GUIDELINES ON SAFE USE OF MEDICATION IN ANAESTHESIA

MALAYSIAN SOCIETY OF ANAESTHESIOLOGISTS

COLLEGE OF ANAESTHESIOLOGISTS, AMM

GUIDELINES ON SAFE USE OF MEDICATION IN ANAESTHESIA

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Statement of Intent
These guidelines are issued in 2024 and will be reviewed periodically. It is designed to guide anaesthesia healthcare professionals in the safe use of medications in anaesthesia practice. It is written based on the best available evidence at the time of development. Adherence to these guidelines does not guarantee that medication error does not occur. Anaesthesia healthcare professionals are responsible for the handling of the medications they use during their anaesthesia practice.

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PREFACE

On behalf of the Writing Committee, I would like to extend our gratitude to the College of Anaesthesiologists, Academy of Medicine of Malaysia and the Malaysian Society of Anaesthesiologists for entrusting us to establish these guidelines on the safe use of medications in anaesthesia practice.

In the ever-evolving field of anaesthesia, where patient safety is our priority, these guidelines represent a crucial step towards implementation of evidence-based medicine and best practices into minimising medication-related risks. The Writing Committee hopes that these guidelines will aid anaesthesia healthcare professionals in handling medications safely in their daily practice which in turn will improve patient safety. These guidelines provide evidence-based recommendations and educational resources to increase knowledge and skill of anaesthesia healthcare professionals.

Standardising practices, consistency in medication preparation, dosing, administration, and monitoring should reduce variability in care and medication-related errors.

Lastly, I would like to thank the members of the Writing Committee for their effort and commitment in producing these guidelines.

Associate Professor Dato' Dr. Wan Rahiza Wan Mat
Writing Committee Chairperson, 2024
Guidelines on Safe Use of Medication in Anaesthesia

KEY POINTS FOR SECTION 1

1. *Unsafe medication practices and medication errors are the leading causes of avoidable harm in healthcare.*

2. *Standardising practices in medication preparation, dosing, administration, and monitoring reduces variability in care and medication-related errors.*

3. *Anaesthesia healthcare professionals need to employ critical personal and team-based practices and techniques to reduce the risk of medication-related errors.*

1.1. BACKGROUND

Safe and effective use of medications is of paramount importance in anaesthesiology and critical care. Medications play a crucial role in inducing unconsciousness, managing pain, facilitating procedures, and stabilising critically ill patients. Unsafe medication practices and medication errors are the leading causes of avoidable harm in healthcare across the world. It is projected that 5% of all patients who are admitted to a hospital experience a medication error, and that an average hospital will have one medication error every 23 hours or every 20 admissions. Medication errors result in severe patient harm, disability, and even death.[1]

Medication use in anaesthesiology and critical care is unique as the process of prescription, dosage calculation, preparation, administration, documentation, monitoring, and managing potential adverse effects are performed in a continuum treatment period in an environment where typical medication safety processes available in other healthcare settings may require modification in practice. Often, medications are administered during emergencies in time-sensitive situations. The complexity and diversity of medications used in these settings pose high-stake challenges, requiring anaesthesia healthcare professionals to employ critical personal and team-based practices and techniques to mitigate the risk of medication-related errors.

1.2. PURPOSE

The primary purpose of this guideline is to enhance patient safety by providing anaesthesia healthcare professionals with evidence-based recommendations and educational resources to enhance knowledge and skill in safe medication management. Where standardising practices are recommended, consistency in medication preparation,

dosing, administration, and monitoring should reduce variability in care and medication-related errors. Protocols and streamlining medication workflows optimise work efficiency by ensuring timely and appropriate medication treatment. This improves patient outcome and throughput.[2]

1.3. SCOPE

This guideline aims to provide guidance in the safe use of medication in anaesthesiology and critical care for anaesthesia healthcare professionals trained in this field across a diverse range of locations and facilities. While this guideline references established international and national guidelines and protocols, it is specifically tailored for application in the Malaysian healthcare context.

In this document, the term 'anaesthesia healthcare professionals' refers to specialists, medical officers, nurses and/ or medical assistants who are trained in the field of anaesthesiology and critical care. The term 'anaesthesia care' encompasses the provision of various forms of anaesthesia, analgesia, sedation and critical care provided by trained anaesthesia healthcare professionals. Where relevant, the text refers to anaesthesiologist specifically.

The term 'medication use' in this guideline is framed to address medication practices directly affecting patient safety. Where relevant, drug storage and work processes affecting patient safety are described when it is unique to anaesthesiology and critical care practice. Certain medications in anaesthesia practice are inherently abuse potentials. Secure storage and proper disposal of unused medications are specifically addressed in this guideline as part of overall safe medication use. Minimising environmental pollution by proper disposal of anaesthetic drugs are also mentioned.[3,4,5]

This guideline is tailored to local settings for use by anaesthesia healthcare professionals in Malaysia as of year 2024 but it is not exhaustive and does not supersede any institutional guidelines specific to their safe use of medications in anaesthesia. It will be reviewed every five years or not earlier when the need arises.

REFERENCES:

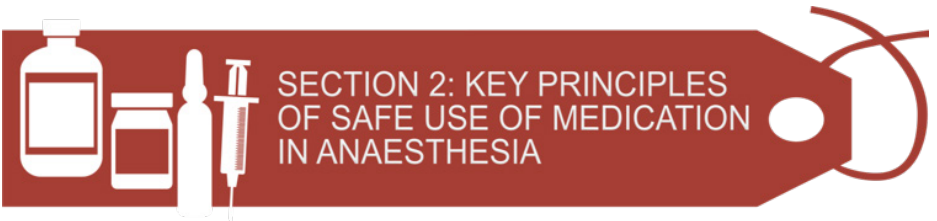
1. *World Federation of Societies of Anaesthesiologists (WFSA). Medication Safety https://wfsahq.org/news/world-anaesthesia-day-2022-medication-safety-medsafe/*

2. *The Institute for Safe Medication Practices (ISMP). Guidelines for Safe Medication Use in Perioperative and Procedural Settings, 2022 https://psnet.ahrq.gov/issue/ismp-guidelines-safe-medication-use-perioperative-and-procedural-settings*

3. *Australian and New Zealand College of Anaesthetists. PG51(A) Guideline for the Safe Management and Use of Medications in Anaesthesia, 2021 https://www.anzca.edu.au/getattachment/17f3f75c-9164-41e6-a918-9f403261c8eb/PG51(A)-Guideline-for-the-safe-management-and-use-of-medications-in-anaesthesia-(PS51)*

4. *World Health Organization (WHO). Medication Without Harm initiative, 2023. https://www.who.int/initiatives/medication-without-harm*

5. *Mackay, E., Jennings, J., Webber, S. Medicines Safety in Anaesthetic Practice. BJA Education, 2019. 19(5): 151e157*



KEY POINTS FOR SECTION 2

1. *Optimising medication management workflow and processes ensures safe medication use in anaesthesia which includes efficient purchasing, appropriate storage, systematic anaesthesia medication carts, accurate drug preparation, clear labelling, safe administration, strict infection control, detailed documentation, and responsible drug disposal.*

2. *Human errors in preparation and administration of medications can be prevented with understanding of drug pharmacology, adhering to safety medication use protocols, and maintaining comprehensive medication records.*

3. *Storage of anaesthesia medications must be systematically organised to enhance drug identification and minimise mix-ups despite they are being stored at various locations of anaesthesia and critical care services.*

4. *Diligent syringe labelling, patient verification and vigilant anaesthesia healthcare professionals are essential during the administration of medications especially in operating rooms.*

5. *Standardised protocols of dilution, preparation, and administration should be implemented when handling vasopressors, inotropes, highly concentrated, and hyperosmolar drugs.*

6. *Prevention strategies and management protocols should be established for complications of extravasation and inadvertent intra-arterial medication administration.*

7. *Maintaining clean workspaces and strictly adhering to infection control protocols during medication preparation and administration is essential for patient safety.*

8. *Accurate documentation of administered medications is crucial for evaluating and planning patient management and mitigating risks of malpractice.*

2.1. AIMS OF SAFE MEDICATION ADMINISTRATION

2.1.1. Ensure that the appropriate medication is administered to the designated patient, in the accurate dosage, through the proper route and at the designated time. This is following the 5Rs concept, the right patient, the right medicine, the right dose, the right route, and the right time of administration.

2.1.2. Document accurately medication details in the anaesthesia record, patient's drug chart, and controlled medication registers in accordance with Dangerous Drug Act 1952.[2]

2.1.3. Assess patients for anticipated responses to medications and potential adverse effects.

2.1.4. Reduce chances for substance misuse and unauthorised distribution.

2.2. RESPONSIBILITIES OF ANAESTHESIA HEALTHCARE PROFESSIONALS

2.2.1. Thorough comprehension of medication pharmacology, potential adverse effects, and its management.

2.2.2. Complete knowledge of medication prescription and administration systems, including relevant legislation.

2.2.3. Document complete records of prescribed medications in the anaesthesia record and patient's drug chart.

2.2.4. Understand the human factors that contribute to medication errors and implement proactive strategies to mitigate them.

2.2.5. Monitor patients for the desired effects and potential side effects of the drugs.

2.3. COLLABORATIVE PRACTICES WITH HOSPITAL PHARMACISTS

2.3.1. Engagement with hospital pharmacists to guarantee the availability and proper presentation of medications.

2.3.2. Collaborate with pharmacists to ensure proper storage and disposal procedures of medications.

2.3.3. Regular auditing of medication handling and reporting of administration errors to drive improvements in safe medication administration.

2.4. PURCHASING DECISIONS FOR ANAESTHESIA MEDICATIONS

2.4.1. Hospital pharmacy purchasing strategies should be based on 'medication purchasing safety' best practice that include the assessment of supply chain, source, quality, labelling, packaging, storage and delivery of the products.

2.4.2. Involve pharmacists together with anaesthesiologists, pain medicine and critical care physicians in purchasing decisions.

2.4.3. Essential anaesthesia medication purchases must be prioritised to ensure uninterrupted supply.[6]

2.4.4. Purchasing decisions should prioritise clear labelling and avoid look-alike presentations to ensure easy identification of medications. This includes similar drugs with different concentrations *(Figure 1)*.[7,8]

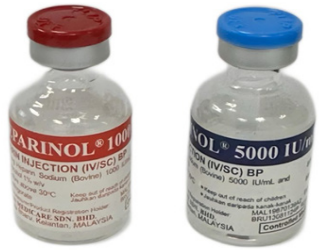


Figure 1. Example of clear labelling of medication with different concentration.

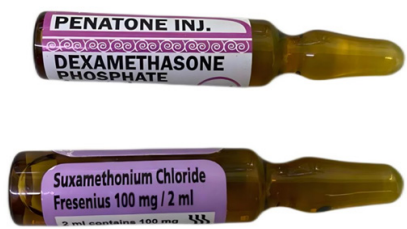


Figure 2. Example of look-alike drugs.

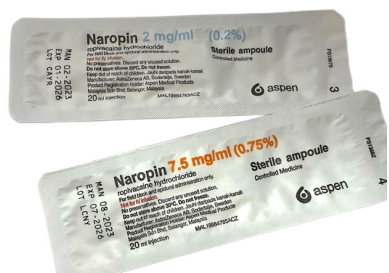


Figure 3. Example of medication with different concentrations.

2.4.5. Consideration to purchase ready-to-use medications that reduce the necessity for dilution before administration.

2.4.6. Utilisation of prefilled and pre-labelled syringes where appropriate to reduce medication errors. Factors affecting this decision are frequency of use and shelf-life.

2.5. PREOPERATIVE MEDICATION RECONCILIATION

2.5.1. Obtain a complete and accurate medication history, including:

a. All prescription drugs, over-the-counter medicines, vitamins, supplements, and herbal/alternative medicines the patient is currently taking.

b. Any occurrences of adverse drug-related events.

c. Drug allergies and intolerances. This information should be gathered from both the patient interview and a review of their medical records.

2.5.2. Instruct patients to bring all their medications with them on the admission day or the day of surgery.

2.5.3. Provide clear instructions to patients on which medications to continue or withhold prior to surgery. Inform the drugs that can be continued (e.g., beta blockers, statins, proton pump inhibitors), and the drugs that should be withheld (e.g., ACE inhibitors, oral hypoglycaemic agents, diuretics, NSAIDs). Some drugs require specialist consultation (e.g., anticoagulants, insulin).

2.5.4. Clearly document the medication plan in the patient's record so it is visible to all hospital staff. A copy should also be provided to the patient and their physician.

2.5.5. Consider alternative routes of administration if the patient will be nil by mouth pre-operatively.

2.5.6. Monitor for potential complications related to continuing or withholding specific drugs in the perioperative period, such as hyperglycaemia, hypertension, hypotension, arrhythmias and withdrawal syndromes.

2.6. ANAESTHESIA MEDICATION STORAGE

2.6.1. Storage of anaesthesia medications must adhere to regulations specific to institutional practice. Dangerous and psychotropic drugs must be securely locked, and the usage is controlled and recorded in accordance with Dangerous Drug Act 1952.[2]

2.6.2. Anaesthesia medications are stored in various workspaces, such as resuscitation trolleys, fluid and drug stores, Dangerous Drug Act drug cupboards and anaesthesia medication carts. The storage should be organised systematically with standardisation within and across institutions. This includes keeping inventory of drugs, practising First In First Out method and ensuring security of storage.

2.6.3. Storage of the medication is designed to optimise drug identification and minimise mix-ups.[3]

2.6.4. Essential medications should be immediately and independently accessible to anaesthesia healthcare professionals 24 hours a day in sufficient quantities.

2.6.5. Access of the essential medications in the recovery bay and post anaesthesia care unit (PACU) should be of similar standard of the operation rooms.

2.6.6. Routine inventory and check for expired medications should be performed.

2.6.7. Recommendations regarding anaesthesia medication cart to improve efficiency and reduce errors:

a. Arrangement of the drugs should be categorised with clear labelling. Limit the quantity of medications to prevent selection error.

b. Medications within the same function and purpose should be stored together in the same medication drawers.

c. Separate high-risk, less-frequently used medications from routine anaesthesia medications. Recommendations of the arrangement for medication are the routine anaesthesia drugs in the first drawer (e.g., antiemetics, reversal agents and vasopressors) and the high risk, less frequently used drugs in the second drawer (e.g., inotropes, vasodilators and electrolytes).

d. Clearly distinguish look-alike, sound-alike medications (LASA) by prominently flagging or storing them separately *(Figure 2)*.[8]

e. Medications with different concentrations but similar physical presentation should be clearly segregated and flagged, e.g., local anaesthetics *(Figure 3).*

f. The anaesthesia medication cart should be securely locked, preferably using keyless locks either by pin codes or swipe cards. This to ensure only authorised individuals have the access to the drugs in the cart.

g. Consider changes in medication suppliers and the presentation of medication ampoules, regular evaluation of medication storage in the anaesthesia cart is crucial.

2.7. MEDICATION PREPARATION AND VERIFICATION

2.7.1. Prescriptions must specify the generic drug name, dose, route, frequency, and any special instructions. This includes prescription to pharmacy and recording of prescribed drugs in anaesthesia records.

2.7.2. Maintain adequate lighting and minimise distractions during medication preparation.

2.7.3. Verify the drug name, concentration, and expiry date before medication preparation.

2.7.4. Standardise workflows for labelling syringes. Syringes should be labelled immediately after each medication preparation.

2.7.5. It is good practice to use gauze to hold the ampoule while breaking it, ensuring the breaking part faces away from the anaesthesia healthcare professionals. If available, ampoule breakers should be used.

2.7.6. Glass particle contamination of medications may occur when opening glass ampoules with potential harm to patients. The use of blunt filter needles or straws with a 5-micron filter is recommended to aspirate the medication from the glass ampoules.

2.7.7. Check the labels on both the ampoule and the syringe after completion of the medication preparation to ensure they match.

2.7.8. Discard and restart the preparation process if it is interrupted.

2.7.9. Medications prepared for routes other than intravenous should be clearly flagged and separated.

2.7.10. Isolate medications for emergency use to avoid unintended administration.

2.7.11. It is recommended that empty ampoules be retained until the end of anaesthesia for verification in case of the following events: no expected drug effect (to check the manufacturing batch), adverse drug effects, and drug administration errors.

2.7.12. The solution of reconstituted medications must be stored according to the manufacturer's recommendations. Generally, it is not advisable to keep these solutions at room temperature for more than 24 hours.

2.7.13. Multi-dose vials in anaesthesia practice are not recommended. If this is unavoidable, proper storage and infection control measures should be taken according to the manufacturer's recommendations and institutional guidelines.

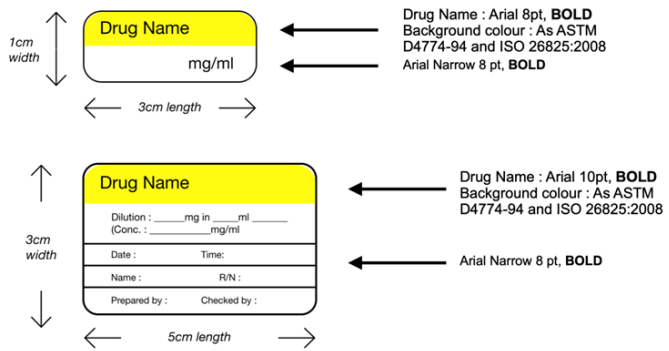


Figure 4. Guide to label syringes.

2.8. MEDICATION LABELLING

2.8.1. Label syringes according to the national standard; Guideline on Syringe Labelling in Critical Care Areas.[11]

2.8.2. The labelling of reconstituted medication solutions must include the medication name, concentration, date of preparation, and the name of the person who prepared it. *(Figure 4).* The exception to include the name of the person who prepared the reconstituted medication on the labels is when the reconstituted medications are being used as bolus drugs in OTs.

2.8.3. Optimise label legibility on ampoules and syringes.

2.8.4. Use colour-coded, self-adhesive pre-printed syringe labels that conform to standards, according to ASTM D4774-94 and ISO 26825:2008. e.g., process yellow C for induction agents, fluorescent red 805 for muscle relaxants and blue 297 for narcotics.

Table 1. Examples of tall man lettering for anaesthesia medications.

Examples of Non-TML Labelling	Examples of TML Labelling
Fentanyl *Sufentanil*	*FentaNYL* *SUFentanil*
Atracurium *Rocuronium*	*ATRAcurium* *ROcuronium*
Ephedrine *Phenylephrine*	*EPHEDrine* *PHENylephrine*
Epinephrine *Norepinephrine*	*EPINEPHrine* *NORepinephrine*
Dopamine *Dobutamine*	*DOPamine* *DOBUTamine*
Ropivacaine *Bupivacaine*	*ROPIvacaine* *BUPIvacaine*

2.8.5. Utilise tall-man lettering (TML) on medication labels to help differentiate look-alike drug names and prevent errors (Table 1)[7,12]

2.8.6. Handwritten labels or writing on the syringes with permanent markers are strongly discouraged.

2.8.7. Sterile labels should be available for utilisation during sterile procedures. In the absence of sterile labels, different sizes of syringes should be used for different medications and vigilance must be practised. However, this does not replace the safe practice provided by use of sterile labels.

2.8.8. High alert medications should have 'HIGH ALERT MEDICATION' labels on storage shelves, containers, product packages and loose vials/ ampoules.[9]

2.8.9. Short or simple labels during emergency usage and resuscitation are acceptable to improve the speed of the resuscitation process. However, labelling according to standard needs to be complied with whenever possible.

2.8.10. Using distinguishable labels on tubing sets is mandatory for continuous neuraxial and peripheral nerve infusions to reduce medication errors. Many commercially prepared regional block infusion sets provide coloured labels to be used for this purpose.

2.9. MEDICATION ADMINISTRATION

2.9.1. Introduction

a. Good medication administration practice requires independent double-checks to verify medications before administration.[4]

b. This should be practiced whenever possible. However, operation theatre workflow makes this process impractical. Hence, vigilance must be practised.

c. Anaesthesia healthcare professionals must be aware that fatigue may reduce vigilance and seek assistance to avoid medication error.

d. Utilising barcode drugs identification scanning systems prior to medication administration can mitigate this issue.[4]

2.9.2. Safe Practice

a. Positively identify every patient before administering medications.[13]

b. Minimise the time between medication preparation and administration to the patient.

c. The anaesthesiologist incharge of the patient is responsible for administering the medication to the patient under his care. If a second anaesthesia healthcare professional needs to administer the medication (e.g., in case of an emergency or relieve duty), there must be clear communication regarding the medications or should be carried out under direct supervision. Drugs that are brought from the operation room to the recovery bay or ICU for postoperative use should be labelled and handed over properly to receiving teams.

d. The 'time-out' session prior to procedures in WHO Safe Surgery Saves Lives checklist includes information on a patient's drug allergies and timely prophylactic antibiotic administration.[14]

e. In anaesthesia practice, the administration of highly concentrated drugs, electrolytes, glucose, and insulin requires special attention to ensure medication safety.

2.10. ADMINISTRATION OF HIGHLY CONCENTRATED DRUGS, ELECTROLYTES, GLUCOSE, AND INSULIN.

2.10.1. Potent drugs like vasopressors (e.g., epinephrine, norepinephrine) are often used in anaesthesia and are available in highly concentrated formulations. Inadvertent

administration of undiluted drugs can lead to life-threatening complications, such as severe hypertension, arrhythmias, or cardiorespiratory arrest.[16]

2.10.2. Highly concentrated anaesthetic drugs such as remifentanil and dexmedetomidine should be used with extra caution. Inadvertent administration of undiluted drugs can lead to life-threatening complications, such as severe hypotension, severe bradycardia, or cardiorespiratory arrest.

2.10.3. Concentrated electrolyte solutions, such as potassium chloride, and magnesium sulphate can cause significant harm if administered too rapidly or in excessive doses. Errors in electrolyte administration can lead to arrhythmias, cardiac arrest, or neurological damage.

2.10.4. Glucose solutions are prepared in different concentrations and administered mainly for hypoglycaemia. Inappropriate glucose administration can lead to electrolyte disturbances, osmotic shifts, or neurological complications.[17]

2.10.5. Insulin is administered to treat hyperglycaemia, hyperkalaemia and others. The incorrect administration can cause severe hypoglycaemia, seizures, or even death. Errors in insulin dosing can occur due to incorrect calculations or failure to monitor blood glucose levels adequately.

2.10.6. Safety measures in handling and administering the drugs:

a. Store drugs in separate, clearly labelled compartments or drawers.

b. Use pre-filled syringes when possible.

Table 2. Medications to be administered via central venous catheter.

Medication	Recommendation
Adenosine	Injection into the most proximal injection site or central venous line.
Amiodarone	Administer centrally if central access is available. Central line is recommended for infusions greater than 24 hours and for concentrations greater than 2mg/ml.
Calcium Gluconate	High risk for tissue necrosis. Administer slowly via central line or a large peripheral vein.
Dantrolene	It is a vesicant. Ensure proper dilution as per guideline.
Dextrose in water	Central line is preferred for infusion concentrations ≥ 10%.
Dobutamine	Central line is preferred. Peripheral administration may be used for less than 4 hours while preparation for a central line is underway. However, it should be administered via a large bore intravenous line and the rate should be less than 2 mcg/kg/min.
Dopamine	Central line is preferred. May use concentrations of 1600 mcg/ml (400 mg / 250 mls) at doses less than or equal to 3 mcg/kg/min peripherally. Central line recommended for higher concentrations infusions >12 hours.

Medication	Recommendation
Epinephrine	*Central line is preferred.* *Peripheral administration via a large bore IV may be used for less than 4 hours while preparations for a central line is underway.*
Esmolol	*Boluses can be administered via large bore IV.* *Central line is preferred for concentrations > 10mg/ml.* *Central line is recommended for all concentrations if administering greater than 72 hours.*
Mannitol	*Boluses can be administered via a large bore peripheral IV line.* *Central line is still recommended if possible.* *Central line is preferred for infusion.*
Norepinephrine	*Central line is preferred.* *Peripheral administration via a large bore IV may be used for less than 4 hours while preparations for a central line is underway.*
Phenylephrine	*Peripheral administration via a large bore IV for boluses.* *Central line is preferred for infusion.*
Phenytoin	*Avoid extravasation. Severe tissue necrosis may occur.* *Administer through a large vein, at least as large as the antecubital vein and preferably accessed with a catheter size 20 gauge or larger.*

Medication	Recommendation
Dilutions of concentrated potassium salts	*Maximum rate of peripheral administration is 10 mEq potassium / hour.* *Central line requires concentrations greater than 0.1 mEq/ml of potassium.* **Potassium Chloride, Potassium Phosphate, Potassium Acetate.*
3% Sodium Chloride infusions	*Administer hypertonic saline only through a large bore IV or preferably via a central venous catheter.*
Thiopental	*Boluses can be given via a peripheral line.* *Infusion of 5 mg/kg and more should be given via a central line.*
Vasopressin	*Central line is preferred.* *Peripheral administration via a large bore IV may be used for less than 4 hours while preparations for a central line is underway.*
Commonly used antibiotics	*Commonly used antibiotics that may be given via a peripheral venous access device:* *Ceftriaxone, Cefepime, Daptomycin, Ertapenem, Levofloxacin, Imipenem.* *Vancomycin can be given peripherally if concentration is 5 mg/ml or less.* *Commonly used antibiotics that may prompt consideration of PCC or central line for prolonged infusions:* *Acyclovir, Caspofungin, Ciprofloxacin, Nafcilin, Oxacillin, Tobramycin.* *Vancomycin at concentrations above 5 mg/ml.*

c. Standardise dilution protocols should be employed for high concentrated drugs to prevent error during dilution.

d. Always double-check the concentration, dose, and volume before administration.

e. Electrolytes require an independent double-check by another provider before administration.

f. Utilise colour-coded labels or syringes to differentiate the drugs.

g. Administer drugs slowly (infusion) and titrate to effect while closely monitoring the patient's response.

h. Vasopressors, concentrated electrolytes and glucose solutions should be administered via a central venous catheter. While waiting for a central venous access, initial administration via large bore peripheral IV line is acceptable (Table 2).

2.11. INTRAVENOUS MEDICATION DELIVERY

2.11.1. Standardise the use of intravenous infusion pumps and syringe drivers within each facility to improve familiarity and reduce error.

2.11.2. Place the label at the patient-end of the infusion line for fast identification of the medication.

2.11.3. Anti-siphon and anti-reflux (one-way) valves are recommended to prevent free flow and retrograde pumping of analgesic agent into the infusion lines. Patient-controlled analgesia delivery lines must utilise infusion tubing with anti-siphon and anti-reflux valves.

2.11.4. Infusion line connections should utilise a lock design that minimises risk of disconnection. Checking for disconnection is the responsibility of the anaesthesia healthcare professionals especially when the intended drug effect is not seen.

2.11.5. The use of smart infusion pumps with dose error reduction software is highly recommended to prevent drug delivery errors. However, anaesthesia healthcare professionals need to understand the limitations of the pump that include intervariability among patients.

2.12. MANAGEMENT OF EXTRAVASATION INJURIES AND INTRA-ARTERIAL INJECTION

2.12.1. Extravasation injuries and inadvertent intra-arterial drug injection may be seen during anaesthesia practice due to higher number of intravenous drugs administered during anaesthesia and some of the drugs used are vesicants, irritants and hyperosmolar solutions.[34]

2.12.2. Table 3 shows examples of anaesthesia drugs and the side effects that were previously reported.

2.12.3. Other drugs with potential for tissue damage are hyperosmolar solutions such as calcium chloride and sodium bicarbonate, acidic or alkaline drugs such as amiodarone and phenytoin, and inotropes, for example, norepinephrine and vasopressin.

2.12.4. The sequela of extravasation is minor. Major complications of extravasation are tissue necrosis, tissue loss and scarring. On the other hand, intra-arterial injection of high-risk drugs may lead to extremity ischaemia and gangrene.

Table 3. Complications of extravasation and intra-arterial injection of anaesthesia drugs.

Drugs	Possible complications following extravasation	Possible complications following intra-arterial injection
Atracurium	Tissue ischaemia and necrosis	Tissue ischaemia
Ketamine	Tissue ischaemia and necrosis	Tissue necrosis
Propofol	Tissue ischaemia	'Distal' blanching and hyperaemia
Rocuronium	Local irritation	Tissue ischaemia
Thiopental	Tissue ischaemia and necrosis	Tissue ischaemia and necrosis

2.12.5. Anaesthesia healthcare professionals should adhere to institutional guidelines on the management of extravasation injuries and intra-arterial injection.

2.12.6. Steps to prevent extravasation injuries:

a. Be cautious when using intravenous lines at the antecubital fossa and joints in view that the lines are easier to dislodge as the patient moves.

b. Flush and check the intravenous line whether it is still in the vein before every use.

c. Use a secure adhesive dressing and clear dressing to allow observation of swelling or inflammation at the IV-line site.

d. Educate patients to report if they encounter pain, stinging and burning sensation upon drug injection or infusion.

e. Remove promptly lines which are dislodged out from the vein.

f. Aspirate central line lumens to make sure it is not migrated out from the vessel before every use.

2.12.7. Management of extravasation injuries:

a. Stop the drug administration, attempt to aspirate 5-10 ml from the IV line and remove the IV line.

b. Assess the severity according to the Milliam assessment grading system. Mark the edges of extravasation to enable daily assessment.[35]

c. Elevate the affected limb, apply warm or cold compression accordingly, and provide analgesia.

d. Consider referral to a plastic surgeon if high risk drugs (vesicants and hyperosmolar drugs) or Grade 3 and 4 severity of injury, or signs of compartment syndrome of the affected limb.

e. Inform the incident and the management plans to the patient.

f. Make a documentation of the assessment, management and counselling to patient and relative.

g. Consider informing the hospital risk management team for severe extravasation cases.

2.12.8. Steps to prevent intra-arterial injection:

a. Upon insertion of intravenous line, be cautious with high-risk areas that are in close vicinity with arteries, e.g., femoral and antecubital fossa.

b. Whenever there are signs of arterial cannulation, take steps to exclude arterial placement or remove the line.

c. Be alert of signs of intra-arterial injection such as severe pain on injection, pallor paraesthesia, hyperaemia, and cyanosis of the affected limb. Stop the drug administration immediately and check the placement of the lines.

d. General precaution for arterial lines should be carried out to prevent inadvertent drug injection through the line. These include either to use cannula without injection port or close the injection port of the cannula with dressing, label arterial line and all its port, accordingly, use red lining tubing and red injection ports, and provide regular education to doctors and staff who use arterial lines.

2.12.9. Management of intra-arterial injection:

a. Stop drug administration and assess the affected limb using tissue ischaemia score or any relevant score.[36]

b. Leave the line for angiogram and intra-arterial therapy if needed. The line should be removed within 48 hours to prevent clot formation.

c. Provide analgesia and elevate the affected limb.

d. Monitor perfusion to the affected limb.

e. Consider interventions if the ischaemia is developing and high-risk drugs administered such as hyperosmolar drugs, acidic or alkali drugs, e.g., thiopental, benzodiazepine and phenytoin. Interventions that can be considered are anti-coagulant therapy, angiography and intra-arterial thrombolysis and administration of vasodilator drugs.

f. These cases should be referred to a vascular surgeon and an interventional radiologist.

g. Inform the incident and the management plans to the patient.

h. Make a documentation of the assessment, management and counselling to patient and relative.

i. Consider informing the hospital risk management team for severe intra-arterial injection cases.

2.13. INFECTION CONTROL IN MEDICATION ADMINISTRATION

2.13.1. Maintain clean workspaces and adhere to infection control practices as suggested in the Guidelines on Infection Control in Anaesthesia. Examples of good practices are recapping the syringes either by syringe caps or plugs, always keeping syringes in dedicated medication trays and proper hand hygiene while handling and administering medications.[37]

2.13.2. Use single-dose vials or ampoules for each patient to minimise the risk of cross-contamination. If sharing an

ampoule among multiple patients is unavoidable, the anaesthesia healthcare professionals must ensure the integrity of the ampoule's contents and prevent cross-contamination.

2.13.3. In between patients, all work surfaces and medication trays must be decontaminated. Using different medication trays for each patient is advisable.

2.13.4. All syringes should be discarded after completion of anaesthesia for each case. Sharing used syringes is not acceptable.

2.13.5. Crystalloid solutions (e.g., Normal saline or D5% solution) used as a diluent may be cross contaminated when used for more than one patient. Only clean unused syringes can be used to draw the diluent each time. Hub disinfection with 70% alcohol swab is required prior to each use.

2.13.6. Administering intravenous bolus medication with a needle carries a risk of needle prick injury and is highly discouraged. Injections should be done directly into the intravenous access port.

2.13.7. The intravenous access ports should be kept clean and covered with a cap when not in use. Hub disinfection with 70% alcohol swab and allowing it to dry is a good practice.[13] Passive hub disinfection is another option.

2.14. WASTE AND DISPOSAL PRACTICES (REFER SECTION 6: SAFE WASTE MANAGEMENT)

2.15. MEDICATION DOCUMENTATION

2.15.1. Accurately record each medication administered, including the drug name, dose, route time and date.

2.15.2. The anaesthesia record must be signed by the anaesthesiologist and include the full name and the Malaysian Medical Council (MMC) registration number. The utilisation of doctor identification stamps is highly encouraged.

2.15.3. Ensure the legibility of medication records, especially handwritten documentation. Use of electronic records enhances accuracy.

2.15.4. Document the handling of controlled substances according to regulatory requirements. The records must include the disposal of leftover controlled substances.

REFERENCES:

1. *Australian and New Zealand College of Anaesthetists. PG51(A) Guideline for the Safe Management and Use of Medications in Anaesthesia. 2021 https://www.anzca.edu.au/getattachment/17f3f75c-9164-41e6-a918-9f403261c8eb/PG51(A)-Guideline-for-the-safe-management-and-use-of-medications-in-anaesthesia-(PS51)*

2. *Laws of Malaysia. Act 234. Dangerous Drugs Act 1952 (Revised 1980). https://pharmacy.moh.gov.my/sites/default/files/document-upload/dangerous-drugs-act-1952.pdf*

3. *Dobson, G., Chow, L., Filteau, L., Hurdle, H., McIntyre, I., Milne, A., Milkovich, R., Perrault, MA., Sparrow, K., Swart, PA., Wang, Y. Guidelines to the Practice of Anesthesia– Revised Edition 2021. Can J Anesth/J Can Anesth 2021. 68:92–129*

4. *Mackay, E., Jennings, J., Webber, S. Medicines safety in anaesthetic practice. BJA Education, 2019. 19(5): 151e157*

5. *Mahajan, R.P. Medication errors: can we prevent them? British Journal of Anaesthesia 2011. 107(1):3-5*

6. *Pharmaceutical Service Programme, Ministry of Health. National Essential Medicines List, 6th edition. 2023.*

7. *Pharmaceutical Service division, Ministry of Health. Guide on Handling Look Alike, Sound Alike Medication 2012 https://pharmacy.moh.gov.my/sites/default/files/document-upload/guide-handling-lasa.pdf*

8. *World Health Organization. Medication safety for look alike, sound alike medicine. 2023. https://iris.who.int/bitstream/handle/10665/373495/9789240058897-eng.pdf?sequence=1*

9. *Pharmaceutical Service Programme, Ministry of Health. Guideline on Safe Use of High Alert Medications (HAMs), Second Edition. 2020. https://pharmacy.moh.gov.my/sites/default/files/document-upload/guideline-safe-use-high-alert-medications-hams-2nd-edition_1.pdf*

10. *Muluk, V., Cohn, SL., Whinney, C. Perioperative medication management. UpToDate. June 2024.*

11. *Pharmaceutical Services Division, Ministry of Health. Guideline on Syringe Labelling in Critical Care Areas. 2012. https://pharmacy.moh.gov.my/sites/default/files/document-upload/guideline-syringe-labelling-critical-areas.pdf*

12. *Castro-Gómez, A. Labeling of medications in anesthesia: colors and letters that save lives. Colombian Journal of Anesthesiology, 2023. 51: e1065*

13. *Malaysian Nursing Board. Guideline of Injection Administration. 2021.*

14. *World Health Organization. Surgical Safety Checklist 2009 https://iris.who.int/bitstream/handle/10665/44186/9789241598590_eng_Checklist.pdf*

15. *Pharmacy Department, Hospital Canselor Tuanku Muhriz UKM. Hospital Canselor Tuanku Muhriz Drug Formulary. Second edition https://hctm.ukm.my/farmasi/wp-content/uploads/2020/09/PDF-PPUKM-Drug-Formulary-2014-V1-2.pdf*

16. *Epinephrine. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated February 7, 2019. Accessed April 3, 2019.*

17. *Dextrose. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated July 16, 2015. Accessed April 4, 2019.*

18. *Adenosine. Clinical Pharmacology. Tampa, Fl: Elsevier, Inc. Updated January 24, 2020. Accessed August 28, 2020.*

19. *Amiodarone. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated November 2, 2017. Accessed February 14, 2019*

20. *Dantrolene. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated July 10, 2017. Accessed April 4, 2019.*

21. *Dobutamine. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated April 16, 2020. Accessed August 28, 2020.*

22. *Dopamine. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated April 16, 2020. Accessed August 28, 2020.*

23. *Esmolol. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated July 15, 2015. Accessed July 16, 2019.*

24. *Mannitol. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. http://clinicalkey.com. Updated January 14, 2019. Accessed February 25, 2019.*

25. *Norepinephrine. Lexicomp Online. Hudson, OH: Wolters Kluwer Clinical Drug Information, Inc. Updated July 15, 2019. Accessed July 16, 2019.*

26. *Phenylephrine. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated July 1, 2014. Accessed March 4, 2019.*

27. *Phenytoin. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated December 6, 2016. Accessed February 15, 2019.*

28. *Potassium acetate. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated June 20, 2017. Accessed April 5, 2019.*

29. *Potassium chloride. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated June 16, 2017. Accessed April 5, 2019.*

30. *Potassium phosphate. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated June 12, 2018. Accessed April 5, 2019.*

31. *Sodium chloride. Lexicomp Online. Hudson, OH: Wolters Kluwer Clinical Drug Information, Inc. Updated July 11, 2019. Accessed July 16, 2019.*

32. *Thiotepa. Clinical Pharmacology. Tampa, FL: Elsevier, Inc. Updated February 8, 2017. Accessed August 28, 2020.*

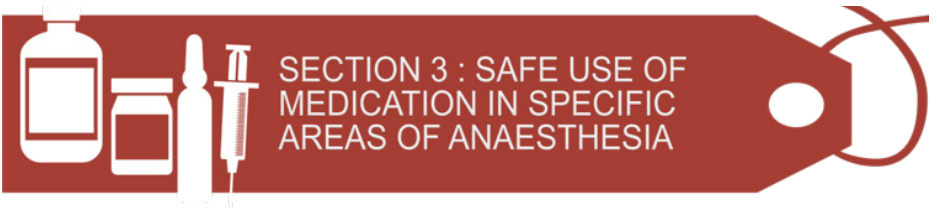
33. *Vasopressin. Lexicomp Online. Hudson, OH: Wolters Kluwer Clinical Drug Information, Inc. Updated July 9, 2019. Accessed July 16, 2019.*

34. *Lake, C., Beecroft, CL. Extravasation injuries and accidental intra-arterial injection. Continuing Education in Anaesthesia, Critical Care & Pain, 2010. 10(4): 109-113*

35. *Billingham, MJ., Mittal, R. Peripheral venous extravasation injury. BJA Education, 2023, 23(2): 42e45*

36. *McCallum, A., Reid, D. Management of Accidental Intra-Arterial Injections. Anaesthesia Tutorial of the Week 498. 2023. https://resources.wfsahq.org/atotw/management-of-accidental-intra-arterial-injections/*

37. *Guideline on Infection Control of Anaesthesia. College of Anaesthesiologists, Academy of Medicine of Malaysia and Malaysian Society of Anaesthesiologists. 2014. https://www.acadmed.org.my/index.cfm?&menuid=24*



KEY POINTS FOR SECTION 3

SECTION 3: KEYPOINTS FOR GENERAL ANAESTHESIA

1. *Volatile anaesthetic agents and medical gas cylinders should be stored safely.*

2. *Opened volatile anaesthetic bottles need to be labelled with the date they were opened, and empty bottles should properly dispose of to avoid reuse.*

3. *Regular maintenance and checks of anaesthetic machines, vaporisers, breathing circuits and gas cylinders are essential.*

4. *Before starting a case, ensure a stable and constant supply of pipeline gases by checking the pressure gauges.*

5. *Smart Infusion pump technology use in perioperative settings is recommended to ensure precise fluid delivery.*

6. *Fluid warming devices are recommended to prevent inadvertent hypothermia during perioperative fluid management.*

7. *Monitoring of depth of anaesthesia via processed EEG is indicated when using TIVA.*

8. *Neuromuscular monitoring should be available whenever a neuromuscular blocking agent is administered.*

9. *If a patient is taking medications that delay gastric emptying, withhold them before scheduled procedures when possible. If not feasible, consider delaying the surgery or treat the patient as having a 'full stomach'.*

SECTION 3: KEYPOINTS FOR REGIONAL ANAESTHESIA

1. *A standardised and safe institutional regional anaesthesia workflow should be adopted to reduce variation in practice and minimize errors from various stages of drug handling.*

2. *Use of Local Anaesthetics (LA) for specific indication must take into consideration the volume and concentration of such preparation.*

3. *The maximum dose of LA drug mass is based on milligram-per-lean body weight (mg/kg).*

4. *Monitoring and vigilance are key elements whenever any LA preparations are used.*

SECTION 3: KEYPOINTS FOR ACUTE PAIN SERVICE

1. *Institutions should implement formal protocols and quality assurance programmes to safely individualise pain management.*

2. *Effective communication with the primary team prevents double prescriptions.*

3. *Patients on opioids should be closely monitored for potential complications.*

4. *Institutions should standardise Patient-Controlled Analgesia equipment to minimise medication errors and ensure that only authorised anaesthesia healthcare providers access and programs the pumps to maintain safety and security.*

5. *Familiarity with epidural infusion protocols, ensuring proper handover, careful consideration of anticoagulation timing, and readiness with resuscitation equipment and medications should be done to prevent and manage potential complications.*

6. *Epidural infusion lines and syringes are to be clearly labelled "For Epidural Use Only," stored separately from other infusions, and connected promptly by the clinician to minimise the risk of wrong-route administration.*

3.1. GENERAL ANAESTHESIA

3.1.1. Handling of Inhalational Agents/ Volatile Agents

a. Given the high potency and potential lethality of volatile anaesthetic agents, particularly in liquid form, it is crucial to securely store bottles, including those already opened.[1]

b. Refilling of the vaporisers using unique key-fill systems must be strictly practised. Check the vaporiser is adequately filled but not overfilled and filling ports are tightly closed.

c. Partially emptied bottles need to be labelled with the date they were opened.[1]

d. Empty bottles should have their caps removed and be disposed of in a suitable container to prevent inadvertent reuse or refilling with a different liquid.[1]

e. Ensure to regularly maintain and check the anaesthetic machines, vaporisers and breathing circuit to prevent leakage and environmental pollution.[2] Vaporiser leak test according to the manufacturer's recommendations must be performed prior to each use.

f. Large spills of volatile agents require specific cleaning and containment procedures. Institutions need to provide protocols on spill management which must be complied with.

3.1.2. Medical Gases

a. Storage of Medical Gas Cylinders

i. It is important that medical gases in cylinders are stored safely and securely to mitigate the following health and safety and diversion risks:[3]

- cylinders are heavy and can cause severe injuries if mishandled.
- cylinders contain compressed gas at high pressure and can cause severe injury or death if damage leads to sudden escape of gas.
- oxygen supports combustion and increases the risk of fire.

ii. Cylinders must be stored in a cool, dry, and well-ventilated area, away from heat and potential ignition sources, and in a secure and upright position (Figure 5).[4]

iii. Warning notices prohibiting smoking and naked lights must be posted at the cylinder store that is clearly visible to all.

iv. Cylinders must be regularly inspected and maintained to ensure they are in good condition and safe to use. This includes checking for signs of corrosion, leaks, and damage to the valve or cylinder.[4]

v. The storage area must provide adequate space to allow segregation of cylinders of different gases as well as full and empty cylinders. It must also be large

enough to allow easy access for stock examination and cylinder rotation.[3]

vi. Cylinders must be checked daily and documented for obvious signs of leakage.[3]

vii. Full cylinders should be used in strict rotation according to expiry dates.[3]

viii. A record must be maintained for each type of medical gas cylinder kept at each location.[3]

- this record should be used for inventory control purposes and for establishing maximum numbers of stock to be kept at the unit.
- it is very important that accurate inventory control is maintained to avoid wastage or loss.
- in the event of an emergency the Emergency services should be advised of the location of the cylinder store by the responsible person for fire safety at the site.

b. Handling Medical Gas Cylinders

i. All personnel handling medical gas cylinders must receive regular manual handling training in line with the statutory and mandatory training matrix.[3]

ii. It is highly recommended to have trained personnel who handle medical gases be aware of the hazards and emergency procedures.[4]

iii. Personnel moving cylinders should be aware of the hazards of moving cylinders and wear appropriate Personal Protective Equipment (PPE).[3]

iv. Cylinders must be handled with care, never knocked violently or allowed to fall over. Cylinders should never be lifted by the neck.[3]

v. Cylinders must only be moved with the appropriate size and type of trolley. When cylinders are moved with apparatus attached, the cylinder valve should always be closed.[3]

vi. When in use cylinders must be firmly secured to a suitable cylinder support.3

vii. Never roll cylinders along the ground as this may cause the valve to open accidentally. It may also damage the cylinder label and paintwork.[3]

Figure 5. Examples of medical gas cylinders.

viii. Cylinders must be turned off/fully closed when not in use.[3]

c. Use of Cylinders

i. When using medical gas cylinders, it is most important that no part of the cylinder valve or equipment is either lubricated or contaminated with oil or grease.[3]

ii. Special care is needed with the use of hand creams as these could provide sufficient contamination to the medical cylinder valve surface when handling the cylinder to cause an ignition when the valve is turned on.[3]

iii. Before use ensure that:

- always confirm the medical gas type by checking the gas cylinder identification label, the cylinder label must be used as the primary means of gas identification.
- where a regulator is required, check that the cylinder product and filling pressure are compatible with the selected regulator.
- the cylinder is not expired. Leave the spindle key in the valve so that it may be closed in an emergency.[3]

iv. Ensure that the equipment operating instructions are available.[3]

v. While in use, cylinders should be checked regularly to ensure that they have sufficient content and that leaks do not occur.[3]

d. Handling of Oxygen Cylinders and their Regulators

i. All staff involved with medical oxygen should be fully trained in the use of cylinders and the attachment of regulators as well as the fire risks associated with oxygen.[3]

ii. Ensure hands are clean before handling oxygen cylinders due to the risk of combustion from oils and grease. Make sure that hands are adequately dried after the use of alcohol gels.[3]

iii. Clean clothing, free from oil and easily combustible contaminants should be worn when handling oxygen cylinders.[3]

iv. Make sure that the oxygen cylinder outlet and oxygen regulator inlet are clean before attaching a regulator. Always open the cylinder slowly and check for leaks.[3]

v. When using medical oxygen cylinders ensure adequate ventilation.[3]

e. Piped Medical Gases

i. Ensure a stable and constant supply of gas, prior to starting a case. Check that all pressure gauges for pipelines connected to the anaesthetic machine indicate 400–500 kPa.[5]

ii. Anaesthesia providers are responsible for the gases supplied from the terminal outlet to the anaesthetic machine and patient.[3]

iii. Identify and take note of the gases that are being supplied by pipeline, confirming with a 'tug test' that each pipeline is correctly inserted into the appropriate gas supply terminal.[5]

iv. All anaesthesia healthcare professionals should be well versed with safety practices related to the use of pipe medical gas and vacuum. These include colour coded Shrader socket with Shrader probe, colour coded hoses, non-interchangeable screw thread connection to anaesthetic machines *(Figure 6).*

v. Check that the anaesthetic apparatus is connected to a supply of oxygen and that an adequate reserve supply of oxygen is available from a spare cylinder.[5]

vi. All cylinders on General anaesthesia (GA) machines should be securely seated and turned off after checking their contents.[5]

3.1.3. Fluid administration

a. It is recommended that Smart Infusion pump technology be used for the administration of intravenous (IV) solutions in perioperative/procedural environments to minimise potential complications arising from both excessive and insufficient fluid delivery, particularly in volume sensitive patient populations. (e.g., paediatric, or geriatric patient).[6]

b. Gravity infusions could be used for IV solutions provided they are solely utilised as a flush solution (carrier fluid) or for immediate fluid resuscitation needs.[6]

Figure 6. Examples of piped medical gases.

c. Rapid IV infusion systems should be made available for rapid administration of fluids and blood when required. The anaesthesia healthcare professionals should have comprehensive knowledge and skills in handling the system to prevent potential harm from its use.

d. Fluid warming devices are recommended for perioperative fluid management to prevent inadvertent hypothermia.

3.1.4. Target-controlled Infusion / Total Intravenous Anaesthesia monitoring

a. When administering drugs via infusion, it is essential to label the patient end of the infusion line and implement precautions with one-way valves to prevent any

unintended syphoning of the administered medication. When feasible, a dedicated IV cannula should be used. Precaution should be taken to avoid bolus injection of residual drugs in the infusion tubing at the end of total intravenous anaesthesia (TIVA)/ target-controlled infusion (TCI).[1]

b. Recommended to use TCI when maintaining general anaesthesia with TIVA. Before determining the initial bolus and subsequent infusion rates, the user should choose both the drug and pharmacokinetic model and input the patient characteristics. (e.g., age, gender, body weight).[7]

c. Monitoring of depth of anaesthesia via processed EEG is indicated when TIVA is practised.[8]

d. It is advisable for anaesthesia departments to utilise a standard concentration of propofol and dilution of remifentanil to reduce medication error.[7]

e. Syringes containing the intended drugs should be placed in the pump prior programming the infusion pumps.[7]

f. Whenever feasible, the IV cannula used to deliver infusion should remain visible throughout the anaesthesia process.[7]

g. When administering TIVA outside the operating room, it is essential to uphold the same standards of practice and monitoring as for anaesthesia within the operating room.[7,8]

3.1.5. Use of Neuromuscular Blocking Agent

a. A neuromuscular monitoring should be available whenever a neuromuscular blocking agent (NMBA) is used.[8]

3.1.6. Drugs Affecting Gastric Emptying

a. Several drugs used in perioperative period can result in delayed gastric emptying and potential for increased risk for regurgitation and aspiration.

b. Examples of drugs are glucagon-like peptide-1 (GLP-1) receptor agonists, opioids, anti-Parkinson's medication-levodopa.

c. When possible, these medications should be withheld prior to scheduled procedures.[9] When this is not feasible, consider delaying the surgery or treating the patient as 'full stomach' and manage accordingly.

d. Special considerations are required for patients on GLP-1 agonists.

   i. It is an oral hypoglycaemic agent that is also used as weight reduction medication. It causes delayed gastric emptying as one of its mechanisms of action. e.g., Liraglutide.

   ii. Irrespective of the indication and dose of GLP-1 agonists, or the type of procedure/surgery:[10]

      - for patients on daily dosing consider withholding GLP-1 agonists on the day of the procedure/ surgery or three half-lives.[11]

- for patients on weekly dosing consider withholding GLP-1 agonists a week prior to the procedure/ surgery.
- on the day of surgery, gastrointestinal (GI) symptoms of GLP-1 agonist effects should be assessed for delayed gastric emptying (e.g., vomiting, retching, bloating)

iii. Preoperative gastric ultrasound is recommended to measure gastric residual volume when GLP-1 agonists have not been withheld adequately or the patients have symptoms of delayed gastric emptying.[10,11]

- based on gastric ultrasound, if the stomach is full, inconclusive or not possible to perform, consider delaying the procedure.
- when delaying the surgery is not feasible, treat the patient as 'full stomach' and manage accordingly.

iv. Due to lack of current evidence, no recommendation can be made of optimal preoperative fasting duration.[10] General preoperative fasting guidelines may not be applicable to patients taking GLP-1 agonists.

v. If GLP-1 agonists prescribed for diabetes management are held for longer than the dosing schedule, consider consulting an endocrinologist for bridging the antidiabetic therapy to avoid hyperglycaemia.

3.2. REGIONAL ANAESTHESIA

3.2.1. Safe Administration of Drugs in Regional Anaesthesia (RA)

a. Recommended measures to avoid errors in drug administration include General and Specific measures.

b. 'General' measures are steps and processes, from purchasing, storage and supply should be adopted for all drugs including those used in regional anaesthesia, as specified in Section 2: Key Principles of Safe Use of Medication in Anaesthesia

c. Specific measures related to RA techniques:

i. A standardised institutional RA workflow should be adopted to reduce variation in practice and minimise errors.

ii. A standard institutional pre-procedural checklist for RA should be used.

iii. Minimising environmental distraction during RA procedure will minimise errors ('Sterile cockpit' concept) during drug preparation and administration.[2]

iv. Drugs and diluent solutions that are to be injected must be drawn up directly into syringes from the ampoule, and never transferred via a gallipot/ container.

v. Dilution of drugs for RA is to be performed in a sterile field during the procedure, prior to administration.

vi. Two-person checking is recommended when the practitioner draws up from an ampoule held by an assistant.

vii. Pre-packed sterile labels should be used when available.

viii. If sterile labels are not available, anaesthesia health-care professionals should develop consistency in syringe sizes, the order of preparation and use of medications.

ix. A consistent work surface layout should be made an institutional routine.

x. Ampoules or prefilled syringes supplied in sterile packs, either from the manufacturer or from pharmacy services are recommended to increase safety and reduce bacterial contamination of the local anaesthetic (LA) drugs used in regional anaesthesia.

xi. In the absence of sterile packaging, cleaning the ampoule necks with alcohol before breaking the ampoules has been shown to minimise bacterial contamination.

xii. The risk of contamination of aspirated LA with glass ampoule particles during opening is minimised by using particulate filter straws.

xiii. For continuous infusion, pre-prepared sterile solutions by hospital pharmacies are preferred.

xiv. Pre-prepared sterile solutions can be stored at low temperatures (4- 21◦C) for a period not exceeding 14

days, as it retains its physical-chemical characteristics without bacterial contamination.[4,5]

xv. It is recommended to replace the LA solution after 72-hour infusion as microbiological stability is maintained for 72 hours.[6]

xvi. Meticulous application of antisepsis solution is recommended to avoid dripping, splashing or contamination of the LA injectate. Both chlorhexidine and alcohol are neurotoxic and should be allowed to air-dry thoroughly (about 2-3 minutes) before a block needle is inserted.

3.2.2. Dosing and Dilution of Local Anaesthetic for Regional Anaesthesia

a. The volume and concentration of LA prepared must take into consideration the following factors: block intention for anaesthesia or analgesia, desired onset, duration and recovery profile.

b. The maximum dose of LA drug mass is based on milligram-per-lean body weight (mg/kg).

c. For peri-articular knee injection, the use of LA beyond its maximum dose based on lean body weight has been safely described in ropivacaine use.[7] Similarly, for lignocaine use as tumescent anaesthesia in Plastic and Reconstructive Surgery.[8]

d. Monitoring and vigilance are key elements for early detection and treatment of local anaesthetic systemic toxicity (LAST) in these situations.

3.3. ACUTE PAIN SERVICES

3.3.1. Acute Pain Management in the Ward

a. Institutions should have formal protocols and quality assurance programmes for effective acute pain management.

b. Communication with the primary team is crucial to prevent double prescription.

c. Patients with the following conditions may need individualised therapy. (e.g., sleep-disordered breathing, renal or hepatic impairment, opioid tolerance or substance use disorder and/or cognitive behavioural).

d. Regular assessments and documentation of analgesia, monitoring, and adverse effects or complications are crucial to safely and effectively individualise treatment regimens.

e. All patients on opioids must be monitored for opioid-induced ventilatory impairment.

f. Medications employed as part of multimodal analgesia regimens should not increase the risk of adverse effects or interactions with other analgesic medications.

g. Routine prescription of modified release opioids is best avoided unless there is a demonstrated need, close monitoring is available, and a cessation plan is in place.

h. Implementation of standardised monitoring and protocols in various techniques of pain management are recommended.

3.3.2. Patient-Controlled Analgesia

a. Anaesthesia healthcare professionals and ward staff should be familiar with the use of Patient-Controlled Analgesia (PCA) pumps, routes of administration and institutional protocols for PCA administration. This includes monitoring for potential complications.

b. It is preferable that the institutions limit variability of equipment used for PCA to minimise medication error.

c. Anaesthesia healthcare professionals must be meticulous in programming the pump to the prescribed initial loading dose, PCA dose, lockout interval, continuous infusion rate, and one and four-hour limits.

d. For intravenous PCA, the medication line must be connected to a fluid infusion line with anti-reflux valves.

e. To prevent tampering with PCA pumps, access to the medication and pump programming should only be done by anaesthesia healthcare providers who have a key or code to the pump.

f. PCA devices should be routinely checked to ensure there has been no compromise to their locking mechanisms or any pump malfunction.

g. The acute pain service team should verify orders and ensure correct drug delivery.

3.3.3. Epidural Infusion in Ward

a. Personnel, Staffing and Ward Environment

i. Anaesthesia healthcare professionals and ward staff should be familiar with the epidural infusion in ward and institutional protocols for epidural administration. This includes monitoring for potential complications.

ii. Responsibility for the epidural infusion lies with the initiating practitioner who must ensure effective handover to ward staff before transfer of patient to ward.

iii. Dose, timings and therapeutic effect of all anticoagulation must be considered during insertion and removal of catheter as well as instituting anticoagulation whilst an epidural is in situ.

iv. Oxygen, resuscitation equipment, including specific medication (e.g. 20% Intralipid emulsion, naloxone) must be readily available.

b. Epidural Drug Administration

i. The epidural infusion system should be closed, with no injection ports. An anti-bacterial filter must be inserted at the junction of epidural catheter and infusion line.

ii. Bolus injection should use the pump or strict aseptic technique and should only be performed by trained staff.

iii. Epidural infusion lines should be clearly marked.

iv. There should be a limited range of epidural solutions agreed and approved in every hospital through local formulary.

v. Epidural infusions should be labelled 'For Epidural Use Only' and stored separately from other infusions.

vi. Use the lowest effective concentration of LA to preserve motor function.

vii. Epidural Infusions should be connected to the epidural catheter as soon as possible by the clinician to minimise errors due to wrong route administration of LA.

viii. The insertion site should be regularly examined for signs of catheter migration, leaks and inflammation.

REFERENCES:

GENERAL ANAESTHESIA

1. *Australian and New Zealand College of Anaesthetists. PG51(A): Guideline for the safe management and use of medications in anaesthesia, 2021. https://www.anzca.edu.au/getattachment/17f3f75c-9164-41e6-a918-9f403261c8eb/PG51(A)-Guideline-for-the-safe-management-and-use-of-medications-in-anaesthesia-(PS51)*

2. *Environmental Health & Safety University of Washington. Anesthetic gases: Safe Use Guidelines, 2024. https://www.ehs.washington.edu/system/files/resources/anesthetic-gases-safe-use-guidelines.pdf*

3. *Policy for safe handling of medical gases, East London NHS Foundation Trust. https://www.elft.nhs.uk/sites/default/files/2022-01/policy_for_safe_handling_of_medical_gases_final_march_2020_version_3.pdf*

4. *The Definitive Guide to Proper Medical Gas Cylinder Storage 2023, Ken Coffman. https://tri-techmedical.com/the-definitive-guide-to-proper-medical-gas-cylinder-storage/*

5. *Association of Anaesthetists of Great Britain and Ireland (AAGBI); Hartle, A., Anderson, E., Bythell, V., Gemmell, L., Jones, H., McIvor, D., Pattinson, A., Sim, P., Walker, I. Checking anaesthetic equipment 2012: Association of Anaesthetists of Great Britain and Ireland. Anaesthesia, 2012. 67(6):660-8.*

6. *The Institute for Safe Medication Practices (ISMP). Guidelines for Safe Medication Use in Perioperative and Procedural Settings, 2022 https://psnet.ahrq.gov/issue/ismp-guidelines-safe-medication-use-perioperative-and-procedural-settings*

7. *Nimmo, AF., Absalom, AR., Bagshaw, O., Biswas, A., Cook, TM., Costello, A., Grimes, S., Mulvey, D., Shinde, S., Whitehouse, T., Wiles, MD. Guidelines for the safe practice of total intravenous anaesthesia (TIVA): Joint Guidelines from the Association of Anaesthetists and the Society for Intravenous Anaesthesia. Anaesthesia, 2019. 74(2): 211-224*

8. *Recommendations for patient safety and minimal monitoring standards during anaesthesia and recovery, 5th edition, 2022 https://www.coanaes.com/practice-guidelines*

9. *Joshi, GP. Anesthetic Considerations in Adult Patients on Glucagon-Like Peptide-1 Receptor Agonists: Gastrointestinal Focus. Anesthesia and analgesia, 2024. 138(1): 216-220*

10. *American Society of Anesthesiologists Consensus-Based Guidance on Preoperative Management of Patients (Adults and Children) on Glucagon-Like Peptide-1 (GLP-Receptor Agonists, Joshi, GP., Abdelmalak, BB., Weigel, WA., Soriano, SG., Harbell, MH., Kuo, CI., Stricker, PA., Domino, KB. American Society of Anesthesiologists (ASA) Task Force on Preoperative Fasting https://www.asahq.org/about-asa/newsroom/news-releases/2023/06/american-society-of-anesthesiologists-consensus-based-guidance-on-preoperative*

11. *Milder DA., Milder TY., Liang SS., Kam PCA. Glucagon-like peptide-1 receptor agonists: a narrative review of clinical pharmacology and implications for peri-operative practice. Anaesthesia, 2024. 79(7):735-747*

REGIONAL ANAESTHESIA

1. *Mulroy MF., Weller RS., Liguori GA. A checklist for performing regional nerve blocks. Reg Anesth Pain Med, 2014. 39: 195e9*

2. *Kinsella SM., Boaden B., El-Ghazali S., Ferguson K., Kirkpatrick G., Meek T., Misra U., Pandit JJ., Young PJ. Handling injectable medications in anaesthesia: Guidelines from the Association of Anaesthetists. Anaesthesia, 2023. 78(10):1285-1294*

3. *Topor B., Oldman M., Nicholls B. Best practices for safety and quality in peripheral regional anaesthesia. BJA Educ, 2020. 20(10): 341-347.*

4. *Priston MJ., Hughes JM., Santillo M., Christie IW. Stability of an epidural analgesic admixture containing epinephrine, fentanyl and bupivacaine. Anaesthesia, 2004. 59: 979-83.*

5. *Azi LMTA., Fonseca NM., Linard LG. SBA 2020: Atualização das recomendações para segurança em anestesia regional [SBA 2020: Regional anesthesia safety recommendations update]. Braz J Anesthesiol, 2020. 70(4): 398-418*

6. *Sevarino FB., Pizarro CW., Sinatra R. Sterility of epidural solutions-recommendations for cost- effective use. Reg Anesth Pain Med, 2000. 25:368-71*

7. *Busch CA., Shore BJ., Bhandari R., Ganapathy S., MacDonald SJ., Bourne RB., Rorabeck CH., McCalden RW. Efficacy of periarticular multimodal drug injection in total knee arthroplasty. A randomized trial. J Bone Joint Surg Am, 2006. 88(5): 959-63*

8. *Klein JA., Jeske DR. Estimated Maximal Safe Dosages of Tumescent Lidocaine. Anesth Analg, 2016. 122(5):1350–1359*

ACUTE PAIN SERVICES

ACUTE PAIN MANAGEMENT IN THE WARD

1. *Australian and New Zealand College of Anaesthetists. PS41(G) Position statement on acute pain management, 2023 https://www.anzca.edu.au/getattachment/558316c5-ea93-457c-b51f-d57556b0ffa7/PS41-Guideline-on-acute-pain-management*

2. *Ministry of Health, Malaysia. Pain Free Program: Pain Free Manual, 3rd Edition, 2023*
https://jknselangor.moh.gov.my/images/2024/Pain/PAIN%20FREE%20PROGRAM%20(PAIN%20FREE%20MANUAL)%203RD%20EDITION%202023.pdf

PATIENT CONTROLLED ANALGESIA

1. *Pastino A., Lakra A. Patient-Controlled Analgesia. [Updated 2023 Jan 29]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan- .*
Available from: https://www.ncbi.nlm.nih.gov/books/NBK551610/

2. *Ministry of Health, Malaysia. Pain Management Handbook, 3rd edition, 2023*
https://www.moh.gov.my/moh/resources/Penerbitan/PErkhidmatan%20Pembedahan%20KKM/LATEST_FINAL_PAIN_MGT_HANDBOOK_3rd_Edition_MOH_-_05.01_.2023-comp_.pdf

EPIDURAL INFUSION IN THE WARD

1. *The Faculty of Pain Medicine of the Royal College of Anaesthetists. Best Practice in the Management of Epidural Analgesia in the Hospital Setting, 2020*
https://fpm.ac.uk/sites/fpm/files/documents/2020-09/Epidural-AUG-2020-FINAL.pdf

2. *Ministry of Health, Malaysia. Pain Management Handbook, 3rd edition, 2023*
https://www.moh.gov.my/moh/resources/Penerbitan/PErkhidmatan%20Pembedahan%20KKM/LATEST_FINAL_PAIN_MGT_HANDBOOK_3rd_Edition_MOH_-_05.01_.2023-comp_.pdf

KEY POINTS FOR SECTION 4

1. *Use child's current body weight for precise dosing and follow standard protocols to minimise medication errors.*

2. *Dose adjustment among elderly is based on age-related changes and organ function.*

3. *Vigilant and mindful observation for complications after drug administration in children and elderly is important.*

4. *Adherence to strict protocols among obstetric patients when administering and titrating epidural and neuraxial analgesia ensures safety, especially in high-risk obstetric patients.*

5. *Anaesthetic drug dosing needs to be tailored to patients' weight categories when managing extreme body weights and use objective monitoring to ensure effective and safe drug administration.*

4.1. PAEDIATRIC PATIENTS

4.1.1. Use of the patient's body weight in kilograms units is recommended. Refrain from relying on estimated or past weights unless it's a life-threatening situation where the delay involved in weighing the patient could lead to serious harm.[1]

4.1.2. It's advisable for anaesthesia departments to utilise standard concentration and dilution of drugs according to body weight groups to reduce medication errors.

4.1.3. Identify patients who are at risk of respiratory depression (e.g., premature infant <60 weeks post conceptual age, obstructive sleep apnoea) to tailor perioperative management.

4.1.4. Off-label use of drugs in paediatrics should follow institutional regulatory requirements.

4.2. ELDERLY/ OLDER PATIENTS

4.2.1. Ageing is associated with pharmacokinetic and pharmacodynamic changes. Physiologic reserve is reduced, and organ systems may be further compromised during surgical stress.

4.2.2. Identify safe dosage ranges, taking into consideration organ function e.g., renal or liver impairment.

4.2.3. Age should be correctly set in monitoring and drug delivery devices that use age adjustment to accurately monitor or deliver medications [e.g., TCI pump and minimum alveolar concentration (MAC)].

4.2.4. Preoperative frailty should be assessed to determine the safe use of medication or additional monitoring required.

4.2.5. Considerations to prevent postoperative delirium or postoperative cognitive dysfunction should be taken. These include avoidance of excessive anaesthetic depth during general anaesthesia, excessive sedation during regional anaesthesia, extremes of blood pressure and fluctuations, and cerebral desaturation.

4.2.6. Use perioperative benzodiazepines and gabapentinoids judiciously. Multimodal opioid-sparing techniques for postoperative pain management is recommended to minimise total opioids doses. Dexmedetomidine is recognised to have neuroprotective effects and is considered to reduce delirium perioperatively

4.3. OBSTETRIC PATIENTS

4.3.1. Epidural Labour Analgesia

a. Only anaesthesia healthcare professionals are allowed to titrate the dosage of epidural labour analgesia.

b. Dilution of epidural labour analgesia concentration should be standardised according to individual hospital protocol to reduce medication errors.

c. It is recommended that epidural labour analgesia cocktail is pre-prepared by hospital pharmacy.

4.3.2. Central Neuraxial Block for Caesarean Section

a. Reduce the dose of spinal anaesthesia in morbidly obese patients as they are at risk of a higher block.

b. Do not administer morphine either intrathecal or epidural to patients with obstructive sleep apnoea (OSA) or morbid obesity.

c. No other sedative or parenteral opioids in the first 24 hours after receiving intrathecal or epidural morphine.

4.4. EXTREME BODY WEIGHT PATIENTS

4.4.1. General Principles

a. Extreme body weight, either obese or underweight, is associated with pharmacokinetic and pharmacodynamic changes.

b. Anaesthetic drug dosing should be modified according to lean body weight, adjusted body weight, ideal body weight or total body weight depending on the drug used.

c. Anaesthetic drugs should be titrated to effect whenever appropriate.

4.4.2. Obesity

a. In the obese patient, volumes of distribution, binding and elimination of drugs are unpredictable.

b. Theoretically, lipophilic drugs will have a larger volume of distribution than hydrophilic drugs. The current evidence showed that changes in volume of distribution in the obese are drug-specific, so generalisations are difficult.

c. This uncertainty necessitates the anaesthesiologists to focus on the clinical effect of drug action and

titrate-to-effect accordingly. The use of objective clinical monitoring such as depth of anaesthesia and neuromuscular monitors is shown to be useful in this group of patients.

d. Hydrophilic drugs such as neuromuscular blocking drugs are distributed mainly in the central compartment. Therefore, lean body weight should be used to calculate dose. However, total body weight is suitable for suxamethonium due to increase in plasma cholinesterase activity.

e. Multimodal opioid sparing analgesia techniques including regional anaesthesia are highly recommended. If opioids are required use short acting agents whenever possible.

4.4.3. Underweight and Sarcopenia

a. With reduced total body mass, albumin concentration and volume of distribution, careful consideration of drug dosing is crucial to avoid drug overdose or toxicity.

b. Consider reducing the dose of neuromuscular blocking drugs due to possible increased sensitivity to these drugs. The use of neuromuscular monitors is recommended.

c. Neostigmine can cause life threatening cardiac arrhythmias in severely malnourished patients.

REFERENCES:

PAEDIATRIC

1. *The Institute for Safe Medication Practices (ISMP). Guidelines for Safe Medication Use in Perioperative and Procedural Settings, 2022 https://psnet.ahrq.gov/issue/ismp-guidelines-safe-medication-use-perioperative-and-procedural-settings*

ELDERLY/ OLDER ADULT

1. *Griffiths R., Beech F., Brown A., Dhesi J., Foo I., Goodall J., Harrop-Griffiths W., Jameson J., Love N., Pappenheim K., White S; Association of Anesthetists of Great Britain and Ireland. Peri-operative care of the elderly 2014: Association of Anaesthetists of Great Britain and Ireland. Anaesthesia, 2014. 69 Suppl 1:81-98*

2. *Centre for Perioperative Care and British Geriatrics Society. Guideline for Perioperative Care for People Living with Frailty Undergoing Elective and Emergency Surgery, 2021 https://www.cpoc.org.uk/sites/cpoc/files/documents/2021-09/CPOC-BGS-Frailty-Guideline-2021.pdf*

3. *Brodier EA., Cibelli M. Postoperative cognitive dysfunction in clinical practice. BJA Educ, 2021. 21(2): 75-82*

4. *Rivera R., Antognini JF. Perioperative drug therapy in elderly patients. Anaesthesiology, 2009. 110(5):1176-81*

OBSTETRICS

1. *Ministry of Health, Malaysia. Pain Management in Obstetrics and Gynaecology Guidelines, 2023 https://www.moh.gov.my/moh/resources/Penerbitan/Program%20Bebas%20Kesakitan/Garis%20Panduan/PAIN_MANAGEMENT_IN_OBSTETRICS_AND_GYNAECOLOGY_20231.pdf*

2. *Obstetric Anaesthesia & Analgesia Service, Policies & Guidelines 2014, Department of Anaesthesiology & Critical Care, Hospital Kuala Lumpur.*

3. *Quick Reference on Regional Anaesthesia for LSCS 2024, Obstetric Anaesthesia Unit, University Malaya Medical Centre.*

EXTREME BODY WEIGHT

OBESITY

1. *College of Anaesthesiologists and Malaysian Society of Anaesthesiologists. Guidelines For the Management of Obese Patients Coming for Surgery, 2016 https://www.acadmed.org.my/index.cfm?&menuid=24*

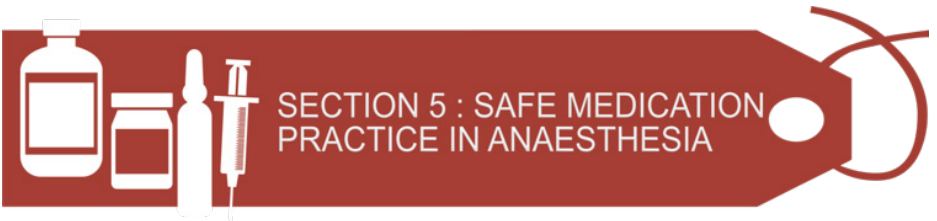
2. *Society For Obesity & Bariatric Anaesthesia SOBA Guideline, Anaesthesia for Children Living with Obesity https://www.apagbi.org.uk/news/soba-anaesthesia-children-living-obesity*

3. *The Association of Anaesthetists of Great Britain and Ireland (AAGBI) Peri-operative management of the obese surgical patient, 2015 https://anaesthetists.org/Home/Resources-publications/Guidelines/Peri-operative-management-of-the-obese-surgical-patient*

4. *American Society of Health-System Pharmacists (ASHP). Therapeutic Guidelines. Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery*
https://www.ashp.org/surgical-guidelines

UNDERWEIGHT AND SARCOPENIA

5. *Anaesthetising the malnourished patient. Update in Anesthesia, volume 31, June 2016*
https://resources.wfsahq.org/wp-content/uploads/uia31-Anaesthetising-the-malnourished-patient.pdf



KEY POINTS FOR SECTION 5

PERIOPERATIVE HYPERSENSITIVITY AND ANAPHYLAXIS

1. *Serum mast cell tryptase level should be done when perioperative anaphylaxis is suspected to confirm the diagnosis.*

2. *For patients with history of suspected antibiotic allergy, risk stratification should be performed using Penicillin Allergy Clinical Decision Rule.*

3. *Choice of alternative antibiotics should be based on estimated cross-reactivity rate, type of surgery and in accordance with the National Antimicrobial Guideline*

4. *There is no evidence to avoid the use of propofol in egg, soy, or peanut allergy.*

5. *Patients with previous suspected perioperative anaphylaxis but not yet investigated presenting for urgent surgeries, if known, all prior exposure should be avoided.*

6. *Regional anaesthesia should be the mode of choice wherever applicable.*

7. *If general anaesthesia is necessary, NMBAs should be avoided if possible.*

MALIGNANT HYPERTHERMIA

1. *The diagnostic features are unexplained, unexpected increase in ETCO2, heart rate and temperature.*

2. *Management focuses on stopping the process and treating its effects.*

3. *Patients with confirmed or suspected history should be provided with trigger-free anaesthesia.*

4. *Availability of dantrolene in the hospitals or the nearest hospital should be known.*

5. *Malignant hyperthermia cart should be available in hospitals that provide GA.*

6. *All suspected MH with Larach's score rank 4 and above should be reported to the malignant hyperthermia database in Hospital Kuala Lumpur.*

ANTICOAGULANTS AND ANTIPLATELET IN REGIONAL ANAESTHESIA

1. *Perioperative use of anticoagulants and antiplatelets in providing Regional Anaesthesia are to follow current practice guidelines.*

2. *Considerations should be made to balance the risk and benefits of use of anticoagulants and antiplatelet perioperatively.*

LOCAL ANAESTHESIA AND NERVE INJURY

1. *All local anaesthetics are potentially neurotoxic with the ability to reduce neural blood flow in a concentration- and time-dependent manner*

2. *Neurotoxicity is made worse with the concomitant use of epinephrine.*

3. *Use the lowest concentration of local anaesthesia solution to achieve the desired block effect.*

LOCAL ANAESTHETIC SYSTEMIC TOXICITY

1. *Monitoring and vigilance are key elements whenever any local anaesthetic preparations are used.*

2. *Resuscitation drugs and equipment including Lipid emulsion 20% must be accessible immediately.*

3. *Severity of clinical presentation is determined by the level of free plasma concentration which are affected by several pharmacokinetic and pharmacodynamic factors.*

4. *Practices that mitigate risk reduction shall always be employed whenever any local anaesthetics are being administered.*

5. *Caution with concurrent use of epinephrine.*

5.1. PERIOPERATIVE HYPERSENSITIVITY AND ANAPHYLAXIS

5.1.1. Introduction

a. Perioperative hypersensitivity (POH) reactions are unexpected, unpredictable and potentially life-threatening critical events during surgery and anaesthesia.

b. The severity of reactions ranges from mild to severe (see Table 4).[1] In extreme cases, it may be fatal despite prompt recognition, adequate resuscitation and treatment.

c. The estimated incidence of POH in different countries is in the range of one in 18 600 to one in 353 anaesthetic procedures with substantial geographical variability.[2] Possible under-reporting might affect the true incidence.

d. Neuromuscular blocking agents (NMBA) and antibiotics are the most common causes of POH worldwide.[2] In the recent 6th National Audit Project (NAP6) of the Royal College of Anaesthetists, the incidence of severe life-threatening anaphylaxis (grades 3 and 4 POH, Table 4) was estimated at one in 10 000 anaesthetic procedures.[3]

5.1.2. Management of Perioperative Hypersensitivity Reactions

a. Management of suspected perioperative allergic (POA) reactions involves the following three key steps depending on the severity of the reaction:[3,4]

Table 4. Australian and New Zealand Anaesthetic Allergy Group grading of perioperative anaphylaxis.

Grade 1	*Mucocutaneous signs only (e.g., erythema, urticaria, peripheral angioedema).*
Grade 2	*Multi-organ manifestations, typically mucocutaneous signs combined with hypotension, brady- or tachyarrhythmia, and/or bronchospasm.*
Grade 3	*Life-threatening hypotension and/or high airway pressure requiring immediate and specific treatment to avoid progression from inadequate tissue perfusion to cardiac arrest or significant hypoxia.*
Grade 4	*Cardiac arrest.*

i. Timely diagnosis

ii. Appropriate dosing of adrenaline (depends on severity)

iii. Appropriate intravascular volume replacement.

b. For the guide to POH and POA management refer to

i. https://anzaag.com/anaphylaxis-management/management-resources/

ii. https://anaesthetists.org/Portals/0/PDFs/QRH/QRH_3-1_Anaphylaxis_v5.pdf?ver=2022-04-12-124225-493

5.1.3. Serum Mast Cell Tryptase

i. Serum mast cell tryptase (MCT) level should be done when POA is suspected to confirm diagnosis.

ii. This test is performed at the Institute for Medical Research (IMR) and some private laboratories. If MCT is to be tested in IMR, the test request form is shown in Appendix 1.

iii. Blood sampling:

- following stabilisation, the first sample is taken within 60 min up to 3 hours post reaction.
- the second sample is taken 24 hours post reaction.
- place blood in plain serum tubes and label with date and time of sampling.
- immediately send the sample to the hospital pathology lab for proper storage and handling before sending it to IMR.
- samples need to be stored at 4ºC for not longer than 4 days.

5.1.4. Referral to Anaesthetic Allergy Clinic, Hospital Kuala Lumpur

a. After a suspected POH has occurred and following appropriate management and stabilisation is achieved, referral to this clinic can be made.

b. Indications for referral

i. Unexplained cardiac arrest during anaesthesia.

ii. Unexplained, unexpected hypotension which required active treatment, (especially if only responded to adrenaline boluses/ infusion).

iii. Unexplained, unexpected bronchospasm that caused a significant decrease in oxygen saturation and was relatively resistant to treatment.

iv. Generalised rash, flushing or urticaria.

v. Exhibited angioedema.

c. Guide for referral

i. Preferably the first sample of MCT had been sent to the lab prior to referral.

ii. Referral should be made via phone and email consultation to the Anaesthetic Allergy Clinic, Department of Anaesthesiology and Critical Care, Hospital Kuala Lumpur (HKLAAC). This referral is to be documented in the patient's case note/medical record in the referring hospital and notified to the primary team.

iii. Initial consultation is via a telephone call to the anaesthesiologist in charge of the clinic to ascertain indication of the referral. Tel: 03-26155555 (ext.1133/1153).

iv. This is followed by an email communication (hklaac@gmail.com) providing information and documentation as below:

- completed HKLAAC referral form (see Appendix 2), this includes
  - description of the reaction and time of onset in relation to induction of anaesthesia and various drug administration.

- Details of blood tests sent and timing in relation to reaction.
- Contact details of anaesthesiologist, surgeon, patient (at least 2 contact phone numbers of the patient/family).

• please attach the following in the email

- legible softcopy of GA form/vital signs chart/ recovery room/Post Anaesthetic Care Unit chart.
- legible softcopies of drug charts if not stated in GA form.

v. Appointments will be given over the phone to the patients based on urgency of the referral. Walk-in consultation is not available. Hard copies of the referral documents are not required for the patients to bring along to the clinic.

vi. The importance of attending the allergy clinic and allergy testing should be explained to the patient by the referring team.

5.1.5. Managing Suspected Perioperative Hypersensitivity Reaction Cases

a. A history of a previously uninvestigated perioperative immediate reaction is a known risk factor for a recurrence during subsequent anaesthetics.

b. These patients must be referred to the HKLAAC for investigations. Elective procedures should be postponed till the results of the investigations are available.

c. Skin testing will be performed 4 to 6 weeks after the reaction. There is a risk of false negative results if the skin testing is performed earlier.

d. A report will be issued to the patient and referring anaesthesiologist and surgeon after skin and serum testing at the clinic.

e. Along with the report provided, patients are supplied with

   i. completed application form for patient to apply for Medic Alert bracelet.

   ii. adverse drug reaction (ADR) and the Allergy Card application forms to be submitted to the Pharmacy Department of the referring hospital.

f. If the causative agent is identified, it should be avoided. Other recommendations in the report by HKLAAC should be followed.

g. In cases of allergy to latex or disinfectants (chlorhexidine or povidone iodine), the patient needs to be educated to inform all healthcare personnel involved in managing the patient to avoid accidental re-exposure in the future.

h. For NMBAs, the causative NMBA as well as the cross-reactive NMBAs should be avoided. If the patient tested negative to an alternative NMBA, this NMBA can be used in future, but caution and vigilance are advised.

5.1.6. Managing Suspected β-lactam Antibiotic Allergy Cases

a. Alterations in antibiotic prescribing due to unconfirmed penicillin allergy have been shown to result in poorer clinical outcomes, increased incidence of serious antibiotic-resistant infections, prolonged hospitalizations, and increased healthcare burden.

b. Careful evaluation of antibiotic allergy history including prior tolerance history is essential to guide further management.

c. Risk stratification should be performed using Penicillin Allergy Clinical Decision Rule (PEN-FAST) to identify low risk penicillin allergy patients that do not require formal allergy testing.[5]

d. If the PEN-FAST score is 3 and above, the patient should be referred to the allergist/immunologist in IMR, or dermatologist specialised in antibiotic allergy testing to do skin testing for cross-reactivities with other beta-lactam antibiotics.

e. If the surgery is urgent or referral for antibiotic allergy testing is not feasible,

i. antibiotics from the penicillin or cephalosporin group should be avoided.

ii. use alternative non-β lactam antibiotics where indicated.

iii. Dual allergy (allergic reaction with another cephalosporin with dissimilar side chain) occurs in about 4% of patients.[6]

f. Cross-reactivity between penicillin-allergic patients with third and fourth-generation cephalosporins and/or carbapenem is low and very low respectively (Table 5).

g. Choice of alternative antibiotics should be made taking into consideration estimated cross-reactivity rate, type of surgery and in accordance with the National Antimicrobial Guideline.[5]

h. Test dose of antibiotics for surgical prophylaxis commonly practised by anaesthesiologists for surgical prophylaxis, has been shown to be not effective in preventing or reducing the severity of an anaphylactic reaction in susceptible individuals (NAP6).[3] It is recommended that antibiotics should be administered prior to induction of anaesthesia to simplify treatment and subsequent diagnostic workup (NAP6).[3]

5.1.7. Managing Cases with Multiple Allergies

a. Multiple drug allergies are defined as reactions to two or more chemically unrelated drugs.

b. Some patients have hypersensitivity to many drugs in the same class such as antibiotics, NSAIDs etc. They should not be considered to have multiple drug allergies.

c. Patients who are labelled as multiple drug allergies might have underlying chronic urticaria, either spontaneous or inducible.

d. These patients should be referred directly to the allergist/immunologist or dermatologist for further investigations. Refer to the Anaesthetic Allergy Clinic only when there are multiple allergies include IV anaesthetic agents, local anaesthetics or other perioperative agents.

Table 5. β-lactam cross reactivity in penicillin-allergic patients.[5]

Drug Class and Available Formulary Agents	***Estimated Cross-Reactivity***
1st Generation Cephalosporins (e.g., cefadroxil, cephalexin)	*1.9 - 7.9%*
2nd Generation Cephalosporins (e.g., refactor, cefuroxime, cefoxitin)	*1.9%*
3rd Generation Cephalosporins (e.g., ceftriaxone, cefotaxime, ceftazidime	*0.7%*
4th/5th Generation Cephalosporins (e.g., cefepime, ceftaroline)	*Not available*
Carbapenem (e.g., imipenem, meropenem, ertapenem)	*≤ 1%*
Monobactam (aztreonam)	*Negligible (except with ceftazidime which shares identical side chains*

e. Patients with chronic urticaria usually will be on antihistamines and/or steroids. These agents should be continued perioperatively to prevent flare-ups.

5.1.8. Managing Cases with Food Allergies[6]

a. There is no evidence to avoid the use of propofol in egg, soy, or peanut allergy.

b. Allergy to fish or shellfish is not related to iodine.

c. There is no evidence to avoid iodinated drugs in seafood allergy.

d. There is no evidence to avoid the use of protamine in fish allergy and neutral protamine hagedorn (NPH) insulin use. The usual precautions when administering protamine should be exercised.

5.1.9. Managing Suspected Perioperative Hypersensitivity Cases Planned for Urgent Surgeries (Figure 7)

a. The anaesthesiologist should try to get as much information about the reaction and anaesthetic procedure as possible.

b. If information from the reaction is available, all exposures before the reaction should be avoided, and alternatives should be used whenever possible.

c. If no information is available:

i. Use an alternative anaesthetic technique when possible. Regional anaesthesia may be the technique of choice when applicable due to a smaller number of drugs used.

ii. Minimise the number of IV agents, use as few drugs as possible.

iii. If the chosen technique is general anaesthesia, avoid NMBAs if possible

iv. When the use of NMBA is absolutely indicated, caution and vigilance should be exercised. There is insufficient data in the Malaysian population; however, international published data suggest the following:

- suxamethonium and rocuronium had been reported to be associated with a higher risk of anaphylaxis, whereas pancuronium and cis-atracurium are reported to have lowest risk.[1]
- cross-reactivity is most frequently observed with rocuronium and less frequently with cis-atracurium.
- patients with a history of anaphylaxis to suxamethonium cross-react with cis-atracurium in 10% of cases and with rocuronium in 20% of cases.
- cross-reactivity between atracurium and cis-atracurium is reported to be about 50%.[1]

v. Use of latex and chlorhexidine should be avoided if possible.

vi. If history of penicillin allergy is strongly suspected, antibiotics from the penicillin or cephalosporin group should be avoided. Where indicated, use alternative non-β lactam antibiotics.[7,8]

vii. Resuscitation drugs and equipment must be readily available to treat anaphylaxis.

viii. Pre-treatment with steroids and antihistamines may be considered although there is still no strong evidence that this will prevent anaphylaxis.

5.2. MALIGNANT HYPERTHERMIA

5.2.1. Introduction

a. Malignant hyperthermia (MH) is a rare but potentially fatal anaesthetic emergency.

b. It has been estimated to occur in between 1:10,000 and 1:150,000 general anaesthetics.[1,2] Genetically susceptible individuals are at risk of developing MH if they are exposed to inhalational anaesthetics or suxamethonium.

c. The cardinal clinical features result from excessive carbon dioxide (CO^2)production due to skeletal muscle hypermetabolism.

d. Diagnostic features of MH

i. Unexplained, unexpected increase in $ETCO^2$

ii. Unexplained, unexpected increase in heart rate

iii. Unexplained, unexpected increase in temperature

5.2.2. Management of Malignant Hyperthermia

a. Management of suspected MH focuses on stopping the MH process and treating the effects of MH.

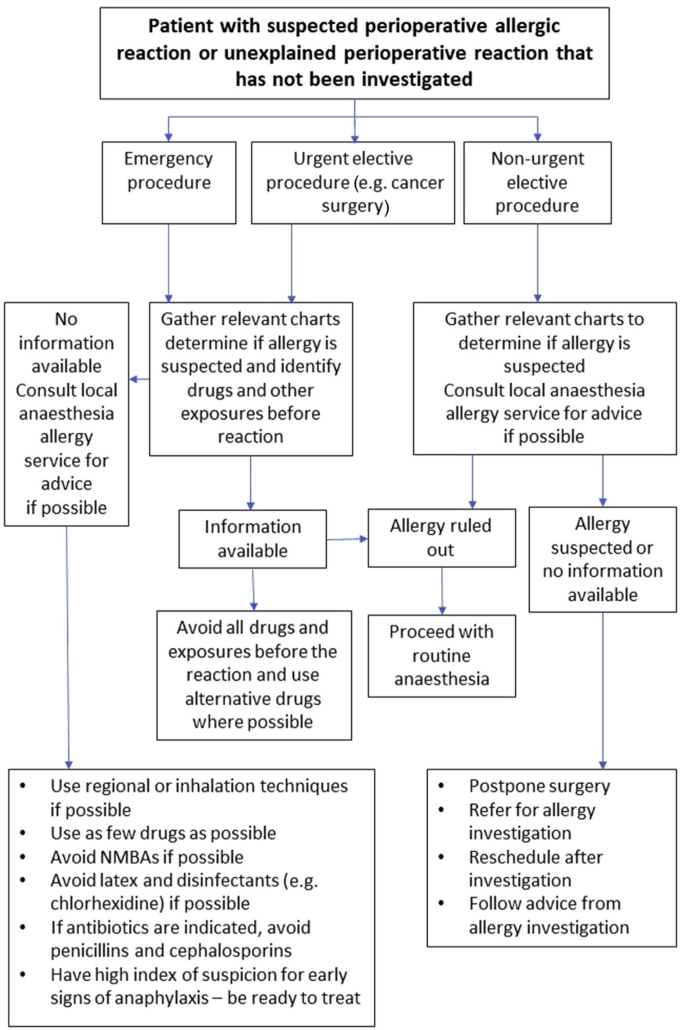


Figure 7. Management of the patient with a suspected perioperative allergic reaction or unexplained perioperative reaction that has not been investigated.

Reproduced with permission from Garvey, LH., Dewachter, P., Hepner, DL. et al. Management of suspected immediate perioperative allergic reactions: an international overview and consensus recommendations. Br J Anaesth, 2019. 123 (1): e50- e64)

b. For the guide to manage MH refer to Malignant hyperthermia resource and reporting form, Ministry of Health Malaysia. *https://www.moh.gov.my/moh/resources/Penerbitan/Anestesiologi/Malignant_Hyperthermia.pdf*

c. Anaesthesia healthcare professionals should know where dantrolene is kept in their respective hospitals. In hospitals where dantrolene is not available on site, anaesthesia healthcare professionals should know where the nearest hospital dantrolene is available.

d. The Malaysian Society of Anaesthesiologists' website has an updated list of hospitals where dantrolene is available. This is the hyperlink to the site *https://www.msa.net.my/index.*

e. All hospital pharmacies that do not have dantrolene should have established understandings with the nearest hospitals regarding immediate access to dantrolene when needed.

f. All hospitals which provide GA are recommended to have the MH cart.[3] This includes written instruction on reconstitution of dantrolene.

   i. Reconstitution of dantrolene

      - dantrolene is presented in 20 mg ampoules formulated with 3 g of mannitol.
      - each vial should be mixed with 60 ml of sterile preservative-free distilled water.

- dantrolene may dissolve faster if several ampoules are emptied into a sterile dish and a large volume of sterile water added.
- prewarming (not to exceed 38°C) the sterile water will speed solubilisation of dantrolene.
- the Ministry of Health, Malaysia recommends at least 12 vials should be available on the MH cart.[3]

5.2.3. Malignant Hyperthermia Database in Hospital Kuala Lumpur

a. Currently there is no MH registry in Malaysia.

b. The Department of Anaesthesiology & Critical Care, Hospital Kuala Lumpur (HKL) keeps a database of voluntarily reported suspected MH cases in Malaysia since 2017.

c. Currently this database is not available for reference in the management of patients who give histories of suspected MH.

d. Anaesthesia healthcare professionals are encouraged to report suspected MH to HKL using the form attached (see Appendix 3) in developing the national MH registry.

e. All suspected MH with Larach's score-rank 4 and above should be reported to the MH database in HKL.[4]

f. The primary anaesthesiologist should issue an alert card or letter to the patient and family regarding the suspected MH. The patient and family should also be counselled on confirmation of MH diagnosis by genetic testing or in vitro contracture testing which are not available in Malaysia.

g. All anaesthesia healthcare professionals should be familiar with trigger-free anaesthesia for patients with history of confirmed or suspected MH.

5.3. ANTICOAGULANTS AND ANTIPLATELET IN REGIONAL ANAESTHESIA

5.3.1. Bleeding complications following the use of either neuraxial, or peripheral nerve block procedures are a rarity.

5.3.2. Current advisory states that the use of various regional anaesthesia (RA) approaches in patients who are on concurrent anticoagulant and antiplatelet therapy, is to follow latest evidence-based guidelines to enhance safety.[1]

5.3.3. Risk-benefit assessment should be considered in patients on anticoagulant or antiplatelet agents when RA is considered.[1-6]

5.3.4. As a guide to minimise risk of spinal hematoma with neuraxial procedures refer to *https://med.stanford.edu/content/dam/sm/pain/documents/neuraxial-procedure-v2-3.26.19.pdf*

5.4. LOCAL ANAESTHESIA AND NERVE INJURY IN REGIONAL ANAESTHESIA

5.4.1. Introduction

a. The incidence of postoperative prolonged neurological deficit is generally very low.[1,2]

b. All local anaesthetics are potentially neurotoxic with the ability to reduce neural blood flow in a concentration- and time-dependent manner.[3-7]

c. Highest risk occurs with the use of high concentration LA with concomitant use of Epinephrine.[7,8]

d. Axonal damage may occur, particularly if there is an intra-fascicular injection, if the concentration is high and if duration of exposure is prolonged.[9]

e. Local anaesthetics from the ester group are found to be more toxic than amide, with ropivacaine having the lowest potential for neurotoxicity.[10]

5.4.2. Mitigation of LA-related Risk of Peripheral Nerve Injury

a. Proper conduct of block procedures reduces the risk of peripheral nerve injury (PNI) secondary to LA injection.[11]

b. The least concentrated LA solution to achieve an efficient block should be administered.[12] For example, 0.5% Ropivacaine is usually efficacious for surgical anaesthesia with a favourable recovery profile. 0.375% Ropivacaine is usually efficacious for perioperative pain relief in the setting of multimodal analgesia.

c. The use of Epinephrine in peripheral nerve blocks is associated with increased risk of ischaemic axonal injury. Although its use is suggested as an adjunct to reduce rapid absorption in the administration of large doses of LA and as an intravascular marker to aid early detection of local anaesthetic systemic toxicity (LAST), such use should be cautioned.[7,8,12]

5.5. LOCAL ANAESTHETIC SYSTEMIC TOXICITY

5.5.1. Introduction

a. Local anaesthetic systemic toxicity is a rare but potentially fatal complication.

b. When administering LA, anaesthesia healthcare professionals need to remain vigilant and monitor for LAST. When large volume and/or continuous infusion techniques are used, anaesthesia healthcare professionals should have a high index of suspicion of this complication.

c. It is a joint responsibility of anaesthesia healthcare professionals and surgeons to ensure the LA dose administered does not exceed the total safe dose.

d. For every location where LA is administered, resuscitation drugs and equipment including Lipid emulsion 20% must be made immediately accessible. For the guide to LAST management refer to Appendix 4.

5.5.2. General Principles to Reduce the Risk of LAST

a. Severity of clinical presentation of LAST is determined by the level of free plasma concentration of LA which is a balance between drug absorption and clearance.

b. Free plasma levels are affected by several factors:

   i. Drug factors: For example, type of LA, addition of epinephrine, dose, pharmacokinetic (metabolism and excretion).

   ii. Patient factors: For example, age, comorbidity, pregnancy, pharmacodynamic (sensitivity and muscle mass).

   iii. Technique factors: For example, site of injection, use of ultrasound guidance, catheter technique.

c. High lipid solubility LAs are more potent but have higher risk of toxicities.

d. Local anaesthetics with high Cardiovascular Collapse / Central Nervous System (CC/CNS) ratios have higher safety margins, e.g., levobupivacaine and ropivacaine have higher safety margins compared to bupivacaine.

5.5.3. Specific Principles to Reduce the Risk of LAST

a. The use of ultrasound for regional anaesthesia (RA) reduces risk of LAST by nearly four-fold.[1]

b. Dosing in LA should be based on lean body weight.[2]

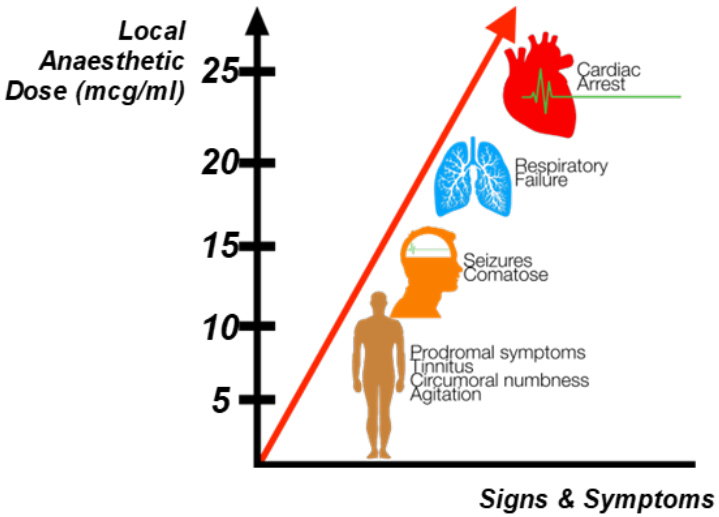


Figure 8. Signs and symptoms correlate with the serum levels of local anaesthetic.

c. The lowest effective dose of LA should be used based on body mass, site of injection, patient's age and medical history.[2]

d. Consider dose reductions between 10 to 20%:

   i. when using continuous techniques or requiring multiple boluses.[3]

   ii. In patients with the following conditions:

   - extremes of age.[3,4]
   - cardiac dysfunction with decompensated heart failure.[5]
   - parturients.[5]

- renal impairment with uraemia or acidosis.[3]
- liver disease with concomitant cardiac or renal disease.
- metabolic disorders, for example diabetes mellitus, mitochondrial disease, carnitine deficiency, or malnourishment.

iii. Injection of LAs should be in small volume aliquots with gentle aspiration before each injection.

- during peripheral nerve block, aliquots of <5 mL with 30–45 seconds pause in between injections (longer in low cardiac output states) should be done.[2,5]
- during LA injection into the epidural catheters, gentle aspiration prior to administration and test dose may detect intravascular catheter placement.

e. Subsequently, LAST may still occur due to large volumes of LA infusion or catheter migration.

f. Vigilance must be practised throughout the duration of the epidural catheter use.

g. Addition of epinephrine in LAs may serve as an intravascular marker of injection, prolonging the duration of action of LA and reduce risk of LAST.

i. 15 µg/ml of epinephrine in the LA solution will increase the heart rate by ≥10 beats per minute or systolic blood pressure by ≥15 mmHg, but users must be aware of its limitations as a safety measure.[6]

REFERENCES:

PERIOPERATIVE HYPERSENSITIVITY AND ANAPHYLAXIS

1. *ANZAAG/ANZCA Anaphylaxis Management Guidelines https://anzaag.com/anaphylaxis-management/management-resources/*

2. *Mertes PM., Ebo DG., Garcez T., Rose M., Sabato V., Takazawa T., Cooke PJ., Clarke RC., Dewachter P., Garvey LH., Guttormsen AB., Hepner DL., Hopkins PM., Khan DA., Kolawole H., Kopac P., Krøigaard M., Laguna JJ., Marshall SD., Platt PR., Sadleir PHM., Savic LC., Savic S., Volcheck G.W, Voltolini S. Comparative epidemiology of suspected perioperative hypersensitivity reactions. Br J Anaesth, 2019. 123(1): e16-e28*

3. *Harper NJN., Cook TM., Garcez T., Farmer L., Floss K., Marinho S., Torevell H., Warner A., Ferguson K., Hitchman J., Egner W., Kemp H., Thomas M., Lucas DN., Nasser S., Karanam S., Kong KL., Farooque S., Bellamy M., McGuire N. Anaesthesia, surgery, and life-threatening allergic reactions: epidemiology and clinical features of perioperative anaphylaxis in the 6th National Audit Project (NAP6). Br J Anaesth, 2018. 121(1): 159-171*

4. *Garvey LH, Dewachter P, Hepner DL et al. Management of suspected immediate perioperative allergic reactions: an international overview and consensus recommendations. Br J Anaesth 2019: 123 (1): e50-e64*

5. *Ministry of Health, Malaysia. National Antimicrobial Guideline. 4th Edition, 2024 https://pharmacy.moh.gov.my/nag*

6. *Dewachter P., Kopac P., Laguna JJ. Anaesthetic management of patients with pre-existing allergic conditions: a narrative review. British Journal of Anaesthesia, 2019. 123 (1): e65ee81*

7. *Pichichero, ME., Zagursky, R. Penicillin and Cephalosporin allergy. Ann Allergy Asthma Immunol, 2014. 112: p.404-412*

8. *Romano A et al. Cross-reactivity and tolerability of cephalosporins in patients with IgE-mediated hypersensitivity to penicillins. J Allergy Clin Immunol Pract, 2018. 6(5): 1662-72*

MALIGNANT HYPERTHERMIA

9. *Hopkins, PM., Girard, T., Dalay, S. et al. Malignant hyperthermia 2020. Guideline from the Association of Anaesthetists. Anaesthesia 2021, 76, 655–664.*

10. *Rüffert H., Bastian B., Bendixen D., Girard T., Heiderich S., Hellblom A., Hopkins PM., Johannsen S., Snoeck MM., Urwyler A., Glahn KPE; European Malignant Hyperthermia Group. Consensus guidelines on perioperative management of malignant hyperthermia suspected or susceptible patients from the European Malignant Hyperthermia Group. Br J Anaesth, 2021. 126(1): 120-130*

11. *Ministry of Health Malaysia. Malignant hyperthermia resource and reporting form. https://www.moh.gov.my/moh/resources/Penerbitan/Anestesiologi%20dan%20Rawatan%20Rapi/Malignant_Hyperthermia.pdf*

12. *Larach MG., Localio AR., Allen GC., Denborough MA., Ellis FR., Gronert GA., Kaplan RF., Muldoon SM., Nelson TE., Ording H., et al. A clinical grading scale to predict malignant hyperthermia susceptibility. Anesthesiology, 1994. 80(4): 771-9*

ANTICOAGULANTS AND ANTIPLATELET IN REGIONAL ANAESTHESIA

13. *Working Party: Association of Anaesthetists of Great Britain & Ireland; Obstetric Anaesthetists' Association; Regional Anaesthesia UK. Regional anaesthesia and patients with abnormalities of coagulation: the Association of Anaesthetists of Great Britain & Ireland the Obstetric Anaesthetists' Association Regional Anaesthesia UK. Anaesthesia, 2013. ;68(9): 966-72. Erratum in: Anaesthesia, 2016. 71(3): 352*

14. *Horlocker TT., Vandermeuelen E., Kopp SL., Gogarten W., Leffert LR., Benzon HT. Regional Anesthesia in the Patient Receiving Antithrombotic or Thrombolytic Therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (Fourth Edition). Reg Anesth Pain Med, 2018. 43(3): 263-309. Erratum in: Reg Anesth Pain Med, 2018. 43(5): 566. Vandermeuelen, Erik [corrected to Vandermeulen, Erik].*

15. *Tsui BCH., Kirkham K., Kwofie MK., Tran Q., Wong P., Chin KJ., Sondekoppam RV. Practice advisory on the bleeding risks for peripheral nerve and interfascial plane blockade: evidence review and expert consensus. Can J Anaesth, 2019. 66(11): 1356-1384*

16. *Kubulus C., Gürtesch CA., Wagenpfeil G., Sessler DI., Volk T. Antithrombotic drugs and the risk of bloody punctures in regional anesthesia - a retrospective registry analysis. Reg Anesth Pain Med, 2022. 3: rapm-2022-103806.*

17. *Ashken T., West S. Regional anaesthesia in patients at risk of bleeding. BJA Educ. 2021. ;21(3): 84-94 Epub 2021 Jan 26. Erratum in: BJA Educ. 2021 Jul;21(7):278.*

18. *Kietaibl S., Ferrandis R., Godier A., Llau J., Lobo C., Macfarlane AJ., Schlimp CJ., Vandermeulen E., Volk T., von Heymann C., Wolmarans M., Afshari A. Regional anaesthesia in patients on antithrombotic drugs: Joint ESAIC/ESRA guidelines. Eur J Anaesthesiol, 2022. 1;39(2): 100-132*

LOCAL ANAESTHESIA AND NERVE INJURY IN REGIONAL ANAESTHESIA

1. *Borgeat A., Ekatodramis G., Kalberer F., Benz C. Acute and nonacute complications associated with interscalene block and shoulder surgery: a prospective study. Anesthesiology 2001; 95: 875-80*

2. *Neal JM., Barrington MJ., Brull R., Hadzic A., Hebl JR., Horlocker TT., Huntoon MA., Kopp SL., Rathmell JP., Watson JC. The Second ASRA Practice Advisory on Neurologic Complications Associated with Regional Anesthesia and Pain Medicine: Executive Summary 2015. Reg Anesth Pain Medn 2015. 40(5): 401-30*

3. *Lambert LA., Lambert DH., Strichartz GR. Irreversible conduction block in isolated nerve by high concentrations of local anesthetics. Anesthesiology, 1994. 80: 1082-1093*

4. *Myers RR., Kalichman MW., Reisner LS., Powell HC. Neurotoxicity of local anesthetics: Altered perineurial permeability, edema, and nerve fiber injury. Anesthesiology, 1986.;64: 29-35*

5. *Gadsden J. Chapter 10. Neurologic Complications of Peripheral Nerve Blocks. In: Hadzic A. eds. Hadzic's Peripheral Nerve Blocks and Anatomy for Ultrasound-Guided Regional Anesthesia, 2e. The McGraw-Hill Companies; 2012. Accessed July 24, 2024. https://accessanesthesiology.mhmedical.com/content.aspx?bookid=518&sectionid=41534296*

6. *Myers RR., Heckman HM. Effects of local anesthesia on nerve blood flow: Studies using lidocaine with and without epinephrine. Anesthesiology, 1989. 71: 757-762*

7. *Partridge BL. The effects of local anesthetics and epinephrine on rat sciatic nerve blood flow. Anesthesiology, 1991. 75: 243-250*

8. *Borgeat A., Blumenthal S. Nerve injury and regional anaesthesia. Current opinion in anaesthesiology, 2004. 17: 417-421*

9. *Hogan QH. Pathophysiology of peripheral nerve injury during regional anesthesia. Reg Anesth Pain Med, 2008. 33(5): 435-441*

10. *O'Flaherty D., McCartney CJL., Ng SC. Nerve injury after peripheral nerve blockade-current understanding and guidelines. BJA Educ, 2018. 18(12): 384-390.*

11. *College of Anaesthesiologists, Academy of Medicine, Malaysia. Recommendations for Peripheral Nerve Blocks, 2019*

12. *Hewson DW., Bedforth NM., Hardman JG. Peripheral nerve injury arising in anaesthesia practice. Anaesthesia, 2018. 73 Suppl 1:51-60.*

LOCAL ANAESTHETIC SYSTEMIC TOXICITY

1. *Barrington MJ., Kluger R. Ultrasound guidance reduces the risk of local anesthetic systemic toxicity following peripheral nerve blockade. Regional Anesthesia and Pain Medicine, 2013. 38: 289–99*

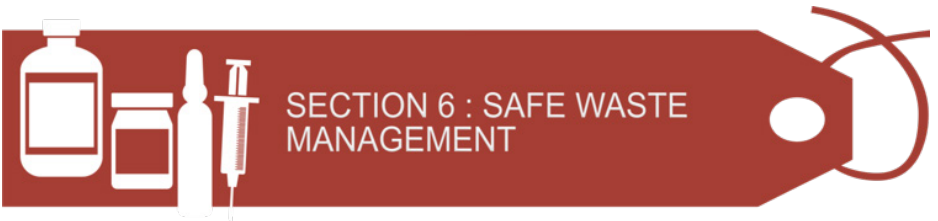
2. *Neal JM., Barrington MJ., Fettiplace MR., Gitman M., Memtsoudis SG., Mörwald EE., Rubin DS., Weinberg G. The Third American Society of Regional Anesthesia and Pain Medicine Practice Advisory on Local Anesthetic Systemic Toxicity: Executive Summary 2017. Reg Anesth Pain Med, 2018.43(2): 113-123*

3. *El-Boghdadly K., Chin KJ. Local anesthetic systemic toxicity: Continuing Professional Development. Can J Anaesth, 2016. 63(3): 330–349*

4. *Macfarlane AJR., Gitman M., Bornstein KJ., El-Boghdadly K., Weinberg G. Updates in our understanding of local anaesthetic systemic toxicity: a narrative review. Anaesthesia, 2021. 76 Suppl 1:27-39*

5. *Rosenberg PH., Veering BT., Urmey WF. Maximum recommended doses of local anesthetics: a multifactorial concept. Reg Anesth Pain Med, 2004. ;29(6): 564–575*

6. *El-Boghdadly K., Pawa A., Chin KJ. Local anesthetic systemic toxicity: current perspectives. Local Reg Anesth, 2018. 11: 35-44.*



KEY POINTS FOR SECTION 6

1. *Safely discard used vials, ampoules, and syringes in designated containers, following institutional protocols to prevent contamination and injury.*

2. *Ensure controlled substances and hazardous drugs are disposed of according to institutional regulations and environmental guidelines, avoiding potential abuse and minimising environmental harm.*

3. *Use scavenging systems to vent waste anaesthetic gases (WAGs) from the operating room and ensure adequate air exchange to reduce accumulation.*

4. *In areas without scavenging systems, alternatively activated charcoal canisters should be used for WAGs.*

6.1. DISPOSAL OF VIALS, AMPOULES AND SYRINGES

6.1.1. Safely discard all used vials, ampoules, and syringes after each case. It is the responsibility of anaesthesia healthcare professionals to discard items that had been used.

6.1.2. All partially used ampoules and syringes filled with drugs should be disposed appropriately to minimise the risk of drugs being inadvertently administered to the next patient.[1]

6.1.3. The proper disposal of sharps and contaminated items should follow institutional protocols.[1,2]

6.1.4. If recycling is not an option, used glass ampoules or bottles pose a risk of sharp injury and should be placed in a sturdy sharp bin/ container appropriate for disposal.

6.1.5. Syringes with attached needles shall be discarded into sharps containers as one unit.

6.2. PROPER DISPOSAL OF DRUGS

6.2.1. The disposal of medications with potential for diversion and abuse, such as opioids, benzodiazepines, and propofol, should be carried out in a way that minimises this risk.[1] Witness and document the disposal of unused controlled substances in compliance with institutional regulations. Leftover unused controlled substances in syringes or ampoules must be emptied into medical waste bins (yellow bin). Empty vials may be kept for Dangerous Drug inventory according to institutional practice.

6.2.2. Medications used in anaesthesia should be disposed of in a manner that reduces potential environmental harm. Hospital waste management policy and local legislative requirements should be adhered to.[1]

6.2.3. Unmetabolised propofol does not degrade in the environment, is highly mobile in soil, accumulates in fat and is toxic to aquatic life. Unused propofol (in syringes, ampoules or infusion lines) should be disposed of into the hospital waste management system to be incinerated. Do not empty propofol into the sink.

6.3. SCAVENGING, INHALATIONAL AGENT ABSORBER, CARBON DIOXIDE ABSORBER AND OPERATING ROOM ENVIRONMENT POLLUTION

6.3.1. Waste anaesthetic gases (WAGs) are vented to the outdoor atmosphere virtually not metabolised.

6.3.2. To minimise accumulation of WAGs in the operating room environment:

a. WAGs from the breathing circuit should be vented out from the operation room through a scavenging system.

b. The operation room air exchange rate is recommended at a minimum total of 15 air changes per hour with a minimum of 3 air changes of outdoor air per hour.[1]

6.3.3. In remote areas where there is no scavenging system available, canisters filled with activated charcoal should be used as WAGs disposal. Activated charcoal canisters will adsorb halogenated anaesthetic gases but not nitrous oxide.[1]

6.3.4. Nitrous oxide is discharged to the environment by the scavenging system and is responsible for most of the ozone depletion in anaesthesia practice.[2]

6.3.5. Used carbon dioxide absorbers are disposed of in the medical waste (yellow) bin.

6.3.6. Handling and disposal of medical waste including the above wastes mentioned are to follow institutional waste management protocols.

REFERENCES:

GOOD PRACTICE OF DISPOSAL OF WASTE

1. *Australian and New Zealand College of Anaesthetists. PG51(A): guideline for the safe management and use of medications in anaesthesia 2021. 2021. https://www.anzca.edu.au/getattachment/17f3f75c-9164-41e6-a918-9f403261c8eb/PG51(A)-Guideline-for-the-safe-management-and-use-of-medications-in-anaesthesia-(PS51)*

2. *Ministry of Natural Resources and Environment. Guidelines on the Handling and Management of Clinical Wastes in Malaysia, 2009*

SCAVENGING, INHALATIONAL AGENT ABSORBER, CARBON DIOXIDE ABSORBER AND OPERATING ROOM ENVIRONMENT POLLUTION

1. *Occupational Safety and Health Act U.S. Department of Labor. Anaesthetic Gases: Guidelines for Workplace Exposures, 2000 https://www.osha.gov/waste-anesthetic-gases/workplace-exposures-guidelines*

2. *McGain F., Muret J., Lawson C., Sherman JD. Environmental sustainability in anaesthesia and critical care. Br J Anaesth, 2020. 125(5): 680-692*

Appendix 1

ALLERGY REQUEST FORM

Allergy Unit
Allergy & Immunology Research Centre (AIRC)
Institute for Medical Research (IMR)
National Institutes of Health (NIH)
No 1, Jalan Setia Murni U13/S2
Seksyen U13 Setia Alam, 40170 Shah Alam, Selangor
No Tel: 03-33628385
Email: allergyimrkl@gmail.com

For IMR Lab No. ONLY

1. Name:	2. R/N:
3. I/C No.:	4. Date of Birth:
5. Age:	6. Gender:
7. Race :	8. Ward/Clinic:
9. Requesting Doctor:	10. Hospital:

11. Related disease:
(Please tick if relevant)

- ☐ Bronchial asthma
- ☐ Allergic rhinitis/ eye disease
- ☐ Eczema
- ☐ Urticaria
- ☐ Anaphylaxis
- ☐ Mast cell disease
- ☐ Food/ Medication Allergy
- ☐ Multi-trigger wheeze
- ☐ Primary immunodeficiency disorder (PID)
- ☐ Hypereosinophilia syndrome
- ☐ Allergic bronchopulmonary aspergillosis

12. Clinical Summary:

13. Diagnosis:

14. Test Requested: (Please tick ONLY appropriate test/s required)

No.	Test	Tick
i.	Total IgE	
ii.	Specific IgE:	Please specify allergen to be tested: ☐ Aeroallergen:_____ ☐ Food: _____ ☐ Medication: _____ ☐ Others: _____
iii.	Tryptase	☐ Anaphylaxis *Onset/Death time:* *Sampling time :* ☐ Mast cell disorder
iv.	Eosinophil cationic protein (ECP)	☐ Allergic disease ☐ Eosinophil associated disorder

For IMR Allergy Laboratory Use ONLY

15. Specimen Collection Details:

Date:..... Sampling site (forensic case) :

Time:.....

16. Applicant's Name (Signature & Stamp):

IMPORTANT NOTICE: To ensure correct and reliable result given, please fill up the entire form and refer next page for sampling guidance.

Sample Collection Instruction and Guidance

No	Tests	Specimen Type	Vacutainer	Guidance/Indication	LTAT (Working days)
1	**Total Ig E**	Blood	• Plain tube • 3 ml • Store at 2 - 8°C • Minimum volume 150 microlitre/test	• Patients with suspected diseases associated with elevations of total immunoglobulin E (Ig E) : including allergic disease, primary immunodeficiencies,autoimmunity, infections, malignancies, or other inflammatory diseases • Diagnostic evaluation/progression in patient with allergic bronchopulmonary aspergillosis • Identifying candidates for omalizumab (anti-IgE) therapy	10
2	**Specific Ig E**	Blood	• Plain tube • 3 ml • Store at 2 - 8°C	• Testing should be focusing on allergy focus history • Screening without valid history is **not recommended**	10
3	**Tryptase**	Blood	• Plain tube • 3 mL • Store at 2 - 8°C • 1 plain tube for each sampling time	*Timing of samples collection* **1. After anaphylaxis:** • 1st sample within 15 minutes up to 3 hours after the onset of the symptoms • 2nd sample after 24-48 hours to confirm the return to baseline levels • 3rd sample after 1-2 weeks if incidents of mastocytosis or other causes of elevated basal levels are suspected **2. For forensic sample,** please specify **sampling site, time of death** and **time of sampling.** • ***Accurate timing of sampling is important for interpretation***.	14
4	**Eosinophil cationic protein (ECP)**	Blood	• Plain tube • 3 ml • Store at 2 - 8°C	Indication for ECP: • Eosinophilic related disease including eosinophilic esophagitis, eosinophilic gastroenteritis, hypereosinophilic syndrome etc. • Allergic disease including bronchial asthma, atopic eczema, allergic rhinitis, ocular allergy, chronic urticaria etc.	14

** Private hospital/laboratory are advised to call the Allergy Unit prior to sending sample(s).*

** Sample(s) from East Malaysia are suggested to be transported in ice.*

** Spin/separate serum from RBC immediately. Grossly haemolysed samples will be rejected.*

Appendix 2

HKLAAC referral form v2. Aug 2019

REFERRAL FORM FOR PERIOPERATIVE ANAPHYLAXIS
Anaesthetic Allergy Clinic
Hospital Kuala Lumpur

Patient details:	Patient label (if available)
Name:	
IC:	
Primary phone No:	
Secondary phone No:	
Email:	
Mailing Address:	
Referring Doctor:	
Name:	Phone:
Hospital:	Email:
Position: □ Consultant Anaesthetist □ Specialist Anaesthetist □ Medical Officer □ Others (if referring doctor is non-anaesthetist)	
OT personnel involved:	
Anaesthetist's name: (if not referring doctor)	
Anaesthetist's position:	
Surgeon's name:	
Surgeon's position:	
Patient Medical History:	
Does the patient have □ Pregnancy □ Asthma □ Eczema □ Allergic Rhinitis □ Drug Allergy (specify): □ Food Allergy (specify): □ Other Allergy (specify):	
Medical Conditions:	
Current Medications:	
Is the patient currently on: □ oral steroids □ antihistamines □ β blockers □ antidepressant □ NSAID □ ACE Inhibitors/AII Receptor antagonist	

HKLAAC referral form v2. Aug 2019

Details of reaction			
Procedure:			
Date of reaction:			
Date of referral:			
Time of induction:			
Time reaction first noted:			
Mode of anaesthesia □ General □ Regional □ Local □ IV sedation □ GA+RA			
The patient was exposed to the following medications PRIOR to the reaction(indicate time of exposure):			
Agent	Time administered	Agent	Time admistered

Please tick if the patient was exposed to the agents listed below (indicate time of exposure):

Agent	Time
Chlorhexidine □ skin prep □ others	
Povidone	
Latex □ gloves □ others	
Contrast (specify)	
Methylene Blue	
Colloids	
Blood products (specify type)	
Central venous line □ chlorhexidine coated □ antibiotic coated □ uncoated	
Urinary catheter (specify type)	
Lubricant (specify type)	

HKLAAC referral form v2. Aug 2019

Symptoms & Signs of Reaction
Tachycardia >100bpm (before adrenaline): □ Yes □ No
Bradycardia <60bpm: □ Yes □ No
Arrhythmia (specify type): □ Yes □ No
Hypotension: □ Yes □ No Baseline BP: Lowest BP:
Cardiac Arrest : □ Yes □ No
Cough : □ Yes □ No
Bronchospasm: □ Yes □ No □ Mild wheeze □ moderate wheeze □ severe wheeze □ difficulte to ventilate □ dyspnoea reported by patient
Desaturation (specify SpO2 range): □ Yes □ No
Flushing/erythema: □ Yes □ No □ Generalised □ Localised
Urticaria : □ Yes □ No □ Generalised □ Localised
Angioedema: □ Yes □ No
Swelling (specify site): □ Yes □ No
Gastrointestinal signs: □ Yes □ No □ Nausea □ Vomiting □Abdominal cramps/pain
What was the first symptom you noticed?
What was the predominant symptom?
Severity of Allergic Reaction Please specify the Grade of Allergic Reaction from the categories below:
□ Grade I – cutaneous-mucous signs: erythema, urticaria +/- angioedema
□ Grade II – Moderate multisystemic signs: cutaneous-mucous signs +/- hypotension +/- tachycardia +/- dyspnoea +/- gastrointestinal disturbance
□ Grade III – Life-threatening single- or multisystemic signs: cardiovascular collapse, tachycardia or bradycardia +/- cardiac dysrythmia +/- bronchospasm +/- cutaneous-mucous signs +/- gastrointestinal disturbance
□ Grade IV – cardiac arrest

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Details of Treatment
Airway management
Assisted/mechanical ventilation □ Yes □ No □ Planned □ Unplanned
Endotracheal intubation □ Yes □ No □ Before onset □ After onset
Bronchospasm treatment □ Yes □ No Specify drugs used and dose:
Adrenaline given? □ Yes □ No □ IV □ IM □ SC □ ETT Total dose given:_____mcg
IV Fluids given for resuscitation? □ Yes □ No Specify type/s of fluid & total volume:
Cardiac compressions? □ Yes □ No Duration of CPR:
Cardioversion/Defibrillation □ Yes □ No Number of shocks:_____
Vasopressors other than adrenaline given? □ Yes □ No □ Ephedrine Dose_____ □ Phenylephrine Dose_____ □ Noradrenaline Dose_____ □ Others (specify):
Steroids given? □ Yes □ No Specify steroid used & dose:
Antihistamines used? □ Yes □ No Specify antihistamine used and dose:
Investigations
Serum tryptase taken? □ Yes □No Please take 5mls in serum bottle at 1 hour, 4 hours and 24 hours after reaction (state brief history in request form) Please record time samples taken and attach results to this referral (if available) Sample 1: Time_____Result:_____mcg/L Sample 2: Time_____Result:_____mcg/L Sample 3: Time_____Result:_____mcg/L Which pathology laboratory were the specimens sent to?_____ * Send to IMR if from HKL or via hospital lab if from other hospitals. Store at 4 degrees if there is delay in transport (max 4 days).
Other differential diagnosis other than anaphylaxis? Comments

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Outcome/Sequelae
Operation/procedure □ Completed □ Abandoned
Patient transferred to recovery? □ Yes □ No
Post op care in ICU/HDU? □ Yes □ No If yes: Was patient intubated/ventilated on transfer? □ Yes □ No Duration of intubation/ventilation:
Was inotrope infusion continued? □ Yes □ No Specify inotrope: Duration of inotrope infusion:
Duration of ICU stay
Further complications □ ECG Changes □ Coagulopathy □ Troponin rise □ Pneumothorax □ Anxiety/PTSD □ Others (specify)
Comments/ summary of events:
□ *Please forward this referral and supporting documents to Anaesthetic Allergy Clinic, Hospital Kuala Lumpur (contact 0326155555 ext 1133/1134, email hklaac@gmail.com)* □ *Please attach a copy of the anaesthetic/recovery/PACU chart* □ *Please ensure the correct patient details have been supplied* □ *Please inform the patient of the events and this referral which entails skin and serum testing.* □ *Provide the patient with a letter listing all substances administered perioperatively to show to those providing care until testing can be conducted.* **Patient will be contacted by our clinic for an appointment date.*

Prepared by Dr Kwok Fan Yin/ Dr Cindy Thomas Joseph
Anaesthetic Allergy Clinic, Hospital Kuala Lumpur
Adapted from ANZAAG referral form 2017

Appendix 3

MALIGNANT HYPERTHERMIA
Malignant hyperthermia (MH) is an uncommon pharmacogenetic disorder of muscle induced by exposure to suxamethonium and all the volatile anaesthetic agents. It is characterized by hypermetabolism, muscle rigidity and muscle injury.
SIGN AND SYMPTOMS
The clinical features are a direct consequence of loss of skeletal muscle calcium homeostasis, resulting in increased intracellular calcium ion concentration, which causes **muscle rigidity, hypermetabolism,** and **rhabdomyolysis.** The diagnosis may be difficult as there is no one sign that is unique to MH, and the onset may be rapid or insidious.
1.Unexplained **increased CO2 production** and **tachycardia.** The rise in CO2 production results in **tachypnoea** in the spontaneously breathing patient or a rise in end-tidal CO2 in a ventilated patient. **Elevation of the end-tidal CO2 -** earliest, most sensitive and specific signs of MH.
2. **BP** is often unstable, with a tendency for decreasing SpO2.
3. **Increase in body temperature** occurs later, and may be at a rate of > 1 ◦ C every 5 minutes.
4. **Generalised muscle rigidity, raised plasma CK** and **myoglobinuria** are late signs.
5. **Cardiac arrhythmias, hyperkalaemia and disseminated intravascular coagulation may develop**
6. **Arterial blood gas analysis -** hypercarbia with respiratory and metabolic acidosis.
Masseter muscle spasm Rigidity of the jaw muscles after administration of suxamethonium, referred to as masseter muscle spasm (MMS) may be the first sign of possible susceptibility to MH. It is defined as impeding intubation and lasting for 2 minutes. It is more common in children and young adults.
Sudden or unexpected cardiac arrest in young patient
ACUTE PHASE TREATMENT
1. **GET HELP. GET DANTROLENE and Notify Surgeon**
• Discontinue volatile agents and succinylcholine
• Hyperventilate with 100% oxygen at flows of 10L/min or more
• Halt the procedure as soon as possible; if emergent, use non-triggers. (Use GA machine without vaporisers or use ICU ventilator)
2. **Dantrolene 2.5mg/kg rapidly IV**
• Repeat until there is control of the sign of MH

	• Sometimes more than 10 mg/kg (Up to 30mg/kg) is necessary
	• Dissolve the 20mg in each vial with at least 60ml **sterile preservative-free water** for injection. Prewarming (not to exceed 38°C) the sterile water will speed solublization of dantrolene.
	• The crystals also contain NAOH for a PH of 9, mannitol 3g.
3.	**Bicarbonate for metabolic acidosis**
	• 1-2mEq/kg if blood gas values are not yet available
4.	**Cool** the patient with core temperature >39°C, via cold saline IV. Lavage open body cavities, stomach, bladder or rectum. Apply ice to surface. Stop cooling if temp. <38°C and falling to prevent drift <36°C.
5.	**Dysrhythmias** usually respond to treatment of acidosis and hyperkalaemia
	• Use standards drug therapy **except calcium channel blockers which may cause hyperkalaemia or cardiac arrest in the presence of dantrolene**
6.	**Hyperkalaemia** – Treat with hyperventilation, bicarbonate, glucose/insulin, calcium
	• Bicarbonate 1-2mg/kg IV
	• For **Paediatric,** 0.1 units insulin/kg and 1ml/kg 50% glucose or for **Adult,** 10 units regular insulin IV and 50ml 50% glucose
	• Calcium gluconate 10% 10-50mg/kg for life-threatening hyperkalaemia
	• Check glucose level hourly
7.	**Monitor** – $ETCO_2$, electrolytes, blood gases, CK, core temperature, urine output and colour, coagulation studies
	• Venous blood gas (e.g., femoral vein) values may document hypermetabolism better than arterial values
	• Central venous or PA monitoring as indicated • Minute ventilation
POST ACUTE PHASE	
A	Observe the patients in an ICU for at least 36 hours, due to the risk of recrudescence
B	Dantrolene 1mg/kg q 4-6 hours or 0.25mg/kg/hr by infusion for at least 36 hours. Further doses may be indicated.
C	Monitor vitals and labs as above (see #7)
	• Frequent ABG
	• CK every 6-8 hours
D	Counsel the patient and family regarding MH and further precautions

CONTENTS OF MALIGNANT HYPERTHERMIA CART

	Items	Quantity	Purpose
1	Dantrolene	At least 12 vials	——
2	Sterile water for injection	3 liter	Reconstitution of dantrolene
3	50mL syringes and 14 gauge needles	12	Draw up dantrolene
4	Lignocaine	5 ampoules	Bolus and continuous infusion
5	Amiodarone	5 ampoules	Bolus and continuous infusion
6	Dextrose 50%	4 ampules	Treatment of hyperkalemia
7	Mannitol 25%	1 bag	Renal protection
8	Frusemide	200 mg	Renal protection
9	Sodium bicarbonate 8.4%	(10 ampules)	Treatment of metabolic acidosis
10	Calcium gluconate 10%	4 ampules	Treatment of hyperkalemia
11	Adrenaline 1 mg	4 ampules	Treatment of hypotension
12	Normal saline (refrigerated)	6 L	For injection and irrigation

OTHERS :
Also included on the cart: crushed ice or ice maker, irrigating Foley catheter, rectal tube, cooling blanket, central venous access kits,
pulmonary artery catheter, new fresh gas hose, carbon dioxide–absorption canisters, anesthesia breathing circuit,ventilator bellows,
blood-collection tubes, lab slips, labels

PRIVATE AND CONFIDENTIAL **Report for suspected Malignant Hyperthemia Reaction**			
Hospital :			
Patient Contact Details (or Sticker)			
Patient Name :			
IC :			
Address :			
Phone :		Mobile :	
Date of Birth :		sex :	
Name and Contact details of Doctor Completing This Form :			
Name :			
Address (Hosp) :			
Phone :	Mobile :		Email :
Events			
Date of Procedure :			
Name of Procedure :			
Name of Anaesthetist :			
Drugs administered and doses **(attach a copy of the anaesthetic chart) :**			
Description of events and suspected drug (s) :			
Patient's usual medications :			
Family history of muscle disorders, anaethetics reactions or sudden unexplained death ?			
Number of previous uneventful anaesthetic procedures :			
Untoward events during previous anaesthetic procedures ?			
Reaction (s) :			
Muscle Rigidity			
Generalized Rigidity		Masseter Rigidity shortly following Succinyl choline administration	

Myonecrosis				
Elevated Creatinine Kinase > 10,000 IU (no sux)			Myoglobin in Urine (> 60mcg/L)	
Elevated Creatinine Kinase > 20,000 IU (with sux)		Blood /plasma/serum K^+ >6 mEq/L in the absence of renal failure		
Cola Coloured Urine		Myoglobin in serum > 170 mcg/L		
Respiratory Acidosis				
ET CO_2 > 55 mmHg with appropriately controlled ventilation		Inappropriate hypercarbia		
ET CO_2 > 60 mmHg with spontaneous ventilation		Inappropriate tachypnoea		
$PaCO_2$ > 60 mmHg with controlled ventilation		$PaCO_2$ > 65 mmHg with spontaneous ventilation		
Temperature Increase				
Rapid increase in temperature		Inappropriate temperature > 38.8°C in the perioperative period		
Cardiac Involvement				
Inappropriate tachycardia		VT or VF		
Other				
Rapid reversal of MH signs with Dantrolene		Base excess >- 8meq/L or pH < 7.25		
Positive MH family history together with another indicator from the patients own anaesthetic experience other than elevated resting serum creatine kinase				
Resting elevated serum creatine kinase (in patient with a family history of MH)				
Family History (Used to determine MH susceptibility only)				
Positive MH family history in relative of first degree				
Positive MH family history in relative not of first degree				
*** Please send the completed form to Anaesthetic Department, Hospital Kuala Lumpur.**				

Appendix 4

LOCAL ANAESTHETIC SYSTEMIC TOXICITY

Local Anaesthetic Systemic Toxicity (LAST) is a rare but potentially fatal adverse drug reaction resulting from circulating levels of local anaesthetics (LA) reaching toxic levels

MONITORING

1. Patients receiving LA administration during regional anaesthesia procedures shall be continuously monitored in accordance with the College recommendation. Minimal monitoring in the perioperative period includes electrocardiography, non-invasive blood pressure and pulse oximetry. Labour analgesia and acute pain management in the ward using LA should follow institutional protocols.
2. Clinical monitoring and observation for signs and symptoms of LAST should be performed at appropriate intervals.
3. All anaesthesia healthcare professionals should be able to recognise signs and symptoms of LAST.

CLINICAL PRESENTATION

a. Central Nervous System (CNS) toxicity is the most common feature (68%-77%).
b. Prodromal symptoms are perioral numbness, tinnitus, and agitation. CNS manifestations may progress to generalized seizure.
c. As toxicity progresses, full inhibition of CNS occurs which may lead to loss of consciousness and depression of the respiratory centre.
d. A third of patients (1/3) will progress from CNS to cardiovascular system (CVS) signs.

e. Approximately 20% of patients may present with isolated CVS disturbances.

f. CVS manifestations are hypotension and cardiac dysrhythmias which may progress to cardiac arrest.

MANAGEMENT OF LAST

https://resources.wfsahq.org/wp-content/uploads/uai25-2-Management-of-severe-local-anesthetic-toxicity.pdf

Link to Safety Guideline produced by Association of Anaesthetists of Great Britain and Ireland

Immediate management

- Stop LA administration and call for help.
- Lipid Emulsion Therapy
- 20% lipid emulsion 1.5 ml/kg (bolus over 2-3 min)
- Infusion 0.25 ml / kg / min over 15-20 min
- Repeat bolus or Increase infusion rates to 0.5 ml / kg / min
- Total dose maximum ~ 12 ml / kg
- Cardio-Pulmonary Bypass in lipid emulsion failure

Subsequent management

- It is advisable to monitor LAST patients who have experienced a significant cardio-vascular event for at least 4 to 6 hours after treatment.
- If the event is limited to CNS symptoms, it may be prudent to monitor for at least 2 hours.
- Prolonged vigilance remains essential, given that the time to peak plasma concentrations can vary from 2 to 6 hours.

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