An Overview of Vascular Access Devices Inserted via the Antecubital Area

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For the past few years, antecubital vascular access devices have gained much acceptance. Many patients have experienced the advantages of having one catheter placed for receiving several weeks of intravenous therapy. Nurses have accepted the responsibility for administering and monitoring these devices. This expanded role, however, requires increased knowledge of anatomy and physiology, sterile insertion techniques, required nursing care, and recognition and treatment of complications.

Intravenous nurses have always been taught that the veins located in the antecubital fossa were not suited for placement of a cannula. Trauma to these large veins could render the entire extremity useless for future I.V. needs should a severe infiltration or phlebitis occur. This precaution still holds true for regular peripheral cannulas. During the past 10 years, however, advances in technology have led to improvements in catheter materials and better methods for introducing the cannula into the vein.

Ten years ago, the use of longer catheters inserted into the veins of the antecubital area was introduced to the nursing community. Since that time, this type of catheter has met with much success and increased usage by nurses in many areas of specialization. These devices vary in length from 3 in to 22 in and are available in a variety of sizes from 28 ga to 16 ga. Many patients have benefitted from the use of these devices. Now it is widely accepted that the antecubital approach to the central venous system is by far the safest of all locations.[1,2]

These catheters can be studied with regard to a variety of aspects: 1) the type of material used for these devices; 2) the method of introduction; and 3) the ultimate location of the catheter tip. This group of devices has also raised many questions for several state boards of nursing, and a few states have written policies prohibiting nurses from inserting them. Several issues concerning correct insertion technique, appropriate nursing care, and recognition and treatment of complications have also been deliberated during the past few years.

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Anatomy and Physiology

A clear understanding of vascular anatomy and certain principles of physiology is very important because these catheters are threaded many inches into the veins. The location of the veins, the venous valves, and the endothelial lining of the veins; the size of the veins in the upper arm and chest; the velocity of blood flow; and the viscosity of the blood are all significant factors. The ability to apply this knowledge in the assessment of potential patient candidates is crucial to their successful use. The successful employment of antecubital vascular access devices (VADs) depends on an understanding of the principles of proper insertion technique and nursing care and the management of possible complications.

In most patients, three veins will be prominent for venipuncture in the antecubital region of the arm: the basilic, cephalic, and medial cubital veins.

The basilic vein ascends from the ulnar side of the arm, moves into the axillary area on the median aspect, and is usually the largest of the three. Venipuncture above the bend of the arm may be difficult because the vein plunges under the subcutaneous fascia. The cephalic vein ascends from the radial side of the arm and moves up on the lateral side. The median cubital vein communicates between the basilic and cephalic vein and is usually located directly in the antecubital fossa (Table 1).

The axillary and subclavian veins are a continuation of the basilic. In the shoulder, the cephalic vein usually curves inward to join with the axillary vein. Variations in anatomy may include the cephalic vein joining the external jugular vein, or dividing into two smaller veins—one joining the external jugular, and the other joining the axillary vein.[3,4]

The subclavian vein curves upward across the first rib and then moves downward in a medial and slightly forward position. The external jugular vein meets the subclavian vein in the middle of the clavicle. The internal jugular vein and subclavian vein join behind the sternoclavicular joint and form the brachiocephalic, or innominate, vein. The brachiocephalic vein varies in length depending upon the side of the body. The right brachiocephalic is about 1 in long, the left is about 2.5 in long and larger in diameter than the right. Both brachiocephalic veins unite to form the superior vena cava, which is 2.5 to 3 in long.

Valves are semilunar folds that project from the internal wall of the vein. Their purpose is to keep the blood moving toward the heart and to prevent pooling by gravity at the distal end of the extremities. They frequently appear at points of bifurcation and may look like bulges in the vein, especially when there is a tourniquet in place. Valves can present an obstruction during the advancement of any catheter in the vein. Methods that promote relaxation and prevent damage to the valves are crucial to the success of all catheter insertions, and will be discussed in a later section of this paper.

All veins have a lining composed of smooth, flat cells. When this lining is damaged, a series of four steps begins to occur. Contraction or vasoconstriction of the injured vessel occurs first and is usually transient. The disruption of the smooth endothelial cells exposes

TABLE 1. ANTECUBITAL VASCULAR ACCESS DEVICES

Name of Company	Name of Device	Catheter Material	Methods of Introduction	Available Gauge Sizes	Lengths of Catheter
Baxter	Intrasil	Silicone	Peel-away sheath	16	20 in (50.8 cm)
Becton-Dickinson	Careflow Microline	Polyurethane	Break-away needle	27	8 in (20 cm)
Catheter Technology Corporation	Groshong PICC	Silicone	Conventional Peripheral Catheter	17	22 (55 cm)
Cook Critical Care	Peripheral Intravenous Catheter Sets	Silicone	Peel-away sheath	16, 18, 20	20 in (50 cm)
Critikon	Micro Catheter	Polyurethane	Break-away needle	28	3.2 in (8 cm), 7.9 in (20 cm), 9.8 in (25 cm)
Becton-Dickinson Critical Care Monitoring	Intracath	Polyurethane	Through-the-needle, nonremovable needle with cover	16, 19, 22	8 in (20.3 cm), 12 in (30.5 cm), 24 in (61 cm), 36 in (91.4 cm)
Gesco	Per-Q-Cath	Silicone	Break-away needle	16, 20, 23	13.4 in (33.5 cm), 15.2 in (38 cm), 20 in (50 cm)
HDC Corporation	Ven-A-Cath	Silicone	Break-away needle	23	16 in (40 cm)
Luther Medical Products	L-Cath	Polyurethane	Break-away needle	24, 28	3.2 in (8 cm), 8 in (20 cm), 10 in (25 cm), 12 in (30 cm)
Menlo Care	Landmark	Elastomeric Hydrogel	Over-the-needle	22, 20	6 in (15 cm)
Pharmacia Deltec	P.A.S. Port	Polyurethane	Seldinger technique	18	30.4 in (76 cm)

subendothelial cells. Platelets adhere to these subendothelial cells and undergo activation, forming a hemostatic plug. Small amounts of plasma clotting protein contact the injured area, forming a mesh of fibrin strands that enhances the mass of platelets. There is, however, a mechanism for limiting the size of the mass. Endothelial cells bordering the injured site produce prostacyclin, which inhibits platelet aggregation, and vascular plasminogen activator, which activates fibrinolysis. For a period of several days, this process of fibrin formation and dissolution at the injured site maintains a seal while the smooth cells form a new connective tissue matrix and repair the damage to the vessel wall.[5]

Vessel size and the physiology of blood flow are important considerations. The entire output of blood from the heart is received by the aorta, which has the smallest cross-sectional area of the circulatory system. Therefore, the highest mean flow velocity occurs in the aorta. As the arteries branch and become smaller, their cross-sectional area increases and the flow velocity decreases. A capillary is the smallest "tube" for the blood to pass through, usually only large enough to acommodate one red blood cell. Its total cross-sectional area, however, is several hundred times the area of the aorta. The slowest flow velocity of blood occurs in the capillaries, allowing for the exchange of gases and metabolities. Venules arise from the capillary beds and are an average of 0.2 ml in diameter. As the venules become veins, the diameter increases, and the total amount of cross-sectional area decreases. The veins gradually become larger as they lead back to the vena cava, where the mean flow velocity is about one-half that of the descending aorta.[5] The diameter of the vena cava was discussed by two researchers, who had differing figures. In 1954, Burton reported that the lumen diameter of the vena cava in man was 30 millimeters. Whitmore, in 1968, reported a diameter of 20 mm.[5] Considering the vast range in size of the human body, it would be safe to assume that the diameter of the vena cava would be 20 to 30 mm in most adults.

The sizes of the cephalic and basilic veins of the arm are of particular importance for venipuncture and catheter advancement, but it is most difficult to locate a reference that lists the actual sizes of these veins. One study reports the mean diameter of the axillary vein as 16 mm and the subclavian vein as 19 mm.[6] Because veins become progressively larger, the basilic vein should then be slightly smaller than the axillary vein. The wide ranges in size of the human body and numerous anatomic variations make it impossible to confirm a definite size for each vein. All references do agree, however, that the basilic vein is larger than the cephalic vein in most adults and that the veins gradually become larger as they reach the central venous system in the chest.

The venous side of the circulation acts as a reservoir for the blood, about two thirds of the total blood volume flowing in the veins all the time.[5] Because of the elastic fibers in healthy veins, distension can occur with only minimal changes in pressure. In comparison, the pressure in large arteries will rise dramatically when the volume is increased. All vessels can reach a point where they will not stretch any further, but the distending volume for veins is much larger than it is for arteries.

Viscosity of the blood is affected by the flow velocity, hematocrit, and the size of the blood vessel. A fluid such as water is classified as a *Newtonian fluid*, or a fluid that maintains the same viscosity regardless of the flow velocity. Blood is a complex non-Newtonian suspension, the viscosity being determined by the red blood cells and proteins in solution in the plasma. As the flow velocity of whole blood decreases, its viscosity increases, and vice versa. When the velocity is decreased, red blood cells aggregate in stacks, a formation called *rouleaux*. This formation is encouraged by the presence of fibrinogen and globulin. The ability of red cells to change shape plays an important role in assuring an ample flow rate. When this characteristic is lost, the viscosity is increased, resulting in a decrease in flow velocity. Patients with sickle cell anemia experience this kind of change in viscosity. Disease states that cause high concentrations of plasma proteins can also increase the viscosity of the blood.[5]

The hematocrit has a dramatic effect on the viscosity of the blood, especially when it rises above 50%. Patients with fluid volume deficits or polycythemia vera and persons living in high altitudes will experience increased hematocrit levels and a corresponding increase in viscosity. Vessel size has a significant influence on viscosity, but not what one might expect. As blood flows into smaller capillaries, its viscosity will decrease. This may be partly explained by a phenomenon in which the blood closest to the vessel walls become relatively cell-free, leading to a lower hematocrit level in the smaller blood vessels. This mechanism prevents clogging of the capillaries with highly viscous blood.[5] Careful attention should be given to a patient's fluid volume status because of the types of medications being given and the presence of a catheter in the vein. Adequate flushing of the catheter when blood is seen may help prevent or delay the accumulation of rouleax or fibrin that can lead to the occlusion of the catheter lumen.

Patient Assessment

A thorough assessment of all aspects of the clinical situation will help to determine if the patient is a good candidate for an antecubital VAD. The length of therapy required is the first consideration. When nursing and medical diagnoses are made and the course of treatment is planned for several weeks, an antecubital VAD may be indicated. These devices work very well for patients with infectious disease processes, such as osteomyelitis or endocarditis, where antibiotics may be needed for 6 to 8 weeks. They are useful for hydration in a variety of patients (from young women with hyperemesis during pregnancy to terminally ill patients). VADs may also be a good choice for geriatric patients with poor skin turgor and/or limitations in peripheral venous access who may have good veins in the antecubital area.

Patients who will require venous access for many months, or even years usually need a device of a more permanent nature. Oncology patients, diabetics with recurring infections, sickle cell anemia, or AIDS patients may all benefit from an implanted port or tunneled catheter. Some time may be needed to arrange the surgical procedure to insert these devices, however, and antecubital VADs may fill the need during the interim. These patients may be able to accept their situation better if they are allowed to have more control. Therefore, an explanation of all devices, allowing the patient to make the decision about which device is most appropriate is in order.

The next consideration is the treatment location: will the patient be receiving treatment in the hospital or in the home? Antecubital VADs can be inserted successfully and cared for in both places. During hospitalization, the need for venous access can be met with these catheters if only one lumen is required. At the present time, there are no antecubital VADs manufactured with a multiple-lumen configuration. Patients who require numerous medications, hydration, and parenteral nutrition along with repeated blood sampling may need a device with double or triple lumens.

In the home care setting, patients may benefit from a secure route for administration of medications. It can eliminate the need for repeated venipuncture at inconvenient hours, which is characteristic of conventional peripheral catheters. This may decrease the possibility of serious complications from infiltrations or phlebitis. Patients should be evaluated on the basis of their ability to participate in their own care, and a nursing care plan should be tailored around their abilities.

The evaluation of the condition of the patients' veins is another key area for assessment. The antecubital area is well suited for access to the larger veins because the veins can be examined easily and be properly distended for venipuncture with the patient lying in a comfortable, supine position. Visual and palpable examination of the veins of both extremities should be done with a tourniquet in place. Veins that feel hardened or cordlike on palpation may be difficult for threading the catheter. Look for areas of bruising or scarring from previous venipuncture or cutdowns. A better outcome will be achieved if the catheter is inserted early in the course of treatment. The gauge of the catheter used should be the smallest possible needed to deliver the necessary infusions. Healthy veins have the ability to distend, but larger catheters may increase the possibility of phlebitis and decrease the blood flow around the catheter.

Characteristics of Devices

Catheter Materials

The introduction of a catheter through the veins of the arm has been called the hardest test of thrombogenicity of catheter materials in man.[7] A large portion of the length of the vein is in contact with the cannula. The presence of valves and the motion of the arm also have a great effect on the development of complications with these devices.

Polyurethane, silicone elastomer, and elastomeric hydrogel (Aquavene, Menlo Care, Menlo Park, CA) are currently being used in antecubital VADs. Polyurethane is moderately firm, allowing for easier insertion. It becomes softer after insertion because of body temperature. Polyurethane is reported to have less thrombogenicity than Teflon (DuPont, Wilmington, DE).[3]

Silicone is an extremely soft and pliable material. It is too soft to be inserted by conventional over-the-needle methods and requires special insertion procedures generally using through-the-needle techniques. Silicone antecubital VADs are available with and without a guidewire inside the catheter.

Elastomeric hydrogel is a new material currently being used for antecubital VADs. This material is stiff in the dry state. After 30–45 minutes in the vein, it absorbs enough fluid from the bloodstream to become as soft as silicone. The complete hydration process, which lasts for about 2 hours, causes the material to enlarge by two gauge sizes. Elastomeric hydrogel is reported to have a lower incidence of complications such as phlebitis and infiltrations compared with conventional Teflon.[8] Immediately after insertion, the patient is instructed to immobilize the arm for a minimum of 30 minutes to allow the softening process to occur. After that period the normal activities of daily living can be resumed.

Methods of Introduction

Through-the-needle, through-the-introducer, and over-the-needle designs are available for introducing the catheter into the vein. The Seldinger (through-the-needle) technique is employed with devices intended for insertion via the subclavian and jugular veins.

Recently, it is being used with the implanted peripheral port.

Over-the-needle designs have some advantages because the needle is smaller than the catheter, causing less bleeding around the puncture site. Elastomeric hydrogel is stiff in the dry state and lends itself to an over-the-needle design. One catheter (Landmark, Menlo Care, Menlo Park, CA), made from elastomeric hydrogel, uses an over-the-needle method with folding butterfly wings.

Through-the-needle and through-the-introducer methods are being used with silicone elastomer catheters. Currently, there are four different through-the-needle or through-the-introducer designs: 1) break-away needles; 2) peel-away sheaths; 3) slotted needles on a drum cartridge; and 4) conventional peripheral catheters.

The venipuncture is made with the break-away needle and the catheter advanced into the desired position. The needle is withdrawn, and force is applied to the attached wings, resulting in the needle breaking completly along its shaft. When a break-away needle is used, care must be taken to move the catheter *forward* through the needle. Inadvertently moving the catheter backwards out of the vein and needle in a distal direction could result in damage to the catheter from the sharp needle. Complete shearing resulting in a catheter emboli could be the outcome when small-gauge catheters are used.

The use of catheters with a peel-away sheath design may eliminate some of the problems of a break-away needle. The stainless steel needle is covered by a peel-away sheath. Once the venipuncture is made, the needle is removed in a manner similar to that of other peripheral over-the-needle catheters. The longer catheter is then advanced into the vein through the sheath, not the needle, thus eliminating the risk of damage to the catheter. When the catheter is in place, the sheath is withdrawn and peeled away by pulling on bilateral tabs.

Another type has a slotted needle on a drum cartridge with the catheter coiled inside the cartridge. The venipuncture is made with the slotted needle, and the drum is turned to advance the catheter into the vein. Once the venipuncture is made with this device, a large amount of blood escapes onto the drapes. The amount is not enough to cause significant blood loss for the patient, but it is enough to cause concern about contact with blood-contaminated drapes, linens, and equipment for health care workers.

Conventional, peripheral Teflon catheters are employed with some types of silicone elastomer catheters (Groshong, Catheter Technology Corporation, Salt Lake City, UT). This method offers the familiarity of a regular peripheral catheter and, like the peel-away sheath design, eliminates the risk of catheter damage from needles. Venipuncture is made with a conventional catheter, the stylet is removed, and the long catheter is threaded into the desired location. The conventional catheter is then removed. This method does require that the hub of the long catheter be attached after the conventional catheter has been removed.

The Seldinger technique is used with the peripherally implanted port (P.A.S. Port, Pharmacia-Deltec, St. Paul, MN). The venipuncture is made with large-gauge needle attached to a syringe. When blood is aspirated into the syringe, it is disconnected and a guidewire is threaded through the needle into the vein. The needle is removed, leaving the guidewire in place, and a vessel dilator is inserted over the guidewire. The guidewire is then removed and the catheter is threaded through the dilator. When the catheter tip is in the desired position, the dilator is removed. The port is then placed in a surgically created pocket; thus, the insertion of this device has not become accepted practice for nurses.

After the venipuncture, the catheter must be threaded into the vein for several inches, depending on the ultimately desired tip location. Silicone elastomer catheters are very soft and flexible, and are manufactured with and without guidewires. When the device does not contain a guidewire, it must be fed through an introducer by the use of forceps without teeth. The catheter is held with the forceps about 1/2 inch distal from the needle and delicately introduced into the vein in small segments. Because of the flexibility of the silicone, this process requires time and patience.

Catheters with a guidewire can be threaded into the vein manually without the use of forceps. Because this is a much faster process, care must be taken to avoid rapid advancement into the vein. This could lead to damage to the endothelial lining of the vein. Some nurses feel that a silicone catheter with a guidewire can be seen much more easily on x-ray than one without. It has been speculated that catheters with a guidewire produce a greater incidence of phlebitis than do catheters without a guidewire. More research into this question is definitely needed.

In the dry state, the elastomeric hydrogel is stiff enough to be advanced into the vein without the use of guidewires. The catheter is advanced into the vein by pulling the tab of a sheath that covers the entire length of the catheter.

Catheter Tip Location

Originally, antecubital VADs were intended for placement of the catheter tip in the superior vena cava

(SVC). Currently, there are two other locations being used for tip placement: 1) midline or in the larger portion of basilic or cephalic veins in the upper part of the arm; 2) midclavicular or subclavian vein.

The midline placement with the tip location in the cephalic or basilic vein in the upper portion of the arm is useful for delivery of all types of medications, hydration, and low (usually 10% or less) dextrose nutrition solutions. Antibiotics, pain management agents, and antineoplastic agents have all been given through a midline catheter. Because the catheter tip does not enter the chest, an x-ray to confirm placement is not necessary.

Midclavicular tip location is being used for the delivery of these same agents as well as hydration and nutrition solutions. Most references still feel, however, that total parenteral nutrition (TPN) solutions should be infused through a catheter with the tip in the SVC. Midclavicular catheter tip placement still needs to be confirmed by radiography. Catheters have been known to travel into different locations such as the mammary or jugular veins, and, without x-ray confirmation, the actual tip location is unknown. Complex shoulder joint motion, muscular contractions, variations in anatomy and numerous other smaller venous tributaries could be responsible for catheter tip displacement. A series of studies on "half-way" catheters (devices with tips located in the proximal axillary or distal subclavian vein) reports that no chest x-rays are needed *if* 1) the basilic approach is used; 2) no resistance is encountered on advancement of the catheter; 3) the length of catheter inserted is no more than 1/5 of the patient's height, and blood can be freely aspirated from the catheter.[9] It is very unlikely that all clinical situations and all patients can fit into the above categories. Therefore, the standard of care for all catheters advanced past the axillary vein should include confirmation of tip placement by chest x-ray.

Devices with the tip located in the superior vena cava are known as peripherally (or percutaneously) inserted central catheters (PICC). All medications and I.V. infusions can be given through these catheters, including TPN solutions and continuous infusions of vesicant-type medications. The term "PICC line" was coined and applied to the original catheter tip location in the SVC. Many published studies refer to a central catheter as one whose tip lies in the SVC or at the junction of the SVC and the right atrium.[10] The acronym PICC should therefore not be applied to a catheter whose tip lies in a vein other than the SVC.

Catheter Insertion

When a PICC, or a midclavicular placement, is planned, a physician's order is required. This order must also include a chest x-ray to verify tip placement. Consideration should be given to the appropriate steps necessary to assure third-party reimbursement. When a midline catheter is to be placed, a physician's specific order may not be needed. Two schools of thought exist on this issue: because the catheter tip will remain in the peripheral circulation and no x-ray is needed, it could fall within the scope of nursing practice; the increased dwell time, however, leads some nurses to feel hesitant about insertion without a physician's specific order. The requirements should be established by the institution or agency as written policy statements.

Measurements from the proposed insertion site to the desired tip location should be taken before venipuncture. This will be an indication of how many inches of cannula need to be inserted into the vein.

A sterile insertion procedure should be used with all these devices. A recent research study on peripheral venous catheters by Maki stated that "cutaneous antisepsis at the time of catheter insertion and the site care regimen may now be more important in prevention of catheter-related infections with peripheral venous catheters than limiting the duration of catheter placement."[11] All antecubital VADs inserted by nurses are placed by peripheral percutaneous puncture with a goal of increased dwell time. Therefore, strict attention must be given to sterile technique. This usually involves two pairs of sterile gloves—one for prepping the skin and the other for the venipuncture. The tourniquet can be applied after the first pair of gloves is removed.

The use of face masks by the nurse and patient should be given serious consideration, especially in cases of immunocompromised patients. For PICC insertions, the patient's head must be turned to the side where placement is being made, and the chin moved close to the chest. Aerosolization is likely, and the use of masks will protect the sterile field and the insertion site.

The patient should be lying in a comfortable, supine position, with one arm fully extended and supported by a towel roll. With the arm slightly flexed, it may be difficult to make the venipuncture. The arem should be approximately at a 45° angle from the patient's body. This position is satisfactory for the complete insertion of a midline catheter or midclavicular device. For a PICC the arm should be moved to a 90° angle from the body, with the head turned to the side of the insertion and the chin placed on the chest.

Skin preparation should be done with careful attention to sterile technique. Most frequently used procedures call for use of three or four alcohol swabs followed by three or four povidine-iodine swabs. Both solutions should be applied liberally with a moderate amount of friction in a circular motion, working from the proposed point of venipuncture outward. The swabs should never be returned to the inner area. The prepped area should be allowed to air dry. The diameter of the prepped area should be at least 4 to 6 in.

Drapes should be placed on top of the arm to create a large sterile field. Some catheters are quite long and may be difficult to manage without a sufficient amount of sterile area. Fenestrated drapes can be used or folded sterile towels placed to leave an opening over the prepped area.

The use of an intradermal local anesthetic is controversial. Local injections of xylocaine have been known to cause serious systemic reactions.[12] When large-gauge introducers are used, however, a local anesthetic may be necessary for patient comfort. Smaller gauge needles for the introduction of smaller cannulas may not require this injection. When an anesthetic is used, it should be injected with a small, preferably 27-ga, needle, gently infiltrating the area around the vein. After insertion into the skin, the syringe should always be aspirated for a lack of blood return. This will assist in preventing accidental I.V. injection.

Silicone catheters can be placed in a bath of sterile water or saline prior to insertion, to make these devices easier to slide into the vein. Devices made of elastomeric hydrogel, however, must *not* be in contact with fluid before venipuncture. Read and follow the manufacturer's instructions carefully.

The catheter should be advanced slowly into the vein in a manner that will not traumatize the delicate endothelial lining. This irritation could be the cause of phlebitis in the first week after insertion. The catheter should be moved freely up the internal lumen of the vein without contacting the vein walls.

Obstructions may be encountered during this phase of insertion. The most important step to take when this occurs is to *stop* threading the catheter. Do not place any force or pressure on the catheter to push it through or past an obstruction. Techniques that promote relaxation of the patient should be tried first. Simply distracting a patient by discussing something familiar may get his or her mind off the procedure and encourage relaxation. Adequate patient education before the procedure is started can help prevent any fear and tension. Other techniques to encourage relaxation of the valves include 1) providing a warm, comfortable environmental temperature; 2) rotating the wrist or moving the arm at a different angle from the body to help the catheter move away from the valve or other obstruction; and 3) instructing the patient to open and close his or her hand several times. It is important to remember that these techniques will not work on all obstructions and that they are aimed only at encouraging relaxation of the valves. Obstructions may also be caused by scarring of the vein wall, or sclerosis, this could prevent successful insertion of antecubital VADs in some patients.

Before infusion of any solutions, a chest x-ray must be performed to confirm the tip location for PICC and midclavicular devices; practices vary depending on who will read the x-ray. Some institutions have policies allowing the nurse inserting the catheter to check the placement and require a final report by the radiologist; others require that placement be confirmed by a radiologist immediately. Catheters without a guidewire, or those with the guidewire removed, may be difficult to see on the x-ray. Some protocols require that the guidewire be left in place while a stat chest x-ray is obtained to confirm tip placement. When proper position is confirmed, the guidewire is removed, a heparin lock is added, and the catheter is flushed and dressed.[13] Allowing the nurse to confirm placement prevents any delay in completion of the procedure while waiting for a radiologist. A final report from the radiologist is always placed in the chart.

A good working relationship with and support from the radiology department is important when questions or problems arise. Anatomic variations, surgery, or disease processes may have caused alterations in the familiar landmarks of the chest. If a catheter needs to be repositioned, assistance may be needed to determine how much to advance or withdraw the catheter for optimal placement.

Various methods can be used to anchor the catheter in place. Sutures can be placed on the catheter wings and loosely around the catheter. Care must be taken to prevent puncture of a soft catheter by the suture needle, or occlusion of the catheter by the sutures. Some states do not include suturing in the scope of practice for registered nurses, and many nurses may not feel sufficiently skilled at suturing. My experience validates that the use of sterile tape or sterile skin closure tapes can be as effective as sutures.

When the entire procedure is complete, documentation should include the vein used for insertion, the type and length of catheter inserted, the results of the chest x-ray, any methods used to reposition the catheter, the method used to anchor the catheter, and the type of dressing applied. The use of the term "by protocol" will indicate that the sterile prepping procedure was used. If any part of the written policy or procedure has not been followed, the variations of the procedure and the nursing assessment that lead to those changes should be documented carefully. This may include changes in prepping solution because of allergies or eliminating the face mask for a patient with respiratory difficulties.

Nursing Care

Dressing changes should be done with the same frequency and vigilance as they are with any other centrally located catheter or catheter intended for increased dwell time. Dressings should also be changed whenever they become wet, soiled, or nonocclusive.

Antecubital VADs can be connected to I.V. tubing for continuous infusion, or converted to a heparin lock. All tubing should have luer-lock fittings to prevent accidental disconnection. Before disconnection, the junction of the catheter and tubing or lock should be thoroughly cleansed with an antiseptic solution. The patient should be placed in a position so that the catheter exit site will be at or below the level of the heart when the tubing or lock is changed to prevent air from entering the catheter.

Patients with antecubital VADs can be allowed to perform all activities of normal daily living. The arm in which the catheter is placed does not need to be restrained in any way. The soft catheter materials permit motion of the arm. However, the patient should be cautioned against strenuous exercises or heavy lifting with the arm. Soft catheters can migrate out of the puncture site, especially when the catheter has been placed in the cephalic vein. It appears that muscular contractions of the biceps against the cephalic vein may create pressure on the soft catheter that can cause it to move distally.

Most manufacturers of these devices advise against the use of high pressures on these soft catheter materials. Damage to the cannula in the form of small holes or tears can occur when the pressure inside the lumen becomes too high. Excessive pressures can occur when small syringes are used; larger syringes create lower pressures. Forceful flushing of catheters with an occluded or partially occluded lumen can also cause catheter damage. During the flushing of all catheters, the first 1 to 2 ml should be given in a very slow, gentle push until the nurse is confident of absolute patency. The remainder of the flush should be vigorous enough to flush all blood out of the lumen. This is important for preventing any build-up of fibrin or red cells that might occlude the lumen. Infusions may be delivered by gravity or electronic infusion devices (EID). Check the catheter information for the amount of pressure that the particular catheter can withstand, and compare this to the pressures exerted by the EID.

Blood samples can be successfully withdrawn if close attention is given to good technique and proper management of the device. Flushing the catheter with 5 to 10 ml of saline prior to aspirating blood will help make obtaining blood easier. Movement of the extremity or placing the patient in various positions may move the catheter tip away from a valve or vein wall and improve the backflow of blood. All antecubital VADs are made of soft, flexible materials that can collapse when negative pressure is applied. For this reason, successful blood drawing may be easier with a syringe than it is with a vacuum blood collection system. The syringe plunger should be pulled back very slowly and gently for best results. After obtaining the blood sample, all blood should be thoroughly flushed from the cannula to assure patency of the catheter.

Catheter Complications

Phlebitis is the most frequent complication seen with these devices. Most studies report a frequency of between 12.5 to 23%.[14,15] My experience teaching nurses how to insert these catheters suggests that the phlebitis rate will be higher until the technique has been mastered and a confidence level achieved. Some investigators report that this phlebitis can be transient; can be resolved with early, aggressive treatment; and does not indicate immediate removal of the device.[1,14,15] Several names have been attached to this type of phlebitis, including mechanical, sterile or aseptic, and transient phlebitis. It is seen only within the first week after insertion of the catheter, which tends to support the theory that the cause is trauma to the endothelial lining of the vein on insertion. It can occur anywhere along a vein that houses the catheter.

After any trauma to a vein, initial vasoconstriction will occur as part of the body's response to the damage. Applying moist heat intermittently during the first 24 hours after insertion may aid the body's own repair work and help prevent the occurrence of phlebitis.

Frequent observation of the arm and insertion site are of utmost importance, especially during the first week.

At the first sign of any discoloration, edema, skin temperature change, or tenderness, aggressive treatment should be started. For patients in the home care setting, thorough education of the patient and/or care giver is indispensable.

The extremity should be placed at rest and elevated with heat applied continuously; moist heat may be preferable to dry. The catheter can still be used for infusions because the source of the phlebitis is mechanical and not chemical. Improvement may be seen within the first 24 hours, and all clinical signs and symptoms will usually be resolved within 72 hours. If treatment is unsuccessful, the catheter should be removed. Written policies and procedures should direct the nursing management of this problem. The physician should be informed, but valuable time can be lost in the attempt to locate the physician for directions about the treatment.

PICC and midclavicular devices will deposit infused solutions into the deep veins of the chest. Any chemical irritation will therefore not be observed. The midline catheter tip, however, will be located in the upper portion of the arm, and any vein irritation caused from the infused solution may be observed in the form of the classical signs and symptoms of phlebitis. When phlebitis of any etiology appears, it is important to know which type of antecubital VAD was inserted, what length of catheter was inserted, and where the tip lies. When the cause is suspected to be a chemical agent, the catheter should be removed immediately. Other factors that should be examined for cause include the amount and type of diluant for the medication, the rate of infusion, and the use of 0.22-μ final filters to eliminate particulate matter.

Catheter-related infections of VADs have been reported at rates as low as 2% even in a neutropenic patient population.[14] The importance of good sterile technique on insertion and maintenance cannot be overemphasized. A core group of experienced I.V. nurses who insert and care for these devices will have a better success rate than inexperienced and untrained personnel. A detailed look at the causes and frequency of catheter-related infections in the home care setting is urgently needed. If sepsis is suspected, the source should be carefully investigated by means of x-ray, cultures, and physical examination. If the source cannot be identified, the catheter may have to be removed and cultured. In the presence of a progressive, febrile illness, the catheter should be removed and cultured. All available literature reports a very low rate of infection, but these studies report only on patients who demonstrate clinical signs and symptoms of infection. To date, I have found no studies that reported on blood and catheter tip cultures from all patients.

Thrombosis of the large veins of the chest can occur, although no figures have been reported solely for antecubital VADs. The clinical picture includes edema of the entire extremity, upper chest, and neck because of pooling of venous blood in the extremity. Tenderness in the affected extremity, inability to aspirate blood and/or infuse through the catheter, and possibly some discoloration of the extremity may also be seen. Placement of these devices in extremities that have been affected by cerebral vascular accidents, mastectomy, or any other disease processes or surgical interventions that have resulted in impairment of the circulation should be avoided. Several reports indicate that tip placement in the subclavian vein may increase the chances of thrombosis development.[1,14,16] It can be speculated that the curvature of the subclavian vein allows more contact between the endothelial lining and the cannula tip, supporting the development of thrombi.

Catheter occlusion may result from clot formation inside the lumen of the catheter, precipitate formation by imcompatible drugs, or a catheter tip positioned against a vein wall or valve. Repositioning the patient and moving the extremity may help move the tip away from the obstruction. Adequate flushing between medications can help reduce the incidence of precipitate formation. Clotting inside the lumen can be prevented by not allowing infusions to run dry and by observing good flushing procedures. Urokinase can be employed to dissolve clots. All manufacturers' recommendations concerning this procedure and the internal volume of the cannula should be followed.

Conclusion

Antecubital VADs can meet the needs of many patients in hospital and home care settings when adequate knowledge of the devices is combined with good nursing care. Insertion, care, and maintenance of these devices should only be performed by nurses who are prepared to accept the responsibility and accountability for their actions.

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