

Title:	Intraosseous needle insertion—paediatric guideline
Version:	1.1
Supersedes:	Not applicable
Application:	The guideline is intended for use by any hospital team caring for infants, children and young people under 16 years age across the Paediatric Critical Care Network in the North West & North Wales

Originated /Modified By: Designation:	Su Ying Ong, anaesthetic senior clinical fellow, NWTS / Alder Hey Children’s NHS Trust Isabel Wardach, senior clinical fellow, NWTS Kate Parkins, paediatric intensive care medicine consultant, NWTS Sophina Mahmood, paediatric pharmacist, PCC ODN & RMCH
Ratified by:	North-West (England) & North Wales Paediatric Critical Care Operational Delivery Network, which includes multi-disciplinary clinical representation from all local and tertiary hospitals across the region.
Date of Ratification:	10.08.23
Ratified by:	RMCH (host trust for PCC ODN) policies and guidelines committee & Pharmacy and Medicines Management Committee
Date of Ratification:	01.05.24

Issue / Circulation Date:	1 Circulation date: 02.05.24
Circulated by:	North West (England) & North Wales Paediatric Critical Care Operational Delivery Network,
Dissemination and Implementation:	Via networks December 2023
Date placed on: NWTS & PCC /LTV / SiC networks website	03.05.24 NWTS Network website: May ‘24

Planned Review Date:	3 years ie January 2028
Responsibility of:	Clinical lead, North-West & North Wales Paediatric Critical Care Network & NWTS guideline lead consultant

Minor Amendment Notified To:	IO lidocaine guidance added approved via: PMMC & PGC, RMCH Femoral site changed from medial to mid-line and lidocaine added
Date notified:	December 2024 Approved 20.01.25

EqIA Registration Number (RMCH):	2023-173
-----------------------------------------	-----------------

1. Detail of Procedural Document

Guidelines for insertion of paediatric intraosseous needle

2. Equality Impact Assessment

EqIA registration Number for RMCH:	2023-173
------------------------------------	----------

3. Consultation, Approval and Ratification Process

This guideline was developed with input from:

- North-West (England) and North Wales Paediatric Transport Service (NWTS).
- North-West and North Wales Paediatric Critical Care Operational Delivery Network
- Representatives from the District General Hospitals within network above.

These guidelines were circulated amongst the North-West and North Wales Paediatric Critical Care Network for comments on 27.06.23

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the Network Oversight Committee and Clinical Lead on 10.08.23

For ratification process for network guidelines see appendix 1.

4. Disclaimer

These clinical guidelines represent the views of the North West (England) and North Wales Paediatric Transport Service (NWTS) and the North West and North Wales Paediatric Critical Care Operational Delivery Network (PCCN). They have been produced after careful consideration of available evidence in conjunction with clinical expertise and experience.

It is intended that trusts within the Network will adopt this guideline and educational resource after review and ratification (including equality impact assessment) through their own clinical governance structures.

The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.

Clinical advice is always available from NWTS on a case-by-case basis.

Please feel free to **contact NWTS (01925 853 550)** regarding these documents if there are any queries

.

Quick reference guide for paediatric intraosseous insertion

Patient requires vascular access

Do you need immediate vascular access?

NO

Further discussion about need for peripheral or central access.
IO access can be a reliable bridge until longer term vascular access can be established.

YES

Cardiac or respiratory arrest, impending arrest or shock or unstable dysrhythmia? **OR**
Is peripheral access difficult &/or urgent treatment required eg anti-microbials/insulin in DKA/anti-convulsants in status epilepticus?

YES

Intraosseous (IO)

NO

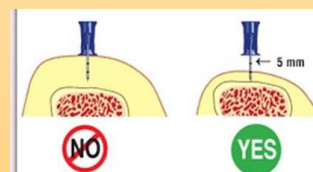
Peripheral IV line

Consider contraindications:

- Fracture near or proximal to the insertion site
- Recent surgery to the limb or indwelling metal work
- IO insertion in the same site in the previous 48 hours
- Overlying infection or abscess
- Osteogenesis imperfecta; osteomyelitis
- Crush injury or ipsilateral vascular injury
- Landmarks not identifiable

Needle selection: check size of child & site of insertion, don't base it solely on weight

Check the depth marker to ensure at least **one black line is visible** above the skin **when needle has been pushed through skin & is resting on bone**

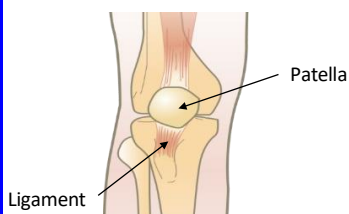


Option 1: Proximal tibia

1. Position:

Infant: flexed knee

Child / Adolescent: straight leg



2. Palpate tibial tuberosity (bony thickness below patella)

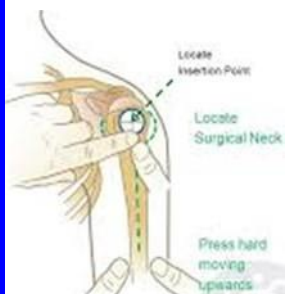
3. Insert 2-3cm below (or 2 FB) + 1 FB medial to tibia tuberosity at 90° to flat antero medial surface of tibia



Option 2: Proximal humerus

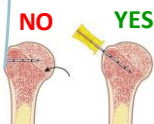
1. Position: Internal rotation of arm: bend arm at elbow & tuck hand behind pt's back

2. Palpate up mid-shaft humerus towards humeral head to **locate surgical neck**



3. Palpate greater tuberosity (small bony protrusion directly above surgical neck)

4. Insert at 45° to anterior plane (ie bed) into base of the greater tuberosity

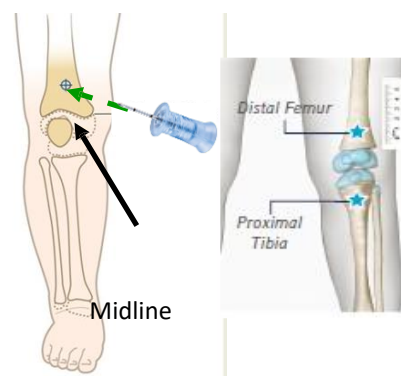


Option 3: Distal femur

1. Position: leg outstretched so knee does not bend

2. Palpate: in midline
neonate/small child: 1-2 cm OR older child 5 cm proximal to superior border of patella

3. Insert at approx. 90° to bone (after pushing thru' soft tissue)



Step by Step Guide

1. Identify landmark, position patient and clean site with 2% chlorhexidine (if not allergic)

2. Place needle perpendicular (at 90° angle) to the bone (except for humerus at 45° angle to the bone)

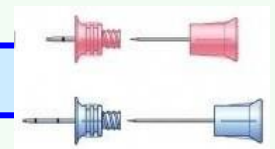
3. **PUSH** (don't drill) needle through skin/soft tissue & rest needle on bone. CHECK min. one black line is visible.

4. Start the drill (once through the skin) and gently drive into the bone without any additional force.
Let the drill do the work.

5. **STOP** when you feel loss of resistance or 'give' or 'pop'

6. CHECK that the needle is stable/solid in the bone—ie no 'wobble'

7. Unscrew and remove central stylet and dispose of sharp safely



8. Aspirate bone marrow to confirm location (NB not always possible) then send sample for culture and glucose if able (do NOT use blood gas machine as may block/damage analyser)

9. Secure with dressing (ideally ones with the EZ-IO set). Flush extension set with 0.9% sodium chloride then connect to IO

10. Confirm position by flushing with 5-10mL fluid via a syringe. Bolus will need more pressure than PVL.
'No flush = no flow' ie NOT in correct position.

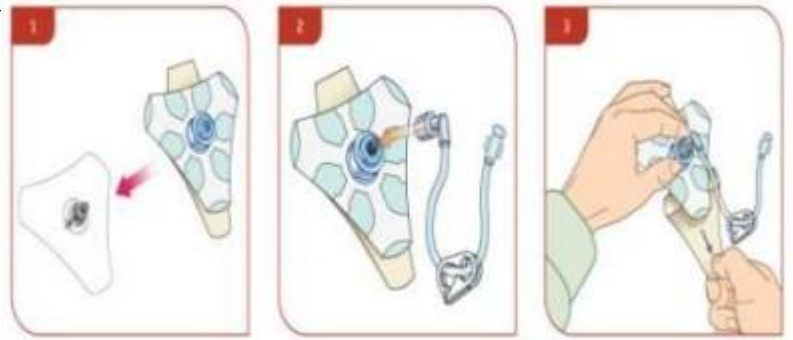
11. Check regularly for extravasation & monitor limb to check for dislodgement or compartment syndrome

12. Document accurately in patient's notes, including any sites where insertion failed.

WARNING: IO lidocaine may be considered for pts responsive to pain with caution & ECG monitoring. Take care with dosing and administration as accidental OD has been associated with cardiac arrhythmias (see page 9).

REMEMBER! AFTER INSERTION, CHECK:

- Firmly seated needle (no wobble)
- Aspirate blood via a syringe (flash of blood)
- No leaking around site.
- No sign of extravasation.
- Secure eg using EZ stabiliser/sterile dressing or similar method.
- EZ-connect/luer lock extension set.
- Regularly for limb perfusion and any signs of extravasation or compartment syndrome (feel tissue / muscles surrounding insertion site and compare with opposite side. If it feels firmer /woody than the side without an IO, the IO has tissue)
- Put pink IO name band on appropriate limb (leave in situ even if IO removed) to indicate which limb has had an IO.



INFUSIONS VIA IO

- Attach a luer-lock extension line and then 3-tail extension line (see photo) to allow multiple compatible infusions to run via one IO
- IV fluids need to be infused under pressure or bolused using a 20 mL syringe.
- Gravity is insufficient to drive fluid through an IO
- All medications given intravenously can be given intraosseously at the same doses.



MONITOR / OBSERVATIONS

- Check colour of the limb—should remain pink / healthy. Extravasation indicated if limb becomes pale / blue
- Presence of subcutaneous oedema, increasing limb size, tense muscle compartment (feels firmer or 'woody') compared to other limb, altered sensation, weak or absent distal pulses
- Position and fixation of the needle, patency of the IO, appearance of the insertion site (check for redness)
- Time elapsed since placement (ideally <24 hours)

Potential Complications

- Extravasation or subperiosteal infusion
- Dermal abrasion due to friction from the rotating plastic base surrounding the EZ-IO needle
- Compartment syndrome: rare but the smaller the patient the higher the risk
- Fracture or growth plate injury
- Osteomyelitis: very rare
- Fat embolus: rare

REMOVAL

- Ideally remove within 24 hours.
- Remove the EZ-connect extension set.
- Attach a clean 5 or 10mL luer lock syringe (acting as a handle/grip).
- Rotate the syringe clockwise.
- While rotating, gently pull the needle out, avoiding use of excessive force.
- Dispose of sharps safely.
- Apply pressure for a few minutes, if necessary then a small sterile dressing to the site.
- NB caution if coagulopathic—may need sustained pressure +/- platelets and clotting products.



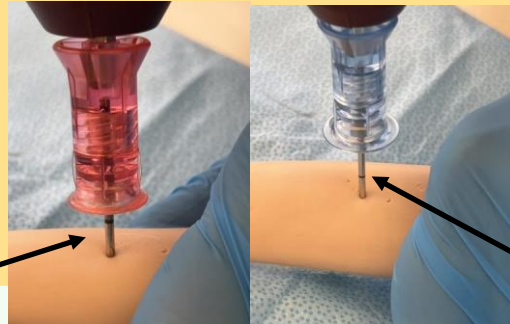
APPENDIX 1: INSERTION SITES

Needle selection: check size of child & site of insertion.

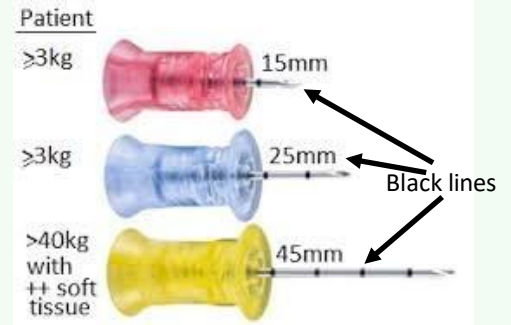
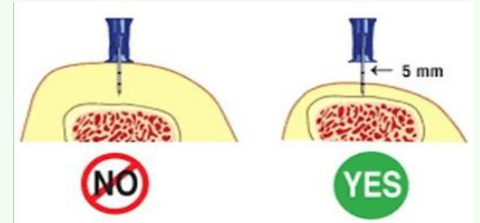
Do not base it solely on weight.

Check depth marker (black line) AFTER the needle has been pushed through soft tissue & is resting on bone (at 90° to surface of bone).

STOP with needle tip resting on bone surface & CHECK that at least one black line (5 mm mark) is visible above the skin surface before starting to drill into bone so that the needle is long enough to penetrate into the marrow.



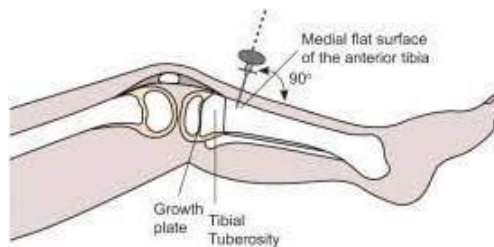
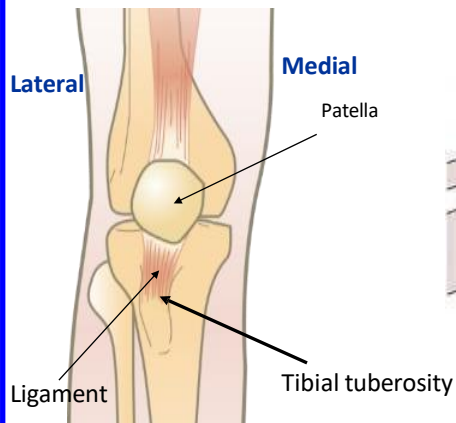
Black 5 mm marker visible on IO needle after passing thru soft tissue & resting on bone/periosteum



Black 5 mm marker visible on IO needle after passing thru soft tissue & resting on bone/periosteum

Option 1: Proximal tibia

- POSITION:** Infant: flexed knee Child / Adolescent: straight leg
- PALPATE tibial tuberosity** = bony thickness below patella



NB Landmarks become more defined / easier to find as child gets older

- INSERTION:** if **tibial tuberosity CAN** be felt insert **1 finger breadth (FB) below & 1FB medial to tibia tuberosity**
If **tibial tuberosity CANNOT** be felt, insert **2 FB below patella & 1 FB medial** along flat surface of tibia

Aim to keep needle at 90° to the flat anteromedial surface of tibia

Neonate / infant



Older child



- STOP** when you feel loss of resistance or 'give'

Appendix 1 (continued)

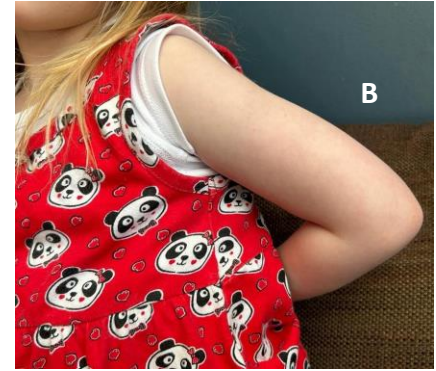
Option 2: Proximal humerus

1. POSITION: Internal rotation of arm 3 options:

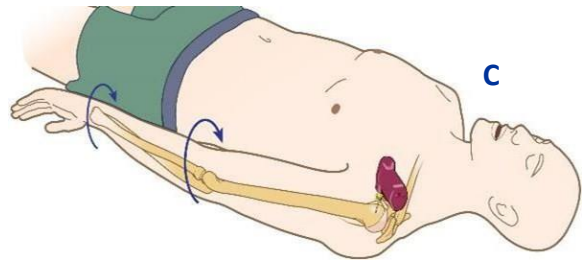
OPTION A: Bend arm at elbow & place palm of hand on umbilicus, thumb up towards head



OPTION B: More ideally, tuck dorsal aspect of hand behind their back, resting against the hip (lying down: palm of hand against bed with thumb up towards head)

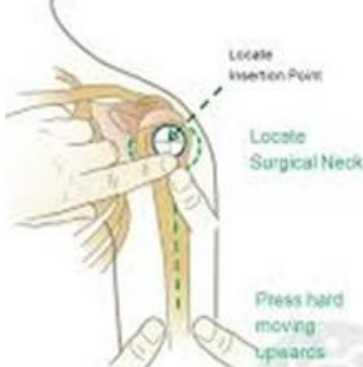


OPTION C: Place arm tight against body & rotate hand so palm is facing outwards, thumb pointing down to the floor

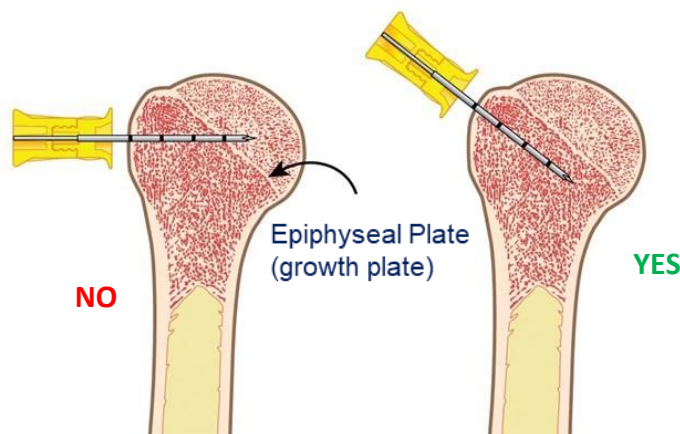
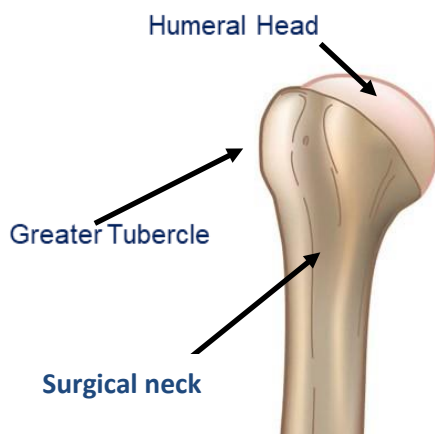
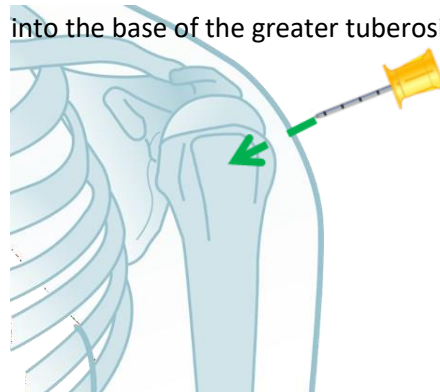


2. PALPATE UP mid-shaft humerus towards humeral head to **locate surgical neck** (narrower region).

PALPATE greater tuberosity (small bony protrusion directly **above surgical neck**)

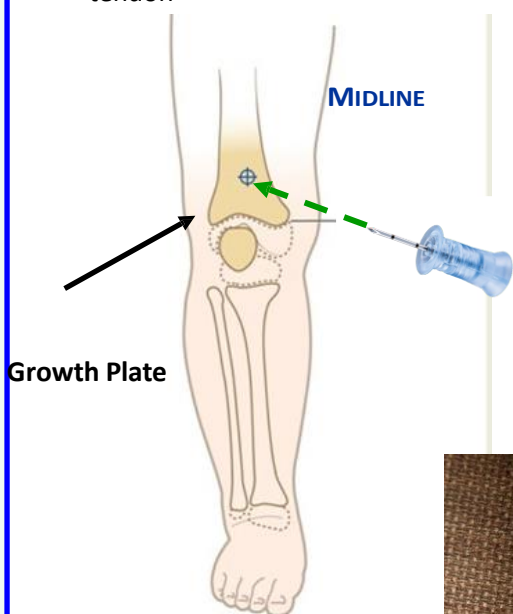


3. INSERT at 45° to anterior plane (ie the patient's bed) into the base of the greater tuberosity

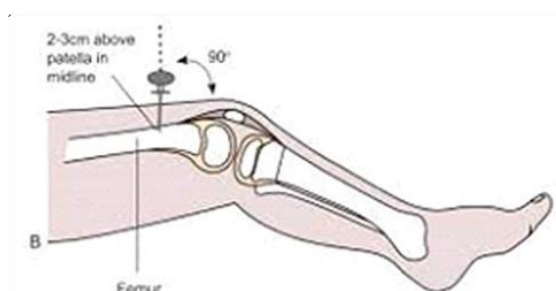


Option 3: Distal femur

1. **POSITION:** leg outstretched to make sure the knee does not bend
2. **PALPATE** in **MID-LINE** above the superior / upper border of patella (hold knee / lower leg steady)
Neonate/Small child: 1-2 cm above superior / upper border of patella
Older child: 5 cm above superior / upper border of patella
3. **INSERT:** angle needle at 90° to bone and approx. 15° cephalad (towards head) to avoid growth plate and the tendon



Distal Femur



INSERT MIDLINE
Neonate/small child: 1-2 cm
above superior border of
patella
Older child: 5 cm above
superior border of patella



**Push needle through skin,
muscle / soft tissue until
resting on bone.**

**Drill into distal femur with
needle at 90° to bone**



FOR THOSE PATIENTS RESPONSIVE TO PAIN

Insertion of intra-osseous needle using EZ-IO drill device is relatively painless compared to insertion of peripheral IV line (therefore local anaesthetic administration to skin or subcutaneous tissues is not usually recommended).

The most painful aspect of using intra-osseous route for drugs / fluid resuscitation is the initial infusion/bolus of a drug or fluid. There is some evidence that using preservative and epinephrine (adrenaline) free lidocaine as described below may help relieve the pain/discomfort in those patients who are responsive to pain.

- **Always check the contra-indications and cautions before use.**
- **Be incredibly careful with both prescribing and administration, as errors (eg confusing mg and mL) may be fatal.**

IO LIDOCAINE may be considered for patients who are responsive to pain **with caution (see contraindications below)**

ENSURE CONTINUOUS SpO₂, ECG & BP MONITORING

Always check lidocaine manufacturer's information prior to administration, check cautions & contraindications

CONTRA-INDICATIONS TO USING IO LIDOCAINE

Severe myocardial depression (shock), Sino-atrial disorders, all grades of AV block; Acute porphyria

CAUTIONS:

Epilepsy, respiratory impairment, impaired cardiac function, bradycardia, severe shock, myasthenia gravis, hepatic and renal impairment, congestive cardiac failure, hypertension, post-op cardiac surgical patients

OBSERVE & CHECK FOR:

Extravasation (e.g. inflammation, swelling), hypersensitivity, and other side-effects e.g. arrhythmias.

If side-effects occur immediately stop administration and treat appropriately.

EXTRAVASATION

1. Stop infusion—do NOT remove IO (but do not use)
2. Attempt aspiration of any residual lidocaine via IO
3. Mark edge of skin change with a pen & photograph injury
4. Optimise analgesia
5. Document drug, dose, volume, time of administration, time of injury
6. Cold compress may be used to limit drug dispersing over larger area (may not be warranted given very small volumes used)
7. Grade 3 extravasation or above will need washout

Insert: new IO needle insertion at different site

DRUG AND STRENGTH	FIRST DOSE	ADMINISTRATION	NOTES
LIDOCAINE Preservative AND epinephrine free 1% (10mg/mL) 2% (20mg/mL)	0.5 mg/kg maximum dose 40mg (see chart below)	<ul style="list-style-type: none"> • Slow Bolus over 2 minutes directly via IO needle • Allow to dwell for 1 minute • Prime extension set with 0.9% sodium chloride and flush IO with 2-5mL 0.9% sodium chloride 	SECOND dose lidocaine may be given (HALF first dose). ALWAYS wait MINIMUM 5 minutes after first dose. DOSE: 0.25 mg/kg (max 20mg) over 1 minute

VOLUME OF LIDOCAINE (PRESERVATIVE AND EPINEPHRINE (ADRENALINE) FREE): FIRST DOSE ONLY

Warning: be careful **NOT** to confuse the different strengths of lidocaine

Weight (kg)	3	5	7	9	10	16	20	25	30	40	50	60	70	80+
LIDOCAINE 1% 10mg/mL Volume (mL)	0.2	0.3	0.4	0.5	0.5	0.8	1	1.3	1.5	2	2.5	3	3.5	4
LIDOCAINE 2% 20mg/mL Volume (mL)					0.3	0.4	0.5	0.6	0.8	1	1.3	1.5	1.8	2

GUIDELINES: www.nwts.nhs.uk/clinicalguidelines

NWTS emergency drug guide via NWTS website: <https://www.nwts.nhs.uk>

- for intubation drugs / sedation regime / inotropes etc

NWTS LocSIPPS / Checklists includes sizes of ETT, CVL & arterial lines

EDUCATION: www.nwts.nhs.uk/education-website

Login details for education site are available from your nursing and medical paediatric critical care (PCC) operational delivery network (ODN) links

Videos for IO insertion

ADULT intraosseous insertion: <https://handbook.bcehs.ca/clinical-practice-guidelines/pr-clinical-procedure-guide/pr12-intraosseous-cannulation/>

All Age Groups: <https://www.teleflex.com/usa/en/clinical-resources/ez-io/>

REFERENCES

FOR DRUG DOSES: British National Formulary for Children 2019-2020

Advanced Life Support Group (ALSG). (2016). *Advanced Paediatric Life Support: A Practical Approach to Emergencies*. John Wiley & Sons Inc.

Nagler, J., & Krauss, B. (2011, February 24). Intraosseous Catheter Placement in Children. *The New England Journal of Medicine*. doi:10.1056/NEJMc0900916

Olson, D., Fesselet, J.-F., & Grouzard, V. (2018). Appendix 6. Intraosseous (IO) needle insertion in children. In *Management of a CHOLERA EPIDEMIC*. Médecins Sans Frontières. Retrieved from <https://medicalguidelines.msf.org/viewport/CHOL/english/appendix-6-intraosseous-io-needle-insertion-in-children-25297231.html#:~:text=The%20malleoli%20sites%20are%20approximately,where%20the%20bone%20is%20flat.>

Teleflex. (2022, February). Arrow EZ-IO Intraosseous Vascular Access: Care, Maintenance, and Removal. Retrieved from https://www.teleflex.com/global/clinical-resources/documents/MCI-2019-0394_VA_DS_EZ-IO_Intraosseous_Vascular_Access_LR.pdf

The Royal Children's Hospital Melbourne. (2022, February). Intraosseous access - Clinical Practice Guideline. Retrieved from https://www.rch.org.au/clinicalguide/guideline_index/Intraosseous_access/

Gavin Owen and Owen Keane. Intraosseous Access, Don't Forget The Bubbles, 2020.

Available at <https://dontforgetthebubbles.com/author/gavinowen/>

Acknowledgements photos: either author's own (Kate Parkins) or Alys and Elin Owen (with permission)

Contact numbers:

Regional Paediatric Intensive Care Unit Alder Hey Childrens Hospital 0151 252 5241

Regional Paediatric Intensive Care Unit Royal Manchester Childrens Hospital 0161 701 8000

NWTS (North-West & North Wales Paediatric Transport Service) 01925 853 550

Guideline authors:

Dr Su Ying Ong, senior anaesthetic fellow, AHCH

Dr Isabel Wardach, senior clinical fellow, NWTS

Dr Kate Parkins, PICM consultant, NWTS

Consulted parties:

North-West & North Wales Paediatric Transport Service (NWTS)

North West and North Wales Paediatric Critical Care Network

PICU, Royal Manchester Children's Hospital

PICU, Alder Hey Children's Hospital

GUIDELINE CONTACT POINT: Kate.parkins@nwts.nhs.uk & Nicola.longden@mft.nhs.uk

Please visit NWTS website for the most up to date version of this guideline: www.nwts.nhs.uk/guidelines

Date of Approval by Paediatric Critical Care ODN: 10.08.23

Date of Approval by ODN Host Trust (RMCH/MFT): 20.01.25

Date of Review: January 2028

RATIFICATION PATHWAY

