Title:	Guidelines for the insertion of paediatric intraosseous needle
Version:	**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 region.

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
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
Date of Ratification:	13.10.23

Issue / Circulation Date:	**1 Circulation date: 08.12.23**
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**	07.12.23 NWTS Network website: December '23

Planned Review Date:	**3 years ie December 2026**
Responsibility of:	Clinical lead, North West & North Wales Paediatric Critical Care Network & NWTS guideline lead consultant

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

Minor Amendment (If applicable) Notified To:	
Date notified:	

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

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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. Think about local anaesthesia for awake patients (see pg 9)

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)

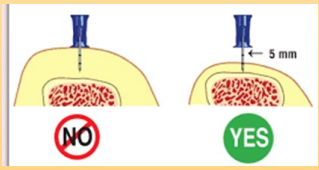
NO → Peripheral IV line

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**

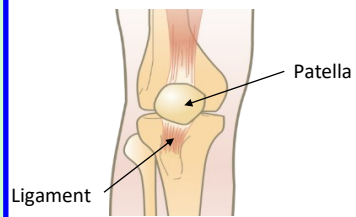


Option 1:Proximal tibia

1. Position:

Infant: flexed knee

Child / Adolescent: straight leg



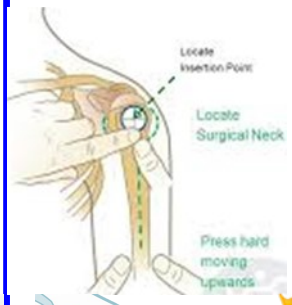
2. Palpate tibial tuberosity (bony thickness below patella)

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

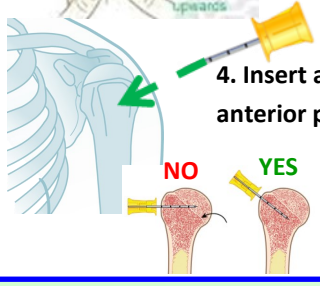
Option 2: Proximal humerus

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**



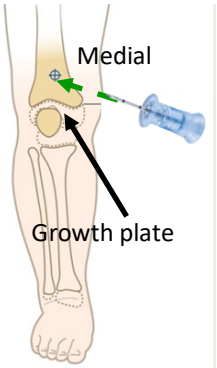
3. Palpate greater tuberosity (small bony protrusion directly above surgical neck)

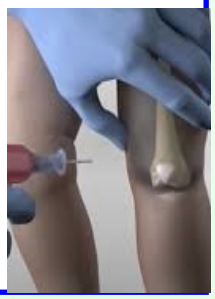


4. Insert at 45° to anterior plane (ie bed) into base of the greater tuberosity

Option 3: Distal femur

1. **Position:** leg outstretched
2. **Palpate** in **mid-line**, 1-2 FB above & 1 FB medial to the superior border patella
3. Insert at approx. 15° cephalad (towards head) to avoid growth plate and the tendon





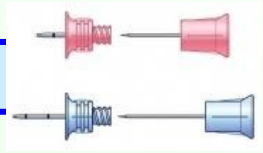
North West & North Wales Paediatric Transport Service

Guidelines for insertion of paediatric intraosseous needle

ODN NORTHWEST SiC LTV PCC

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 the skin & rest needle on bone. CHECK a minimum one black line is visible.
4. Start the drill 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 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% NaCl 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.

- **IO LIGNOCAINE** should be considered for patients responsive to pain **with caution (see CI below) & ECG monitoring**
- **0.5mg/kg (max 40mg) 2% preservative free and epinephrine free lidocaine** as slow bolus through IO over 2 minutes (120 seconds), allow to dwell for about 1 minute (60 seconds) then flush with 2-5mL 0.9% sodium chloride
- **Contra-indications:** sino-atrial disorders, all grades of AV block, severe myocardial depression, 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 pts

REMEMBER! AFTER INSERTION, CHECK:

Firmly seated needle (no wobble)

Aspirate blood via a syringe (flash of blood)

No leaking around site

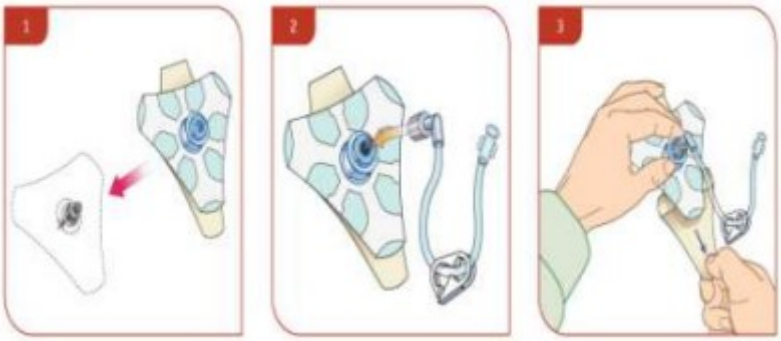
No sign of extravasation

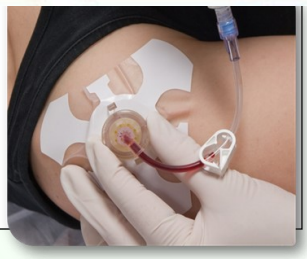
Secure eg using EZ stabiliser/sterile dressing or similar method

EZ-connect/luer lock extension set

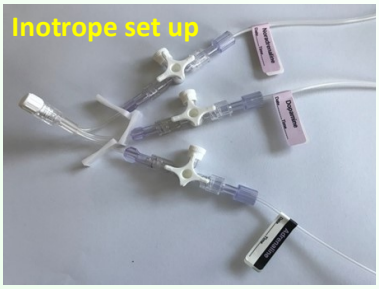
Regularly for limb perfusion and any signs of extravasation or compartment syndrome (feel tissue / muscles surrounding insertion site and compare with opposite side. If it feels firmer /woody than the side without an IO the IO has tissued)

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 that can be given intravenously can be given intraosseously at the same doses.

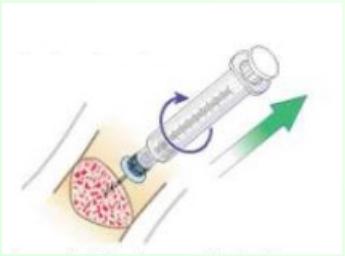
MONITOR / OBSERVATIONS

- 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.

Guidelines for insertion of paediatric intraosseous needle

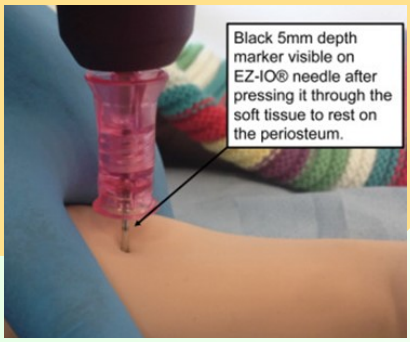
Appendix 1: Insertion sites

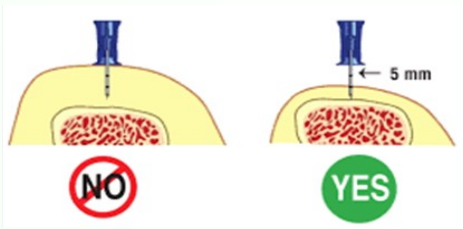
Needle selection: check size of child & site of insertion.

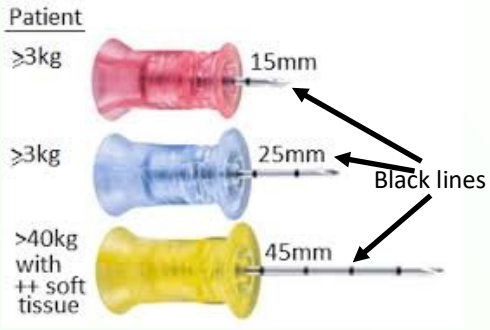
Don't base it **solely on weight.**

Check the **depth marker AFTER the needle** has been pushed through skin and is **resting on bone (at 90° to surface of bone).**

When tip of needle touching bone **STOP & CHECK** that at least **one black line (5 mm mark) is visible above** the **skin before** starting to drill ie insert into bone, to ensure the needle is long enough to reach the marrow.

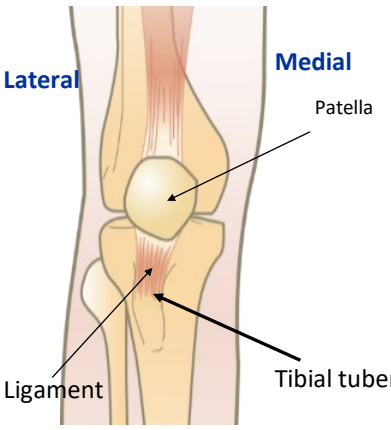


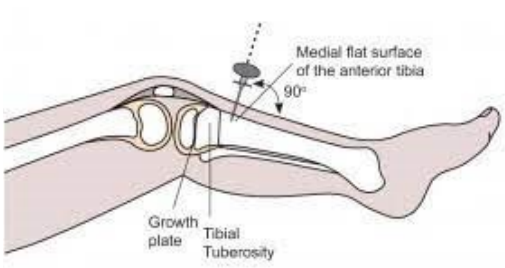


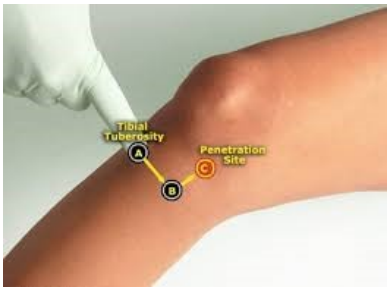


Option 1:Proximal tibia

1. **Position:** Infant: flexed knee Child / Adolescent: straight leg
2. **Palpate tibial tuberosity** = bony thickness below patella



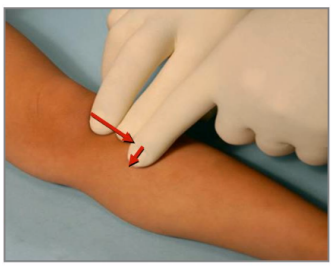




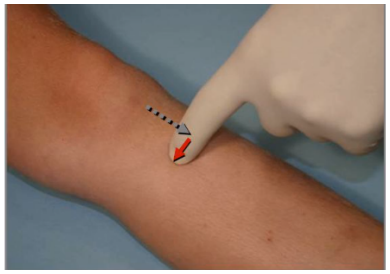
NB Landmarks become more defined / easier to find as child gets older

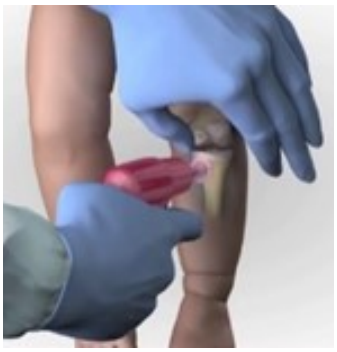
3. Insertion: if **tibial tuberosity CAN** be felt insert **1 finger breadth (FB) below & 1FB medial** to **tibia tuberosity**
If **tibial tuberosity CANNOT** be felt, insert **2 FB below patella** & **1 FB medial** along flat surface of tibia
Aim to keep needle at 90° to the flat anteromedial surface of tibia

Neonate / infant



Older child





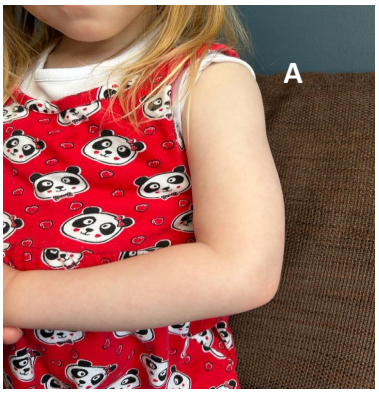
4. STOP when you feel loss of resistance or 'give'

Appendix 1 (continued)

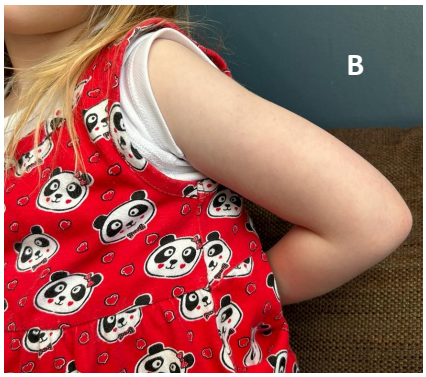
Option 2: Proximal humerus

1. POSITION: Internal rotation of arm 3 options:

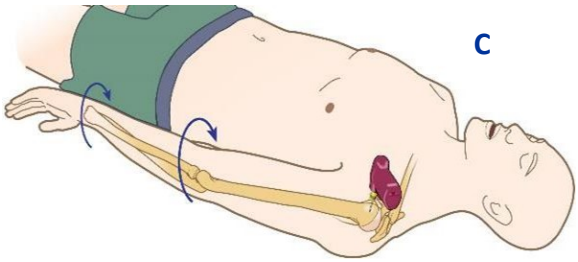
OPTION A: Bend arm at elbow & place palm of hand on umbilicus, thumb up towards head



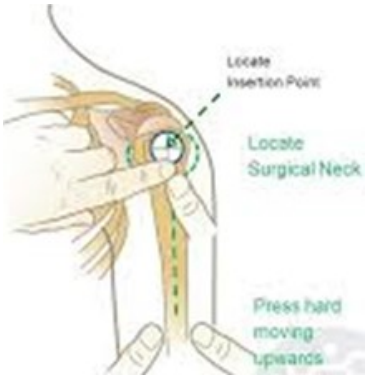
OPTION B: More ideally, tuck dorsal aspect of hand behind their back, resting against the hip (lying down: palm of hand against bed with thumb up towards head)



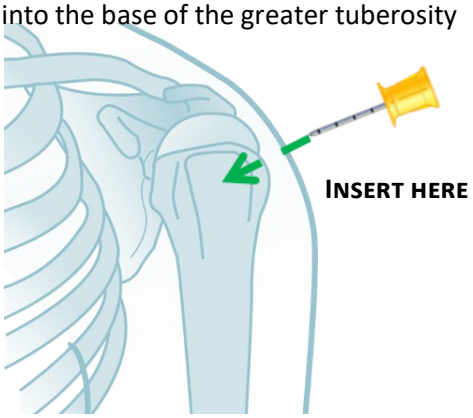
OPTION C: Place arm tight against body & rotate hand so palm is facing outwards, thumb pointing down to the floor

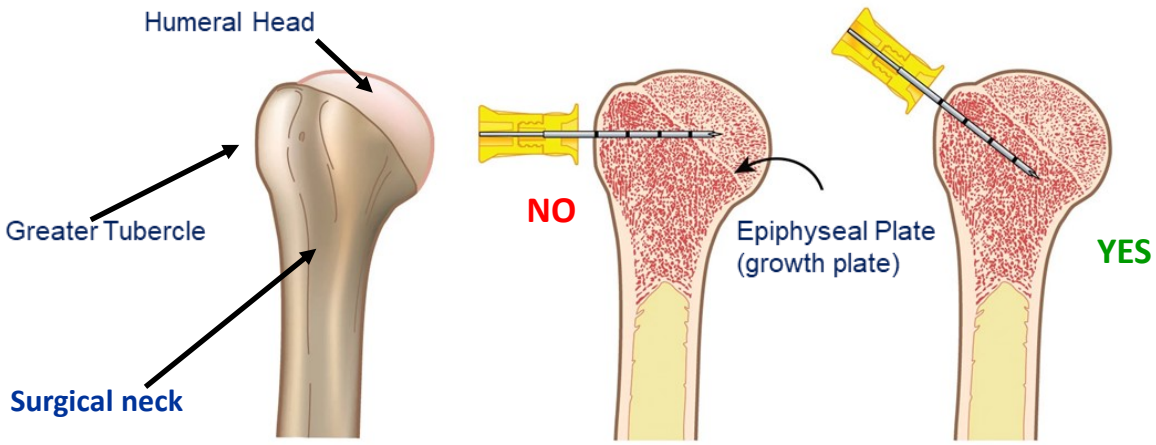


2. PALPATE UP mid-shaft humerus towards humeral head to **locate surgical neck** (narrower region). **PALPATE greater tuberosity** (small bony protrusion directly **above surgical neck**)



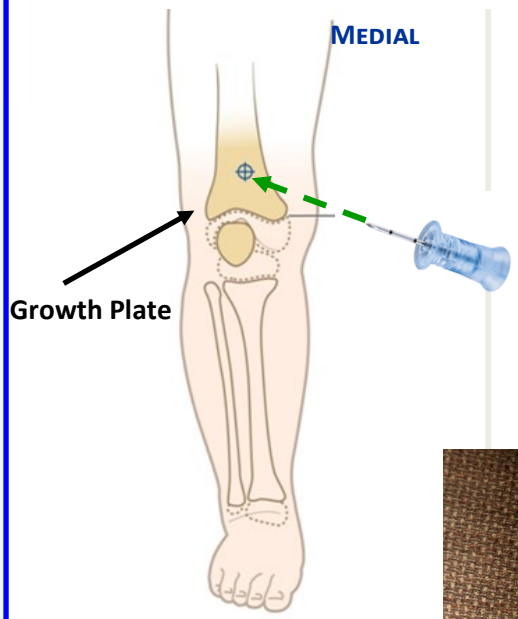
3. INSERT at 45° to anterior plane (ie the patient's bed) into the base of the greater tuberosity

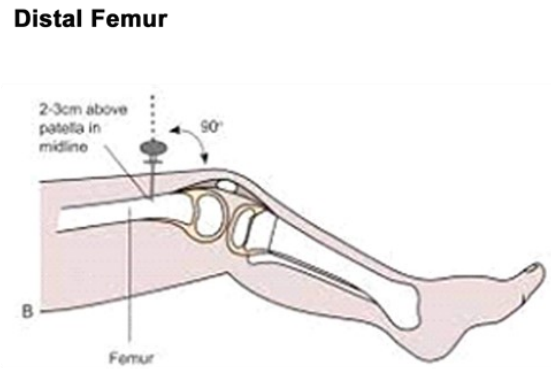


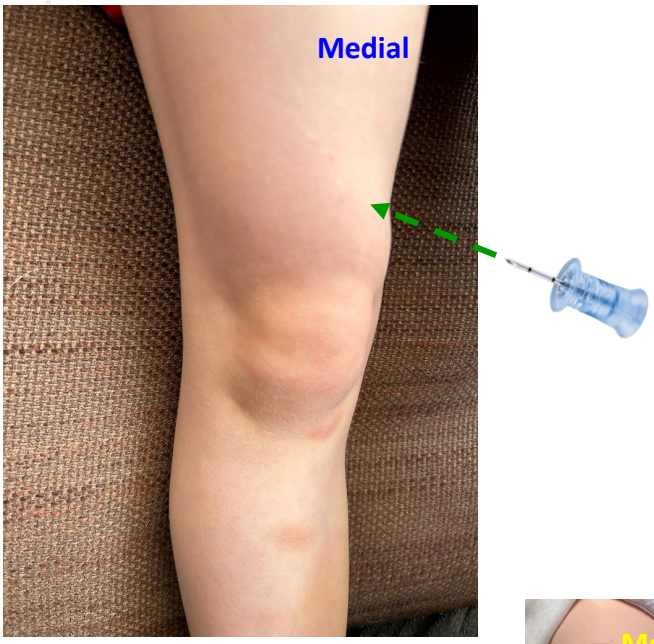


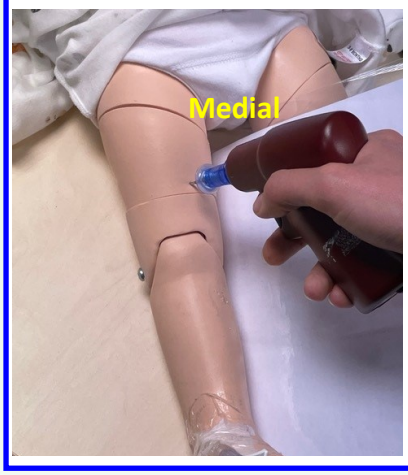
Option 3: Distal femur

1. **POSITION:** leg outstretched
2. **PALPATE** in **mid-line**, 1-2 FB above and 1 FB medial to the 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









Appendix 2:

Intraosseous infusion pain management using lidocaine (preservative free and adrenaline free) 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 adrenaline (epinephrine) free lidocaine as described below may help relieve the pain/discomfort in those patients who are responsive to pain.

NB 1. Always check the contra-indications and cautions before use

2. Be very careful with both prescribing and administration, as errors (eg confusing mg and mL) may be fatal.

Volume of preservative free lidocaine and adrenaline (epinephrine) free

Wt (kg)	Volume 2% (mL) 2% = 20 mg/mL	Volume 1% (mL) 1% = 10 mg/mL
3		0.15
4		0.2
5		0.25
6		0.3
7		0.35
8		0.4
9		0.45
10	0.25	0.5
12	0.3	0.6
14	0.35	0.7
16	0.4	0.8
18	0.45	0.9
20	0.5	1
25	0.6	1.25
30	0.75	1.5
32	0.8	1.6
35	0.9	1.75
40	1	2
45	1.1	2.25
50	1.25	2.5
55	1.4	2.75
60	1.5	3
70	1.75	3.5
80+	2	4

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

Ensure continuous SpO_2, ECG & BP monitoring

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

DOSE: 0.5mg/kg (max 40mg) lidocaine (preservative AND epinephrine free)

Administration:

Slowly infuse dose of lidocaine directly via IO needle **over 2 minutes** and allow to **dwell** for further **1 minute**

NEXT: Attach extension set primed with 0.9% sodium chloride and flush IO with 0.9% sodium chloride 2-5 mL.

A second dose, of lidocaine at 0.25 mg/kg may be given no less than 5 minutes after first dose. Maximum total dose:
Neonate—12 years = 3 mg/kg or 12-17 years = 200 mg

Contra-indications:

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

Cautions:

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

Observe & Check for:

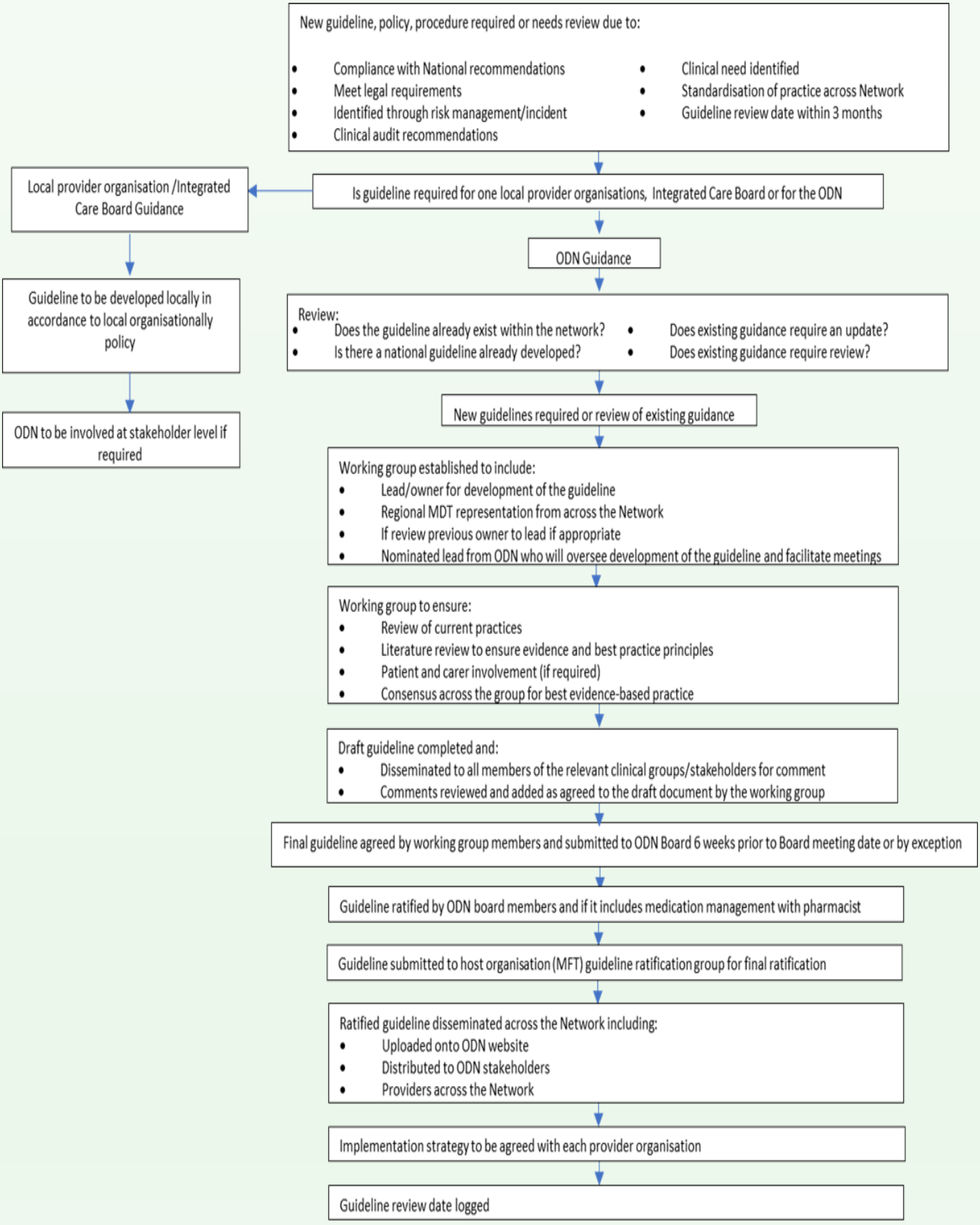
Extravasation (eg inflammation, swelling), hypersensitivity, and other side-effects eg arrhythmias. If side-effects occur immediately stop administration and treat appropriately.

Extravasation

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

Insert: new IO needle insertion at **different site**

RATIFICATION PATHWAY



GUIDELINES: ***www.nwts.nhs.uk/clinicalguidelines***

Crashcall link via NWTS website: ***https://www.nwts.nhs.uk/documentation/crashcall***

- 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/

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

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