Chapter 3. Midline Catheters

I. History (Chopra, Kaatz, Swaminathan, et al., 2019)

A. Midline catheters were first introduced in the 1950s for surgical patients and intended for subclavian access. In the 1980s, the split-away plastic introducer was developed to facilitate midline catheter placement.

B. Extensive use of midline catheters has been controversial, with little evidence-based research supporting risks and benefits.

C. Retrospective studies support midline catheters as a safe alternative to central devices, with complication rates comparable to those of other short- and long-term devices (Diaz, Gardeney, Pilar et al., 2019; Shanja-Grabarz, Santoriello, Ritter et al., 2020).

II. Device characteristics (Pathak, Gangina, Jairam, and Hinton, 2018) (see Figure 3-1)

A. Short-term peripheral device: Research suggests replacing short-term central catheters, when feasible, with midline catheters to reduce the incidence of central venous access device complications.

B. A meta-analysis comparing midline catheters (MCs) and peripheral inserted central catheters (PICCs) and the prevalence of catheter-related blood stream infections found no significant difference between MCs and PICCs. (Lu, Hou, Chen, et al., 2021).

C. Considered a peripheral line because the tip is not located in the central circulation. The midline catheter tip terminates in the axillary vein in the upper arm (Gorski, et al., 2021; Pathak, Gangina, Jairam, & Hinton, 2018).

III. Device features (Chopra, Kaatz, Swaminathan, et al., 2019; Pathak, Gangina, Jairam, & Hinton, 2018)
A. Catheter material: Silicone, polyurethane, and available with latex-free design

B. Available as radiopaque

C. Available in single and double lumens with valved or non-valved tips

D. Available in power-injectable design

E. Range from 2 Fr (23 gauge) to 6 Fr (18 gauge)

F. Range from 8–25 cm in length

G. Prime volume of 0.5–1.5 ml

H. Pediatrics: Available in 24- and 22-gauge sizes in 6–8 cm in length

IV. Device advantages and disadvantages (see Figure 3-2)

V. Patient selection criteria (Keleekai-Brapoh, Fernandes, Richards, & Gilpin, 2021; Lescinskas, Trautner, Saint, Colozzi, Evertsz, Chopra, & Krein, 2020;)

A. Patients with limited peripheral veins for venous access

B. Patients with need for venous access for a limited length of time (≤ 14 days but can be used for up to 4 weeks) (Keleekai-Brapoh, Fernandes, et al., 2021)

C. Patients or caregivers who are willing and able to follow instructions to properly care for a midline device in the home setting.

D. Patients receiving intravenous (IV) therapy that is appropriate for a midline catheter. Contraindicated for continuous irritant or vesicant therapy or solutions with extremes of pH or osmolality (Gorski et al., 2021; Keleekai-Brapoh, Fernandes, Richards, & Gilpin, 2021; Lescinskas, Trautner, Saint, Colozzi, Evertsz, Chopra, & Krein, 2020)

E. Patient preference for this type of device over more permanent devices

F. Patients with limited life expectancy
G. Patients scheduled to receive IV therapy for more than a week, a plan should be followed to maximize comfort and preserve the integrity of the veins.

H. Contraindicated in an extremity affected by lymph node dissection, or lymphedema. Contraindicated in patients with severe renal dysfunction who may require arteriovenous fistula formation. Avoid use in patients with a history of thrombosis or hypercoagulability.

VI. Insertion techniques (Gorski et al., 2021; Keleekai-Brapoh, Fernandes, et al., 2021; Mourneau & Carr, 2018)

A. Implement care bundles similar to those used with central venous access devices (CVADs) to reduce the chance of infection during insertion. (see Appendices 3 and 4).

B. Only health care professionals who have successfully completed a specialized training course should insert midline catheters. In the United States, state boards of nursing govern who may insert midlines, laws governing this practice vary state by state. Follow manufacturer recommendations and institution policy and procedures for insertion and ultrasound use. Training and competency records must be maintained.

C. Prior to insertion placement, ensure that contraindications do not exist, informed consent is obtained, preplacement assessment is completed, and laboratory values are verified, as needed (see Appendix 4). Explain the insertion procedure to the patient and answer any questions the patient or caregivers may have.

D. Perform a patient assessment and preparation before the procedure.

1. Consider any special needs regarding age, physical condition, or type of fluid being infused.
2. Older adult patients have fragile veins and less subcutaneous (SC) support tissue because of thinning of the skin. Excessive antiseptic can dry already compromised skin.

3. Use minimal tourniquet pressure over clothing or no tourniquet with older adults. Venous distention may take longer because of slower venous return.

4. Children’s veins are smaller in diameter and may be covered by a layer of SC fat, which can make veins difficult to access.

E. Implement patient centered interventions to reduce the pain and fear of insertion (see Appendix 7)

F. Vein selection: Insertion should be ultrasound guided by an experienced practitioner to ensure large caliber basilic, cephalic, or brachial veins are selected to avoid thrombosis. The tip is advanced no farther than the distal axillary vein in the upper arm. Pediatric insertion sites: Basilic and cephalic vein in the upper extremity (see Figure 2-3 in Chapter 2).

G. Insertion methods (Carr et al., 2020; Gorski et al., 2021; Gupta et al., 2021; Rachapalli et al., 2017).

1. Modified Seldinger Technique: Fine catheter over a micro puncture needle advanced into the vessel and the needle is then withdrawn.

2. Accelerated Seldinger technique (AST): Introducer needle inserted into vein with ‘fast-flash’ observed in transparent sheath and then the guidewire and dilator are removed.

3. Seldinger technique (ST): Introducer needle inserted into vein then a guidewire is inserted into the vein via the introducer needle.

H. Insertion procedure
1. The midline catheter should be placed per the manufacturer’s guidelines; the nurse inserting should be skilled regarding the specifics of the individual product.

2. Can use ultrasound guidance at the bedside to facilitate effective placement (Elli, S., Pittruti, M., Pigozzo, V. Cannizzo, L., Giannini, 2020; Gorski et al., 2021).

3. The catheter should be secured with a securement device, and a dressing applied over insertion site. X-ray verification of tip placement is not required.

4. Document insertion, including type of line used, catheter length, size and number of lumens, arm circumference and patient tolerance.

5. Assess dressing during initial 24 hours. Change the dressing immediately if the dressing is visibly soiled, loosened, or dislodged or if there is any moisture, drainage, blood, or compromised skin integrity beneath the dressing. If the site and dressing are intact, change transparent semipermeable dressings every 7 days and gauze dressings every 2 days and as needed using ANTT. (Gorski et al., 2021). (See Appendices 2, 3, 4, and 5).

VII. Unique maintenance and care (Centers for Disease Control, 2017; Gorski et al., 2021; O’Grady et al., 2011) (see Appendices 2, 4, 5, and 6): No definitive recommendations can be made regarding flushing and locking solution, volume, and frequency; or blood sampling technique.

A. Implement care bundles to reduce the chance of infection during daily maintenance (see Appendices 3 and 4).

B. Review utilization need and criteria for discontinuation and removal. Inspect the catheter insertion site and palpate for tenderness daily through the intact dressing. If signs of po-
tential infection are present, remove dressing and inspect the site visually. Minimize ma-
ipulation of the catheter to prevent mechanical phlebitis.

C. Replace midline catheters only when there is a specific indication (DeVries, Lee, & Hoffman, 2019; Gorski et al., 2021; Moureau & Carr, 2018; Pathak, 2018; Seo et al., 2020). Midline catheters are associated with lower rates of phlebitis than PIVs (O’Grady et al., 2011; Pathak et al., 2018).

D. Dressing changes: Change dressing if it becomes wet, soiled, or nonocclusive.
   1. Remove existing dressing and securement device while stabilizing midline cathe-
ter with nondominant hand.
   2. Change transparent semi-permeable dressing every 7 days and sterile, gauze
dressing every 2 days using ANTT (See Appendix 3).

E. Flushing and Locking: Flush catheter prior to and after use with preservative free 0.9% sodium chloride utilizing a minimal volume that is twice the catheter fill volume plus any add on devices, typically 5-10 mL. Catheters not in use should be flushed at least once every 24 hours. Due to insufficient evidence to recommend one locking agent over another, lock midlines with either preservative free 0.9% sodium chloride or heparin 10 units/mL (Gorski et al., 2021; Lee & Ramaswamy, 2018; Lopez-Briz et al., 2018; Pai et al., 2018; Zhong et al., 2017). Volume of lock should equal the internal catheter volume and add on devices plus 20%. Following completion of final flush, each VAD lumen should be locked to decrease the risk of intraluminal occlusion (Gorski et al., 2021). Consider manufacturer recommendations and institutional policies and procedures when selecting a locking agent.
   1. Use a 10 mL syringe or greater to assess patency or aspirate.
   2. Use pulsatile flushing technique.
F. Ensure all devices added onto catheter are Luer Lok designed, including needleless connectors, stopcocks, short extensions, filters, and multisite connectors.

1. Needleless connectors allow for IV administration without use of a needle, thereby reducing the risk of needle stick. These devices also ensure that the IV system remains closed. Change needleless connector every 96 hours or if removed, there is residual blood, prior to blood culturing and upon contamination (Gorski et al., 2021). Follow institutional policies and procedures and manufacturer’s instructions for clamp sequence.

2. Actively disinfect the needleless connector before accessing using vigorous mechanical friction for 5-15 seconds (depending on the product) with 70% isopropyl alcohol or alcoholic chlorohexidine and allowing it to air dry (Rickard et al., 2021; Slater et al., 2020; Slater, Cooke, Whitby, & Rickard, 2021). Passive disinfection caps or covers protect the connector from contamination between uses and do not negate the need for active disinfection. Follow individual manufacturer recommendations for use.

G. Blood specimens: No definitive recommendation can be made regarding specific volume of blood discard or flush. Prior to policy development, the dead space volume of the products used must be known. Using midline catheters continues to be unreliable as a blood sampling method (Gorski et al., 2021; Keleekai-Brapoh, Fernandes, Richards, & Gilpin, 2021).

1. In general, within certain limitations of infusate, midlines flushed with 0.9% sodium chloride are simple and safe for collecting blood samples for most laboratory tests (Keleekai-Brapoh, 2021).
H. Administration practices (Cullinane, 2019; Dix, 2021; Gorski et al., 2021)

1. IV push: Following the flushing procedure, cleanse the needleless connector, allow the solution to dry, attach the syringe containing the medication, infuse over a short period of time, and flush with 5–10 mL 0.9% sodium chloride following completion of infusion.

2. Intermittent infusions: Used for drugs that require dilution or slow administration. Following the flushing procedure, cleanse needleless connector, allow solution to dry, attach administration set of infusion to be administered, infuse over specified time, and flush with 5–10 mL 0.9% sodium chloride following completion of infusion.

3. Continuous infusions: Most common method of administering IV fluids, drugs, and peripheral nutrition. Following the flushing procedure, cleanse needleless connector, allow solution to dry, attach administration set of infusion to be administered, and infuse at specified rate.

4. If used for intermittent vesicant administration, exercise caution and carefully monitor, as a risk of extravasation exists, which may go undetected because the line may be misidentified as a central line. A midline catheter is a peripheral venous device.

VIII. Removal technique (Gorski et al., 2021; O’Grady et al., 2011; Webster et al., 2019) (See Appendix 16)

A. Prior to removal, verify scope of practice with the individual state board of nursing and institutional policies and procedures.
B. Indications: Remove the catheter when signs and symptoms of infection, infiltration, or phlebitis exist, or when no longer required for therapy.

C. Procedure

1. Verify order and indication for removal when IV therapy is discontinued.

2. Gather materials including gauze and occlusive dressing.

3. Explain procedure to the patient.

4. Perform hand hygiene and confirm patient identity using at least 2 patient identifiers.

5. Place the patient in a chair or bed to stabilize the extremity.

6. Inspect the general condition of the catheter pathway.

7. Discontinue all infusions into the device.

8. Perform hand hygiene and don non-sterile gloves; remove dressing; remove securement device; and observe site for any pain, edema, redness, or discharge.

9. Grasp device by the hub; and while stabilizing the skin and vein with sterile gauze in the nondominant hand, slowly and steadily pull until device is completely removed.

10. If removal of the catheter is indicated for infection, send the catheter tip for culture, if ordered.

11. Apply constant, firm pressure, using your fingers and gauze pad, to the exit site until bleeding stops (longer in patients with coagulopathies or thrombocytopenia and those on anticoagulants). Apply occlusive dressing; monitor as necessary. Remove dressing in 24 hours.

12. Instruct the patient or caregiver to report any discomfort or signs of bleeding, bruising, redness, swelling, or drainage.
13. Measure the catheter for appropriate length and catheter integrity. Inspect the device for defects, and report any to the manufacturer and regulatory agencies. Examine distal tip for signs of jagged, uneven edges suggestive of breakage.


IX. Complications (Berndt, & Steinheiser, 2019; Gorski et al., 2021; Odom et al., 2018; O’Grady et al., 2011) (See Chapter 9)

A. Insertion complications: Bleeding, vein injury, nerve injury, infiltration, phlebitis, or thrombosis

B. Vein injury: Pain, tenderness, edema, redness (vasodilation), thrombosis, sclerosis, or infiltration

C. Phlebitis: Most common complication, resulting in inflammation of the vein
   1. Etiology: Insufficient vessel size to accommodate the catheter and allow hemodilution, traumatic insertion, or mechanical or chemical irritation
   2. Risk factors
      a) Prolonged dwell time
      b) Mechanical irritation: Movement of the catheter, multiple cannulation attempts, catheter too large for vein, location of the catheter, or catheter material.
      c) Chemical irritation: Tonicity of fluid, number and dosage of medications, pH of the medications, or skin not allowed to dry after cleaning and prior to insertion.
      d) Increases with age of device or advanced age of the patient.

3. Signs and symptoms: Pain, erythema, streak formation, or palpable cord edema
Older adult patients may not experience pain from phlebitis or infiltration because of a decrease in sensory perception; monitoring for complications through observation is important.

Patients with communication limitations may not be able to verbalize pain.

4. Diagnostic tests: Not indicated

5. Management: Remove device, apply heat, and give analgesic, as needed.

D. Infiltration: Second most common complication

1. Etiology: Mechanical (e.g., injury during insertion, catheter malposition following insertion) or physiologic (e.g., preexisting or developing vein problems such as sclerosis). From the penetration of the catheter into or through the venous wall, infiltration leads to infusion of non-vesicant fluids or medications into the surrounding soft tissue.

2. Risk factors: Insertion into antecubital fossa, inadequate catheter securement, traumatic injury to vessel wall on insertion, older or younger age, dehydration, and obesity.

3. Assessment: Assess for infiltration by occluding the vessel at the tip of the catheter with digital pressure. If infusion continues, the fluid is likely infiltrating.

4. Prevention: Use of 10mL syringes or a syringe specifically designed to generate lower injection pressure, will prevent vein rupture or infiltration with flushing and aspiration or a vacuum on blood aspiration. When administering medications, use the syringe the medication is supplied in. The larger the syringe, the less pressure is generated when force is applied and the more force is required to create a vacuum. Less force is generated in either infusion or aspiration with larger syringes, thereby reducing or preventing complications.
5. Signs and symptoms: Leaking fluid around insertion site, cool and pale skin, possibly decreased infusion rate, edema at insertion site, tenderness, or skin tightness or discomfort

6. Diagnostic tests: Not indicated

7. Management:
   a) Stop the infusion
   b) Remove device
   c) Outline the infiltrated area with a skin marker.
   d) Apply heat or cold as indicated, and give analgesic as ordered, as needed.
   e) Estimate and document the amount infiltrated and photograph the site as applicable.

E. Infection

1. Etiology: Microorganisms enter by migration at insertion site, the interior of the catheter, contamination of connectors, excessive catheter manipulation, palpation of a proposed puncture site prior to insertion, or by contaminated infusion. The most common organism is *Staphylococcus aureus*.

2. Risk factors: Inadequate cleansing technique, contamination of insertion site or supplies, immunocompromised patient, older or younger age, comorbidities (e.g., diabetes, cancer, heart disease), or malnourishment


4. Signs and symptoms: Depend on type of infection
   a) Local: Erythema, purulent drainage, warmth, induration, or palpable cord
   b) Phlebitis: Pain, erythema, streak formation, palpable cord, or edema
c) Bloodstream: Pain, erythema, streak formation, palpable cord, edema, fever, or chills

5. Diagnostic tests: Wound and blood cultures, as ordered

6. Management: Remove device, apply heat, and administer antibiotics systemically, per culture result.

F. Extravasation: The leaking or escape of a vesicant infusate from the vessel into the surrounding tissue (Berndt, & Steinheiser, 2019; Kim et al., 2020; Odom et al., 2018; Coyle et al., 2014; Le & Patel, 2014; Molas-Ferrer et al., 2015; Polovich et al., 2014)

1. Etiology: Peripheral vein wall puncture; administration of a vesicant in a vein below a recent venipuncture; or inadequately secured IV catheter, which results in leaking of vesicant agent into surrounding tissue. Damage is dependent on specific factors.

a) Mechanism of action or properties of drug

b) Amount of drug extravasated

2. Risk factors: Inadequate insertion technique, small fragile veins, history of multiple venipunctures, limited extremity vein selection, decreased sensation or circulatory impairments, and patient with altered mental status

3. Prevention

a) Use appropriate procedures for catheter site selection and insertion. Use clinicians with the highest skill level in performing insertion in patients who have difficult venous access.

b) Avoid areas of flexion and impairment, previous IV sites, and insertion distal to previous venipuncture sites.
c) Use transparent dressing over catheter to visualize the site throughout vesicant administration and a catheter securement device.

d) Verify blood return prior to, during, and after administration. Do not give vesicant through midline without a blood return.

e) Instruct the patient to promptly report symptoms of extravasation.

4. Signs and symptoms: Burning or stinging at site; pain; erythema; difficulty infusing solution; leaking around the insertion site; absence of blood return during or following infusion, followed by blistering, tissue necrosis, and ulceration; decreased IV flow.

5. Diagnostic tests: Not indicated

6. Management

   a) Stop infusion and aspirate residual drug from the catheter using a 3 mL syringe.

   b) Remove midline catheter, unless antidote is given through existing midline; in that case, remove after administration of antidote.

   c) Assess site and estimate amount of vesicant extravasated.

   d) Notify the provider.

   e) Administer antidote or extravasation treatment, as indicated. Remove catheter. Do not apply pressure to area of extravasation.

   f) Apply cold or heat, as indicated.

   g) Determine the cause of extravasation, use a sterile skin marker to outline the affected area and photograph the site.

   h) Document patient assessment and nursing care, and provide patient education and follow-up.
X. Education and documentation (See Chapter 17) Training and competency records must be maintained.

XI. Practicum on midline insertion and care (see Appendix 16)

XIII. Infusion teams (see Appendix 15)

References


Infusion Nurses Society. Policies and Procedures for Infusion Therapy: Acute Care. 6th Ed. *Infusion Nurses Society; 2021*


Figure 3-1. Midline Venous Catheters

Note. Note: https://rebelem.com/midline-iv-catheters/

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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>• Considered peripheral lines; chest x-ray not required for tip placement verification</td>
<td>• May limit a patient’s overall mobility or comfort if necessary to insert into contralateral limb due to compromised alternate limb (e.g., lymphedema, axillary dissection)</td>
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<td>• Can be placed at the bedside by a specially trained nurse</td>
<td>• Unreliable ability to draw blood because of size and flexible nature</td>
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<td>• Dwell time of 1–4 weeks</td>
<td>• Contraindicated for continuous infusions of irritant or vesicant therapy or solutions with extremes of pH and osmolality.</td>
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<td>• Ideal for those with limited peripheral access but who require prolonged IV therapy</td>
<td>• Require a patient to have adequate peripheral veins</td>
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<td>• Available in single and double lumens, radiopaque, and power-injectable versions</td>
<td>• Require adequate patient support to maintain catheter in homecare setting</td>
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<tr>
<td>• Can be used for most IV solutions well tolerated by peripheral veins</td>
<td>• Not available as a triple lumen</td>
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<tr>
<td>• Do not require routine replacement (only replaced as is clinically indicated)</td>
<td>• Avoid in patients with a history of thrombosis, hypercoagulable, end stage renal disease/chronic kidney disease.</td>
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<tr>
<td>• Can be removed at the bedside</td>
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<td>• Relatively economical compared to more permanent lines</td>
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