Guidelines for Intra-operative High Volume Local Infiltration Analgesia (HVLIA)

+/- Peripheral Nerve Blockade

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1.1 Reason for Guideline Update

- Re-implementation of the Lower limb arthroplasty Enhanced Recovery Pathway at Whipps Cross.
- We are currently operating on a higher proportion of ASA 3+, frail, elderly patients having elective Hip & Knee arthroplasty, this has implications for the pharmacokinetic handing of large HVLIA doses[1].
- HVLIA administration has a strong evidence base demonstrating at least equivalence to peripheral nerve blockade[2,3,4,5,6].
- Increasing evidence for use of concurrent peripheral regional anaesthesia (RA) and HVLIA[7,8,9], which has implications for safe intraoperative HVLIA dosing[10].
- There is increasing use of autologous transfusion of drain contents, as a means of reducing allogenic packed red blood cell (PRBC) administration. This has implications for post-operative plasma ropivacaine levels, and risk of Local Anaesthetic Toxicity Syndrome (LAST)[11,12,13].
- Future incorporation of intra-articular surgical catheters (TKA) to provide post-operative analgesia by some surgeons This also has implications for post-operative plasma ropivacaine levels, and risk of Local Anaesthetic Toxicity Syndrome (LAST)[13].
- Varying consensus on safe dose of Ropivacaine in intraoperative HVLIA with/without epinephrine in literature, with several dosing strategies being employed (150mg, 200mg, 250mg, 300mg, 400mg). Symptoms of LAST and/or toxic levels of ropivacaine can be demonstrated with doses exceeding 3mg/kg in both HVLIA and regional anaesthesia[14,15,16,17].

1.2 Drugs required for HVLIA

- Ropivacaine infusion 400mg/200ml
- Ketorolac Injection 30mg (1ml 30mg/ml)
- Adrenaline Injection 0.5mg (0.5 1:1000)
- Clonidine Injection 75mcg (0.5ml 150mcg/ml) [18]

- *Intralipid 20% infusion- for managing local anaesthetic toxicity.*

Theatre staff are responsible for ordering these drugs from Pharmacy Distribution using the pre-printed stock list and ensuring that a sufficient supply of this is always held in Theatres. It should be stored separately from other intravenous drugs so can be readily found and allocated in the morning

1.2.1 HVLIA Preparation

- For the reasons above, the maximum dose of Ropivacaine for HVLIA calculations in this document is 3mg/kg – to maximum 300mg (max reached in 100kg adult). This is the most common weight based calculation in the literature[19,20].

- Cases that require HVLIA should be identified at team brief and required drugs made available in the morning.

- The calculations, preparation volumes, and drugs themselves should be checked by both the anaesthetist and theatre nurse. This should be confirmed to the operating surgeon and written on the Theatre whiteboard after WHO Time out.

- Mixture to be made up under sterile conditions by the scrub nurse as per instructions

1.3 HVLIA Calculations – Total Knee Arthroplasty

1.3.1 With Adductor Canal Block

- The Adductor Canal block is an US Guided quadriceps sparing peripheral nerve block, which targets the Saphenous nerve (branch of femoral n) and articular branches of the obturator nerve. It has a useful role in multimodal analgesia for Enhanced Recovery following TKA[21,22].

- Use maximum of 75 mg L-Bupivacaine (30ml 0.25% or 20ml 0.375%) in adductor canal.

How to calculate remaining 0.2% Ropivacaine dose for HVLIA

1. Calculate maximum L-Bupivacaine allowance: **2mg/kg = A mg** **(note max 200mg – reached at 100kg)**
2. Calculate maximum Ropivacaine allowance: **3mg/kg = B mg** **(note max 300mg – reached at 100kg)**
3. Calculate fraction of maximum local anaesthetic allowance that has been used in Adductor Canal: **75 divided by A = C**
4. Calculate fraction of maximum local anaesthetic remaining for use in HVLIA: **1 minus C = D**
5. Calculate amount of Ropivacaine (mg) for use in HVLIA: **D x B = E mg**
6. Calculate volume (ml) of 0.2% Ropivacaine for use in HVLIA: **E divided by 2**
7. Remove appropriate quantity of 0.2% Ropivacaine from 200ml infusion bag (2mg/ml) leaving the above a dose in the bag
8. Add 0.5ml (0.5mg) of Adrenaline injection and 1ml of Ketoralac injection 30mg/ml, 0.5ml Clonidine (75mcg) to the Ropivacaine infusion bag.
9. If resulting mixture is <100ml, add 0.9% Saline to make the volume up to **100ml**
10. Mix the solution in the bag thoroughly.

Example 1.

70kg adult (Note there has been rounding up/down)

1. A = 140mg, B = 210mg
2. C = 75/140 = 0.53
3. D = 1 – 0.53 = 0.47
4. E = 0.47 x 210 = 99 mg
5. Volume of 0.2% Ropivacaine = 99/2 = 50 ml

Example 2.

110kg adult (Note there has been rounding up/down)

1. A = 200mg, B = 300mg (maximum levels reached)
2. C = 75/200 = 0.375
3. D = 1 – 0.375 = 0.625
4. E = 0.625 x 300 = 188 mg
5. Volume of 0.2% Ropivacaine = 188/2 = 95 ml

1.3 HVLIA Calculations – Total Knee Arthroplasty

1.3.2 Without Adductor Canal Block

- Maximum Ropivacaine dose or HVLIA is **3mg/kg (max 300 mg – reached at 100kg)**

Example 70kg adult:
- *Amount of Ropivacaine (mg) for HVLIA: 3 x 70kg = 210 mg*
- *Volume of 0.2% Ropivacaine (ml) for HVLIA: 210 mg divided by 2 = 105ml*

- Remove appropriate quantity of 0.2% Ropivacaine from 200ml infusion bag (2mg/ml) leaving the above a dose in the bag
- Add 0.5ml (0.5mg) of Adrenaline injection and 1ml of Ketoralac injection 30mg/ml, 0,5ml Clonidine (75mcg) to the Ropivacaine infusion bag.
- If resulting mixture is <150ml, add 0.9% Saline to make the volume up to **150ml (will not be required at patient weight >100kg)**
- Mix the solution in bag thoroughly.
- Discard any remaining solution when surgical procedure completed.

1.4 HVLIA Calculations – Total Hip Arthroplasty

1.4.1 With Fascia Iliaca Block

- The Fascia Iliaca block is a high volume fascial plane block which targets the femoral, lateral cutaneous and obturator nerves. As such it has become part of a multimodal analgesia for Enhanced Recovery following THA
- Use maximum of 50 mg L-Bupivacaine (40ml 0.125%).

How to calculate remaining 0.2% Ropivacaine dose for HVLIA

1. Calculate maximum L-Bupivacaine allowance: **2mg/kg = A mg (note max 200mg – reached at 100kg)**
2. Calculate maximum Ropivacaine allowance: **3mg/kg = B mg (note max 300mg – reached at 100kg**
3. Calculate fraction of maximum local anaesthetic allowance that has been used in Fascia Iliaca: **100 divided by A = C**
4. Calculate fraction of maximum local anaesthetic remaining for use in HVLIA: **1 minus C = D**
5. Calculate amount of Ropivacaine (mg) for use in HVLIA: **D x B = E mg**
6. Calculate volume (ml) of 0.2% Ropivacaine for use in HVLIA: **E divided by 2**

7. Discard any remaining solution when surgical procedure completed.
8. Remove appropriate quantity of 0.2% Ropivacaine from 200ml infusion bag (2mg/ml) leaving the above a dose in the bag

9. Add 0.5ml (0.5mg) of Adrenaline injection and 1ml of Ketoralac injection 30mg/ml, 0,5ml Clonidine (75mcg) to the Ropivacaine infusion bag.

10. If resulting mixture is <100ml Add 0.9% Saline to make the volume up to **100 ml.**

    If resulting mixture is > 100 mls. Please cap total volume at **100 mls***

11. Mix the solution in the bag thoroughly.

12. Discard any remaining solution when surgical procedure completed.

Example 1.

70kg adult (Note there has been rounding up/down)

1. A = 140mg, B = 210mg
2. C = 50/140 = 0.36
3. D = 1 – 0.36 = 0.64
4. E = 0.64 x 210 = 134 mg
5. Volume of 0.2% Ropivacaine = 134/2 = 67 ml

Example 2.

110kg adult (Note there has been rounding up/down)

1. A = 200mg, B = 300mg (maximum levels reached)
2. C = 50/200 = 0.25
3. D = 1 – 0.25 = 0.75
4. E = 0.75 x 300 = 225 mg
5. Volume of 0.2% Ropivacaine = 225/2 = 112 ml. (100 mls used*)

1.4 HVLIA Calculations – Total Hip Arthroplasty

1.4.2 Without Fascia Iliaca Block

- Maximum Ropivacaine dose or HVLIA is **3mg/kg (up to 300 mg)**

Example 70kg adult:
- Amount of Ropivacaine (mg) for HVLIA: 3 x 70kg = 210 mg
- Volume of 0.2% Ropivacaine (ml) for HVLIA: 210 mg divided by 2 = 105ml

- Remove appropriate quantity of 0.2% Ropivacaine from 200ml infusion bag (2mg/ml) leaving the above a dose in the bag
- Add 0.5ml (0.5mg) of Adrenaline injection and 1ml of Ketoralac injection 30mg/ml, 0,5ml Clonidine (75mcg) to the Ropivacaine infusion bag.
- If resulting mixture is <150ml, add 0.9% Saline to make the volume up to **150ml (will not be required at patient weight >100kg)**
- Mix the solution in the bag thoroughly.
- Discard any remaining solution when surgical procedure completed.

1.5 HVLIA Administration – General

- Mixture to be administered periarticularly by the Orthopaedic Surgeon during surgery using 50ml syringe/s.
- Please ensure that injections are made into soft tissues only (aspiration of syringe should be carried out first to rule out intravascular placement.
- The mixture to be systematically injected into all tissues exposed, instrumented or incised during arthroplasty surgery including the capsule, ligaments and other soft tissue as well as the subcutaneous layers
- Injection to be spread over 30 mins to one hour, injecting one layer at a time as the operation progresses (to keep blood levels of the local anaesthetic to a minimum).
- Keep a close eye on patient when the tourniquet (TKA) is removed as this is the time when the plasma concentration of local anaesthetic may be at its highest.
- Patients need to be monitored post-operatively for at least 30 minutes in recovery for signs of local anaesthetic toxicity.
- Patients should also be monitored clinically for signs of local anaesthetic toxicity on the ward in the first six hours of the post-operative period as per the ward monitoring guidelines, and should be attached to one of the available monitors if required by the anaesthetist.

1.6 HVLIA Administration – Total Knee Arthroplasty

1.6.1 With Adductor canal block

- Mixture calculated as previous (1.3.1), made to total volume 100 ml with 0.9% Saline.
- The injection to be made in three stages:

1. **The first injection is carried out after the femoral and tibial bone surfaces have been prepared, but before the components have been inserted.** 40 mL is injected through the joint from the front to a depth of 5-10 mm into the tissues around the posterior joint capsule, using a systematic sequence from one side to the other to ensure uniform delivery to these tissues. Care is taken to avoid the midline neurovascular structures.
2. **The second injection can be carried out before or after the components have been inserted, but before both wound closure and tourniquet release.** 40 mL is injected into the anterior capsule, onto anterior surface of the femur (through supra-patellar pouch), deep tissues, the medial and lateral collateral ligaments, quadriceps and the wound edges.
3. **The third injection of 10 mL is made during wound closure,** into the subcutaneous tissue, carefully avoiding immediate subdermal injection in order to avoid intense vasoconstriction in the skin.

1.6.2 Without Adductor canal block

- Mixture calculated as above (1.3.2) to total volume 150ml.
- The injection to be made in three stages:

1. **The first injection is carried out after the femoral and tibial bone surfaces have been prepared, but before the components have been inserted.** 70 mL is injected through the joint from the front to a depth of 5-10 mm into the tissues around the posterior joint capsule, using a systematic sequence from one side to the other to ensure uniform delivery to these tissues. Care is taken to avoid the midline neurovascular structures
2. **The second injection can be carried out before OR after the components have been inserted, but before both wound closure and tourniquet release.** 70 mL is injected into the anterior capsule, onto anterior surface of the femur (through supra-patellar pouch), deep tissues, the medial and lateral collateral ligaments, quadriceps and the wound edges.
3. **The third injection of 10 mL is made during closure into the subcutaneous tissue,** carefully avoiding immediate subdermal injection in order to avoid intense vasoconstriction in the skin.

1.6 HVLIA Administration – Total Knee Arthroplasty

1.6.3 Peri articular catheter placement for post op use (Surgical discretion)

- Immediately before closure of the deep layer, a Touhy® needle is inserted about 10cm above the incision through the skin, subcutaneous tissue, and quadriceps muscles. The tip of the catheter is then inserted through the hub of the needle into the surgical field. The catheter is then led along the medial femoral condyle usually on raw bone, medial to the metal femoral component and adjacent to the medial capsule. The tip may then be passed posterior to the medial femoral condyle, so that the tip lies immediately anterior to the posterior capsule or left in the medial gutter. Finally, the needle is removed and the slack is taken up. Care is taken during closure to avoid stitching the catheter in. Free movement of the catheter should be checked after closure.

- The hub and bacterial filter are then connected and about 1–5 mL of Ropivacaine 0.2% is injected through the pain catheter to ensure patency. The catheter and bacterial filter must be secured firmly to the limb under a sterile transparent adhesive dressing

1.7 HVLIA Administration – Total Hip Arthroplasty

1.7.1 With Fascia Iliaca Block

- Mixture calculated as above (1.4.1) to total volume 100 ml.
- *The injection to be made in three stages:*

1. **The first injection is carried out after the bone surfaces have been prepared, but before the components have been inserted.** 50 mL is injected around the periarticular area, hip short rotators & capsule
2. **The second injection is carried out after the components have been inserted, but before both wound closure.** 40 mL is injected into the deep tissues, iliotibial band and wound edge
3. **The third injection of 10 mL is made during closure** into the subcutaneous tissue, carefully avoiding immediate subdermal injection in order to avoid intense vasoconstriction in the skin.

1.7.2 Without Fascia Iliaca Block

- Mixture calculated as above (1.4.2) to total volume 150 ml.
- *The injection to be made in three stages:*

1. **The first injection is carried out after the bone surfaces have been prepared, but before the components have been inserted.** 70 mL is injected around the periarticular area, hip short rotators & capsule
2. **The second injection is carried out after the components have been inserted, but before both wound closure.** 70 mL is injected into the deep tissues, iliotibial band and wound edge
3. **The third injection of 10 mL is made during closure** into the subcutaneous tissue, carefully avoiding immediate subdermal injection in order to avoid intense vasoconstriction in the skin.

1.8 Patient Exclusions and caution (BNF)

- The mixture should be used with caution in the elderly, in patients with impaired cardiac conduction, cardiovascular disease, hypovolemia, impaired respiratory function, epilepsy, or myasthenia gravis. ***This is a reason why this updated guideline now recommends 3mg/kg***
- Ropivacaine is contraindicated in patients with a history of hypersensitivity to amide local anaesthetics.
- Avoid using Ketorolac in pregnancy and breast feeding.
- Ketorolac is contraindicated in patients with a history of intolerance/allergy to NSAIDS or aspirin, gastro-intestinal ulceration or bleeding, severe heart failure, severe liver disease or renal impairment.
- Ketorolac should be used with caution in patients with bleeding disorders, uncorrected dehydration, uncontrolled hypertension, heart failure, ischaemic heart disease, peripheral arterial disease, cerebrovascular disease, hepatic impairment, Crohns disease or ulcerative colitis.

1.9 LA Toxicity

- Systemic toxicity of local anaesthetics mainly involves the central nervous system (CNS) and cardiovascular system and is usually due to accidental intravascular administration.

- Symptoms of local anaesthetic induced neurotoxicity may include: initially visual or hearing disturbances, perioral numbness, dizziness, light-headedness, tingling and paraesthesia, then dysarthria, muscular rigidity and muscle twitching. These may precede the onset of respiratory failure, generalised convulsions and loss of consciousness.

- Symptoms of local anaesthetic induced cardio toxicity may include bradycardia, tachycardia, hypotension and cardiac arrest.

- Cardiovascular toxic effects are usually preceded by signs of CNS toxicity unless the patient is receiving general anaesthetic or is heavily sedated with drugs such as benzodiazepines or barbiturates.

    - Renal, gastrointestinal toxicity and increased bleeding risk is possible with Ketorolac.

    - Adrenaline may cause tachycardia or hypertension.

1.9 LA Toxicity

Risks may be reduced by:

- Avoiding or exercising caution in the group of patients mentioned above.
- Accurately calculating the dose of Ropivacaine as above.
- Careful injection technique making sure that injections are made into soft tissues only as described (avoiding intravascular injection of LA). Injections should be spread over about 30 mins -1 hour as the operation progresses.
- Appropriate monitoring of vital parameters and increased staff awareness of risks of CNS, cardiac, renal, gastro toxicity and increased bleeding. These patients will need to be monitored in the recovery until they are stable enough to be discharged to the ward – Risk of systemic toxicity is highest in the 30 mins after tourniquet release.
- Ensuring the patient is kept well hydrated before, during and after surgery to prevent NSAID related renotoxicity.
- Adrenaline is included in the mixture to induce local vasoconstriction thus reducing the intraoperative systemic absorption of the Ropivacaine and ketorolac. Also to detect inadvertent vascular injection of the infiltratant as adrenaline may cause an increase in heart rate and blood pressure.
- If symptoms of toxicity occur, then injection of mixture to be stopped immediately.
- Please see AAGBI Safety Guideline (Appendix 1) for further information about recognition of symptoms and management of local anaesthetic toxicity.
- Consider using Intravenous Lipid Emulsion (Intralipid) where appropriate.
- Bags of Intralipid 20% are kept in each Theatre area. More (if required) may be obtained from the Pharmacy or if Out Of Hours from the Emergency Drugs Cupboard and via on call Pharmacy service.

1.10 References

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