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Difficult Peripheral Venous Access: Recognizing and Managing the Patient at Risk

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Abstract

Nurses commonly face challenges placing peripheral intravenous (IV) lines in adults and children, a situation described as difficult venous access (DVA). Multiple venipuncture attempts can heighten patient anxiety and suffering, delay vital treatment, and increase costs. Numerous factors such as small, fragile or hidden veins can predispose patients to DVA, and collapsed veins due to dehydration are especially problematic. Several techniques can improve venous prominence, but when IV access cannot be achieved promptly, other routes of administration can be valuable. For rehydration fluids and certain drugs, subcutaneous administration may be a safe and effective alternative, providing cost and ease-of-use advantages.

From time to time, every nurse faces the challenge of a "hard stick," a patient whose peripheral intravenous (IV) line cannot be easily inserted. This can cause the patient and family to grow more anxious with each failed venipuncture attempt, and can cause the nurse to feel frustration and have a sense of inadequacy, while much-needed therapy is delayed. Staff time is wasted and costs mount as intravenous therapy (IVT) experts are called in for consultation, and can escalate if special interventions, such as central lines, are needed. The term "difficult venous access" or DVA, has been proposed to describe situations in which multiple attempts or specialist care is needed to establish IV access. This article focuses on how to recognize and manage pediatric and adult patients who have a history of problems with IV insertion, or who exhibit other conditions that predispose them to DVA. It begins with an overview of the risk factors, costs, and consequences of multiple failed attempts to place an IV line and continues with a discussion of the techniques that nurses can use to enhance the visibility, palpability, and stability of peripheral veins. In addition, alternative routes of administration are proposed for patients in whom, or settings in which, venous access cannot be achieved in a timely manner.

Consequences of Multiple Failed Attempts to Achieve Venous Access

When initial attempts to place an IV line are unsuccessful, patients and their families can become agitated, making the task even more arduous. Multiple placement attempts can worsen "needle phobia" since subsequent venipunctures are often more painful and are associated with an increased incidence of extravasation, vascular perforation causing hematoma or hemorrhage, and phlebitis (Pector, 1998). Failed attempts can also compromise the trust and confidence a patient has in the nursing staff.

Since the number of sticks a patient receives can significantly affect his/her experience and alter overall perception of patient care within the hospital or other care settings, most facilities have guidelines for the number of attempts that can be made (Costantino, Parikh, Satz, & Fojtik, 2005; Lininger, 2003; Mbamalu & Banerjee, 1999). The *Journal of Infusion Nursing: Standards of Practice* recommends only two insertion attempts by any one nurse (Infusion Nurses Society, 2006).

Clinical studies have shown that initial peripheral intravenous (PIV) insertion success rates are higher in nurses who are specifically trained in infusion therapy (91%) than in staff nurses who have not received specialized training, or those who do not routinely place IV catheters (53%–65%) (Jacobson & Winslow, 2005; Lininger, 2003; Cosentino, 1984). Nurse specialists also have lower complication rates (e.g., bacteremia and phlebitis) associated with their catheterizations, thus making them a cost-effective addition to the staff of most medical centers (Miller, 1998). Despite these benefits, there has been a trend for hospitals to eliminate or reduce the number of their IV teams to minimize costs (Robertson, 1995). This strategy, however, may ultimately reduce the quality of IV therapy because it shifts the responsibility of starting IVs to the floor nurse, who may be less skilled in placing an IV line than is an expert.

The Scope of the Problem

Nurses encounter DVA across a wide variety of clinical settings, including emergency medical transport, emergency department, hospital, clinician's office, long-term care facility, hospice, and home care. There is, however, no assessment scale to predict the degree of difficulty in placing peripheral IVs and

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no consensus guidelines on preventing or managing these challenges. There also is little information on the frequency of DVA in adult and pediatric patients, other than a few clinical studies of PIV insertion success rates in prehospitalized and hospitalized patients. These findings suggest that, in emergency situations, IVs are placed within two attempts in 92% of adults (Lapostolle et al., 2007) and in 86% of children (Black et al., 2005). Success rates in nonemergency situations are somewhat lower, with medical–surgical or "floor nurses" placing an IV line within two attempts in 67% of children and in 86% of a mixed sample of adults and children between four and 95 years of age (Jacobson & Winslow, 2005; Lininger, 2003). Based on these limited data, at least 8% of adults and 14% of children are "hard sticks" that may potentially fall into the category of DVA.

Recognizing and Managing Patients Who Are Likely to Have DVA

When patients with potential DVA are identified early in the course of treatment, nurses have time to adjust their approach and employ special techniques to enhance venous access and improve cannulation success rates. This, in turn, reduces the emotional and financial burdens associated with repeated failed attempts to place an IV line. Patients who are likely to have IV insertion problems can often be recognized by identifying certain risk factors, and there are a number of approaches that nurses can take to enhance venous prominence when these situations arise. Many of these approaches involve basic venipuncture skills, such as reducing the angle of insertion in elderly patients with sunken veins, applying pressure over veins to displace adipose tissue in the obese, or anchoring veins that roll by positioning the patient's arm off the side of the bed or by pulling the skin taut (Rosenthal, 2005). In infants less than one year of age, IV cannulation may be more successful if the needle is inserted bevel down rather than bevel up (Black et al., 2005). If venous prominence does not improve using these methods, warming the limb may help promote vasodilation and improve venous access. In a clinical trial conducted by Lenhardt et al. in 2002, significantly less time was needed to place an IV cannula in adults whose hands and forearms were cradled in an active warming unit that was heated to 52^0C in comparison with cradling in a passive nonheated unit (36 seconds vs 62 seconds, respectively) (Lenhardt, Seybold, Kimberger, Stoiser, & Sessler, 2002). First attempt PIV insertions were also achieved in significantly more patients who received active versus passive treatment (94% vs 72%).

Transillumination can be used to improve visualization of veins that are nonvisible and nonpalpable in patients of all ages, but it is particularly useful in children (Goren et al., 2001; Mbamalu & Banerjee, 1999; Kuhns, Martin, Gildersleeve, & Poznanski, 1975). Veins appear as dark lines within the pinker subcutaneous tissue when illuminated by light emitting diodes (LEDs) or fiber optic lights that are placed around or under an extremity (John, 2007; Mbamalu & Banerjee, 1999). In one study, transillumination of the palm improved visualization of veins in 40 of 100 infants and young children, and successful venipuncture was achieved on the first attempt in 39 of these 40 cases (Goren et al., 2001). Although ultrasonography also has the potential to improve visualization and cannulation of peripheral veins, the data for both children and adults are very limited (Chinnock, Thornton, & Hendey, 2005; Schnadower, Lin, Perera, Smerling, & Dayan, 2007).

Children rate needle sticks as the most distressing part of their hospitalization (Burling & Collipp, 1969). Even under the best of circumstances, IV cannulation can be difficult. When children experience extreme anticipatory anxiety because they are afraid of needles or have had bad experiences, the situation is complicated because fear activates the sympathetic nervous system and can produce peripheral vasoconstriction (Johnstone, 1976). Nurses can play an important role in helping children cope with potentially painful procedures and in reducing their long-term adverse effects. By providing coping strategies that help alleviate distress, nurses can help patients feel that they have some control over the fear-provoking event. For example, allowing a parent or family member to be present during the procedure, or letting a child assist by holding bandages or applying pressure to the site after venipuncture can help empower the patient. Distractions such as conversation, headphones with music, video games, or a comforting toy may also reduce fear and anxiety. Nurses should create a supportive environment and provide an accurate, age-appropriate explanation of the procedure when the time is right. In general, young children should be given a simple explanation right before the procedure, whereas older children need a more detailed explanation, so that they can understand why the procedure is necessary. When time and circumstances permit, Child Life Specialists can be enlisted to help young patients cope with stress through play, preparation, education, and distraction. These professionals are experts in child development and family support, and are trained to help patients and their parents navigate the challenges of healthcare and hospitalization.

A minority of adults may also experience significant anticipatory anxiety and stress during the initial venipuncture. In addition, nearly all patients experience some degree of distress and sympathetic activation after the first failed attempt to place an IV, which makes subsequent attempts increasingly difficult (Lenhardt et al., 2002). The nurse can help to reduce anxiety in adults by creating an atmosphere that is accepting and open to the discussion of fears. Because fear is exacerbated by negative experiences, it is important that the nurse ensure that the procedure is as pain-free and stress-free as possible.

The use of topical anesthetics can significantly reduce the pain and anxiety associated with IV cannulation. Agents such as eutectic lidocaine plus prilocaine cream and amethocaine gel provide adequate analgesia within 30 minutes for venipuncture and within 45 to 60 minutes for IV cannulation (Willock, Richardson, Brazier, Powell, & Mitchell, 2004). Despite their proven effectiveness, topical anesthetics are not used routinely in the emergency room, possibly due to time constraints (Fein & Gorelick, 2006; Fein, Callahan, & Boardman, 1999).

Certain illness- and treatment-related factors can also heighten a patient's risk of DVA. For example, dehydration can lead to venous collapse because blood volume is diminished, making IV hydration difficult to initiate. Fragile veins associated with diabetes, peripheral vascular damage related to cardiovascular or sickle cell disease, and "blown-out" veins resulting from repeated IV treatments for various chronic medical conditions and cancers also are causes of frustration for the IV nurse.

Alternative Routes of Fluid Administration

Oral Rehydration Therapy

Oral rehydration therapy (ORT) can be used effectively in patients of all ages who have mild-to-moderate dehydration due to acute diarrhea of any cause and is, therefore, recommended as first-line therapy in these cases (World Health Organization [WHO], 2005; American Academy of Pediatrics [AAP] Provisional Committee on Quality Improvement, 1996). ORT is not suitable, however, for those who have persistent vomiting or difficulty swallowing, or for drowsy or demented patients who require close supervision to ensure that adequate fluids are taken (WHO, 2005; King, Glass, Bresee, & Duggan, 2003; AAP Provisional Committee on Quality Improvement, 1996). In these cases, nasogastric or IV rehydration is recommended. ORT is also not indicated for severe dehydration since this is a medical emergency requiring the rapid infusion of large fluid volumes that are best administered intravenously using a large bore cannula.

Despite the proven efficacy of ORT in the treatment of mild-to-moderate dehydration, physicians continue to prescribe IVT for all degrees of dehydration (King et al., 2003). Many apparently believe that IVT is less time-consuming and more effective than ORT, though this is not always the case (Spandorfer, Alessandrini, Joffe, Localio, & Shaw, 2005; Fonseca, Holdgate, & Craig, 2004; Conners, Barker, Mushlin, & Goepp, 2000).

Subcutaneous Administration

The subcutaneous route of administration can be a safe and effective alternative for administering fluids and certain drugs in adults. Clinical studies in elderly patients have shown that subcutaneous rehydration is as effective as IVT and is associated with only minor side effects that are typically limited to the injection site (O'Keeffe & Lavan, 1996; Challiner, Jarrett, Hayward, al Jubouri, & Julious, 1994; Schen & Singer-Edelstein, 1981). Agitated patients may also tolerate subcutaneous fluid infusions better than IVT. In a study of elderly patients with cognitive deficits, for example, significantly fewer patients experienced agitation during subcutaneous infusion (37%) than during IVT (80%) (O'Keeffe & Lavan, 1996).

Although current practice guidelines recommend the use of oral, nasogastric, and IV routes for pediatric hydration (King et al., 2003), each has its drawbacks in young children. Consequently, there is a continued need for a safe and well tolerated alternative that can be rapidly administered to this age group. Although subcutaneous fluid therapy has not been adequately studied in children, experience in adults suggests that it has several advantages that might be especially valuable in children:

- Advanced nursing skills are not required to start or maintain the infusion (Challiner et al., 1994; Bruera, Legris, Kuehn, & Miller, 1990)
- Subcutaneous therapy can be administered in the home or in other settings where IV therapy is not readily available (Barua & Bhowmick, 2005; O'Keeffe & Lavan, 1996; Bruera et al., 1990)
- It is "vein-sparing": it avoids some local complications of IV therapy (e.g., discomfort associated with IV cannulation, thrombophlebitis, septicemia) (Barua & Bhowmick, 2005; Dasgupta, Binns, & Rochon, 2000; Farrand & Campbell, 1996)
- There are many potential subcutaneous injection sites, and if a limb is chosen, immobilization is not necessary (Challiner et al., 1994; Bruera et al., 1990)
- Subcutaneous lines can be inserted and maintained in relatively pain-insensitive areas of the body (e.g., thigh, upper arm); hence, they cause little discomfort (Barua & Bhowmick, 2005; O'Keeffe & Lavan, 1996)
- Subcutaneous therapy can be stopped and restarted without the risk of clotting (Sasson & Shvartzman, 2001; Bruera et al., 1990)
- It may be more cost-effective than IV hydration because it does not require the intervention of skilled infusion nurses or multiple staff members, and it rarely takes more than one attempt to start. Less time is needed for catheter insertion and for replacing peripheral catheters that are removed accidentally or because of complications (Barua & Bhowmick, 2005; Walsh, 2005; O'Keeffe & Lavan, 1996; Challiner et al., 1994)
- It may also reduce costs by avoiding the need for specialized central venous access techniques that are expensive and associated with complications, such as bleeding, infection, blood clots, and pulmonary embolism (Dalal & Bruera, 2004)

It should be noted that subcutaneous fluid therapy has not been recommended for severe dehydration or any situation requiring the administration of more than three liters of fluid in 24 hours (Barua & Bhowmick, 2005) due to limitations on absorption rate. Its use also is contraindicated in cases where careful titration of fluids is required, such as in patients with heart or renal failure. Subcutaneous fluid therapy is generally used on a short-term basis (1-3 days). Isotonic fluids of the type used in IV therapy can be infused at rates of up to 125 mL/hour at a single site. (Walsh, 2005).

Figure 1 shows a clysis strip, which is commonly used for subcutaneous hydration therapy (Walsh, 2005). Suitable sites include the posterior upper arm, upper chest, abdomen, thigh, infraclavicular area, and flank, where there is a fat fold at least 1 inch thick. The needle tip must be able to move freely between skin and muscle (Walsh, 2005). Subcutaneous access devices

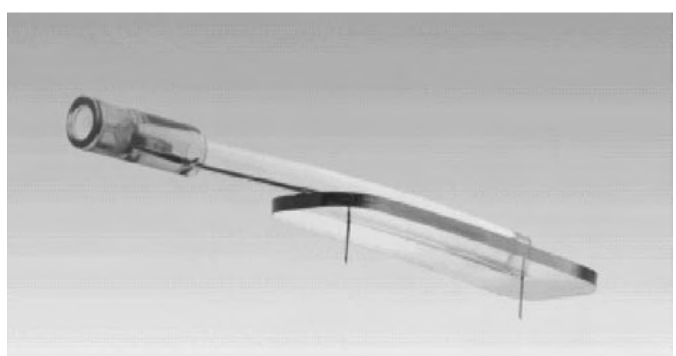

Figure 1. Clysis strip. (Walsh, 2005)

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(22- to 24-gauge) should be inserted at a 90º angle. Butterfly or hypodermic needles should be inserted at a 45º to 60º angle (Walsh, 2005). Another option is continuous subcutaneous infusion using 25- to 27-gauge winged or butterfly IV needles. Suitable sites include the posterior upper arm, upper chest, abdomen, thigh, infraclavicular area, and flank. Circulatory shock and reduced tissue perfusion from trauma are contraindications to continuous subcutaneous infusion.

Hyaluronidase-Augmented Subcutaneous Fluid and Drug Delivery

Studies of elderly hospital and nursing home patients suggest that large subcutaneous fluid volumes may cause local edema and pain when the rate of administration exceeds the rate of absorption (Hussain & Warshaw, 1996). These adverse events can be managed by reducing the rate of infusion, changing the site of administration, or adding a spreading agent such as hyaluronidase to the infusion mixture (Schen & Singer-Edelstein, 1981; Hussain & Warshaw, 1996).

Hyaluronidase is an enzyme that enhances the dispersion and absorption of subcutaneously injected fluids by temporarily depolymerizing hyaluronan, an intracellular polysaccharide found in the connective tissue of skin. This reduces tissue resistance and alters permeability, so that fluid can be administered at faster rates (Bookbinder et al., 2006). The effects of hyaluronidase are transient, dissipating within 24 to 48 hours after administration (Bookbinder et al., 2006; Frost, 2007). Studies using animal-derived forms of hyaluronidase show that adjunctive use allows fluids to be administered at a single site at rates approaching those achieved by IV administration (up to 500 mL/hr) with only minor side effects (Bruera, Neumann, Pituskin, Calder, & Hanson, 1999; Constans, Dutertre, & Froge, 1991).

Until recently, all forms of hyaluronidase were derived from animal tissue. Although they have a proven history of efficacy and safety, their use is limited by concerns about allergic and immunologic reactions. For example, bovine hyaluronidase has caused allergic reactions and, in rare cases, anaphylaxis (Yocum, Kennard, & Heiner, 2007; Ebo, Goossens, Opsomer, Bridts, & Stevens, 2005).

A recombinant human form of hyaluronidase called rHuPH20 (***hylenex*** 150 U/mL; Baxter International Inc., Deerfield, Illinois) was approved in 2005 by the Food and Drug Administration as an adjunct to accelerate subcutaneous fluid and drug administration. It is 100 times purer than the reference standard animal slaughter house-derived hyaluronidase based on specific activity (Bookbinder et al., 2006). A study in healthy adults showed no evidence of allergenicity after intradermal injection of a single dose of rHuPH20 (Yocum et al., 2007). Clinical experience suggests that coadministration of 150 U rHuPH20 allows pump-driven subcutaneous fluids to be administered at rates approaching those of the IV route, and that it enhances the subcutaneous delivery of certain medications, with no significant adverse events (Pirrello, Ting Chen, & Thomas, 2007). In healthy adults, rHuPH20 has been shown to accelerate the administration of clinically relevant volumes of subcutaneous fluids without the use of a pump (Thomas, Yocum, Haller, & von Gunten, 2007). Gravity-driven flow rates of lactated Ringer's solution were 383 mL/hr when coadministered with rHuPH20 in comparison with 82 mL/hr when administered with placebo. Adverse events occurred with similar frequency in rHuPH20- and placebo-treated subjects, and were generally mild to moderate in severity and limited to the injection site. No signs of cardiac overload were reported. Nonetheless, when administering subcutaneous fluids, volumes should be carefully titrated using physiologic and hemodynamic endpoints to ensure that systemic overload does not occur.

Clinical experience with hyaluronidase-augmented hydration in children is very limited, and almost all published reports are more than 50 years old. The available data indicate, however, that hyaluronidase accelerates subcutaneous fluid absorption in a manner similar to that seen in adults, and that it is safe and well tolerated (Burket & Gyorgy, 1950; Jaworski & Farley Jr., 1950; Boyd, 1951).

Specialized Interventions

Specialized interventions, such as peripherally inserted central catheters (PICCs), central venous lines, and intraosseous administration of fluids and emergency medications significantly increase anxiety in patients and their families because of their invasive nature. Additionally, each modality is associated with its own set of risks and benefits. PICCs are being used with growing frequency to deliver parenteral nutrition to adults in home care situations (Sands, 2006). In comparison with traditional central line catheters, PICCs may decrease the incidence of bloodstream infections, but may increase the rates of catheter malposition, local phlebitis, inadvertent dislodgement, and overall catheter dysfunction—particularly thrombotic dysfunction (Sands, 2006). Although potentially less life-threatening than infection, catheter dysfunction can cause treatment delays, and hence, increases in morbidity and mortality, the need for device replacement, and additional hospitalizations.

The intraosseous route enables the rapid delivery of a variety of drugs, crystalloid solutions, and blood products in emergency and nonemergency situations (Fowler et al., 2007). Although intraosseous procedures may take less time than IVs to achieve access and administer medications, they are more expensive and painful for the patient (Fowler et al., 2007). Complications are rare, but they increase with long-term infusions (Haas, 2004). Osteomyelitis is the most frequent adverse event (Fowler et al., 2007).

Conclusions and Implications for Practice

Venous access is challenging to achieve in some pediatric and adult patients. Multiple, failed venipuncture attempts are distressing to both patients and their families, can delay vital treatment, and can add to the cost of care. Healthcare providers lack established consensus guidelines on how to recognize or manage DVA. Patients likely to have IV insertion problems can however, often be identified on the basis of certain risk factors. In these cases, other routes of administration can be useful alternatives. For adults with known or suspected DVA, subcutaneous infusion may be a safe and effective option for fluid administration. It can be started quickly and maintained easily by healthcare staff members, even if they do not have advanced nursing skills. When augmented with the enzyme rHuPH20, subcutaneous fluid administration is significantly accelerated in adults, and subcutaneous infusion rates approach those obtained during IV administration, using either pump or gravity-driven delivery systems. A clinical trial is currently underway to assess the effects of concomitant rHuPH20 on fluid administration in dehydrated children.

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