Course Prerequisites:

- There are no course prerequisites.

Course Goals and Objectives:

Goal

This course will cover safe techniques and principles for assessment and selection of veins suitable for venipuncture.

Course Objectives

At the completion of this module, the learner will be able to:

1. Describe the anatomical position of veins, arteries and nerves in the cubital fossa.
2. Locate and name three veins in the cubital fossa that are commonly used for venipuncture and venous access.
3. List factors to consider in venous site selection.
4. Describe situations that are causes for concern and procedures to follow when encountering each situation.
5. Identify venous access danger areas in the cubital fossa.
6. Describe the risk associated with each of the danger areas in the cubital fossa.
7. Describe the differences between arteries and veins.
1 ANATOMY OF THE ARM AND VEIN LOCATION

This module introduces participants to veins, arteries and nerves found in the cubital fossa, lower forearm and hand. The anatomical structure of veins is discussed in relation to nerves and arteries that may be inadvertently punctured or otherwise damaged during blood collection.

Module 1 Objectives

At the end of this module, the learner will be able to:

1. Describe the anatomical position of veins, arteries and nerves in the cubital fossa.
2. Locate and name three veins in the cubital fossa that are commonly used for venipuncture and venous access.
3. List factors to consider in venous site selection.
4. Describe situations that are causes for concern and procedures to follow when encountering each situation.
5. Identify venous access danger areas in the cubital fossa.
6. Describe the risk associated with each of the danger areas in the cubital fossa.
7. Describe the differences between arteries and veins.

1.1 Venous Access Introduction

Blood collection and intravenous catheter insertion involve venous access: venipuncture for the purposes of blood collection is usually performed on superficial veins in the cubital fossa region. Whereas, when catheter insertion is for infusion purposes it is more often performed on superficial in the lower forearm and hand.

The cubital (forearm/elbow) fossa (shallow depression) may also be referred to as the antecubital fossa. The cubital fossa is the triangular-shaped depression in the anterior region of the upper forearm, just below the elbow crease. The three veins most commonly recommended for venipuncture lie in the cubital fossa:

1. Median cubital vein
2. Cephalic vein
3. Basilic vein

Veins on the back of the hand and in the lower arm are often used for blood collection only when there are no accessible veins in the cubital fossa. In special circumstances when there are no accessible veins in the arm, it may be necessary to perform venipuncture on superficial veins of the foot or ankle for blood collection. However, due to the increased risk of infection and clot formation associated with venous access of foot veins, venipuncture at these locations is a last resort and is only appropriate following a physician’s permission.
Catheter insertion for the purposes of intravenous (IV) infusion, however, is more often performed on superficial veins in the lower forearm, and on the backs of the wrist or hand. Other than in infants, the foot is not acceptable for catheter insertion.

Nerves and arteries lie in close proximity to veins in the cubital fossa, forearm and wrist. Knowledge of the location of these structures relative to commonly accessed veins is essential to protect the patient from nerve injury and subcutaneous bleeding.

1.2 Superficial arteries of the arm

Blood is supplied to the arm by the brachial artery, which originates from the axillary artery in the neck. The brachial artery passes from the shoulder on the medial side of the arm to the inner aspect of the elbow. At the bend in the elbow, the brachial artery sinks deeply into the cubital fossa.

Just below the bend in the elbow the brachial artery branches forming the radial artery, which supplies the lateral or thumb-side of the forearm, and the ulnar artery, which supplies the medial or baby-finger side of the forearm.

Arteries need more protection than veins and are usually located deep in the tissues protected by muscle to reduce the chance of injury and haemorrhage. Small arterial branches extend from the deeper arteries to supply surface tissue.

However, in certain areas such as the arm, arteries may be found relatively close to the surface: the brachial artery on the medial (baby-finger side) of the inner arm, and the ulnar (baby-finger side) and radial (thumb-side) arteries on the inner wrist, which supply the hand. At the elbow bend, a fibrous layer of tissue, known as the bicipital aponeurosis or bicipital fascia lies on top of the artery, separating it from the median cubital vein, and protecting it against inadvertent puncture during blood collection. The bicipital fascia, is an extension of the biceps tendon, passes medially across the elbow aponeurosis and was named the “thank God fascia” or “grace a Dieu fascia” by barber-surgeons who practiced bloodletting techniques in the 17th and 18th centuries.

The median nerve lies close to the brachial artery on its medial side. The biceps tendon and radial artery lie laterally to the brachial artery – the brachioradialis muscle conceals the radial artery (the most superficial muscle on the radial or thumb-side of the forearm).

1.2.1 Blood return

Blood is returned from the arm through two main veins – the cephalic and basilic veins. In 70-80% of individuals, a connecting vein – the median cubital – connects the cephalic vein to the basilic vein just below the cubital fossa.

Veins of the arm receive blood from the capillaries supplying the tissues of the hand and arm, returning it to the heart from where it enters the pulmonary circulation for a fresh supply of oxygen prior to being pumped back to the tissues through the arteries.
There are generally two sets of veins in the limbs – deep and superficial. The deep veins follow the arteries and often travel in pairs (venae comitantes). They are usually enclosed in a sheath with the arteries.

The superficial veins of the arm are drained by the basilic and cephalic veins that travel in the fibrous membrane that lies below the surface of the skin (superficial fascia).

1.3 Arteries and Veins

Arteries pulsate in response to pressure on the vessels walls caused by the contractions of the right ventricle. Blood passes through the larger arteries at a flow rate of approximately 30 cm/sec. By the time blood reaches the vast network of capillaries, flow-rate slows to approximately 0.04 – 0.1 cm/sec. Blood return to the heart through veins is controlled by muscular and skeletal movement – flow-rate in the veins is approximately 8.0 cm/sec. To counteract the effect of gravity on the relatively slow flow-rate through veins, many veins are equipped with valves. This is to prevent back flow of blood in veins, and keep blood moving in a forward direction back toward the heart.

Varicose veins are caused by inadequacies in the action of venous valves resulting in prolonged and excessive pressure over a long period of time. Valve inadequacy leads to stasis (slowing) of blood flow, back-flow and distension of the veins. Varicose veins most commonly occur in the extremities where gravitational forces are greatest for example, the legs. Venous valves are discussed further under Tunica intima.

A single artery supplies circulation to a particular area. If the artery becomes damaged, impaired circulation occurs, and may lead to tissue death (necrosis) or gangrene. In contrast, generally many veins supply an area, so that if one is injured, circulation will be maintained.
1.4 Structure of arteries and veins

Arteries and veins are similar in structure in that both are composed of three layers of tissue:

- Tunica intima (inner layer)
- Tunica media (middle layer)
- Tunica adventitia (outer layer)

The tunica intima (inner layer):

- Is an inner elastic endothelial lining
- Forms the valves in veins
- Is identical in arteries and veins, except that valves are absent in arteries
- Consists of a smooth layer of flat cells
- Has a smooth surface that allows cells and platelets to flow through with little resistance
- Is susceptible to roughening during entry or removal of needle, which may encourage thrombosis as cells and platelets adhere to vessel wall

Veins may contain half-moon shaped folds of the endothelium known as valves. Valves are found in the larger veins of the extremities and are usually found in pairs. They function to keep blood moving in one direction, toward the heart, when muscular and skeletal pressure is uneven. Valves are located at points of branching and may cause a slight bulge in the vein. The bulge may be accentuated in old age or in vascular dysfunctions and may appear knotty in large veins that are engorged with clotted blood.

Valves may interfere with blood collection. If blood collection is attempted in the area where a valve is located, the valve may compress and close the lumen of vein when the tourniquet is applied and suction is applied (either by syringe or evacuated/vacuum pressure tube). Valves are absent in many of the small veins.

The tunica media (middle layer) is:

- Composed of muscular and elastic tissue
- The location of nerve fibres, vasoconstrictors and vasodilators
- Stronger and stiffer in arteries than veins (because of this, veins tend to collapse or distend in response to pressure changes; whereas, arteries do not collapse

The tunica adventitia (outer layer) is:

- Is areolar connective tissue (tissue that supports and connects other tissues)
- Surrounds and supports the vessel
- Is thicker in arteries than veins, because of greater blood pressure in the arteries
Why is routine blood collection performed on veins rather than arteries?

Arteries are:

- Located deeper in the body to protect against haemorrhage.
- Muscular, to withstand heavy pumping and therefore more difficult to puncture.
- Supplied with abundant nerve fibres; therefore, arterial puncture tends to be more painful.
- At risk of extended bleeding after puncture because blood flowing through is under great pressure.

Veins are:

- Generally located closer to the surface in the extremities and are easier to locate
- Easier to puncture than arteries because vein layers contain less tissue
- Supplied with fewer nerve fibres than arteries; therefore venipuncture is less painful.
- Under less pressure so it is easier to stop bleeding after puncture
1.4.1 How will I know if I puncture an artery by mistake?

- Generally, arteries are located deep in the body to protect against injury and possible haemorrhage. However, in the extremities, arteries such as the brachial artery, the radial and the ulnar artery are located superficially and may be inadvertently punctured.
- Arteries transport oxygen-rich blood from heart and lungs to the tissues through capillaries – arterial blood is bright cherry red in color.
- Veins receive waste-rich blood from capillaries in the tissues to transport it back to the heart where it is pumped to the lungs to exchange carbon dioxide for oxygen – venous blood is deep purplish in color.
- Because blood flowing through arteries is under considerable pressure due to the force exerted by the heart, arterial blood will spurt into the blood collection tube in time with the contractions of the right ventricle forcing blood through the arteries.
- Blood flowing through the veins is under the control of muscular and skeletal movement and is much more passive than arterial blood flow. Venous blood does not spurt into the tube but is drawn in by the tube vacuum.
- If drawing blood by syringe, blood obtained from an artery will fill the syringe without applying pressure to the plunger; pressure is necessary when drawing blood from veins.

1.4.2 Support following accidental arterial puncture

Recognizing that an artery has been accidentally punctured is essential so that proper care can be applied.

- Unless otherwise specified by institutional policy, blood collection should be discontinued and pressure applied to the site for a full 5 minutes.
- Stoppage of bleeding should be ensured before leaving the patient, and the direct patient caregiver should be notified so that if bleeding reoccurs proper support will follow. It may be necessary for the caregiver to apply a pressure bandage to the site.
- An incident report should be completed according to institutional policy.

Subsequent venous access should be attempted on the opposite arm to avoid the risk of subcutaneous haemorrhage resulting from bleeding from the punctured artery.

1.5 Superficial veins of the arm

Venous access (either for blood collection or intravenous lines) is generally performed on the superficial veins of the arm. Superficial veins lie just beneath the skin in the superficial fascia – connective tissue that lies below the two layers of skin (dermis and epidermis).

The superficial veins of the arm consist of the digital and metacarpal veins on the back of the hand, and the cephalic, basilic and median veins (median cephalic, median basilic, median cubital and median antebrachial).
Blood is generally collected from the superficial veins in the cubital fossa. Venous access for intravenous insertion is more commonly performed on the back of the hand and back of the lower forearm.

1.5.1 Placement of cubital fossa superficial veins

There are two major variations in the placement of veins in the cubital fossa and forearm.

“H” Orientation of cubital fossa veins

The most common and simplest placement of veins, found in approximately 70-80% of individuals, involves the cephalic vein on the lateral or thumb-side of the arm connected to the basilic vein on the medial or baby-finger side by the median cubital vein just below the elbow crease. The placement of these three veins forms a letter “H” as in the diagram below. The cephalic vein often has a lateral branch that begins above, at, or below the elbow crease and travels the dorsal surface of the forearm – this branch is referred to as the accessory cephalic vein.

Figure 1-I: “H” Vein Orientation

“M” Orientation of cubital fossa veins

The less common placement of superficial veins (20-30% of individuals) forms the letter “M” in the cubital fossa. With this placement, there is no distinct branch from the cephalic vein to the basilic vein. Instead the median antebrachial vein passes up the centre of the forearm and branches near the elbow crease with one branch – the median cephalic – connecting to the cephalic vein, and the second branch – the median basilic – connecting to the basilic vein as in figure 1-II below.
Realistically everybody will not have palpable veins in the exactly same position. Less common variations may also occur. The terms used here describe where the veins are usually found, but there will be individual exceptions and variations not accounted for by the anatomical names assigned, as you will quickly learn when attempting to find veins in others.

### 1.6 Major nerves of the arm

Peripheral nerves send impulses from the central nervous system to the shoulders, arms, hands, buttocks, legs and feet. They respond to physical, emotional and chemical sensations in the organs and tissues.

Major nerves of the upper limb originate from the brachial plexus, a network of nerves formed by cervical and spinal nerves supplying the arm and parts of the shoulder. There are numerous nerves supplying the arm; however, we will discuss only the ones most likely to be encountered in areas commonly used for venous access.
1.6.1 Cubital fossa nerves

In the cubital fossa where blood collection is usually performed, there are two major nerves of concern – the median (medial) cutaneous nerve and the lateral cutaneous nerve.

**Medial (median) antebrachial cutaneous nerve**

The medial antebrachial cutaneous nerve runs down the ulnar side (baby-finger side) of the arm medial to the brachial artery. It pierces the deep fascia with the basilic vein at the elbow and divides into two branches – volar and ulnar.

At the elbow the medial nerve lies on the surface of the brachialis muscle and beneath the bicipital aponeurosis, which provides some protection during median-cubital vein puncture.

The larger volar branch of the nerve usually passes in front of the median basilic vein and then descends the forearm to the wrist on the front ulnar side. The ulnar branch descends the forearm to the wrist on the medial side of the basilic vein on the back of the forearm.

**Lateral antebrachial cutaneous nerve**

The lateral antebrachial cutaneous nerve originates from the musculocutaneous nerve just above the elbow. The lateral antebrachial nerve lies laterally (toward thumb-side) of the biceps tendon, behind the cephalic vein, and continues into the forearm.

There are a few reports of injury to the lateral antebrachial cutaneous nerve during or following venipuncture to the cephalic vein (see references). However, precautions related to the lateral cutaneous nerve are missing from current versions of the Clinical Laboratory and Standards Institute (CLSI) Procedure for the Collection of Diagnostic Blood Specimens by Venipuncture and available phlebotomy texts. Damage has been reported both through direct damage to the nerve and through compression injury resulting from subcutaneous bleeding. Sander et al. recommend avoiding the cephalic vein immediately lateral to the biceps tendon and medial to the brachioradialis muscle, if possible, and using as superficial an attempt as possible when this area is accessed.

Care must be taken to avoid puncture of the nerve through misdirection of the needle and/or excessive needle depth. Use the lowest possible angle when performing venipuncture and ensure that the needle is directed into the vein lumen.

To avoid compression injury, avoid probing (excessive redirection of the needle), which may nick the vein resulting in subcutaneous bleeding. Also, avoid transfixing the vein (advancing the needle past the lumen through the back or side wall of the vein), and ensure that bleeding has stopped before bandaging the site and leaving the patient.

If the patient complains of pain upon introduction of the needle or needle movement, discontinue the venipuncture. Removing the needle from the arm may reduce the severity of the nerve injury. Symptoms of nerve injury should be reported to the direct caregiver for
further follow-up and investigation as warranted, and an incident report completed as per institutional policy.

At the elbow, the lateral antebrachial cutaneous nerve divides into volar (inner surface of forearm) and dorsal (outer surface of forearm) branches. The volar branch passes through the forearm to the wrist along the thumb-side, and at the wrist lies in front of the radial artery before it passes down to the thumb. The dorsal branch passes through the forearm to the wrist on the dorsal or outer surface of the arm.

1.6.2 Lower forearm nerves

Collection of blood from the veins of the inner (volar) lower forearm is avoided due to the closer proximity of nerves, tendons and arteries as the arm becomes more slender from the elbow to the wrist. However, intravenous access is sometimes performed on the cephalic vein or the median antebrachial vein on the volar surface of the lower forearm despite the greater risk of discomfort on insertion, infiltration, vein rolling and nerve damage.

The lateral antebrachial cutaneous nerve lies in close proximity to the cephalic vein in the lower forearm, and the medial antebrachial cutaneous nerve lies in close proximity to the antebrachial vein. Care must be taken to avoid puncture of the nerve, and blood or fluid collection, which may lead to compression injury to this nerve and other nerves passing through the lower forearm. Attention to needle angle, direction, positioning and vein anchoring in addition to awareness of the symptoms of nerve injury are essential to protect the patient.

1.7 Wrist nerves

1.7.1 Median nerve

The median nerve lies on the medial side of the brachial artery behind the bicipital aponeurosis at the elbow bend. It extends through the middle of the forearm arm to the hand, and a superficial branch emerges at the lower part of the forearm, on the inner aspect of the wrist.

1.7.2 Ulnar nerve

The ulnar nerve passes along the medial side (baby-finger side) of the forearm and hand. It is smaller than the median nerve, and in the upper arm lies behind the median nerve, but descends through the forearm on the ulnar side of the median nerve. About 5 cm above the wrist, the ulnar nerve splits to form dorsal and volar branches. Damage to this nerve may result in ulnar-side finger pain, hand weakness or abnormal baby-finger position.
1.7.3 Radial nerve

The radial nerve descends the radial side (thumb-side) of the forearm and becomes superficial, approximately 7 cm above the wrist. Here, it splits forming lateral and medial branches.

Damage to this nerve may result in ‘wrist drop’ and loss of ability to work the hand. Venous access should not be performed on the inner (volar) wrist area due to the presence of radial and ulnar nerves, tendons, and arteries. Care must be taken when performing venipuncture on the thumb-side of the wrist to avoid damage caused by puncture or compression of the radial nerve. Venipuncture of the cephalic vein less than 4 inches above the level of the wrist may result in compression injury.

Figure 1-III: Cephalic vein at wrist

1.8 Vein Selection

Blood is routinely collected from the superficial veins in the cubital fossa - the shallow triangular-shaped depression in the anterior region of the upper forearm just below the elbow crease. Intravenous insertion is more commonly performed in veins on the back of the wrist or hand, or in the lower forearm. A thorough understanding of the location of the nerves and arteries, and the relative risks associated with accessing each of the commonly used veins can protect the patient from injury and you and your employer from litigation.

Superficial veins lie just beneath the skin in the superficial fascia. The superficial veins of the arm consist of the digital and metacarpal veins on the back of the hand, and the cephalic,
basilic and median veins (median cephalic, median basilic, median cubital and median antebrachial) of the forearm.

Current recommendations for venous access in phlebotomy standards and texts are somewhat simplistic, misleading and poorly referenced. The veins in order of preference are:

1. Median cubital vein
2. Cephalic vein
3. Basilic vein

1.8.1 Median Cubital Vein

The vein of choice, recommended because of its large size and superficial location, is the median cubital. The median cubital vein usually shunts some of the blood collected by the cephalic vein to the basilic vein (70-80% of individuals). In the more common “H” vein placement in the cubital fossa, the median cubital vein is the branch that connects the cephalic vein to the basilic vein. It runs from the cephalic vein in a slight upward angle and attaches to the basilic vein somewhere in the elbow crease forming the crosspiece of the letter “H”. However, the median cubital vein, or its alternative in the “M” orientation, the median basilic vein, may cross over the brachial artery increasing the risk of arterial puncture, and may lie over, under or near the medial antebrachial cutaneous or median nerves increasing the risk of nerve damage. In the case of intravenous access, a hematoma may readily form when the needle or cannula is removed. There is the additional risk of nerve compression injury if the back or sidewall of the vein is punctured during access, or infusion fluids infiltrate the tissues.

1.8.2 Cephalic Vein

The second choice of vein is the cephalic vein. This vein originates in the radial part of the dorsal venous network formed by metacarpal veins on the dorsum of the hand, and drains the radial of the forearm, ascending the radial border of the forearm and the lateral side of the cubital fossa and biceps. At the hand and lower forearm, the cephalic vein is found on the dorsal surface of the radial bone and ascends the radial surface of the forearm to the cubital fossa. The cephalic vein is relatively large in size and is well positioned for venipuncture and intravenous fluid administration. It readily accommodates a large cannula, and the forearm provides a natural splint for the cannula and adapter. However, the lateral antebrachial cutaneous nerve, which originates from the musculocutaneous nerve just above the elbow and lies laterally to the biceps tendon, passes behind the cephalic vein, and continues into the forearm.

At the elbow, the lateral antebrachial cutaneous nerve divides into volar (inner surface of forearm) and dorsal (outer surface of forearm) branches. The volar branch passes through the forearm to the wrist along the thumb-side, and at the wrist lies in front of the radial artery before it passes down to the thumb, often intertwining with the cephalic vein and dorsal vein of the thumb. The dorsal branch passes through the forearm to the wrist on the dorsal or outer surface of the arm, and may cross the cephalic vein in the lower forearm.
Despite the fact that there are reports of injury to the lateral antebrachial cutaneous nerve during or following venipuncture of the cephalic vein, precautions related to the lateral cutaneous nerve are missing from venipuncture guidelines and phlebotomy texts. Damage may occur through, both direct damage to the nerve and compression injury resulting from subcutaneous bleeding.

1.8.3 Basilic Vein

The third recommended vein of choice, the basilic vein, drains the ulnar or baby-finger side of the forearm and ascends the ulnar posterior portion of the forearm diverging toward the anterior surface of the arm just below the elbow where it meets the median cubital vein. At the hand and lower forearm, the basilic vein, positioned on the dorsal surface of the baby-finger side, crosses to the ulnar posterior surface of the forearm. The basilic vein is best brought into view by flexing the elbow and bending the arm up as in the figure below.

Figure 1-IV: Basilic vein

![Basilic Vein](image)

The basilic vein is easily palpated, but must be well anchored due to its greater tendency to roll. The medial antebrachial cutaneous and median nerves descend the ulnar side (baby-finger side) of the arm on either side of the brachial artery. The medial antebrachial cutaneous nerve pierces the deep fascia with the basilic vein at the elbow and divides into two branches – volar and ulnar.

The median nerve lies on the medial side of the brachial artery behind the bicipital aponeurosis at the elbow bend. It extends through the middle of the forearm arm to the hand, and a superficial branch emerges at the lower part of the forearm, on the inner aspect of the wrist. The bicipital aponeurosis (bicipital fascia) is a fibrous layer of tissue, which provides some protection during median-cubital vein puncture. The bicipital fascia extends from the biceps tendon and passes medially across the elbow beneath the basilic and median cubital veins, separating them from the median nerves and brachial artery. The bicipital fascia is an important structure, because it protects the underlying artery and nerves from inadvertent puncture during venous access. The bicipital fascia was named the “thank God fascia” or “grace a Dieu fascia” by barber-surgeons who practiced bloodletting techniques in the 17th and 18th centuries. The recommendation for the median cubital vein as the vein of choice for
venous access may even have originated during this period. This was because damage to either of the two major superficial veins – the cephalic or the basilic - may have resulted in reduced drainage from the arm; whereas, damage to the median cubital vein was less likely to result in drainage complications as it merely shunted blood from the cephalic to the basilic vein. However, puncture to the medial antecubital cutaneous and median nerves remains one of the most common causes of phlebotomy related lawsuits.

The larger volar branch of the medial antebrachial cutaneous nerve usually passes in front of the median basilic vein and then descends the forearm to the wrist on the front ulnar side. The ulnar branch descends the forearm to the wrist on the medial side of the basilic vein on the back of the forearm. It is smaller than the median nerve, and in the upper arm lies behind the median nerve, but descends through the forearm on the ulnar side of the median nerve. About 5 cm above the wrist, the ulnar nerve splits to form dorsal and volar branches. Damage to this nerve may result in ulnar-side finger pain, hand weakness or abnormal baby-finger position.

1.8.4 Accessory cephalic vein

The accessory cephalic vein, not even mentioned among the top three recommendations for venous access. It originates from a network of vessels on the back of the forearm or the dorsal venous network on the back of the hand and is also a good choice. It ascends the arm and joins the cephalic vein, sometimes below the elbow crease and sometimes above the elbow crease. The accessory cephalic may arise from the cephalic vein just above the wrist and flow back into the main trunk of the cephalic vein at some point higher in the forearm. It readily receives large cannula.

1.9 Median veins of forearm:

1.9.1 Median antebrachial vein

The median antebrachial vein arises from the venous plexus on the palm of the hand and extends upward along the ulnar side of the inner (volar) surface of the forearm. It empties into the basilic, median basilic, or median cubital vein.

1.9.2 Median cephalic vein

The median cephalic vein, when present ("M" vein placement) is often used for blood collection, because it is usually large, superficial, readily accessible, and has little tendency to roll because of the muscular and connective tissue supporting it.

1.9.3 Median cubital vein

The median cubital vein ("H" vein placement) was discussed previously. Care must be taken when accessing this vein to avoid puncturing the brachial artery and median cutaneous nerve.
1.9.4 Median basilic vein

The median basilic vein ("M" vein placement) is found on the ulnar curve of the forearm just below the cubital fossa. It is least desirable for venipuncture and intravenous placement as it may cross over the brachial artery and median cutaneous nerve increasing the risk of arterial puncture and nerve damage. In the case of intravenous access, a hematoma may readily occur when the needle and/or cannula is removed, especially if the elbow is flexed to stop the bleeding rather than elevating the arm and applying direct pressure to the puncture site.

1.10 Superficial hand veins

1.10.1 Digital veins (Dorsal digital and network)

The digital veins flow along the lateral portions of the fingers and are joined by communicating branches. They may be suitable for venipuncture with a small-gauge needle, but are considered a last resort for fluid administration.

1.10.2 Metacarpal veins

There are three metacarpal veins formed by the union of the digital veins. Their positioning makes these veins well adapted for IV use, because the needle and adapter lie flat between the joints, and the metacarpal bones and provide a natural splint.

Performing venipunctures for fluid administration at the distal end of the arm is beneficial, as each successive venipuncture can be performed above the previous puncture site; irritating fluids passing through a vein where there has been previous venipuncture trauma can be painful and may result in inflammation. Use of these veins may be contraindicated in the elderly due to inadequate tissue and thin skin resulting in increased risk of bleeding into the tissues during and/or following venipuncture.

1.11 Protection of structures in the cubital fossa

The bicipital aponeurosis (discussed previously) is an important structure to phlebotomists because it covers the brachial artery and median nerve, separating them from the median cubital and basilic veins at the elbow providing some protection of the deeper structures during venipuncture. However, puncture to the median nerve remains one of the most common causes of phlebotomy related lawsuits. Needle direction, angle, vein anchoring, and proper positioning of the phlebotomist and patient is critical to prevent nerve damage and accidental puncture of the brachial artery.

As discussed previously, the lateral antebrachial cutaneous nerve lies behind the cephalic vein in the cubital and is subject to injury from direct puncture and/or compression injury due to accumulation of blood and/or fluids. Needle direction, angle, vein anchoring, and proper positioning of the phlebotomist and patient is critical to prevent nerve damage. To reduce the risk of bleeding and resulting compression injury, care should be taken not to advance the needle through the back or sidewalls of the vein.
Additionally, phlebotomists must be aware of the signs and symptoms of inadvertent puncture, and sensitive to cues given by the patient. If, at any time during the procedure, the patient complains of pain or unusual discomfort, the venipuncture should be discontinued, and attempted in the opposite arm (assuming that the opposite arm is available).

Reapplying the tourniquet to the same arm for a repeat venipuncture may result in bleeding from a previously punctured vein into the tissue, leading to hematoma and/or compression injury to nerves below the vein. In the event that the opposite arm is unavailable for venipuncture, a repeat attempt may be made below or distal to the previous puncture where tourniquet pressure will not encourage bleeding from the initial puncture site. For I.V. access, it is recommended that insertion be performed at the most distal acceptable site, so that subsequent access can be performed above the initial site, if necessary.

1.12 Symptoms of nerve injury

Nerve injury can be caused by direct puncture of the nerve or compression injury resulting from continued bleeding from a vessel onto the nerve, infiltration of I.V. fluid and pressure on the nerve, or tourniquet paralysis resulting from the tourniquet being too tight or left on for too long. Direct puncture results in immediate symptoms; whereas, compression injuries may not be apparent for up to 48 hours after the venipuncture. Permanent damage can result from either direct puncture or compression injury – early recognition, investigation and intervention may reduce the risk and severity of permanent injury.

Direct puncture results in:

- Sharp acute pain at venipuncture site
- Sharp shooting pain up or down the arm
- Sensation of pain that changes in severity depending on needle position
- ‘Pins and needles’ sensation or ‘electric shock’ descending the arm from where venipuncture was performed
- Pain or tingling discomfort in the hand or fingertips
- Verbal or non-verbal indications of pain during needle entry or needle movement
- Pain that persists following needle removal

Compression injury results in:

- Pain, numbness and tingling in arm or hand occurring 24-96 hours after the venipuncture

Response to possible nerve injury:

1. Immediately withdraw the needle or I.V. device – continuing the procedure could sever the nerve. Removing the device immediately reduces the risk and severity of nerve damage
2. Apply pressure to the site to prevent hematoma
3. Report the situation to your supervisor and the patient’s direct caregiver
4. Document the incident, recording the date, time and location of nerve puncture, patient complaints and comments, and interventions
5. Collect from an alternate site, when attempting a second collection, preferably the opposite arm

1.13 Avoiding nerve injury

1. Choose the most prominent of the acceptable veins (avoid the inner/volar surface of the wrist and forearm)
2. Position the patient properly
3. Anchor the vein securely
4. Use low needle angle (~ 15 degrees), relative to vein depth
5. Advance needle into the lumen of the vein in the direction that the vein is running – not across the vein
6. Avoid puncturing the back and sidewalls of the vein
7. Choose the other arm for a second attempt in the event that you are unsuccessful on your first attempt
8. Limit attempts: do not attempt venipuncture more than twice – have a more experienced phlebotomist attempt
9. Avoid probing: Relocating the needle without knowing the location of the vein is probing and could result in subcutaneous bleeding and/or injury to the patient. Needle relocation should not be performed until the exact location of the vein in relation to the needle is determined
10. Remove the needle immediately if the patient complains of discomfort and perform venipuncture in the opposite arm. Document complaints of symptoms that persist following needle removal
11. Apply pressure to the venipuncture site until bleeding has stopped (~ 3 minutes). For patients receiving anticoagulant therapy, elevate the arm and apply pressure for 5 minutes, or until bleeding has stopped

1.14 Summary: Venous access danger areas

1.14.1 Medial Cutaneous Nerve

Cutaneous nerves convey impulses for stimuli to the skin. The median cutaneous nerve is a major arm nerve that lies along the path of the brachial artery in the vicinity of the basilic vein.

1.14.2 Tendon for Biceps Muscle

The tendon for the biceps muscle is found in the general venipuncture area, but can be distinguished from the veins because it feels less pliable. Bending the arm while continuing to palpate will readily distinguish between a vein and the biceps tendon – veins will not be palpable when the arm is bent, but the tendon will remain firm and palpable.
1.14.3 Brachial Artery

An artery has a pulse and should not be confused with a vein. The brachial artery is located superficially in the cubital crease on the medial or ulnar side of the arm. Although it is separated from the median cubital vein by the bicipital aponeurosis, it is possible to inadvertently puncture it when accessing the median cubital and basilic veins in the cubital fossa. Care should be taken to ensure that patients are properly positioned, veins are securely anchored, and that needle angle is not excessive.

1.14.4 Lateral cutaneous nerve

The lateral cutaneous nerve is superficial and lies behind the cephalic vein in the cubital crease. Care should be taken to ensure that patients are properly positioned, veins are securely anchored, and that needle angle is not excessive.

1.14.5 Radial nerve

The radial nerve is superficial on the wrist and lower forearm in the area where the cephalic vein is found. Venous access for the purposes of intravenous is not recommended in the cephalic vein less than 4 inches from the base of the thumb, and care must be taken to ensure that needle angle is as low as possible to avoid advancing the needle through the vein into the nerve and/or compression injury to the nerve resulting from blood and/or fluid collection.
References


