, and may improve provider attitude and confidence and insertion-related complications, although the evidence is uncertain (51-85). One systematic review reported higher success rates and marginally lower complications when practical education was compared to traditional education (51). Provider attitude and confidence was examined in 23 studies, with the majority reporting improvement in provider confidence from pre- to post-implementation of education or compared to a control group (55-60, 62, 63, 66, 67, 69-72, 74-76, 78, 79, 81, 82, 84). The majority of studies focused on practical education for CVAD insertion and management, but some studies also focused on PICC management (61), PVAD insertion (55, 67-73, 85), and arterial catheter insertion (54, 56, 78, 84). There was no evidence specifically examining PVAD maintenance.

There were no studies that reported harms as a result of health providers receiving practical education on the insertion and management of VADs.

The overall certainty of the evidence was rated as low due to serious concerns in how individual studies were conducted, inconsistency in the measurement of the outcomes, and imprecision related to the small number of total events or participants across the studies. For more detailed information on the impact of practical education on the prioritized outcomes (complications, insertion-related complications, number of **successful observed attempts**<sup>G</sup> and provider attitude/confidence), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”

## Values and Preferences

Where reported, health providers in seven studies highly valued the practical education offered (60, 62, 66, 67, 76, 81, 82). In one study, in addition to the improved self-reported confidence, nurses described that the simulation environment was a safe place to learn, stating that they were able to concentrate on learning without being interrupted or disturbed (60). Medical residents that participated in a single 60- to 90-minute ultrasound-guided CVAD training session reported enjoying the practical training sessions because they were very realistic and rated higher perceived educational benefits (76).

## Health Equity

No evidence was identified in the systematic review that directly assessed the impact of practical education for health providers on health equity. More research is required on this topic.

## Expert Panel Justification of Recommendation

Conventionally based on GRADE, this recommendation could have been voted conditional since the certainty of the evidence of the effects was low. Based on the balance of benefits and harms, including the harms of not following the recommendation, as well as values and preferences, the expert panel came to consensus on a strong recommendation. There are benefits to practical education for health providers on the insertion and management of VAD. The expert panel noted the risk of potential harms of health providers not receiving practical education on the insertion and management of VADs. Practical education was highly valued by health providers in the literature. Although the certainty of the evidence was rated as low, the expert panel voted the recommendation as strong as there were no harms noted in the studies, and they felt that all health providers would benefit from practical education.

## Practice Notes

### Considerations from the expert panel

- Education is to be standardized within the health-service organization, with specific educational competencies outlined. See [Appendix J](#) for an example of a global rating scale for ultrasound-guided PVAD insertion. Additionally, organizations are to document competencies and review them on a regular basis through a formal process.
- Due to loss of skills over time among health providers, refresher and ongoing education is to be offered.
- Educators providing practical education need formal training, including skill development in debriefing.
- High-fidelity simulation is preferable for complex cases and skills. However, it is recognized that high-fidelity simulation may not be feasible in all practice settings due to cost or accessibility issues.



- If simulation labs are used, simulation experts should be involved in their planning. It is important to note the consideration of the clinical experience levels of the learners when creating and conducting practical education sessions. Benner’s Stages of Clinical Competence Framework may be used to tailor training to levels of expertise (see Guiding Framework and Principles on page 33).

**Table 8: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<b>Demonstration of correct technique</b>	<ul style="list-style-type: none"> <li>■ Experienced instructors demonstrated the correct technique prior to health providers practising, either in person or through video or online learning modules (52, 55, 56, 58, 72, 74-76, 78, 79, 85).</li> </ul>
<b>Opportunity for hands-on practice in simulation settings prior to attempts in real-life clinical settings</b>	<ul style="list-style-type: none"> <li>■ Through coaching, mentoring, formal simulation scenarios, or self-directed learning on mannequins or models (51-53, 55-61, 73-79, 85).</li> <li>■ Three studies noted the use of high fidelity simulation training for more invasive insertions (such as those for CVADs) or manipulation, including PICCs (51, 52, 75).</li> <li>■ The opportunities were offered in a small group setting (55, 56, 60, 61, 73-76, 78) or one-on-one (52, 53, 57, 85).</li> </ul>
<b>Observed practice with an appropriate evaluation</b>	<ul style="list-style-type: none"> <li>■ Health providers typically needed to achieve sufficient competency demonstrated through a certain number of successful observed attempts or a score on a validated skills checklist prior to practising on people (52, 53, 56, 71, 72, 74-78).</li> </ul>
<b>Loss of skills over time</b>	<ul style="list-style-type: none"> <li>■ One study noted that with practical training there is potential for skill decay. Refresher training sessions were thus needed to ensure staff competencies (53).</li> </ul>
<b>Education length</b>	<ul style="list-style-type: none"> <li>■ Most of the training was offered in a single session ranging from two to three hours in length (52, 56, 73-75). Other sessions were 60 to 90 minutes long (76) or via a five-hour-long workshop (78).</li> <li>■ Other education was offered in multiple sessions, including three sessions of up to two hours each (85) and three sessions of 90 minutes each (61).</li> </ul>

### Supporting Resources

RESOURCE	DESCRIPTION
<p>Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.</p>	<ul style="list-style-type: none"> <li>Canadian Vascular Access Association guideline.</li> <li>Includes education and competency.</li> <li><b>Note:</b> this is a resource for which there is a fee.</li> </ul>
<p>Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th Edition. J Infus Nurs. 2021; 44(1S), S1–S224. doi: 10.1097/NAN.0000000000000396</p>	<ul style="list-style-type: none"> <li>Infusion Nurses Society Standards of Practice.</li> <li>Includes competency assessment and validation (beginning on page S26).</li> <li><b>Note:</b> this is a resource for which there is a fee.</li> </ul>
<p>International Nursing Association for Clinical Simulation and Learning (INACSL) Standards Committee. INACSL standards of best practice: simulation design. Clin Simul Nurs. 2016 Dec;12(S):S5-12. <a href="https://doi.org/10.1016/j.ecns.2016.09.005">https://doi.org/10.1016/j.ecns.2016.09.005</a></p>	<ul style="list-style-type: none"> <li>The International Nursing Association for Clinical Simulation and Learning (INACSL) has developed comprehensive best practices for clinical simulation in nursing.</li> </ul>
<p>Ma IW, Brindle ME, Ronksley PE, et al. Use of simulation-based education to improve outcomes of central venous catheterization: a systematic review and meta-analysis. Acad Med. 2011;86(9):1137-47. doi:10.1097/ACM.0b013e318226a204</p>	<ul style="list-style-type: none"> <li>Systematic review and meta-analysis focused on use of simulation education for CVAD insertion.</li> </ul>

RECOMMENDATIONS

## RECOMMENDATION QUESTION #3:

### Should vascular access specialist teams be recommended?

**Outcomes:** Complications (including insertion-related complications), and number of successful observed attempts

#### RECOMMENDATION 3.1:

The expert panel suggests that acute care health-service organizations implement vascular access specialists or vascular access specialist teams to support the insertion and management of vascular access devices.

**Strength of the recommendation:** Conditional

**Certainty of the evidence of effects:** Low

### Discussion of Evidence:

#### Benefits and Harms

A VAST refers to a grouping of health providers who have advanced knowledge and skills in the assessment, insertion, care and management of VADs. This includes intravenous therapy teams and individual VAS (e.g., nurses, physicians, respiratory therapists, laboratory technicians, radiology technologists and physician assistants) (3).

The evidence suggests the implementation of VASTs and VAS may reduce complications, and that it probably improves successful attempts of VAD insertions (86-93). Most studies focused on the insertion and management of CVADs, including PICCs (86-89, 93). The remaining studies focused on the insertion and management of PVADs (90-92).



All studies took place in acute care settings. This recommendation therefore is specific to acute care.

In terms of complications, most studies reported an overall decrease in complications rates, catheter failure, catheter-related blood stream infections and deep vein thrombosis rates when a VAST or VAS was involved in providing care (86-89, 91, 93). Three studies reported on the number of successful attempts and noted more successful insertions in persons who received care from VASTs compared to those who did not (90, 92, 93).

All studies except one reported no harms as a result of persons receiving care from a VAST. One study reported that the incidence of phlebitis was five per cent higher in VAS-inserted PVADs than for generalist insertions (90).

The overall certainty of the evidence was rated as low due to serious concerns about imprecision related to the small number of total events or participants across studies, and due to some concerns about how individual studies were conducted. For more detailed information on the impact of VASTs and VAS on the prioritized outcomes (complications, number of successful attempts), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”

### Values and Preferences

One study reported on patient satisfaction and found higher patient satisfaction rates among persons who received care from a VAS compared to those who did not (90). The median score of patient satisfaction with PVAD insertion was higher among those who received care from a VAS compared to those who received PVAD insertion from generalist health providers (9 versus 7, on a scale out of 10) (90).

### Health Equity

One study noted that persons with hematological malignancy may particularly benefit from VASTs and VAS compared to persons with other disorders (89). Of the persons who had a catheter-related bloodstream infection, 3 out of 4 of them also had a hematological malignant disorder (75%), and of the persons with a catheter-related deep venous thrombosis 3 out of 10 of them also had a hematological malignant disorder (30%) (89). The incidence of deep venous thrombosis in persons with hematological malignancy was 0.4/1000 catheter days, compared to 0.17/1000 catheter days in the overall cohort (89).

### Expert Panel Justification of Recommendation

There may be benefits to implementing VASTs and VAS in acute care health-service organizations. However, the certainty in the evidence was low. There also may be few harms of implementing VASTs and VAS. All people may not benefit equally from this intervention. Specific groups may benefit more from this intervention, such as older adults, children, persons with cancer and those with repeated need for device insertion. The expert panel recognized that there is limited evidence on the cost-effectiveness of VASTs or VAS. In addition, some health-service organizations may have challenges accessing VASTs or VAS due to cost or organization size. The expert panel felt the benefits of VASTs were important but that the evidence was not sufficient to make a strong recommendation.

### Practice Notes

#### Considerations from the expert panel

- The type of device needs to be considered when designing VASTs. For example, CVAD insertion and care are more likely to need VAST or VAS care than PVAD insertion and care.
- Organization, training, certification, policies and responsibilities of the VAST or VAS will be up to the individual health-service organization. This includes consideration of resources, acuity and population needs. See examples of VAST or VAS responsibilities and training in the studies included in “Supporting Resources,” below.
- This recommendation excludes some health settings, such as home care and long-term care, but the expert panel feels that there are likely benefits to VASTs in these areas. However, there was no evidence from these health settings. See **Table 15** on page 80 for research gaps and future implications.

**Table 9: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<p><b>Examples of VAST or VAS responsibilities in the evidence</b></p>	<p><b>VAD insertion:</b></p> <ul style="list-style-type: none"> <li>■ Responsible for all PVAD insertions (88, 90-92).</li> <li>■ Responsible for difficult PVAD insertions and difficult blood draws (87).</li> <li>■ Responsible for all CVAD insertions (86) or all PICC insertions (88-90, 94).</li> <li>■ The VAS intervention in one study included individual assessment to identify the person’s expected tolerance of the procedure (i.e., their sedation and pain management needs) (87).</li> </ul> <hr/> <p><b>VAD management:</b></p> <ul style="list-style-type: none"> <li>■ Responsible for CVAD dressing changes (87).</li> <li>■ Education for persons and staff caring for persons with a short PVAD (87, 88).</li> <li>■ Responsible for all CVAD maintenance (including removal) (86).</li> <li>■ Monitoring of VAD, including necessity (88, 91).</li> <li>■ Assessment and maintenance of CVAD and PVAD, as needed (92).</li> </ul>
<p><b>VAS health provider in the evidence</b></p>	<ul style="list-style-type: none"> <li>■ Exclusively nurses (88-93).</li> <li>■ Nurse-led (87).</li> <li>■ Nursing, medical and respiratory therapy (86).</li> </ul>
<p><b>VAST or VAS training</b></p>	<ul style="list-style-type: none"> <li>■ Training on ultrasound-guided VAD placement (short PVAD or midline catheter) (88, 91).</li> <li>■ Competency was validated through an assessment (86, 88, 93).</li> </ul>

RECOMMENDATIONS

### Supporting Resources

RESOURCE	DESCRIPTION
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>Canadian Vascular Access Association guidelines.</li> <li>Include considerations for a specialist team or service.</li> <li><b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Carr PJ, Higgins NS, Cooke ML, et al. Vascular access specialist teams for device insertion and prevention of failure. <i>Cochrane Database Syst Rev.</i> 2018 Mar 20;3(3):CD011429. doi: 10.1002/14651858.CD011429.pub2	<ul style="list-style-type: none"> <li>Cochrane systematic review focused on VASTs.</li> <li>Provides an overview of the literature as well as suggestions for further research.</li> </ul>
Carr PJ, Moureau NL. Specialized vascular access teams. In: Moureau N, editor. <i>Vessel health and preservation: the right approach for vascular access.</i> New York (NY): Springer, Cham; 2019. p. 59-65	<ul style="list-style-type: none"> <li>Book chapter providing further detail on use of VASTs including examples of VASTs use in organizations.</li> </ul>
Marsh N, Larsen E, Webster J, et al. The benefit of a vascular access specialist placing a peripheral intravenous catheter: a narrative review of the literature. <i>Vascular Access.</i> 2020;6(1):10-15.	<ul style="list-style-type: none"> <li>Narrative review focused on VAST teams</li> <li>Specifically focused on teams whose role includes placing PVADs and the organization and benefits of such teams.</li> </ul>

RECOMMENDATIONS

## RECOMMENDATION QUESTION #4:

**Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?**

**Outcomes:** Specimen rejection, patient satisfaction, contamination rate (specific to blood culture) and dwell time.

### RECOMMENDATION 4.1:

The expert panel suggests health providers perform venipuncture when drawing blood samples to maintain specimen integrity.

**Strength of the recommendation:** Conditional

**Certainty of the evidence of effects:** Very low

## Discussion of Evidence:

### Benefits and Harms

The evidence suggests that **venipuncture**<sup>G</sup> for drawing blood samples may reduce specimen rejection and may reduce contamination of blood cultures compared with drawing blood from a VAD (94-96). However, one study also suggests that venipuncture for drawing blood samples may reduce patient satisfaction, when compared with drawing blood from a VAD (95). The certainty of the evidence was very low.

A systematic review concluded that blood sample collection through PVADs is associated with a higher risk of **hemolysis**<sup>G</sup> compared with blood drawn by venipuncture (94). Two additional non-randomized controlled trials were identified for the outcome of specimen rejection. One of the studies supported the findings of the systematic review (95). The other study reported lower rates of hemolysis in blood draws from a VAD compared with venipuncture, but it was blood drawn from a PICC (96).

The systematic review also reported on contamination of blood cultures based on two individual studies with mixed results (94). One study included in the review reported higher rates of blood culture contamination and false positives when blood was drawn from a PVAD compared with venipuncture (97). The other study included in the review reported no difference in blood culture contamination when blood was drawn from a PVAD within one hour of insertion when compared with venipuncture (98).

One study examined patient satisfaction, which was assessed on a scale from 0 to 10 (95). The study reported a mean difference of 1.27 in favour of blood draws from a PVAD (95). Finally, only one study reported on dwell time and concluded that blood draws from PVAD had little to no effect on dwell time (99). There were no additional harms reported in the studies.



Venipuncture is the preferred method of blood sampling. If this method is not feasible following an individualized risk–benefit assessment, then a blood draw from a VAD may be considered.

With any blood draw, health providers must adhere to a standardized blood sampling protocol or organizational policy.

The certainty of the evidence was rated as very low due to limitations in how individual studies were conducted, inconsistency across study results and a low number of total events and participants for some outcomes.

For more detailed information on the impact of the venipuncture compared to blood draws from a VAD on the prioritized outcomes (specimen rejection, patient satisfaction, contamination rate and dwell time), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

### Values and Preferences

One study reported that 99 per cent of people preferred blood draw from a PVAD compared with venipuncture (95). Additionally, one study reported lower pain when blood was drawn from a VAD (96).

### Health Equity

No evidence was identified in the systematic review that directly assessed the impact of venipuncture or blood draws from a VAD on health equity. More research is required on this topic. See **Table 15** on page 80 for research gaps and future implications.

### Expert Panel Justification of Recommendation

There may be some benefits to using venipuncture compared to blood draws from a VAD, but the certainty of the evidence was very low. The evidence indicates that there are harms to performing blood draws from a VAD, such as specimen rejection of blood samples or contamination of blood cultures. Additionally, patient satisfaction may be lower when blood is drawn using venipuncture. The expert panel noted the potential for additional harms that were not captured in the body of evidence, including microclots in the samples and delayed treatment or misdiagnosis when blood draws are performed from a PVAD. Additionally, the expert panel felt that blood draws using venipuncture may not be appropriate at all times for all people. The examples of young children, people with cancer requiring repeated blood sampling or older adults with difficult intravenous access were given as potential populations where venipuncture may sometimes be more harmful than beneficial. Following an individualized risk–benefit assessment, other individuals also may not be appropriate candidates for venipuncture. Therefore, the expert panel determined the strength of the recommendation to be conditional.



## Practice Notes

### Considerations from the expert panel

- Venipuncture procedures are to follow current best practices, including aseptic technique and appropriate site selection. See “Supporting Resources” below for guidance on venipuncture procedure.
- Decisions around blood draws require an individualized risk–benefit assessment, including factors such as the following:
  - Person factors:
    - age;
    - health history;
    - DiVA;
    - pain and comfort;
    - fear and anxiety, including needle phobia;
    - bleeding disorders; and
    - risk for infection (e.g., immunocompromised individuals).
  - VAD factors:
    - size and location;
    - integrity of the site;
    - condition of the VAD; and
    - current infusion therapy (i.e., can it be safely stopped for blood sampling).
  - Blood sampling factors:
    - importance of highly accurate sampling; and
    - frequency of blood draws.
- Health providers need adequate training and education on blood draws and VADs to support this recommendation. Specifically, the expert panel noted that health providers need to be educated on additional harms associated with blood draws from VADs (e.g., hemolysis and contamination of the specimen leading to false positive results and unnecessary treatment). Additionally, health-service organizations are to document competency of staff and review competencies on a regular basis through a formal process.
- Health-service organizations are to develop policies based on their equipment and in collaboration with the VAD vendor specifications.
- When developing policies, health-service organizations are to collaborate with laboratory guidelines and personnel.
- Where an arterial blood sample is needed (e.g., for arterial blood gases), health providers are to follow established best practices for drawing blood from an artery or arterial catheter. See “Supporting Resources” (below) for guidance on arterial sampling procedure.
- For persons with a CVAD in situ, see “Supporting Resources” (below) for guidance on sampling procedure. Decisions around blood draws from a CVAD also require an individualized risk–benefit assessment (see the factors listed above).

## Supporting Resources

RESOURCE	DESCRIPTION
Aseptic Non Touch Technique (ANTT®) [website]. [place unknown]: Aseptic Non Touch Technique; c2019. Available from: <a href="http://www.antt.org/ANTT_Site/theory.html">http://www.antt.org/ANTT_Site/theory.html</a>	<ul style="list-style-type: none"> <li>■ Site outlining the use of the Aseptic Non Touch Technique (ANTT®).</li> <li>■ Details guiding principles and steps to ANTT.</li> </ul>
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>■ Canadian Vascular Access Association guidelines.</li> <li>■ Include information on blood draws.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Clinical practice guideline: prevention of blood specimen hemolysis in peripherally-collected venous specimens. J Emerg Nurs. 2018;44(4):402.e1-402.e22. doi:10.1016/j.jen.2018.05.017	<ul style="list-style-type: none"> <li>■ Guidance on the prevention of contamination of blood cultures.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th Edition. J Infus Nurs. 2021; 44(1S), S1–S224. doi: 10.1097/NAN.0000000000000396	<ul style="list-style-type: none"> <li>■ Infusion Nurses Society has standards on drawing blood from a VAD as well as venipuncture.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
WHO guidelines on drawing blood: best practices in phlebotomy [Internet]. Geneva (CH): WHO; 2010. Available from: <a href="https://www.euro.who.int/_data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf?ua=1">https://www.euro.who.int/_data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf?ua=1</a>	<ul style="list-style-type: none"> <li>■ Best practice guidelines on drawing blood.</li> <li>■ Includes both venous and arterial blood draws.</li> </ul>

## RECOMMENDATION QUESTION #5:

### Should the daily review of peripheral vascular access devices by health providers be recommended?

**Outcomes:** Complications

#### RECOMMENDATION 5.1:

The expert panel recommends that acute care health-service organizations implement a multi-component PVAD care protocol. This protocol includes a minimum of a daily review by health providers, in collaboration with persons and their families.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Low

### Discussion of Evidence:

#### Benefits and Harms

A **multi-component care protocol**<sup>G</sup> is a group of evidence-based interventions that can ensure the delivery of a standardized method of care (100). When these interventions are performed together, they can have a better outcome than if performed individually (this may be referred to as a “care bundle”) (100). The evidence suggests that multi-component PVAD care protocols may reduce complications (91, 101-112).

The multi-component care protocol involved PVAD daily review and documentation (91, 101-112) and at least one of the following interventions:

- hand hygiene and aseptic care techniques (101, 106, 108, 109, 111),
- provider education and training (101-106, 112),
- persons and family/caregiver involvement (102, 107, 112),
- standardized PVAD equipment (91, 103),
- standardized securement device (91, 102, 108, 111), and
- inclusion of PVAD assessment at rounds and handover (104, 106, 109).

At a minimum, daily review involved an assessment of signs and symptoms of PVAD complications (91, 101-112). A majority of the studies also included assessment of device necessity as part of the PVAD daily review (91, 101-105, 108, 109, 111, 112).

Eleven out of 13 studies reported a decrease in complications when a multi-component PVAD care protocol with daily review was implemented (91, 101-112). Steere et al. (2019) reported an overall decrease in complication rates and catheter failure rates (91). Infiltration was the most commonly assessed complication across studies, and its rate decreased in all the studies in which the outcome was reported (91, 101, 102, 104, 107, 110, 111). Phlebitis rate also decreased in the majority of the studies in which the outcome was reported (91, 101, 105, 110). Furthermore, infection was assessed in three studies, and all studies reported a decrease in infection rate after implementation of a multi-component PVAD care protocol that included a daily review (103, 106, 109). There were no harms reported in the studies related to the use of a multi-component PVAD care protocol with daily review.

The certainty of the evidence was rated as low due to serious limitations in how individual studies were conducted. For more detailed information on the impact of the multi-component PVAD care protocols, including a daily review on the prioritized outcomes (complications), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”



All studies took place in acute care settings. This recommendation therefore is specific to acute care.

## Values and Preferences

Another study conducted interviews with caregivers as part of intervention development (108). The following themes emerged related to PVAD care: the importance of communication, apprehension and fear around the device, an appreciation of skilled health providers and technology, and a recognition of the role of the caregiver (108).

## Health Equity

No evidence was identified in the systematic review that directly assessed the impact of multi-component PVAD care protocols on health equity. More research is required on this topic. See **Table 15** on page 80 for research gaps and future implications.

## Expert Panel Justification of Recommendation

Conventionally based on GRADE, this recommendation could have been voted conditional since the certainty of the evidence of the effects was low. Based on the balance of benefits and harms, including the harms of not following the recommendation, as well as values and preferences, the expert panel came to consensus on a strong recommendation. There may be benefits of implementing PVAD multi-component care protocols that include a daily review. Additionally, there was some evidence to suggest that multi-component PVAD care protocols would be highly valued by persons and families or caregivers, particularly when caregivers were involved. The expert panel also noted that a daily review of a PVAD in particular would avoid additional harms not captured in the literature, as short PVAD complications can greatly impact a person’s safety. A strong recommendation was selected by the panel to align with person’s safety as well as values and preferences.

## Practice Notes

### Considerations from the expert panel

- Daily reviews of PVADs are to be completed a minimum of once daily. More frequent assessment will be necessary for specific populations (such as neonatal or pediatric) and for infusing catheters.
- PVAD care is not just the responsibility of an individual health provider; it also needs to be incorporated into health-service organization policies and procedures. Discussion of PVAD necessity, functionality and utilization is to include bedside and interprofessional team members.
- Health-service organizations need to be responsible for education, training and monitoring related to multi-component PVAD care policies and protocols. Additionally, organizations are to document competency of staff and review competencies on a regular basis through a formal process.

- The assessment of a PVAD needs to follow an established protocol. See [Appendix L](#) for an example of a PVAD assessment protocol and [Appendix G](#) for daily evaluation included in the UK Vessel Health Preservation Framework.
- Although this recommendation is for acute care settings, the expert panel felt that a multi-component PVAD care protocol would be beneficial in other settings, including long-term care and home care. More research is needed in these areas. See [Table 15](#) on page 80 for research gaps and future implications.
- This recommendation applies to PVADs. The expert panel did not feel that a recommendation on CVAD care was necessary, as there are many established multi-component care protocols (or “care bundles”) currently in use. For more information on CVAD care, see [Appendix M](#).

**Table 10: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
PVAD daily review process	<ul style="list-style-type: none"> <li>■ PVAD reviews were at minimum once per shift in some studies (107, 109, 110, 112). They were once per day in others (91, 101, 102, 109, 110, 112). Additionally, three protocols mandated hourly site assessment (104, 108, 111). One study required that assessment be completed whenever solutions changed or drugs were added to the intravenous therapy (105).</li> <li>■ The acronym TLC (touch, look, compare) was used in one study (102), while ACT (assess, compare, touch) was used in another (104).</li> <li>■ The acronym PIVCS formed the maintenance bundle in two studies: prompt removal, inspect hourly, vein patency by intermittent flush of 0.9% sodium chloride, clean hands, scrub the hub with 2%, chlorhexidine gluconate and 70% alcohol swab (108, 111).</li> </ul>
PVAD dressings/securement devices	<ul style="list-style-type: none"> <li>■ Chlorhexidine antimicrobial bordered securement dressing (91).</li> <li>■ Transparent dressing (91, 101).</li> <li>■ Semi-transparent polyurethane sterile dressing (106).</li> <li>■ Sterile self-transparent adhesive gauze (105).</li> <li>■ Bordered polyurethane dressing (108, 111).</li> <li>■ An additional elastic bandage was applied to reduce the risk of inadvertent withdrawal (105).</li> </ul>

## Supporting Resources

RESOURCE	DESCRIPTION
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>■ Canadian Vascular Access Association guidelines.</li> <li>■ Includes PVAD care and daily assessment.</li> <li>■ <b>Note:</b> this is a resource for which there is a fee.</li> </ul>
United States Centers for Disease Control and Prevention (US CDC). Guidelines for the prevention of intravascular catheter-related infections [Internet]. [place unknown]: US CDC; 2011. Available from: <a href="https://www.cdc.gov/hai/pdfs/bsi-guidelines-2011.pdf">https://www.cdc.gov/hai/pdfs/bsi-guidelines-2011.pdf</a>	<ul style="list-style-type: none"> <li>■ Rigorous guidance from the US CDC.</li> <li>■ Includes guidance on a daily review of PVAD.</li> <li>■ <b>Note:</b> the online edition of this guideline was updated in 2016 and 2017 respectively.</li> </ul>
Ray-Barruel G, Cooke M, Chopra V, et al. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. <i>BMJ Open</i> . 2020;10(1):e035239.	<ul style="list-style-type: none"> <li>■ Tool for PVAD assessment and decision making.</li> <li>■ Standardized assessment that includes device necessity, effectiveness, complications, dressing, evaluation, education and documentation.</li> </ul>
Royal College of Nurses. Standards for infusion therapy [Internet]. 4th ed. London (UK): Royal College of Nurses; 2016. Available from: <a href="https://www.rcn.org.uk/clinical-topics/infection-prevention-and-control/standards-for-infusion-therapy">https://www.rcn.org.uk/clinical-topics/infection-prevention-and-control/standards-for-infusion-therapy</a>	<ul style="list-style-type: none"> <li>■ Includes assessment considerations and appendices with checklists and scales used for PVAD assessment.</li> </ul>

## RECOMMENDATION QUESTION #6:

**Should use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?**

**Outcomes:** Success rate on first attempt/number of failed attempts, patient satisfaction and complications.

### RECOMMENDATION 6.1:

The expert panel recommends that health providers use ultrasound-guided technique for the insertion of peripheral arterial catheters.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Moderate

## Discussion of Evidence:

### Benefits and Harms

Evidence suggests that the use of visualization technologies—specifically **ultrasound-guided technique<sup>G</sup>**—for the insertion of peripheral arterial catheters will increase the success rate on first attempts and will likely reduce complications (113-118). Ultrasound-guided technique refers to ultrasound imaging (an image created by using sound waves within the body) that allows health providers to see surrounding anatomical structures such as arteries and veins (119). It is used to aid the health provider when inserting a PIV or peripheral arterial catheter. In particular, the use of ultrasound-guided technique was more effective when compared to the palpation technique in adult and pediatric populations (118).

Hematoma was the most frequently reported complication in the evidence. The systematic review reported fewer incidences of hematoma when using ultrasound-guided technique for arterial catheter insertion compared to palpation or traditional methods (118). Additional **randomized controlled trials<sup>G</sup>** that were included supported these findings (113-117).

Ultrasound-guided technique could provide greater value in the care of certain subpopulations. Based on subgroup analysis, one review noted that first attempt success rate of ultrasound-guided technique versus traditional palpation techniques for radial artery catheterization was particularly beneficial in children and persons undergoing emergent procedures (118).

There were no studies that reported on the outcome of patient satisfaction.

There were no harms reported in the studies.

The evidence was of moderate certainty due to some limitations in how individual studies were conducted. For more detailed information on the impact of the intervention (ultrasound-guided technique for arterial catheter insertion) on the prioritized outcomes (success rate on first attempt, patient satisfaction and complications), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”



Appropriate scope of practice and level of training or expertise needs to be considered when applying this recommendation and determining the most appropriate health provider to insert the peripheral arterial catheter.

### Values and Preferences

There was no evidence identified in the systematic review that reported on the values and preferences of persons with a VAD related to the use of ultrasound-guided technique for the insertion of a peripheral arterial catheter.

### Health Equity

It is important to note that implementation barriers such as the cost of ultrasound devices may limit the feasibility and accessibility of ultrasound-guided technique in some health-service organizations.

### Expert Panel Justification of Recommendation

The benefits of using ultrasound-guided technique outweigh the harms, and there was moderate certainty of evidence for this. The expert panel agreed that the technique was feasible in most health-service organizations, and that it was acceptable to patients.

Overall, the expert panel noted that the potential harms of not using ultrasound-guided technique can be severe. The expert panel noted the potential for additional harms that were not captured in the body of evidence, including ischemia, hemorrhage and thrombosis. Therefore, the expert panel determined the recommendation to be strong.

### Practice Notes

#### Considerations from the expert panel

- Training on the use of ultrasound needs to include a basic understanding of ultrasound technology, as well as ongoing maintenance of competencies (not a one-time certificate). Additionally, health-service organizations are to document competency of staff and review competencies through a formal process on a regular basis.
- Training of health providers in ultrasound-guided techniques should involve practical education with the technology (see **Recommendation 2.1** for details on practical education).
- Two health providers may be required when using ultrasound, depending on the expertise and experience level of the health provider (i.e., one to hold the ultrasound probe and the other to insert the needle).
- When using ultrasound-guided technique for the insertion of arterial catheters, it is important that health providers ensure correct positioning of the VAD prior to initiating treatment.
- See **Appendix K** for an example of ultrasound-guided technique.



**Table 11: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
Health provider experience	<ul style="list-style-type: none"> <li>■ Health provider training and experience may affect the outcome of ultrasound-guided technique (119). In subgroup analysis, it was noted that those with ultrasound expertise had a higher first attempt success rate than those with no expertise (119).</li> <li>■ Previous experience may improve the results and success of ultrasound-guided technique (120).</li> </ul>
Details of ultrasound technique	<ul style="list-style-type: none"> <li>■ Short axis view, out-of-plane (113, 118-120). <ul style="list-style-type: none"> <li>□ One review noted that there was higher incidence of first attempt success in the subgroup analysis of pooled trials that used short axis out-of-plane ultrasound-guided approach (118).</li> </ul> </li> <li>■ Dynamic Needle Tip Positioning (DNTP) technique (a modified ultrasound technique that requires confirmation of the needle tip position in the vessel before advancing the catheter) (113, 117).</li> <li>■ Long axis view, in plane (115, 118).</li> <li>■ Seldinger technique (119, 120)</li> <li>■ Single or double wall technique (120).</li> <li>■ Vascular transducer used (120).</li> </ul>

### Supporting Resources

RESOURCE	DESCRIPTION
Bardin-Spender A, Spencer TR. Position paper: ultrasound guided peripheral arterial catheter insertion by qualified vascular access specialist or other applicable healthcare clinicians [Internet]. [place unknown]: Association for Vascular Access; 2019. Available from: <a href="https://cdn.ymaws.com/www.avainfo.org/resource/resmgr/files/position_statements/insertion_of_arterial_cathet.pdf">https://cdn.ymaws.com/www.avainfo.org/resource/resmgr/files/position_statements/insertion_of_arterial_cathet.pdf</a>	<ul style="list-style-type: none"> <li>■ Statement on the use of ultrasound technology for the insertion of arterial catheters.</li> <li>■ Provides considerations for the use of ultrasound technology.</li> </ul>
American Institute of Ultrasound in Medicine (AIUM). Practice parameter for the use of ultrasound to guide vascular access procedures. <i>J Ultrasound Med.</i> 2019;38(3):E4-E18. doi: 10.1002/jum.14954.	<ul style="list-style-type: none"> <li>■ Practical guide for the use of ultrasound in vascular access procedures.</li> </ul>

**RECOMMENDATION 6.2:**

The expert panel suggests that health providers use ultrasound-guided technique for the insertion of PVADs for persons with difficult intravenous access.

**Strength of the recommendation:** Conditional

**Certainty of the evidence of effects:** Very Low

**Discussion of Evidence:****Benefits and Harms**

Evidence suggests that the use of visualization technologies, specifically ultrasound-guided technique, for the insertion of PVADs in persons with difficult intravenous access may increase the success rate on first attempts and decrease complications, and that it likely will increase patient satisfaction (121-128). However, the certainty of the evidence was very low.

Ultrasound-guided technique refers to ultrasound imaging (an image created by using sound waves within the body) that allows health providers to see surrounding anatomical structures, such as arteries and veins (119). It is used to aid the health provider when inserting a PVAD or peripheral arterial catheter.

Ultrasound-guided technique can be particularly useful for persons with DiVA, which is defined as a clinical situation where multiple attempts or special interventions are required to obtain and maintain peripheral venous access (129). How DiVA was determined varied across studies and included previous failed attempts (121, 122), history of difficult access (121, 122, 127), health provider assessment (121, 122, 124, 125, 128), self-report (121, 130) or certain comorbidities, such as sickle cell disease, obesity or intravenous drug use (121, 124). Some studies focused on pediatric populations with different levels of venous access difficulty, or different ages and behaviours that may have influenced their cooperation with the procedure (22, 123).

In adults and children with DiVA, ultrasound-guided PVAD insertion resulted in a higher success rate when compared to traditional techniques of palpation and direct visualization (22, 122-128). Furthermore, the evidence reported that adults and children with DiVA (or their parents/guardians) who received ultrasound-guided technique for the insertion of PVADs reported higher patient satisfaction than those who did not receive PVADs through ultrasound-guided technique (122, 124, 125).

Most studies reported fewer complications during the use of ultrasound-guided technique (121, 125). There were no additional harms reported in the studies.

Of note were two systematic reviews that examined the effect that the use of near-infrared devices during PVAD insertion had on the success rate of first attempts (21, 130). Both systematic reviews found no difference in first attempt success rate when using near-infrared devices. Due to the limited evidence on this intervention, it was determined more research is needed in this area. As a result, the recommendation is solely focused on ultrasound-guided technique. See **Table 15** on page 80 for research gaps and future implications.

The evidence was of very low certainty due to limitations in how individual studies were conducted and inconsistency in the reported results. For more detailed information on the impact of the intervention (ultrasound-guided technique) on the prioritized outcomes (success rate on first attempt, patient satisfaction and complications), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”



Appropriate scope of practice and level of training or expertise needs to be considered when applying this recommendation and determining the most appropriate health provider to insert the PVAD.

### Values and Preferences

There was no evidence identified in the systematic review that reported on the values and preferences of persons with a VAD related to ultrasound-guided technique beyond the patient satisfaction outcome reported above.

### Health Equity

It is important to note that implementation barriers, such as the cost of ultrasound devices, may limit the feasibility and accessibility of ultrasound-guided technique in some health-service organizations. No evidence was identified in the systematic review that directly assessed the impact that visualization techniques for PVAD insertion had on health equity. More research is required on this topic. See **Table 15** on page 80 for research gaps and future implications.

### Expert Panel Justification of Recommendation

There may be benefits to using ultrasound-guided technique in persons with DiVA in terms of insertion success rate and improvement of patient satisfaction. There was a reduction in the number of complications when using ultrasound-guided technique compared to traditional methods. The expert panel felt that the success of this recommendation would be dependent on individual considerations of the person receiving the PVAD and the expertise of the health provider. The certainty in the evidence was very low. Therefore, the expert panel determined the recommendation to be conditional.

### Practice Notes

#### Considerations from the expert panel

- Training on the use of ultrasound needs to include a basic understanding of ultrasound technology and ongoing maintenance of competencies (not a one-time certificate). Additionally, health-service organizations are to document and review competencies of staff on a regular basis through a formal process. See **Appendix J** for a validated scale on ultrasound-guided PVAD insertion and **Appendix K** for an example of ultrasound use during VAD insertion.
- Health providers caring for persons in the community or home-care settings may need to refer persons with DiVA to an acute care setting to utilize ultrasound technology (if traditional methods of PVAD insertion are unsuccessful).

- A validated scale can be used to determine DiVA. DiVA status should be assessed by an expert in PVAD insertion or a health provider who is appropriately trained to use the validated DiVA scale. Referral to VAS or VASTs may be needed to support the insertion of VADs in DiVA patients using ultrasound-guided technique (in organizations where available).
- When using ultrasound-guided technique for the insertion of PVAD, it is important that health providers ensure correct positioning of the VAD prior to initiating treatment.
- See [Appendix N](#) for examples of validated DiVA scales. See also [Appendix G](#) for the UK Vessel Health Preservation Framework.

**Table 12: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<p><b>Health provider experience</b></p>	<ul style="list-style-type: none"> <li>■ Insertions were completed by a variety of health providers, including registered nurses, nurse practitioners, nurse anesthetists, emergency physicians and anesthetists (22, 121-126, 128, 130).</li> <li>■ It was noted that provider comfort and previous experience affected the success and implementation of the intervention (122, 123, 125).                             <ul style="list-style-type: none"> <li>□ One systematic review reported that provider expertise level and technique (e.g., one-person versus two-person, and dynamic versus static) were associated with better results (122).</li> <li>□ One study reported significant health provider effect on needle redirections, total time and needle manipulation time (123).</li> <li>□ One study noted that attending physicians and nurses may have had higher success rates inserting PVADs than fellows because of more experience with placing ultrasound-guided VADs (125).</li> </ul> </li> </ul>
<p><b>Details of ultrasound technique</b></p>	<ul style="list-style-type: none"> <li>■ Dynamic Needle Tip Positioning (123, 125-127).</li> <li>■ Short axis (121, 123, 125).</li> <li>■ Long axis (121).</li> <li>■ Single-operator technique (121, 125-127).</li> <li>■ Two-provider technique (22, 121, 122).                             <ul style="list-style-type: none"> <li>□ One nurse operated the equipment and examined vessels in transverse and longitudinal directions with a 90-degree angle of the transducer, then chose the vein to be used. Another nurse performed skin antisepsis and the catheter insertion, analyzing the image on the screen (22).</li> </ul> </li> </ul>

## Supporting Resources

RESOURCE	DESCRIPTION
<p>Pitts S, Ostroff M. Position paper: the use of visualization technology for the insertion of peripheral intravenous catheters [Internet]. [place unknown]: American Vascular Association; 2019. Available from: <a href="https://cdn.ymaws.com/www.avainfo.org/resource/resmgr/files/position_statements/Visualization_for_Peripheral.pdf">https://cdn.ymaws.com/www.avainfo.org/resource/resmgr/files/position_statements/Visualization_for_Peripheral.pdf</a></p>	<ul style="list-style-type: none"> <li>■ Statement on the use of ultrasound technology for the insertion of short PVADs.</li> <li>■ Provides considerations for the use of ultrasound technology.</li> </ul>
<p>American Institute of Ultrasound in Medicine (AIUM). Practice parameter for the use of ultrasound to guide vascular access procedures. <i>J Ultrasound Med.</i> 2019;38(3):E4-E18. doi: 10.1002/jum.14954.</p>	<ul style="list-style-type: none"> <li>■ Practical guide for the use of ultrasound in vascular access procedures.</li> </ul>
<p>Hallam C, Denton A. Vessel health and preservation 1: minimising the risks of vascular access [Internet]. <i>Nursing Times.</i> 116:7;22-5. Available from: <a href="https://cdn.ps.emap.com/wp-content/uploads/sites/3/2020/04/200610-Vessel-health-and-preservation-1-minimising-the-risks-of-vascular-access.pdf">https://cdn.ps.emap.com/wp-content/uploads/sites/3/2020/04/200610-Vessel-health-and-preservation-1-minimising-the-risks-of-vascular-access.pdf</a></p>	<ul style="list-style-type: none"> <li>■ Publication outlining vessel health preservation framework.</li> <li>■ Details the use of ultrasound, assessment and device selection.</li> </ul>

**RECOMMENDATION QUESTION #7:**

**Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?**

**Outcomes:** Patient’s rating of pain, patient comfort, fear/anxiety (related to poke/needle phobia) and patient satisfaction.

**RECOMMENDATION 7.1:**

The expert panel recommends that health providers offer adults non-pharmacological and pharmacological pain management strategies during the insertion of a vascular access device.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Moderate

**Discussion of Evidence:****Benefits and Harms**

Evidence suggests that both pharmacological and non-pharmacological pain management interventions probably decrease pain, fear and anxiety, increase patient satisfaction during the insertion of a VAD for adults, and may increase patient comfort (131-156). Various needle procedures were examined across the studies, including CVAD insertion (131), arterial blood gas draw (147-149), intramuscular injections (141-143, 156), venipuncture (132, 140, 143, 146), implanted port access (152), and PVAD insertion (132, 133, 136, 138, 143-145, 150, 151, 153-155).

Various types of pharmacological interventions were used in the studies, including fentanyl prior to CVAD insertion (131), a “needle-free powder lidocaine delivery system” given prior to venipuncture or PVAD insertion, and a variety of topical anesthetics (e.g., lidocaine-prilocaine cream, diclofenac patch, ketoprofen patch and tetracaine 4 per cent) (133-138, 148, 149). Specifically, the evidence reports that members of the “caine” family of drugs were estimated to be much more effective at reducing pain compared to no treatment (133).

Non-pharmacological interventions included both physical and psychological interventions (e.g., distraction techniques, acupressure, a vibrating cold device, vapocoolant spray, crushed ice, heat application, aromatherapy, a virtual reality device or hypnosis) (132, 140-156). The evidence reported that non-pharmacological techniques probably decrease pain and increase patient satisfaction (132, 140-147, 149-156).

The evidence demonstrated that overall, there was minimal or no difference in patient comfort levels when they were given pharmacological or non-pharmacological pain management interventions when compared to no pain management intervention (131, 132, 142, 155). For the outcome of patient fear/anxiety, two systematic reviews demonstrated minimal to no difference when patients were given pharmacological or non-pharmacological pain management interventions when compared to no pain management intervention (132, 143).

The harms reported in the literature were due to side effects from pharmacological interventions. These included episodes of decreased oxygen saturation related to fentanyl use (131), nausea and pruritis related to fentanyl use (131), and mild skin reactions related to topical medications (e.g., skin blanching, rashes, petechiae, erythema and edema) (132, 134, 136, 137).

The evidence was of moderate certainty due to how individual studies were conducted and inconsistency in the measurement of the outcomes. For more detailed information on the impact of the intervention (pharmacological and non-pharmacological pain management strategies) on the prioritized outcomes (patient’s rating of pain, patient comfort, fear/anxiety related to poke or needle phobia, and patient satisfaction), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”

### Values and Preferences

Several studies reported on patient satisfaction. Persons reported they were satisfied with the experience of topical anesthetic application, and more than 76 per cent were willing to use the cream again (134). Persons given lidocaine by injection for their procedure were more likely to want it next time than those who had never had lidocaine (133). Many persons also had a preference for lidocaine when asked to choose between lidocaine, guided imagery or nothing prior to PVAD insertion (133). All of those who chose lidocaine said they were satisfied with the PVAD insertion compared to those who chose no pain relief (133).

For non-pharmacological pain management, it was noted that individual differences—such as the desire to attend a medical procedure—may impact an individual’s ability to engage with a distraction intervention (143). In one study that used heat and cold application prior to PVAD insertion, 93.3 per cent of those in the hot application group stated that they were satisfied with the application, whereas 80.0 per cent stated that they wanted the application again (150). Conversely, 50 per cent of those in the cold application group stated that they were not satisfied with the application, and 56.7 per cent expressed that they did not want the application again (150).

### Health Equity

Minimal considerations related to health equity were reported in the evidence. There were some studies that discussed accessibility issues. Non-pharmacological pain management devices such as the “needle-free powder lidocaine delivery system” and vibrating cold devices are currently unavailable in Canada (as of May 2021) (157). In addition, not all settings may have access to lidocaine-prilocaine cream (134), particularly in some developing countries that restrict its use as a routine medication for PVAD insertion (136). One study recommended using diclofenac gel instead of lidocaine-prilocaine cream because of increased accessibility and domestic production in general (135).

### Expert Panel Justification of Recommendation

There are likely benefits to offering non-pharmacological and pharmacological pain management strategies. Although there were some harms in the form of side effects associated with pharmacological pain management strategies, the expert panel felt that the benefits greatly outweighed the harms. The interventions were also highly valued by persons, and the expert panel felt that the recommendation aligned with person- and family-centred care principles. It is important to note that the expert panel chose the action word “offer” for this recommendation to highlight that pain

management strategies need to be person- and family-centred and that ultimately the person with a VAD will make the decision whether or not to receive pain management. The certainty in the evidence was moderate. Therefore, the expert panel determined the recommendation to be strong.

## Practice Notes

### Considerations from the expert panel

- Aseptic technique needs to be maintained during VAD insertion, regardless of the type of pain management strategy used.
- The expert panel recognized that time constraints experienced by health providers may be a barrier to providing pain management strategies. In these situations, pain management strategies should still be offered. Health providers may consider faster acting strategies, such as thermotherapy or cryotherapy, while keeping in mind the preferences of persons and their families/caregivers.
- The expert panel noted that some individuals may not prefer topical anesthetic due to the increase in overall procedure time (i.e., topical anesthetic can take longer to take effect).
- A physician order may be required prior to administration of pharmacological pain management interventions.
- Decisions around pharmacological pain management interventions may require an individualized risk-benefit assessment, including (but not limited to) factors such as the following:
  - person preference;
  - presence of needle phobia, or fear/anxiety about the procedure;
  - DiVA score/history of DiVA; and
  - type of pharmacological intervention and potential side effects, such as vasoconstriction associated with some topical medications.
- It may not be possible to offer pharmacological or non-pharmacological pain management strategies to persons needing vascular access in an emergency care situation. Health providers should not delay the life-saving treatments of persons during emergency situations.



**Table 13: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<p><b>Type of VAD insertion</b></p>	<ul style="list-style-type: none"> <li>■ It is important to consider the type of vascular access procedure when choosing a pain management intervention. Most studies focused on venipuncture or PVAD insertion. Specialized pain management strategies were used for the following:                             <ul style="list-style-type: none"> <li>□ Arterial catheter insertion: There were three studies that examined using ice or topical anesthetics for arterial blood gas draws, and these were found to be effective pain management strategies (147-149).</li> <li>□ CVAD insertion: One study examined the use of fentanyl for CVAD insertion (131). This type of intervention may not be necessary for less invasive procedures, such as venipuncture or PVAD insertion.</li> </ul> </li> </ul>
<p><b>Local anesthetic administration</b></p>	<ul style="list-style-type: none"> <li>■ Choice of drug: One systematic review and network meta-analysis found that drug members of the “caine” family (e.g., lidocaine and iontophoretic) were most effective in reducing patient pain when undergoing needle procedures (133).</li> <li>■ Timing: Three studies reported that topical anesthetic cream should be applied 60 minutes prior to the procedure in order to be most effective (134-136).</li> </ul>

RECOMMENDATIONS

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<p><b>Distraction</b></p>	<ul style="list-style-type: none"> <li>■ The evidence examined various types of distraction techniques (143, 144, 152-155).                             <ul style="list-style-type: none"> <li>□ Verbal cues were found to have a mixed effect in reducing a person’s pain. These interventions included giving a verbal signal to the person to warn them of the impending needle poke (e.g., “sting” or “sharp scratch”) (143).</li> <li>□ Visual distraction techniques may include having people look through a kaleidoscope (143), distraction cards containing optical illusion pictures (154) or virtual reality devices (154).</li> <li>□ Hypnosis was used in one study, involving classical non-verbal hypnotic tools adapted to the subject and indirect suggestion of comfort by body language (155).</li> <li>□ Aromatherapy, including lavender, eucalyptus or peppermint essential oils inhaled by persons prior to needle insertion, was used in two studies (152, 153). For aromatherapy interventions, health providers should be aware of any allergies prior to administering the aromatherapy oils.</li> <li>□ Breathing techniques may include things such as the “cough trick” or <b>Valsalva maneuver</b><sup>G</sup> (143) or spirometry (144). The Valsalva maneuver is a breathing technique that can be used as a pain management strategy during VAD insertion. It involves a deep inhale, followed by a forceful holding of the breath during which the venous cannulation insertion occurs (143).                                     <ul style="list-style-type: none"> <li>○ For breathing techniques, health providers should be aware of the person’s health history and status and related contraindications to the Valsalva maneuver or coughing, including respiratory conditions such as COPD and asthma.</li> </ul> </li> </ul> </li> </ul>
<p><b>Scope of practice considerations</b></p>	<ul style="list-style-type: none"> <li>■ <b>Acupressure:</b> If considering acupressure as a pain management intervention, it is important to recognize that health providers would need additional education and training in order to utilize this pain management strategy.</li> <li>■ <b>Opioids:</b> One study found that the use of intravenous fentanyl given prior to CVAD placement procedure was effective in reducing person’s pain (131). Health providers need to be aware of scope of practice surrounding prescribing or administering opioids. They should consult with the interprofessional team about opioid administration in circumstances where it would be beneficial to advocate for this pain management strategy for the person with a VAD.</li> <li>■ <b>Hypnosis:</b> One study examined the impact of hypnosis on PVAD insertion, but it is important to note that the health providers received additional certifications in hypnosis prior to delivering the intervention (155).</li> </ul>

## Supporting Resources

RESOURCE	DESCRIPTION
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>Canadian Vascular Access Association guideline.</li> <li>Provides details on pain management for VAD insertion.</li> <li><b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Registered Nurses' Association of Ontario (RNAO). Assessment and management of pain: (3rd ed.). Toronto (ON): RNAO; 2013. Available from: <a href="https://rnao.ca/bpg/guidelines/assessment-and-management-pain">https://rnao.ca/bpg/guidelines/assessment-and-management-pain</a>	<ul style="list-style-type: none"> <li>RNAO BPG on pain assessment and management</li> </ul>
Registered Nurses' Association of Ontario (RNAO). Long-term care best practices toolkit, 2nd edition: pain assessment and management [Internet]. Toronto (ON): RNAO; 2018. Available from: <a href="https://tctoolkit.rnao.ca/clinical-topics/pain-assessment">https://tctoolkit.rnao.ca/clinical-topics/pain-assessment</a>	<ul style="list-style-type: none"> <li>Includes a list of resources for pain assessment and management in long-term care settings.</li> <li>Includes links to various pain scales.</li> </ul>
Pain Management: Older Adults. In: Saskatchewan Health Authority [Internet]. [place unknown]: Saskatchewan Health Authority; c2021 [updated 2017 Sep 21]. Available from: <a href="https://www.saskatoonhealthregion.ca/locations_services/Services/pain-management/Pages/Seniors.aspx">https://www.saskatoonhealthregion.ca/locations_services/Services/pain-management/Pages/Seniors.aspx</a>	<ul style="list-style-type: none"> <li>Lists resources for pain management in older adults.</li> </ul>
Senior friendly 7 pain toolkit. Version 1 [Internet]. Toronto (ON): Regional Geriatric Program of Toronto; 2018. Available from: <a href="https://www.rgptoronto.ca/wp-content/uploads/2018/11/SF7-Toolkit-V1-2018-Pain.pdf">https://www.rgptoronto.ca/wp-content/uploads/2018/11/SF7-Toolkit-V1-2018-Pain.pdf</a>	<ul style="list-style-type: none"> <li>Senior Friendly 7 focuses on seven clinical areas that support resilience, independence, and quality of life.</li> <li>Pain toolkit for older adults.</li> <li>Includes pain scales and pain management strategies.</li> </ul>

**RECOMMENDATION 7.2:**

The expert panel recommends that health providers offer non-pharmacological and pharmacological pain management strategies during the insertion of a vascular access device to infants and children, tailored to their age and developmental stage.

**Strength of the recommendation:** Strong

**Certainty of the evidence of effects:** Low

**Discussion of Evidence:****Benefits and Harms**

Research evidence suggests that both pharmacological and non-pharmacological pain management interventions may decrease pain (139, 156, 158-175) fear and anxiety (162, 164, 166, 171, 173, 174), and increase comfort (176), and that they probably increase patient or parent/guardian satisfaction (139) during the insertion of a VAD for infants and children.

The majority of studies examined non-pharmacological interventions. These included psychological interventions (e.g., distraction techniques, virtual reality devices, cartoons, aromatherapy and informational materials about the procedure) (164, 165, 168, 171-175, 177-197) and physical interventions (e.g., breastfeeding and other feeding interventions, a vibrating cold device, ice, heat therapy, acupressure and holding/positioning techniques) (139, 156, 160-163, 166-168, 170, 176, 177, 179, 180, 182, 197-220). One systematic review showed that interactive distraction interventions—such as virtual reality, a toy accompanied by a reading activity and video games—were most effective in reducing fear/anxiety prior to the needle procedure (164). Furthermore, a meta-analysis reported a positive effect on the outcome of fear/anxiety among children who received distraction during the insertion of a VAD compared to those who did not receive distraction (164). Types of non-pharmacological interventions used in the studies varied with child and infant age and developmental stage. Further details of effective non-pharmacological pain management strategies are outlined below, under “Practice Notes.”

Various pharmacological interventions were used in the studies, including oral melatonin 30 minutes before venipuncture (221), and lidocaine-prilocaine cream (169), 5 per cent lidocaine cream (169), vapocoolant spray (156), amethocaine, paracetamol and ibuprofen before needle procedures (158, 159). Lidocaine-prilocaine cream and oral melatonin were found to reduce pain scores, and it was noted that lidocaine-prilocaine cream had the highest probability of being most effective in reducing pain (158, 159). In addition, children who received melatonin had lower anxiety than those treated with placebo (221). Paracetamol and ibuprofen were not shown to reduce pain scores (158).

The harms reported in the literature were due to side effects from pharmacological interventions or adverse events associated with non-pharmacological interventions. In one review, two studies reported skin blanching as an adverse effect of lidocaine-prilocaine cream application (159). Feeding-related adverse events included choking while drinking formula milk during vaccination (not leading to additional interventions or complications) (212), or infants coughing, gagging and vomiting following sucrose administration (116, 160, 199, 207). One study reported that when using non-nutritive sucking, some infants may refuse to suck and should not be forced to do so, as it may increase distress (162). Mild to moderate nausea was noted in some children when participating in a virtual reality intervention (187), and in another study examining virtual reality as an intervention two children took off the headset

during the procedure stating that they felt distressed (175). Finally, one study on breathing techniques reported adverse events: three of 50 children reported respiratory difficulties when asked to engage in a specialized form of deep breathing (164).

The evidence was of low certainty due to some concerns over how individual studies were conducted, inconsistency in the measurement of the outcomes, and variability in the types of needle procedures examined. For more detailed information on the impact of the intervention (pharmacological and non-pharmacological pain management strategies) on the prioritized outcomes (patient’s rating of pain, patient comfort, fear/anxiety related to poke or needle phobia, and patient satisfaction), refer to the evidence profiles available here: <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Specific components of the intervention noted in the literature are outlined below, under “Practice Notes.”

### Values and Preferences

An important consideration reported in the literature was recognizing the developmental stage of the child and how it may influence their preferred pain management intervention. In addition, children in a study using a virtual reality intervention reported positive satisfaction: one child explained that he was “nervous at the idea of blood draw, [but] the virtual reality game truly helped distract [him] from the feeling of the needle being inserted” (187). Another study that used virtual reality as an intervention reported that users of the virtual reality headsets stated that the device was effective in reducing pain and anxiety and offered a pleasant experience (190).

The evidence also reported infant feeding/positioning preferences. Not all mothers may want to breastfeed (or formula feed) their child, especially during immunization, if they are anxious themselves (208). One study stated it is important to consider the parental wishes for infant procedures (e.g., they could stay in the room or leave during the procedure, or they could offer comfort measures to the child) (200). In one study, parents preferred to have their children sitting up for the injections (162).

### Health Equity

Multiple studies examined breastfeeding as an intervention and noted it to be inexpensive, readily available and convenient (182, 209). However, it is important to recognize person- and family-centred care principles: not all persons have the ability to breastfeed, or they simply may prefer not to do so.

No additional considerations for health equity were reported in the studies.

### Expert Panel Justification of Recommendation

Conventionally based on GRADE, this recommendation could have been voted conditional since the certainty of the evidence of the effects was low. Based on the balance of benefits and harms, including the harms of not following the recommendation, as well as values and preferences, the expert panel came to consensus on a strong recommendation. There are likely benefits to offering non-pharmacological and pharmacological pain management strategies. Although there were some harms in the form of side effects associated with pharmacological pain management strategies and feeding, the expert panel felt that the benefits greatly outweighed the harms. The interventions were also highly valued by children, infants and parents/guardians, and the expert panel felt that they aligned with person- and family-centred care principles. It is important to note that the expert panel chose the action word “offer” for this

recommendation to highlight that pain management strategies need to be person- and family-centred and that ultimately the decision whether or not to receive pain management is up to the child and/or parents/guardians.

The certainty of the evidence was low, but due to the reasons stated above, the expert panel determined the recommendation to be strong.

## Practice Notes

### Considerations from the expert panel

- Aseptic technique needs to be maintained during VAD insertion, regardless of the type of pain management strategy used.
- The expert panel emphasized the importance of offering children, infants and parents/guardians the choice of a variety of pain management interventions. The expert panel noted that some children do not prefer topical anesthetic due to the increase in overall procedure time (i.e., topical anesthetic can take longer to take effect). An additional example was given of some children disliking the feeling associated with cryotherapy (such as aerosol vapocoolant sprays).
- A physician order may be required prior to administration of pharmacological pain management interventions.
- Decisions around pharmacological pain management interventions may require an individualized risk–benefit assessment, including (but not limited to) factors such as:
  - person and family preference;
  - presence of needle phobia, or fear/anxiety about the procedure;
  - DiVA score/history of DiVA; and
  - type of pharmacological intervention and potential side effects, such as vasoconstriction associated with some topical medications.
- It may not be possible to offer pharmacological or non-pharmacological pain management strategies to persons needing vascular access in an emergency care situation. Health providers should not delay the life-saving treatments of persons during emergency situations.
- See [Appendix O](#) for details of pain management strategies for infants and children across various ages and developmental stages.

**Table 14: Practice Notes from the Evidence**

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<b>Interventions tailored to age and developmental stage</b>	<ul style="list-style-type: none"> <li>■ It is important to tailor the pain management strategy to the age and developmental stage of the child.               <ul style="list-style-type: none"> <li>□ One study reported that “the receptivity of infants to distraction is hypothesized to vary due to developing motor and cognitive capacities. On the basis of developmental milestones, a two-month old would seem less likely to benefit from distraction. However, a child older than 12 months would seem to have greater ability to benefit from distraction” (165).</li> <li>□ Another study reported that distraction methods such as toys or books are generally preferred for children aged 7–12 years (190).</li> </ul> </li> <li>■ Information and preparation materials should be tailored to the age of the child. Storybooks that include age-appropriate health education messages and pictures enable children to better understand their treatment regimen (189).</li> </ul>
<b>Psychological techniques</b>	<ul style="list-style-type: none"> <li>■ Various distraction interventions may be used by health providers. These include movies, cartoons, video games, storybooks, toys, cards, blowing bubbles, chewing gum, balloon inflation, virtual reality, music, parent distraction, a medical clown or squeezing a rubber ball.               <ul style="list-style-type: none"> <li>□ Interactive or directed distraction may confer a larger benefit than non-directed distraction interventions. For example, one study stated that passive distraction by watching a cartoon may be less effective in reducing procedural pain than virtual reality motion videos, such as riding a roller coaster (190).</li> <li>□ One systematic review that examined combined cognitive behavioural therapy and breathing interventions for reducing children’s needle-related pain or distress found that combining multiple psychological strategies can be beneficial (164).</li> </ul> </li> </ul>
<b>Positioning and touch</b>	<ul style="list-style-type: none"> <li>■ Positioning of infants for the vascular access procedure may be different than it is for children.               <ul style="list-style-type: none"> <li>□ Children: Parents may want to hold their older child sitting upright during the procedure (162, 214). Holding the child in a parent’s lap in a gentle hug, with the child’s legs on either side of the parent, may be one way to deliver this intervention (162).</li> <li>□ Infants: Skin-to-skin, swaddling, hugging, caressing, or facilitated tucking may be appropriate interventions (161, 162, 219).</li> </ul> </li> </ul>
<b>Infant feeding</b>	<ul style="list-style-type: none"> <li>■ Breastfeeding was shown to confer the greatest benefit as a non-pharmacological pain management intervention, since it combines the therapeutic effects of feeding, skin-to-skin care and infant positioning (161).</li> <li>■ Formula feeding, non-nutritive sucking and sucrose were also found to be effective interventions if breastfeeding is not an option based on person- and family-centred care principles (162, 212).</li> <li>■ One study noted that non-nutritive sucking may be particularly beneficial for infants with latching difficulties or those who are unable to breastfeed (173).</li> </ul>

KEY INTERVENTION	DETAILS FROM THE EVIDENCE
<p><b>Acupressure/massage</b></p>	<ul style="list-style-type: none"> <li>■ Three studies examined acupressure or massage therapy (216, 220, 222).</li> <li>■ One study reported that “acupressure is a safe, inexpensive and easy-to-learn technique. Therefore, nurses can teach this technique to patients and involve them in their own treatment, and thereby enhance their self-confidence” (222).                             <ul style="list-style-type: none"> <li>□ However, it is important to note that health providers need additional training to perform acupressure.</li> <li>□ The study that used this intervention noted that the acupressure intervention was implemented in two steps, with a 30-minute interval in between, and that it was performed by someone who had received the necessary acupressure training from an acupressure specialist (222).</li> </ul> </li> <li>■ Another study also noted that the researcher performing acupressure received certification prior to performing the intervention (220).</li> </ul>
<p><b>Aromatherapy</b></p>	<ul style="list-style-type: none"> <li>■ One study demonstrated that aromatherapy using inhaled lavender essential oil for infants prior to heel lance reduced pain (197).</li> <li>■ A systematic review demonstrated that inhaled maternal milk odor prior to heel lance was also effective in reducing pain in infants (167).</li> <li>■ For aromatherapy interventions, health providers should be aware of any known allergies prior to administering the aromatherapy oils.</li> </ul>
<p><b>Heat therapy</b></p>	<ul style="list-style-type: none"> <li>■ Two studies examined forms of heat therapy prior to heel lance or PVAD insertion in infants and children (176, 218).                             <ul style="list-style-type: none"> <li>□ Electric heating pad: In one study of children aged 5–18 years, an electric heating pad (40°C) was applied at the site of the identified PVAD insertion for 10 minutes before PVAD insertion (218). The child was asked to inform the health provider if the heating device caused discomfort when applied to the chosen site (218).</li> <li>□ In another study, infants in the experimental group received a heating pad (“thermophore”) application for five minutes before a heel lance procedure (176). The warmth of the pad was kept between 34–37°C. To prevent the heating pad from directly contacting the sole of the infant’s foot, it was wrapped in a cloth and placed on the sole from which the heel lance would be taken (176).</li> </ul> </li> <li>■ Health providers should be aware of the potential for burns, irritation and skin discomfort when using heat therapy interventions.</li> </ul>



## Supporting Resources

RESOURCE	DESCRIPTION
Comfort Promise: Learning Hub. In: About Kids Health [Internet]. Toronto (ON): The Hospital for Sick Children; c2021. Available from: <a href="https://www.aboutkidshealth.ca/comfortpromise">https://www.aboutkidshealth.ca/comfortpromise</a>	<ul style="list-style-type: none"> <li>Resources from The Hospital for Sick Children for pain management during needle procedures.</li> <li>Includes pharmacologic and non-pharmacologic strategies.</li> <li>Outlines pain management strategies for a variety of ages and stages.</li> </ul>
SickKids staff. Tools for Measuring Pain. In: About Kids Health [Internet]. Toronto (ON): The Hospital for Sick Children; c2021 [updated 2009 Sep 18]. Available from: <a href="https://www.aboutkidshealth.ca/Article?contentid=2994&amp;language=English">https://www.aboutkidshealth.ca/Article?contentid=2994&amp;language=English</a>	<ul style="list-style-type: none"> <li>Resource from The Hospital for Sick Children that outlines pain scale tools for various ages.</li> </ul>
Beltramini A, Milojevic K, Pateron D. Pain assessment in newborns, infants, and children. <i>Pediatr Ann.</i> 2017 Oct 1;46(10):e387-95. doi: 10.3928/19382359-20170921-03	<ul style="list-style-type: none"> <li>Publication that outlines options for pain scales for infants and children.</li> </ul>
Trottier ED, Doré-Bergeron M-J, Chauvin-Kimoff L, et al. Position statement: managing pain and distress in children undergoing brief diagnostic and therapeutic procedures. <i>Paediatr Child Health.</i> 2019; 24(8):509-21.	<ul style="list-style-type: none"> <li>Position statement that provides an evidence-based overview of pain management in children and infants undergoing brief procedures (including needle procedures).</li> </ul>
Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	<ul style="list-style-type: none"> <li>Canadian Vascular Access Association guideline.</li> <li>Provides details on pain management for VAD insertion.</li> <li><b>Note:</b> this is a resource for which there is a fee.</li> </ul>
Pain Management, Research and Education Centre. In: SickKids [Internet]. Toronto (ON): The Hospital for Sick Children; c2021. Available from: <a href="http://www.sickkids.ca/pain-centre/Health-care-Professionals/Online%20Pain%20Curriculum/index.html">http://www.sickkids.ca/pain-centre/Health-care-Professionals/Online%20Pain%20Curriculum/index.html</a>	<ul style="list-style-type: none"> <li>Ten free modules for health providers on managing pediatric pain.</li> <li>Includes topics such as assessment, pharmacologic management, non-pharmacologic management and ethics.</li> </ul>
Taddio A, McMurtry M, Shah V, et al. Reducing pain during vaccine injections: clinical practice guideline. <i>CMAJ.</i> 2015;187(13):975-82. doi: 10.1503/cmaj.150391	<ul style="list-style-type: none"> <li>Clinical practice guideline on pain management during vaccinations.</li> </ul>

# Research Gaps and Future Implications

In reviewing the evidence for this BPG, the RNAO best practice guideline development and research team and expert panel identified priority areas for future research (outlined in **Table 15**). Studies conducted in these areas would provide further evidence to support high-quality and equitable support for persons with VAD. The list is not exhaustive; other areas of research may be required.

**Table 15: Priority Research Areas per Recommendation Question**

RECOMMENDATION QUESTION	PRIORITY RESEARCH AREA
<p><b>RECOMMENDATION QUESTION #1:</b> Should providing education to persons and their families about their vascular access device be recommended?</p> <p><b>Outcomes:</b> Hospital re-admission rate and complications.</p>	<ul style="list-style-type: none"> <li>■ The impact of providing education to persons and families about PVADs and arterial catheters.</li> <li>■ Qualitative studies examining the experience of persons and their families related to VAD education.</li> <li>■ Studies examining the impact that education for persons and their families has on VAD dwell time and completion of therapy.</li> <li>■ Studies exploring health teaching about VADs in settings outside of acute care, such as home care and long-term care.</li> </ul>
<p><b>RECOMMENDATION QUESTION #2:</b> Should practical education for the insertion and management of vascular access devices for health providers be recommended?</p> <p><b>Outcomes:</b> Complications, including insertion-related complications, number of successful observed attempts and provider attitude/confidence.</p>	<ul style="list-style-type: none"> <li>■ Studies exploring the impact of practical education for the management of PVADs and arterial catheters.</li> <li>■ Randomized controlled trials exploring practical education for the insertion and management of PICC lines.</li> <li>■ Qualitative studies examining the impact of practical education on health provider experience.</li> </ul>
<p><b>RECOMMENDATION QUESTION #3:</b> Should vascular access specialist teams be recommended?</p> <p><b>Outcomes:</b> Complications, including insertion-related complication, and number of successful observed attempts.</p>	<ul style="list-style-type: none"> <li>■ Studies exploring the organization of VASTs in settings outside of acute care, such as home care and long-term care.</li> <li>■ Studies exploring the composition and organization responsibilities of VAS and VASTs.</li> <li>■ Robust study designs, including randomized controlled trials examining the impact of VASTs on person-reported outcomes.</li> </ul>

RECOMMENDATIONS

RECOMMENDATION QUESTION	PRIORITY RESEARCH AREA
<p><b>RECOMMENDATION QUESTION #4:</b></p> <p><b>Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?</b></p> <p><b>Outcomes:</b> Specimen rejection, patient satisfaction, contamination rate (specific to blood cultures) and dwell time.</p>	<ul style="list-style-type: none"> <li>■ Studies that explore blood draws from a VAD and their impact on device dwell time.</li> <li>■ The impact of blood draws from a VAD versus blood draw from venipuncture on person and family values and preferences.</li> <li>■ Qualitative studies examining the impact of blood draw technique on person and family experience (including a range of ages and cognitive needs).</li> <li>■ Studies that explore blood draws from CVADs and their impact on infection and specimen integrity.</li> </ul>
<p><b>RECOMMENDATION QUESTION #5:</b></p> <p><b>Should the daily review of peripheral vascular access devices by health providers be recommended?</b></p> <p><b>Outcomes:</b> Complications.</p>	<ul style="list-style-type: none"> <li>■ Randomized controlled trials exploring the effectiveness of multi-component care protocols or daily PVAD reviews.</li> <li>■ Long-term follow-up studies exploring the effect of PVAD care on rare complications.</li> <li>■ Qualitative studies examining the role of PVAD care in person and family experience.</li> <li>■ Studies exploring the role of multi-component PVAD care protocols in settings outside acute care, including home care and long-term care.</li> </ul>
<p><b>RECOMMENDATION QUESTION #6:</b></p> <p><b>Should the use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?</b></p> <p><b>Outcomes:</b> Success rate on the first attempt/number of failed attempts, patient satisfaction and complications.</p>	<ul style="list-style-type: none"> <li>■ Studies exploring the effectiveness of vein finder (infrared) visualization techniques.</li> <li>■ Studies exploring person and family satisfaction related to use of visualization techniques.</li> <li>■ Studies exploring the use of visualization techniques for special populations, including infants and small children, older adults, and persons with dehydration or other complex needs.</li> <li>■ Qualitative studies exploring experiences of persons receiving care and health providers with the use of visualization technologies for VAD insertion.</li> </ul>

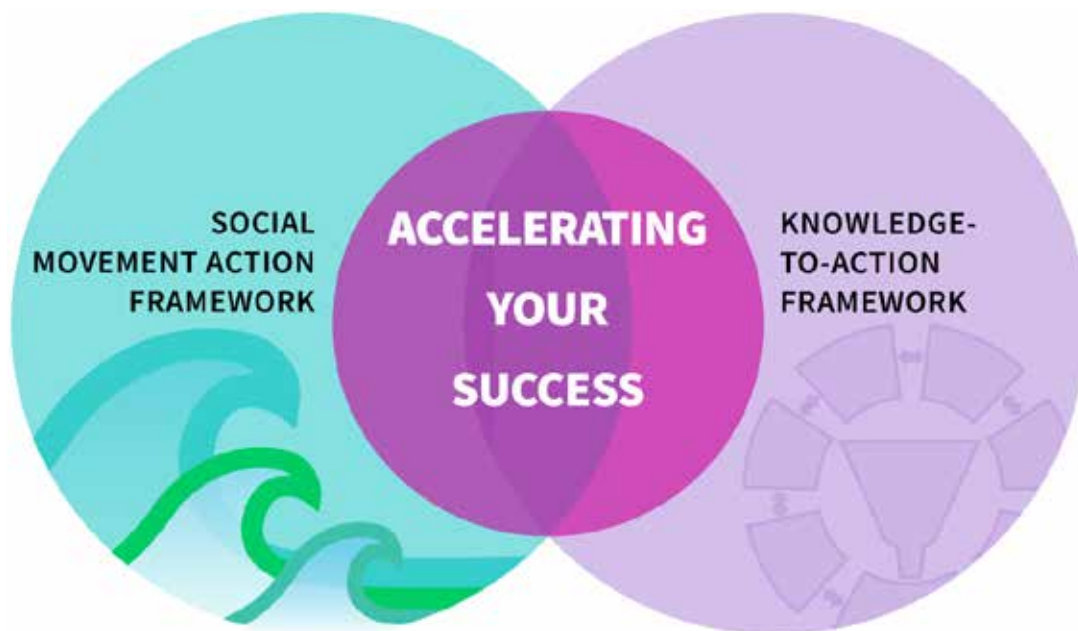
RECOMMENDATION QUESTION	PRIORITY RESEARCH AREA
<p><b>RECOMMENDATION QUESTION #7:</b></p> <p><b>Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?</b></p> <p><b>Outcomes:</b> Patient’s rating pain, patient comfort, fear/anxiety (related to poke/needle phobia) and patient satisfaction.</p>	<ul style="list-style-type: none"> <li>■ Studies exploring pain management strategies for CVAD insertion and arterial catheter insertion.</li> <li>■ Studies exploring the impact of routine use of topical anesthesia for PVAD insertion or venipuncture in adults.</li> <li>■ Studies exploring person and family satisfaction and experience with pain management strategies (including people of various ages and cognitive needs).</li> <li>■ Qualitative studies exploring pain management strategies for VAD insertion in adults and children.</li> </ul>
<p><b>Applicable to all recommendation questions</b></p>	<ul style="list-style-type: none"> <li>■ Studies exploring the health equity implications of VAD insertion and management.</li> </ul>

# Implementation Strategies

Implementing guidelines at the point of care is multi-faceted and challenging. It takes more than awareness and distribution of BPGs for practice to change must be adapted for each practice setting in a systematic and participatory way to ensure that recommendations fit the local context (223). The RNAO *Leading Change Toolkit*<sup>™</sup> (2021), available online at <https://www.RNAO.ca/leading-change-toolkit> provides evidence-informed processes for this (see [Appendix Q](#)).

The *Leading Change Toolkit*<sup>™</sup> uses two complementary frameworks to guide evidence uptake and sustainability (see [Figure 1](#)). They can be used together to maximize and accelerate change.

**Figure 1: *Leading Change Toolkit*<sup>™</sup> Two Complementary Frameworks to Accelerate your Success**



The Social Movement Action Framework (224) is descriptive and identifies the defining elements of a social movement for knowledge (e.g., BPGs) uptake and sustainability. It integrates a ‘bottom-up’, people-led approach to change for a shared concern (or common cause) in which change agents and change teams mobilize individual and collective action to achieve goals. The framework’s elements, categorized as preconditions, key characteristics and outcomes, are dynamic, inter-related and develop spontaneously as the social movement evolves.

The Knowledge-to-Action Framework uses a process model of action cycle phases to systematically guide the adaptation of the new knowledge (e.g., BPG) to the local context and implementation. This framework suggests identifying and using knowledge tools/products, such as guidelines, to determine gaps and begin the process of tailoring the new knowledge to local settings.

The *Leading Change Toolkit*<sup>™</sup> is based on emerging evidence in health and social sciences that successful uptake and sustainability of best practice in health care is more likely when:

- BPGs are selected for implementation through a participatory process led by change agents and change teams;
- The selected BPGs reflect priority areas for a shared concern that is credible, valued and meaningful, or an urgency for action;
- Stakeholders are identified and engaged throughout implementation to engage in individual and collective action;
- Receptivity for implementing BPGs, including environmental readiness, is assessed;
- Implementation strategies are tailored to the local context and designed to address barriers;
- Use of the BPG is monitored and sustained;
- Evaluation of the BPG's impact is embedded in the process to determine if the goals and outcomes have been met;
- There are adequate resources to complete all aspects of the uptake and sustainability of the BPG; and,
- The BPG is scaled up, out, or deep, where possible, to widen its influence and create lasting health improvements.

RNAO is committed to widespread deployment and implementation of our BPGs. We use a coordinated approach to dissemination, incorporating a variety of strategies, including the following:

1. The Nursing Best Practice Champion Network<sup>®</sup>, which develops the capacity of individual nurses to foster awareness, engagement, and adoption of BPGs.
2. The BPG Order Sets<sup>™</sup> provide clear, concise and actionable intervention statements derived from practice recommendations. BPG Order Sets<sup>™</sup> can be readily embedded within electronic records, but they can also be used in paper-based or hybrid environments.
3. The BPSO<sup>®</sup> designation supports implementation at the organization and system levels. BPSOs focus on developing evidence-based cultures with the specific mandate to implement, evaluate and sustain multiple RNAO BPGs.

In addition, we offer annual capacity-building learning institutes on specific BPGs and their implementation.

Information about our implementation strategies can be found at:

- RNAO Best Practice Champions Network<sup>®</sup>: [www.RNAO.ca/bpg/get-involved/champions](http://www.RNAO.ca/bpg/get-involved/champions)
- RNAO BPG Order Sets<sup>™</sup>: <https://RNAO.ca/ehealth/bpgordersets>
- RNAO BPSO<sup>®</sup>: [www.RNAO.ca/bpg/bpso](http://www.RNAO.ca/bpg/bpso)
- RNAO capacity-building learning institutes and other professional development opportunities: [www.RNAO.ca/events](http://www.RNAO.ca/events)

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## Appendix A: Glossary of Terms

**Arterial catheter:** Device that can be inserted peripherally or centrally, and that can be used to monitor blood pressure and the hemodynamic status of people in critical care settings (225).

**Aseptic Non Touch Technique (ANTT®):** Aseptic Non Touch Technique (ANTT®) is a unique, standardized approach to aseptic practice that has been shown to support the reduction of health care-acquired infection” (34).

**Best practice guidelines:** “Best practice guidelines are systematically developed, evidence-based documents that include recommendations for nurses and the interprofessional team, educators, leaders and policy-makers, persons and their families on specific clinical and healthy work environment topics. BPGs promote consistency and excellence in clinical care, health policies and health education, ultimately leading to optimal health outcomes for people and communities and the health system” (226).

**Caregiver:** “A family member, friend or person of choice who gives unpaid care to someone who has care needs due to a disability, a physical, neurological or mental condition, a chronic illness, frailty or age” (227). In this BPG, care needs may be related to a VAD.

**Central line-associated bloodstream infection (CLABSI):** “A central line-associated bloodstream infection (CLABSI) is a serious infection that occurs when germs (usually bacteria or viruses) enter the bloodstream through the central line” (16).

**Central vascular access device (CVAD):** “A catheter that is inserted into a peripheral or large vein of the chest or groin with the tip advanced to a central position, either the superior or inferior vena cava” (228).

**Central venous catheter (CVC):** “Non-tunneled central venous catheters (CVCs) are often referred to as “acute” or “short-term” CVCs. These are often inserted for durations of 7 to 14 days. They are typically 15 to 25 cm in length, and are placed via direct puncture (often using ultrasonography) and cannulation of the internal jugular, subclavian or femoral veins” (229).

Tunneled CVCs can be permanent or temporary devices. They are characterized by the creation of a subcutaneous tunnel between the insertion of the catheter on the skin and the point of puncture in the vein. Tunneled catheters are generally placed in the interventional radiology suite or in the operating room by radiologists or surgeons (229).

**Colonization:** When a skin contaminant is repeatedly isolated from cultures taken from a catheter (i.e., central or arterial catheter), but peripheral catheter cultures remain negative (230).

**Complications:** Adverse events associated with a VAD, such as phlebitis, infiltration, extravasation, infection, pain, bleeding or embolism. Insertion-related complications are those that occur at the time of insertion, such as arterial puncture or hematoma.



**Comprehensive health teaching:** Any combination of learning experiences designed to help individuals and communities improve their health by increasing their knowledge or influencing their attitudes (adapted from (231)).

**Consensus:** A process used to reach agreement among a group or panel during a Delphi or modified Delphi technique (232). A consensus of 70 per cent agreement from all panel members was required for the strength of recommendations within this BPG.

**Contamination:** “Introduction or transference of pathogens or infectious material from one source to another” (228).

**Difficult intravenous access (DiVA):** In general, difficult intravenous access (DiVA) is defined as a clinical situation where multiple attempts or special interventions are required to obtain and maintain peripheral venous access (129).

**Downgrade:** In GRADE, when limitations in the individual studies potentially bias the results, the certainty of evidence will decrease (233). For example, a body of quantitative evidence for one priority outcome may begin with high certainty, but due to serious limitations in one or more of the five GRADE criteria, it will be rated down by one or two levels (233).

*See Grading of Recommendations Assessment, Development and Evaluation (GRADE)*

**Evidence-based nursing practice:** The “integration of best research evidence with clinical expertise and patient values” (234). It unifies research evidence with clinical expertise and encourages the inclusion of patient preferences (234).

**Evidence-to-Decision (EtD) framework:** A table that facilitates guideline panels to make decisions when moving from evidence to recommendations. The purpose of the Evidence-to-Decision (EtD) framework is to summarize the research evidence, outline important factors that can determine the recommendation, inform panel members about the benefits and harms of each intervention considered, and increase transparency about the decision-making process in the development of recommendations (8).

**Extravasation:** “Inadvertent infiltration of vesicant solution or medication into surrounding tissue; rated by a standard tool or definition” (228).

*See vesicant*

**Family:** A term used to refer to individuals who are related (biologically, emotionally or legally) to and/or have close bonds (friendships, commitments, shared households and child rearing responsibilities, and romantic attachments) with the person receiving health [services]. A person’s family includes all those whom the person identifies as significant in his or her life (e.g., parents, caregivers, friends, substitute decision-makers, groups, communities and populations). The person receiving care determines the importance and level of involvement of any of these individuals in their care based on his or her capacity (adapted from (235) and (236)).

**Good practice statement:** A good practice statement is directed primarily to nurses and the interprofessional teams who provide care to persons and their families across the spectrum of care, including (but not limited to): primary care, acute care, home care and long-term care. It refers to a practice already accepted as beneficial or to practical advice.

In the case of this BPG, the good practice statement is believed to be so beneficial that conducting a systematic review to prove its efficacy would be unreasonable. These statements are not based on a systematic review and do not receive a rating of the certainty or confidence in the evidence or strength (i.e., conditional or strong) (7).

**Grading of Recommendations Assessment, Development and Evaluation (GRADE):** The Grading of Recommendations Assessment, Development and Evaluation (GRADE) is a methodological approach to assess the certainty of a body of evidence in a consistent and transparent way, and to develop recommendations in a systematic way. The body of evidence across identified important and/or critical outcomes is evaluated based on risk of bias, consistency of results, relevance of studies, precision of estimates, publication bias, large effect, dose-response and opposing confounding (8).

When using GRADE, five components contribute to the assessment of confidence in the evidence for each outcome. These components are as follows:

1. Risk of bias, which focuses on the flaws in the design of a study or problems in its execution.
2. Inconsistency, which looks at a body of evidence and assesses whether the results point in the same direction, or if they are different.
3. Imprecision, which refers to the accuracy of results based on the number of participants and/or events included, and the width of the confidence intervals across a body of evidence.
4. Indirectness, whereby each primary study that supports an outcome is assessed and a decision is made regarding the applicability of the findings to the population, intervention and outcome outlined in the research question.
5. Publication bias, where a decision is made about whether the body of published literature for an outcome potentially includes only positive or statistically significant results (237).

**Health provider:** Refers to both regulated workers (e.g., nurses, physicians, and respiratory therapists) and unregulated workers (e.g., physician’s assistants and paramedics) who are part of the interprofessional team.

**Regulated health provider:** In Ontario, the *Regulated Health Professional Act, 1991* (RHPA) provides a framework for regulating 23 health professions, outlining the scope of practice and the profession-specific controlled or authorized acts that each regulated professional is authorized to perform when providing health services (5).

**Unregulated health provider:** These providers fulfill a variety of roles in areas that are not subject to the RHPA. They are accountable to their employers but not to an external regulating professional body (e.g., the College of Nurses of Ontario). Unregulated health providers fulfill a variety of roles and perform tasks that are determined by their employer and employment setting. Unregulated health providers only have the authority to perform a controlled act as set out in the RHPA if the procedure falls under one of the exemptions set out in the Act (6).

**Health-service organization:** In this BPG, health-service organization refers to any health setting or workplace in which persons and/or families receive care from a health provider related to a VAD. .

**Hemolysis:** “Destruction of the membrane of the red blood cells, resulting in the liberation of hemoglobin, which diffuses into the surrounding fluid”(228) . Blood samples that are hemolyzed due to improper handling or drawing of blood samples cannot be processed. This is the leading cause of samples being rejected by clinical laboratories.

**Implanted vascular access device (IVAD):** Permanent catheters that are characterized by a subcutaneous reservoir with a diaphragm that acts as a receptacle for infusion. The reservoir is connected to a central vein in the chest with a catheter (229). Port-a-caths (single or double) and broviacs (single or double) are examples of IVADs.

**Implementation science:** Defined as “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services and care” (page 1) (270).

**Infiltration:** “The inadvertent administration of medication or solution into the surrounding subcutaneous or subdermal tissue instead of into the intended vascular pathway” (238). This has been reported to be the most frequent complication that is associated with short PVADs, specifically when located in the hand (102).

**Interprofessional team:** team comprising multiple health providers (regulated and unregulated) who work collaboratively to deliver comprehensive and quality health services to people within, between and across health settings (4). Key interprofessional team members supporting persons with vascular devices may include: nurses, nurse practitioners, physicians, respiratory therapists, physician’s assistants, paramedics and child life specialists. It is important to emphasize that persons with a VAD and their chosen family are at the centre as active participants of the team.

**Meta-analysis:** systematic review that uses statistical methods to analyze and summarize the results of the included studies (239).

See *systematic review*

**Multi-component care protocol:** A group of evidence-based interventions that can ensure the delivery of a standardized method of care; when these interventions are performed together, they can have a better outcome than if performed individually (also sometimes called a “care bundle”) (adapted from (100).

**Nurse:** “Refers to registered nurses, licensed practical nurses (referred to as registered practical nurses in Ontario), registered psychiatric nurses and nurses in advanced practice roles, such as nurse practitioners and clinical nurse specialists” (5).

**Osmolarity:** The number of osmotically active particles in a solution (228).

**Outcomes:** A dependent variable, or the clinical and/or functional status of a patient or population, that is used to assess if an intervention is successful. In GRADE, outcomes are prioritized based on if they are critical for decision making, important but not critical for decision making, or not important. In so doing, the literature search and systematic reviews are more focused (8).

*See Grading of Recommendations Assessment, Development and Evaluation (GRADE)*

**Peripherally inserted central catheter (PICC):** “A catheter inserted through veins of the upper extremity or neck in adults and children. For infants, the PICC may be inserted through veins of the scalp or a lower extremity. The catheter tip is located in the superior or inferior vena cava, preferably at its junction with the right atrium, regardless of insertion site” (228).

**Peripheral Vascular Access Device (PVAD):** “VAD inserted in peripheral vein with its tip not extending into the central vasculature” (25).

**Person:** An individual with whom a health provider has established a therapeutic relationship for the purpose of partnering for health. Replaces the terms “patient,” “client,” and “resident,” which are used across health-service organizations (235).

**Person- and family-centred care:** An “approach to care [that demonstrates] certain practices that put the person and their family members at the centre of health services. Person- and family-centred care respects and empowers individuals to be genuine partners with health providers for their health” (235).

**Phlebitis:** Redness, swelling, tenderness, pain, purulent discharge and/or induration (palpable cord) at the insertion site of a vascular device (240, 241).

**PICO research question:** A framework to outline a focused question. It specifies four components:

1. The patient or population that is being studied.
2. The intervention to be investigated.
3. The alternative or comparison intervention.
4. The outcome that is of interest (8).

**Practical education:** For the purposes of this guideline, practical education refers to deliberate practice, supervised insertions of VADs, hands-on training or one-on-one training for health providers. Practical or skills lab training follows a structured teaching concept, takes place under supervision and in consideration of foundational concepts, and ideally creates an atmosphere that allows the repeated, risk-free practice of targeted clinical skills (50).

**Quasi-experimental study:** A study that estimates causal effects by observing the exposure of interest, but in which the experiments are not directly controlled by the researcher and lack randomization (e.g., before-and-after designs) (242).

**Randomized controlled trial:** An experiment in which the investigator assigns one or more interventions to participants who are randomly allocated to either the experimental group (receives intervention) and the comparison (conventional treatment) or control group (placebo or no intervention) (239).

**Recommendation:** A course of action(s) that directly answers a recommendation question (also known as a PICO research question). A recommendation is based on a systematic review of the literature and is made in consideration of its (a) benefit and harms, (b) values and preferences, and (c) health equity. All recommendations are given a strength—either strong or conditional—through panel consensus.

It is important to note that recommendations should not be viewed as dictates, because recommendations cannot take into account all of the unique features of individual, organizational and clinical circumstances (8).

**Recommendation question:** A priority research area of practice, policy or education identified by expert panel members that requires evidence to answer. The recommendation question may also aim to answer a topic area around which there is ambiguity or controversy. The recommendation question informs the research questions, which guides the systematic review (8).

**Simulation (simulation learning):** “Simulation is the imitation of some real thing, state of affairs or process. In health professions education, simulation is a methodology to help achieve educational goals. Health-care simulation encompasses a range of activities that share a broad but common purpose: to improve the safety, effectiveness and efficiency of health-care services” (243). “Simulation activities can include computer-based simulation, e-learning, high-fidelity patient simulators, role playing and other blended approaches” (244).

**Social movement in the context of knowledge uptake and sustainability:** Individuals, groups and/or organizations who, as voluntary and intrinsically motivated change agents, mobilize to transform health outcomes (266).

**Stakeholder:** “An individual, group or organization that has a vested interest in the decisions and actions of organizations, and which may attempt to influence decisions and actions” (245). Stakeholders include all of the individuals and groups that will be directly or indirectly affected by the change or solution to the problem.

**Successful Observed Attempt (or Successful VAD insertion attempt):** A PVAD insertion attempt is deemed to be successful if there is evidence of blood flashback in the catheter upon insertion, and if the device flushes easily with no signs of infiltration, swelling or leakage upon flushing (adapted from (126), (127), and (128)).

**Note:** If ultrasound-guidance technique is used, it should be evident on ultrasound that the catheter is positioned properly in the vein. A CVAD insertion attempt should be confirmed with x-ray.

**Systematic review:** A comprehensive review of the literature that uses clearly formulated questions and systematic and explicit methods to identify, select and critically appraise relevant research. A systematic review collects and analyzes data from the included studies and presents them, sometimes using statistical methods (239).

*See meta-analysis*

**Ultrasound-guided Technique:** Ultrasound imaging (an image created by sending sound waves through soft tissue) allows health providers to see surrounding anatomical structures (119). It can be used to aid the health provider when inserting a PVAD, CVAD or peripheral arterial catheter. Ultrasound guidance allows visualization of both the needle and the target vessel on the monitor, using either the short-axis or long-axis view (123).

**Valsalva maneuver:** A breathing technique that can be used as a pain management strategy during VAD insertion. It involves “a deep inhale, followed by a forceful holding of the breath, during which the venous cannulation insertion occurs” (143).

**Vascular access device (VAD):** Vascular access devices (VADs) are defined as a catheter (thin tube) inserted into veins that can be implanted or inserted under the skin, allowing fluids and medicines to be delivered into veins (adapted from (3)). Catheters inserted into arteries can be used to monitor therapy (adapted from (3)). Examples of VADs include:

- peripheral vascular access devices (PVADs), such as short peripheral intravenous catheters (PIVs) and extended dwell, midline catheters;
- central vascular access devices (CVADs), such as peripherally inserted central catheters (PICCs), tunneled catheters, non-tunneled catheters and implanted vascular access devices (IVADs);
- peripheral arterial catheters; and
- phlebotomy devices.

**Vascular access specialist team (VAST) or vascular access specialists (VAS):** “A grouping of health providers who have advanced knowledge and skills in the assessment, insertion, care and management of VADs” (3). This includes infusion/intravenous, intravenous therapy teams and individual vascular access specialists (nurses, physicians, respiratory therapists, laboratory technicians and physician assistants) (3).

**Venipuncture:** “A procedure in which a needle is used to take blood from a vein, usually for laboratory testing. Also called blood draw and phlebotomy” (246).

**Vesicant:** “An agent capable of causing tissue damage when it escapes from the intended vascular pathway into surrounding tissue” (228). Tissue damage can cause injury, blistering, necrosis and redness of the skin.

## Appendix B: RNAO Guidelines and Resources That Align with This Guideline

The following are topics that align with this BPG, suggested RNAO guidelines and resources from other organizations.

TOPIC	RESOURCE(S)
<b>Assessment and management of pain</b>	Registered Nurses' Association of Ontario (RNAO). Assessment and management of pain. (3rd ed.) [Internet]. Toronto (ON): RNAO; 2013. Available from: <a href="https://RNAO.ca/sites/rnao-ca/files/AssessAndManagementOfPain_15_WEB- FINAL_DEC_2.pdf">https://RNAO.ca/sites/rnao-ca/files/AssessAndManagementOfPain_15_WEB- FINAL_DEC_2.pdf</a>
<b>Client-centred learning</b>	Registered Nurses' Association of Ontario (RNAO). Facilitating client centred learning [Internet]. Toronto (ON): RNAO; 2012. Available from: <a href="https://RNAO.ca/sites/rnao-ca/files/BPG_CCL_2012_FA.pdf">https://RNAO.ca/sites/rnao-ca/files/BPG_CCL_2012_FA.pdf</a>
<b>Implementation science, implementation frameworks and resources</b>	<p>Registered Nurses' Association of Ontario in partnership with Healthcare Excellence Canada. <i>Leading Change Toolkit™</i> (3rd ed.). Toronto (ON): RNAO; 2021 Available from: <a href="https://www.RNAO.ca/leading-change-toolkit">https://www.RNAO.ca/leading-change-toolkit</a></p> <p>The National Implementation Research Network's Active Implementation Hub. In: Get Started [Internet]. [place unknown]: AI Hub; c2013–2018. Available from: <a href="http://implementation.fpg.unc.edu/">http://implementation.fpg.unc.edu/</a></p> <p>Canadian Patient Safety Institute. In: Improvement Frameworks Getting Started Kit [Internet]. [place unknown]: safer healthcare now!; August 2015. Available from: <a href="http://www.patientsafetyinstitute.ca/en/toolsResources/ImprovementFramework/Documents/Improvement%20Frameworks%20GSK%20EN.PDF">http://www.patientsafetyinstitute.ca/en/toolsResources/ImprovementFramework/Documents/Improvement%20Frameworks%20GSK%20EN.PDF</a></p> <p>Publications. In: Dissemination &amp; Implementation Models in Health Research &amp; Practice [Internet]. [place unknown]: The Center for Research in Implementation Science and Prevention; [date unknown]. Available from: <a href="http://dissemination-implementation.org/content/resources.aspx">http://dissemination-implementation.org/content/resources.aspx</a></p>
<b>Interprofessional collaboration</b>	Registered Nurses' Association of Ontario (RNAO). Developing and sustaining interprofessional health care: optimizing patients/clients, organizational and system outcomes [Internet]. Toronto (ON): RNAO; 2013. Available from: <a href="https://RNAO.ca/bpg/guidelines/interprofessional-team-work-healthcare">https://RNAO.ca/bpg/guidelines/interprofessional-team-work-healthcare</a>
<b>Person- and family-centred care</b>	Registered Nurses' Association of Ontario (RNAO). Person-and family-centered care [Internet]. Toronto (ON): RNAO; 2015. Available from: <a href="https://RNAO.CA/bpg/guidelines/person-and-family-centred-care">https://RNAO.CA/bpg/guidelines/person-and-family-centred-care</a>



# Appendix C: Best Practice Guideline Development Methods

This appendix presents an overview of the RNAO guideline development process and methods. RNAO is unwavering in its commitment that every BPG be based on the best available evidence. To meet international standards, the GRADE methods have been implemented.

## Scoping the Guideline

The scope sets out what an RNAO guideline will and will not cover (see Purpose and Scope on p. 6). To determine the scope of this BPG, the RNAO best practice guideline development and research team conducted the following steps:

1. **A review of previous BPGs.** The RNAO BPGs *Care and Maintenance to Reduce Vascular Access Complications* (1) and *Assessment and Device Selection for Vascular Access* (2) were reviewed to inform the purpose and scope of this BPG.
2. **An environmental scan of guidelines.** Two guideline development methodologists searched an established list of websites for guidelines and other relevant content between March and July 2018. This search was then updated in May 2020. The purpose of the environmental scan was to gain an understanding of existing guidelines about vascular access in order to identify opportunities to develop the purpose and scope of this BPG. The resulting list was compiled based on knowledge of evidence-based practice websites and recommendations from the literature. Detailed information about the search strategy for existing guidelines, including the list of websites searched and the inclusion criteria used, is available on the RNAO <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

The guidelines were reviewed for content, applicability to nursing scope of practice, accessibility and quality. The two guideline development methodologists appraised 13 international guidelines using the AGREE II tool (247). Guidelines with an overall score of 6 or 7 (on a 7-point Likert scale) were considered to be of high quality and therefore, considered for GRADE-ADOLOPMENT (237). GRADE-ADOLOPMENT provides a framework for adopting or adapting trustworthy recommendations from existing guidelines (237). However, the expert panel did not identify any priority recommendations from the existing guidelines to be adopted or adapted for this BPG.

The following guidelines were appraised as indicated:

- Royal College of Nurses. Standards for infusion therapy. 4th ed. London (UK): Royal College of Nurses; 2016.
  - Score: 3 out of 7.
  - This guideline was used as a supporting resource.
- Shaw CM, Shah S, Kapoor BS, et al. ACR Appropriateness Criteria<sup>®</sup> radiologic management of central venous access. *J Am Coll Radiol*. 2017;14(11):S506-S529.
  - Score: 3 out of 7.
  - This guideline was not used in this BPG.
- Cancer Care Ontario. Part 2: administration of chemotherapy and management of preventable adverse effects. Toronto (ON): Cancer Care Ontario; 2014.
  - Score: 6 out of 7.
  - This guideline was not used in this BPG.



- Canadian Vascular Access Association. Occlusion management of central venous access devices. Hamilton (ON): Canadian Vascular Access Association; 2016.
  - Score: 5 out of 7.
  - This guideline was used in **Appendix M** on CVAD care.
- University of Michigan Health System. Inpatient diagnosis and treatment of central vascular catheter (CVC) infections. Ann Arbor (MI): University of Michigan; 2016.
  - Score: 4 out of 7.
  - This guideline was not used in this BPG.
- Schiffer CA, Mangu PB, Wade JC, et al. Central venous catheter care for the patient with cancer: American Society of Clinical Oncology clinical practice guideline. 2013. J Clin Oncol. 31(10):1357-70.
  - Score: 5 out of 7.
  - This guideline was used in **Appendix M** on CVAD care.
- Murgo M. Central venous access device: post insertion management [Internet]. Chatswood (AU): NSW Agency for Clinical Innovation; 2014. Available from: [https://www.aci.health.nsw.gov.au/data/assets/pdf\\_file/0010/239626/ACI14\\_CVAD-2-2.pdf](https://www.aci.health.nsw.gov.au/data/assets/pdf_file/0010/239626/ACI14_CVAD-2-2.pdf)
  - Score: 6 out of 7.
  - This guideline was used in **Appendix M** on CVAD care.
- United States Centers for Disease Control and Prevention (US CDC). 2017 updated recommendations on use of chlorhexidine-impregnated dressings for prevention of intravascular catheter-related infections: an update to the 2011 guidelines for the prevention of intravascular catheter-related infections from the Centers for Disease Control and Prevention. [place unknown]: US CDC; 2017.
  - Score: 6 out of 7.
  - This guideline was not used in this BPG.
- Pittiruti M, Bertoglio S, Scoppettuolo G, et al. Evidence-based criteria for the choice and the clinical use of the most appropriate lock solutions for central venous catheters (excluding dialysis catheters): a GAVeCeLT consensus. J Vasc Access. 2016;17(6):453-64. <https://doi.org/10.5301/jva.5000576>
  - Score: 4 out of 7.
  - This guideline was not used in this BPG.
- National Institute of Health and Care Excellence (NICE). Healthcare-associated infections: prevention and control in primary and community care. London (UK): NICE; 2017.
  - Score: 6 out of 7.
  - This guideline was used to inform the background, guiding principles and frameworks of this BPG. This guideline was used in **Appendix M**.
- Chopra V, Flanders SA, Saint S, et al. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA Appropriateness Method. Ann Intern Med. 2015;163(6 Suppl):S1-S40. <https://doi.org/10.7326/M15-0744>
  - Score: 6 out of 7.
  - This guideline was used to inform the background and glossary of terms of the BPG.
- Gorski L, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice. Norwood (MA): Infusion Nurses Society; 2016.
  - Score: 4 out of 7.
  - This guideline\* was used as a supporting resource in this BPG, and to inform the good practice statement, glossary and appendices.

\***Note:** An updated edition of the infusion therapy standards of practice published in early 2021, and this updated version was used as a supporting resource in this BPG, and to inform the good practice statement, glossary and appendices where applicable.

- Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.
    - Score: 5 out of 7.
    - This guideline was used as a supporting resource in this BPG, and to inform the background, good practice statement, glossary and appendices.
3. **Telephone key informant interviews.** Eleven interviews were conducted with experts in the field—including direct care health providers, researchers, educators and managers—to understand the needs of nurses, members of the interprofessional health team and persons with lived experience.
  4. **Telephone discussion group sessions.** Three sessions were convened to understand the needs of nurses, members of the interprofessional health team and persons with lived experience.

### Assembly of the Expert Panel

RNAO aims for diversity in membership of an expert panel; this is in alignment with its Organizational Statement on Diversity and Inclusivity, which is part of the RNAO Mission and Values (248).

RNAO identifies and selects members of an expert panel through numerous different avenues. This includes the following:

- searching the literature for researchers in the topic area;
- soliciting recommendations from key informant interviews;
- drawing from established professional networks, such as RNAO Interest Groups, the Nursing Best Practice Champions Network<sup>®</sup> and BPSOs<sup>®</sup>; and
- drawing from other nursing and health provider associations, topic-relevant technical associations or organizations, and advocacy bodies.

For this BPG, the RNAO best practice guideline development and research team assembled a panel of experts from nursing practice, research and education, as well as other members of the interprofessional team, to represent a range of sectors and practice areas (see members of the RNAO Best Practice Guideline Expert Panel on page 24).

The expert panel engaged in the following activities:

- approved the purpose and scope of this BPG,
- determined the recommendation questions and outcomes to be addressed in this BPG,
- participated in a **consensus**<sup>G</sup> development process to finalize recommendation statements,
- provided feedback on the drafts of this BPG,
- participated in the development of evaluation indicators,
- helped develop BPG Order Sets<sup>™</sup>, and
- identified appropriate stakeholders to review the draft guideline prior to publication.

In addition to the above, the expert panel co-chairs engaged in the following activities:

- participated in monthly meetings with the guideline development methodologists and guideline development project coordinator,
- facilitated expert panel meetings,
- provided in-depth guidance on clinical and/or research issues, and
- moderated voting processes.

### Conflict of Interest

In the context of RNAO BPG development, the term “conflict of interest” (COI) refers to situations in which an expert panel member’s or RNAO staff member’s financial, professional, intellectual, personal, organizational or other relationships may compromise their ability to conduct panel work independently. Declarations of COI that might be construed as constituting a perceived and/or actual conflict were made using a standard form by all members of the expert panel prior to their participation in guideline development work. Expert panel members also updated their COI at the beginning of each in-person guideline meeting and upon final review of the guideline. Any COI declared by an expert panel member was reviewed by both the RNAO best practice guideline development and research team and by expert panel co-chairs. No limiting conflicts were identified. See Declarations of Conflicts of Interest Summary at <https://rnao.ca/bpg/guidelines/vascular-access-second-edition>.

### Identifying Priority Recommendation Questions and Outcomes

RNAO systematic review questions are developed as per the PICO format (population, intervention, comparison and outcome).

The RNAO best practice guideline development and research team and expert panel convened in-person to determine the priority recommendation questions and outcomes for this BPG. A comprehensive list of recommendation questions that the BPG could potentially address was developed at the meeting. This was informed by:

- the environmental scan of guidelines;
- the review of the literature;
- key informant interviews and discussion groups; and
- expert panel discussion at the in-person meeting.

This comprehensive list of potential recommendation questions was presented to the expert panel for a vote. Each expert panel member was allowed six votes for preferred recommendation questions. The six recommendation questions with the most votes were deemed the final recommendation questions. The recommendation question on VAST was originally a sub-question of the recommendation question on practical education, bringing the total to seven questions. Expert panel co-chairs did not participate in the vote.

Following this initial vote—and in alignment with GRADE standards for assessing and presenting the evidence—outcomes were identified and prioritized per recommendation question. A comprehensive list of outcomes per recommendation question was developed at the in-person meeting, informed by the following:

- the review of the literature;
- key informant interviews and focus groups; and
- expert panel discussion at the in-person meeting.

Based on the comprehensive list of outcomes, the expert panel was asked to rank-order the relative importance of each outcome per recommendation question. Each panel member participated in a confidential online rank-order vote. It was deemed feasible to have up to a total of 18 prioritized outcomes across the seven recommendation questions. Expert panel co-chairs did not participate in the vote as they functioned as co-facilitators. Voting results were presented to the expert panel and through a facilitated discussion, priority outcomes were determined per recommendation question.

The seven recommendation questions—and their respective PICO research questions—are presented below.

**Recommendation Question #1:** Should providing education to persons and their families about their vascular access device be recommended?

**PICO Research Question #1**

**Population:** Persons with a vascular access device and their families.

**Intervention:** Comprehensive education about the vascular access device (e.g., reason for the device, assessing for infection, what to do if infection is suspected and maintenance of the device).

**Comparison:** Standard care (may include basic education).

**Outcomes:** Dwell time\*, completion of therapy\*, hospital re-admission rate and complications.

\*The two outcomes of dwell time and completion of therapy were not reported in the literature. Additional surrogate outcomes were not selected.

**Recommendation Question #2:** Should practical education for the insertion and management of vascular access devices for health providers be recommended?

**PICO Research Question #2**

**Population:** Nurses and other members of the interprofessional team.

**Intervention:** Practical education for the insertion and management of vascular access devices (e.g., simulation labs, deliberate practice, supervised insertions, and hands-on and one-on-one training).

**Comparison:** Standard education (e.g., lectures and reading material).

**Outcomes:** Complications (including insertion-related complications), number of successful observed attempts and provider attitude/confidence.

**Recommendation Question #3:** Should vascular access specialist teams be recommended?

**PICO Research Question #3**

**Population:** Persons with a vascular access device.

**Intervention:** Insertion of vascular access devices by specialists (specialized training and ongoing competency).

**Comparison:** Insertion of vascular access devices by non-specialists.

**Outcomes:** Complications (including insertion-related complications), and number of successful observed attempts.

**Recommendation Question #4:** Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?

**PICO Research Question #4**

**Population:** Persons with a vascular access device.

**Intervention:** Blood draw from a vascular device.

**Comparison:** Blood draw from venipuncture.

**Outcomes:** Specimen rejection, patient satisfaction, contamination rate (specific to blood cultures) and dwell time.

**Recommendation Question #5:** Should the daily review of peripheral vascular access devices by health providers be recommended?

**PICO Research Question #5**

**Population:** Persons with a vascular access device.

**Intervention:** Daily review of peripheral vascular access device.

**Comparison:** No daily review of peripheral vascular access device/standard care.

**Outcomes:** Complications.

**Recommendation Question #6:** Should the use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?

**PICO Research Question #6**

**Population:** Persons with a vascular access device.

**Intervention:** Use of visualization technology (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices or arterial catheters (\*technology and education and competency).

**Comparison:** No use of visualization technology.

**Outcomes:** Success rate on the first attempt/number of failed attempts, patient satisfaction and complications.

**Recommendation Question #7:** Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?

**PICO Research Question #7**

**Population:** Persons who require a vascular access device (peripheral or central).

**Intervention:** Pharmacological and/or non-pharmacological pain management strategy.

**Comparison:** Standard care/no pharmacological/non-pharmacological pain management strategy.

**Outcomes:** Patient's rating of pain, patient comfort, fear/anxiety (related to poke/needle phobia) and patient satisfaction.

## Systematic Retrieval of the Evidence

RNAO BPGs are based on a comprehensive and systematic review of the literature.

For this BPG, a search strategy was developed by RNAO's best practice guideline development and research team and a health sciences librarian for each of the aforementioned research questions. A search for relevant research studies published in English limited to January 2013 was applied to the following databases: Cumulative Index to Nursing and Allied Health (CINAHL), Medline, Medline in Process, Cochrane Central, Cochrane Database of Systematic Reviews, Embase, Emcare and Epub ahead of print. Initial searches were conducted in November 2018 for question 5, December 2018 for question 4, January 2019 for questions 1, 2 and 3 and were conducted in March 2019 for question 6.

Expert panel members were asked to review their personal libraries for key studies not found through the above search strategies (see **Appendix D**). Detailed information on the search strategy for the systematic reviews, including the inclusion and exclusion criteria and search terms, is available from <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

Systematic review search dates were limited to the last five years from the guideline launch in order to capture the most up-to-date evidence. All study designs were included in the search. As there was a large yield for research questions six and seven, an overview of reviews methodology was used. Systematic reviews and randomized controlled trials were included. Non-randomized controlled trials were not included. For research question two, the inclusion of systematic reviews and randomized controlled trials were prioritized, and non-randomized controlled trials were used to supplement outcomes not reported in the systematic review and randomized controlled trials. In cases where there were multiple systematic reviews based on the same body of evidence, only the highest quality review was included as assessed using the ROBIS tool (249). In a case of two high-quality reviews, the most recent one was selected. Non-randomized controlled trials or randomized controlled trials included in systematic reviews were excluded to avoid double counting.

All studies were independently assessed for relevance and eligibility by two guideline development methodologists based on the inclusion and exclusion criteria. Any disagreements were resolved through consensus.

All included studies were independently assessed for risk of bias by study design using validated and reliable tools. Randomized controlled trials were assessed using the Risk of Bias 2.0 tool (250), while **quasi-experimental studies**<sup>G</sup> and other non-randomized studies were assessed using the ROBINS-I tool (251), and systematic reviews were assessed using the ROBIS tool (249). The risk of bias assessment of individual studies included in systematic reviews was extracted from the review when available; if unavailable, the two guideline development methodologists conducted a risk of bias assessment of the included individual studies using the appropriate tool. The two guideline development methodologists reached consensus on all scores through discussion.

For data extraction, the included studies were divided equally between the guideline development methodologists. Each guideline development methodologist extracted information from their assigned studies, and this was reviewed by the other guideline development methodologist for accuracy.

In November 2020, the health science librarian conducted an update search for relevant research studies published in English between the end of the original search dates (late 2018 or early 2019) and November 2020 that answer the research questions. The search was applied to the following databases: Cumulative Index to Nursing and Allied Health (CINAHL), Medline, Medline in Process, Cochrane Central, Cochrane Database of Systematic Reviews, Embase and Emcare. Results from 56 studies were incorporated into the discussions of evidence for all Recommendations. In April 2021, the health science librarian conducted a final update search from November 2020 that answer the research question. Results from 17 studies were incorporated into the discussions of evidence for **Recommendation 1.1, 2.1, 6.1, 7.1 and 7.2**. See the PRISMA diagrams in **Appendix D** for studies included in the update search.

## Determining Certainty and Confidence of Evidence

### Certainty of Evidence

The certainty of quantitative evidence (i.e., the extent to which one can be confident that an estimate of an effect is true) is determined using GRADE methods (8). First, the certainty of the evidence is rated for each prioritized outcome across studies (i.e., for a body of evidence) per research question (8). This process begins with the study design and then requires an examination of five domains—risks of bias, inconsistency, imprecision, indirectness and publication bias—to potentially **downgrade**<sup>G</sup> the certainty of evidence for each outcome. See **Table 16** for a definition of each of these certainty criteria.

**Table 16. GRADE Certainty Criteria**

CERTAINTY CRITERIA	DEFINITION
<b>Risk of bias</b>	Limitations in the study design and execution that may bias study results. Valid and reliable quality appraisal tools are used to assess the risk of bias. First, risk of bias is examined for each individual study and then examined across all studies per defined outcome.
<b>Inconsistency</b>	Unexplained differences (heterogeneity) of results across studies. Inconsistency is assessed by exploring the magnitude of difference, and possible explanations in the direction and size of effects reported across studies for a defined outcome.
<b>Indirectness</b>	Variability between the research and review question and context within which the recommendations would be applied (applicability). There are four sources of indirectness which are assessed: <ol style="list-style-type: none"> <li>1. differences in population,</li> <li>2. differences in interventions,</li> <li>3. differences in outcomes measured, [and]</li> <li>4. differences in comparators.</li> </ol>
<b>Imprecision</b>	The degree of uncertainty around the estimate of effect. This is usually related to sample size and number of events. Studies are examined for sample size, number of events and confidence intervals.
<b>Publication bias</b>	publication of studies based on study results. If publication bias is strongly suspected, downgrading is considered.

Source: Reprinted from: Schunemann H, Brozek J, Guyatt G, et al., editors. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach [Internet]. [place unknown: publisher unknown]; 2013. Available from: <https://gdt.gradeapro.org/app/handbook/handbook.html#h.svwnsg6pm0f2>. Reprinted with permission.



Following the initial consideration for rating down the certainty of quantitative evidence, three factors are assessed that can potentially enable rating up the certainty of evidence for observational studies:

1. **Large magnitude of effect:** If the body of evidence has not been rated down for any of the five criteria and a large estimate of the magnitude of intervention effect is present, there is consideration for rating up.
2. **Dose–response gradient:** If the body of evidence has not been rated down for any of the five criteria and a dose–response gradient is present, there is consideration for rating up.
3. **Effect of plausible confounding:** If the body of evidence has not been rated down for any of the five criteria and all residual confounders would result in an underestimation of treatment effect, there is consideration for rating up (8).

GRADE categorizes the overall certainty of evidence as high, moderate, low or very low. See **Table 17** below for the definitions of these categories.

For this BPG, the five GRADE quality criteria for potentially downgrading quantitative evidence and the three GRADE quality criteria for potentially rating up were independently assessed by the two guideline development methodologists. Any discrepancies were resolved through consensus. An overall certainty of evidence per recommendation was assigned based on these assessments. The certainty of evidence assigned to each recommendation was based on the certainty of prioritized outcomes in the studies that informed the recommendation.

**Table 17: Certainty of Evidence**

OVERALL CERTAINTY OF EVIDENCE	DEFINITION
<b>High</b>	We are very confident that the true effect lies close to that of the estimate of the effect.
<b>Moderate</b>	We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
<b>Low</b>	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
<b>Very Low</b>	We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Source: Reprinted from: Schunemann H, Brozek J, Guyatt G, et al., editors. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach [Internet]. [place unknown: publisher unknown]; 2013. Available from: <https://gdt.gradeapro.org/app/handbook/handbook.html#h.svwngs6pm0f2>. Reprinted with permission.



## Formulating Recommendations

### Summarizing the Evidence

Studies were grouped according to themes based on consensus by the two guideline development methodologists for each research question. Draft recommendation statements were developed based on the themes. For each draft recommendation, GRADE evidence profiles were constructed by the two guideline development methodologists. GRADE evidence profiles are used to present decisions on determining the certainty of evidence, as well as general information about the body of research evidence, including key statistical or narrative results (8).

The evidence profiles for the body of quantitative studies presented the decisions made by the two guideline development methodologists on the five key GRADE certainty criteria for rating down the population included in the studies, the countries where the studies were conducted, the key results, and the transparent judgments about the certainty underlying the evidence for each outcome (8). The evidence profiles for quantitative studies presented the relative importance of outcomes as determined by the expert panel through a confidential online vote using a nine-point Likert scale that ranged from 1 (less important) to 9 (most important). For this BPG, **meta-analyses<sup>G</sup>** were not performed; therefore, results were synthesized using narrative.

The GRADE evidence profiles for each recommendation, organized per outcome, can be accessed online at <https://RNAO.ca/bpg/guidelines/vascular-access-second-edition>.

### Evidence-to-Decision Frameworks

**Evidence-to-Decision (EtD) frameworks<sup>G</sup>** outline proposed recommendations and summarize all necessary factors and considerations based on available evidence and expert panel judgement for formulating the recommendation statements. EtD frameworks are used to help ensure that all of the important factors (i.e., certainty of the evidence, benefits and harms, values and preferences, and health equity) required to formulate recommendation statements are considered by the expert panel (8). The guideline development methodologists draft the EtD frameworks with available evidence from the systematic reviews.

For this BPG, the EtD frameworks included the following areas of consideration for each drafted recommendation statement (see **Table 18**):

- Background information on the magnitude of the problem.
  - This includes the PICO question and general context related to the research question.
- The balance of benefits and harms of an intervention.
- Certainty of the evidence.
- Values and preferences.
- Health equity.

### Decision Making: Determining the Direction and Strength of Recommendations

Expert panel members are provided with the EtD frameworks to review prior to a scheduled two half-day virtual meeting to determine the direction (i.e., a recommendation for or against an intervention) and the strength (i.e., strong or conditional) of a BPG's recommendations. Expert panel members are also given access to the complete evidence profiles and full-text articles.

For this guideline, the expert panel convened virtually to determine the direction and strength of the guideline’s recommendations. The expert panel co-chairs and the two guideline development methodologists facilitated the virtual meeting to allow for adequate discussion for each proposed recommendation.

The decision on direction and strength of each recommendation statement was determined by discussion and a consensus vote of at least 70 per cent of voting panel members. The voting process was anonymous, using a virtual poll through the online meeting platform. It was moderated by the expert panel co-chairs, guideline development methodologists and guideline development project coordinator. In determining the strength of a recommendation statement, the expert panel was asked to consider the following (see **Table 18**):

- the balance of benefits and harms of an intervention,
- the certainty and/or confidence of the evidence,
- values and preferences, and
- health equity.

There was one recommendation that was not voted on during the virtual meetings due to time constraints (**Recommendation 1.1**). This recommendation was voted on by the expert panel through an online survey platform in the week following the virtual meetings. Expert panel members were able to vote on the strength and direction of the recommendation, and provide any feedback through this survey.

**Table 18: Key Considerations for Determining the Strength of Recommendations**

FACTOR	DEFINITION	SOURCES
<b>Benefits and harms</b>	<p>Potential desirable and undesirable outcomes reported in the literature when the recommended practice or intervention is used.</p> <p>“The larger the difference between the desirable and undesirable effects, the higher the likelihood that a strong recommendation is warranted. The narrower the gradient, the higher the likelihood that a conditional recommendation is warranted” (252).</p>	Includes research exclusively from the systematic review.
<b>Certainty of evidence</b>	<p>The extent of confidence that the estimates of an effect are adequate to support a recommendation. The extent of confidence that a review finding is a reasonable representation of the phenomenon of interest (253).</p> <p>Recommendations are made with different levels of certainty or confidence; the higher the certainty or confidence, the higher the likelihood that a strong recommendation is warranted (252).</p>	Includes research exclusively from the systematic review.

FACTOR	DEFINITION	SOURCES
<b>Values and preferences</b>	<p>The relative importance or worth of the health outcomes of following a particular clinical action from a person-centred perspective.</p> <p>“The more values and preferences vary or the greater the uncertainty in values and preferences the higher the likelihood that a conditional recommendation is warranted” (252).</p>	Includes evidence from the systematic review (when available) and other sources, such as insights from the expert panel.
<b>Health equity</b>	<p>Represents the potential impact of the recommended practice or intervention on health outcomes or health quality across different populations.</p> <p>The greater the potential for increasing health inequity, the higher the likelihood that a conditional recommendation is warranted (254).</p>	Includes evidence from the systematic review (when available) and other sources, such as insights from the expert panel.

Source: Adapted by the RNAO expert panel from: Schunemann H, Brozek J, Guyatt G, et al., editors. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach [Internet]. [place unknown: publisher unknown]; 2013. Available from: <https://gdt.gradeapro.org/app/handbook/handbook.html#h.svwngs6pm0f2>

## Developing Good Practice Statements

Following the in-person meeting, the good practice statement was developed by the RNAO best practice guideline development and research team to capture the need for health providers to complete a systematic assessment prior to initiating vascular access. The expert panel was sent a survey asking them to respond to five questions pertaining to each statement:

1. Is the statement clear and actionable?
2. Is the message really necessary in regards to actual health practice?
3. After consideration of all relevant health outcomes and potential downstream consequences, will implementing the good practice statement result in large net positive consequences?
4. Is a systematic review of the evidence necessary or required for this recommendation?
5. Is there a clear and explicit rationale to support this good practice statement?

Thirteen out of 17 panel members completed the survey on the good practice statement on assessment prior to initiating vascular access. The results are as follows:

- For the first question, 12 of 13 respondents answered “yes.”
- For the second question, 12 of 13 respondents answered “yes.”
- For the third question, 9 of 13 respondents answered “yes.”
- For the fourth question, 9 of 13 respondents answered “no.”
- For the fifth question, 12 of 13 respondents answered “yes.”

### Determining Supporting Resources and Appendices

Content for the supporting resources and appendices was submitted throughout the guideline development process by expert panel members and stakeholders. The two guideline development methodologists reviewed the content based on the following five criteria:

1. **Relevance:** Supporting resources and appendices should be related to the subject of the BPG or recommendation. In other words, the resource or appendix should be suitable and appropriate in relation to the purpose and scope of the BPG or the specific recommendation(s).
2. **Timeliness:** Resources should be timely and current. Resources should be published within the last 10 years or in line with current evidence.
3. **Credibility:** When assessing credibility, the trustworthiness and expertise of the source material's author or authoring organization is considered. Potential biases are also assessed, such as the presence of advertising or the affiliation of the authors with a private company selling health products.
4. **Quality:** This criterion assesses the accuracy of the information and the degree to which the source is evidence-informed. The assessment of quality is in relation to the subject of the resource. For example, if a tool is being suggested, is that tool reliable and/or valid?
5. **Accessibility:** This criterion considers whether the resource is freely available and accessible online.

### Drafting the Guideline

The guideline development methodologists wrote the draft of this BPG. The expert panel reviewed the draft and provided written feedback. The BPG then proceeded to external stakeholder review.

### Stakeholder Review

As part of the guideline development process, RNAO is committed to obtaining feedback from: (a) nurses and other health providers from a wide range of practice settings and roles, (b) knowledgeable administrators and funders of health services, and (c) stakeholder associations.

Stakeholder reviewers for RNAO BPGs are identified in two ways. First, stakeholders are recruited through a public call issued on the RNAO website ([RNAO.ca/bpg/get-involved/stakeholder](https://rnao.ca/bpg/get-involved/stakeholder)). Second, individuals and organizations with expertise in the guideline topic area are identified by the RNAO best practice guideline development and research team and the expert panel, and are directly invited to participate in the review.

Stakeholder reviewers are individuals with subject matter expertise in the guideline topic or those who may be affected by its implementation. Reviewers may be nurses, members of the interprofessional team, nurse executives, administrators, research experts, educators, nursing students, or persons with lived experience and family members.

Reviewers are asked to read a full draft of the BPG and participate in its review prior to its publication. Stakeholder feedback is submitted online by completing a survey questionnaire. The stakeholders are asked the following questions about each recommendation and the good practice statement:

- Is this recommendation/statement clear?
- Do you agree with this recommendation/statement?
- Is there a clear and explicit rationale to support the recommendation/statement?

In addition, the stakeholders are asked the following:

- About the appendices:
  - Are the appendices included in this guideline appropriate?
  - Are there any gaps in the content provided?
- About the guideline title:
  - Do you think this title is appropriate?
  - Do you think this title is clear?
- About the guideline as a whole:
  - Do you have any additional comments/suggestions about the background section of the guideline?
  - Do you agree with the wording of the key concepts and accompanying definitions?

In addition, stakeholder reviewers were given the option to enter additional comments or suggestions. Survey submissions are compiled and feedback is summarized by the RNAO best practice guideline development and research team. Together with the expert panel, they review and consider the survey results. If necessary, BPG content and recommendations are modified prior to publication to reflect the feedback received.

For this BPG, the stakeholder review process was completed between November 11, 2020 and December 2, 2020. Diverse perspectives provided feedback (see Stakeholder Acknowledgement).

### Procedure for Updating the Guideline

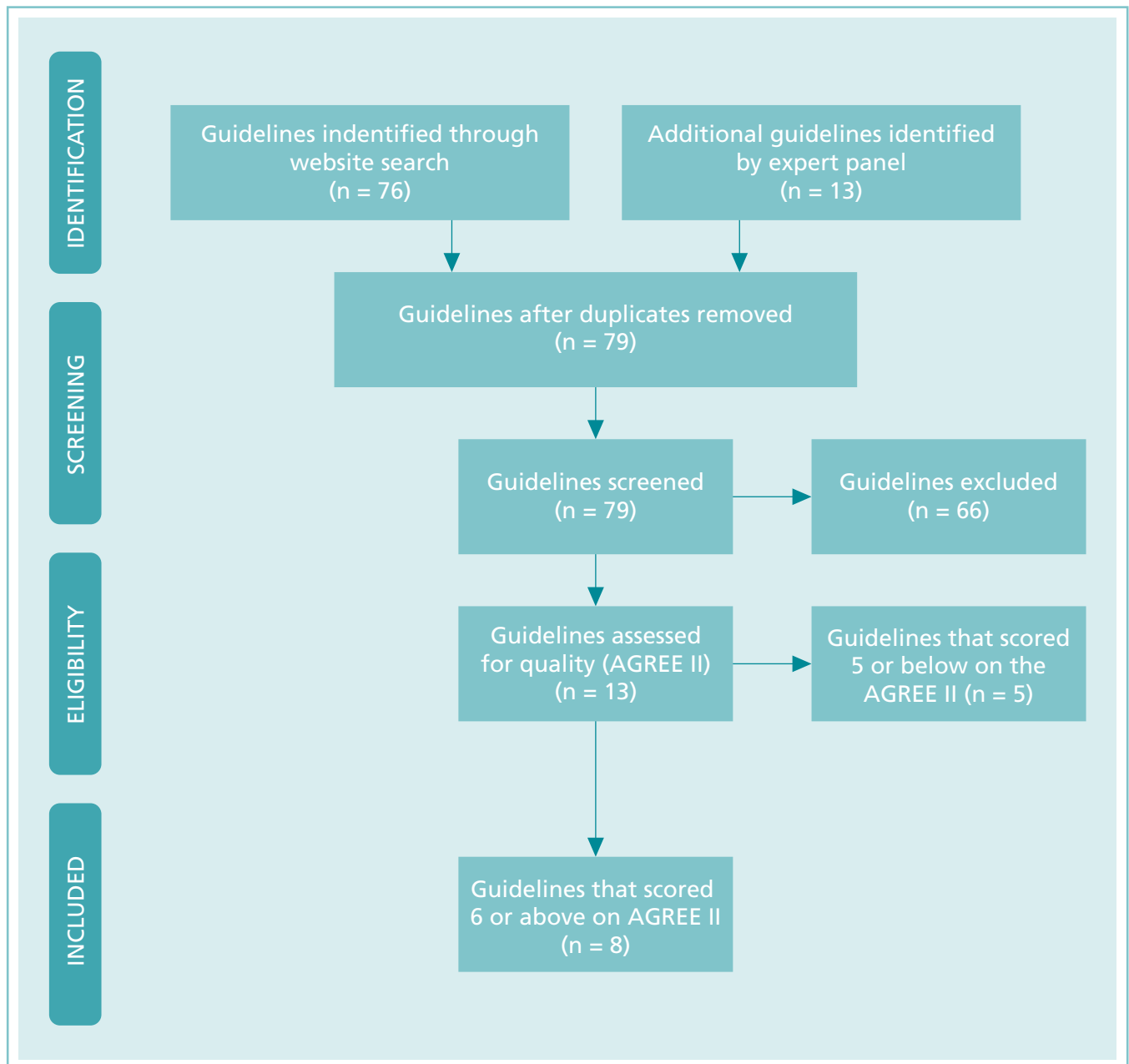
The RNAO commits to updating all BPGs, as follows:

1. Each BPG will be reviewed by a team of specialists in the topic area every five years after publication of the previous edition.
2. RNAO International Affairs and Best Practice Guidelines Centre staff regularly monitor for new systematic reviews, randomized controlled trials and other relevant literature in the field.
3. Based on that monitoring, staff may recommend an earlier revision period for a particular BPG. Appropriate consultation with members of the original expert panel and other specialists and experts in the field will help inform the decision to review and revise the BPG earlier than planned.
4. Three months prior to the review milestone, staff commence planning of the review by doing the following:
  - a. Compiling feedback received and questions encountered during the implementation, including comments and experiences of BPSOs<sup>®</sup> and other implementation sites regarding their experiences.
  - b. Compiling a list of new clinical practice guidelines in the field and refining the purpose and scope.
  - c. Developing a detailed work plan with target dates and deliverables for developing a new edition of the BPG.
  - d. Identifying, with RNAO's CEO, the potential BPG panel co-chairs.
3. Compiling a list of specialists and experts in the field for potential participation on the expert panel. The expert panel will be comprised of both members from the original expert panel and new ones.
5. New editions of BPGs will be disseminated based on established structures and processes.

# Appendix D: PRISMA Diagrams for Guideline Search and Systematic Reviews

**Figure 2: Guidelines Review Process Flow Diagram**

Included guidelines were considered for GRADE-ADOLOPMENT and were required to have an overall AGREE II score of 6 or more (out of 7) (237).

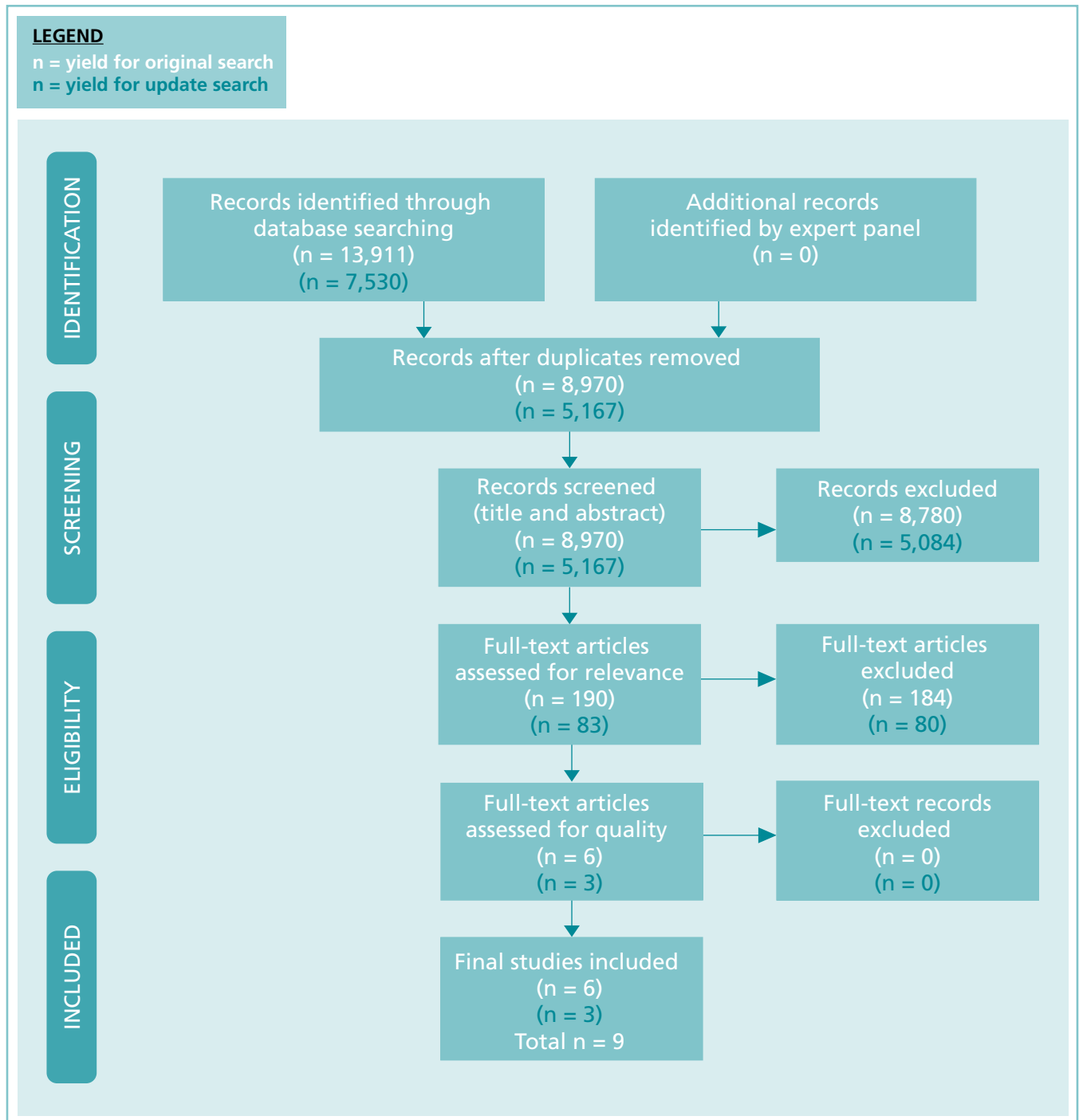


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 3: Article Review Process Diagram for Recommendation Question #1**

**Recommendation Question #1:**

Should providing education to persons and their families about their vascular access device be recommended?

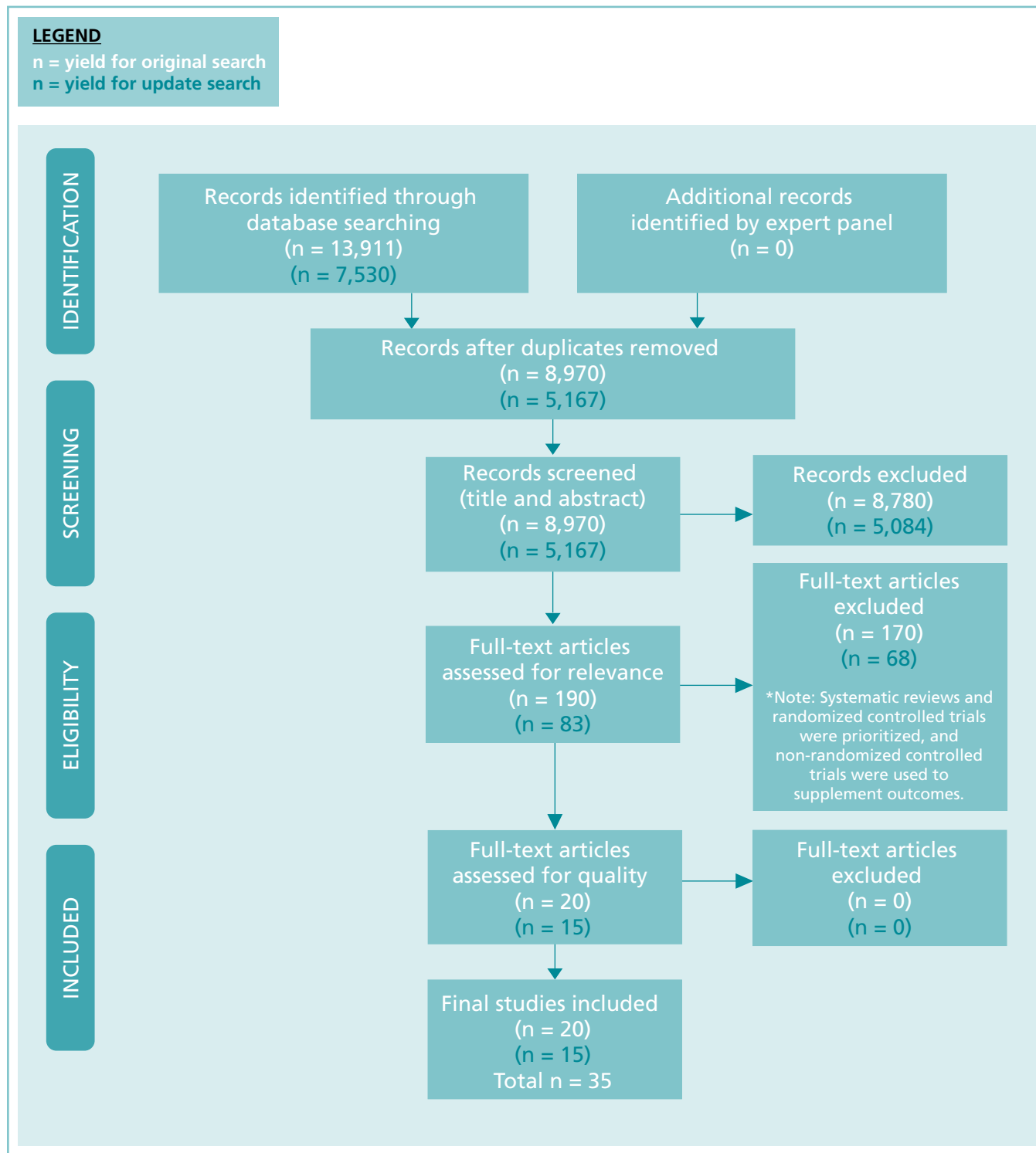


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 4: Article Review Process Diagram for Recommendation Question #2**

**Recommendation Question #2:**

Should practical education for the insertion and management of vascular access devices for health providers be recommended?



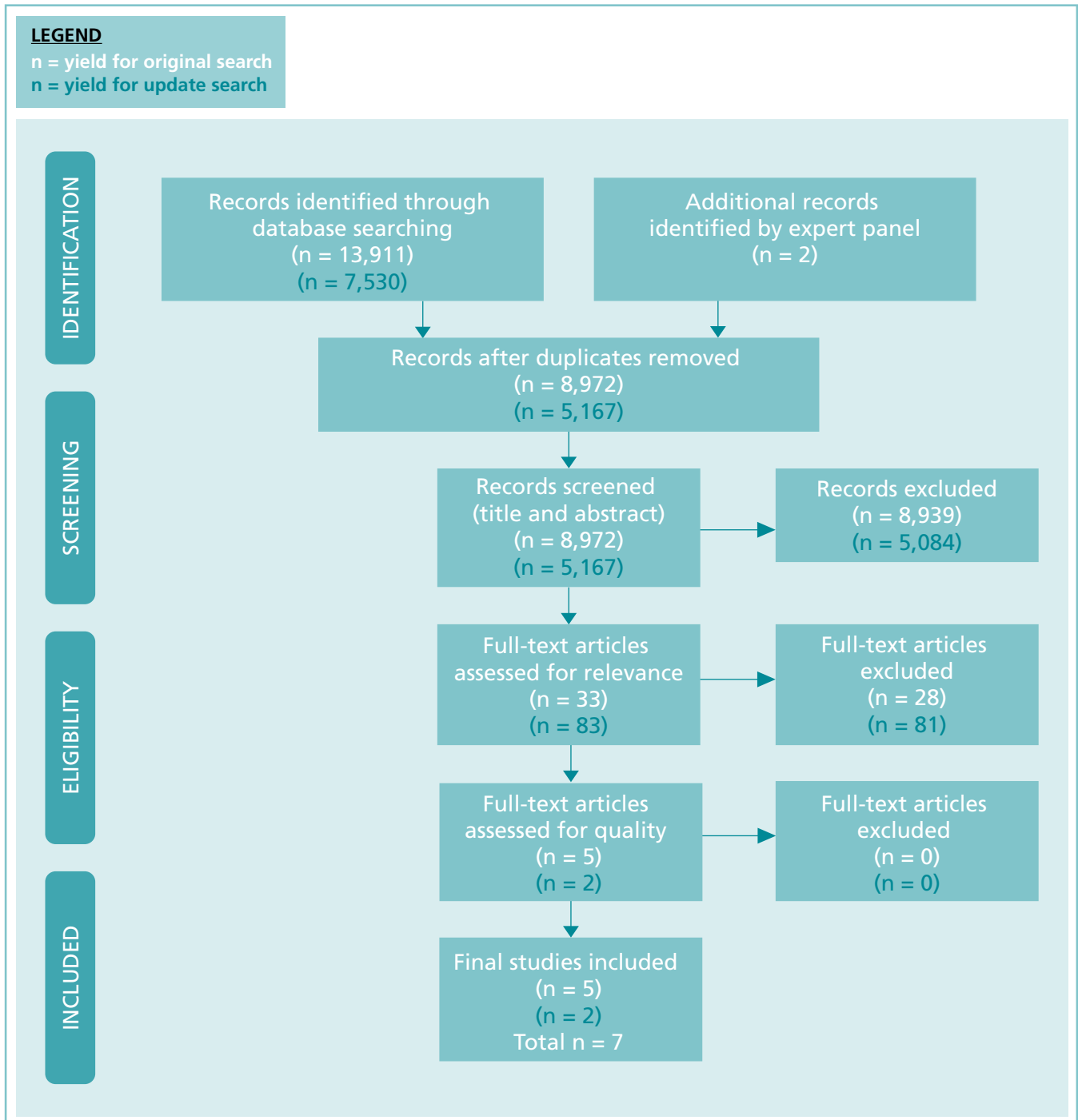
Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535



**Figure 5: Article Review Process Diagram for Recommendation Question #3**

**Recommendation Question #3:**

Should vascular access specialist teams be recommended?

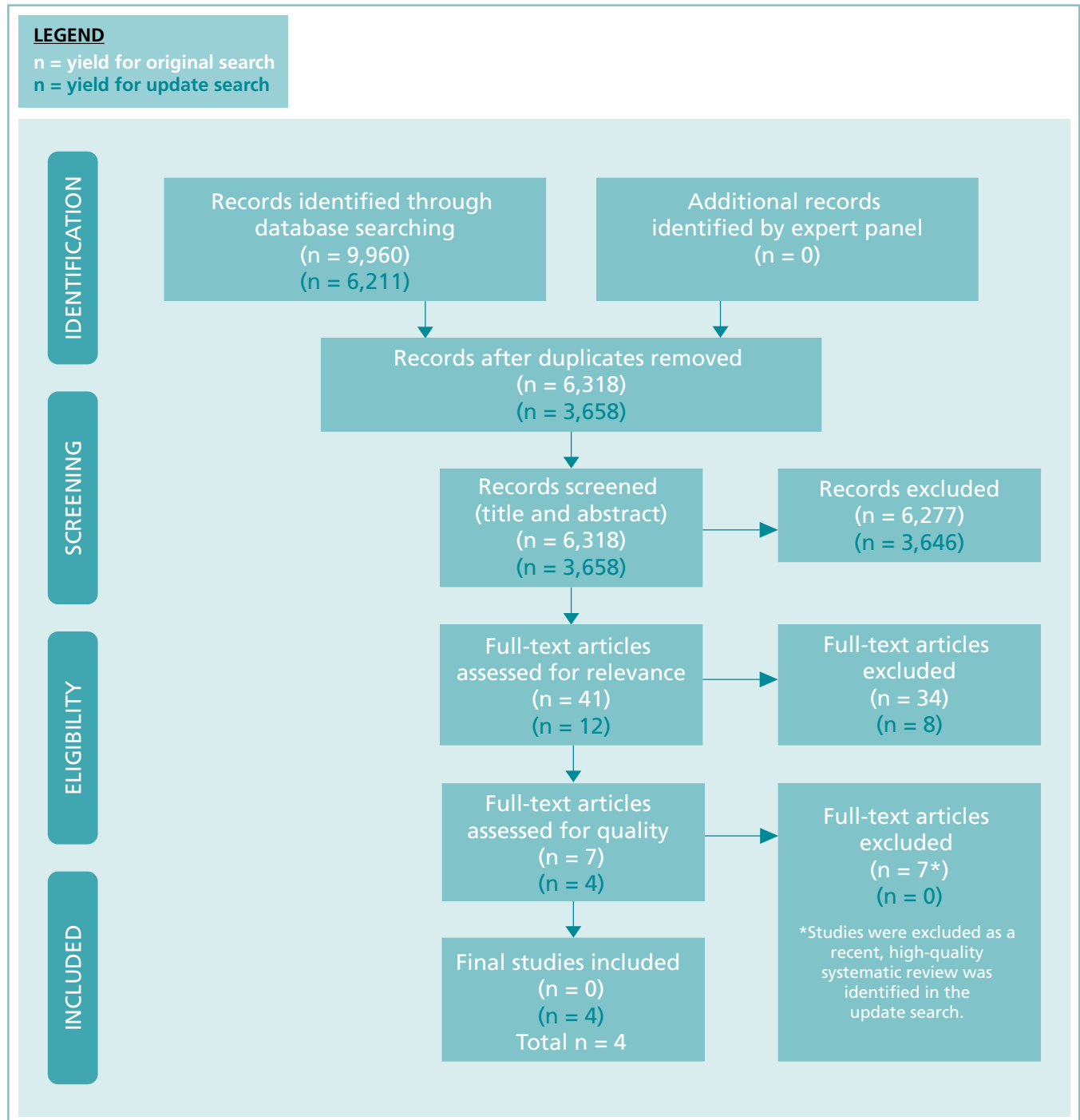


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 6: Article Review Process Diagram for Recommendation Question #4**

**Recommendation Question #4:**

Should blood draws from a vascular access device versus blood draws from venipuncture be recommended?

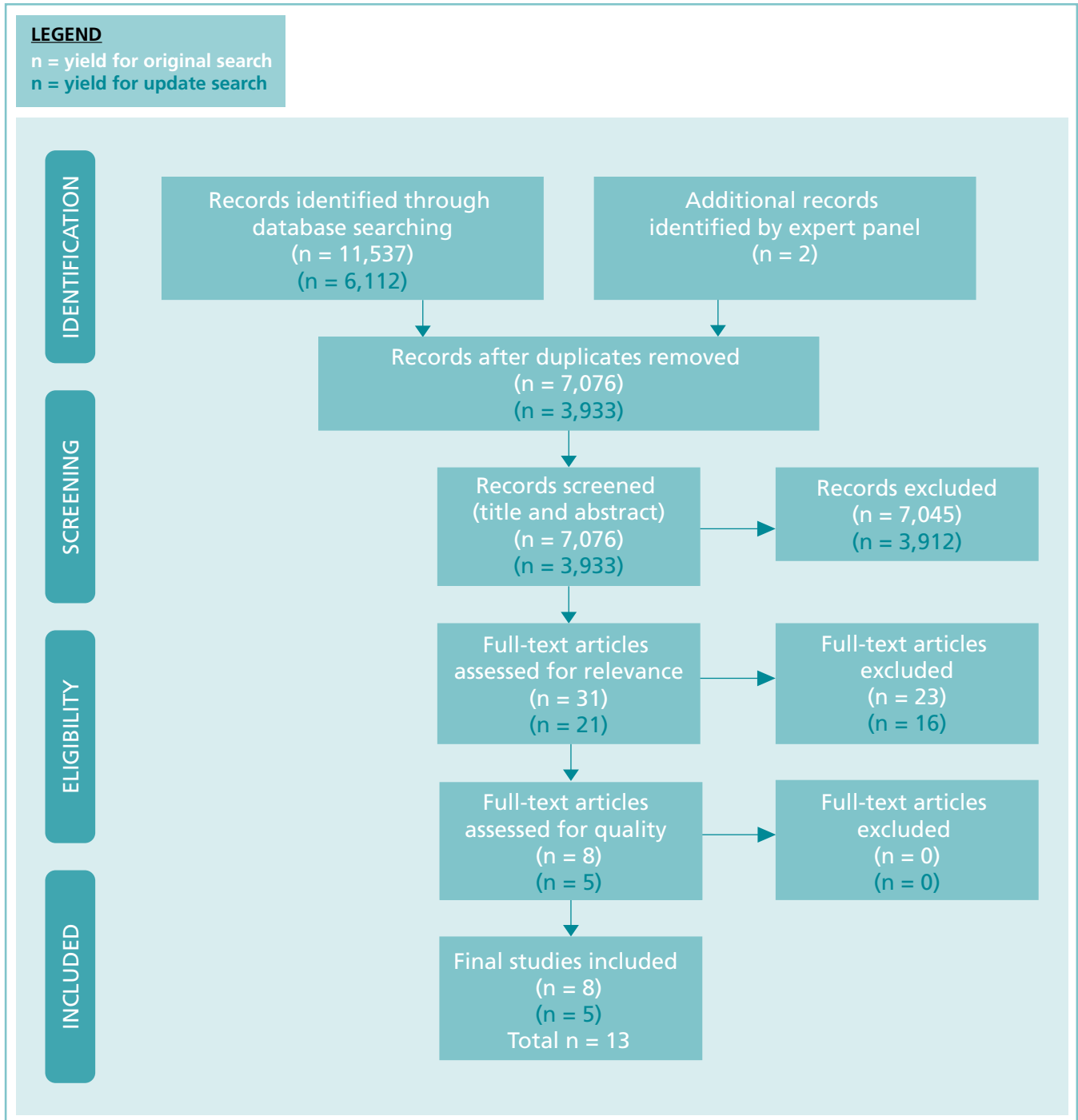


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 7: Article Review Process Diagram for Recommendation Question #5**

**Recommendation Question #5:**

Should the daily review of peripheral vascular access devices by health providers be recommended?

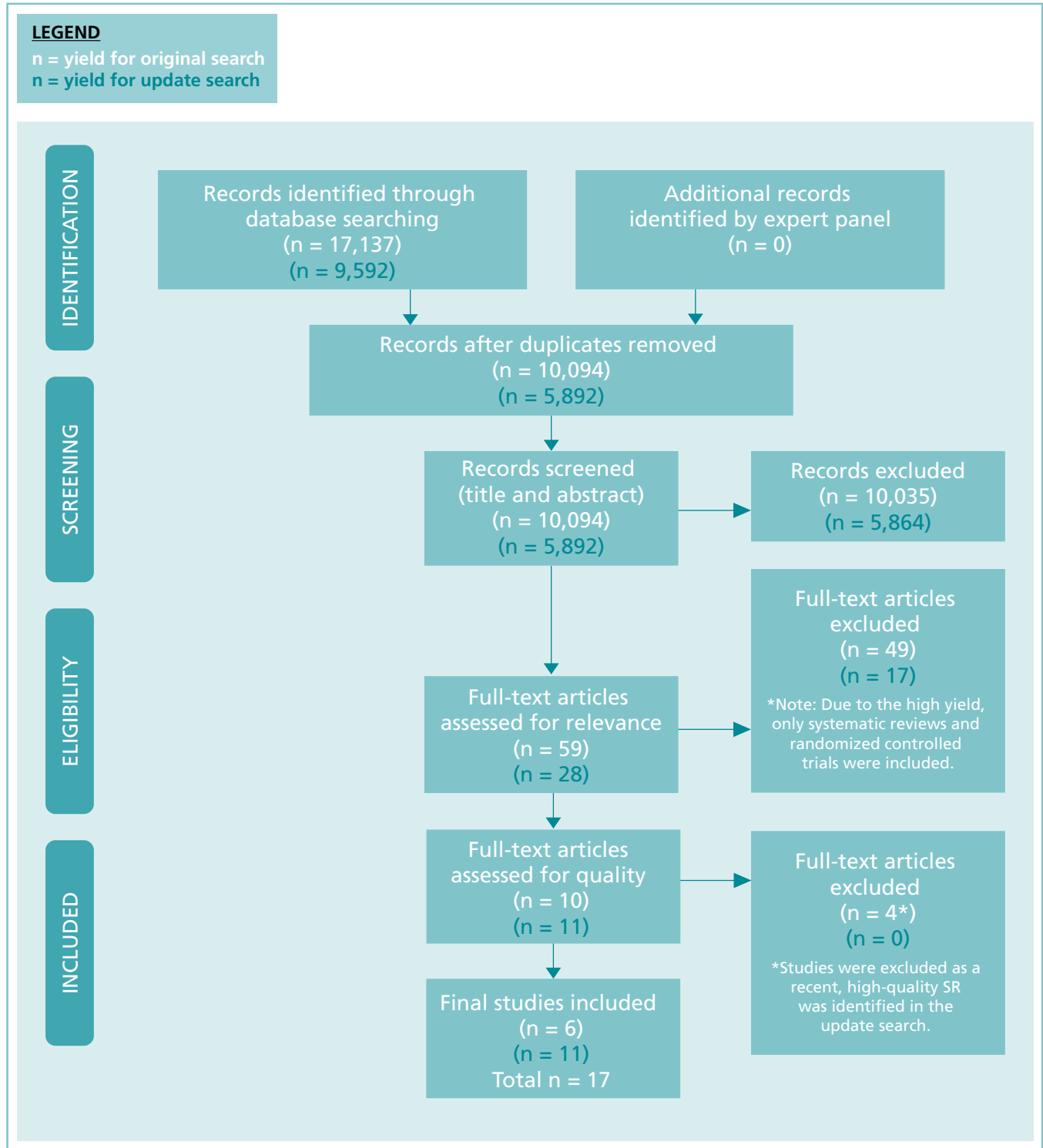


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 8: Article Review Process Diagram for Recommendation Question #6**

**Recommendation Question #6:**

Should the use of visualization technologies (e.g., ultrasound and vein finders) for the insertion of peripheral vascular access devices be recommended?

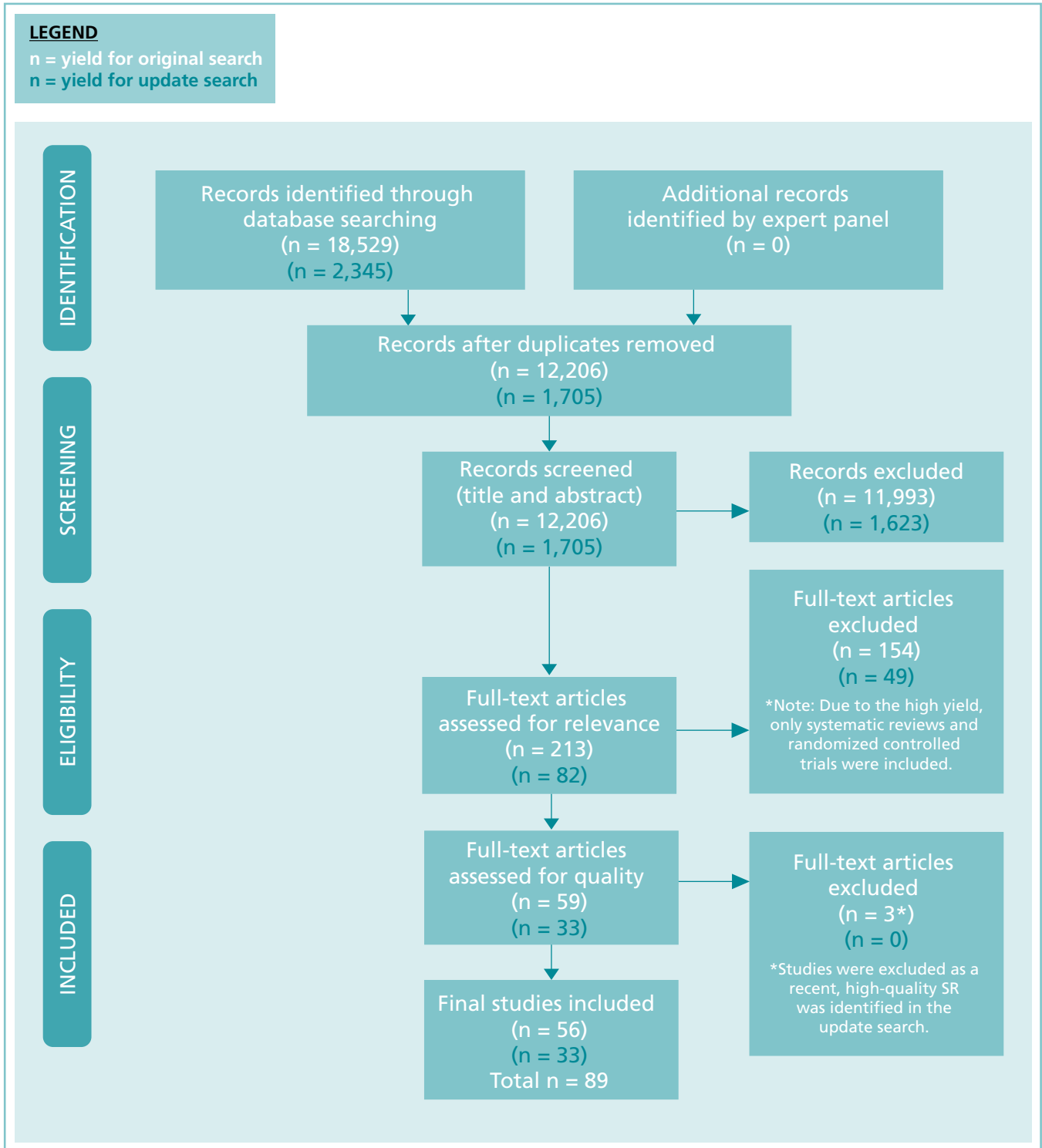


Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

**Figure 9: Article Review Process Diagram for Recommendation Question #7**

**Recommendation Question #7:**

Should pain management strategies (including pharmacological and non-pharmacological strategies) during the insertion of a vascular access device be recommended?



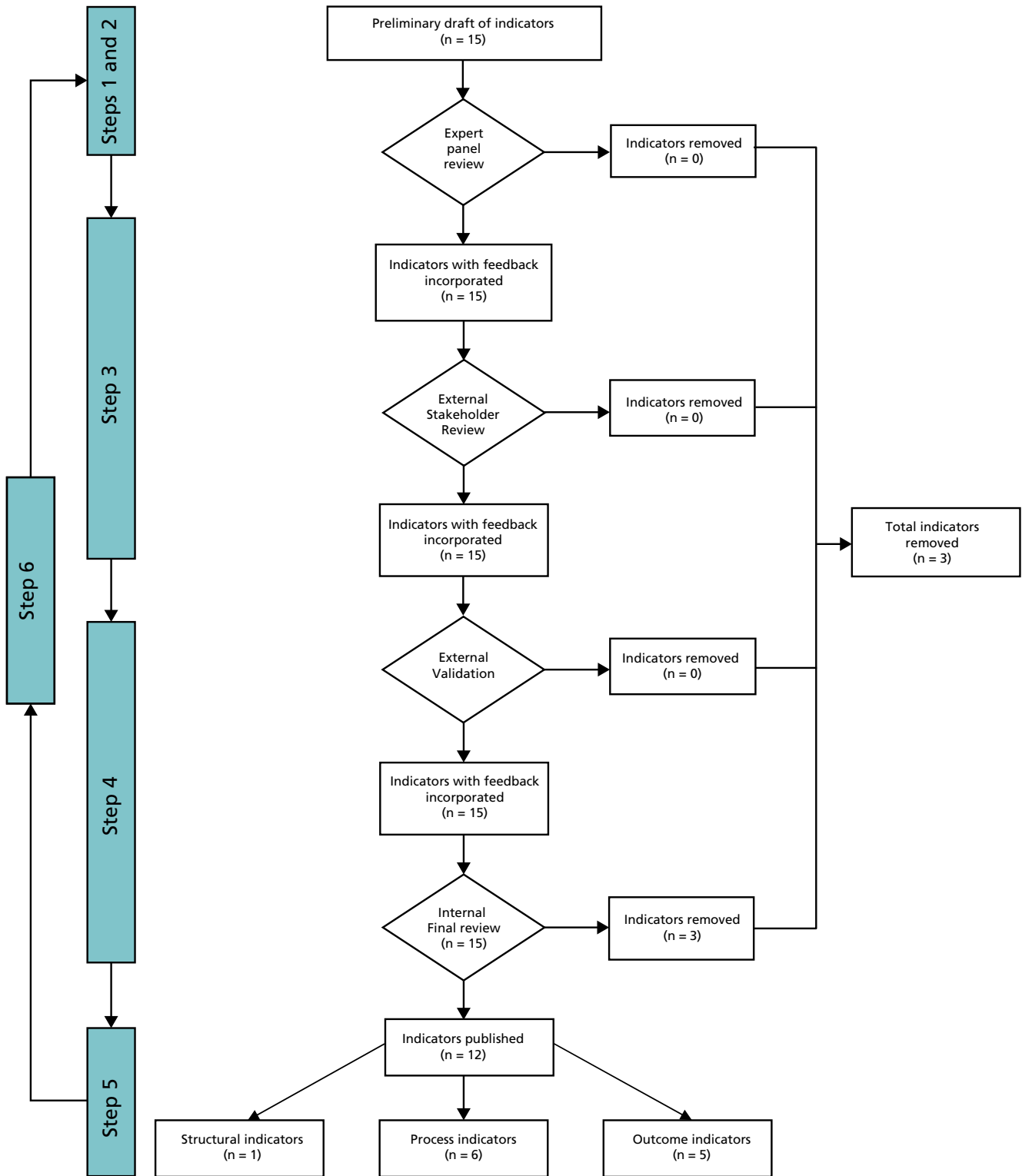
Source: Adapted from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

## Appendix E: Indicator Development Process

The RNAO indicator development process steps are summarized below (see **Figure 10**):

1. **Guideline selection:** Indicators are developed for guidelines focused on health system priorities, with an emphasis on filling gaps in measurement while reducing reporting burden.
2. **Extraction of recommendations:** Practice recommendations, overall guideline outcomes and BPG Order Sets™ (if applicable) are reviewed to extract potential measures for indicator development.
3. **Indicator selection and development:** Indicators are selected and developed through established methodology, including alignment with external data repositories and health information data libraries.
4. **Practice test and validation:** Proposed indicators are internally validated through face and content validity, and externally validated by national and international organization representatives.
5. **Implementation:** Indicators are published in the Evaluation and Monitoring chart, and data dictionaries are published on the NQuIRE® website.
6. **Data quality assessment and evaluation:** Data quality assessment and evaluation, as well as ongoing feedback from BPSOs, ensure purposeful evolution of NQuIRE indicators.

Figure 10: Indicator Development Flow Diagram



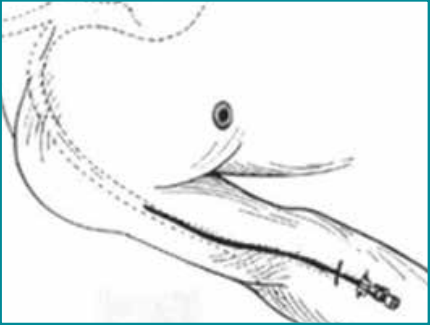
Source: Adapted by the expert panel from: Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535

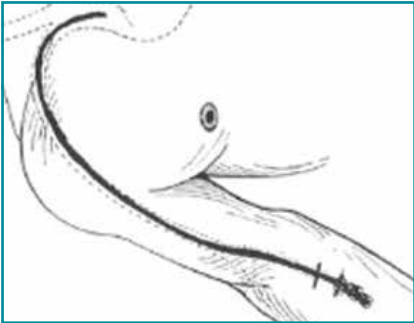
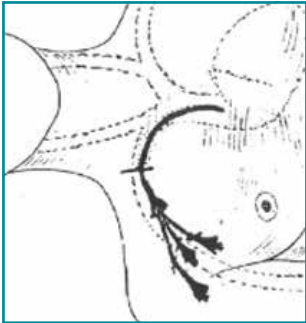
# Appendix F: Overview of Types of Vascular Access Devices

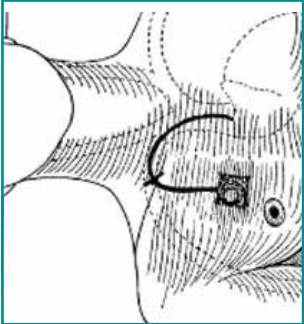

Table 19: Overview of Types of VAD

TYPE OF DEVICE	DESCRIPTION	PRACTICE CONSIDERATIONS
<p>1. Peripheral vascular access device (PVAD)</p> <p>1a) Short peripheral vascular access device (PVAD)</p> 	<p>VAD inserted in peripheral vein with the tip not extending into the central vasculature (25).</p> <p>A short, usually winged device that provides access to peripheral veins of the arm or foot or the external jugular vein in the neck. Short PVADs can be placed at the patient's bedside by various health providers (229).</p>	<ul style="list-style-type: none"> <li>■ In extremes of pH—use PVAD with caution (25).</li> <li>■ <b>See details for specific types of PVAD devices below.</b></li> <li>■ Use an accessible peripheral vein in the upper extremity for the duration of therapy (25).</li> <li>■ Use for short-term duration of therapy (e.g., &lt; 7 days) (25).</li> <li>■ Consider the infusate characteristics (e.g., irritant, vesicant or osmolarity) in conjunction with the anticipated duration of infusion therapy and availability of peripheral vascular access sites (37).</li> <li>■ Do not use short PVADs for continuous vesicant therapy, parenteral nutrition or infusates with an osmolarity greater than 900 mOsm/L (37).</li> <li>■ Select the smallest-gauge short PVAD catheter that will accommodate the prescribed therapy and patient need (37):             <ul style="list-style-type: none"> <li>□ 20–24 gauge for most infusion therapies.</li> <li>□ 22–24 gauge for infant or pediatric populations.</li> <li>□ Larger gauge (16–20) when rapid fluid replacement is required, such as with trauma patients.</li> </ul> </li> <li>■ When administering irritating or vesicant medications, consider the use of smaller gauges, as the overflow content is less and there consequently is less damage in cases of infiltration or extravasation.</li> <li>■ Use the venous site most likely to last the full length of the prescribed therapy (37).             <ul style="list-style-type: none"> <li>□ For adults: Veins in the forearm, dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic and median veins. Do not use veins of the lower extremities unless necessary due to risk of tissue damage, thrombophlebitis and ulceration.</li> <li>□ For pediatric populations: Consider veins in the hand, forearm and upper arm below the axilla. Avoid the antecubital area, which has a higher failure rate. For infants and toddlers, also consider veins of the scalp, and if not walking, the foot. For pediatric populations: Consider veins in the hand, forearm and upper arm below the axilla. Avoid the antecubital area, which has a higher failure rate. For infants and toddlers, also consider veins of the scalp, and if not walking, the foot.</li> </ul> </li> </ul>



TYPE OF DEVICE	DESCRIPTION	PRACTICE CONSIDERATIONS
<p><b>1b. Midline and extended dwell catheters</b></p>  <p><i>Image reprinted from: Registered Nurses' Association of Ontario (RNAO). Assessment and device selection for vascular access. Toronto (ON): RNAO; 2004.</i></p>	<p>A VAD inserted in peripheral vein in upper arm, with the tip residing near or at the level of the axilla and distal to the shoulder (25).</p>	<ul style="list-style-type: none"> <li>■ Use an accessible peripheral vein in the upper extremity, above the antecubital fossa (ACF) (25).             <ul style="list-style-type: none"> <li>□ Select sites in the upper arm (preferred) or the region of the antecubital fossa (secondary option), using the basilic, cephalic, median cubital and brachial veins, with the basilic vein preferred (37).</li> <li>□ For neonates and pediatric patients, additional site selections include veins in the leg with the tip below the groin, and in the scalp with the tip in the neck, above the thorax (37).</li> </ul> </li> <li>■ Use when the duration of therapy is less than 4 weeks (25).</li> <li>■ Consider a midline catheter for medications and solutions, such as antimicrobials, fluid replacement and analgesics, with characteristics that are well tolerated by peripheral veins (37).</li> <li>■ Do not use midline catheters for continuous vesicant therapy, parenteral nutrition or infusates with an osmolarity greater than 900 mOsm/L (37).</li> </ul>
<p><b>2. Central vascular access device (CVAD)</b></p>	<p>Catheter inserted into a peripheral or centrally located vein, with the tip residing in the superior or inferior vena cava (37). CVADs can be inserted by various health providers with the appropriate certifications and training.</p>	<ul style="list-style-type: none"> <li>■ Use central access when (25):             <ul style="list-style-type: none"> <li>□ Suitable peripheral access is unavailable.</li> <li>□ Osmolarity of continuous solution and/or medication is greater than 900 mOsm/L (e.g., parenteral nutrition).</li> <li>□ Continuous vesicant infusion is needed (i.e., infusion required for more than 60 minutes).</li> </ul> </li> <li>■ Consider implanted or tunneled CVAD for long-term therapy.</li> <li>■ Consider long-term intermittent vesicant infusion.</li> <li>■ Consider CVAD for irritant infusion that is required to infuse longer than 60 minutes, or ongoing intermittent infusion (i.e., irritant medication infusion multiple times per day, for multiple days) (25).</li> <li>■ See details for specific types of CVAD devices below.</li> </ul>

TYPE OF DEVICE	DESCRIPTION	PRACTICE CONSIDERATIONS
<p><b>2a. Peripherally inserted central catheter (PICC)</b></p>  <p><i>Image reprinted from: Registered Nurses' Association of Ontario (RNAO). Assessment and device selection for vascular access. Toronto (ON): RNAO;2004.</i></p>	<p>A catheter inserted through veins of the upper extremity or neck in adults and children. For infants, it may be inserted through veins of the scalp or lower extremity. The catheter tip is located in the superior or inferior vena cava, preferably at its junction with the right atrium, regardless of insertion site (37). PICCs can be inserted by various health providers with the appropriate certifications and training.</p>	<ul style="list-style-type: none"> <li>Confirmation of the anatomic location of the catheter tip is needed prior to initial use, and as needed for evaluation of VAD dysfunction (37).</li> <li>PICCs are indicated when a patient requires long-term antibiotic therapy, chemotherapy or other medication administration in the presence of DIVA.</li> </ul>
<p><b>2b. Central venous catheter (CVC)</b></p>  <p><i>Nurses' Association of Ontario (RNAO). Assessment and device selection for vascular access. Toronto (ON): RNAO;2004.</i></p>	<p><b>Tunneled:</b> Permanent or temporary devices that are characterized by the creation of a subcutaneous tunnel between the insertion of the catheter on the skin and the point of puncture in the vein. Tunneled catheters always terminate in central veins.</p> <p><b>Non-tunneled:</b> Often referred to as “acute” or “short-term” CVCs, these are often inserted for durations of 7 to 14 days. They are typically 15 to 25 cm and are placed via direct puncture (often using ultrasonography) and cannulation of the internal jugular, subclavian or femoral veins (229).</p>	<ul style="list-style-type: none"> <li>Can be cuffed or un-cuffed. The cuff is a silicone-based flange that provides tethering to the subcutaneous tissue and prevents the catheter from migrating. The cuff may also provide protection against infection (229).</li> <li>Confirmation of the anatomic location of the catheter tip is needed prior to initial use, and as needed for evaluation of VAD dysfunction (37).</li> <li>A permanent dialysis line is an example of a tunneled catheter.</li> </ul>

TYPE OF DEVICE	DESCRIPTION	PRACTICE CONSIDERATIONS
<p><b>2c. Implanted vascular access device (IVAD) (may be referred to as a “port”)</b></p>  <p><i>Image reprinted from: Registered Nurses’ Association of Ontario (RNAO). Assessment and device selection for vascular access. Toronto (ON): RNAO;2004.</i></p>	<p>Permanent catheters that are characterized by a subcutaneous reservoir with a diaphragm that acts as a receptacle for infusion. The reservoir is connected to a central vein in the chest with a catheter (229).</p>	<ul style="list-style-type: none"> <li>■ Requires a minor surgical procedure for placement and removal.</li> <li>■ Confirmation of the anatomic location of the catheter tip is needed prior to initial use, and as needed for evaluation of VAD dysfunction (37).</li> <li>■ Consider an implanted vascular access port for patients who are anticipated to require intermittent long-term infusion therapy (e.g., antineoplastic therapy or chemotherapy). When used intermittently, ports have a lower incidence of catheter-related bloodstream infection, but continuous port access has infection rates that are similar to other long-term CVADs (37).</li> </ul>
<p><b>3. Peripheral arterial catheter</b></p> 	<p>Device that can be inserted peripherally or centrally and can be used to monitor blood pressure and the hemodynamic status of people in critical care settings (225).</p>	<ul style="list-style-type: none"> <li>■ Place a peripheral arterial catheter for short-term use for hemodynamic monitoring, obtaining blood samples and analyzing blood gas in critically ill patients (37).</li> <li>■ Do not administer infusion therapy in peripheral arteries via peripheral arterial catheters (37).</li> <li>■ Use solution containing heparin (e.g., 1 unit per mL of 0.9% sodium chloride [USP]) or preservative-free 0.9% sodium chloride (USP) as a continuous flow to maintain patency of arterial catheters used for hemodynamic monitoring. The decision to use preservative-free 0.9% sodium chloride (USP) instead of heparin infusion should be based on the clinical risk of catheter occlusion, the anticipated length of time the arterial catheter will be required and individual factors (such as heparin sensitivities) (37).</li> <li>■ Use heparin 5 units per mL, 1 mL per hour as a continuous infusion for neonates and children with peripheral arterial catheters (37).</li> </ul>

## Appendix G: UK Vessel Health Preservation Framework

The following framework is an evidence-based tool that includes a device selection algorithm (“right line decision tool”) and details of peripheral vein assessment and daily review (“daily assessment”). Vessel health preservation involves following a specific clinical pathway of care that adheres to evidence-based practice, the outcomes are optimized, veins are preserved, and the treatment plan is completed while minimizing delays and complications (255). Vessel health preservation also promotes person-centred care.

Further readings and descriptors can be found in the associated publication, which can be accessed here: <https://www.ips.uk.net/vessel-health-and-preservation-framework-2020>.

Figure 11: UK Vessel Health and Preservation 2020

# UK VESSEL HEALTH AND PRESERVATION 2020

### RIGHT LINE DECISION TOOL

Get your VHP score from the [VHP app](#) or [VHP website](#)

**YES** → **Get your VHP score** → **Get your VHP score** → **Get your VHP score**

**NO** → **Get your VHP score** → **Get your VHP score** → **Get your VHP score**

**PERIPHERAL VEIN ASSESSMENT**

Grade	Number of palpable veins	Prescription Management
1	4-6 veins	Instructions by individual prescribers (e.g. GPs, nurses, pharmacists, etc.)
2	3-5 veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
3	1-3 veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
4	By palpable veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
5	No palpable veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

**DURATION OF ANTICIPATED THERAPY:**

- Short-term (e.g. 4-6 weeks)
- Medium-term (e.g. 7-12 weeks)
- Long-term (e.g. 13+ weeks)

**PERIPHERAL VEIN ASSESSMENT** (Include from Examiners, Public and prescribers, time to engage)

Grade 1: 4-6 veins, Prescriptions by individual prescribers (e.g. GPs, nurses, pharmacists, etc.)

Grade 2: 3-5 veins, Prescriptions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

Grade 3: 1-3 veins, Prescriptions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

Grade 4: By palpable veins, Prescriptions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

Grade 5: No palpable veins, Prescriptions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

### SUITABILITY OF MEDICINES

The most important principle is to ensure that medicines used in the VHP are suitable for use in the VHP. This is determined by the suitability of the medicine for use in the VHP. This is determined by the suitability of the medicine for use in the VHP.

**RIGHT LINE DECISION TOOL**

**PERIPHERAL VEIN ASSESSMENT**

**DURATION OF ANTICIPATED THERAPY:**

**PERIPHERAL VEIN ASSESSMENT**

**SECONDARY QUESTIONS**

**REFERENCES**

**GLOSSARY OF TERMS**

**INTRODUCTION**

### DAILY EVALUATION

How the patient will respond to treatment? (e.g. VHP score)

**YES** → **Get your VHP score** → **Get your VHP score** → **Get your VHP score**

**NO** → **Get your VHP score** → **Get your VHP score** → **Get your VHP score**

**PERIPHERAL VEIN ASSESSMENT**

**DURATION OF ANTICIPATED THERAPY:**

**PERIPHERAL VEIN ASSESSMENT**

**SECONDARY QUESTIONS**

**REFERENCES**

**GLOSSARY OF TERMS**

**INTRODUCTION**

### PERIPHERAL VEIN ASSESSMENT

Include from Examiners, Public and prescribers, time to engage

Grade	Number of palpable veins	Prescription Management
1	4-6 veins	Instructions by individual prescribers (e.g. GPs, nurses, pharmacists, etc.)
2	3-5 veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
3	1-3 veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
4	By palpable veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)
5	No palpable veins	Instructions by trained prescribers (e.g. GPs, nurses, pharmacists, etc.)

**DURATION OF ANTICIPATED THERAPY:**

- Short-term (e.g. 4-6 weeks)
- Medium-term (e.g. 7-12 weeks)
- Long-term (e.g. 13+ weeks)

**PERIPHERAL VEIN ASSESSMENT**

**SECONDARY QUESTIONS**

**REFERENCES**

**GLOSSARY OF TERMS**

**INTRODUCTION**

Source: Reprinted from: Hallam C, Denton A, Weston V, et al. UK vessel health and preservation (VHP) framework: a commentary on the updated VHP 2020 [Internet]. J Infect Prev. 2020. doi:10.1177/1757177420976806 Available from: <https://www.ips.uk.net/vessel-health-and-preservation-framework-2020>.



## Appendix H: List of Vesicant Medications

The following list includes some commonly administered vesicant drugs capable of causing injury if they escape from the intended vascular pathway into surrounding tissue (256). It is not a comprehensive list and does not include cytotoxic medications such as chemotherapy. For further details see Gorski et al.'s 2017 article “Development of an Evidence-Based List of Noncytotoxic Vesicant Medications and Solutions” (256).

### Antimicrobials:

- acyclovir,
- nafcillin sodium,
- pentamidine isethionate, and
- vancomycin hydrochloride.

### Vasopressors/vasoactive:

- dobutamine hydrochloride,
- dopamine hydrochloride,
- epinephrine hydrochloride,
- norepinephrine bitartrate,
- phenylephrine, and
- vasopressin injection.

### Fluids/electrolytes:

- calcium chloride,
- calcium gluconate,
- dextrose  $\geq 10\%$ ,
- parenteral nutrition  $> 900$  mOsm/L,
- potassium  $\geq 60$  mEq/L,
- sodium bicarbonate, and
- sodium chloride  $\geq 3\%$ .

### Other:


- amiodarone,
- arginine monochloride,
- contrast medianonionic,
- mannitol  $\geq 20\%$ ,
- pentobarbital sodium,
- phenytoin sodium injection, and
- promethazine hydrochloride.

# Appendix I: Example Peripherally Inserted Central Catheter (PICC) Health Teaching Guide

The following is an example of a comprehensive health teaching guide for pediatric persons going home with a PICC line. This guide is meant to be used as an example only, and modifications may need to be made based on the patient population, setting and type of VAD.

Please refer to other examples available from the Hamilton Health Sciences patient education library: <https://www.hamiltonhealthsciences.ca/patient-education-library/>

Figure 12: McMaster Children’s Hospital PICC Discharge Teaching Guide

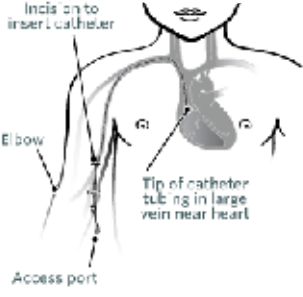


## Going home with a PICC line (Pediatrics)

---

**Information about your Peripheral Inserted Central Catheter (PICC)**

Your PICC was inserted on \_\_\_\_\_ (date) at McMaster Children’s Hospital in the Interventional Radiology Department (IR)



Brand name of PICC: \_\_\_\_\_

Size: \_\_\_\_ French

Cuffed OR  Non-Cuffed

Entire length of catheter if known: \_\_\_\_\_ cm

Length catheter (from exit site to hub): \_\_\_\_\_ cm

Final flush:  Normal Saline OR  Heparin  
OR \_\_\_\_\_ (refer to orders)

Dressing last changed on: \_\_\_\_\_

Needless Connector last changed on: \_\_\_\_\_

---

**When you get home:**

Your PICC will need routine care such as weekly dressing changes and routine flushing. A visiting nurse will see you in your home or nearby clinic. The nurse will give you medications, change the dressing, provide PICC care and teach you about caring for the PICC at home.

The Local Health Integration Network (LHIN) will organize your homecare nursing appointments and delivery of supplies to your home. It is important to keep the supplies in a safe place that is clean and dry.

**The dressing:**  
The PICC site must **always** be covered with a dressing. This is important to keep this area free of germs. Keeping the dressing covered and dry reduces the chance of germs entering the body and causing an infection.

**Bathing:**  
To help prevent infection, you should shower/bathe every day. Keep the dressing dry while you shower/bathe by wrapping the PICC in plastic wrap. After bathing, change into clean clothes every day to help your PICC stay clean.



**When your nurse comes to your home to provide PICC care:**

Set aside 30-60 minutes. Consider finding an ideal place with:

- Good lighting
- A comfortable spot to sit or lie down
- A clean surface for supplies



Remember, everyone must wash their hands before doing anything with the PICC, tubing or dressing.

**Problems to watch for:**

Problem:	What to do:
	<b><i>always wash your hands before touching the line</i></b>
The dressing is lifting, or has come off	Cover with another clean dressing Call your visiting nurse
The dressing is soaked with clear fluid	Do not remove the dressing Call your visiting nurse
The dressing is soaked with blood	Do not remove the dressing Apply pressure with another dressing or clean cloth Call your visiting nurse If bleeding is a lot, or does not stop go to <b>Emergency Department immediately</b>
The area around the PICC is red, swollen, tender or sore	Call your visiting nurse
If you develop fevers, chills or sweating	Go to <b>Emergency Department immediately</b>
The cap at end of the PICC is loose or it falls off	If the PICC has a clamp, make sure it is closed off Clean off the end of the PICC with an alcohol wipe Put on a new cap and go to Emergency Department
If you notice the PICC line is leaking or cracked	Cover the crack with tape or clean dressing and go to Emergency Department

**If there is trouble breathing call 911. If you are unsure of what to do or have concerns about the PICC, call your visiting nurse**

**What happens when the PICC is no longer needed?** The doctor who ordered your antibiotics will organize the removal of your PICC line. If your PICC line is cuffed, you will have an appointment booked in the Intervention Radiology Department at McMaster Children's Hospital to have your line removed. There is no special preparation needed for this appointment.

© Hamilton Health Sciences, 2020  
Date of last update: 03/2020  
PD 10159

Source: Reprinted from: Hamilton Health Sciences—Patient Education. Going home with a PICC line (pediatrics). Unpublished document. Hamilton (ON): Hamilton Health Sciences; 2020. Reprinted with permission.



# Appendix J: Peripheral Ultrasound-guided Vascular Access (P-UGVA) Global Rating Scale

The Peripheral Ultrasound-guided Vascular Access (P-UGVA) global rating scale has been validated for ultrasound-guided PIV insertion (257). This scale may be used for training and skill assessment of health providers using ultrasound guidance to insert PVADs. Additionally, it may be used as an example to develop other skills checklists.

**Figure 13: The P-UGVA Rating Scale**

Preparation of utensils	1	2	3	4	5
Preparation of utensils before the procedure	No preparation before scan		Incomplete preparation. Unnecessary interruptions during the procedure or need for assistance.		Perfect preparation. Procedure performed in a smooth workflow.
Ergonomics	1	2	3	4	5
Working posture including stabilization of the transducer and the needle. Placement of the apparatus relative to the puncture site.	Working posture and apparatus positioning complicate the procedure unnecessarily.		Partial optimization of working posture.		Perfect working posture and positioning of the apparatus.
Preparation of the ultrasound device	1	2	3	4	5
Choice of transducer and transducer orientation. Picture optimization: preset, gain, depth and focus.	Incorrect selection and/or orientation of transducer. No image optimization.		Inconsistent selection and/or orientation of transducer. Incomplete image optimization.		Correct selection and orientation of transducer. Image optimization performed systematically.
Identification of blood vessels	1	2	3	4	5
Distinction of arteries and veins in 2D. Optimization of vessel filling and transducer pressure.	No regards to distinction between arteries and veins. No optimization of vessel filling.		Insecure distinction between arteries and veins. Incomplete optimization of vessel filling.		Perfect distinction between arteries and veins. Optimization of vessel filling.
Anatomy	1	2	3	4	5
Recognition of anatomy and search for blood vessel and puncture site for the procedure.	Random approach to location. Important structures are neglected. Unsuitable puncture site.		Partially systematic approach to location of vessels.		Systematic location of target vessel. Recognition of all important anatomy. Most suitable puncture site.
Hygiene	1	2	3	4	5
Performance of the procedure according to current guidelines for hygiene and intravascular procedures.	Shows no regard to hygiene.		Follows guidelines partially.		Follows guidelines.

<b>Coordination of the needle</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Control of the needle tip position and ability to navigate the needle tip through the tissue and into the target vessel.	Lack of control and navigation of the needle tip. Misses target vessel.		Insecure control and navigation of the needle tip. Places needle in target vessel.		Full control of the needle tip and navigates to perfection. Places needle in target vessel.
<b>Completion of the procedure</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Ability to complete the procedure and ensure intravascular placing.	Intravascular placement is not ensured.		Intravascular placement is ensured partially.		Intravascular placement is ensured correctly.

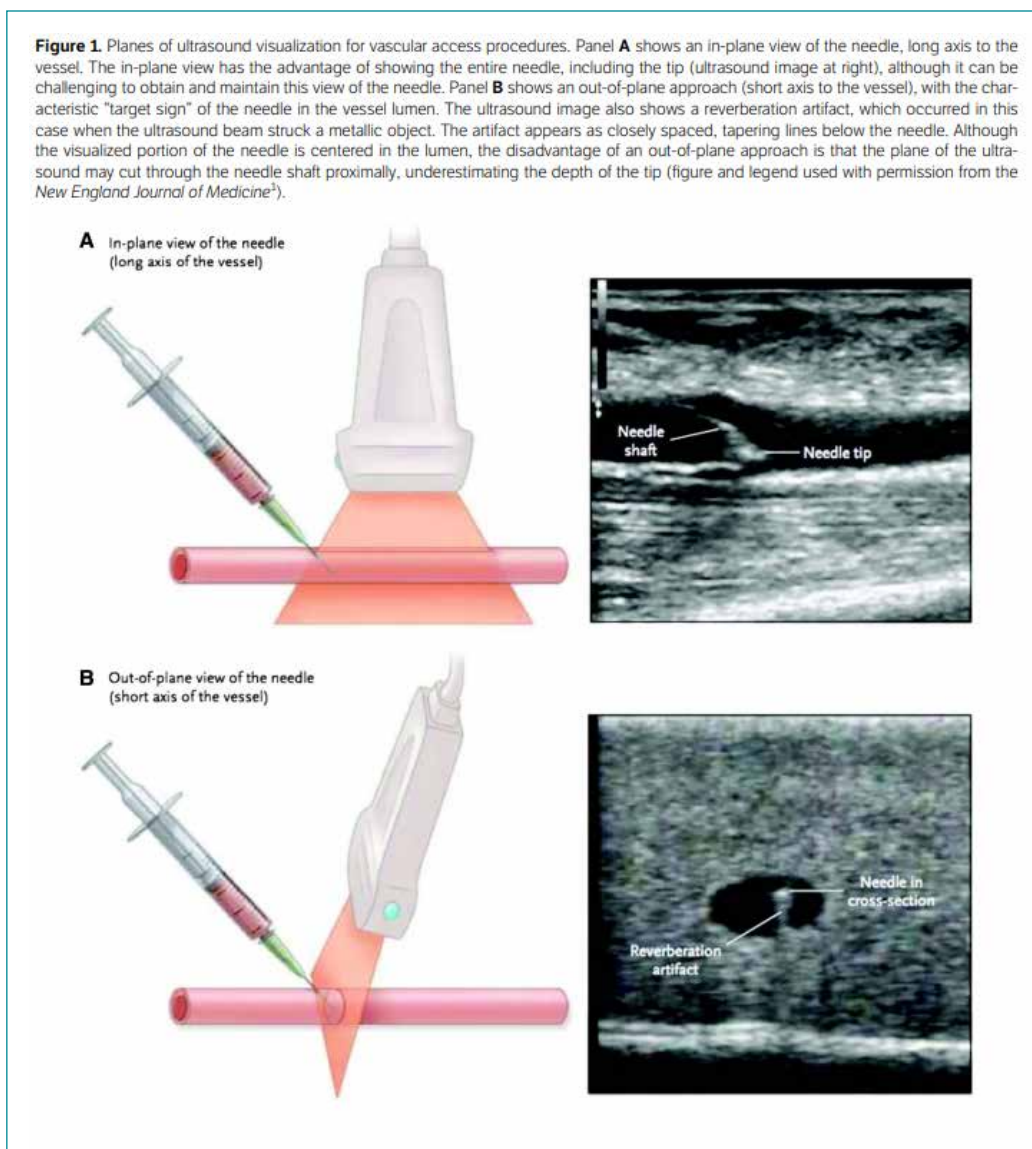
Source: Primdahl SC, Weile J, Clemmesen L, et al. Validation of the Peripheral Ultrasound-guided Vascular Access rating scale. *Medicine (Baltimore)*. 2018;97(2):e9576.

## Appendix K: Example of Ultrasound-guided Device Technique

This figure provides an example of how ultrasound-guided technique may be used for the insertion of a VAD. There are two visualization techniques that can be used: the long axis (“in plane”) view or the short axis approach.

This example is meant to be used for general information purposes only, and is not to be used as a sole resource when teaching health providers ultrasound-guided technique for VAD insertion. See the American Institute of Ultrasound in Medicine’s *Practice Parameter for the Use of Ultrasound to Guide Vascular Access Procedures* for further details on ultrasound-guided technique (258).

**Figure 14: American Institute of Ultrasound in Medicine Planes of Ultrasound Visualization**



Source: Reprinted from: American Institute of Ultrasound in Medicine (AIUM). Practice parameter for the use of ultrasound to guide vascular access procedures. *J Ultrasound Med.* 2019;38(3):E4-E18. doi: 10.1002/jum.14954 Reprinted with permission.

# Appendix L: Example of a Peripheral Vascular Access Device (PVAD) Assessment Protocol

The following is an example of a PVAD assessment protocol used in an acute, pediatric health-service organization. The protocol may need to be adapted for other populations or health-service organizations. In adult settings, assessment every four hours while infusing may be more appropriate (25). Additionally, more frequent assessments are necessary in a variety of situations, such as for infusion of vesicants or blood products and for persons who may be critically ill.

**Figure 15: PVAD Assessment Protocol (TLC+)**

IV Care with			
T	L	C	+
TOUCH	LOOK	COMPARE	PLUS
<p><b>TOUCH every 60 minutes</b></p> <p>IV site should feel:</p> <ul style="list-style-type: none"> <li>Soft</li> <li>Warm</li> <li>Dry</li> <li>Pain free</li> </ul>	<p><b>LOOK every 60 minutes</b></p> <p>IV site should be:</p> <ul style="list-style-type: none"> <li>Uncovered</li> <li>Without redness</li> <li>Without blanching (temporary whitening of skin when touched)</li> </ul>	<p><b>COMPARE every 60 minutes</b></p> <p>IV site should be:</p> <ul style="list-style-type: none"> <li>Without swelling</li> <li>Same size as the other side</li> </ul>	<p><b>PLUS engage patients/families</b></p> <p>IV site should feel:</p> <ul style="list-style-type: none"> <li>Provide IV care teaching                             <ul style="list-style-type: none"> <li>Hourly checks (even when sleeping)</li> </ul> </li> <li>Ensure TLC assessment at handover</li> <li>Educate patient/family to speak up if they notice:                             <ul style="list-style-type: none"> <li>Swelling/firmness, pain/numbness, redness/bruising or wetness</li> </ul> </li> </ul>

caringsafely

The TLC concept has been adopted from Cincinnati Children's Hospital (CCH) and used with their permission.

SickKids

Source: Reprinted from: The Hospital for Sick Children. IV Care TLC+. Unpublished document. Toronto (ON): The Hospital for Sick Children; [date unknown]. Reprinted with permission.

## Appendix M: List of Central Vascular Access Device (CVAD) Care Guidelines

Table 20 provides a list of guidelines found during the environmental scan of guidelines (see page 124). Each of the listed guidelines includes multi-component CVAD care protocols and scored a 4 or higher on an AGREE II appraisal.

**Table 20: List of Guidelines That Include Multi-component CVAD Care Protocol**

ORGANIZATION	CITATION	AGREE II SCORE (OUT OF 7)
Agency for Clinical Innovation, New South Wales Health, Australia	Murgo M. Central venous access device: post insertion management [Internet]. Chatswood (AU): NSW Agency for Clinical Innovation; 2014. Available from: <a href="https://www.aci.health.nsw.gov.au/_data/assets/pdf_file/0010/239626/ACI14_CVAD-2-2.pdf">https://www.aci.health.nsw.gov.au/_data/assets/pdf_file/0010/239626/ACI14_CVAD-2-2.pdf</a>	6
American Society of Clinical Oncology	Schiffer CA, Mangu PB, Wade JC, et al. Central venous catheter care for the patient with cancer: American Society of Clinical Oncology clinical practice guideline. 2013. <i>J Clin Oncol</i> . 31(10):1357-70.	5
Canadian Vascular Access Association	Canadian Vascular Access Association. Canadian vascular access and infusion therapy guidelines. Pembroke (ON): Pappin Communications; 2019.	5
Canadian Vascular Access Association	Canadian Vascular Access Association. Occlusion management of central venous access devices. Hamilton (ON): Canadian Vascular Access Association; 2016.	5
Infusion Nurses Society	Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice. Norwood (MA): Infusion Nurses Society; 2016.	4
National Institute of Health and Care Excellence	National Institute of Health and Care Excellence (NICE). Healthcare-associated infections: prevention and control in primary and community care. London (UK): NICE; 2017.	6

# Appendix N: Difficult Intravenous Access (DiVA) Scales

The following scales have been validated for determining DiVA. The DIVA scale has been validated for use in children (see **Table 21**) and the A-DIVA scale has been validated for use in adults (see **Table 22**) (259, 260). For the DIVA scale, a score of 4 or higher identifies children in whom PIV access is likely to fail the first time it is attempted (259). In adults, the A-DIVA scale is used to determine whether a person is at low risk (score 0–1), medium risk (score 2–3) or high risk (score 4 plus) for DiVA (260). Health providers should be trained on the appropriate use of these scales prior to using them in practice. It is important to note that although skin colour can be a predictor variable, it should not be the only determinant of DiVA.

**Table 21: DiVA Scale**

PREDICTOR VARIABLE	SCORES		
Visibility	Visible = 0		Not Visible = 2
Palpability	Palpable = 0		Not palpable = 2
Age	≥ 36 months = 0	12-35 months = 1	< 12 months = 3
Prematurity	Not premature = 0		Premature = 3
Skin shade	Light = 0	Dark = 1	

Source: Riker MW, Kennedy C, Winfrey BS, et al. Validation and refinement of the Difficult Intravenous Access Score: a clinical prediction rule for identifying children with difficult intravenous access. *Acad Emerg Med.* 2011;18(11):1129-34.

**Table 22: A-DiVA Scale**

RISK FACTOR	DEFINITION	ADDITIVE RISK SCORE
<b>Palpable appearance</b>	Is it impossible to identify the target vein by palpating the upper extremity?	1
<b>History of difficult intravenous access</b>	Was it difficult to insert a peripheral intravenous catheter in the past?	1
<b>Visual Appearance</b>	Is it impossible to identify the target vein by visualizing the upper extremity?	1
<b>Unplanned indication for surgery</b>	Is the patient at an emergency indication for surgery?	1
<b>Diameter of the vein <math>\leq</math> 2 millimeters</b>	Does the target vein have a diameter of at most 2 millimeters?	1
<p><b>Note:</b> the A-DiVA scale is represented as an additive scoring system to calculate the predicted risk for an individual patient; the scores for existing risk factors are added to give an approximate estimation of a difficult intravenous access. Score are added after answering a question with “yes.”</p>		

Source: van Loon FHJ, Puijn LAPM, Houterman S, et al. Development of the A-DiVA Scale: a clinical predictive scale to identify difficult intravenous access in adult patients based on clinical observations. *Medicine (Baltimore)*. 2016;95(16):e3428-e.

# Appendix O: Pain Management Strategies for Infants and Children Across Ages and Stages

**Table 23: Pain Management Strategies for Infants and Children Across Ages and Stages**

AGE	PHARMACOLOGIC INTERVENTIONS	NON-PHARMACOLOGIC INTERVENTIONS
<b>Infants (birth–12 months)</b>	<ul style="list-style-type: none"> <li>■ Topical anesthetic (such as lidocaine-prilocaine numbing cream).</li> </ul>	<ul style="list-style-type: none"> <li>■ Swaddling.</li> <li>■ Facilitated tucking.</li> <li>■ Skin-to-skin (kangaroo) care.</li> <li>■ Breastfeeding.</li> <li>■ Formula feeding.</li> <li>■ Sucrose.</li> <li>■ Parental presence/holding.</li> <li>■ Distraction:                             <ul style="list-style-type: none"> <li>□ toys,</li> <li>□ pacifier (i.e. non-nutritive sucking),</li> <li>□ bubbles, and</li> <li>□ singing/talking to infant.</li> </ul> </li> </ul>
<b>Toddlers and young children (1–5 years)</b>	<ul style="list-style-type: none"> <li>■ Topical anesthetic (such as lidocaine-prilocaine numbing cream).</li> <li>■ Oral melatonin.</li> </ul>	<ul style="list-style-type: none"> <li>■ Comfort positioning:                             <ul style="list-style-type: none"> <li>□ sitting upright,</li> <li>□ comfortable chair,</li> <li>□ avoid laying flat, and</li> <li>□ holding by parent (e.g., chest-to-chest, or between parent’s legs back-to-chest).</li> </ul> </li> <li>■ Parental presence.</li> <li>■ Distraction:                             <ul style="list-style-type: none"> <li>□ music,</li> <li>□ toys,</li> <li>□ bubbles,</li> <li>□ singing/talking to child, and</li> <li>□ reading a story.</li> </ul> </li> <li>■ Vapocoolant spray (&gt;3 years old only).</li> </ul>



AGE	PHARMACOLOGIC INTERVENTIONS	NON-PHARMACOLOGIC INTERVENTIONS
<p><b>School-aged children</b> (6–12 years)</p>	<ul style="list-style-type: none"> <li>■ Topical anesthetic (such as lidocaine-prilocaine numbing cream).</li> <li>■ Oral melatonin.</li> </ul>	<ul style="list-style-type: none"> <li>■ Comfort positioning:                             <ul style="list-style-type: none"> <li>□ sitting upright,</li> <li>□ comfortable chair, and</li> <li>□ avoid laying flat.</li> </ul> </li> <li>■ Parental presence.</li> <li>■ Distraction:                             <ul style="list-style-type: none"> <li>□ deep-breathing exercises,</li> <li>□ music,</li> <li>□ toys,</li> <li>□ books,</li> <li>□ video games,</li> <li>□ virtual reality device,</li> <li>□ mobile device,</li> <li>□ conversation, and</li> <li>□ drawing.</li> </ul> </li> <li>■ Vapocoolant spray.</li> </ul>
<p><b>Adolescents and young adults</b> (13–18 years)</p>	<ul style="list-style-type: none"> <li>■ Topical anesthetic (such as lidocaine-prilocaine numbing cream).</li> <li>■ Oral melatonin.</li> </ul>	<ul style="list-style-type: none"> <li>■ Comfort positioning (e.g., sitting upright and using a comfortable chair).</li> <li>■ Parental presence.</li> <li>■ Distraction:                             <ul style="list-style-type: none"> <li>□ deep-breathing exercises,</li> <li>□ music,</li> <li>□ video games,</li> <li>□ virtual reality device,</li> <li>□ mobile device,</li> <li>□ conversation, and</li> <li>□ drawing.</li> </ul> </li> <li>■ Vapocoolant spray.</li> </ul>

## OTHER CONSIDERATIONS (FOR ALL AGES)

- Discuss the plan of care with the child and their family/caregiver.
- Offer multiple pain management strategies, and consider child and/or family/caregiver preference in deciding which pain management strategy to use for the procedure.
- Adopt the least invasive approach. Group blood drawings, when possible.
- Involve a child life therapist (if available).
- Combining multiple non-pharmacological psychological interventions can be beneficial.

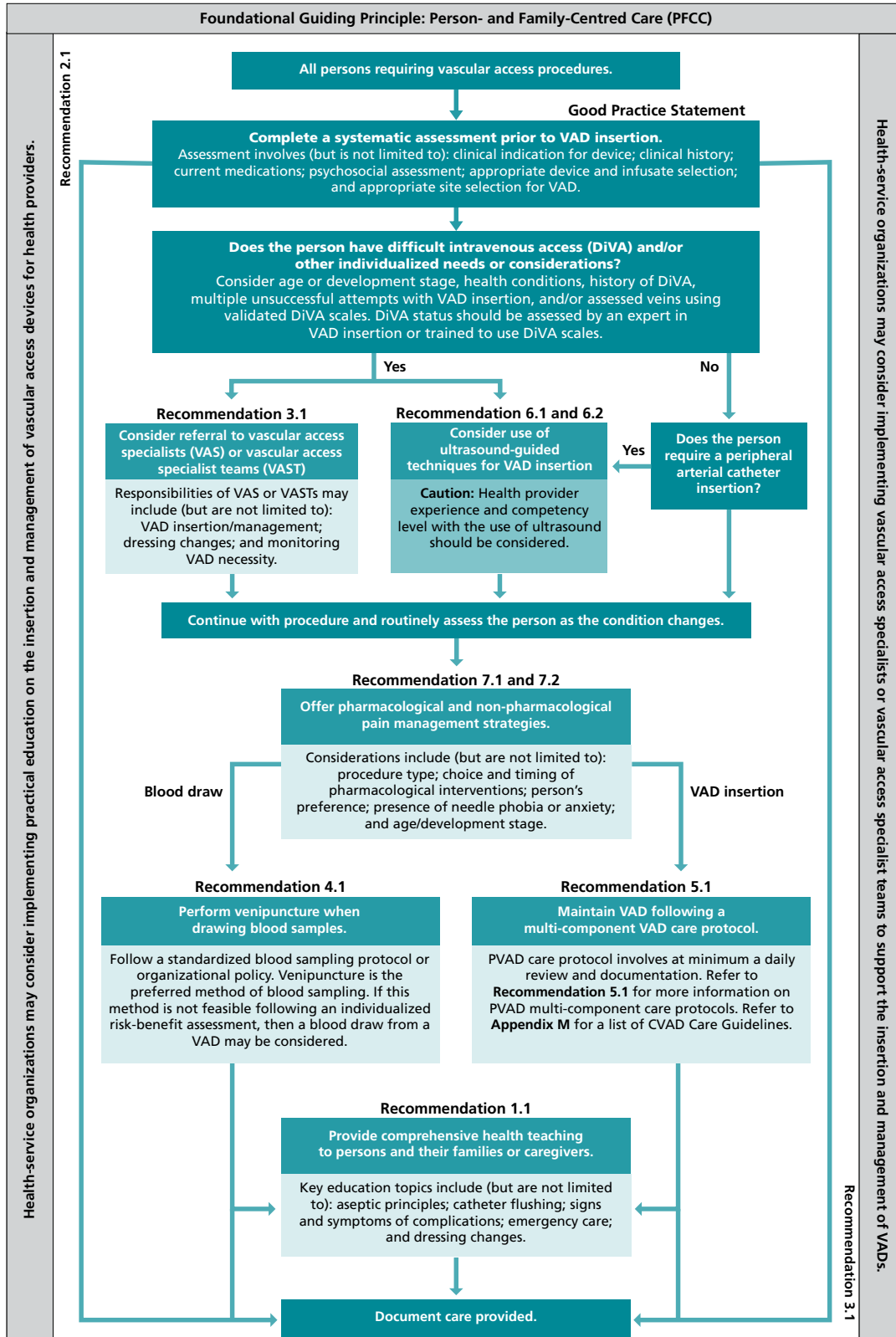
If using distraction techniques:

- Children older than 12 months have a greater ability to benefit from distraction techniques.
- Storybooks that include age-appropriate health education messages and pictures enable children to better understand their treatment regimen.
- Interactive or directed distraction may confer a larger benefit than non-directed distraction interventions. For example, passive distraction by watching a cartoon video may be less effective in reducing procedural pain than virtual reality motion videos, such as riding a roller coaster.
- Be cautious of mild to moderate nausea if using virtual reality as an intervention.
- If using breastfeeding, formula feeding or sucrose administration:
  - Be cautious of feeding-related adverse events (e.g., choking, gagging and vomiting).
- If using lidocaine-prilocaine cream:
  - Apply cream 30 to 60 minutes before the procedure.
  - Maximum application time of 4 hours in children, or a maximum of 1 hour in infants equal to or less than 3 months of age.
  - Side effects include vasoconstriction, methemoglobinemia and hypersensitivity.
  - Contraindications include: allergy, application on mucosae or an open wound, methemoglobinemia or G6PD.
- If using vapocoolant spray:
  - Spray 10 seconds or until blanching (use a maximum of twice at the same site).
  - Immediate onset.
  - Side effects include: burning sensation and frostbite.
  - Contraindications: less than 3 years of age, hypersensitivity, or application on mucosae or an open wound.

References: (139, 160-165, 177-190, 199-214, 261-265)

# Appendix P: Recommendation Workflow Algorithm

Figure 18: Recommendation Workflow Algorithm



APPENDICES

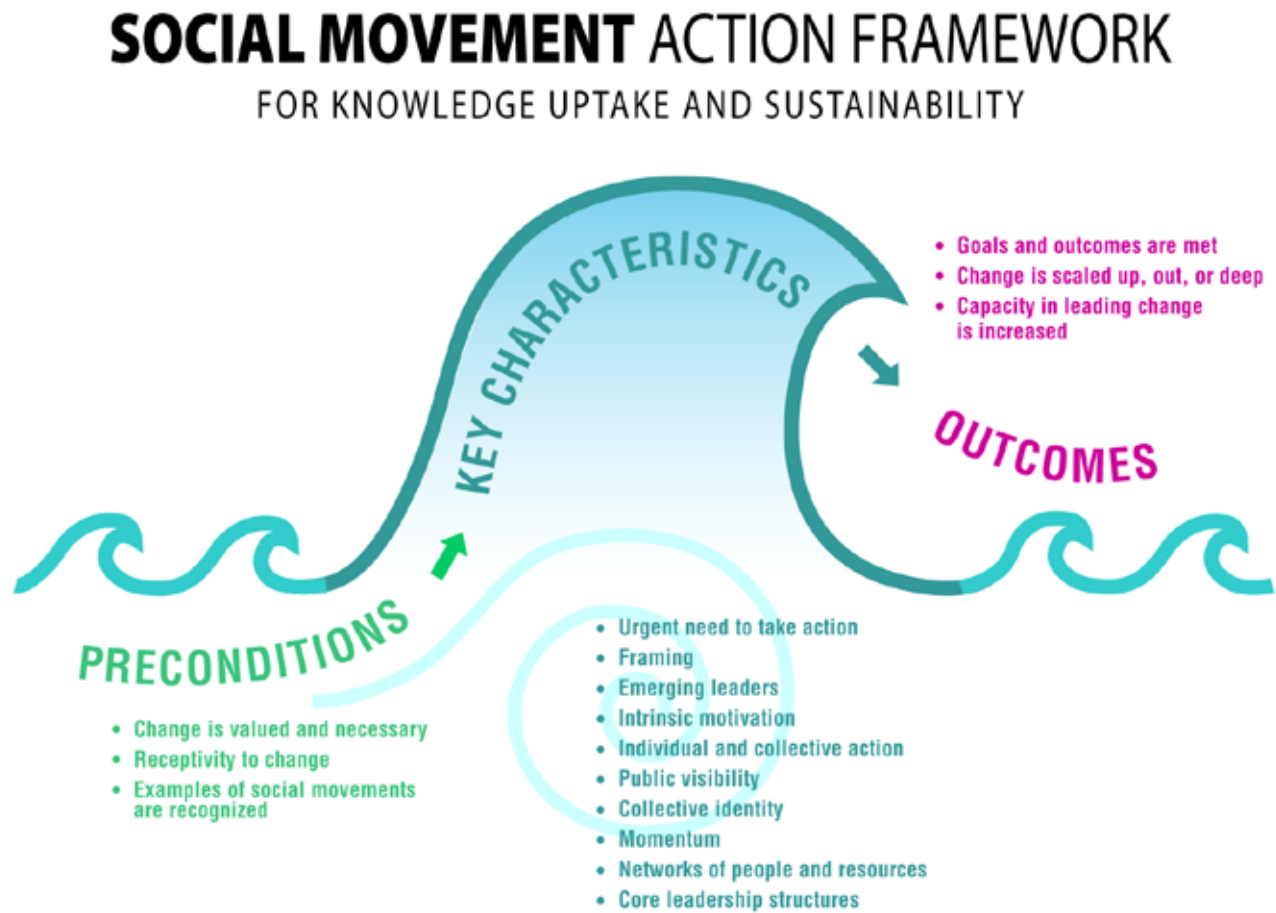
## Appendix Q: Description of the *Leading Change Toolkit*<sup>™</sup>

BPGs can only be successfully implemented and sustained if planning, resources, organizational and administrative supports are adequate and there is appropriate facilitation. Active engagement and involvement of formal and informal leaders (e.g., change agents, peer champions) are also essential. To encourage successful implementation and sustainability, an international expert panel of nurses, researchers, patient/person advocates, social movement activists and administrators has developed the *Leading Change Toolkit*<sup>™</sup> (2021) (10). The *toolkit* is based on available evidence, theoretical perspective and consensus. We recommend the *Leading Change Toolkit*<sup>™</sup> for guiding the implementation of any BPG in health-care or social service organizations.

The *Leading Change Toolkit*<sup>™</sup> includes two frameworks – the Social Movement Action (SMA) Framework (266) and the Knowledge-to-Action (KTA) Framework (267)– for change agents and change teams leading the implementation and sustainability of BPGs. Both frameworks outline the concept of implementation and its inter-related components. As such, either framework – the SMA or the KTA – can be used to guide change initiatives, including the implementation of BPGs. Using both frameworks serves to enhance and accelerate change (224).

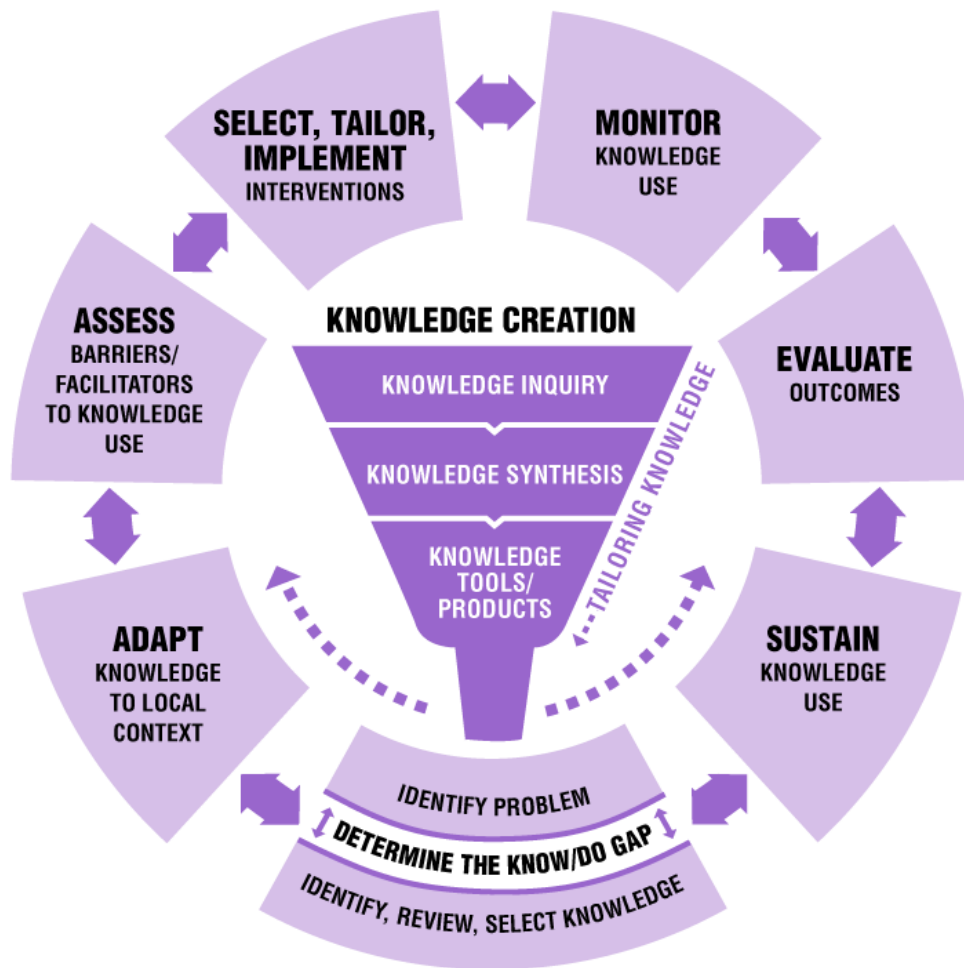
The SMA Framework includes elements of **social movements in a context of evidence uptake and sustainability**<sup>G</sup> that have demonstrated powerful impact and long-term effects. Based upon the results of a concept analysis, the framework includes 16 elements categorized as preconditions (i.e., what must be in place prior to the occurrence of the social movement), key characteristics (i.e., what must be present for the social movement to occur) and outcomes (i.e., what may happen as a result of the occurrence of the social movement) (224, 268). The three categories and elements of the SMA Framework are shown in **Figure 17**.

Figure 17: Social Movement Action Framework



The KTA Framework is a planned cyclical approach to change that integrates two related components: the knowledge creation and the action cycle. The knowledge creation process is what researchers and guideline developers use to identify critical evidence results to create a knowledge product, like an RNAO BPG. The action cycle is comprised of seven phases in which the knowledge created is implemented, evaluated and sustained (267). Many of the action cycle phases may occur or need to be considered simultaneously. The KTA Framework is depicted in **Figure 18** (269).

Figure 18: Knowledge-to-Action Framework



Implementing and sustaining BPGs to effect successful practice changes and positive health outcomes for patients/ persons and their families, providers, organizations and systems is a complex undertaking. The *Leading Change Toolkit™* is a foundational implementation resource for leading this process. It can be downloaded at <https://www.rnao.ca/leading-change-toolkit>.

# Endorsements



Canadian Vascular Access Association  
Association Canadienne d'Accès Vasculaire

753 Main Street East, P.O. Box 68030 Hamilton, Ontario L8M 3M7 Phone/Fax: 1-888-243-9307 [cvaa@cvaa.info](mailto:cvaa@cvaa.info)

May 6, 2021

Dr. Doris Grinspun, RN, MSN, PhD, LLD (hon), Dr (hc), FAAN, O.ONT.  
Chief Executive Officer  
Registered Nurses' Association of Ontario (RNAO)

Dear Dr. Grinspun,

The Canadian Vascular Access Association (CVAA) is delighted to endorse the Registered Nurses' Association of Ontario's (RNAO) best practice guideline *Vascular Access, Second Edition*. CVAA commends RNAO on the development of this very important work. The purpose of this BPG is to provide nurses (nurse practitioners, registered nurses, registered practical nurses and nursing students) and other members of the interprofessional team with evidence-based recommendations and resources related to the insertion, assessment, and maintenance of vascular access devices (VADs) in the infant (0–1 year), pediatric (1–18 years) and adult populations (18 years and older).

CVAA is the national resource for vascular access and infusion therapy specialists. We advocate for safe, quality care across the healthcare continuum by providing leadership and empowering/engaging its members and the broader healthcare community to promote education, partnerships, knowledge and research in vascular access and infusion therapy for optimal patient outcomes. CVAA is confident that RNAO's *A Vascular Access, Second Edition* BPG will enable nurses and the interprofessional team to provide collaborative, evidence-based and person-centred care to persons with a VAD. Collaboration among the interprofessional team, the person receiving care, and their families is therefore essential for achieving improved health outcomes.

On behalf of the Board of Directors, I want to congratulate RNAO on this excellent work!

Regards,

Melissa Stark, BA (Hons), MLIS, CAE  
Executive Director  
Canadian Vascular Access Association



Registered Nurses' Association of Ontario

1<sup>st</sup> June 2021

This guideline document provides a comprehensive review of existing evidence, national and international guidelines. It will provide a great resource for healthcare professionals involved with vascular access to guide local policy and education programmes. It is great to see patients identified as partners and experts in the assessment and decision making of their VAD. The IPS are pleased to endorse the RNAO's vascular access best practice guidelines and give permission for the use of the UK VHP framework to be included in these guidelines.

A handwritten signature in black ink, appearing to read 'J Wilson', written in a cursive style.

Professor Jennie Wilson  
President Infection Prevention Society

A handwritten signature in black ink, appearing to read 'Carole Hallam', written in a cursive style.

Carole Hallam  
IPS VHP Co-ordinator

Mailing Address - IPS, Blackburn House, Redhouse Road, Seafield, West Lothian, EH47 7AQ

Tel: + 44 (0)1506 811077 | Fax: +44 (0)1506 811477 | Email: [IPS@fitwise.co.uk](mailto:IPS@fitwise.co.uk) |

Website: [www.ips.uk.net](http://www.ips.uk.net) | Twitter: @IPS\_infection | Facebook: Infection Prevention Society

Patrons: Professor Didier Pittet | Dame Gillian Morgan

Registered Office - IPS, c/o Saffery Champness, 71 Queen Victoria Street, London, EC4V 4BE  
Company Registration No. 6273843, Charity Registration No. 1120063, VAT No. 925 4238 25



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**ia** BPG

INTERNATIONAL  
AFFAIRS & BEST PRACTICE  
GUIDELINES

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NURSING THROUGH  
KNOWLEDGE

## Best Practice Guideline

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