Clinical Principles of Intraosseous Vascular Access
Disclosures

Presenter Information
And
Disclosure as applicable
Objectives

- Verbalize indications and contraindications of the Arrow® EZ-IO® Vascular Access System
- List considerations for insertion site selection
- Recognize insertion sites and landmarking techniques
- Identify critical concepts for needle set selection
- Understand preparation for procedure and supplies
- Distinguish insertion technique recommendations
- Apply pain management technique for IO infusions
- Understand utilization, care and remove of the IO vascular access
- Discuss care and maintenance of the EZ-IO® Driver
- Identify documentation and additional considerations
Why Consider IO Access?
Intraosseous Vascular Access History

- 1922: Drinker
- 1942: Papper
- 1945: WWII
- 1985: Orlowski

Global Leaders: Emergency and Critical Care

- American Heart Association (AHA)
  - 1988 PALS
  - 2005 ACLS
- European Resuscitation Council (ERC)
- International Liaison Committee on Resuscitation (ILCOR)
Organizational Support

AACN
RCN
ESICM
SCCM
NAEMSP
INS
ACEP
AHA
ENA
ERC

Clinical Papers
Position Statements
Program Inclusion
Publications

Clinical Evidence

500+ Intraosseous Access Research Articles\(^1\)

200 Clinical Articles Specific to the EZ-IO\(^\circledast\) System\(^1\)

Widespread Utilization of EZ-IO\(^\circledast\) System

\(70^{+}\) Studies and Clinical Trials\(^1\)

5000\(^+\) Patients Studied\(^1\)

Over 3 million needles sold\(^2\)

50 Countries\(^2\)

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\(^1\) Internal clinical evidence summary on file.

\(^2\) IMS Data and internal business data on file.
Difficult Vascular Access Considerations

- Time
- Skill
- Cost
- Risk
- IO
- PIV
- USGPIV
- EJ
- CVC
- PICC

Right Line
Right Patient
Right Time™

Clinical Principles EZ-IO® System
# Clinical Scenarios

## Emergent/urgent situations

<table>
<thead>
<tr>
<th>Anaphylaxis</th>
<th>DKA</th>
<th>RSI</th>
<th>Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altered LOC</td>
<td>Drug overdose</td>
<td>Resuscitation</td>
<td>SCC</td>
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<tr>
<td>Burns</td>
<td>Dysrhythmias</td>
<td>Seizures</td>
<td>Stroke</td>
</tr>
<tr>
<td>Dehydration</td>
<td>ESRD</td>
<td>Sepsis</td>
<td>Trauma</td>
</tr>
</tbody>
</table>

## Non-urgent/medically necessary situations; difficult vascular access (DVA)

<table>
<thead>
<tr>
<th>Analgesia</th>
<th>Chest Pain</th>
<th>Induction</th>
<th>Rescue Line</th>
</tr>
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<tbody>
<tr>
<td>Antibiotic Therapy</td>
<td>Fluid Management</td>
<td>Metabolic disorders</td>
<td>Sedation</td>
</tr>
</tbody>
</table>
Difficult Vascular Access Algorithm

**IS THE NEED FOR VASCULAR ACCESS IMMEDIATE?**

**YES**
- Peripheral access challenging?
  - **YES**
    - Intraosseous (IO) access
  - **NO**
    - Peripheral IV (PIV) access

**NO**
- Anticipated time frame for IV therapy <24 hours?
  - Peripheral IV (PIV) access
- Anticipated time frame for IV therapy >24 hours?
  - CVC/PICC

More than 2 unsuccessful PIV or CVC attempts: Consider IO access as a bridge until definitive long-term access can be established.
Indications and Contraindications
EZ-IO® System
Indications
The EZ-IO® System provides intraosseous access for adult and pediatric patients when intravenous access is difficult or impossible to obtain in emergent, urgent or medically necessary cases for up to 24 hours in the US and up to 72 hours in the EU.

<table>
<thead>
<tr>
<th>Adults</th>
<th>Pediatrics</th>
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</thead>
<tbody>
<tr>
<td>• Proximal humerus</td>
<td>• Distal femur</td>
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<tr>
<td>• Proximal tibia</td>
<td>• Proximal humerus</td>
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<tr>
<td>• Distal tibia</td>
<td>• Proximal tibia</td>
</tr>
<tr>
<td></td>
<td>• Distal tibia</td>
</tr>
</tbody>
</table>

Contraindications
Fracture in target bone
Infection at area of insertion
Inability to identify landmarks
IO access or attempted IO access in target bone within previous 48 hours
Previous, significant orthopedic procedure at the site, prosthetic limb or joint.
Anatomy and Physiology

Highly vascular, non-collapsible access

Rapid flush to displace marrow
Real-time Fluoroscopy - Human Model
Site Selection

Do not use the powered EZ-IO® System in the sternum!
Insertion Site Identification
Proximal Humerus Site Identification
**Proximal Humerus Insertion Angle**

**Humerus:** Insert needle set at a 45-degree angle to the anterior plane and medial.
**Positioning for Proximal Humerus Site**

Using either method below, adduct elbow, rotate humerus internally

Place the patient’s hand over the abdomen with arm tight to the body **OR**

Place the arm tight against the body, rotate the hand so the palm is facing outward, thumb pointing down

Option A

Option B
Proximal Tibia Site

Adult

Infant/Child

Growth Plate

Growth Plate
Distal Tibia Site Identification

Insert medially on the flat, center aspect of the bone
Distal Femur Site Identification - Pediatrics

- Medullary cavity
- Quadriceps m.
- Compact bone
- Spongy bone (red marrow)
- Patella
- Articular cartilage
- Infrapatellar fat

Femur
Diaphysis
Epiphysis

Tibia

Growth Plate
Needle Set Selection
**EZ-IO® Needle Set Selection**

Clinical judgment should be used to determine appropriate needle set selection based on patient weight, anatomy and tissue depth overlying the insertion site.

- **45 mm**
  - 40 kg or over, excessive tissue depth

- **25 mm**
  - 3 kg or over

- **15 mm**
  - 3-39 kg
**Needle Set Selection Tips**

With the tip of the needle set touching bone, at least 1 black line must be visible above the skin.
Insertion
Insertion Preparation
Correct

In the adult patient, the proximal tibia insertion site is approximately 2 cm medial to the tibial tuberosity, or approximately 3 cm below the patella and approximately 2 cm medial, along the flat aspect of the tibia.

Incorrect

Distal to the correct insertion site, the bone cortex becomes increasingly thicker and the IO space increasingly smaller in diameter; this may lead to suboptimal results impacting insertion.
Insertion Technique
**Insertion Technique Tips**

Use gentle, steady pressure for insertion

Cross-section of bone; precise hole
Code Configuration - Hospital

Code Cart

Medication RN

Compressions

Monitor

Defibrillator

Pharmacist

Recorder

Lab

Code Lead

and Hospitalist

Airway

IO Access

IO Access

EKG/Compressions

Clinical Principles EZ-IO® System
Resuscitation Configuration – Pre-Hospital

- BLS Leader
- Airway Ventilation
- IO Meds
- CPR 1
- CPR 2
- AED
- Commander Monitor
**EZ-IO® Driver vs. Manual Insertion**

- **Benefits: Driver Insertion**
  - Control with proven tactile feedback\(^1\)
  - Minimizes risk of extravasation and dislodgement\(^2\)
  - Faster, gentler experience\(^1\)

- **Risks: Manual Insertion**
  - Increased risk of extravasation and dislodgement\(^2\)
  - Longer insertion\(^3\)
  - May cause more patient discomfort\(^3\)
  - Risk for over or under-penetration\(^1\)


\(^2\) Teleflex internal study done in cadaveric bone.

Manual Insertion

Rotate clockwise/counter-clockwise while applying gentle- moderate, steady downward pressure
Use and Removal
Flush

Adults: 5-10 mL

Infants and Small Children: 2-5 mL
**Infusion and Medications**

- For optimal flow infuse with pressure
- IO vascular access is a peripheral line
Laboratory Analysis/Blood Sampling

Check with your laboratory for specimen processing capabilities.

1. Connect a syringe directly to the hub
2. The first 2 mL of IO blood aspirate may be discarded or considered for point of care testing
3. Samples must be identified as IO blood
IO Infusion Pain Management

2% lidocaine (preservative-free and epinephrine-free)

- **Adult**: Typically 40 mg
- **Infant/Child**: Typically 0.5 mg/kg (NOT to exceed 40 mg)

- **Lidocaine**: Initial dose 120 seconds
- **Dwell**: 60 seconds
- **Rapid Flush**: Lidocaine ½ initial dose 60 seconds

≥ 4 minutes total time

www.eziocomfort.com

Observe cautions/contraindications for lidocaine, confirm dose per institution
IO Access Care and Maintenance

• Assess frequently
  • IO access patency
    • Repeat flush as needed
  • Monitor site
  • Patient comfort
Removal
Who Can Utilize The EZ-IO® System?

MEDICAL PROFESSIONALS
- Physicians
- Mid-Levels
- Registered Nurses
- Pre-Hospital Providers

TYPICAL REQUIREMENTS
- Policy/Protocol
- Education
- Competency
- Practice
Driver Considerations and Supplies
Driver Specifics

- Cradle
- Battery Indicator LED
- Sealed Lithium Batteries

- Magnetic Shaft
- Trigger
- Battery Indicator LED
- Sealed Lithium Batteries
**Driver Storage**

- Remove cradle from driver when stored in the yellow soft-sided case
- Remove cradle from driver when stored in the black hard-sided case
Driver Storage (cont.)

- Supply List
  - Needle Sets (2 of each length)
  - EZ-Stablizer® Dressings (4)
  - Driver (1)
  - Skin prep
  - Pre-filled normal saline syringes
  - Lidocaine dosing instructions
IO Access and Mechanical CPR Devices
**Proximal Humerus IO Access and Mechanical CPR Devices**

- Properly position arm and landmark for insertion
- Immobilize arm with IO vascular access
  - Arm should remain adducted
  - Maintain appropriate stabilization; if mechanical CPR device has arm straps, these may be used to secure arms
  - Ensure EZ-Stabilizer® Dressing is utilized
- Use caution when lifting or rolling patient
  - Avoid rolling to side where IO access is in place
**Proximal Humerus IO Access and Mechanical CPR Devices**

According to Jolife, the manufacturer of the LUCAS® Chest Compression System, a properly placed and fixated IO device in the proximal humerus should not affect LUCAS® chest compressions.

Information on file at Teleflex.
Proximal Humerus IO Access and Mechanical CPR Devices

AutoPulse® Resuscitation System and EZ-IO® System vascular access

In both the prehospital and hospital settings the AutoPulse® from ZOLL® and a proximal humerus EZ-IO® System vascular access are used in the same patient.

Information on file at Teleflex.
Education Resources
**Training Kit**

- Training Driver
- Non-sterile Needle Sets
  - 15 mm, 25 mm and 45 mm
- EZ-Stabilizer® Dressings
- Yellow storage pack
- Simulated bone models
www.teleflex.com/ezioeducation

- Online Learning Module System with Quiz and Certificate
- Frequently Asked Questions
- Instructions for Use (IFU)
- Videos
- PowerPoints
- Pain Management Resources
- Site Identification Resources

- Templates
  - Policy/Procedure
  - Difficult Vascular Access Algorithm
  - Competency
  - Exam

- Links
  - Cadaveric Lab Programs
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iPhone and Android app

24 Hour Clinical Support
800-680-4911

Outside the US
+1.800.680.4911
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Thank You
ARROW® EZ-IO® Intraosseous Vascular Access System Competency Template (Annotated)

☐ **IDENTIFIES INDICATIONS FOR USE**

For adult and pediatric patients any time vascular access is difficult to obtain in the proximal humerus, proximal and distal tibia in adults and pediatric patients and the distal femur in pediatric patients in emergent, urgent or medically necessary situations for up to 24 hours.

☐ **IDENTIFIES CONTRAINDICATIONS**

- Fracture of the targeted bone
- Previous, significant orthopedic procedures at insertion site (e.g. prosthetic limb or joint)
- IO in the target bone within the past 48 hours
- Infection at area of insertion
- Excessive tissue or absence of adequate anatomical landmarks

☐ **PREPARES FOR PROCEDURE/OBTAINS SUPPLIES**

- EZ-IO® Power Driver
- EZ-IO® Needle Set and EZ-Connect® Extension Set
- EZ-Stabilizer® Dressing
- Non-sterile gloves
- Cleansing agent of choice
- Luer lock syringe with sterile normal saline flush (5-10 mL for adults, 2-5 mL for infant/child)
- Sharps container
- Additional Equipment/Supplies if Indicated/Ordered:
  - 2% preservative & epinephrine-free lidocaine (intravenous lidocaine)
  - Intravenous fluid
  - Infusion pressure pump or pressure bag, tubing, 3-way stop cock
  - Supplies for lab samples

☐ Explains procedure to patient/family

☐ Indicates intent to obtain assistance if needed

☐ Performs hand hygiene

**INSERTION SITE IDENTIFICATION**

☐ **Proximal Humerus (Adult)**

1. Places the patient’s hand over the abdomen (elbow adducted and humerus internally rotated)
2. Places palm on the patient’s shoulder anteriorly to identify the “ball: under the palm as the general target area
3. Places the ulnar aspect of one hand vertically over the axilla and the ulnar aspect of the other hand along the midline of the upper arm laterally
4. Places the thumbs together over the arm to identify the vertical line of insertion on the proximal humerus
5. Palpates deeply up the humerus to surgical neck then moves 1-2 cm proximal to the most prominent aspect of the greater tubercle

☐ **Proximal Tibia (Adult)**

1. Extends patient’s leg
2. Palpates insertion site approximately 2 cm medial to the tibial tuberosity, or approximately 3 cm below the patella and approximately 2 cm medial, along the flat aspect of the tibia

☐ **Distal Tibia (Adult)**

1. Palpates insertion site approximately 3 cm proximal to the most prominent aspect of the medial malleolus
2. Palpates the anterior and posterior borders of the tibia to assure insertion site is on the flat center aspect of the bone

☐ **Distal Femur (Infant/Child)**

1. Secures the leg out-stretched to ensure the knee does not bend
2. Identifies the patella by palpation. Identifies the insertion site just proximal to the patella (maximum 1 cm) and approximately 1 cm medial to midline

☐ **Proximal Humerus (Infant/Child)**

1. Places the patient’s hand over the abdomen (elbow adducted and humerus internally rotated)
2. Places palm on the patient’s shoulder anteriorly to identify the “ball” under the palm as the general target area
3. Places the ulnar aspect of one hand vertically over the axilla and the ulnar aspect of the other hand along the midline of the upper arm laterally
4. Places the thumbs together over the arm to identify the vertical line of insertion on the proximal humerus
5. Palpates deeply up the humerus to surgical neck then moves 1-2 cm proximal to the most prominent aspect of the greater tubercle

- **Proximal Tibia (Infant/Child)**
  1. Extends patient’s leg. Palpates the tibia to identify the medial and lateral borders
  2. Identifies the insertion site approximately 1 cm medial to the tibial tuberosity, or just below the patella (approximately 1 cm) and slightly medial (approximately 1 cm), along the flat aspect of the tibia.

- **Distal Tibia (Infant/Child)**
  1. Identifies insertion site approximately 1-2 cm proximal to the most prominent aspect of the medial malleolus
  2. Palpates the anterior and posterior borders of the tibia to assure insertion site is on the flat center aspect of the bone

**NEEDLE SET SELECTION**
- Considers patient’s weight and anatomy
  - EZ-IO® 45 mm Needle Set (yellow hub) considered for proximal humerus insertion in patients ≥ 40 kg and/or excessive tissue over any insertion site
  - EZ-IO® 25 mm Needle Set (blue hub) considered for patients ≥ 3 kg
  - EZ-IO® 15 mm Needle Set (pink hub) considered for patients approximately 3-39 kg

**INSERTION**
- Utilizes clean, “no touch” technique, maintaining asepsis
- Prepares supplies
  - Inspects needle set packaging to ensure sterility, checks expiration date on package
  - Attaches normal saline filled syringe (5-10 mL adult, 2-5 mL infant/child) to extension set, primes tubing; leaves the syringe attached, set unclamped
- Prepares the site by using antiseptic; stabilizes the extremity for insertion
- Removes the needle set cap

**ADULT INSERTION TECHNIQUE**
- **Proximal Humerus – Adult**
  1. Aims the needle set at a 45-degree angle to the anterior plane and posteromedial
  2. Pushes the needle set tip through the skin until the tip rests against the bone; identifies 5 mm mark above the skin
  3. Gently drills into the humerus approximately 2 cm or until the hub is close to the skin
- **Tibia – Adult**
  1. Aims the needle set at a 90-degree angle to the bone
  2. Pushes the needle set tip through the skin until the tip rests against the bone; identifies 5 mm mark above the skin
  3. Gently drills, advancing the needle set approximately 1-2 cm after entry into the medullary space or until the needle set hub is close to the skin

**INFANT/CHILD INSERTION TECHNIQUE**
- **Proximal Humerus – Infant/Child**
  1. Aim the needle set tip at a 45-degree angle to the anterior plane and posteromedial
  2. Pushes the needle set tip through the skin until the tip rests against the bone; identifies 5 mm mark above the skin
  3. Gently drills, immediately release the trigger when you feel the loss of resistance as the needle set enters the medullary space; avoids recoil
- **Femur and Tibia – Infant/Child**
  1. Aims the needle set at a 90-degree angle to the bone
  2. Pushes the needle set tip through the skin until the tip rests against the bone; identifies 5 mm make above the skin
  3. Gently drill, immediately release the trigger when you feel the loss of resistance as the needle set enters the medullary space; avoids recoil

**INSERTION COMPLETION**
1. Removes driver and stylet
  - Holds the hub in place and pull the driver straight off; continues to hold the hub while twisting the stylet off the hub with counter clockwise rotations; notes catheter feels firmly seated in bone
  - Disposes of all sharps and biohazard materials using standard biohazard practices and disposal containers. If using the NeedleVISE® 1 port sharps block, place on stable surface and use a one-handed technique.
2. Places the EZ-Stabilizer® Dressing over the hub
3. Attaches a primed EZ-Connect® Extension Set to the catheter hub, firmly securing by twisting clockwise
4. Pulls the tabs off the dressing to expose the adhesive, applies to the skin
5. Aspirates for blood/bone marrow
   - Notes inability to withdraw/aspirate blood from the catheter hub does not mean the insertion was unsuccessful.
6. Identifies correct technique based on situation:
   □ ADULT - RESPONSIVE TO PAIN – RECOMMENDED ANESTHETIC
     Observes recommended cautions/contraindications to using 2% preservative and epinephrine-free lidocaine (intravenous lidocaine) and confirms lidocaine dose per institutional protocol
     1. Primes extension set with lidocaine; notes that the priming volume of the EZ-Connect® Extension Set is approximately 1.0 mL
     2. Slowly infuses lidocaine 40 mg IO over 120 seconds
     3. Allows lidocaine to dwell in IO space 60 seconds
     4. Flushes with 5 to 10 mL of normal saline
     5. Slowly administers an additional 20 mg of lidocaine IO over 60 seconds.
        Repeats PRN; considers systemic pain control for patients not responding to IO lidocaine
   □ ADULT - UNRESPONSIVE TO PAIN
     1. Primes extension set with normal saline
     2. Flushes the IO catheter with 5-10 mL of normal saline
     Notes if patient develops signs indicating responsiveness to pain, will refer to adult recommended anesthetic technique.
   □ INFANT/CHILD - RESPONSIVE TO PAIN – RECOMMENDED ANESTHETIC
     Observes recommended cautions/contraindications to using 2% preservative and epinephrine-free lidocaine (intravenous lidocaine) and confirms lidocaine dose per institutional protocol; notes usual initial dose is 0.5 mg/kg, not to exceed 40 mg
     1. Primes extension set with lidocaine; notes priming volume of the EZ-Connect® Extension Set is approximately 1.0 mL
     For small doses of lidocaine, considers administering by carefully attaching syringe directly to needle hub (prime extension set with normal saline)
     2. Slowly infuses lidocaine over 120 seconds
     3. Allows lidocaine to dwell in IO space 60 seconds
     4. Flushes with 2-5 mL of normal saline
     5. Slowly administers subsequent lidocaine (half the initial dose) IO over 60 seconds.
        Repeat PRN; considers systemic pain control for patients not responding to IO lidocaine
   □ INFANT/CHILD - UNRESPONSIVE TO PAIN
     1. Primes extension set with normal saline
     2. Flushes the IO catheter with 2-5 mL of normal saline
     Notes if patient develops signs indicating responsiveness to pain, will refer to infant/child recommended anesthetic technique.
   □ Verifies placement/patency prior to all infusions. Uses caution when infusing hypertonic solutions, chemotherapeutic agents, or vesicant drugs.
   □ Connects fluids if ordered and pressurizes up to 300 mmHg for maximum flow
   □ Assesses for any signs of extravasation/complications
   □ Documents date and time on wristband and places on patient
   □ Stabilizes and monitors site and limb for extravasation or other complications
     - For proximal humerus insertions, apply arm immobilizer or other securement device
     - For distal femur insertions, maintain securement of the leg to ensure the knee does not bend

REMOVAL TECHNIQUE
1. Removes extension set and dressing
2. Stabilizes catheter hub and attaches a luer lock syringe to the hub
3. Maintains axial alignment, twists clockwise and pulls straight out
   - Did not rock the syringe
   □ Disposes of catheter with syringe attached into sharps container
   □ Applies pressure to site as needed to control bleeding and applies dressing as indicated

SOURCES/REFERENCES available at www.teleflex.com/ezioeducation including:
ARROW® EZ-IO® Intraosseous Vascular Access Competency/Skills

Department: __________________________ Competency # __________________

Name of Learner: __________________________________________________ Date __________

<table>
<thead>
<tr>
<th>Mode of Competency</th>
<th>Method of Instruction</th>
<th>Assessment of Competency</th>
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<tbody>
<tr>
<td>S Simulated return demo</td>
<td>P Protocol/Procedure review</td>
<td>0 Not competent</td>
</tr>
<tr>
<td>A Actual performance</td>
<td>I Inservice</td>
<td>1 Minimal, needs review</td>
</tr>
<tr>
<td>V Verbal explanation</td>
<td>S Self-learning</td>
<td>2 Competent with mentor/educator only</td>
</tr>
<tr>
<td>W Written test</td>
<td>D Demonstration</td>
<td>3 Proficient, may perform independently</td>
</tr>
<tr>
<td>C Case Study</td>
<td>C Clinical practice</td>
<td>4 Expert, able to act as resource to others</td>
</tr>
</tbody>
</table>

PERFORMANCE CRITERIA

- States indications for IO access
- States contraindications for IO access
- Identifies patient, answers patient/family questions
- Gathers/prepares equipment/supplies
- Assesses for potential pain response prior to insertion
- Correctly identifies insertion site
- Correctly identifies appropriate needle set
- Performs IO access procedure for insertion using appropriate technique
- Confirms placement and flushes catheter
- Follows steps correctly for lidocaine administration
- Reassesses and confirms patency of IO catheter
- Removes the IO catheter

Mentor/Educator:

Name /Title __________________________ Signature ____________________ Initials_______ Date______________

Name /Title __________________________ Signature ____________________ Initials_______ Date______________

Learner Signature _________________________________________________________________ Date______________
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