

The occasional peripherally inserted central catheter insertion updated

Ashley R.
Wallace, MD¹,
Lesley D. Smith, RN²,
Sarah M. Giles, MD^{2,3}

¹Internal Medicine
Residency Program,
Queen's University,
Kingston, Ontario,
Canada, ²Nurse Educator,
Department of Emergency
and Family Medicine,
Lake of the Woods District
Hospital, Kenora, Ontario,
Canada, ³Department of
Family Medicine, Faculty
of Medicine, NOSM
University, Thunder Bay,
Ontario, Canada

Correspondence to:
Sarah M. Giles,
sgiles@lwdh.on.ca

This article has been peer
reviewed.

INTRODUCTION

A peripherally inserted central catheter (PICC) is a thin flexible catheter that can be inserted through a peripheral vein in the upper arm and passed into the superior vena cava (SVC) providing central venous access.¹⁻³ PICCs can stay in place for several months and have a variety of clinical uses including administration of long-term intravenous (IV) antibiotics, parenteral nutrition and chemotherapy.^{1,4} While large healthcare institutions often have dedicated teams of registered nurses with specialty training to insert PICCs, many rural and remote communities do not have the luxury of a PICC team, and therefore, rural physicians may be required to insert them.

INDICATIONS

- IV therapies lasting >1 week, i.e. antibiotics
- Hyperosmolar solutions, i.e., dextrose 50% and total parenteral nutrition
- Administration of caustic agents, i.e., chemotherapy and vasoactive drugs
- Difficult peripheral venous access in patients requiring frequent

blood draws or IV administration and

- Difficult central catheter placement due to anomalous anatomy in the neck and/or thorax.^{1,4-6}

CONTRAINDICATIONS

There are no absolute contraindications, only relative contraindications:

- Inability to locate vein or small vein diameter (<3–4 mm)
- Oral therapy is an available, appropriate alternative to IV therapy
- Previous axillary lymph node dissection and/or mastectomy on the side of the insertion
- Persistent cough or vomiting (catheter migration risk)
- Site-specific skin infections, radiation, burns, oedema
- End-stage renal disease (veins preserved for fistula).⁴⁻⁶

ANATOMY

PICCs are inserted into the basilic, cephalic and brachial veins [Figure 1].^{4,7,8} The basilic vein is most commonly used due to its large diameter, superficial location and linear course to the SVC.^{4,7,9} The

Access this article online

Quick Response Code:



Website:
<https://journals.lww.com/cjrm>

DOI:
10.4103/cjrm.cjrm_17_23

Received: 28-03-2023 Revised: 12-04-2023 Accepted: 23-04-2023 Published: 20-08-2024

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Wallace AR, Smith LD, Giles SM. The occasional peripherally inserted central catheter insertion updated. Can J Rural Med 2024;29:125-31.

cephalic vein often enters the axillary vein at a sharp angle, has a non-linear path and is smaller than the basilic vein, making catheter insertion difficult.^{4,7,9} The paired brachial veins are the deepest of the 3 veins but, due to their proximity to nerves and the brachial artery, they are often avoided.^{4,7,9} The PICC tip should be placed at the distal third of the SVC at the cavoatrial junction.¹⁰ When determining which arm to use, consider the patient's preference, hand dominance, skin at the insertion site and vein size.⁷

Consider the best location for PICC insertion by using the Zone Insertion Method (ZIM) which has been shown to decrease catheter-related bloodstream infections, deep vein thrombosis and phlebitis.¹¹ With the ZIM, the upper arm is divided into three zones [Figure 2].¹¹ The red zone comprises the distal third of the upper arm. It is composed of smaller veins and is known for catheter instability due to its proximity to the elbow joint.¹¹ The yellow zone is the proximal third of the upper arm. While it may house a large diameter brachial vein, this moist area has a high number of hair follicles and can be unstable due to its proximity to the shoulder.¹¹ The green zone is located in the middle third of the upper arm. It is the ideal location for catheter insertion, specifically, the proximal half known as the ideal zone, due to its stability, lack of moisture and vein access.¹¹

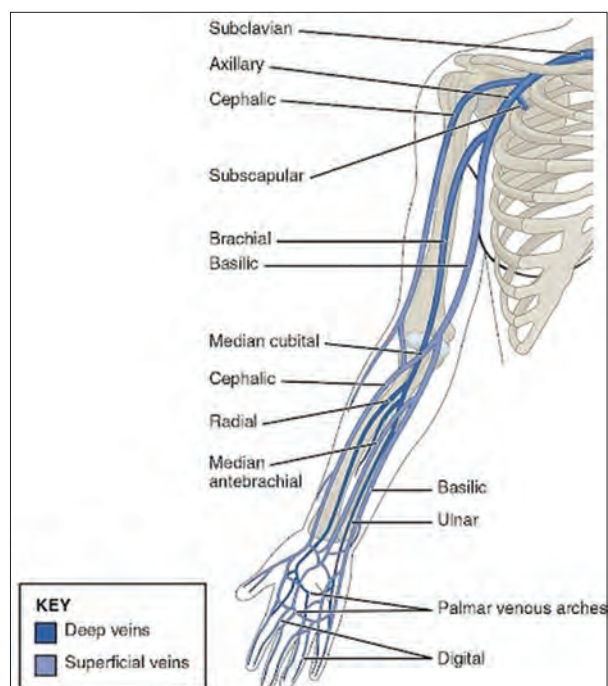


Figure 1: Upper arm venous anatomy.

ULTRASOUND GUIDANCE

Before the introduction of ultrasound (US) guidance, PICCs were commonly inserted into the antecubital fossa.¹² Today, with US assistance, deeper veins in the upper arm are the preferred site for PICC insertion as they have been shown to increase patient satisfaction and line longevity.^{11,13} US guidance helps the practitioner identify the most appropriate vein, assists with navigation of needle insertion, increases insertion success rates, reduces complications and results in fewer referrals to interventional radiology to complete the insertion under fluoroscopy.¹⁴⁻¹⁷

When using the US, hold the linear probe with the non-dominant hand. Placing the probe in a transverse view displays the vein as an anechoic circle with a thin vessel wall on the monitor, helping identify anatomical structures and guide needle insertion.¹⁸ Placing the probe parallel to the vein in a sagittal view displays the vein as a long tube, allowing the practitioner to follow the vein course and identify anatomical abnormalities.¹⁸ It is imperative that the practitioner is able to differentiate a vein from an artery in the US, as an accidental arterial dilation can be limb-threatening. Pulsatile feedback and compressibility are the essential vessel attributes to assist with identification.¹⁹ A suitable vein should be easily compressible and provide no pulsatile feedback. The inability to compress the vein completely or partially is concerning for a thrombus or other pathology, rendering the vein inappropriate for insertion.¹⁹ An artery will resist compression, provide pulsatile feedback and typically have a thicker, more hyperechoic

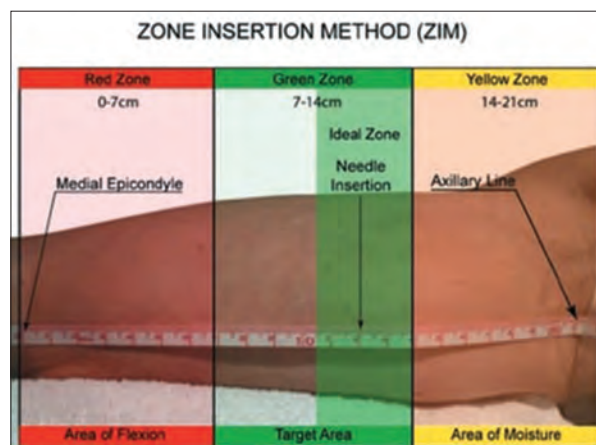


Figure 2: Identify the best location for peripherally inserted central catheter insertion using the zone insertion method.

wall than a vein.¹⁹ Using the US's colour Doppler mode can also help the practitioner distinguish arteries from veins by characterising the direction of blood flow.¹⁹

The cephalic vein is located superficially on the anterolateral side of the upper arm in the ZIM green zone and sits on top of the biceps brachii muscle [Figure 3].^{8,11} The brachial vein and basilic veins are located on the medial side of the upper arm in the ZIM green zone. Locate the brachial artery by applying pressure mid-shaft on the upper arm. The vessels on either side of the artery are the brachial veins. The basilic vein is located medially and superficial to the brachial veins. The median and ulnar nerve run between the basilic and brachial veins [Figure 4].^{8,9,11}

INTRAVASCULAR ELECTROCARDIOGRAPHY WAVEFORM GUIDANCE

If available, internal electrocardiography (ECG) monitoring can assist the practitioner to more accurately place the PICC at the cavoatrial junction by providing real-time PICC tip location.²⁰⁻²³ This method cannot be used on patients who have a pacemaker or do not have regular P-waves (i.e., atrial fibrillation) as it relies on changes in P-wave morphology.²⁰⁻²² Practitioners are generally eligible to receive training for intravascular ECG guidance from their PICC supplier.

EQUIPMENT

- Disposable waterproof paper soaker pad
- Tourniquet
- US machine
- Sterile and non-sterile gel
- Skin marker
- Chlorhexidine 2% with alcohol 70% (swabs)
- Lidocaine 1% without epinephrine
- Non-sterile tape measure
- Eye protection
- Face mask
- Surgical cap/hair bouffant
- Sterile gown and gloves
- Sterile drape and towels
- PICC caps
- PICC insertion kit-catheter, guidewire, echogenic needle, scalpel, gauze, sterile tape measure, obturator, peel-away introducer and 10 mL syringe

- Sterile saline flush
- Sterile US probe cover
- Securement device (StatLock™ PICC Stabilization Device or SecurAcath™)
- Central venous access device sterile transparent dressing.

PROCEDURE

1. Gather supplies
2. Have the patient lie supine with the chosen arm abducted and externally rotated out to 90°
3. Identify the vein(s) for PICC insertion:
 - a. Apply a tourniquet to the patient's arm near the axilla. Apply non-sterile US gel to the upper arm. Using the linear US probe, identify the suitable vein for PICC insertion. Preferably, identify two veins for insertion (basilic and brachial/cephalic vein)

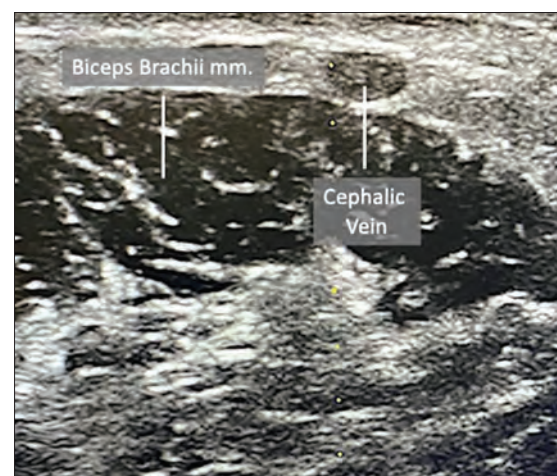


Figure 3: Transverse ultrasound view of the cephalic vein of the upper arm.

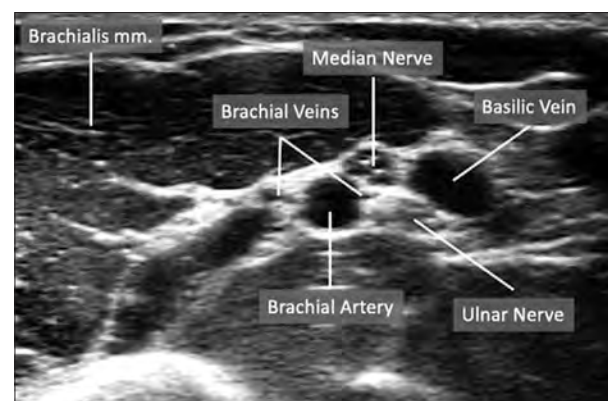


Figure 4: Transverse ultrasound view of the structures of the medial upper arm.

- b. With the skin marker create three markings at 1 cm increments on the chosen vein(s) - these will serve as possible site insertions
 - c. Release the tourniquet. To reduce the incidence of future venous thrombosis, measure the chosen vessel(s) without a tourniquet to ensure that the catheter will not occupy more than 45% of the vessel lumen
 - d. Wipe off the gel.
4. Cleanse the marked insertion site for 30 seconds using chlorhexidine swabs
5. Inject enough lidocaine to form a bleb (approximately 0.3 ml) at the marked insertion sites
6. Determine the desired internal length of the PICC using the non-sterile tape measure:
 - a. Ensure the patient's arm is at a 90° angle to the thorax
 - b. Measure the course from the most distal marked site on the arm to the joint space below the acromioclavicular joint, to the sternal notch and then to the sternal angle. If using the left arm, bypass the sternal notch when measuring.
7. Set up sterile field:
 - a. Wash hands
 - b. Don mask, eye protection, hair bouffant, sterile gown and sterile gloves
 - c. With the aid of an assistant, place the sterile fenestrated drape on the patient covering them head to toe, with the fenestration over the marked insertion site.
8. Using the sterile technique, open the PICC kit, sterile saline and PICC caps onto the sterile field
9. Prepare the PICC for insertion:
 - a. Using the scalpel, cut the PICC to the desired internal length measured in Step 6, leaving an extra 3–5 cm for the external securement device. The catheter has external markings spaced 1 cm apart. Confirm the length using the sterile tape measure
 - b. Insert the obturator into the catheter approximately 1 cm from the end so that the catheter has a soft tip
 - c. Pre-flush PICC lumen(s) and cap(s) with sterile saline.
10. Cleanse the insertion site again with chlorhexidine swabs for 30 seconds using a back-and-forth linear scrubbing motion
11. Have your assistant apply non-sterile gel onto the US probe. With their help, sheath the sterile US sleeve over the probe. To reduce air bubbles, apply a sterile elastic band around the end of the probe. Apply a small amount of sterile US gel on the outside of the probe cover
12. Have your assistant re-apply the tourniquet near the patient's axilla underneath the sterile field
13. Use the US to re-identify the vein at the marked site
14. Use the US to perform in-plane/out-of-plane dynamic needle guidance when inserting the echogenic needle into the vein¹⁹
 - a. Out-of-plane approach: This is the most common approach. Place the needle perpendicular to the transducer, which is in a transverse view. Use probe rocking, sliding, tilting, and/or compression to help localise the needle from the skin surface. Maintaining continuous visualisation of the needle, advance it until you visualise the hyperechoic dot (tip) inside the anechoic vessel [Figure 5]. You should now have blood return. Be vigilant not to mistake the needle shaft for the tip, which can result in overreaching of the needle and damage to surrounding structures
 - b. In-plane approach: Place the needle parallel to the transducer, which is in a sagittal view, allowing for visualisation of the entire needle shaft and tip during insertion. This view is often employed by the advanced practitioner as the inability



Figure 5: Successful insertion of an echogenic needle into the vein on transverse view.

- to see surrounding structures can result in incorrect vessel cannulation and/or damage to surrounding structures. Use probe rocking, sliding, tilting, and/or compression to help localise the needle from the skin surface. Maintaining continuous visualisation of the needle, advance it until you visualise the hyperechoic tip inside the vessel [Figure 6]. You should now have blood return
- c. Due to varied patient anatomy, there is no standard angle of needle insertion. However, insertion at 45° for veins <1 cm deep and 90° for veins >1 cm deep is a commonly used guide.
15. Advance guidewire through the access needle and gently lower your needle angle
 - a. The wire should advance smoothly. If you meet resistance do not advance it. Using the US, re-identify the vein using a sagittal view. The needle may be malpositioned and/or the vein is not fully cored, requiring manipulation. Re-adjust and attempt to advance the wire again.
 16. Slide the needle off the end of the guidewire leaving the guidewire in place. Have your assistant release the tourniquet
 17. Thread the introducer over the guidewire until it is fully in the vein
 - a. You may need to cut the skin (<0.5 cm) with the scalpel to make room for the introducer.
 18. Remove the guidewire. Remove the inner cannula of the introducer. Cover the open

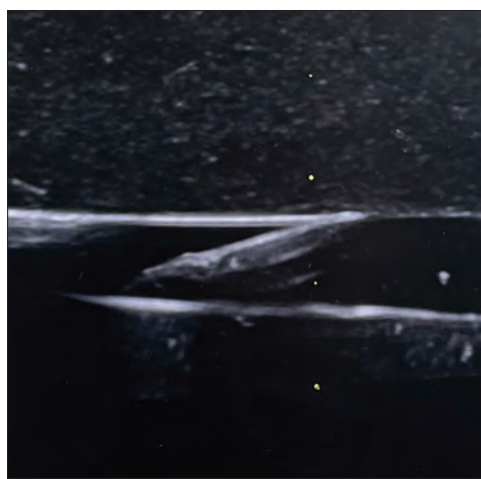


Figure 6: Successful insertion of an echogenic needle into the vein on sagittal view.

- introducer with a sterile finger to prevent air embolism
19. Feed prepped PICC line through the introducer at 1 cm/s to the desired length
 - a. To reduce catheterisation of the jugular vein, ask the patient to turn their head and tuck their chin under the sterile field towards their shoulder on the side of the PICC insertion arm. Have them take deep regular breaths, slowly advancing the catheter with each breath to draw the PICC into the SVC.
 20. Once the PICC is fully inserted, aspirate and flush each lumen with 10 mL of saline to ensure patency and blood return
 - a. If the patient can hear a whooshing in their ear, the PICC may be in the jugular vein (confirm with neck US). Reposition the catheter by pulling it back, leaving approximately 10 cm internally. Repeat step 19.
 21. Remove the tear-away introducer
 22. Place pre-flushed caps on the PICC. Aspirate and flush each lumen with 20 mL of normal saline
 23. Apply StatLock™ PICC Stabilization Device or SecurAcath™. Remove the obturator from the catheter
 24. Apply a 2 × 2 gauze at the PICC insertion site if oozing. Apply a transparent sterile dressing over the securement device (+/-gauze) and as much of the external catheter as possible
 25. Verify catheter placement with a chest X-ray. The catheter should be positioned at the cavoatrial junction-2 vertebral bodies below the carina²⁴
 - a. If the PICC needs to be advanced, you can advance the catheter within 2 h of insertion to maintain sterility. Outside of this window requires a new PICC
 - b. If the PICC needs to be withdrawn, this can be done at any time after insertion.
 26. Document date, time, placement verification, internal and external measurements, lot # and that the PICC is ready for use.

COMPLICATIONS

Complications can arise at any point from the time the PICC is inserted until it is removed. The complications include air embolism, bleeding from

the site, blood clots, cardiac arrhythmias (often caused by the PICC line in the right atrium), infection, migration or malposition of the catheter, nerve injury, phlebitis and infiltration.^{4,25} There is an increased risk of infection for every additional lumen attached to the catheter.²⁵ The most common organisms associated with hospital-acquired catheter-related bloodstream infections include coagulase-negative staphylococci (part of normal human skin flora), *Enterococcus* spp. and *Staphylococcus aureus*.²⁵

MAINTENANCE

Line care

- Flush each lumen with 20 mL saline using the push-pause method (short boluses of 1 mL) before and after each use and every 7 days if dormant²⁶
- Change caps every 7 days.²⁶

Dressing

- Change initial dressing within 24 h if gauze is used at the PICC site, otherwise change every 7 days.²⁶

Securement device

- If using a StatLock™ PICC Stabilization Device, change every 7 days²⁶
- If using a SecurAcath™ leave it in place until PICC removal.²⁶

PATIENT INSTRUCTIONS

To maintain PICC integrity and reduce complications, patients should avoid lifting objects over 4.5 kg, avoid repetitive activities such as shovelling and vacuuming, avoid tight clothing over the PICC site and keep the PICC dry (cover with a plastic bag when showering).^{26,27} Advise patients to contact their healthcare provider if they develop arm or neck swelling, the external catheter length changes or if they notice changes to the PICC site (erythema, tenderness, or swelling).^{26,27} Advise patients to attend the nearest emergency department if they develop shortness of breath, cough, chills, fever and/or neck or shoulder pain.^{26,27}

CONCLUSION

With the assistance of US guidance and internal ECG monitoring when available, the insertion of PICCs by physicians in rural and remote communities is an attainable endeavour.

Acknowledgement: We sincerely thank Lake of the Woods District Hospital's PICC-trained RN's Jennifer Young and Joelle Thomson for their review of the manuscript and clinical expertise.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

REFERENCES

1. Luckianow GM, Smith D, Bullen D, Kaplan LJ. Understanding percutaneous and subcutaneous central venous access devices. JAAPA 2016;29:33-6.
2. Bowe-Geddes L, Nichols H. An overview of peripherally inserted central catheters. Adv Pract Nurs eJournal 2005;5(3). Available from: <https://www.medscape.com/viewarticle/508939>. [Last accessed on 2023 Feb 26].
3. Simonov M, Pittiruti M, Rickard CM, Chopra V. Navigating venous access: A guide for hospitalists. J Hosp Med 2015;10:471-8.
4. Gonzalez R, Cassaro S. Percutaneous central catheter. In: StatPearls. Geneva, Switzerland: StatPearls Publishing; 2022. Available from: <https://www.ncbi.nlm.nih.gov.proxy.lib.nosm.ca/books/NBK459338/>. [Last accessed on 2023 Mar 20].
5. About Your Peripherally Inserted Central Catheter (PICC). Memorial Sloan Kettering Cancer Center. Available from: <https://www.mskcc.org/cancer-care/patient-education/about-your-peripherally-inserted-central-catheter-picc>. [Last accessed 2023 Feb 26].
6. Rejane Rabelo-Silva E, Lourenço SA, Maestri RN, Candido da Luz C, Carlos Pupin V, Bauer Cechinel R, et al. Patterns, appropriateness and outcomes of peripherally inserted central catheter use in Brazil: A multicentre study of 12 725 catheters. BMJ Qual Saf 2022;31:652-61.
7. Jeon EY, Cho YK, Yoon DY, Hwang JH. Which arm and vein are more appropriate for single-step, non-fluoroscopic, peripherally inserted central catheter insertion? J Vasc Access 2016;17:249-55.
8. OpenStax College. Thoracic Upper Limb Veins. Wikimedia Commons; 2013. Available from: https://commons.wikimedia.org/wiki/File:2134_Thoracic_Upper_Limb_Veins.jpg. [Last accessed on 2023 Feb 26].
9. Ultrasoundpaedia. Arm Veins Normal. Available from: <https://www.ultrasoundpaedia.com/arm-veins-normal/>. [Last accessed on 2023 Mar 04].
10. Hostetter R, Nakasawa N, Tompkins K, Hill B. Precision in central venous catheter tip placement: A review of the literature. JAVA 2010;15:112-3,115-6,118-9,121-2,124-5.
11. Dawson RB. PICC Zone Insertion Method™ (ZIM™): A systematic approach to determine the ideal insertion site for PICCs in the upper arm. JAVA 2011;16:156-65.
12. MacLellan K. The occasional peripherally inserted central catheter. CJRM 2000;5:82-4.
13. Simcock L. No going back: Advantages of ultrasound-guided upper arm PICC placement. JAVA 2008;13:191-7.
14. Robinson MK, Mogensen KM, Grudinskas GF, Kohler S, Jacobs DO. Improved care and reduced costs for patients requiring peripherally inserted central catheters: The role of bedside ultrasound and a dedicated team. JPEN J Parenter

- Enteral Nutr 2005;29:374-9.
15. Lamperti M, Bodenham AR, Pittiruti M, Blaivas M, Augoustides JG, Elbarbary M, *et al.* International evidence-based recommendations on ultrasound-guided vascular access. *Intensive Care Med* 2012;38:1105-17.
 16. Spencer TR, Pittiruti M. Rapid Central Vein Assessment (RaCeVA): A systematic, standardized approach for ultrasound assessment before central venous catheterization. *J Vasc Access* 2019;20:239-49.
 17. Kim SC, Heinze I, Schmiedel A, Baumgarten G, Knuefermann P, Hoeft A, *et al.* Ultrasound confirmation of central venous catheter position via a right supraclavicular fossa view using a microconvex probe: An observational pilot study. *Eur J Anaesthesiol* 2015;32:29-36.
 18. Moureau NL. Using ultrasound to guide PICC insertion. *Nursing* 2003;33:20.
 19. American Institute of Ultrasound in Medicine. AIUM Practice Guideline for the Use of Ultrasound to Guide Vascular Access Procedures; 2021. Available from: [https://www.aana.com/docs/default-source/practice-aana-com-web-documents-\(all\)/use-of-ultrasound-to-guide-vascular-access-procedures.pdf?sfvrsn=acfc48b1_2](https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/use-of-ultrasound-to-guide-vascular-access-procedures.pdf?sfvrsn=acfc48b1_2). [Last accessed on 2023 Apr 05].
 20. Krishnan AK, Menon P, Gireesh Kumar KP, Sreekrishnan TP, Garg M, Kumar SV. Electrocardiogram-guided technique: An alternative method for confirming central venous catheter tip placement. *J Emerg Trauma Shock* 2018;11:276-81.
 21. Pittiruti M, Scoppettuolo G, La Greca A, Emoli A, Brutti A, Migliorini I, *et al.* The EKG method for positioning the tips of PICCs: Results from two preliminary studies. *JAVA* 2008;13:179-86.
 22. Angiodynamics. C3 Wave. Available from: <https://www.angiodynamics.com/product/c3-wave/>. [Last accessed on 2023 Mar 10].
 23. Argoti-Velasco YL, Carrillo-Torres O, Sandoval-Mendoza RA, Paez-Amaya WG, Cahuantzi-Caballero XY. Proper electrocardiography-guided placement of a central venous catheter. *Rev Méd Hosp Gen México* 2018;81:262-7.
 24. Bell D. Superior Cavoatrial Junction. Available from: <https://www.radiopaedia.org/articles/superior-cavoatrial-junction-1>. [Last accessed on 2023 Mar 10, Last updated on 2021 Jun 11].
 25. Haddadin Y, Annamaraju P, Regunath H. Central line associated blood stream infections. NCBI Bookshelf Version. StatPearls Publishing; 2022. Available from: <https://www.ncbi-nlm-nih-gov.proxy.lib.nosm.ca/books/NBK430891/>. [Last accessed on 2023 Mar 05, Last updated on 2022 Nov 26].
 26. Canadian Vascular Access Association. National Guidelines; 2019. Available from: <https://cvaa.info/en/education/national-guidelines>. [Last accessed on 2023 Mar 01].
 27. Alberta Health Services. Peripherally Inserted Central Catheter (PICC): Care Instruction. Available from: <https://myhealth.alberta.ca/health/AfterCareInformation/pages/conditions.aspx?hwid=ug6122&>. [Last accessed on 2023 Mar 02].

CALL FOR PAPERS

The Canadian Journal of Rural Medicine (CJRM) is a quarterly peer-reviewed journal available in print form and open access online. It is the first rural medical journal in the world indexed in Index Medicus, as well as MEDLINE/PubMed databases.

The CJRM seeks to promote research into rural health issues and promote the health of rural and remote communities. It looks to support and inform rural practitioners, provide a forum for debate and discussion of rural medicine, provide practical clinical information to rural practitioners and influence rural health policy by publishing articles that inform decision-makers.

The material in the following categories will be considered for publication.

- Original articles: research studies, case reports and literature reviews of rural medicine (3500 words or less, not including references)
- Commentary: editorials, regional reviews and opinion pieces (1500 words or less)
- Clinical articles: practical articles relevant to rural practice. Illustrations and photos are encouraged (2000 words or less)
- Off Call articles: a grab-bag of material of general interest to rural doctors (e.g., travel, musings on rural living, essays) (1500 words or less).
- Cover: artwork with a rural theme

For more information, please visit www.srpc.ca/cjrm