Chapter 28: Intravenous Access

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INTRODUCTION

FOCUS POINTS

1. Establishing and maintaining adequate and reliable vascular access is one of the most critical aspects of pediatric anesthesiology.
2. Internal jugular, subclavian, and femoral central venous access sites are commonly used in pediatrics. Considerations for site selection include indications for placement, anticipated duration, patient-specific factors, and operator experience.
3. Infectious complications can be markedly reduced with universal precautions and good aseptic technique. Strict sterile barrier precautions should be employed including a mask, cap, sterile gown, and gloves. Chlorhexidine solutions are preferred to the use of povidone-iodine solutions for skin preparation.
4. Ultrasound guidance is recommended for central venous cannulation in children. It is also commonly used during placement of peripherally inserted central catheters and difficult peripheral venous line placement.

CENTRAL VENOUS ACCESS

Indications

Although there are no absolute indications for intraoperative central venous pressure (CVP) monitoring in pediatrics, the insertion of a central venous catheter (CVC) is warranted if it contributes to the management of a safe anesthetic. CVP monitoring can provide an estimate of right ventricular filling pressures and intravascular volume status. This information can be used to guide fluid resuscitation during procedures associated with significant blood loss, large fluid shifts, and hemodynamic instability. CVCs also serve as reliable access for the central administration of vasoactive medications, delivery of blood products, blood sampling, and central venous oxygen tension analysis. A multi-orifice CVC positioned at the superior vena cava (SVC) and right atrial (RA) junction allows for aspiration of entrained air in patients at risk for venous air emboli. Finally, insertion of a CVC may be the only option in cases where establishment of peripheral intravenous access is unsuccessful.

In children with chronic diseases, several therapeutic interventions that extend beyond the operating room are made possible with the use of specialized CVCs. In larger cardiac patients, these catheters can serve as conduits for the insertion of transvenous electrodes for cardiac pacing and the placement of pulmonary artery catheters for more comprehensive hemodynamic monitoring. In critically ill patients, these catheters can also be used for temporary hemodialysis, continuous venovenous hemofiltration, and plasmapheresis. Administration of chemotherapy, long-term antibiotics, parenteral nutrition, and the delivery of other chronic continuous intravenous medications such as epoprostenol and milrinone are also common indications for CVCs in pediatric patients. This long-term access requirement usually involves the surgical placement of tunneled catheters that provide better long-term stability and reduced infection risk such as a subcutaneous port, Broviac, or Hickman catheter.

Contraindications

As in adults, there are no absolute contraindications to the placement of CVCs in children. Relative contraindications include coagulopathy/thrombocytopenia, localized infection over the insertion site, target vessel stenosis/thrombosis, anatomical abnormalities/tumor presence, and parental/patient refusal. The use of antimicrobial/antiseptic impregnated CVCs has increased in recent years in pediatric patients in whom catheter is expected to remain in place for greater than 5 days. It is important to note that use of minocycline/rifampin or chlorhexidine/silver sulfadiazine impregnated catheters is contraindicated in patients with allergies to these coatings.

Insertion Site

Various sites can be used for central cannulation in children. Commonly used CVC placement sites for intraoperative use in pediatrics include internal jugular, subclavian, and femoral veins. Considerations prior to site selection should include clinical setting and indication, risks, anticipated duration of use, and operator skill/experience. Intraoperative accessibility makes the internal jugular and subclavian veins favorable for anesthesiologists. Their location at the head of the operating room table allow for direct visualization of the insertion site, permitting routine insertion site assessment, intravascular confirmation with the application of negative pressure/aspiration, and troubleshooting ease when necessary. The more distal location of the femoral veins may be preferable in trauma settings allowing for neck immobilization, as well as simultaneous airway management and resuscitation efforts.

While all insertion sites share common complications such as potential for vessel injury, inadvertent arterial puncture, hematoma formation, embolic events, risk of thrombosis, and infection, each site confers its own unique safety profile that should be considered in the context of patient-specific factors. Practice guidelines issued in 2012 by the American Society of Anesthesiologists Task Force on Central Venous Access state that insertion site selection should be based on clinical necessity, should not be contaminated, or at risk for future contamination.[1] A working group comprised of members from various professional organizations and disciplines, which was led by the Society of Critical Care Medicine, published guidelines for the prevention of intravascular catheter-related infections in 2011. The group's recommendation for the avoidance of femoral venous access was based on category 1A evidence. To reduce infection risk, the subclavian site was recommended over the internal jugular and femoral sites in adults (category 1B).[2] Unfortunately, there is an absence of compelling data in the pediatric literature with respect to this issue.[3]

INTERNAL JUGULAR VEIN

Anatomy

The right internal jugular vein (RIJV) is commonly a preferred site for central venous cannulation because of its anatomical location, distinct surface landmarks, and straight trajectory to the SVC and RA. The vessel initially runs deep to the sternocleidomastoid muscle (SCM), but courses closer to the skin surface within the triangle formed by the sternal and clavicular heads of the SCM and the clavicle. Although the IJV is located anterolateral to the common carotid artery (CCA) in most cases, a wide range of anatomical variations exist.[4,5] An early study that used ultrasound to examine the venous anatomy in children under the age of 6 found that up to 18% had variability of vessel positioning that could result in inadvertent arterial puncture, failed cannulation, or injury.[6] For this reason, real-time direct ultrasound (US) guidance is now commonly used to reduce complications with IJV cannulation.[7,8]

Technique

Intraoperative cannulation of the IJV is typically performed following induction of general anesthesia and endotracheal intubation. When placed in other settings, measures should be taken to make the patient comfortable to both facilitate placement and reduce complications associated with patient movement. Supplemental oxygen should be administered and pulse oximetry, blood pressure, and the electrocardiogram (ECG) should be monitored. As with all invasive procedures, a procedural time out is recommended prior to patient positioning. The patient is positioned on a shoulder roll to provide adequate neck extension and the head is rotated approximately 45° to the contralateral side. Care must be taken to avoid excessive head rotation as this can alter the anatomy and cause the IJV to directly overlie the CA.[9] After identification of surface landmarks, Trendelenburg positioning (15° to 20°) is often utilized to both decrease the risk of air embolus and improve cannulation success by increasing the cross-sectional diameter of the vessel.

Universal precautions and good aseptic technique are required during catheter insertion. Hand hygiene with either antiseptic soaps or alcohol-based products has repeatedly been shown to reduce central line–associated bloodstream infection (CLABSI) rates.[10] Strict sterile barrier precautions should be employed including a mask, cap, sterile gown, and gloves. The anterolateral neck is prepped widely from just below the earlobe and along the clavicle toward the sternoclavicular joint. Chlorhexidine solutions have been shown to reduce the risk of catheter colonization and are preferred to the use of povidone-iodine solutions.[10–12] A large sterile drape is then applied over the patient with care to maintain sterility.

Three percutaneous approaches have been described: central, anterior, and posterior. In the central approach, the carotid pulse is palpated with the nondominant hand. A needle mounted on a slip tip syringe (3 to 5 mL) is then inserted at the apex of the triangle formed by the two heads of the SCM, just lateral to the carotid pulse. The needle should be angled 20° to 45° above the skin surface. With gentle aspiration, the needle is then advanced in the direction of the ipsilateral nipple. The IJV is accessed at a needle depth of 1.0 to 1.5 cm beneath the skin surface in most patients. The landmark for the anterior approach is the midpoint of the anterior edge of sternal head of the SCM, halfway between the angle of the mandible and the sternum. The carotid pulse is palpated along the medial border of the sternal head. The needle is then inserted just lateral to the palpated pulse, along the anterior margin of the SCM and is directed toward the ipsilateral nipple. In the posterior approach, a useful landmark is the point at which the external jugular vein crosses the lateral edge of the SCM, cephalad to its bifurcation into the sternal and clavicular heads. The needle is inserted approximately 1 cm superior to this point and is advanced along the underbelly of the SCM in the direction of the sternal notch.

Although cannulation of the IJV using the landmark technique is considered a safe approach for experienced providers, several publications have demonstrated a reduction in complications when ultrasonography is used to facilitate the placement of CVCs in pediatric patients. Studies have examined the use of both static US (pre-procedural identification of an optimal entry site with the determination of vessel anatomy and course) and real-time US during IJV cannulation. In randomized studies of infants undergoing elective congenital heart disease surgery, the use of US has been associated with a higher success rates, lower rates of arterial puncture, decreased number of total attempts, and shorter procedural/cannulation time.[4,13] The use of ultrasonography during CVC placement is increasingly becoming the standard of care, as several medical organizations and professional groups have issued recommendations and guidelines supporting its use.[14–16]

Irrespective of the approach, most CVCs are placed using the Seldinger technique. Upon venipuncture with a small-bore needle and the establishment of dark, non-pulsatile free venous flow, the needle is stabilized and the syringe is removed. Care must be taken to prevent air entrainment. A long, thin guidewire with either a J-tip or a soft, pliable tip is then inserted through the needle. The guidewire should be advanced into the vessel lumen with little or no resistance. It is important to monitor the ECG during this step to detect the occurrence of arrhythmias that can be elicited with wire advancement into the heart. If arrhythmias occur, the wire should gently be withdrawn until they cease. The needle is then removed while stabilizing the wire. When using landmark methods, it is recommended that venous cannulation is confirmed prior to dilator or CVC placement in the event of unintentional arterial puncture. This can be accomplished by a fluid-column test, where sterile intravenous tubing is attached to the needle or angiocatheter hub and allowed to fill retrograde with blood. The open distal end of the tubing is then raised and held upright at a distance above the patient's approximate venous pressure. The height of the fluid column should correspond to the CVP and demonstrate respiratory variation. A fall in the column of blood should be observed with vertical elevation of the tubing. In the event of inadvertent arterial cannulation, pulsatile blood will quickly fill the entire tubing and will likely escape at the distal end. Alternatively, a sterile transducer can be attached to determine the vessel's waveform and directly measure the pressure. Once venous cannulation is confirmed, the guidewire is reinserted. If US guidance is used, intravenous wire placement should be verified prior to dilator insertion. The insertion site is often enlarged with a No. 11 scalpel tip, and a rigid, tapered-tip vessel dilator is commonly used to dilate the underlying tissue tract prior to catheter insertion. While maintaining control of the guidewire, the dilator is advanced 1 to 2 cm with gentle rotation close to the tip. Once the dilator is removed, the CVC can then be advanced over the guidewire. Adequate control of the external end of the guidewire usually requires that the wire be retracted out of the patient until the distal end extends beyond the catheter hub. This helps prevent wire embolization during catheter advancement through the skin. The CVC should be advanced to an approximate depth that positions the catheter tip at the cavoatrial junction. The guidewire is subsequently withdrawn and blood return should be confirmed in all ports. The catheter is then secured in place with sutures and the skin around the insertion site is cleaned and dried with sterile gauze. A sterile occlusive dressing is then applied and the lumens are connected to monitoring or infusion tubing via Luer-lock connectors.

Although the left IJV (LIJV) can be cannulated with any of the approaches described above, anatomic asymmetries make this vessel a less favorable choice. Whereas the RIJV follows a direct inferior course to the SVC, the nonlinear course of the LIJV complicates vascular access and increases injury risk. Both the guidewire and the catheter must navigate an angulation at the junction of the LIJV and the left subclavian vein (LSCV), where the vessels merge to form the innominate vein. This is also the location where the thoracic duct enters the venous system, which increases the potential for pleural effusion and chylothorax. The innominate vein then courses to the right as it continues its inferior course, where it enters the SVC almost perpendicularly. At any point along this path, the distal tip of either the guidewire or the catheter may impinge on the vessel wall thereby increasing the potential for injury. Additional factors complicating left-sided cannulation include an increased potential for pneumothorax (pleural apex higher on left) and less practitioner familiarity with the left-sided technique.

SUBCLAVIAN VEIN

Anatomy

The subclavian vein (SCV) is a continuation of the axillary vein as it passes over the first rib and courses medially under the medial third of the clavicle where it joins the IJV behind the sternoclavicular joint to form the brachiocephalic trunk. The subclavian artery lies just posterior to the SCV as it passes over the first rib, and in most patients its pulsation can be readily felt in the supraclavicular fossa. This is a useful landmark, as the SCV lies just anterior and medial to the artery. Using the anatomical landmarks technique, the SCV can be accessed by directing the needle under the clavicle just anterior and medial to the palpable subclavian artery.

Technique

SCV cannulation is not used as frequently for central venous access due to the higher risk of pneumothorax and arterial injury, as compared with internal jugular or femoral venous sites. It can be used when access to the head and neck is limited, or when movement of the neck is not possible due to trauma or airway manipulations. It is the most popular route for long-term venous access due to its easier fixation, making it more comfortable for patients as mobility is not restricted.

Disadvantages include the significant risk of pneumothorax (higher on the left due to the apex of the left lung being higher); injury to the subclavian artery which, if it occurs, is not very amenable to digital pressure and may be problematic in coagulopathic patients; misplacement of the line into the ipsilateral internal jugular vein (right > left side); vessel perforation, especially from a left sided line, due to the catheter tip rubbing against the SVC; and vessel stenosis from large bore catheters used for dialysis—this may cause future problems with hemodialysis access. A subclavian central line placed by the infraclavicular approach is not recommended for cardiac surgery as it may become compressed between the clavicle and first rib when the sternal retractor is placed. Approximately 0.5% of normal patients and approximately 5% to 15% of patients with congenital heart disease have a persistent left SVC, which usually drains into the coronary sinus, but may empty into the left atrium. This may increase the risk of systemic particulate and air embolism via the central line.

There are two common approaches to SCV cannulation—infraclavicular (most common) and supraclavicular.[17,18] The supraclavicular approach avoids the “pinching off” of the catheter between the clavicle and first rib, and may be preferable during cases involving sternotomy. Cannulation may be done using anatomical landmarks or with the use of real-time US imaging. US-guided vascular access is rapidly becoming the standard of care in many institutions due to the higher success rate and fewer complications.[19]

Technical considerations to improve the success rate of SCV cannulation include placing the patient in Trendelenburg position, keeping the head in neutral position, orientating the needle bevel caudally, inserting the J-tip of the wire so it exits the needle inferiorly, and turning the head to the ipsilateral side during wire placement to decrease misplacement into the IJV. A rolled towel placed longitudinally between the scapulae is not necessary as it may drop the shoulder posteriorly and reduce the size of the vein by compressing it between the clavicle and first rib. The use of real-time US is highly recommended to visualize the anatomy.

FEMORAL VEIN

Anatomy

The FV is accessed 1 cm below the inguinal ligament, just medial to the femoral artery. The mnemonic NAVEL can be used to remember the anatomical structures—proceeding lateral to medial —Nerve, Artery, Vein, “Empty” space, and Lymphatics. Although traditional landmark techniques have been used, the use of US increases the success rate and reduces arterial puncture. An US study has shown that there is partial or complete overlap of the FV with the femoral artery in up to 12% of pediatric patients.[20] Although either side can be used for access, for patients with cardiac disease, the left side is preferable, leaving the right side available for cardiac catheterization procedures. In addition, there is less overlap of the two vessels on the left side, which may reduce the risk of arterial puncture.[21]

Technique

The femoral vein is used frequently for central venous access in children. It is readily accessible, particularly in resuscitation situations where access to the upper body is limited, relatively superficial, avoids the risk of pneumothorax, and manual pressure can be readily applied in case of arterial puncture. It is especially useful in functional single-ventricle patients in whom upper body central venous cannulation may cause thrombosis, which can have catastrophic consequences. Complications include arterial puncture, thrombosis (particularly after multiple attempts), femoral nerve injury, and rarely, retroperitoneal hematoma.

Procedural aspects for successful FV catheterization include (1) placing a small rolled towel under the pelvis to “open” up the groin, (2) reversing Trendelenburg and moderate abduction of the leg to increase venous pooling and increase vessel diameter, (3) digital pressure above the FV or abdominal compression to increase the size, and (4) using real-time US imaging.[22]

PERIPHERAL VENOUS ACCESS

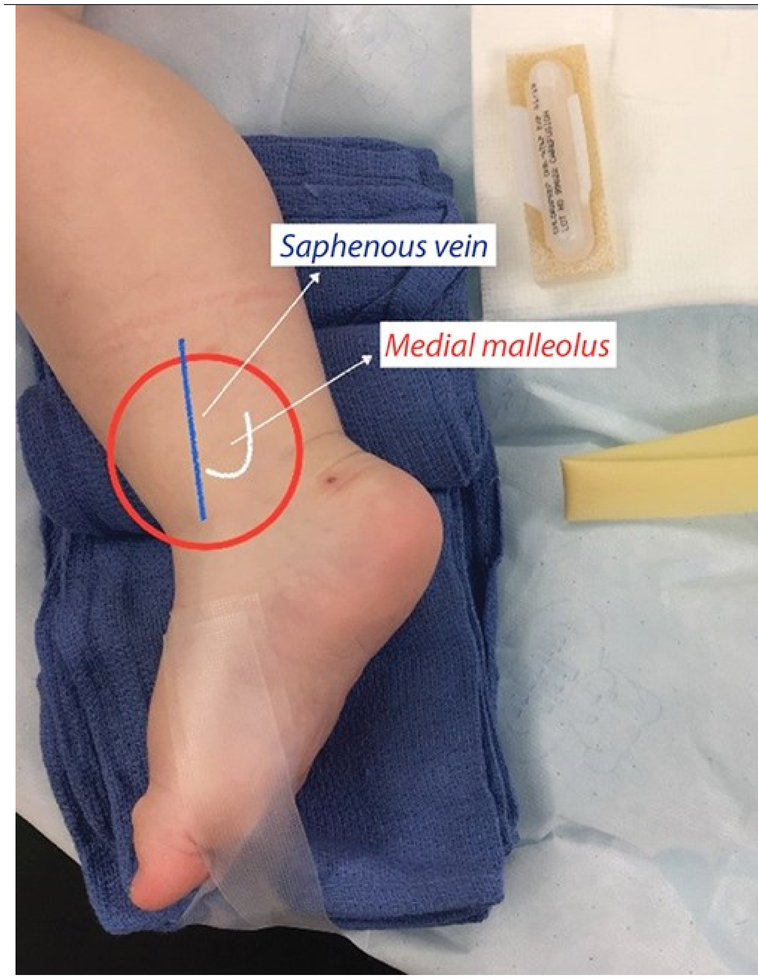
Peripheral intravenous (PIV) catheter placement is one of the most common invasive procedures performed in hospitals today. The ability to obtain and secure PIV access is an essential skill for pediatric anesthesiologists. In most circumstances, this is a relatively simple procedure based on visualization and palpation of the vein. This traditional method of PIV cannulation requires knowledge of vascular anatomy, and experience allows for anticipation of anatomic variables. PIV cannulation in the pediatric population emphasizes the utilization of upper extremity veins, via the basilic, cephalic, or dorsal veins of the hands. Another common site of traditional cannulation technique based on consistent anatomic location is the greater saphenous vein. Three characteristics make the saphenous vein ideal for cannulation based on anatomical landmarks: (1) its consistency (one can depend upon its presence just anterior to the medial malleolus); (2) being the only structure of importance in that location (no arteries or tendons that could get damaged); and (3) the vein lying on the periosteum (providing a tough and solid base for cannulation). Universal precautions are applicable for all PIV placements. Gloves must be worn while starting all IV placements and alcohol swab/chlorhexidine must be used prior to venipuncture.

PERIPHERAL INTRAVENOUS CANNULATION TECHNIQUE

Apply a tourniquet above the site chosen for access. Clean the site with antiseptic solution. With the nondominant hand stabilize the vein and apply counter tension to the skin. This can also be achieved by padding the extremity with towels and anchoring the distal skin with tape to a rigid surface (OR table) (Figure. 28-1). Follow this by using the dominant hand to insert the stylet through the skin and reduce the angle as you advance through the vein. Once a flashback of blood is seen in the back chamber of the stylet, advance the catheter in the vein while keeping tension on the skin. Then remove the needle and secure the IV tubing. The great saphenous vein (Figure. 28-1) is a large and anatomically reliable vein in patients of all ages. It may be hard to visualize and palpate, but it is easily accessible on the medial aspect of the foot where it ascends between the medial malleolus and the medial edge of the tibia.

Figure 28-1

The great saphenous vein is easily accessible on the medial aspect of the foot where it ascends between the medial malleolus and the medial edge of the tibia. (Used with permission, from Dr. Luis M. Zabala, Medical Director of Pediatric Cardiac Anesthesia. University of Texas Southwestern Medical Center/Children’s Health System of Texas - Dallas.)



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In the pediatric population, venous access is generally performed following inhalation induction of anesthesia. Exceptions to this rule are critically ill children, full stomach precautions, and comorbid conditions in which inhalation induction of anesthesia represents a prohibitive hemodynamic risk. In these special circumstances, PIV must be secured prior to anesthesia induction, regardless of age or difficulty. Administration of 50% nitrous oxide in selected patients prior to induction of anesthesia may represent a viable and safe alternative for securing IV access, specifically in those patients in which movement may put at risk the only target for a successful IV access.[23]

The extent of the surgical procedure guides the need for fluid therapy and therefore access. The fluid infusion rate is proportional to the radius to the power of four, and inversely proportional to length; therefore, longer and smaller diameter PIV catheters are associated with slower infusion rates. Catheter size is a limitation for rapid rate of infusion in neonates and small infants, due to the size of their peripheral veins. Recommended sizes are 24 ga 1″ to 22 ga 1″ catheters for newborns through 6 months of age, and 22 ga 1″ to 20 ga 1.25″ catheters from 6 months to 3 years.

Obtaining vascular access is difficult in 35% of the patients who present to the emergency department.[24] Other studies have reported first rate success as low as 53% in the pediatric population.[25] With multiple failed attempts at cannulation, patients experience pain, parental anxiety, and delays in their care. The difficult IV access (DIVA) score is a clinical prediction rule (CPR) developed to determine success rates for IV placement in children. Initially described by Yen et al. there are four variables, each weighted score including (a) age (3 points if less than 1 year, 1 point if 1 to 2 years, and 0 points if older than 2 years); (b) vein visibility (2 points if not visible and 0 points if visible); (c) vein palpability (2 points if nonpalpable and 0 points if palpable); and (d) gestational age (3 points for prematurity <38 weeks of gestation and 0 points if term).[26] Patients with score of 4 or more were 50% more likely than the mean success rate to have failed IV placement on the first attempt. This rule is useful in determining which children would benefit from interventions that may improve successful intravenous placement. The alternative to traditional landmark-driven, palpation, or blind technique is the utilization of any of the available technologies to aid peripheral venous cannulation.

Of the available technologies, the most used in clinical practice are transilluminators, near-infrared light technology, and US. Transillumination technology is based on the transmission of light through tissue. It was first described in 1975 by Kuhns et al., who used it to cannulate peripheral veins of obese children undergoing radiologic studies.[27] Many different devices fall into the category of transilluminators, including light emitted by otoscopes, fiber-optic cables attached to cold light sources and more recently light-emitting diodes (LEDs).[28,29] One serious concern with this technology is the amount of heat generated by the light source and the possibility of burns. Transilluminator-assisted PIV cannulation is used widely in the neonatal population. A meta-analysis of three pediatric randomized control trials (RCTs) found a trend toward a lower risk of first-attempt failure compared to the traditional landmark (visualization and palpation) technique, though it was not statistically significant. One RCT found that the use of transillumination in a subgroup of patients younger than 2 years was associated with a significantly decreased risk of first attempt cannulation failure, suggesting that perhaps the technology is better suited for patients younger than 2 years of age.[30] Near-infrared (NIR) technology aids vessel visualization by emitting NIR light toward the patient's skin which is then differentially absorbed by blood and tissue based on wavelengths. The light that reflects back from the veins is processed by the device. Many devices using NIR technology are coupled with advanced technologies to display an image of superficial vasculature (from 0 to 8 mm below the skin surface) directly onto the patient's skin or to an alternate display. The most commonly used device is the Vein Viewer (Luminetx Technologies Corporation, Memphis, TN). Others include the AccuVein® and the VeinLuminator™. The literature reports conflicting results from the use of this technology. Three RCTs comparing PIV cannulation using an NIR light device with the traditional method found that the use of the device had no impact on PIV cannulation first-attempt failure.[30] Despite disappointing evidence of its utility and efficacy based on multiple studies, NIR technology offers many benefits: allows for rapid assessment of viable targets, easily identifies the valve of a vein, and allows assessment of the catheter/vein ratio (optimal ratio to avoid thrombosis = 3:1).[31–33]

Bedside ultrasonography has been shown to facilitate central venous access in pediatric patients and real-time 2D US needle visualization throughout the cannulation process is today considered the gold standard technique.[34,35] US technology involves the transmission of high-frequency waves aimed at a body part. These waves interact with tissues and can be absorbed, transmitted, or reflected. The reflected waves (bounced waves or "Echoes") are used by the receiver to create 2D image on a screen. The role of US for peripheral venous access has expanded, particularly with difficult access.[36,37] A recent meta-analysis found that US guidance increases the likelihood of successful cannulation in difficult access patients.[38] According to the international evidence-based recommendations on US-guided vascular access, US guidance should be considered when difficult intravenous access is required, and blind deep antecubital fossa puncture should not be attempted.[39]

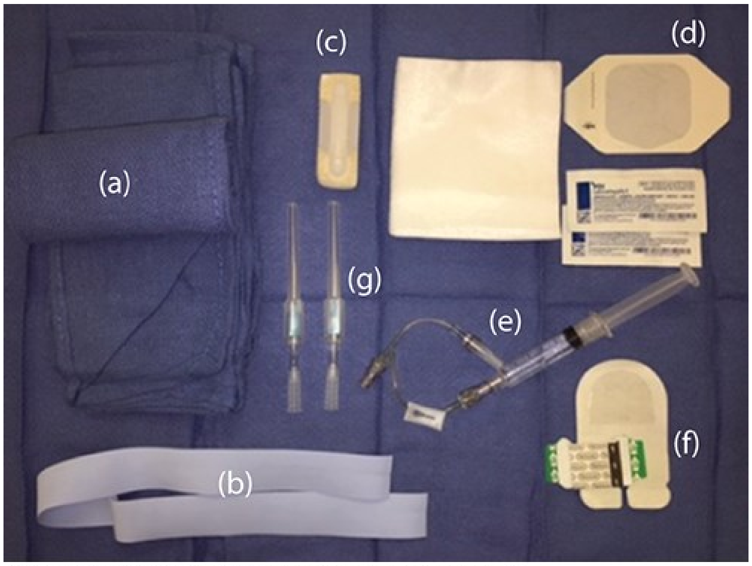
US-guided peripheral access demands complete understanding of peripheral venous anatomy and comfort with the equipment. Other basic concepts include selection of an appropriate vein, image optimization, and US orientation. Maximizing the image heavily relies on adjusting the gain to differentiate fluid-filled structures such as veins from those reflecting US waves or echoes (muscle or subcutaneous tissue). Depth should also be adjusted so that the view of target structures is maximized allowing for posterior structures to also be seen. Orientation of the US probe in relation to the screen is crucial to successful cannulation. Each transducer has an indicator that correlates with the active indicator on the screen of the monitor. A common practice is to match the marker of the transducer at the left of the patient with the marker on the upper left hand of the screen.

PERIPHERAL VENOUS US-GUIDED TECHNIQUE

Station setup is critically important for successful peripheral venous access (Figure. 28-2). ***Preliminary scan of basilic, cephalic, antecubital, and greater saphenous veins is performed to establish preferred site of puncture.*** *The ideal vein is large, superficial, and clearly differentiated from arterial structure (compression test). After having the appropriate equipment, and the selected vein for cannulation, the patient's arm should be propped up with towels and the distal skin secured with tape to a rigid structure (OR table) attempting to stabilize the vein and facilitate entry of the need through the skin. A tourniquet is placed proximal to the site selected and sterile antiseptic solution applied. Out-of-plane (short axis) allows visualization of the vessel in its short-axis view. The needle tip is seen from its skin point of entry and follows its progression through the subcutaneous tissue to the target below. Short axis illustrates whether the needle is aimed directly over the target. The in-plane technique (long axis) displays correct angle of entry and conformation of the catheter after needle withdrawal within the vein lumen. This technique demands exact alignment of the needle shaft with the ultrasound beam.*

Figure 28-2

Station setup for successful peripheral venous access: (a) roll of towels used to place beneath the upper or lower extremity limb used for access to create stability, (b) tourniquet, (c) chlorhexidine pad, (d) conductive gel and transparent adhesive to cover the ultrasound probe, (e) saline connector, (f) adhesive securing mechanism, and (g) appropriately sized intravenous catheters. All elements for peripheral ultrasound cannulation should be available prior to initiation of the procedure. (Used with permission, from Dr. Luis M. Zabala, Medical Director of Pediatric Cardiac Anesthesia. University of Texas Southwestern Medical Center/Children's Health System of Texas - Dallas.)



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PERIPHERALLY INSERTED CENTRAL CATHETER (PICC) LINES

A peripherally inserted central catheter, or PICC, is defined as a catheter inserted percutaneously via a peripheral vein with the tip residing in a central vein. These lines are intended for medium- to long-term venous access in patients who require parenteral therapy or frequent phlebotomy. PICCs are used widely in the pediatric inpatient and outpatient population. Indications include intravenous therapy for greater than 14 days, stable patient requiring intravenous therapy with peripherally incompatible solutions, infusions of vesicants, parenteral nutrition, chemically irritating, frequent phlebotomy, patients in palliative care or hospice, among others. Small vessel, infection at the site of puncture, previous thrombosis of proximal vessel, phlebitis, burn or sclerosis, and emergent intravenous access are considered contraindications for PICC placement.

PICC lines are 1.1–3 Fr catheters of varying lengths, with the smallest single-lumen size being 1.1 Fr and the smallest double lumen being 2 Fr. According to the National Association of Neonatal Nurses (www.nann.org), 1.1–2 Fr catheters are used in infants <2.5 kg and 1.9–3 Fr in those >2.5 kg.

Recognized complications of PICCs include thrombosis, infection, catheter occlusion, phlebitis, chronic venous insufficiency, and pulmonary embolism.[40–43] Centrally placed catheter tips are associated with fewer complications than noncentrally placed catheter tip.[44] Peripherally inserted central catheters require frequent flushing and dressing change.

PICC LINE INSERTION TECHNIQUE

As for any central venous access, informed consent must be obtained. After sedation or induction of general anesthesia, the vein for PICC access is selected using ultrasound. Under sterile conditions and ultrasound guidance a thin metal needle or angiocatheter is used to enter the vein. A thin guidewire with a floppy tip is then inserted through the needle or catheter, into the vein, and the tourniquet is loosened. The needle is then removed and the thin PICC is advanced over the guidewire to the superior vena cava (SVC). The guidewire is then removed and an injection cap is attached to the catheter hub. Tip positioning into the SVC is driven by real-time fluoroscopy, if available, or by anatomic landmark and confirmed by x-ray.

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