



SASRA
SOUTH AFRICAN SOCIETY OF REGIONAL ANAESTHESIA

SASA Guidelines for Regional Anaesthesia in South Africa 2016

All healthcare professionals participating in the assessment, administration, monitoring and recovery of patients receiving a regional anaesthetic technique are accountable for safe practice.

SASA Working Group for Regional Anaesthesia Guidelines

South African Society of Anaesthesiologists

Guidelines for Regional Anaesthesia 2016

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Guidelines for Regional Anaesthesia

This is an official consensus document produced by members of a working party established by the South African Society of Anaesthesiologists (SASA).

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1. Academic acknowledgements

- 1.1. These guidelines are constructed from adaptations of publications with particular reference to the practice of regional anaesthesia from multiple major international anaesthesia bodies including the American Society of Anesthesiologists (ASA), American Society of Regional Anesthesiologists (ASRA), European Society of Regional Anaesthesiologists (ESRA), French Society of Anesthesia and Intensive Care (SFAR), the Association of Anaesthetists of Great Britain and Ireland (AAGBI), the Australian and New Zealand College of Anaesthetists (ANCZA) and the South African Society of Anaesthesiologists (SASA).
- 1.2. These publications have been researched, written and peer reviewed by the specialist anaesthesiologists who make up the organising committees, reading groups and the expert working groups with a special interest in regional anaesthesia of all the major bodies mentioned above.
- 1.3. All international, published guidelines are available online for review.

2. Disclaimer and purpose of the guidelines

- 2.1. While every effort has been made to ensure scientific accuracy, SASA and Medpharm shall not be responsible or in any way liable for errors, omissions or inaccuracies in this publication, whether arising from negligence or otherwise or for any consequences arising therefrom. These guidelines have been developed to encourage best practice, wherever possible. SASA recognises that circumstances, environment and equipment differ and that alternate practices may be deemed appropriate in alternate circumstances.
- 2.2. The purpose of these guidelines is to facilitate the management of major regional blocks including epidural, subarachnoid, plexus and peripheral nerve blocks, and to

reduce the likelihood of adverse outcomes and complications which may be associated with such blocks including, but not limited to, cardiovascular collapse, seizures, hypotension, allergic reactions, ventilatory impairment, impaired consciousness, haematoma, infection, abscess formation and nerve damage (ANCZA).

- 2.3. Major regional analgesia may be initiated for pain management alone, such as providing analgesia in labour or in the perioperative setting for the provision of perioperative analgesia. In certain circumstances, the anaesthetist may not always be continuously physically present; however, it remains the responsibility of the anaesthetist to provide safe care for the patient, by being immediately available should the need arise. This pertains, in particular, to labour epidural and peripheral regional anaesthesia techniques with no/minimal sedation. Analgesia may follow on from the anaesthesia as a continuation of the technique.

3. Introduction

- 3.1. Major regional anaesthesia should only be administered by medical practitioners with appropriate training and resuscitation skills.
- 3.2. A single operator should not assume the dual role of anaesthetist and surgeon/obstetrician. This applies, in particular, to neuraxial anaesthesia.
- 3.3. An exception may occur in that, in an emergency situation, a single practitioner may assume the dual responsibility of the operator and the anaesthetist in the context of neuraxial blockade or major plexus anaesthesia.
- 3.4. A further exception may occur if the operator provides peripheral regional anaesthesia without sedation and continues with peripheral surgery, provided a period of monitored care (usually 20 -30 minutes) has taken place.

Table 1: Advantages and disadvantages of peripheral nerve blocks

Advantages	Disadvantages
<ul style="list-style-type: none"> • Excellent analgesia • Avoids complications of systemic analgesics • Promotes early mobilisation/physiotherapy • Most are easy to perform • Catheters can provide prolonged analgesia • Some can be used in patients with anticoagulation therapy 	<ul style="list-style-type: none"> • Small risk of bleeding, especially with anticoagulation therapy • Requires continual monitoring of analgesia with adjustment of dose/infusion rate • Potential local anaesthetic toxicity with prolonged infusion • Catheter migration with resulting ineffective analgesia • Infection risk with indwelling catheter • Nerve injury • Block-specific side-effects/complications

4. Principles of practice

- 4.1. The practitioner must be adequately trained and sufficiently experienced in the practice of regional anaesthesia before practicing independently.

- 4.2. The practitioner is expected to have the ability to promptly recognise and adequately treat any complication that may arise from the anaesthetic technique.
- 4.3. An information leaflet, handed to the patient before the block, explaining the risks and benefits of the block, expected duration of action of the block, how to care for the insensate limb and warning signs of when to return to hospital, would be considered good practice.
- 4.4. Management of major regional anaesthesia should include appropriate monitoring of the patient during and after completion of the block, and remains the responsibility of the practitioner until such time as the block has resolved and normal neurological function has been restored. It is acceptable to allow patient discharge from the hospital with residual blockade, but it is advised that the practitioner keep in contact with the patient until resolution of the block.
- 4.5. The practitioner must be present until the block is fully established or must hand over the care of the patient to a competent anaesthetist. All the patient's vital signs and physiological parameters must be within normal limits, and his or her condition must be stable before the practitioner leaves the facility where the procedure has been performed.
- 4.6. Staffing and equipment in the area in which the patient is being managed should conform to the recommendations that are contained in this guideline.

5. Agents

5.1 Local anaesthetics

Local anaesthetics exert their effect as analgesics by the blockade of sodium channels and hence impeding neuronal excitation and/or conduction.

Table 2: Classification of local anaesthetics

Esters	Amides
Benzocaine	Articaine
Chloroprocaine	Bupivacaine
Cocaine	Dibucaine
Procaine/Novocaine	Etidocaine
Tetracaine/Amethocaine	Levobupivacaine
	Lignocaine
	Mepivacaine
	Prilocaine
	Ropivacaine

5.1.1 Short-duration local anaesthetics

Lignocaine is the most widely used short-duration local anaesthetic in acute pain management. Although the plasma half-life is approximately 90 minutes, the duration of local anaesthetic effect depends on the site of administration, dose administered and the presence or absence of vasoconstrictors. Although lignocaine is hydrophilic, it is delivered in high

concentrations and therefore usually diffuses well into nerve bundles, resulting in little separation of sensory and motor blocking actions.

5.1.2 Long-duration local anaesthetics

The three commonly used long-duration local anaesthetic agents, bupivacaine, levobupivacaine, and ropivacaine, are structurally related. Whereas bupivacaine is a racemic mixture of S- and R-enantiomers, levobupivacaine is the S- (or levo) enantiomer of bupivacaine; ropivacaine is an S-enantiomer formulation as well.

Clinical practice points

1. Continuous perineural infusion of lignocaine provides less effective analgesia and results in denser motor block than ropivacaine, levobupivacaine and bupivacaine.
2. There are no differences in terms of quality of analgesia or motor blockade between ropivacaine, levobupivacaine and bupivacaine when given in low doses for regional anaesthesia.
3. Ropivacaine and levobupivacaine causes less severe cardiovascular and central nervous system toxic effects than racemic bupivacaine. If ropivacaine and/or levobupivacaine are readily available, they should be used instead of racemic bupivacaine.
4. Lipid emulsion may be effective in resuscitation of circulatory collapse due to local anaesthetic toxicity but must be used in conjunction with advanced cardiac life support. It is mandatory that lipid emulsion (Intralipid®) be readily available in centres using bupivacaine, levo-bupivacaine and ropivacaine.
5. Resuscitation following accidental overdose with ropivacaine is more likely to be successful than with bupivacaine overdose. Prolonged resuscitation may be required following bupivacaine toxicity.

5.2 Opioids

Clinical practice points

1. When compared with placebo, intra-articular morphine following knee arthroscopy does not improve analgesia
2. There is no conclusive evidence that opioids have a peripheral effect at perineural level.

5.3 Adjuvant drugs

Clinical practice points

1. Adrenaline prolongs blockade when added to lignocaine only.
2. Clonidine prolongs duration of analgesia and anaesthesia (by approximately 2 hours) when added to local anaesthetics for axillary and peribulbar blocks, but evidence is inconclusive when clonidine is added to supraclavicular brachial plexus blocks or continuous catheter techniques. Beware of the *dose-independent*, systemic side effect of hypotension, bradycardia and sedation.
3. Adding clonidine to lignocaine intravenous regional anaesthesia delays tourniquet pain.
4. Long-term effects of perineural magnesium are unclear.
5. Magnesium sulphate improves intra- and postoperative analgesia and tourniquet tolerance when added to lignocaine intravenous regional anaesthesia.

Table 3: Local anaesthetic doses and infusion rates for peripheral nerve blocks

Technique	Drugs	Adult dose (ASA 1, < 40years, 65 kg)	Paediatric dose	Considerations
Plexus block	Lignocaine	4 mg/kg without adrenaline 7 mg/kg with adrenaline	4 mg/kg without adrenaline 7 mg/kg with adrenaline	
	Bupivacaine	*LD:0.25-0.5%, 20-40 ml *CI: 0.125-0.25%, 5-10 ml/h	2-3 mg/kg or 0.4-0.6 ml/kg of 0.5%, consider dose reduction in neonates	Maximum 2 mg/kg or 6 mg/kg/24h; Consider dose reduction in patients at high-risk for LAST
	Levobupivacaine	As for bupivacaine	As for bupivacaine	As for bupivacaine
	Ropivacaine	*LD:0.5-0.75%, 10-40 ml *CI: 0.2%, 0.1 ml/kg/hr	Maximum 2-3 mg/kg of 0.2%	Maximum 800 mg/24h or 28mg/h; Maximum 1 ml/kg bolus
Minor nerve blocks or infiltration	Bupivacaine	0.125-0.5% 1-40 ml	2-3 mg/kg or 0.4-0.6 ml/kg of 0.5%	Maximum 2.5 mg/kg or 150 mg
	Levobupivacaine	0.25-0.5% 1-60 ml	As for bupivacaine	Maximum 2.5 mg/kg or 150 mg
	Ropivacaine	0.2-0.75% 1-100 ml	Maximum 2-3 mg/kg of 0.2%	Maximum dose 200 mg

*LD = Loading dose *CI = Continuous infusion

- Ketamine reduces pain when applied topically in oral mucositis. Adding ketamine to local anaesthetic agents is not recommended.
- Alkalinisation by adding sodium bicarbonate is no longer recommended.
- Adding dexamethasone to local anaesthetic agents for peripheral nerve blocks increases the duration of blockade to varying degrees depending on the site of administration, with the most benefit seen with upper limb blocks (50-240%). This effect appears to be equivalent if the dexamethasone is alternatively administered intravenously in doses of at least 10 mg.
- Practitioners are advised that some adjuvant agents have preservatives with potentially undesirable effects and that an increased risk of drug errors exists when combining these adjuvant agents with local anaesthetics.

Clinical practice points for regional and local analgesic techniques

Topical techniques

- Topical EMLA cream (eutectic mixture of lignocaine and prilocaine) reduces the pain of venous ulcer debridement.

Continuous wound infusions

- Continuous local wound infusions lead to reductions in pain at rest and on movement. Decreased opioid consumption, postoperative nausea and vomiting, and length of hospital stay are reported, while there is no difference in the incidence of wound infections.
- Following laparoscopic cholecystectomy, intraperitoneal local anaesthetics reduce early postoperative pain scores.

Peripheral nerve blocks

- Continuous peripheral nerve blockade (regardless of catheter location) provides better postoperative analgesia than systemic opioids and leads to reductions in opioid use and side effects (nausea, vomiting, pruritus and sedation)
- When compared with nerve localisation using a peripheral nerve stimulator alone, ultrasound-guided blocks are faster to perform, have a faster onset and longer duration of action, are more often successful, with a lower incidence of inadvertent vascular injury and subsequent local anaesthetic systemic toxicity.
- Continuous thoracic paravertebral catheters results in comparable analgesia to thoracic epidurals with less urinary retention, hypotension, nausea, and vomiting and a lower incidence of postoperative pulmonary complications.

Table 4: Intravenous regional anaesthesia

Drug	Dose	Comments
Lignocaine	Maximum dose 300 mg or 3 mg/kg	Dilute to 40 ml total volume, adding dexamethasone prolongs analgesia

Table 5: Intra-articular analgesia

Drug	Dose	Comments
Bupivacaine	10-20 ml, 0.5%	Limited postoperative analgesia only.
Levobupivacaine	solution	Warning: the use of intra-articular local anaesthetics has been implicated in possible chondrotoxicity with resultant chondrolysis. Ropivacaine appears to be safer than bupivacaine and/or lignocaine.
Ropivacaine		

- Following open shoulder surgery, continuous interscalene analgesia provides better analgesia and improved patient satisfaction with reduced opioid-related side effects compared with opioid-based intravenous patient-controlled analgesia.
- After total knee arthroplasty femoral nerve block provides better analgesia than parenteral opioid-based techniques.
- Continuous femoral nerve blockade is equi-analgesic to epidural analgesia but with fewer side effects following total knee arthroplasty.
- Continuous posterior lumbar plexus analgesia and continuous femoral analgesia are equally effective following total knee arthroplasty.

6. Neuraxial anaesthesia and analgesia

These procedures refer to the injection of pharmaceutical preparations into the vicinity of the spinal cord or nerve tissue. The chosen method of administration of these agents and the agents that are used may vary, but the underlying principles for the management of the patient remain the same. The agents that are given are local anaesthetics, opiates, and other

analgesics or adjuvants. The method of administration includes bolus or intermittent bolus with or without indwelling catheter placement, and continuous infusion via an indwelling catheter.

6.1. Responsibility of the practitioner

6.1.1. The responsibility for the application, maintenance and sequelae of neuraxial techniques, regardless of the anaesthetic technique or the agent used, is that of the attending practitioner.

6.1.2. When the blockade has been fully established and all haemodynamic changes have been normalised, a practitioner may delegate such responsibility to another suitably trained medical practitioner or competent nursing personnel, who will then assume subsequent responsibility.

6.1.3. The responsible practitioner must:

6.1.3.1. Ascertain that there is no absolute contraindication to the procedure.

6.1.3.2. Ensure that the patient understands and gives his or her informed consent to the procedure.

6.1.3.3. Ensure that all equipment and drugs that are necessary for the management and prevention of complications relating to the procedure are immediately available.

6.1.3.4. Ensure that a surgical pause takes place to confirm the correct surgery (WHO surgical safety checklist)

6.1.3.5. Ensure adequate intravenous access prior to the procedure.

6.1.3.6. Check the agents to be injected and administer the initial dose.

6.1.3.7. Ensure that adequate monitoring is performed and that accurate records are kept.

6.1.3.8. Adequately manage any haemodynamic changes which may occur as a result of administration of the anaesthetic agents used for the blockade.

6.2. Monitoring and clinical observations

6.2.1. The practitioner or a qualified nursing sister or trained observer must be in constant attendance in order to perform regular and appropriate monitoring of the patient's physiological status and the effects of the block.

6.2.2. Such an observer shall:

6.2.2.1. Have been trained in the proper use and have an understanding of monitoring equipment.

6.2.2.2. Have the necessary clinical skills to perform, interpret and react appropriately to basic clinical observations made regarding the neurological, respiratory and cardiovascular status of the patient.

6.2.2.3. Have an understanding of possible complications associated with neuraxial block and the correct management thereof.

6.2.3. Such an observer shall be trained in measures related to basic life support.

6.2.4. All orders and routines to be followed by the observer should be conveyed in writing by the responsible practitioner. All parameters and action lines should be defined when alarms should be raised.

6.2.5. The practitioner who performed the block, or the designated practitioner, must be available to the observer for consultation and recall at all times.

6.2.6. Availability should be interpreted according to the stage of evolution of the blockade, the likelihood of complications pertinent to that stage, the concomitant use of other drugs, including those used for sedation, the presence of other co-morbid disease and the physical status of the patient.

6.2.7. It is not incumbent on the practitioner to be physically present until complete regression of blockade has occurred, provided that the other conditions of these guidelines are fulfilled.

6.2.8. The responsible practitioner is free to embark on other procedures, provided that they do not conflict with the other conditions outlined in these guidelines.

6.3. "Topping up" and management of continuous infusions

6.3.1. There is no objection to a qualified nursing sister or junior doctor undertaking the "topping up" or adjustment of continuous infusion rates. The responsible practitioner must be satisfied that the experience and capabilities of such a person are appropriate and each top up or change in dosage should be verbally confirmed. This must be recorded in writing as soon as possible.

6.3.2. The responsibility for the effects of the top up or dosage alteration remains that of the practitioner who is responsible for the procedure.

6.3.3. The responsible practitioner must issue written instructions as to the dose or infusion rate.

6.3.4. The dose, or change in infusion rate, should be checked and verified by a second competent person prior to any action being taken.

6.3.5. Instructions as to patient posture at the time of injection, clinical observations and measures to be taken in the event of untoward effects must be issued by the responsible practitioner.

6.3.6. There is no objection to a qualified nursing sister or junior doctor removing an epidural catheter on the instructions of the responsible practitioner, providing that timing and monitoring protocols have been adequately outlined, especially when concomitant anticoagulants have been administered.

7. Major plexus anaesthesia

These procedures involve injecting pharmaceutical agents into the close proximity of major nerves or nerve plexuses. The agents that are employed for these purposes include local anaesthetics and opioids, or other recognised adjuvants. The method of drug administration includes single-bolus injections or continuous infusions via indwelling catheters.

7.1. Responsibility of the practitioner

- 7.1.1. The responsibility for the application, maintenance, and sequelae of the block, regardless of the anaesthetic technique or the agent used, is that of the attending practitioner.
- 7.1.2. The responsible practitioner must:
- 7.1.2.1. Ascertain that there is no absolute contra-indication to the procedure.
 - 7.1.2.2. Ensure that the patient understands and gives his or her informed consent to the procedure.
 - 7.1.2.3. Ensure that all equipment and drugs that are necessary for the management and prevention of complications that relate to the procedure are immediately available.
 - 7.1.2.4. Ensure that appropriate measures are taken to minimise the risk of inadvertent nerve damage during the procedure
 - 7.1.2.5. Check the agent to be used and administer the first dose
 - 7.1.2.6. Ensure that adequate monitoring is performed and that accurate records are kept.

7.2. Monitoring and clinical observations

This responsibility remains with the practitioner who performs the procedure. The same principles that apply to neuraxial anaesthesia are relevant to plexus blockade.

7.3. "Topping up" and management of continuous infusions

The same principles that apply to neuraxial anaesthesia are relevant to plexus anaesthesia.

7.4. Prevention of inadvertent nerve damage

The attending practitioner should be familiar with the current methods of performing nerve blocks. It is recommended that:

- 7.4.1. Short-bevel needles should be used.
- 7.4.2. Nerve stimulators, appropriate needles and ultrasound (when available – dual guidance) should be used to determine the correct positioning of the block needle.
- 7.4.3. Where possible, and if the practitioner has been adequately trained, ultrasound-guided block techniques, where appropriate, should be used when performing nerve blocks.
- 7.4.4. All agents that are to be used must be checked to ensure that an appropriate solution is injected.

8. Infection control recommendations for regional anaesthesia (c.f. SASA Guidelines for Infection Control in Anaesthesia in South Africa 2014: Part 6)

Although bacterial colonisation of indwelling peripheral nerve catheters is high (16-57%), serious infections and abscess formation are rare. Risk factors for colonisation are catheter placement in the groin and repeated dressing changes. Catheter tunnelling significantly reduces bacterial colonisation. The strongest recommendations for preventing infection are hand hygiene and effective skin preparation, preferably with alcohol-based chlorhexidine solutions.

Executive summary

8.1 Central neuraxial techniques

- In a patient with known or suspected bacteraemia, prophylactic pre-procedural antibiotic therapy should be considered.
- Aseptic techniques must be applied during preparation of equipment
- A caudal anaesthetic is considered to be a neuraxial technique as the caudal space is a continuation of the epidural space.
- Maximum barrier protection apply:
 - » Jewellery should be removed and hands washed
 - » Caps, masks (covering both mouth and nose), sterile gloves and gowns
 - » Sterile drapes
 - » Face masks should also be worn by the anaesthetic assistant.
 - » An antiseptic, preferably chlorhexidine with alcohol, should be used for skin preparation, and adequate time allowed for drying.
 - » A sterile occlusive dressing must be applied over the catheter site.
 - » Bacterial filters may be considered during extended continuous epidural infusion.
 - » Disconnection and reconnection of the neuraxial delivery system should be limited.
 - » The removal of unwitnessed, accidentally disconnected catheters should be considered.
 - » Catheters must not remain in situ for longer than is clinically necessary.

8.2 Peripheral nerve blocks

- Maximum barrier precautions are generally not necessary.
- Maximum barrier precautions should be used only if the patient is immunocompromised or a perineural catheter needs to be inserted.
- Jewellery should be removed and hands washed. Sterile gloves must be worn.
- Aseptic techniques should always be used during the preparation of equipment, e.g. ultrasound, the drawing up of drugs and the placement of needles and catheters.

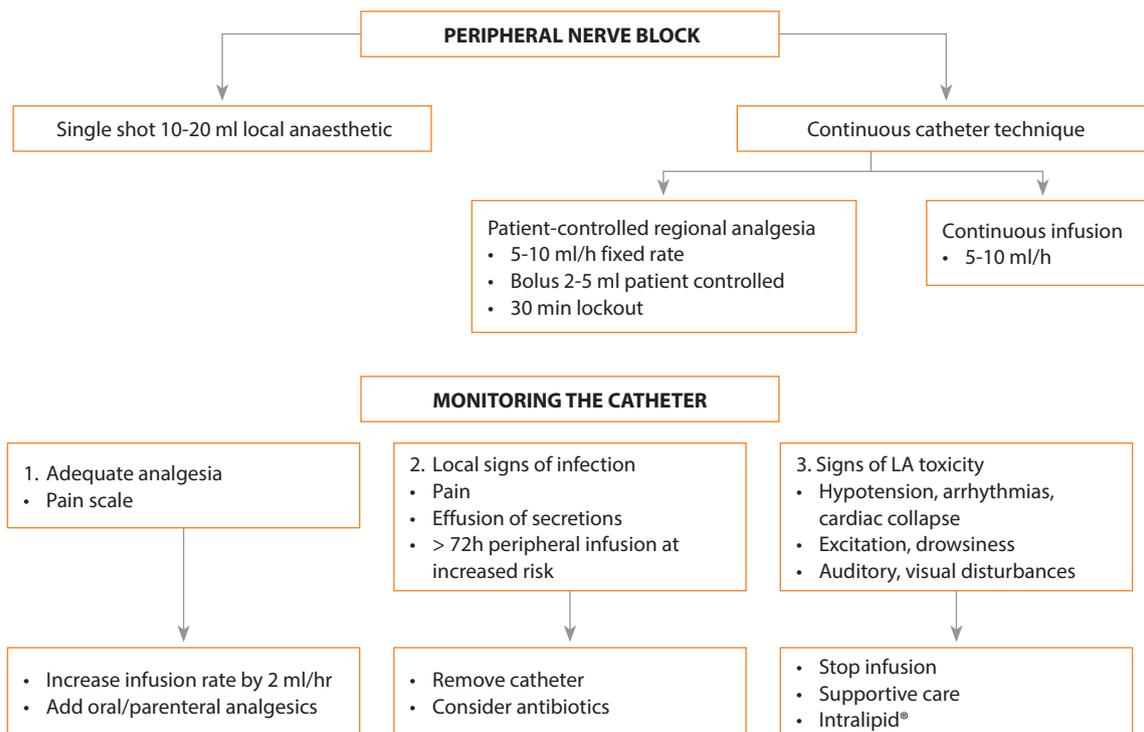


Figure 1: Algorithm for peripheral nerve blocks

- An antiseptic, preferably chlorhexidine with alcohol, should be used for skin preparation, and adequate time allowed for drying.

8.3 Use of ultrasound

- It is recommended that a sterile probe and handle covering is used, e.g. a sterile transducer sheath, at all times, but especially for the following:
 - » Immunocompromised patients
 - » Patients with multi-resistant organisms
 - » Patients undergoing perineural catheter placement
 - » When there is a risk of blood contamination of the probe
- The ultrasound machine and probe should be decontaminated before and after use, e.g. the ultrasound machine and probe should be wiped with a single-use towel to remove visible soiling, and then wiped with another single-use towel that has been soaked in an appropriate disinfectant, e.g. 70% isopropyl alcohol, and then allowed to dry.
- Product information should be consulted as to which cleaning agents are appropriate for the specific machine or probe.
- Use single-use, sterile gel, e.g. K-Y® lubricating gel sachet.

9. Practice advisory

In evidence-based practices, the strength of the results measured in a clinical trial or research study are used to rank levels of evidence. Both the study design, such as case reports and double-blinded randomized-controlled trials, and measured end-points, such as quality of life, affect the strength of the evidence (Wikipedia). The levels of evidence are represented in brackets after each appropriate statement.

- A Good level of evidence for the recommendation to consider an intervention
- B Fair level of evidence for the recommendation to consider an intervention
- C Poor level of evidence for the recommendation to consider an intervention
- D Fair level evidence for the recommendation to exclude an intervention
- E Good level of evidence for the recommendation to exclude an intervention from consideration

9.1 Providing patient information

9.1.1 Informed consent

The anaesthetist should advise the patient on the most appropriate technique(s) based on his/her personal experience and patient characteristics. Both the risks and benefits of the proposed technique(s) should be discussed as well as the risks and benefits of alternative options. It must be emphasised that general anaesthesia may still be used in addition to regional anaesthesia either because the proposed surgery warrants its use or because of an incomplete block. Enough time should be set aside for the patient to engage in an informed decision process. When possible, the patient should be directed to additional information after the consultation to make an informed decision. Thorough documentation of the consultation should take place.

9.2 Patient preparation for regional anaesthesia

9.2.1 The immediate preoperative preparation

- 9.2.1.1 Premedication prior to performing a block may not always be necessary (D).

9.2.1.2 The preoperative fasting guidelines should be followed.

9.2.1.3 Intravenous access should be established prior to the performing the block.

9.2.1.4 Be professional, ensure patient comfort and respect patient privacy (professional consensus).

9.2.2 Regional anaesthesia environment

9.2.2.1 It is desirable to perform the block in a dedicated room in the immediate vicinity of the operating room ("block room") although, this is not always practical (D).

9.2.2.2 Patient monitoring should include (but not limited to) ECG, NIBP and pulse oximetry. Emergency resuscitation equipment and drugs must be available and readily accessible (professional consensus).

9.2.2.3 Expert opinion recommends the use of a dedicated anaesthetic trolley allocated for regional anaesthesia.

9.2.3 Sedation whilst performing the block

9.2.3.1 It may be necessary to provide sedation and/or analgesia for anxious patients or for blocks considered to be painful. Expert opinion does not recommend the routine use of mild sedation in responsive and cooperative patients.

9.2.3.2 Benzodiazepines and propofol are considered safe to limit movement and recall (B) whilst remifentanyl is considered a safe analgesic for pain related to movement. The concern of neurological complications arising from performing regional anaesthesia in sedated patients has not been substantiated.

9.2.4 Sedation for surgery under regional anaesthesia

Expert opinion suggests only mild intraoperative sedation with preserved responsiveness to verbal stimuli in cooperative patients (C). This practice is to be individualised.

9.2.5 Performing the block

9.2.5.1 Shaving at the puncture site

In the absence of studies, the following is recommended:

- Single shot technique (no catheter): no shaving; disinfection using chlorhexidine with alcohol
- Continuous technique (perineural catheter): electric clipping or hair removal cream; disinfection using chlorhexidine with alcohol (professional consensus).

9.2.5.2 Gloves, a mask and a surgical cap are recommended for all cases. Assistants must wear a mask and a cap. A full sterile barrier technique is to be used when placing a perineural catheter for prolonged analgesia (D).

9.2.5.3 Skin disinfection must be systematic, surgical and large enough to perform the block (A).

9.2.5.4 Topical EMLA cream appears to be more effective than the infiltration of lignocaine.

9.2.5.5 Safety tests: No single test has been shown to be of value in all cases. Adrenaline test dose is only of value if positive (increase in heart rate). The disappearance of a nerve twitch in response to stimulation following a 2 to 3 mL injection of local anaesthetic is only of value if negative. A test dose may be recommended for deep blocks (lumbar plexus block by posterior approach) (D).

9.2.5.6 Slow and fractionated injections are recommended (D).

9.2.6 Monitoring the effects of regional anaesthesia

Appropriate monitoring should begin prior to the injection of local anaesthetic and continued intra- and postoperatively (if a perineural catheter has been sited).

9.2.6.1 Special attention must be paid to the patient during the period of local anaesthetic injection. Vigilant monitoring, however, must continue after local anaesthetic injection as delayed systemic local anaesthetic toxicity may occur. The sensory and motor block should be tested prior to surgical incision. Signs of epidural or intrathecal extension should always be sought in the evaluation of a plexus block near the spine (e.g. interscalene or posterior lumbar plexus block) (D).

9.2.6.2 Additional rescue blocks can be performed to supplement an incomplete block (see later). In the event of a complete failure, general anaesthesia should be considered prior to surgical incision (professional consensus).

9.2.6.3 Routine radiological imaging is not recommended after placement of a catheter. Imaging should be considered when the catheter is not functioning AND an aberrant path or intravascular migration is suspected (D).

9.2.6.4 The efficacy of a perineural catheter must be evaluated clinically (or radiologically) before discharge from the recovery room. The catheter which ideally should be connected to a filter must be clearly marked. It is the anaesthetist's responsibility to ensure that management instructions regarding the catheter be clearly understood by the nursing staff at hand over. This should be done verbally and in written form. Depending on the hospital expertise it may be prudent (but not mandatory) for the anaesthetist to prepare the local anaesthetic solution to be infused.

9.2.6.5 Initial block performance, placement of a perineural catheter and first injection through the catheter remain the exclusive responsibility of the anaesthetist. Subsequent injections,

monitoring and removal of the catheter can be entrusted to a nurse.

- 9.2.6.6 Block evaluation should be undertaken more than once a day and should include, but not be limited to, the quality of analgesia, the presence or absence of specific neurological signs and evidence of local infection or extravasation at the catheter insertion site (professional consensus). Appropriate precautions must also be undertaken to mitigate the risk of falls or injury to the affected, insensate limb.

9.2.7 The association of regional anaesthesia and general anaesthesia

Regional anaesthesia may be used in combination with general anaesthesia for reasons of patient comfort related to position, prolonged surgery or anxiety. If the intention of the block is for the provision of post-operative analgesia, then it is imperative to inform the surgical team of the existence of a postoperative sensory and/or motor blockade (D).

- 9.2.7.1 It is recommended to test the block prior to general anaesthesia to utilise the advantages of regional analgesia during surgery (A).

- 9.2.7.2 It is recommended (but not mandatory) that blocks be performed on awake patients, with or without light sedation (D). Nerve stimulation should not be painful and the anaesthetist should aim to perform the block in a calm, cooperative and awake patient. The anaesthetist who performs regional anaesthesia in a patient under general anaesthesia, or where the puncture area is anesthetized (e.g. under spinal anaesthetic) would be unable to use important safety tests to detect and prevent neurological complications during the puncture (paraesthesia, pain at the puncture or on injection) and subjective signs of systemic toxicity. However, clinical cases where regional anaesthesia-related complications occurred in patients under general anaesthesia do not conclude whether these complications could have been avoided if patients were fully awake.

9.3 Intravenous regional anaesthesia (IVRA)

- 9.3.1 Represents 33% of all blocks performed for surgery on upper limb with a success rate of over 85%.
- 9.3.2 It may be indicated for upper limb surgery of short duration in emergency or outpatient settings.
- 9.3.3 The same monitoring is required as for all regional anaesthetic techniques. Intravenous access is established in the contralateral hand. A second intravenous cannula is placed in the ipsilateral hand and flushed with saline. A double tourniquet is placed on the upper arm (A). Blood pressure is measured and arterial occlusion pressure

(in mmHg) is calculated ($AOP = [(SAP-DAP) \times \text{limb circumference} / \text{cuff width} \times 3] + DAP$) (A). Exsanguination using an Esmarch bandage should be avoided. The limb can be elevated at 90° for three to five minutes. The proximal and the distal cuffs are then inflated to 50 mmHg above the AOP (A). The distal tourniquet is then deflated (A). Disappearance of the peripheral pulse in the upper limb to be blocked following the inflation of the tourniquet should be confirmed and 3 mg/kg (0.5 to 0.6 ml/kg) of 0.5% lignocaine injected over 90 seconds, being careful to avoid venous hypertension. The distal cuff should then be inflated and the proximal one deflated to possibly provide additional relief from tourniquet discomfort (B).

- 9.3.4 Lignocaine is the only local anaesthetic recommended IVRA (A). Onset of anaesthesia is in 10 minutes and loss of touch sensation occurs within 15 minutes. Prilocaine, mepivacaine, bupivacaine and ropivacaine (B) should not be used (A).

- 9.3.5 Following intravenous injection of local anaesthetic, the tourniquet should not be deflated in less than 20 minutes nor kept inflated for longer than 90 minutes (A). After tourniquet deflation, sensation reoccurs within 5 minutes. There is no clear correlation between the duration of application of the tourniquet and systemic lignocaine concentration following deflation of the tourniquet. It is recommended that the tourniquet be gradually deflated every 15 seconds followed by intermittent re-inflation for 30 seconds so as to decrease the rapid rise of serum lignocaine concentration (A).

- 9.3.6 Additives such as opiates, anti-inflammatory drugs, muscle relaxants and/or ketamine are not recommended (A). The addition of clonidine 1 µg/kg has been proposed (B), as it significantly improves the tourniquet tolerance and improves postoperative analgesia.

- 9.3.7 The limb must be immobilized for at least 30 minutes after the deflation of the tourniquet until return of the radial pulse has been confirmed (A).

- 9.3.8 IVRA of the lower limb or intra-arterial regional anaesthesia is not recommended (B).

- 9.3.9 Continuous IVRA is not recommended (B).

- 9.3.10 The short duration of action, the absence of postoperative analgesia, patient discomfort and significant incidence of minor side effects of IVRA have led to its decreased use (B). Wound infiltration by the surgeon with long-acting local anaesthetic may prolong analgesia.

9.4 Locating plexus and peripheral nerves (see Figure 2)

- 9.4.1 To facilitate plexus nerve blocks, anatomical, topographical and functional knowledge are essential.

- 9.4.2 Nerve stimulation has been used for many years to increase the accuracy of nerve blocks and reduces the risk of postoperative neuropathy (D). Older techniques

based on paraesthesia increase the risk of postoperative neurological complications and should no longer be performed.

- 9.4.3 The basic optimal characteristics of nerve stimulators must be known: rectangular pulses, monophasic, negative with rise times and fall times, digital display of the actual delivered intensity with a linear variation and a fine adjustment, short term stimulation (50 to 100 μ s) and choice of several predefined durations, high maximum load impedance for maintaining a constant current, well-defined polarity and reliable connections (professional consensus).
- 9.4.4 The block performance process should follow a stereotyped sequence after checking the operation of the nerve stimulator (professional consensus) and the integrity of the circuit. Following skin penetration with an insulated needle, start with the current intensity of 1.0 - 1.5 mA (100 μ s) in the absence of motor response (location mode). Advance the needle tip gently until a motor response is obtained. Gradually decrease the current intensity, to determine the lowest current eliciting a muscle response. Aspirate on the syringe to avoid intravascular injection and inject 1 mL of local anaesthetic as a test dose. A safe injection is heralded by instantaneous disappearance of the motor response, a painless injection, without resistance, a motor response that can be elicited by increasing the intensity, and a slow, incremental injection of the local anaesthetic volume, with aspiration before each aliquot.
- 9.4.5 The minimum stimulation intensity necessary to achieve an effective block is unknown. The stimulation threshold below which an appropriate muscle response is obtained is an essential criterion giving an estimate of the proximity of the needle relative to the nerve. An injection at intensity of 0.5 mA is not without inherent risk. A set of criteria should be defined for each block technique: minimal stimulation intensity, type of muscle response, loss of muscle contraction after injection of 1 mL, no visible blood aspirated, painless injection and without resistance. Do not inject local anaesthetic at a stimulation intensity below 0.2 mA (sentinel mode) as this is associated with almost certain intraneural injection. Block performance must be documented, including the type of nerve stimulator and needle, the various above-mentioned criteria and possible incidences during the injection.
- 9.4.6 When performing an interscalene block, the approach should be lateral and superficial to minimize the risk of complications and allow for the location of the upper trunk (professional consensus). Contractions of the deltoid, biceps brachii, the brachio-radialis and extensors must be sought in response to nerve stimulation.
- 9.4.7 When performing a supraclavicular block, a lateral and tangential approach to the brachial plexus can minimize

the risk of vascular puncture and pneumothorax (professional consensus).

- 9.4.8 When performing an infraclavicular block, the muscle contraction of the flexor muscles of the forearm and / or hand should be sought. The contraction of the biceps brachii muscle does not reflect the location of the brachial plexus because the musculocutaneous nerve can branch off the brachial plexus before the formation of the median nerve.
- 9.4.9 In the axillary region and brachial canal, the median nerve is identified by the contraction of muscles along palmar and flexor carpi radialis. The ulnar nerve is identified by the contraction of the flexor carpi ulnaris.
- 9.4.10 When performing a psoas compartment (lumbar plexus) block, muscle contractions of the iliopsoas, the femoral quadriceps, thigh adductors, tensor fascia lata, small, medium and anterior gluteal and posterior tibial nerves are acceptable. Response of the femoral quadriceps alone cannot guarantee the absence of risk of epidural or intrathecal spread (professional consensus).
- 9.4.11 When performing a femoral nerve block, the injection is made in an even distribution of space beneath the fascia iliaca. Muscle contractions of the sartorius and medial and lateral vastus muscles should be sought (classical "dancing patella") (professional consensus).
- 9.4.12 When performing an infragluteal block, the needle tip is placed at the lower edge of the piriformis muscle, where the nerve is in close proximity to the ischium (professional consensus). Aim to elicit muscle contraction of both tibial and peroneal components, as this is more effective than a single stimulation (A).
- 9.4.13 When performing a sciatic nerve block at the popliteal region, injection should be done by a high puncture, approximately 10 cm superior to the popliteal crease to ensure the proximity of both the tibial and common peroneal components. Again aim to elicit muscle contraction of both tibial and peroneal components, as this is more effective than a single stimulation (A).

9.5 Materials needed for plexus and peripheral nerve blocks

- 9.5.1 Equipment: Nerve stimulation is the gold standard technique (professional consensus).
- 9.5.2 Needle: Only insulated needles are recommended. The use of a blunt, short- bevel needle (20-30 °) is recommended (A), because it is less likely to cause nerve damage than a sharp, long bevel needle (12-15 °) (C). Short-bevel needles may be more uncomfortable for the patient and will cause more damage to the nerve if penetrated than long-bevel needles. This scenario is less common as the blunt nature of the short-bevel needle tends to displace the nerve on gentle contact rather than penetrate it.

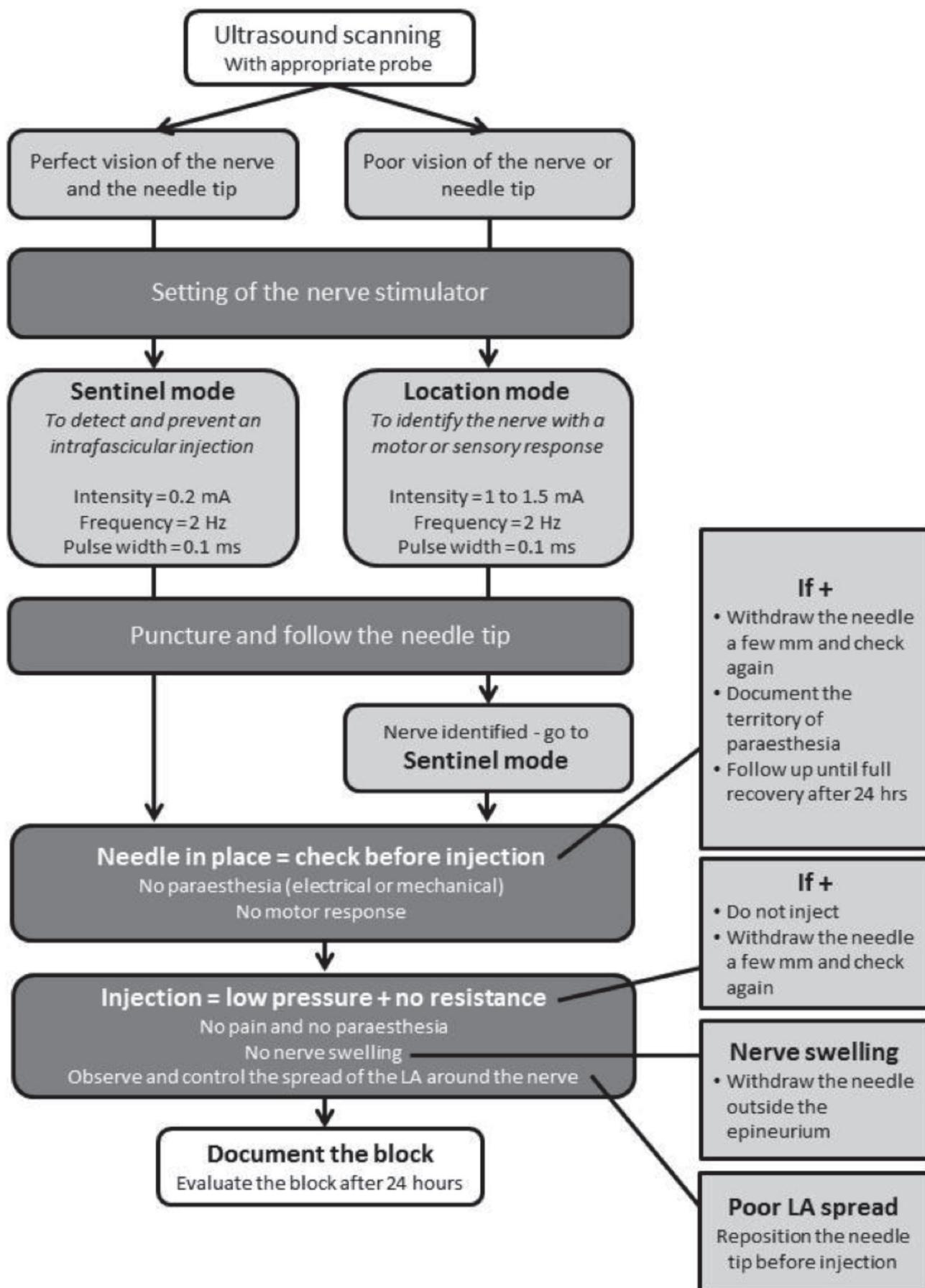


Figure 2: Single shot block performance algorithm

9.5.3 Catheter: Polyamide and polyethylene are well tolerated as long-term tissue materials.

- 9.5.3.1 Closed or open: polyamide or polyethylene catheters with a closed end, a flexible metal guide and 3 lateral openings are recommended for continuous perineural infusions (B). The use of epidural catheters, equipped with lateral openings, increases the incidence of unilateral blocks or insufficient analgesic doses being administered (C).
- 9.5.3.2 Stimulating catheters: The presence of a metal wire enables continuous or intermittent nerve stimulation. There is currently no evidence to support the use of these catheters compared to conventional catheters for continuous perineural analgesia.
- 9.5.3.3 Identification: It is recommended that catheters are identified by a single colour, so as to improve the safe use of perineural catheters (D).
- 9.5.3.4 Filters: The factory-issued filters for continuous analgesia are modified acrylic, have lockable connectors (Luer locks), offer similar resistance to pressure of 10 bars and have a membrane for bacteriological filtration of up to 0.2 micron. These filters prevent the passage of particles, such as glass debris generated by the opening of the local anaesthetic ampoule. In the absence of conclusive evidence for the prevention of bacterial infections, it is intuitively recommended that filters be used with epidural catheters as well as perineural catheters kept in place for several days (D).

9.5.4 Ultrasound: The introduction of ultrasound in the practice of regional anaesthesia is a recent event which requires prior training and the acquisition of specific equipment that may not be available to all anaesthetists. Therefore, the practice of regional anaesthesia without ultrasound does not constitute poor or negligent practice, but its use has become an increasingly worldwide trend towards the gold standard in addition to nerve stimulation.

9.5.4.1 General rules and recommendations

- 9.5.4.1.1 For the safe and successful performance of blocks under ultrasound guidance, the anaesthetist should have an understanding of the physical basics of ultrasound and settings of the ultrasound machine.
- 9.5.4.1.2 The anaesthetist should have anatomical knowledge and be able to identify relevant sono-anatomy structures.
- 9.5.4.1.3 A period of training should focus on skills pertaining to scanning models (human and phantoms), improving sono-anatomy and visualization of passing the needle to its target, prior to patient interaction.

9.5.4.1.4 The anaesthetist should have an understanding of the different needle guidance techniques, including "in plane" and "out of plane". Each anaesthetist is advised to follow his/her own learning curve in order to master each skill and technique.

9.5.4.1.5 Additional recommended techniques for each block include nerve stimulation and/or hydro-localisation and hydro-dissection (using 5 % dextrose water) as well as movement of the tissue during needle movement.

9.5.4.2 Technical recommendations

9.5.4.2.1 Appropriate probes should be used when performing blocks. The highest possible frequency should be used to optimise the spatial resolution of the image. The selection of probe is based on the type of block performed and the depth of the target. Basic skills in manipulating the image on the ultrasound machine should be sought by the anaesthetist ("knob-ology").

9.5.4.2.2 It is recommended to perform a preliminary ultrasound examination of the area intended to be blocked with emphasis on scanning in multiple planes, identifying important anatomical structures by optimising the gain, depth, number and position of focal points and Doppler (for vessels) and planning the exact trajectory of the needle (in-plane or out of plane). It is recommended to visualise the target nerve in a short-axis view for both superficial and deep blocks. The use of dedicated needles specifically designed for enhanced ultrasound visualisation is recommended. The anaesthetist should aim to control the subtle movements of the probe, all the while, monitoring the progress of the needle tip and shaft and directly observing the spread of the local anaesthetic as it is being injected.

9.5.4.3 Safety rules

9.5.4.3.1 Ideally, it is recommended to perform the block with ultrasound guidance in an awake, calm and cooperative patient. However, in situations where the risk outweighs the benefit, it may be justifiable to perform the block in a patient under sedation or anaesthesia (general or spinal). In these cases, ultrasound confers an additional safety benefit.

9.5.4.3.2 To reduce the risk of an intraneural injection, it is recommended to approach the nerve tangentially with the needle tip to ensure the tip is not introduced beneath the epineurium.

9.5.4.3.3 If the distribution of local anaesthetic is not directly observed at any time during the injection, and/or in case of pain or paraesthesia on injection experienced by the patient, increased resistance to injection or observed nerve swelling, it is

recommended to stop injecting, redirect the needle to a safe position and complete the injection.

9.5.4.4 Blocks of the limbs and trunk

9.5.4.4.1 Evidence supports the use of ultrasound in regional anaesthesia to improve block success rates, to reduce block performance time, to reduce the number of needle passes, to reduce volume of local anaesthetics (and thus the incidence of LAST), to reduce block onset time and to reduce complications associated with regional anaesthesia (e.g. intravascular injection, pneumothorax, nerve damage, intrathecal spread, etc.) (A).

9.5.4.4.2 Ultrasound guidance for fascial plane blocks (e.g. thoracic and abdominal wall, fascia-iliaca) is recommended because it allows administration of local anaesthetic more accurately than landmark-based techniques.

9.5.4.4.3 Ultrasound guidance of the spinal and epidural structures aids to determine the accurate level of puncture as well as the depth of the epidural space. Ultrasound may help to optimise the trajectory of the needle and reduce the number of needle passes in patients with aberrant anatomy.

9.6 Agents for plexus and peripheral nerve blocks

9.6.1 Local anaesthetic of short to intermediate duration of action: lignocaine

9.6.2 Local anaesthetic of long duration of action: ropivacaine and bupivacaine

9.6.2.1 At equivalent doses, the systemic toxicity profile of ropivacaine is safer than that of bupivacaine (B).

9.6.2.2 Onset of block time is shorter with ropivacaine 0.75% than with 0.5% bupivacaine (C).

9.6.2.3 The duration of the block is comparable after administration of ropivacaine 0.75% and bupivacaine 0.5% (C).

9.6.3 Mixtures of local anaesthetics : The few studies that compare administration of bupivacaine with a combination of bupivacaine and lignocaine show that:

9.6.3.1 The neurological toxicity of the two agents is additive (B).

9.6.3.2 Cardiac toxicity of the mixture may be less than that of bupivacaine alone (D).

9.6.3.3 Onset of the block is faster with the combination (C).

9.6.3.4 The duration of action of the combination is intermediate between that of lignocaine and bupivacaine (C).

9.6.4 Adjuvants

9.6.4.1 Adrenaline 5 µg/mL reduces plasma concentrations of lignocaine, bupivacaine, the lignocaine + bupivacaine combination, but not that of ropivacaine (B).

9.6.4.2 Adrenaline 5 µg/mL prolongs the block with lignocaine (C). This effect remains to be demonstrated with long-acting local anaesthetics (bupivacaine, ropivacaine).

9.6.4.3 Clonidine (0.5 to 1 mg/kg) prolongs the duration of sensory and motor block and postoperative analgesia when combined with lignocaine (B).

9.6.4.4 Opiates provide minimal benefit (B) and increase the incidence of side effects such as nausea and vomiting (C).

9.6.4.5 Alkalisiation cannot be recommended due to the inhomogeneity of the published results.

9.7 Plexus and nerve blocks of the upper limb

9.7.1 Shoulder surgery

The semi-sitting position ("beach chair") is indicated for shoulder surgery, including arthroscopy (D). It avoids an excessive amount of traction on the shoulder and thereby reduces the risk of damage to the brachial plexus.

9.7.1.1 Hypotension and/or bradycardia is common following an interscalene block performed in patients in a sitting position, mediated by activation of the Bezold-Jarisch reflex, seen more frequently when using solutions with adrenaline, which are not recommended (A). The associated vaso-vagal episodes can be treated with atropine, ephedrine and vascular filling (professional consensus).

9.7.1.2 The interscalene brachial plexus block (ISB) is the gold standard technique. It facilitates anaesthesia of the lower branches of the cervical plexus (C3, C4) and the upper roots of the brachial plexus (C5, C6, C7). The block covers the territory of the shoulder. Ulnar nerve sparing (absence to C8-T1 roots) is common (C).

9.7.1.3 Additional blocks may be required depending on surgical approaches (D):

9.7.1.3.1 Anterior shoulder approach:

A superficial cervical plexus block is necessary when surgery extends medial to the delto-pectoral groove or requires traction in this territory. It is recommended to infiltrate local anaesthetic in the delto-pectoral groove to block the intercostobrachial nerve (T2-T3) for incisions that extend laterally towards the axilla.

9.7.1.3.2 Extensive shoulder surgery and posterior approaches:

For complete anaesthesia of the shoulder, an intercostal block at T2, in the posterior axillary line, or a paravertebral block T1 to T4 (5 mL of

local anaesthetic per level) will be required. local anaesthetic infiltration at multiple levels does, however, increase the risk of a pneumothorax. It is, therefore, recommended to perform a posterior surgical approach in the prone position by combining a general anaesthetic with an interscalene block (professional consensus).

9.7.1.3.3 Shoulder arthroscopy:

If the posterior cutaneous territory (axillary nerve) is insufficient, a rescue block of the suprascapular nerve or a field infiltration of local anaesthetic on the posterior border of the shoulder is helpful. For the anterior territory, if the sensory block does not cover inferior enough, a field infiltration along the delto-pectoral groove is recommended.

9.7.1.4 Fractures of the proximal humerus:

Surgery can include a more distal incision: a supraclavicular block is preferable to an interscalene block as it provides more consistent anaesthesia to the posterior part of the arm and fracture site by blocking the axillary nerve (D).

9.7.1.5 An interscalene block can be used for day-case surgery. It allows a lower postoperative analgesic consumption, an early hospital discharge and is associated with a better index of patient satisfaction (D).

9.7.2 Surgery distal to the middle third of the humerus

The supraclavicular block is indicated for orthopaedic and vascular surgery of the arm. Before surgical incision, the territories of intercostobrachial and medial cutaneous nerve of the arm should be tested and supplemented with further local anaesthetic as necessary.

9.7.3 Elbow surgery

9.7.3.1 Anaesthesia of the elbow requires blockade of four mixed nerves (radial, musculocutaneous, median and ulnar) and the two sensory nerves (medial cutaneous nerves of the arm and forearm). Anaesthesia always extends well beyond the operative site.

9.7.3.2 The supraclavicular block is suitable for elbow surgery. Phrenic nerve palsy is less common (30%) than in association with the interscalene block (100%). The block must often be supplemented by a block of the intercostobrachial nerve and medial cutaneous nerve of the arm through a subcutaneous local anaesthetic infiltration at the base of the lateral axilla.

9.7.3.3 The infraclavicular block may facilitate anaesthesia of the arm without mobilizing the painful arm while performing the block. Failure rate is low if a distal motor response is elicited with nerve stimulation. The sub-coracoid technique is preferable to the conventional

routes (Raj, Winnie, Kilka) due to the lower risk of pneumothorax (D).

9.7.3.4 Axillary plexus and humeral canal blocks can be sufficient for elective surgery. The axillary plexus block is effective in 90% of cases. Subcutaneous local anaesthetic infiltration to the lower postero-lateral border of the deltoid facilitates anaesthesia of the skin innervated by the lower branches of the axillary nerve and branches of the radial nerve (D). The axillary plexus block has a higher success rate of anaesthetising the radial branches and provides a deeper block compared to a block at the humeral canal. The axillary plexus block is recommended, provided that the musculocutaneous nerve is blocked separately. Axillary plexus block eliminates the risk of pneumothorax and phrenic nerve blockade. The trans-arterial technique is no longer recommended because of its low success rate and higher risk of haematoma compared to nerve stimulation (professional consensus).

9.7.3.5 The humeral canal block is commonly used for surgery of the upper limb (professional consensus). This technique allows for a differential anaesthetic on the four mixed nerves of the upper limb (B).

9.7.3.6 The interscalene block is insufficient for elbow surgery, because the ulnar nerve and medial cutaneous nerve of the arm that extend into the forearm are not blocked (D).

9.7.3.7 For elbow arthroscopy, a supraclavicular block is recommended rather than a more distal block because of the uncomfortable position of the shoulder. The supraclavicular block often includes blockade of the axillary nerve (B) and maintains the position without pain.

9.7.4 Forearm and hand surgery

9.7.4.1 For tourniquet tolerance seven nerves need to be blocked: median, ulnar, radial, musculocutaneous, medial cutaneous nerve of the arm, medial cutaneous nerve of the forearm and the intercostobrachial nerve.

9.7.4.2 The axillary plexus block, preferably by nerve stimulation of all 5 branches is effective (C).

9.7.4.3 The humeral canal block enables a differential block in different territories (B).

9.7.4.4 Elbow blocks are limited to the hand. They should be reserved for surgery no more than 15 to 30 minutes with a tourniquet (B).

9.7.4.5 A tourniquet over 20 minutes requires an axillary plexus block or humeral canal block.

9.7.4.6 Short surgery on the hand without a tourniquet can be facilitated with distal blocks (professional consensus).

- 9.7.4.7 The distal blocks can be used as rescue blocks for an incomplete proximal block.
- 9.7.4.8 The elbow or wrist blocks can be used for day-case surgery. They allow an early hospital discharge and are better tolerated by patients than plexus blocks. The wrist block maintains finger movement during surgery.
- 9.7.4.9 The metacarpal flexor sheath block facilitates short anaesthesia or prolonged analgesia in surgery of the 2nd, 3rd, 4th fingers. A tourniquet can be placed at the base of the finger if necessary.

9.8 Plexus and nerve blocks of the lower limb

9.8.1 Hip surgery

- 9.8.1.1 Lumbar plexus block (psoas compartment) and its branches.

Table 6: Indications retenues pour la chirurgie du membre supérieur (consensus professionnel) Accepted indications for surgery of the upper limb (professional consensus)

Indications chirurgicales Surgical indications	Type de bloc Block type	Cathéter Catheter
Open reduction internal fixation shoulder	BISIISB	++
Rotator cuff repair	BISIISB	++
Arthroscopy shoulder	BISIISB	++
Acromioplasty (open)	BISIISB	++
Acromioplasty (arthroscopic)	BISIISB	00
Bankart	BISIISB	+ (painful if accompanied by arthroscopy)
Acromioclavicular dislocation	BISIISB	00
Shoulder dislocation	BISIISB	00
Open reduction internal fixation clavicle	ISB + superficial cervical plexus	00
Open reduction internal fixation humeral head	SCB	++
Open reduction internal fixation humeral shaft	SCB or ICB	++
Open reduction internal fixation distal humerus	SCB, ICB	++
Arthrolysis elbow	SCB, ICB or AXB	++
Elbow arthroscopy	SCB	00
Open reduction internal fixation olecranon	SCB or ICB	00
Epicondylitis, neurolysis elbow	HCB	00
Fractures forearm, wrist	ICB, AXB or HCB	00
Severe hand trauma	ICB, AXB	++
Elective surgery of the hand, the forearm and wrist	AXB, HCB	0
Arteriovenous fistula	AXB, HCB	00

ISB = interscalene block, SCB = supraclavicular block, ICB = infraclavicular block, AXB = axillary block, HCB = humeral canal block

The lumbar plexus block by posterior approach, which spreads to the nerve trunks (femoral, lateral femoral cutaneous and obturator nerves) is almost consistently appropriate. There is a risk of epidural extension, regardless of the level of puncture (B). The radiological imaging of a perineural catheter placed here for anaesthesia and/or analgesia is recommended to exclude epidural migration (professional consensus).

The lumbar plexus block by anterior approach "3-in-1" (femoral, inguinal, fascia-iliaca) is associated with fewer complications, but inconsistently blocks all three nerve trunks (A). The practice of advancing a perineural catheter tip 15-20 cm beyond the skin is not recommended (D). The risk of retroperitoneal haematoma formation, although considered rare in the literature, can be significant. The use of ultrasound reduces this risk considerably.

- 9.8.1.2 The sciatic nerve block is required for anaesthesia for hip surgery, but some branches of the sacral plexus may not be accessible at the trunk level (D).

- 9.8.1.3 Selection of the surgical procedure

Nerve blocks used alone cannot be used as first line anaesthesia for hip surgery (professional consensus). The combination of lumbar plexus and sciatic plexus blocks provides anaesthesia for certain procedures such as fixation of the neck of intertrochanteric fractures (C). For surgery involving the iliac crest, for lateral or posterior approaches, additional blockade of ilioinguinal, iliohypogastric and genitofemoral nerves will be required in combination with lumbar and sciatic blocks (C).

9.8.2 Thigh surgery

The combination of lumbar plexus and sciatic plexus blocks is appropriate for surgery to the thigh and femur (E).

9.8.3 Knee surgery

- 9.8.3.1 Lumbar plexus block and its branches

The posterior approach provides a more consistent block to the nerve trunks than the anterior approach (B). The anterior approach is adapted and recommended for knee surgery (A). No evidence supports one particular approach (femoral, inguinal, fascia-iliaca) (B).

- 9.8.3.2 The sciatic block is recommended to complement the femoral block (A). The parasacral sciatic plexus or posterior transgluteal approaches ensure a more consistent supply of the posterior femoral cutaneous nerve than an anterior approach. A sciatic popliteal approach does not consistently block the posterior femoral cutaneous nerve. There is no evidence in favour of the parasacral over the transgluteal approach (D).

9.8.3.3 Selection of the surgical procedure

The combination of a lumbar plexus (or its branches) with a sciatic block is recommended for all knee surgery (prosthesis, ligament reconstruction, arthroscopy, joint lavage) (A).

9.8.4 Leg and ankle surgery

9.8.4.1 Anaesthesia of medial aspect of the leg and ankle is achieved by a femoral nerve block or by a single block of the saphenous nerve. There is no added benefit of performing a lumbar plexus block over an anterior or distal (saphenous) approach. (B).

9.8.4.2 Anaesthesia of the lateral and posterior aspect of the leg and the ankle is achieved by a sciatic nerve block (A).

9.8.4.3 Selection of the surgical procedure

The combined block of the branches of the lumbar and sacral plexus provides complete anaesthesia of the leg and ankle (C) and facilitates any leg or ankle surgery (A). Any surgery in the prone position requires careful evaluation of anaesthesia before incision (professional consensus).

9.8.4.4 The risk of a compartment syndrome is not a contra-indication to performing a block, because the pain is not the only diagnostic criterion for compartment syndrome (D). Regular, frequent evaluation of the block characteristics is recommended.

9.8.5 Foot surgery

9.8.5.1 The sciatic block is recommended (professional consensus). An additional saphenous nerve block provides anaesthesia to the anterior and medial aspects of the leg. There is no evidence supporting one particular approach to the sciatic nerve above the knee (B).

9.8.5.2 Nerve stimulation of both the tibial and common peroneal components of the sciatic nerve is recommended if a lateral approach to the popliteal fossa is performed (B).

9.8.5.3 Selection of the surgical procedure

The ankle block is a simple and effective technique for minor surgery (C).

The sciatic popliteal block is appropriate for all surgeries of the foot with ankle tourniquet.

The saphenous nerve block can be used to limit the tourniquet pain (C).

The sciatic block above the knee is appropriate for surgery with a thigh tourniquet (C).

9.9 Postoperative analgesia using peripheral blocks of the limbs

9.9.1 After surgery of the upper limb

9.9.1.1 After arthroscopic surgery of the shoulder, a single injection ISB is the analgesic technique of choice (A). A suprascapular nerve block,

combined with an axillary nerve block (shoulder block), is an alternative in the case of a contra-indication (e.g. respiratory failure) (A).

9.9.1.2 After open surgery of the shoulder, the placement of a perineural catheter above the clavicle is recommended (A).

9.9.1.3 After major surgery of the elbow (e.g. arthrolysis), an axillary plexus perineural catheter is a safe and effective technique (D). There is an increased risk of infection at this site. The supraclavicular or infraclavicular are alternatives (D).

9.9.1.4 After major surgery of the hand (e.g. severe trauma, finger anastomosis), the establishment of an infraclavicular perineural catheter provides good analgesia and sympatholysis with the added benefit of vasodilation in vascular disease or anastomosis surgery (B). The placement of a perineural catheter near the median nerve, ulnar and/or radial nerve is possible after specific surgeries (e.g. tenolysis, teno-arthrolysis) (D).

9.9.2 After surgery of the lower limb

9.9.2.1 After total hip replacement, a femoral nerve perineural catheter is an appropriate technique (B). Analgesia by posterior approach lumbar plexus block is possible, but evidence supports its use in revision surgery only at this time (D).

9.9.2.2 After fracture of the femoral neck, a single injection femoral nerve block can be an effective technique (C). The introduction of a catheter, upon arrival in the emergency room could be beneficial (D).

9.9.2.3 After surgery or trauma of the femoral shaft, a single injection femoral nerve block is recommended. A femoral nerve perineural catheter can be considered (professional consensus).

9.9.2.4 After minor arthroscopic surgery (e.g. diagnostic, meniscectomy), intra-articular analgesia (local anaesthetic, morphine, clonidine) is effective (A). For surgical anaesthesia, the use of peripheral nerve blocks in combination with intra-articular administration of local anaesthetic cannot be recommended due to the risk of systemic toxicity (professional consensus).

9.9.2.5 After major arthroscopic surgery (e.g. ligament repair), the femoral nerve block as a single injection (day-case) or catheter (in-patient) is recommended (B).

9.9.2.6 After open knee surgery, a femoral perineural catheter is recommended (A). Other newer techniques are described including adductor canal block (with/without a catheter), local infiltrative analgesia (LIA) and iPACK (infiltration between the popliteal artery and the capsule of the knee).

Table 7: American Society of Regional Anesthesia (ASRA) guidelines for neuraxial anaesthesia in a patient receiving thromboprophylaxis

Unfractionated heparin (UFH)				
Antiplatelet medications	Subcutaneous	Intravenous	Low molecular weight heparin	
NSAIDs: no contraindication Discontinue ticlopidine 14d, clopidogrel 7d, GP IIb/IIIa inhibitors 8-48 hrs in advance	No contraindication with twice-daily dosing and total daily dose <10,000 U, consider delay heparin until after block if technical difficulty anticipated. The safety of neuraxial blockade in patients receiving doses greater than 10,000 U of UFH daily, or more than twice daily dosing of UFH has not been established.	Heparinize 1 hr after neuraxial technique, remove catheter 2-4 hrs after last heparin dose; no mandatory delay if traumatic.	Twice-daily dosing: LMWH 24 hrs after surgery, regardless of technique; remove neuraxial catheter 2 hrs <i>before</i> first LMWH dose. Single-daily dosing: neuraxial technique 10-12 hrs after LMWH; next dose 4 hrs after needle or catheter placement. Therapeutic dose: delay block for 24 hrs Delay first LMWH 24 hrs after neuraxial technique if traumatic.	
Warfarin	Fondaparinux	Direct thrombin inhibitors	Thrombolytics	Herbal therapy
Normal INR (before neuraxial technique); remove catheter when INR ≤ 1.5 (initiation of therapy)	Single injection, atraumatic needle placement or alternate thromboprophylaxis. Avoid indwelling catheters	Insufficient information. Suggest avoidance of neuraxial techniques	Absolute contraindication	No evidence for mandatory discontinuation before neuraxial technique; be aware of potential drug interactions

9.9.2.7 After minor foot surgery, a single injection sciatic block is the most effective technique (C).

9.9.2.8 After major surgery of the foot, the establishment of a popliteal sciatic perineural catheter is recommended (C).

9.10 Patients taking anticoagulant and/or antithrombotic agents

9.10.1 In patients with impaired coagulation, caution is advised when performing blocks where direct pressure in the event of a traumatised blood vessel is not possible (e.g. lumbar plexus, psoas compartment, infraclavicular), as a plexopathy may follow haematoma-induced pressure. Guidelines for removal of peripheral catheters from compressible sites are similar to those for removal of epidural catheters.

9.10.2 The occurrence of a haematoma in a patient taking treatment that interferes with haemostasis after a peripheral nerve block, wherever the site, is unusual (D).

9.10.3 The exact cause of haematoma formation is not always certain.

9.10.4 In the few reported cases, clinical evolution is usually favourable.

9.10.5 The haematoma has three potential sequelae: requires surgical drainage, requires transfusion and results in nerve compression.

9.10.6 Intuitively, patients are at greater risk in the presence of effective anticoagulation or combination anticoagulant/antiplatelet and deep blocks compared to more superficial blocks (professional consensus). The following American Society of Regional Anesthesia guidelines are summarised below.

9.10.7 For patients undergoing deep plexus or peripheral nerve block (e.g. lumbar and/or sacral plexus), follow the ASRA recommendations for neuraxial techniques.

9.10.8 The postoperative neurological monitoring should take into account the potential occurrence of a haematoma formation (D).

9.10.9 The placement of a perineural catheter must be substantiated (D).

9.11 Patients with pre-existing neurological disease

Peripheral neurological complications are more common after general anaesthesia than after regional anaesthesia (B). The potentially deleterious effect of the anaesthetic block of an altered nerve fibre has not been demonstrated. No study exceeds the level of evidence IV or V. Most opinions are extrapolated from studies of epidural analgesia.

9.11.1 Regarding indications

9.11.1.1 There are no absolute contraindications against performing a block in a patient with a well-known, stable neurological condition provided proper documentation of the neurological state is made prior to performing the block (D).

9.11.1.2 The experts have reservations about performing blocks (D) if a polyradiculoneuropathy (e.g. Guillain-Barre syndrome) exists, which may be aggravated in the territory of anaesthesia because of their unpredictable evolutionary nature (D).

9.11.1.3 Diabetes and metabolic disease are not contraindications to performing a block (D).

9.11.1.4 In the case of chronic, stable (for several months) traumatic neurological or vascular deficits, a

block does not increase the risk but does require a carefully documented neurological examination. A discussion of the risks and/or benefits of the block must take place with the patient.

- 9.11.1.5 If the neurological deficit is predominantly central, a block can be performed. Multiple sclerosis is not a contraindication to performing a block (D).
- 9.11.1.6 The myotoxicity of local anaesthetic, described with bupivacaine, must be considered, and care must be taken in patients with mitochondrial myopathy (D). However, considering the low risk of malignant hyperthermia and the weak evidence of myotoxicity of local anaesthetic, discussion of the risk/benefit ratio of the block must take place with the patient (D).

It is difficult to establish a causal link between the development of neurological diseases and the performance of a block. The following diseases are considered at potentially higher risk:

- Severe and progressive diabetic neuropathy when aggravating factors are superimposed (e.g. renal failure) (D);
- Neuropathies associated with chemotherapy (e.g. vincristine, cisplatin) (D);
- Hereditary neuropathies: Charcot-Marie-Tooth (CMT), hereditary neuropathies with hypersensitivity to pressure nerves (e.g. hereditary neuropathy with pressure palsies – HNPP) (D);
- Chronic damage of the anterior horn (e.g. spinal muscular atrophy – SMA and polio sequelae) (D);
- Multifocal motor neuropathy with persistent motor conduction deficits.

9.11.2 Regarding technical issues (D)

- 9.11.2.1 The opinion of a neurologist is recommended in cases of rare disease. No single special investigation contraindicates a practitioner from performing a block. Preoperative electrophysiological investigation has no prognostic value but can serve as a reference baseline investigation.
- 9.11.2.2 Nerve stimulation thresholds can sometimes be higher.
- 9.11.2.3 Continuous perineural catheters used for analgesia should be avoided because of the potential neurotoxicity of local anaesthetic (D).
- 9.11.2.4 The resolution of the block, whether complete or partial, must be documented in the anaesthetic record. In cases of neurological deficit after performance of a block, a neurologist opinion should be sought and, early electrophysiological testing should be considered (see later).

9.12 Management of the failed peripheral nerve block

The practice of regional anaesthetic techniques is never described in literature as being 100 % successful

all of the time. In times of block failure (i.e. the block is insufficient to facilitate surgery), a change in the anaesthetic management must take place – rescue block, supplementary local anaesthetic administered by the surgeon, additional sedation, or conversion to general anaesthesia. This usually occurs when local anaesthetic is not injected close enough to the nerve(s) (e.g. difficult/unusual anatomy, fascial planes or into a nearby vessel). When the injection is performed, the failure may be partial or complete.

9.12.1 Diagnosis of failure

- 9.12.1.1 The complete or partial failure should be diagnosed prior to surgery (professional consensus).
- 9.12.1.2 The quality of anaesthesia should be evaluated in every affected nerve territory (professional consensus) because it provides diagnostic information regarding the possibility of additional blockade. Several methods can be used: cold sensation (ice pack), motor, increase in temperature of the affected limb, light touch, proprioception.
- 9.12.1.3 The block should be evaluated repeatedly and compared to the usual period of block initiation, before making the diagnosis of success or complete or partial failure.

9.12.2 Failure Prevention

- 9.12.2.1 When blocking a nerve plexus, nerve stimulation of multiple branches provides greater success than just one single nerve or trunk (A).
- 9.12.2.2 Using an increased volume improves the spread of local anaesthetic solution and expands the area blocked (A). With equal volumes, increasing the concentration improves the intensity of the block but not its distribution (B).

9.12.3 What to do when ...

- 9.12.3.1 No nerve stimulation is elicited: Question the technique when no motor response is found. Ensure no muscle relaxant was administered. Recheck the function and connections of the nerve stimulator (D). Re-evaluate the position of the patient as well as the surface anatomy landmarks. In the event of on-going failure, change the apparatus or seek senior advice (D).
- 9.12.3.2 Problems with the injection: If blood is aspirated prior to the injection, reposition the needle. If the initial first millilitre of injection does not halt muscle contractions or the patient develops a prodrome of local anaesthetic toxicity, immediately discontinue the injection (professional consensus). The needle should be removed and repositioned.
- 9.12.3.3 Partial block failure: Incomplete anaesthesia may be sufficient to perform surgery if the surgical

area extends marginally past the anaesthetized area. Recommendations include repeating the block, local anaesthetic infiltration by the surgeon, "topping up" a preoperatively placed perineural catheter, or converting to general anaesthesia (B). Supplementing truncal blocks with a more distal infiltration may be of some benefit. Take care, that if blocks have to be repeated or supplemented, the total dose of local anaesthetic does not exceed a toxic dose.

9.12.3.4 Complete block failure: If adequate block characteristics are not achieved within 30 minutes, the block is unlikely to be sufficient (professional consensus). It is inappropriate to increase sedation as this may mask the block failure (D). Recommendations include repeating the block, providing a rescue block or converting to general anaesthesia (D).

9.13 Local anaesthetic systemic toxicity (LAST)

Accidental intravascular injection or rapid absorption of local anaesthetic can lead to toxicity. In a prospective study involving more than 21 000 cases, the incidence of cardiac arrest was 1.4 per 10 000, while that for seizures was 7.5 per 10 000. Surveys specifically investigating brachial plexus blocks have reported a higher rate of seizures (0.2%).

9.13.1 Pharmacokinetics

The peak absorption of local anaesthetic occurs in the following decreasing order: cervical blocks, intercostal, brachial plexus, femoral, ilioinguinal, sciatic.

The addition of adrenaline reduces plasma concentrations of local anaesthetic (A)

A decreased clearance is observed in the elderly.

The short-acting local anaesthetics are absorbed much more rapidly than long-acting local anaesthetics.

For surgery predictably lasting longer than 90 minutes, use long-acting local anaesthetics.

9.13.2 Neurological toxicity of local anaesthetics

Symptoms of CNS toxicity present as a worsening spectrum initially with signs of excitation such as light-headedness and dizziness, difficulty focusing, tinnitus, confusion, and circumoral numbness, progressing to shivering, myoclonus, tremors and seizures. These are typically followed by signs of depression such as cessation of seizure activity, respiratory depression and respiratory arrest.

All local anaesthetic agents can cause seizures (1:800 to 1:1500 blocks).

A history of epilepsy is not a contraindication to regional anaesthesia.

The ratio of neurological toxicity of bupivacaine, ropivacaine and lignocaine is about 4: 3: 1 respectively (A).

The principles of treating a seizure due to systemic absorption include maintaining the airway, oxygenation

Table 8: Equipotency of local anaesthetics

Drug	Equipotency
Lignocaine	1
Bupivacaine	4
Levobupivacaine	4
Ropivacaine	3.6

Clinical practice points

Lignocaine

1. Neurotoxicity occurs before cardiotoxicity.
2. Should not be used intrathecally due to toxicity to spinal cord and nerves

Bupivacaine

1. Cardiotoxicity occurs before neurotoxicity.
2. Intralipid® may be used for cardiotoxicity.
3. More potent than isomers so motor block and cardiotoxicity are more pronounced.
4. There are no consistent differences between ropivacaine, levobupivacaine and bupivacaine when given in low doses for regional analgesia in term of quality of analgesia or motor blockade.

Mixed solutions

Toxicities are additive (see equipotency above)

- E.g. a mixed solution of 20 ml of bupivacaine 0.5% + 20 ml of lignocaine 2% is toxic
 - 20 ml bupivacaine 0.5% = 100 mg of bupivacaine = 400 mg lignocaine AND
 - 20 ml lignocaine 2% = 400 mg
 - Therefore,
 - (Bupi 100 mg x 4 = 400 mg) + (20 ml lig 2% = 400 mg) = 800 mg = overdose (> 12 mg/kg)

and terminating the seizure. Low doses of benzodiazepines or thiopental (less than 200 mg) is indicated if the seizures do not yield quickly. Succinylcholine may be needed for intubation of patients with status epilepticus (professional consensus).

9.13.3 Cardiac toxicity of local anaesthetics

All local anaesthetics can induce cardiac arrhythmias with myocardial depression (with the exception of cocaine, which causes myocardial excitation). Cardiac toxicity worsens in a local anaesthetic dose-dependent fashion with peripheral vasodilatation, reduced cardiac output and hypotension with/without malignant arrhythmias. Cardiac arrest then occurs.

Bupivacaine and, to a lesser extent, ropivacaine can induce serious cardiac events and may cause death. These incidences are rare. Cardiac events are more common in pregnant women (A).

Atrioventricular conduction disorders and heart failure are not contraindications to the use of local anaesthetics (A).

Resuscitation of cardiac arrest uses the universally recommended techniques, including the use of Intralipid®. Prolonged resuscitation may be required.

Adrenaline boluses should be limited to 5-10 µg/kg to prevent ventricular tachycardia or fibrillation.

9.13.4 Metabolic toxicity of local anaesthetics

- 9.13.4.1 Lignocaine is contraindicated in patients with hepatic porphyrias. Only bupivacaine and esters can be used.
- 9.13.4.2 Methaemoglobinaemia can be observed after administration of prilocaine, present in the EMLA cream. The recommended dose is safe to use. Methaemoglobinaemia is treated with intravenous injection of methylene blue (1 - 5 mg/kg).

9.13.5 Allergy to local anaesthetics

Allergy to amide local anaesthetic is very rare, but adrenaline-containing solutions contain preservatives that can cause allergic reactions. Allergy is more frequent with the esters, which are not often used clinically. Most reactions are reported during dental procedures and correspond to an intravascular adrenaline injection or vaso-vagal episode.

Adrenaline-containing solutions should not be used in areas with end arterial supply (e.g. flexor sheath blocks, ring blocks, ears, nose and penile blocks).

9.13.6 Associations, dose recommendations and prevention of complications

- 9.13.6.1 The time interval between two successive injections must not be less than one third of the half-life of the agent used, or 30 minutes to lignocaine, prilocaine, mepivacaine and bupivacaine and 45 minutes for etidocaine and ropivacaine (professional consensus).
- 9.13.6.2 The dose used for the second injection must be at most a third of the maximum initial dose allowed after the above time or half the dose after 60 and 90 minutes respectively (professional consensus).
- 9.13.6.3 From the third injection, the usual rules of pharmacokinetics apply: injection of half the dose after a half-life (90 minutes for lignocaine and 150 minutes for bupivacaine) or third injection dose after half of a half-life (45 minutes for lignocaine and 60-80 minutes for bupivacaine) (professional consensus).
- 9.13.6.4 Local anaesthetic doses are cumulative. When administering a mixture of local anaesthetics, the toxic risk must take into account the sum of the injected doses.
- 9.13.6.5 Complications can be mitigated through the practice of slow and incremental injection (professional consensus) which, however, does not totally prevent complications, such as neurotoxicity.

9.14 Management of neurological complications of peripheral nerve blocks

Most nerve injuries following nerve blocks present as a transient neuropathy with paraesthesia and rarely as permanent neurological injury (persisting for more than

6 to 12 months). The incidence of transient neuropathy (radiculopathy) varies for different block sites: 2.84% for interscalene brachial plexus block, 1.48% for axillary brachial plexus block and 0.34% for femoral nerve block.

Permanent neurological injury has been reported following injection of local anaesthetic directly into the cervical spinal cord when an interscalene block was performed under general anaesthesia.

While ultrasound guidance has been shown to reduce the incidence of intravascular injection, the effect on neurological injury has not been elucidated.

9.14.1 Nerve damage during regional anaesthesia

9.14.1.1 Paraesthesia involves contact of the needle with the nerve trunk and therefore may risk nerve injury from the needle. Short bevel needles are recommended because they are less traumatic than the long bevel needle (B). The latter increase the risk of intraneural injection, which increases the risk of local neurotoxicity of local anaesthetic (B), especially if the solution contains adrenaline.

9.14.1.2 The minimum effective dose of local anaesthetic should be used. All local anaesthetics are potentially neurotoxic when the dose or concentration contacting the nerves is high (A). The dose used to achieve a block is most often much higher than that required to induce sensory and motor effects.

9.14.1.3 Adjuvant drugs administered should be deemed safe (clonidine, dexamethasone, adrenaline) (A).

9.14.2 Neurological complications after the block

9.14.2.1 Local neurological complications are four times less frequent than systemic complications of local anaesthetics or neurological complications of neuraxial anaesthesia (D). The patient should be informed of the risk before performing a regional anaesthetic technique.

9.14.2.2 A neurological assessment should always be performed before regional anaesthesia. This is essential in anaesthesia for traumatic emergency surgery.

9.14.2.3 The complications like paraesthesia, dysaesthesia or anaesthesia and paresis or paralysis may be transient or permanent.

9.14.2.4 Neurological complications are not exclusively attributable to the blocks, but are more often related to the surgical procedure (incidence of neurological complications related to the surgery: 0.1% in the upper limb, 1% at the hip) (D).

9.14.2.5 Horner's syndrome and laryngeal palsies, usually transient, are common after the interscalene block. Central extensions of local anaesthetic are primarily described with the interscalene block, some with the supraclavicular block, as well as the lumbar plexus block.

9.14.3 Nerve damage after nerve blocks

9.14.3.1 Sensory and/or motor disorders are often reported when paraesthesias were felt during the performance of the block (D). The use of a nerve stimulator is recommended: it does not completely prevent the occurrence of paraesthesia, but reduces the impact (D).

9.14.3.2 Intraneural injections generate significant pain both immediately and delayed. Intuitively, performing a block under general anaesthesia is not associated with this immediate pain and thus is not recommended. Evidence, however, does not conclusively support awake or asleep nerve blockade.

9.14.3.3 Risk factors for nerve damage include:

- Age is considered a risk factor for neuropathy (D).
- The nerve compression at the spinal level (or narrow cervical spinal canal) may aggravate peripheral neuropathies.
- Diabetes, chronic renal failure, malnutrition and chronic alcoholism are responsible for most neuropathies (A). The worsening of these conditions by regional anaesthesia has not been demonstrated.
- The demyelinating disorders, such as Hereditary Neuropathy with liability to Pressure Palsies (HNPP) and certain chemotherapeutic agents can promote nerve damage after regional anaesthesia (D).

9.14.4 Recommendations in the case of a neurological complication (see algorithm below)

9.14.4.1 A thorough clinical neurological examination should be done as soon as the effects of the block last longer than the expected duration. This examination should be documented and compared to the preoperative examination. Neurological symptoms guide the subsequent investigations.

9.14.4.2 Urgent referral to a neurologist is recommended.

9.14.4.3 Radiological examinations, aimed at a mechanical cause, may be necessary.

9.14.4.4 The assessment of lesions should be based on essential electrophysiological data (electromyogram [EMG], sensory and motor evoked potentials). By reviewing electrophysiological data of the affected limb and comparing it to the contralateral side, the extent and the prognosis can be clarified and the therapeutic approach can be planned. Due to Wallerian degeneration, signs of active nerve denervation appear only 3 weeks on average after the lesion, in the form of spontaneous activity (fibrillation, slow potential denervation):

- A first review should be conducted as soon as possible to serve as reference (before the 3rd day)
- The second examination should be performed between the 3rd and 4th weeks after injury.
- It is usually necessary to perform a third EMG approximately 3 months after injury, to assess the progress of the re-innervation and provide prognostic information. Nerve recovery is jeopardized if 18 months after injury, recovery is not noted on the electrophysiological examinations (D).

9.14.4.5 When early neurophysiological results reveal a pre-existing disease, more specific tests should be considered.

9.14.4.6 Clonazepam is useful for continuous or burning neuropathic pain. Amitriptyline is indicated for lightning or flashing pain. Both can be used together. Alternatives include Pregabalin and Lamotrigine. Carbamazepine can be used as second-line therapy with progressive dosage. Opioids can be added for intractable pain. Antidepressants may be required.

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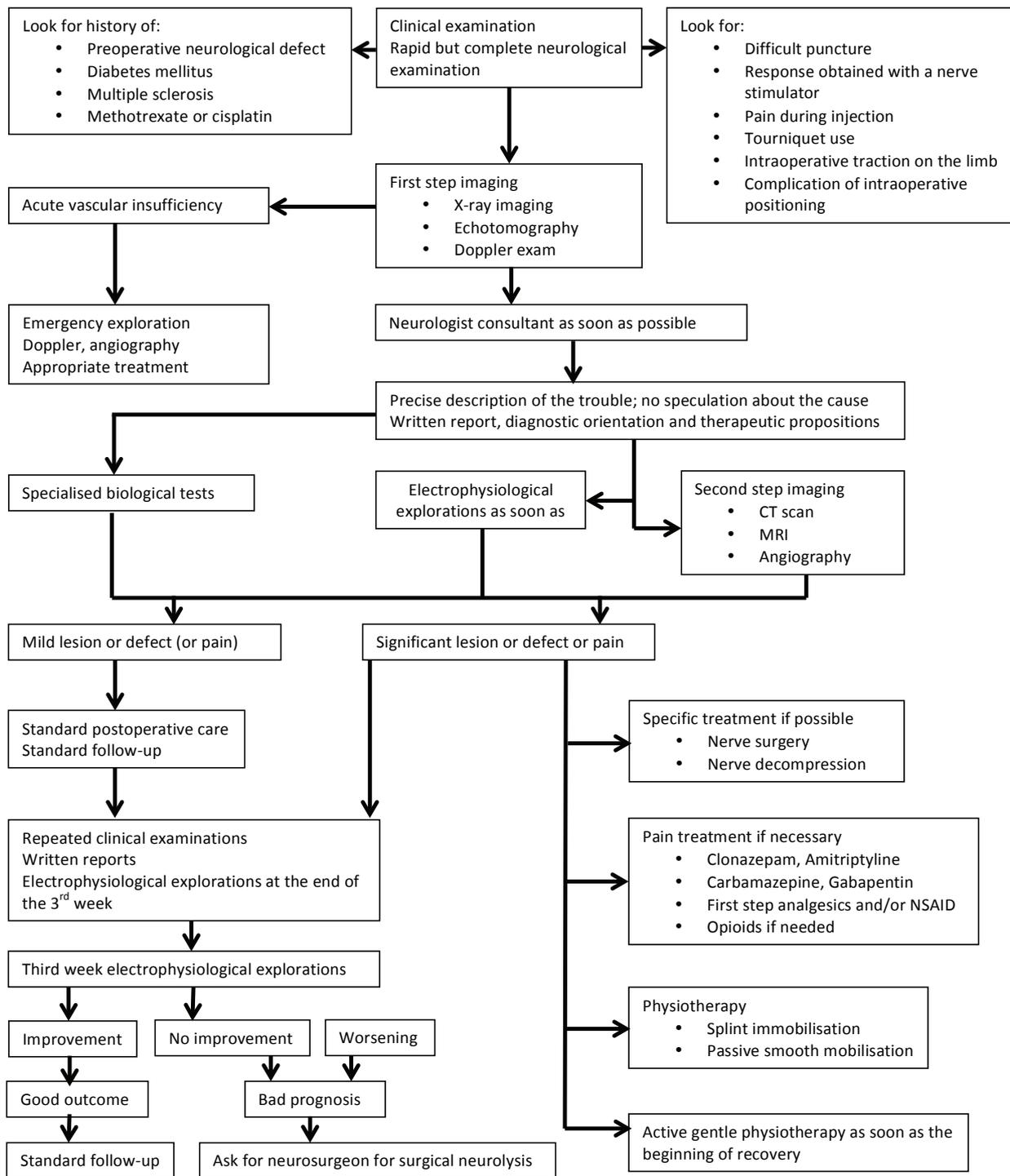


Figure 3: Stepwise management in the case of a neurological complication

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Appendix 1:

AAGBI Safety Guideline

Management of Severe Local Anaesthetic Toxicity

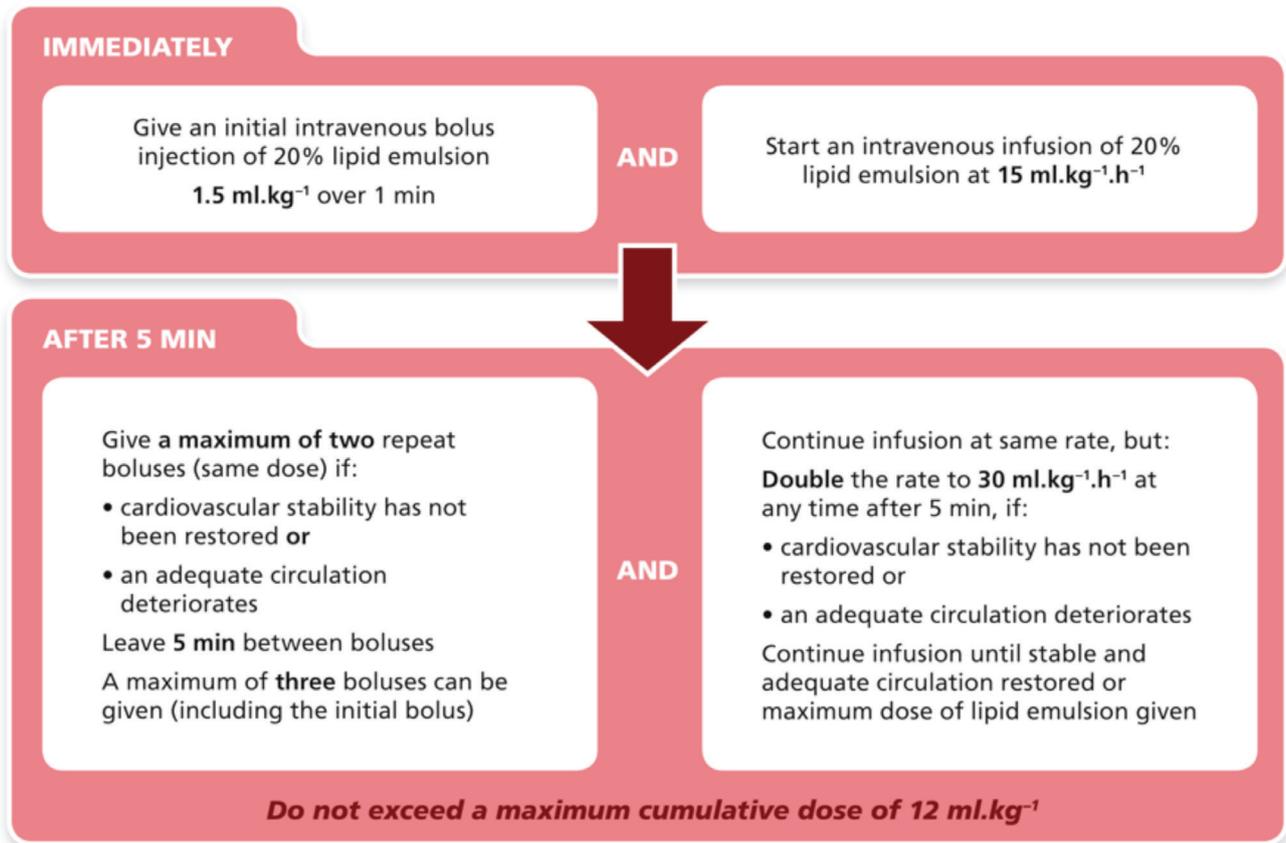


<h3>1 Recognition</h3>	<p>Signs of severe toxicity:</p> <ul style="list-style-type: none"> • Sudden alteration in mental status, severe agitation or loss of consciousness, with or without tonic-clonic convulsions • Cardiovascular collapse: sinus bradycardia, conduction blocks, asystole and ventricular tachyarrhythmias may all occur • Local anaesthetic (LA) toxicity may occur some time after an initial injection 	
<h3>2 Immediate management</h3>	<ul style="list-style-type: none"> • Stop injecting the LA • Call for help • Maintain the airway and, if necessary, secure it with a tracheal tube • Give 100% oxygen and ensure adequate lung ventilation (hyperventilation may help by increasing plasma pH in the presence of metabolic acidosis) • Confirm or establish intravenous access • Control seizures: give a benzodiazepine, thiopental or propofol in small incremental doses • Assess cardiovascular status throughout • Consider drawing blood for analysis, but do not delay definitive treatment to do this 	
<h3>3 Treatment</h3>	<p>IN CIRCULATORY ARREST</p> <ul style="list-style-type: none"> • Start cardiopulmonary resuscitation (CPR) using standard protocols • Manage arrhythmias using the same protocols, recognising that arrhythmias may be very refractory to treatment • Consider the use of cardiopulmonary bypass if available <p>GIVE INTRAVENOUS LIPID EMULSION (following the regimen overleaf)</p> <ul style="list-style-type: none"> • Continue CPR throughout treatment with lipid emulsion • Recovery from LA-induced cardiac arrest may take >1 h • Propofol is not a suitable substitute for lipid emulsion • Lidocaine should not be used as an anti-arrhythmic therapy 	<p>WITHOUT CIRCULATORY ARREST Use conventional therapies to treat:</p> <ul style="list-style-type: none"> • hypotension, • bradycardia, • tachyarrhythmia <p>CONSIDER INTRAVENOUS LIPID EMULSION (following the regimen overleaf)</p> <ul style="list-style-type: none"> • Propofol is not a suitable substitute for lipid emulsion • Lidocaine should not be used as an anti-arrhythmic therapy
<h3>4 Follow-up</h3>	<ul style="list-style-type: none"> • Arrange safe transfer to a clinical area with appropriate equipment and suitable staff until sustained recovery is achieved • Exclude pancreatitis by regular clinical review, including daily amylase or lipase assays for two days • Report cases as follows: <ul style="list-style-type: none"> in the United Kingdom to the National Patient Safety Agency (via www.npsa.nhs.uk) in the Republic of Ireland to the Irish Medicines Board (via www.imb.ie) <p>If Lipid has been given, please also report its use to the international registry at www.lipidregistry.org. Details may also be posted at www.lipidrescue.org</p>	

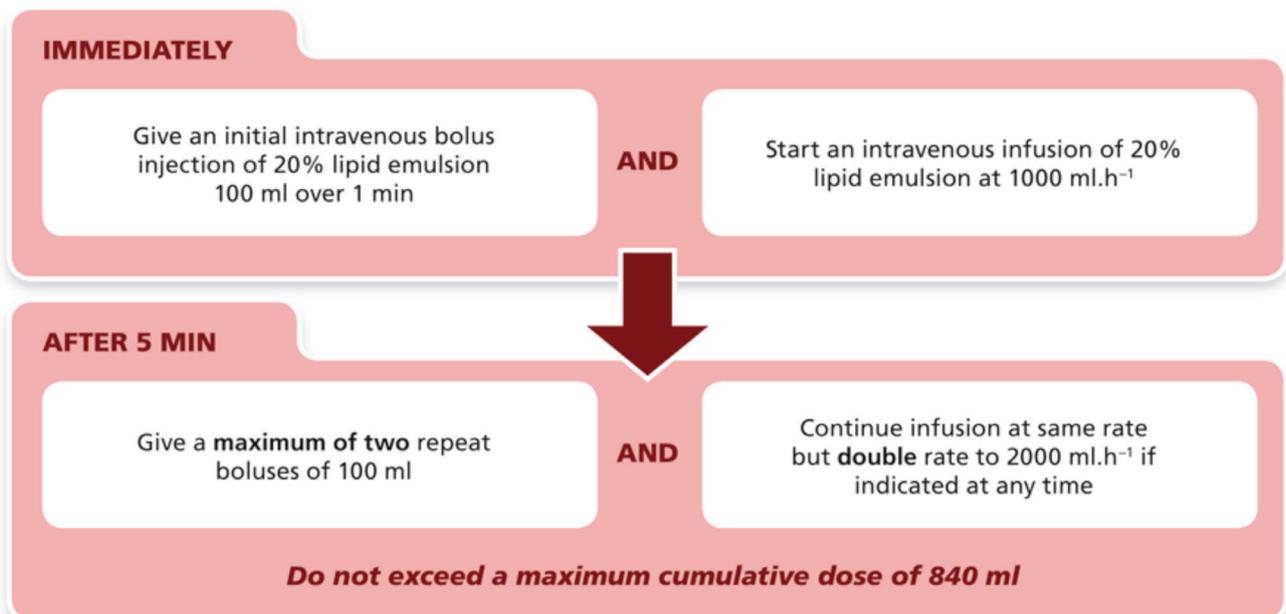
Your nearest bag of Lipid Emulsion is kept.....

This guideline is not a standard of medical care. The ultimate judgement with regard to a particular clinical procedure or treatment plan must be made by the clinician in the light of the clinical data presented and the diagnostic and treatment options available.

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An approximate dose regimen for a 70-kg patient would be as follows:



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This Safety Guideline is endorsed by the Australian and New Zealand College of Anaesthetists (ANZCA).

Upper limb nerve block information sheet

TAKE HOME PLEASE

Hospital sticker	Interscalene block	
	Supraclavicular block	
	Infraclavicular block	
	Axillary block	
	Distal peripheral block	



An upper limb nerve block (regional technique) can be given for one of the following possible reasons:

1. As anaesthesia for your orthopaedic operation of your arm or hand.
2. As pain relief after your orthopaedic operation of your shoulder, arm or hand.

This nerve block is administered through an injection of local anaesthetic at the side of the neck between the interscalene muscles, just above/below the clavicle (collar bone) or at the upper arm. This is a very safe and effective method of pain relief for the shoulder, arm or hand. The block is administered by your anaesthetist who uses special techniques, needles and equipment, which may include an ultrasound machine and/or a nerve stimulator to determine the precise location of the nerves. The bundle of nerves that supply the shoulder, arm and hand originates in both sides of the neck. We sometimes block individual nerves lower down the arm. You can expect to experience complete/partial numbness of the affected limb/area for a period of 8-12 hours, but the duration differs for each patient and can be as long as a day. If you are booked for shoulder surgery please remember to tell your anaesthetist if you chronically experience pins and needles or pain in any part of the arm or hand.

Please ask the anaesthetist during the pre-operative visit to clarify any uncertainty you may have. *It is your right to refuse consent to a regional procedure.*

Anaesthetists exercise extreme care in administering upper limb nerve blocks but, as with any medical procedure, complications can occur. The following complications are possible:

Common complications:

3. **Motor block:** While we intend to block only the pain fibres we inadvertently also block the fibres that control movement. Your arm will most likely feel heavy or lame when you wake up from anaesthesia. Please do not hang your arm from the side of the bed as this can cause permanent nerve damage.
4. **Horner syndrome:** This happens generally when the other nerves in the area are also blocked. Commonly we see on the

side of the block, a drooping eyelid, a blocked nose, small pupil, dry cheek, hoarse voice and sometimes shortness of breath in which case we send you to the ward with some oxygen. As the block wears off, these symptoms will disappear.

5. **Failed block:** It is possible that the block fails due to mechanical reasons or local factors in your neck or previous neck surgery. Therefore the block will provide insufficient pain relief and alternative pain methods will be employed.

Rare complications:

1. **Haematoma:** Because there are a few large blood vessels in that area of the neck, it is possible that one of them can be punctured while performing the block and there is a small chance that a haematoma (blood clot) can be formed.
2. **Local discomfort:** Sometimes it is necessary to go through some of the neck tissue to reach the nerves and this can cause some local discomfort afterwards but it is of short duration.

Very rare complications:

1. **Intravenous administration:** There is a small risk that the local anaesthetic can be injected directly into the bloodstream which can lead to convulsions or heart dysrhythmias. Extreme care is exercised to prevent this complication.
2. **Pneumothorax:** Because the lung is situated close to the area of injection, it is possible that it can be punctured. In case of this unlikely event you will experience shortness of breath and intense chest pain, especially when breathing. An underwater tube will be placed in your chest to help you breathe.
3. **Spinal or epidural:** The spinal cord is also close to the area of injection and if a spinal or epidural space is accidentally injected, it can cause temporary lameness.
4. **Sepsis:** Although we use an aseptic technique, the possibility of a surface infection or abscess exists.
5. **Nerve damage:** This is possible through the insertion of the needle but is unlikely with the use of ultrasound and/or nerve stimulator.
6. A few other extremely rare complications have also been documented in literature.

Lower limb nerve block information sheet

TAKE HOME PLEASE

Hospital sticker	Psoas comp. block	
	Femoral block	
	Lat. femoral cut. block	
	Saphenous block	
	Obturator block	
	Sciatic block	



A lower limb nerve block (regional technique) can be given for one of the following possible reasons:

1. As anaesthesia for your orthopaedic operation of your hip, leg or foot.
2. As pain relief after your orthopaedic operation of your hip, upper leg, knee, lower leg, ankle or foot.

Although the most common method for regional anaesthesia of the lower limb is a spinal or epidural (neuraxial techniques), there is a place for the use of the lower limb nerve block. This is a very safe and effective method of pain relief and may require multiple injections, with the added benefit of avoiding a total sympathectomy associated with the neuraxial techniques. These blocks are administered through an injection of local anaesthetic in the groin, through or below the buttocks, behind the knee joint or around the ankle depending on the type of lower limb nerve block and if it is administered alone or in combination. The block is administered by your anaesthetist who uses special techniques, needles and equipment, which may include an ultrasound machine and/or a nerve stimulator to determine the precise location of the nerves. The nerve supply to the lower limb includes two big components, namely femoral and sciatic nerves. We sometimes block individual nerves lower down the leg. You can expect to experience complete/partial numbness of the affected limb/area for a period of 8-12 hours, but the duration differs for each patient and can be as long as a day.

Please ask the anaesthetist during the pre-operative visit to clarify any uncertainty you may have. *It is your right to refuse consent to a regional procedure.*

Anaesthetists exercise extreme care in administering lower limb blocks but, as with any medical procedure, complications can occur. The following complications are possible:

Common complications:

1. **Motor block:** While we intend to block only the pain fibres we inadvertently also block the fibres that control movement.

Your leg will most likely feel heavy or lame when you wake up from anaesthesia.

2. **Failed block:** It is possible that the block fails due to mechanical reasons or local factors like obesity or previous surgery. Therefore the block will provide insufficient pain relief and alternative pain methods will be employed.

Rare complications:

1. **Haematoma:** Because there are a few large blood vessels in the area, it is possible that one of them can be punctured while performing the block and there is a small chance that a haematoma (blood clot) can be formed. The presence of a venous graft or previous replacement surgery is a relative contra-indication for a block in the same area.
2. **Local discomfort:** Sometimes it is necessary to go through some tissue, like that of the buttocks to reach the nerves and this can cause some local discomfort afterwards but it is of short duration.

Very rare complications:

1. **Intravenous administration:** There is a small risk that the local anaesthetic can be injected directly into the bloodstream which can lead to convulsions or heart dysrhythmias. Extreme care is exercised to prevent this complication.
2. **Sepsis:** Although we use an aseptic technique, the possibility of a surface infection or abscess exists.
3. **Nerve damage:** This is possible through the insertion of the needle but is unlikely with the use of ultrasound and/or nerve stimulator.
4. A few other extremely rare complications have also been documented in literature.

Spinal information sheet

Hospital sticker

TAKE HOME PLEASE



A spinal injection can be given for one of the following possible reasons:

1. As the method of anaesthesia for your caesarean section with the following benefits: you are awake to experience the birth process, you have a smaller risk for airway problems as well as a longer period of pain relief after the operation.
2. As anaesthesia for an orthopaedic operation.

Spinal injections are a safe and very effective way to give anaesthesia. They are administered by an anaesthetist who will also explain the technique to you. Please ask the anaesthetist during the pre-operative visit to clarify any uncertainty you may have.

In short, the procedure is as follows: local anaesthesia is injected in a sitting position before administering the spinal injection. This causes a burning sensation lasting a few seconds. Hereafter the spinal injection is administered. Please note that you should not move at all during this injection, because movement furthers the risk for complications. At this stage you will be asked to lie down on your back. A warm and heavy sensation will move upwards from your feet towards your waist. Most of the time both legs feel heavy and can hardly be moved. This will last for a few hours. Touch and pull sensation (i.e. deep pressure sensation) will still be present, but the spinal blocks all pain impulses.

Anaesthetists exercise extreme care in administering spinals, but, as with any medical procedure, complications can occur. The following complications are possible:

Common complications:

1. *Cardiovascular*: Your blood pressure may drop and you may feel lightheaded, dizzy or short of breath. It is easy to treat this quickly and effectively.
2. *Nausea*: Is very common, especially if your blood pressure drops and is also easily treated.
3. *Shivering*
4. *Itching*: Especially in the face and is a reaction on the medication used in the spinal.
5. *Difficulty in passing urine*: Patients who have had a spinal are not permitted to leave the hospital before they are able to pass urine. In case of a spinal caesarean section a catheter is placed in advance so you needn't be worried.
6. *Hot flushes, palpitations and fleeting headaches*: During the caesarean, the mother is injected with a drug that helps the uterus to contract after the baby is delivered, this causes hot flushes and a headache, but is of short duration.

Rare complications:

1. *Failed block*: It may happen that the block fails because of mechanical and local factors in your back for e.g. obesity,

previous back operations or congenital narrow spaces. This results in insufficient pain relief and the injection can be repeated at a different level or general anaesthesia can be employed.

2. *Headache*: In spinal anaesthesia the outer covering of the spinal cord is always punctured and spinal fluid can leak through the defect caused. This can lead to headache. Young pregnant women are at higher risk to develop a post dural puncture headache but nowadays a very thin needle is used to minimize fluid leakage. To counterfeit this complication, the following measures can be taken: a) strict bed rest for 8 hours postoperative, b) to increase oral fluid intake and c) to increase caffeine intake. If you are breastfeeding, take the caffeine directly after a feed in which case it will be worked out before the next feed. We treat this headache with bed rest and pain medication for 2-3 days. If it is not resolved by this time we can, under sterile conditions, inject some of your own blood into the epidural space to seal off the leakage. This helps in 97% of cases within a few hours.
3. *Backache*: To reach the spinal space the needle penetrates ligaments and soft tissue in the back and you may suffer superficial pain of variable duration at the injection site.

Very rare complications:

1. *Haematoma* (blood clot): Small blood vessels can be damaged during insertion of the spinal needle. In rare cases this can cause continuous internal bleeding. The resultant pressure on the spinal cord can lead to neurological damage and paralysis if not diagnosed and treated timeously. This treatment involves urgent surgical drainage of the haematoma after confirmation with a MRI scan of the back. It is important that the attending anaesthetist is made aware of any medication, including herbal products, that you are taking and that may interfere with blood clotting and thus may increase the risk of a spinal haematoma forming.
2. *High Spinal block*: If the local anaesthetic spreads too far up in the spinal canal, it can cause a high block that temporarily paralyzes the arms and the muscles of breathing.
3. *Sepsis*: In spite of the strict aseptic techniques used, superficial skin infections or even an abscess close to the spinal cord are possible.
4. *Neurological damage*: This can occur during insertion of the spinal needle. If any extreme pain or discomfort during the procedure is experienced, the anaesthetist must be informed immediately.
5. A few other extremely rare complications have also been documented in the literature.

Epidural information sheet

TAKE HOME PLEASE

Hospital sticker



An epidural injection can be given for one of the following possible reasons:

1. On the recommendation of a spinal surgeon or neurologist in the management of back complaints.
2. To manage post-operative or labour pain.

A computerized infusion pump that continuously supplies the local anaesthetic drug via an epidural catheter can also be used in the long term management of pain.

Epidural injections are safe and very effective in controlling pain. They are administered by an anaesthetist who will also explain the technique to you. Please ask the anaesthetist during the pre-operative visit to clarify any uncertainty you may have.

Anaesthetists exercise extreme care in administering epidural injections and infusions but, as with any medical procedure, complications can occur. The following complications are possible:

Common complications:

3. *Cardiovascular:* Your blood pressure may drop and you may feel lightheaded or dizzy. It is easy to treat this quickly and effectively.
4. *Nausea:* This is also easily treated.
5. *Shivering*
6. *Difficulty in passing urine:* Patients who have had an epidural are not permitted to leave the hospital before they are able to pass urine. Occasionally patients require a urinary catheter and have to be kept in hospital overnight. Patients with an epidural catheter for a constant infusion usually have their bladders catheterized until the epidural is stopped.

Rare complications:

1. *Failed block:* In rare cases the epidural injection may give unsatisfactory pain relief. The dosage of epidural drugs can then be adjusted or alternative methods of pain relief can be employed.
2. *Headache:* In some cases the outer covering of the spinal cord is inadvertently punctured and spinal fluid can leak through the defect caused. This can lead to headache which

can respond to bed rest for a few days. If this is not effective a sample of your own blood can be withdrawn and injected aseptically into the space around the spinal cord to stop the leak.

3. *Backache:* You may suffer superficial pain of variable duration at the injection site.
4. *Prolonged or dense block:* We strive to give the minimum amount of local anaesthetic needed to provide satisfactory analgesia without interfering with limb movement. However, sometimes a block can have a prolonged or even a temporary paralyzing effect.

Very rare complications:

1. *Haematoma (bleeding):* Small blood vessels can be damaged during insertion of the epidural needle. In rare cases this can cause continuous internal bleeding. The resultant pressure on the spinal cord can lead to neurological damage and paralysis if not diagnosed and treated timeously. This treatment involves urgent surgical drainage of the haematoma. It is important that the attending anaesthetist is made aware of any medication, including herbal products, that you are taking and that may interfere with blood clotting and thus may increase the risk of a spinal haematoma forming.
2. *Spinal block/high block:* If the unlikely event of the injected local anaesthetic entering the spinal fluid a very dense block that temporarily paralyzes the arms and the muscles of breathing can occur.
3. *Sepsis:* In spite of the strict aseptic techniques used, superficial skin infections or even an abscess close to the spinal cord are possible.
4. *Neurological damage:* This can occur during insertion of the epidural needle or catheter. Any undue discomfort during the procedure must be communicated to the anaesthetist immediately.
5. Rarely during removal of the epidural catheter it can be sheared off with a piece being retained in the epidural space. This may require surgical removal.
6. A few other extremely rare complications have also been documented.

