"Not Kids' Stuff Anymore"

By S. CHRISTOPHER SUPRUN JR., NREMT-P, CCEMT-P, and ROBERT G. NIXON, MBA, EMT-P

"Engines 116 and 119, Rescue Squad 119, Ambulance 126, and Medic 116 respond for a reported motor vehicle collision on Interstate 30, one half mile past Exit 4. Time out: 1648."

As your station's dispatcher completes the audible warning system and the above dispatch information, you think about another call "on the highway." Responding to the accident as the assigned medic/firefighter on your engine, the dispatcher tells you that this accident has two vehicles with numerous 911 calls coming in indicating two trapped patients.

On arrival, your engine company and the rescue squad work quickly to establish a safety zone and extricate the two patients. Although the BLS unit arrives on-scene, the other two units, including the transport medic, are caught in traffic and delayed.

Your first patient has a significantly diminished level of consciousness, rapid breathing, and a pulse that is barely palpable. Obvious bilateral femur fractures are present. In addition, the patient in the back has now lapsed into cardiac arrest, and CPR is in progress. You notice that the crew is aggressively managing the airway, having inserted a Combitube® airway to provide airway support for this patient.

Clearly, this is an extremely difficult situation for the only on-scene ALS provider. There are two patients, one in cardiac arrest and the other headed in that direction. You know that one of your next immediate steps is to gain vascular access. You may consider how to aggressively and appropriately treat one of these patients, much less two.

In an equally distressing situation, a 17-year-old male collapses in cardiac arrest for an unknown reason, and, after four unsuccessful attempts at starting an IV, the on-scene paramedic opts to simply transport the patient while performing CPR. The 17-year-old dies. The reason for the failed IV attempts is vascular collapse.

The problems encountered with both responses and others like them could be solved with adult intraosseous (IO) insertion. IO insertion has long been considered a procedure only for infants and children for most of the world, but that thought process may be evolving for those critical situations where you need immediate vascular access the most. This article will discuss IO infusion in adults—a procedure that will alleviate the frustration over gaining IV access in difficult situations.

The Problem

Failed intravenous access attempts are not uncommon in prehospital care or in emergency departments. Although various studies have somewhat dissimilar results, successful intravenous attempts are in the 96-percent range for patients who are hemodynamically stable. However, the success rate drops to 32 percent for patients in cardiac arrest.

Not only is failed IV access a problem in prehospital care, but so is the delay in moving the patient to a medical facility. Various studies have reported IV start times between five and 10 minutes. In contrast, intraosseous infusion can generally be initiated in less than one minute.

So what are the patient care options in the event of failed IV access? In the prehospital arena, there are only a few, such as the administration of medications by endotracheal tube or subcutaneous, intramuscular, rectal, oral, nasal, and inhalation dosing. However, few, if any, of these methods of drug administration have much value in the emergent patient.

IO: The Way to Go?

Recently, various authorities have extolled the benefits of IO infusion. IO insertion is typically thought of as a pediatric procedure because of the short existence of EMS, compared with the other medical fields. IO insertion may have been used by physicians as early as the late 1800s, but we know that research was being conducted into IO insertion as early as 1922. Throughout World War II, physicians used IO placement to facilitate the movement of blood and fluids. Combat medics also initiated IO drug and fluid therapy that resulted in numerous saves. Unfortunately, because there were no trained EMS providers in the late 1940s, the procedure was not used for civilian trauma and became relatively obscure until recently.

During the past several years, this technique has received much attention. After 15 years of experience with pediatric IO infusion and few complications, the fear of using the technique is minimal. Most paramedics have been trained to use the procedure on children; however, with the advent of easy-to-use IO devices, both pediatric and adult critical patients can benefit from the fast vascular access. Additionally, the 2005 emergency cardiac care guidelines recommend IO access if IV access is unavailable, giving IO a class IIa status.

It should also be noted that clinical application is important for those firemedics assisting local SWAT and emergency response teams because of the usefulness of an efficient adult device for the tactical environment.

Indications

Not every patient needs to receive IO fluids and medications. Table 1 illustrates the indications for using the device on the adult or child patient.

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Table 1. Indications for Using IO Therapy

Cardiac arrest	Coma
Status epilepticus	Head injury
Shock/trauma	Anaphylaxis
Dysrhythmias	Congestive heart failure
Dehydration	Dialysis
Burns	Emphysema
Drug overdose	Respiratory arrest
Diabetic ketoacidosis	Hemophiliac crisis
End-stage renal disease	Sickle cell crisis
Stroke	Pediatric shock
Acute myocardial infarction	Chest pain

Table 2. Common Contraindications for Using IO Therapy

Local infection
Fractures—extremity or sternum
Prosthesis—knee, shoulder, or sternotomy
Previous IO within the past 24 hours
No anatomical landmarks (morbid obesity)
Frailty or small stature (sternal IO)

Table 3. Complications Associated with IO Therapy

Extravasation or leakage of fluid into the tissues
Compartment syndrome
Needle becomes dislodged
Fractured bone
Failure to infuse solution or medication because of blockage
Bent needle
Though-and-through penetration
Pain
Infection
Inflammation of mediastium (sternal IO)
Injury to the heart (sternal IO)

IO insertion has been shown in numerous studies to have the same, or nearly the same, fluid movement and medication-carrying capacity as intravenous access. Remember from your initial advanced life support training, bones are filled with red-blood-producing marrow in the center and have large amounts of blood products flowing through them, similar to the more typical intravenous access.

Any medication that can be administered by a peripheral IV can be given by IO. Further, no adjusting of the dose or volume of medication is required when given by this route. Finally, five milliliters of blood aspirated through the IO device (after the first two milliliters have been discarded) can be used for standard laboratory testing at the emergency department.

Contraindications

As with any medical device, there are contraindications to the use of IO devices. Table 2 highlights the common contraindications for IO therapy.

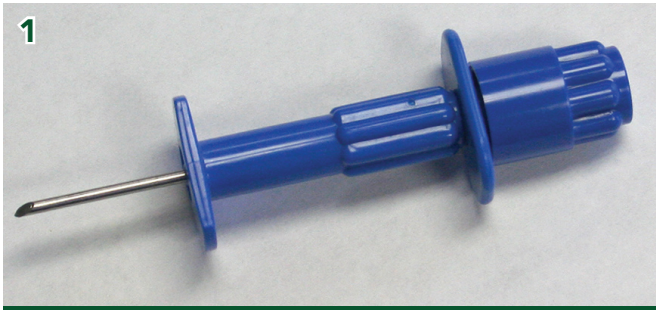
Complications

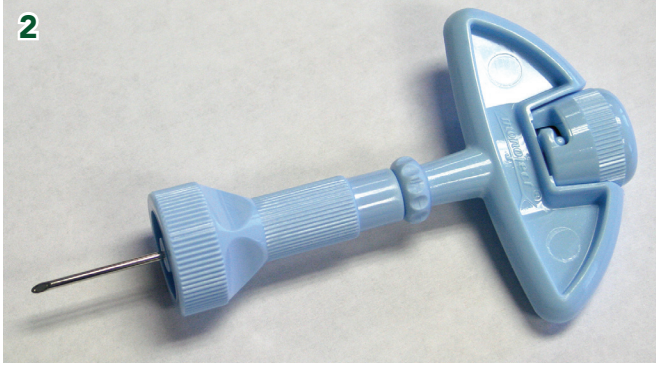
Complications arise with any medical procedure. While minimal, IO placement has shown a few complications, some of which are potentially serious. Table 3 highlights the complications associated with IO.

Pain is mentioned in the above table, but note that pain associated with the insertion of the IO needle is tolerable. Some patients have described the pain as a three on a 10-point scale for the typical IO placement. However, the same is not true regarding the infusion of solution. Patients have described the pain associated with fluid administration as an eight on a 10-point scale. Pain can be controlled through the administration of lidocaine with subsequent dosing as needed.

Available Devices

Several devices for pediatric and adult IO placement are on the market. These devices include the manual IO needles such as the Jamishidi, Sherwood Illinois, and Cook IO needles (photos 1 and 2). Other devices have recently come on the market including the WaisMed Bone Injection Gun (B.I.G.), the Pyng F.A.S.T. 1, and the Vidacare EZ-IO (photos 3-5). Table 4 presents the benefits and detractors of each device.





(1) The Jamishidi needle and (2) the Sherwood Illinois manual IO needle. (Photos by authors unless otherwise noted.)

Disinfecting After Use

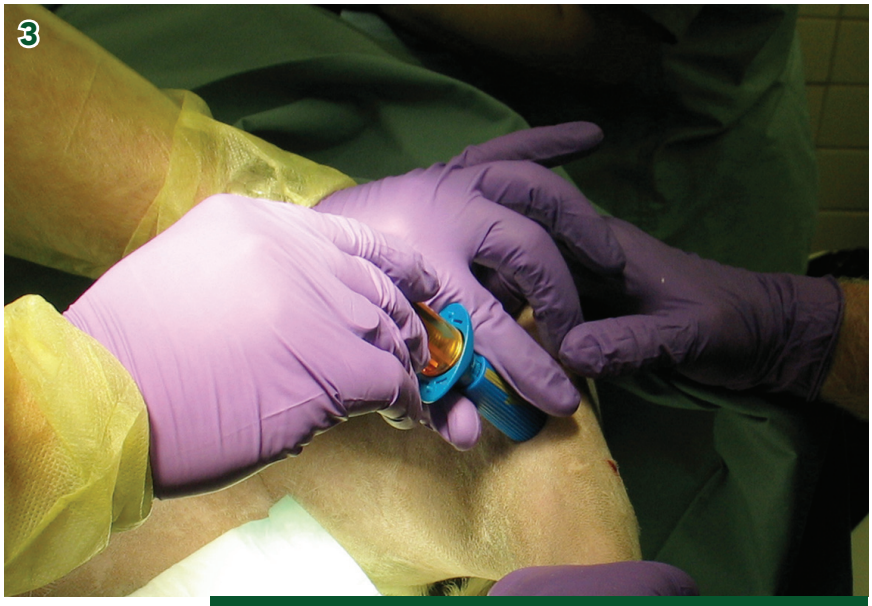
After using any IO device, it is essential to decontaminate any reusable equipment. Because the Vidacare EZ-IO has a reusable hand-held drill, the following procedures should be followed:

Table 4. Pros and Cons of IO Devices

Device	Pros	Cons
Manual IO Needles	• Ease of use • One-piece design • Cost effective • No batteries • Easy to remove	• Placement can cause wider opening than needed with extravasation possible • May require high pressure to insert
Bone Injection Gun	• Ease of use • Rapid insertion • Few parts to misplace • Easy to remove • Multiple sites (tibia and humerus)	• Label on device gives insufficient warning—may self-inject • Potential for inappropriate 'firing'—i.e., at each other • Potential for too deep insertion (through bone)—depth gauge may not be accurate
F.A.S.T. 1	• Ease of use • Rapid insertion • Faster distribution of medications to heart (beneficial in cardiac arrest)	• "Bed of Nails" looks intimidating • Multiple parts can become lost and hinder use • Must use removal device; otherwise, surgery may be required • High potential for complications and potential fatal complications • Limited to manubrium • Limited to average-sized adults • Obesity may be problem • Pressure to insert may be problematic for some, especially if angle of attack is off (indirect) • Removal requires tool
EZ-IO	• Ease of use • Immediate insertion • Multiple sites available (tibia and humerus) • Can be removed with standard syringe	• Not for use in manubrium (yet) • Multiple parts (drill or hand device, needle)

- Wipe clean with moistened cloth to remove large organic material or other contaminants.
- Spray with antimicrobial solution following the manufacturer's recommendations.
- Momentarily press the drill trigger several times during decontamination.
- Remove battery cover and clean as needed.
- Clean around drive shaft with cotton swab to remove any debris
- Wipe dry.

Once the device is clean and decontaminated, it can be returned to its case for storage.



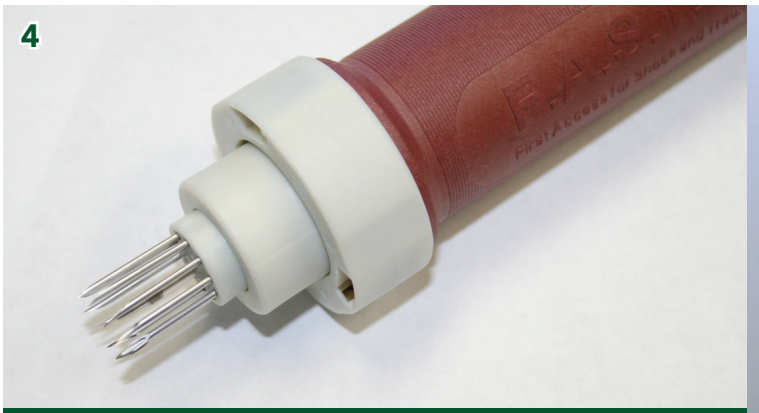
(3) This device is a WaisMed Bone Injection Gun (B.I.G.).

Recommendations

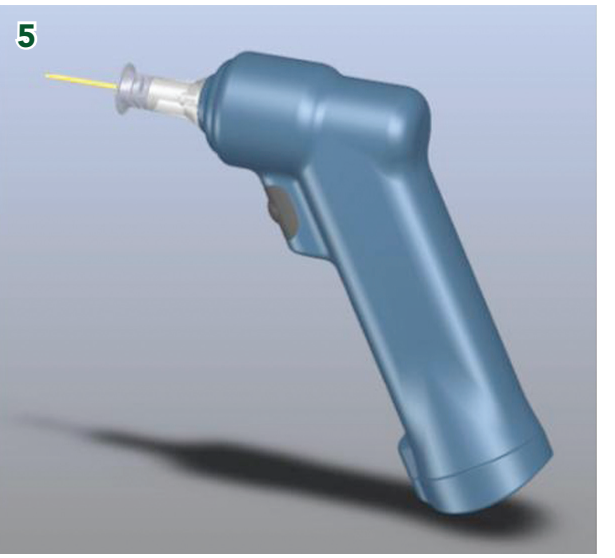
Each organization that provides prehospital care must evaluate each device and choose the one that best fits its needs. Each type of device has its benefits. For example, EZ-IO has benefits that the others do not. With adult IO, the question has always been the difficulty of inserting the needle into the bone, but the EZ-IO driver makes it less of an issue to gain vascular access in a time-sensitive way.

The device, weighing just a few pounds, has a magnetic connection so that the IO needles do not slip off as the field provider prepares for insertion. Using a normal sterile technique for IO insertion, placement on the adult is similar to that for the child patient.

The current FDA approved insertion sites include the tibia in the lower leg and the humeral head in the shoulder. The FDA has been petitioned to approve other insertion sites such as the distal tibia just above the ankle and the sternum. The landmark we consider initially is the tibial tuberosity. Its location is approximately two finger widths below the patient's patella and is a round oval elevation on the front surface of the tibia or lower leg. Coming medially or toward the inside one finger width is the insertion location for the EZ-IO device. This landmark should then be cleaned using an aseptic technique similar to that for other intravenous procedures. The EZ-IO device is inserted into the patient by using a needle cartridge that holds a single-use needle. Once inserted, a fluid bolus is administered to alleviate resistance against subsequent medication or fluid administration in the tissues.



(4) Pyng F.A.S.T. 1 has a "bed of nails" look that can be intimidating.



(5) The Vidacare EZ-IO has a reusable hand-held drill. (Photo courtesy of Vidacare Corporation.)

Intraosseous infusion has again come into focus as an alternative vascular access technique when IV access has failed or is particularly difficult. This article has looked at the scope of the problem of failed IVs and offered the IO as a prehospital answer in pediatric and adult patients. Further, this article has discussed the indications, contraindications, and complication of intraosseous placement. When you experience difficult or impossible IV access cases, the use of IO will provide quick vascular access to your critical patients and enhance the probability of their survival. The IO device is no longer just for kids.