

# DIFFICULT VENOUS ACCESS IN CHILDREN: TAKING CONTROL

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*It's 2 AM and you are feeling anxious and frustrated because you can't get an intravenous line started in a 3-year-old who was just brought into the emergency department after 24 hours of vomiting and diarrhea. After 4 attempts, the child is hysterical and the parents are angry and threatening to leave. How can you defuse the situation and regain control?*

**D**ifficulty in placing a peripheral intravenous line is a very common and frustrating experience for nurses, especially those who care for children. This article presents the consensus of experts in pediatric emergency medicine, nursing, hospital medicine, anesthesia, and critical care on the clinical impact of peripheral difficult venous access (DVA) in children, and the role of the nurse and physician in caring for patients in these challenging situations. This article focuses primarily on the nurse's role; the Panel's recommendations for physicians will be published separately. The Consensus Panel was co-chaired by Daniel Rauch, MD, FAAP, and Laura L. Kuensting,

MSN(R), RN, CPNP, and was made possible by an educational grant from Baxter Healthcare.

The main objectives of the meeting were to develop terminology to accurately describe the condition; explore the frequency and impact of peripheral DVA in pediatric patients; list the risk factors that may help identify children with DVA; describe its clinical and personal impact on the patient, family, and clinician; discuss strategies for the prevention and management of DVA; and develop considerations and recommendations for nursing practice.

## What is Peripheral DVA?

The consensus panel defined peripheral DVA as a clinical condition in which multiple attempts and/or special interventions are anticipated or required to achieve and maintain peripheral venous access. Examples of special intervention are technologies for enhanced vein visualization or staff with unique expertise (eg, intravenous team, anesthesia department, transport team).

Few intravenous lines in children are inserted successfully on the first try. A recent study of 593 attempts in centers with pediatric hospitalist services revealed that the average child required 2.2 sticks to achieve venous access, and that successful insertion took more than half an hour. The first attempt at insertion was successful in fewer than half the children, and a third of them could not be cannulated even after 2 tries. Peripheral intravenous lines could not be placed at all in 5% of cases.<sup>1</sup> A separate review of peripheral intravenous line insertions in children revealed that the first attempt was successful in just 53% of cases, while 67% were successful within 2 attempts and 91% were successful within 4 attempts.<sup>2,3</sup> Initial success rates in infants may be even lower (33%).<sup>2,3</sup>

## Identifying Children at Risk for Peripheral DVA

Children who are likely to present with challenges to peripheral intravenous line insertion often can be identified by certain risk factors (Table 1). Two scoring tools have been developed to help predict which children will be at risk of DVA.<sup>4,5</sup> The first of these tools was developed to predict the degree of skill that a clinician needs to success-

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TABLE 1  
**Risk factors for pediatric difficult venous access**

Risk factors	Consequences
<b>Patient-related factors</b>	
Age <3 years <sup>4,43,44</sup>	Venous fragility
Weight <5 kg or <10th percentile <sup>2</sup>	Poor venous visibility and palpability due to small size
Prematurity (<38 weeks' gestation) <sup>4</sup>	
Obesity <sup>6,21</sup>	Poor venous visibility
Dark or scarred skin <sup>21,45,46</sup>	
Veins that roll <sup>6</sup>	Difficulties with puncture
Pain, anxiety, and fear <sup>34</sup>	Peripheral vasoconstriction
Needle phobia <sup>47</sup>	
Mental/emotional status	Patient restlessness, combativeness, or inability to cooperate
<b>Illness- and injury-related factors</b>	
<i>Acute conditions</i>	
Dehydration	Volume depletion and venous collapse
Sepsis	Disorientation, agitation, chills, severe shaking
Septic shock	Low blood pressure
Vasoconstriction	Poor venous visibility and palpability
Burns	Volume depletion from plasma loss
Trauma	Volume depletion from hemorrhage
	Damage or limited access to peripheral veins
Peripheral edema	Poor venous visibility and palpability
Hypothermia	Peripheral vasoconstriction
<i>Chronic conditions</i>	
Congenital vascular malformations (eg, hemangiomas, birthmarks, arterio-venous fistulas)	Clusters of superficial vessels that are vulnerable to injury <sup>48</sup>
Cardiovascular disease	Reduced cardiac output and volume distribution
Neurologic abnormalities (eg, seizures)	Peripheral vasoconstriction, limited access to veins
Dermatologic abnormalities (eg, eczema, psoriasis)	Poor accessibility and visibility of veins
Cystic fibrosis	Fragile veins due to chronic steroid use and repeated intravenous antibiotic treatments
	Fragile veins
Diabetes mellitus and other endocrine or metabolic abnormalities	
Sickle cell disease	Pulmonary hypertension and poor peripheral perfusion <sup>49</sup>
	Scarred veins
Hemophilia	Need for frequent intravenous coagulation therapy
Cerebral palsy	Limited venous accessibility
	Peripheral vasoconstriction
	Collateral vein system
Spina bifida	Scarred or sclerosed veins
<b>Treatment-related factors</b>	
Long-term or repeated intravenous treatments for chronic conditions (eg, chemotherapy, steroids, certain antibiotics)	Scarred or damaged veins
Shunts, fistulas, tumors	Limited number of intravenous sites

fully place an intravenous line. Key factors that influenced cannulation success were the patient's age, medical history, and cooperation level, as well as the number of available access sites, the number of days the child was expected to require intravenous therapy, and the parent's level of anxiety and degree of cooperation.<sup>5</sup>

The second tool, called the Difficult Intravenous Access (DIVA) score, was created by Yen and colleagues<sup>4</sup> using a prospective analysis of 615 children undergoing peripheral intravenous catheterization. The DIVA score is the cumulative number of points for 4 factors: vein not being visible (2 points), vein not being palpable (2 points), history of prematurity (3 points), and age 1 to 2 years (1 point) or younger than 1 year (3 points).<sup>4</sup> Overall, intravenous cannulation was achieved on the first attempt in 75% of the children in this study. In contrast, the probability of success on the first attempt was less than 50% in children with a composite DIVA score  $\geq 4$ .

Certain parent- and provider-related factors can have an indirect effect on DVA risk in children. Highly anxious parents can cause nurses to feel stressed and distracted, making the delicate task of cannulation more difficult. In addition, children are very sensitive to their parent's emotions; therefore, anxious parents increase the anxiety level of their children. Similarly, providers who are inexperienced in pediatric intravenous line insertion techniques, or who are anxious or fatigued, may have greater difficulty achieving venous access.<sup>6</sup>

### The Negative Effects of DVA

Multiple needle sticks increase patient anxiety, pain, and suffering. Clinical studies have shown that 51% of children and 83% of toddlers experience high levels of distress during routine venipuncture, and 36% of young children experience significant pain.<sup>7,8</sup> Hospitalized children find needle sticks extremely painful and upsetting; in fact, 74% report that intravenous lines are the source of their worst pain.<sup>9</sup> The long-term consequences of poorly managed DVA include increased anticipatory and procedure-related distress during subsequent encounters.<sup>10</sup>

The inability to establish an intravenous line also can have a negative impact on the nursing staff, leading to frustration, worry, and diminished self-confidence. The ability to start an intravenous line is widely seen as one of the chief qualities of a "good nurse." Time constraints and crowded emergency departments can make nurses feel rushed and potentially lead to incidents such as needle-stick injuries.<sup>11</sup> Unrealistic patient or parent expectations for successful intravenous line insertion on the first attempt only make matters worse. Their perception of the quality of care is integrally linked to their experiences with the hospital staff.<sup>12,13</sup>

Multiple failed attempts to achieve venous access are costly because of the need for additional staff time, supplies, and special interventions when a peripheral intravenous line cannot be established.<sup>14,15</sup> Complications such as infection, vein injury, and infiltration/extravasation also can add to the overall costs of care.<sup>16-18</sup> Difficulties with cannulation also may cause significant delays in diagnosis and treatment.

### Caring for the Patient With DVA

Optimal management of the patient with DVA begins when the triage nurse assesses the need for an intravenous line by considering: the severity and chronicity of the underlying medical condition; the need for procedural sedation, hydration, medication, or laboratory work; and the availability of resources and technologies to facilitate intravenous line insertion. In addition, consideration of the child's future medical needs may avoid or delay DVA, or at least minimize its impact. Paying particular attention to the choice of vein, catheter type and size, and proper line securement, for example, could minimize vascular damage and help preserve the integrity of peripheral veins for later use.

Not surprisingly, success in placing an intravenous catheter increases with the nurse's level of experience and training.<sup>6</sup> In addition, intravenous nurse specialty teams that are specifically trained in infusion therapy have higher success rates and lower complication rates when placing intravenous lines than do non-intravenous nurse specialists.<sup>15,16</sup> Specific training programs also may improve staff efficiency, accuracy of insertion, and stress levels when performing intravenous catheterizations.<sup>19</sup> Institutional policies that limit the number of intravenous line attempts and treatment algorithms that show alternative routes of administration also may improve patient outcomes.

Further, good communication skills are essential for quality care. The nurse must act as a patient advocate with the attending physician, collaborate with specialists and other professionals during treatment and follow-up, and interact directly with patients and their families throughout the hospital visit. Providing realistic expectations and appropriate explanations of all procedures to parents and children is critical to gaining their trust and cooperation.

### Nursing Concerns: Barriers to the Optimal Management of Children With DVA

Resource limitations such as inadequate staff, safety regulations that make supplies difficult to access, and rooms with poor lighting or temperature control are barriers to the management of DVA. Other barriers may include limited access to or training with advanced technologies that facilitate peripheral intravenous catheter placement.

TABLE 2

**Routes for medication and fluid delivery (listed least invasive to most invasive)**

Fluid	Medication
Oral	Transdermal
Subcutaneous	Oral
Intravenous	Inhalation (includes endotracheal tube)
Naso/orogastric	Transmucosal (intranasal, buccal, rectal)
Peripherally inserted central catheter	Subcutaneous
Intraosseous	Intramuscular
Central venous cannulation	Intravenous
Central venous cutdown	Naso/orogastric
	Peripherally inserted central catheter
	Intraosseous
	Central venous cannulation
	Central venous cutdown

**Strategies to Improve Venous Access**

A number of approaches can be used to enhance the visibility and palpability of peripheral veins, including gentle slapping of the overlying skin, use of a proximal venous tourniquet or blood pressure cuff, and warming the limb.<sup>20-22</sup> Topical application of nitroglycerin ointment alone or with a eutectic mixture of local anesthetics (EMLA) cream is a safe and effective way to induce local vasodilation, improving the visibility of the veins of the hand and ease of cannulation.<sup>23,24</sup> Veins that roll can be stabilized by proper positioning of the access site or by using the “trigger” method, in which the hand and index finger are used to stretch the skin and obstruct venous flow in a downward motion that can be likened to the act of pulling the trigger of a gun.<sup>25</sup>

In small or dehydrated children who weigh 5 kg or less or who are in less than the tenth percentile for their weight, intravenous line insertion success rates may be improved if the needle is inserted bevel down rather than bevel up.<sup>2</sup> Transillumination is a more advanced technology that can improve the visualization of nonpalpable, nonvisible veins in infants and young children.<sup>26-28</sup> An infrared light source can be used to view both superficial and deep veins and reportedly reduces the number of needle sticks required to achieve venous access by 40%.<sup>29</sup> Other techniques such as ultrasound, fluoroscopy, and micropuncture may improve intravenous line success rates, but they have not been systematically investigated in children.

Intravenous line insertions are difficult in children, even under the best of circumstances. Good preparation, however, can significantly alleviate patient distress and enhance cooperation.<sup>30,31</sup> Good preparation involves providing an age-appropriate explanation of the procedure when the time is right and allowing sufficient time to answer

questions and allay fears. Because children’s anxiety is proportional to the anxiety level of their parents, it may be necessary to “treat” the parents first.<sup>32</sup> By using a family-centered approach that encourages parents to actively participate in decision making, nurses can help them feel that they have some control of the situation.<sup>33</sup>

Intravenous cannulation becomes more difficult and painful as children become increasingly anxious and fearful after each failed attempt, because fear activates the sympathetic nervous system and causes vasoconstriction.<sup>34</sup> Anxiety can be reduced by providing a warm, supportive atmosphere in which the child feels comfortable expressing fears. Distractions, such as conversation, video games, television, or music with headphones also may help to reduce distress.<sup>35,36</sup> If necessary, anxiolysis with nitrous oxide or midazolam can be used.

Although precannulation analgesia (ie, buffered lidocaine or topical anesthetic) effectively reduces the pain of peripheral intravenous cannulation, it is not usually the standard of care for pediatric patients in the emergency department because of time constraints.<sup>37-41</sup> Standing orders or triage protocols for the use of buffered lidocaine or topical anesthetics are recommended if time permits.

**Seeking an Alternative to Intravenous Catheterization**

Most institutions have guidelines that permit no more than 2 to 4 intravenous line insertion attempts per clinician. In a 1999 survey conducted by the National Association of Children’s Hospitals and Rehabilitation, 44% of the responding facilities allowed 2 insertion attempts to establish an intravenous line, 39% allowed 3 attempts, 4% allowed more than 3 attempts, and 13% permitted an unlimited number of attempts to achieve venous access.<sup>42</sup>

If special services (ie, infusion nurse, equipment) are unavailable or subsequent attempts are unsuccessful, an alternate route of administration may need to be considered. The oral, subcutaneous, and naso/orogastric routes are the most common alternatives for fluid and medication delivery in nonresuscitative situations. In resuscitative situations, the endotracheal tube, intraosseous, central venous, or venous cut-down routes are preferred for medication and/or fluid delivery. Alternative routes to intravenous lines for drug delivery in any situation include the intramuscular, transdermal, inhalation, and transmucosal routes (Table 2).

A number of factors should be considered when taking into account alternatives to intravenous therapy: severity of illness, emergency or non-emergency situation, immediate and future medical needs, staff time and resources, and the patient's pain and suffering. No clear criteria exist for when to stop trying to achieve venous access and switch to an alternate therapy or route of administration. Hospital guidelines should encourage ED personnel to reassess the need for intravenous access at pivotal points.

### Considerations for Nursing Practice and Research

Intravenous cannulation is one of the most frequently performed procedures in the emergency department and is widely perceived as a routine, relatively minor procedure. For this reason, its impact on children is often overlooked. They are highly vulnerable to procedural stress and experience significant pain and anxiety during venipuncture.<sup>9</sup> Nurses are in an ideal position to recognize patients with potential DVA and mitigate its short- and long-term consequences.

New nursing fellowship programs and competency tests are needed for pediatric vascular access, using both traditional methods and advanced technologies. Guidelines and algorithms should be developed on assessment of the need for intravenous therapy, protocols for intravenous line insertion, and standards for the maximum number of insertion attempts.

Additional clinical research is needed to determine the prevalence of DVA in different segments of the pediatric population and to document the extent to which it affects the child, parent, and nursing community. Ideally, nurses should complete event reports on the number of needle sticks required to start an intravenous line and the type and severity of any related adverse events. Suboptimal management of DVA is more likely to occur when there are insufficient resources or an inadequate number of staff on duty. ED personnel are well aware that it often takes 2 or more nurses to establish an intravenous line if the child is struggling or advanced technologies are needed. Systematic investigations are needed to document the type and extent of resources required to maintain quality care in specific clinical situations so that a strong case for additional funding can be presented to hospital administrators.

### Conclusions

Nurses encounter children with peripheral DVA on a daily basis. Anxiety worsens when multiple attempts to establish an intravenous line are needed. Early identification of patients with potential DVA gives nurses time to adjust their approach and use special techniques that enhance venous access and improve cannulation success rates. If venous access cannot be achieved after 2 to 4 attempts, alternative routes of administration should be considered.

Standards of practice and treatment algorithms are needed to ensure that children with peripheral DVA are managed effectively. Increased awareness, coupled with better management of DVA, should minimize its immediate and long-term impact on the child, family, and health care provider.

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