Revisiting Peripheral Intravenous Cannula Insertion

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On completion of this article, you will be able to:

- Apply venous system anatomy and physiology to identify peripheral veins appropriate for peripheral intravenous insertion
- Review peripheral intravenous insertion technique
- Identify potential complications related to peripheral cannulation

NOTE: This article may be used for preparation for a facility based competency based programme; it is not intended to replace certification or competency assessments required in some facilities prior to independent practice.

Introduction

Mastering peripheral intravenous (IV) insertion is a challenging clinical skill. If you are like many nurses, you may approach some IV insertion with apprehension. Inserting a peripheral IV catheter tests your skills, takes time, and may be painful for your patient.

Your keys to successful IV insertion starts are assessing your patient's needs, distending the patient's veins, and selecting an appropriate site and device. This knowledge will assist the professional nurse to make some important decisions as to where to site the IV, what type of IV accessed is best used and care for the patient receiving intravenous therapy.

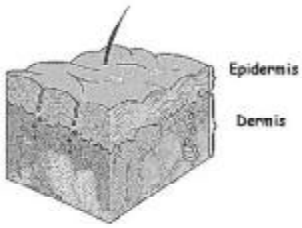
Peripheral intravenous insertion

The first barrier to successful peripheral intravenous insertion is the skin. The skin acts as a barrier between the outside environment and internal organs. The risk for infection increases whenever the skin is broken. An infusion access device perforates the skin, interrupts the integrity of the barrier and increases the risk for infection. Strict aseptic technique for peripheral intravenous insertion, care and maintenance of the site is important. The skin itself serves multiple functions including; mechanical barrier to micro-organisms, regulation of sensation and temperature, as well as aiding in balance of the body's fluid and electrolytes.

The skin consists of two main layers:

Epidermis: Composed of squamous cells that are less sensitive than underlying structures, the epidermis is the first line of defense against infection.

Figure 1. Two layers of the skin



Dermis: Much thicker than and directly below the epidermis, the dermis layer consists of blood vessels, hair follicles, sweat glands, sebaceous glands, collagen and nerves. The dermis reacts quickly to painful stimuli as well as to temperature changes and pressure sensation. The dermis is the most painful layer during a peripheral intravenous insertion for the patient.

"Mastering peripheral intravenous (IV) insertion is a challenging clinical skill"

The fascia lies below the dermis and epidermis and provides a covering for blood vessels. The vascular system is made up of blood vessels, which include arteries, arterioles, capillaries and veins. These vessels vary in size and function.

Arteries carry oxygenated blood away from the heart. The aorta is the largest artery, emanating from the heart. Arteries branch off the aorta. As they branch off the aorta, they decrease in size and become arterioles. Arterioles subdivide into capillaries.

Veins carry deoxygenated blood back to the heart. The deoxygenated venous blood is carried to the right atrium through the superior vena cava. The blood enters the right ventricle, exiting through the pulmonary artery to the lungs, where it is oxygenated and carried to the left atrium through the pulmonary veins.

The pulmonary artery carries deoxygenated blood and the pulmonary veins carry oxygenated blood; these are the only exceptions to the rule that an artery contains oxygenated and a vein deoxygenated blood.

Capillaries provide nutrients to the tissue and take wastes away. Capillaries connect with venules, which are the smallest veins. The venules connect with larger veins, eventually leading to the vena cava, which is the largest vein and connects directly to the heart.

"Good documentation is crucial in order to record your actions, the patient's reaction, and clinical outcomes"

The vein, the second barrier to successful peripheral intravenous insertion, consists of three layers:

- Tunica adventitia--outer coating, is made of connective tissue, which is the support.
- Tunica media--muscle and elastic tissues that causes contraction and dilation.
- Tunica intima--endothelial lining of the vein; a single layer of smooth flat cells lying along the length of the vein, allowing for smooth blood flow; disruption of this layer exposes the basement membrane and the clotting process is immediately begun.

Also in the tunica intima layer are the semi-lunar valves, which are directed toward the heart and prevent blood from flowing toward the extremities. Therefore, the direction of the IV needle should always be toward the heart with the flow of the circulation.

Systemic veins are in two sets: deep and superficial. Deep veins accompany the corresponding arteries and are called venae comites or venae comitantes. The superficial veins commence as a network of small veins just under the skin. Superficial veins in the hand and forearm are generally utilized for the initiation of IV therapy; however, upper arm veins can be and frequently are accessed as peripheral intravenous insertion sites.

Table 1. Peripheral Intravenous Sites

Vein Location Catheter type Comments
Digital Lateral and dorsal segments of fingers Use small flexible catheter • Difficult to access • Best to totally avoid
Metacarpal Dorsum of hand, proximal to knuckles Use flexible catheter or steel needle • Collapse sooner than central veins in cases of shock • Requires splinting in confused and disorientated patients • Increase risk of complications if solutions are hypertonic or irritant
Cephalic Continuation of metacarpal vein of thumb Parallels the radial bone Use flexible catheter • Continues into antecubital fossa • Forearm provides natural splinting
Median antebrachial Travels along ulnar side of inner forearm Use small, flexible catheter • Easily visualised; painful insertion
Basilic Travels along ulnar path on underside of fore arm Use flexible catheter • A large sized vein that can be used for larger infusion devices
Median Cubital, Cephalic and Basilic Veins Located inside the anticubital fossa • Very good for phlebotomy, NOT a preferable site for IV insertion

(Adapted from Williams and Hadaway 2003)

When selecting a vein to perform a peripheral intravenous insertion, consider the following factors:

- **Patient's age**--Infants have fewer accessible sites than older children and adults. Hands, feet and the antecubital region are generally the most accessible sites. The elderly may have fragile veins. The tourniquet may need to be loose or not used at all.
- **Patient's preference**--Use the non-dominant side whenever possible. Advise the patient of the optimal sites and ask which site they prefer.
- **Patient's activity**-- Avoid lower extremities. Consider allowing hands to be free, particularly if the patient uses a walker, crutches or a wheel chair.
- **Previous medical history**--Avoid the affected side, i.e., paralysis, mastectomy, burns, scars. Do not place in close proximity to an infected wound
- **Presence of a shunt or graft**--NEVER use the side

that has a shunt or graft used for haemodialysis.

- **Time of therapy**-When prolonged therapy is required, the distal portion of the vein should initially be used with subsequent re-sites above. If possible, alternate arms and remember to begin distally and work proximally.
- **Type of solution**--Hypertonic solutions and various medications can be chemically irritating to the vein. Consult with the pharmacist regarding properties of the medication or solution. If the solution is a known irritant, select a large vein in the lower forearm. Do not administer continuous vesicant chemotherapy or parenteral nutrition via a peripheral IV.
- **Condition of vein**-Previously used veins can become sensitive. If the vein has been recently used for an infusion, is bruised, red, swollen, sore, or is near a previously affected site; Do Not Use The Vein.
- **Cannula size**--The cannula should be as small as possible and yet be able to effectively deliver the therapy. (see table 2)

Table 2. Catheter Size

26 gauge	0.5mm	• Neonatal
24 gauge	0.6mm	• Neonatal - including blood products • Elderly, fragile veins
22 gauge	0.8mm	• **Paediatric standard** • Neonatal blood components • Single dose
20 gauge	1mm	• **Adult standard** Paediatric blood components • Minor surgery
18 gauge	1.2mm	• Adult blood components • Major surgery
14 and 16 gauge	1.7 to 2mm	• Major trauma • Cardiac arrest • Vascular/ Cardiac Surgery

Note that the colours of the cannula have not been mentioned in Table 2. Although there is an International Organisation for Standardization (ISO) proposal for standardisation of colours for peripheral cannula, different manufacturing companies may alter their colour codes, so know the size rather than the colour a particular brand comes in.

Potential complications of peripheral intravenous access

The possibility that a patient may develop a complication from having a peripheral intravenous access insitu increases proportionally with the time the access is required. Nurses must be aware of these complications (see table 3) to ensure prevention and early detection if a complication arises.

Table 3. Reviewing Peripheral Line Complications

Symptom
Common Causes
Intervention:

Infiltration: the escape of nonvesicant solutions into the extravascular tissue.

- Coolness of skin around site
- Skin taut
- Slowing of infusion rate
- Oedema
- Sited over joint
- Insecurely taped

Discontinue IV, elevate the extremity based on patient comfort, and apply cold compresses.
Notify physician immediately if infiltrate toxic

Air Embolism: obstruction of blood vessel by air

- Pallor, cyanosis
- Dyspnea
- Cough
- Tachycardia

- Syncope
- Shock
- Cracked tubing
- Air in administration set
- Loose connections
- Place patient on left side with head and shoulder lowered
- Tighten all connections
- Administer oxygen
- Notify physician immediately

Phlebitis: inflammation of the vein, caused by mechanical and/or chemical injury.

- Site is red, warm and sore
- Possible red streak along vein
- Immune response
- Injury
- Mechanical Irritation
- Chemical Irritation
- Infection

Discontinue IV, apply warm, then cool compresses.
Draw blood cultures if ordered

Thrombophlebitis: inflammation caused by clot formation.

- Site is sore, hard, cordlike and warm; red line above site, oedema, and sluggish or stopped IV
- Malaise and or fever

Cannula not in use or flushed adequately
Discontinue IV, apply warm compresses.
Avoid massaging or palpating the area to prevent dislodgement of any embolus

Catheter embolism: free floating or dislodged fragment of catheter in the circulatory system.

Discomfort along the vein, decrease in blood pressure, weak rapid pulse, cyanosis and unconsciousness
Catheter is withdrawn before needle, or when the needle is rethreaded into the catheter.
Discontinue IV, apply a tourniquet above the site, take appropriate emergency measures, inspect catheter for rough edges that might indicate loss of fragments.
Obtain order for X-ray to determine if fragments are present.

Haematoma: blood outside the vessel into the extravascular system.

Discoloration of tissue at IV site, oedema
Cannula puncturing other vein wall
Discontinue IV, apply pressure for approximately 5 minutes.

Infection: caused by pathogenic organisms, may be local or systemic.

Site red and sore
Oedema and/or drainage may be present

- Use of unsterile equipment
- Non-aseptic procedures
- Inadequate skin preparation

Discontinue IV, culture any drainage, cleanse site with Povidone iodine and apply dressing. Culture tip of catheter. Observe site; observe patient for signs and symptoms of systemic infection.

(Adapted from Williams and Hadaway 2003)

In order to prevent infection and complications it is important to care for the cannula and the site:

Handle with care: don't contaminate equipment by poor handling techniques

Inspect the site: the insertion site should be checked regularly for any signs of infection or complications
Change the dressing: if a dressing is wet or soiled, it should be changed

Securing the cannula: fixing the cannula securely using a non-occlusive dressing

Signs of venous reactions: redness, tenderness or swelling around the site indicates a localised reaction that requires the cannula to be re-sited

Change the cannula: change the cannula every 48-72hrs (according to your facility policy). Don't forget the lines, every 24hrs for an intermittent infusion and every 48hrs for continuous therapy.

Check connections: all connections should be tight

Flush: Use an appropriate solution such as normal saline 0.9% (in accordance with your facility policy), to regularly flush a cannula

Documenting the Procedure

Good documentation is crucial in order to record your actions, the patient's reaction, and clinical outcomes. According to Millam and Hadaway (2003:10) good documentation includes the following:

- Type, length, and gauge size of the catheter inserted
- Date and time of the procedure
- Number of attempts made
- Exact location of each attempt and the final successful site
- Type of dressing applied
- Patient's tolerance of the procedure, using actual quotes of comments from the patient
- Condition of the site
- Specific types of fluids and medications infused through the catheter, including the infusion rate, dose, and diluent for all medication and any additives to the primary fluid.

Finally

Like any clinical nursing skill, mastering peripheral intravenous (IV) insertion tests your skills, takes time, and may be painful for your patient. Assessing your patient's needs, distending the patient's veins, and selecting an appropriate site and device are the first keys to a successful procedure.

References

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Williams, Penny and. Hadaway, Lynn C. 2003. *Essentials of IV Therapy: MODULE 1: Peripheral IV Catheter Insertion, Care and Maintenance.* Baxter Healthcare Corporation. Accessed on the World Wide Web on June 26th via http://www.baxter.com/doctors/iv_therapies/education/iv_therapy_ce/basic_one/basicone.html

Useful Website: Intravenous Nurses Society on http://www.ins1.org

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Maybe it's a DVT?

Deep Vein Thrombosis (DVT) affects millions of people every year. The development of a DVT in the leg isn't necessarily life threatening, but if the clot moves to the lungs, it can cause a pulmonary embolus. Pulmonary Emboli may be so mild even the patient doesn't even notice any symptoms, or severe enough for them to have a cardiac arrest.

DVT's rarely occur in the absence of certain risk factors. Knowledge of them will assist your skills in identify patients who may be at risk and be focused when performing a nursing physical examination. Can you recognise them?

The risk factors for DVT are known as the 'Virchow's triad':

1. Changes in blood coagulability

- Traumatic, burn, and surgical injuries, because of tissue damage, release of tissue factors, and activation of the extrinsic pathway of coagulation
- Cancer, because fibrinolytic activity may be reduced and because malignant tissue may promote coagulation

2. Changes in the vessel wall

- Atherosclerotic changes leading to rupture of plaque on the vessel wall exposes thrombogenic material, activating platelets and the coagulation cascade.

3. Changes in blood flow

- Stasis related to prolonged immobility (such as long flight), paralysis, varicose veins, or heart failure
- Increased blood viscosity

DVTs certainly cause vein inflammation, but more than 50% of DVTs don't cause symptoms initially as the thrombus doesn't completely occlude the vein and the patient has adequate collateral circulation. The first hint of trouble for some patients is the sudden onset of unexplained tachycardia, tachypnea, anxiety, and hypoxia, indicating a Pulmonary Embolus.

One of the most reliable physical findings in DVT is unilateral oedema of the affected leg. Measure both legs at midthigh and midcalf and compare the circumferences to each other and to earlier measurements. An initial finding of a difference in circumference between the left and right leg may not be significant, but any increase in circumference should be reported and documented. Other common physical signs of DVT include warmth and erythema of the affected extremity.

The patient may experience pain or tenderness in the calf in response to movement or pressure or when they stand. Homans' sign-increased resistance or pain that occurs in the calf on forced dorsiflexion of the foot-has been historically considered an indication of DVT, but it's an unreliable diagnostic sign as calf pain from muscular injury will also elicit a Homans' sign. Because many DVTs are difficult to detect clinically, diagnostic studies may be indicated. One of the simplest is duplex venous ultrasonography or 'Doppler'; otherwise, a venogram or possibly a Magnetic Resonance Image (MRI) may have to be ordered.

Day, M.W. 2003 *Recognizing and managing deep vein thrombosis*. Nursing2003, May. Vol 33 No 5, pages 36 - 41

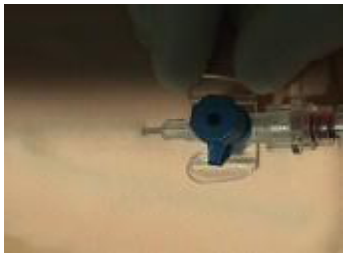
Photographic Procedure for Peripheral Intravenous Insertion

1. Wash hands thoroughly with antiseptic soap.
2. Wear protective gloves.
3. Select appropriate cannulation site (see table 1).

4. Create an adequate venous filling by:
   - applying tourniquet
   - tap vein lightly
   - Instruct patient to clench or pump fest
   - Allow arm to hang over bedside

5. Clean the puncture site and the surrounding thoroughly with iodine or an alcohol and allow to dry.

6. Stabilise skin and vein adequately and insert cannula (see table 2) into the vein at a low angle

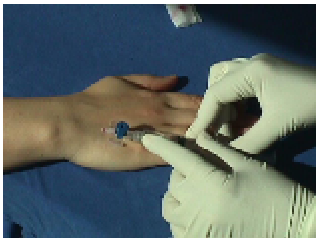


7. Check for blood return in the flash back chamber.

8. Adjust cannula angle and advance cannula and stylet a few millimetres further into the vein.
9. Withdraw the needle partially (about 5 mm.) to avoid exit through the posterior vein wall. Advance the catheter off the needle into the vein. Release the tourniquet.

The needle must never be reinserted while the catheter is in the vein. This may sever the catheter.

10. Remove and discard stylet into sharp container



11. Check patency of cannula

12. Secure the cannula and apply dressing:
    - Tape the wings securely to the patient's skin
    - Protect the puncture site, use either sterile gauze or sterile non-occlusive dressing as shown here.
13. Record date and time of insertion, and the name of the operator.
14. Document procedure in accordance with hospital facility policy

15. Clear area and wash hands.
16. Educate patient and significant others about complications and leave comfortable.