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Scharf, Liesel Anne

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ANAESTHETISTS' EXPERIENCES AND PRACTICES OF PERIOPERATIVE PERIPHERAL NERVE BLOCKS FOR ADULT LIMB SURGERY

Liesel Anne Schärf

A research report submitted to the Faculty of Health Sciences,
University of the Witwatersrand, Johannesburg,
in partial fulfilment of the requirements for the degree of
Master of Medicine in Anaesthesiology

Johannesburg, 2019.

DECLARATION

I, Liesel Anne Schärf, declare that this research report is my own work. It is being submitted for the Degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signed at _____ on this the _____ day of _____, 20 ____.

_____

Liesel Anne Schärf

ABSTRACT

The benefits of regional anaesthesia in the perioperative period are well recognised, but exposure and training may be inadequate or inconsistent, and procedural aspects can show variation and inconsistencies. This study describes the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery in the Department of Anaesthesiology at the University of the Witwatersrand. Data were obtained from a researcher-developed questionnaire completed anonymously by consenting anaesthetists at departmental academic meetings from March to June 2017. This study identified areas where knowledge and current practice may be improved on this academic circuit. These areas include the minimum monitoring used when performing blocks, aseptic precautions when performing blocks, and preparing for and being confident in the management of severe local anaesthetic systemic toxicity. The barriers to performing peripheral nerve blocks were identified. The need for additional and improved training in regional anaesthesia was recognised.

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LIST OF ABBREVIATIONS

AAGBI	Association of Anaesthetists of Great Britain and Ireland
AfPP	Association for Perioperative Practice
ANZCA	Australian and New Zealand College of Anaesthetists
ASA	American Society of Anesthesiologists
ASRA	American Society of Regional Anesthesia and Pain Medicine
CC/CNS	The ratio of the dose of local anaesthetic causing cardiac collapse (CC) to the dose causing seizures (CNS)
CDC	Centres for Disease Control and Prevention
CMSA	Colleges of Medicine of South Africa
ECG	Electrocardiogram
HPCSA	Health Professions Council of South Africa
LAST	Local anaesthetic systemic toxicity
NIBP	Non-invasive blood pressure
PNB	Peripheral nerve block
PNS	Peripheral nerve stimulator
PONSs	Postoperative neurological symptoms
SASA	South African Society of Anaesthesiologists
SpO_2	Pulse oximetry
UGRA	Ultrasound-guided regional anaesthesia
US	Ultrasound
WHO	World Health Organisation
Wits	University of the Witwatersrand

CHAPTER ONE

OVERVIEW OF THE STUDY

1.1 Introduction

The following will be discussed in this chapter: a background to this study, the aims and objectives, the research assumptions, demarcation of the study field, ethical considerations, research methodology, the significance of this study, and an outline of this research report.

1.2 Background

Choice of anaesthetic technique is a complex decision where multiple variables such as patient characteristics, type of surgery, and anaesthetic risks must be considered. General anaesthesia can be particularly high risk in certain patients. The numerous benefits of regional anaesthesia in the perioperative period are well recognised[1, 2]. A growing interest in regional anaesthesia is driven by the demand for patient satisfaction, enhanced postoperative recovery, and cost containment[2, 3].

Regional anaesthetic techniques may be used alone or in conjunction with general anaesthesia. Regional anaesthetic techniques not only provide potentially superior analgesia, but can also reduce the surgical stress response, the requirement for systemic analgesics, opioid-related adverse effects (nausea, vomiting, constipation, urinary retention, pruritus, and respiratory depression), the requirement for general anaesthesia with its potential complications, and the development of chronic pain[1, 2, 4-6].

Regional anaesthesia can be divided into two broad categories: central neuraxial blockade (spinal and epidural anaesthesia) and peripheral nerve blocks (involving a single nerve, multiple nerves, or a plexus)[7].

Neuraxial anaesthesia can quickly and reliably provide anaesthesia for lower limb and abdominal procedures, and is the mainstay of obstetric anaesthesia. Neuraxial techniques have risks, for instance in the presence of sepsis where they are relatively contraindicated, or in cardiovascular instability where they aggravate hypotension[2, 8].

Peripheral nerve blocks can thus offer a vital anaesthetic alternative for lower limb procedures in patients where general anaesthesia and neuraxial anaesthesia are undesirable or unsafe, and for upper limb procedures where general anaesthesia is undesirable or unsafe.

Despite being beneficial, peripheral nerve blocks are underutilised for several reasons[3, 9-11]. Ignorance of potential benefits, patient refusal, inadequate training and skill, unpredictable success, lack of equipment or supplies, time pressure to ensure a rapid turnover of cases, and medicolegal concerns, have all been cited as barriers to performing regional anaesthesia[9, 11-14]. Lower limb blocks are used less frequently than neuraxial techniques or upper limb blocks, possibly due to practitioners having less skill and confidence when performing these blocks[3, 10, 12, 15].

Studies conducted in other countries have pointed to inadequate training, experience, and confidence among both trainees and qualified anaesthetists in performing regional anaesthesia[2, 6, 9-12, 14-19]. It was noted that trainees graduating from different residency programs in the United States will not necessarily have comparable expertise in nerve blocks because recommendations do not specify which blocks should be in the core curriculum[2, 16]. A similar problem has been identified in Chile where there are no specific recommendations regarding the number and type of peripheral nerve blocks in the residency core curriculum[20].

The curriculum for trainees in anaesthesiology, as outlined by the College of Anaesthetists of South Africa, states that trainees need to obtain competency in regional techniques, including peripheral and plexus blocks of the upper and lower limb[21]. The specific blocks and numbers to be performed to acquire competency are not specified.

As with training programs abroad, training programs in South Africa are not uniform. Exposure and training may therefore be inconsistent. The difficulties of ensuring adequate training in regional anaesthesia are well documented[2, 15, 17-19].

Adequate training in regional anaesthesia techniques requires not only a sufficient case load, but also a structured regional anaesthesia rotation, a well-defined training curriculum, and a dedicated team of trained staff[2, 13]. In addition, the varied learning requirements of different individuals must be considered.

Individual learning processes are complex, and it is acknowledged that learning manual skills in anaesthesia differs greatly among the individual procedures and the individuals themselves[22]. Many attempts have been made to determine the minimum number of procedures required to achieve proficiency. The basic manual skills necessary for a general anaesthetic are significantly easier to master than many regional anaesthetic procedures[22]. Furthermore, trainees may not be comfortable with a technique despite achieving a technically successful block[16].

Several procedural aspects related to peripheral nerve blocks can show variation and inconsistencies:

- Regional anaesthesia requires informed consent, which may be obtained and documented in different ways. Consent may be expressed verbally or in writing[23-25].

- Whether to perform regional anaesthesia in the awake, the sedated, or the patient under general anaesthesia, is controversial[26-29].

- Local infection control guidelines state that maximal barrier precautions are generally not necessary for peripheral nerve blocks[30, 31]. There are, however, various possible practices based on different recommendations[32].

- Methods of nerve localisation differ. Practitioners can use a peripheral nerve stimulator to electrically generate a motor response which indicates needle-to-nerve proximity. Ultrasound guidance can be used to obtain visual needle-to-nerve proximity. These two nerve localisation techniques can also be combined. Each technique has advantages and disadvantages, but ultrasound guidance improves block characteristics and efficacy[31, 33, 34].

International studies have explored the experiences and practice of trainees and qualified anaesthetists in regional anaesthesia, and more specifically, peripheral nerve blocks. However, no studies with a local context could be identified. It would be useful to describe local experiences and practices, and to explore the need for additional training during registrar time.

Peripheral nerve blocks for adult limb surgery provide an appropriate background for such a study in the Department of Anaesthesiology at the University of the Witwatersrand. There are many peripheral nerve blocks of the upper and lower limb, and a selection of eight blocks (four upper limb blocks and four lower limb blocks) was used to represent the spectrum of blocks commonly utilised in regional anaesthesia for upper and lower limb surgeries. A more comprehensive selection of blocks would prohibitively lengthen the study because the array is vast. Neuraxial techniques, truncal blocks, and procedures used in the management of chronic pain are not included in this study. Continuous nerve blocks with the placement of perineural catheters are also not included in this study because these are infrequently performed in the Wits setting.

1.3 Aim of the study

The aim of this study was to describe the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery in the Department of Anaesthesiology at the University of the Witwatersrand.

1.4 Objectives of the study

The primary objectives of this study were to:

- describe the current practice of procedural aspects related to peripheral nerve blocks.
- describe the experiences of anaesthetists of peripheral nerve blocks for limb surgery.
- describe the perceived barriers to performing peripheral nerve blocks.

The secondary objectives of this study were to:

- compare the level of confidence in performing certain peripheral nerve blocks between junior and senior anaesthetists.
- describe the level of satisfaction with training in peripheral nerve blocks.

1.5 Research definitions and assumptions

The following definitions were used in this study:

Peripheral nerve block: A form of regional anaesthesia, distinct from neuraxial anaesthesia, produced by the injection of local anaesthetic in proximity to a nerve to produce analgesia or anaesthesia of a part of an extremity. A single nerve, multiple nerves, or a plexus may be involved.

Anaesthetist: A qualified doctor working in the Department of Anaesthesiology including medical officers, registrars and consultants.

Medical officer: A qualified doctor practising in the Department of Anaesthesiology under specialist supervision. Medical officers with more than ten years of experience are career medical officers and are regarded as consultants.

Registrar: A qualified doctor who is registered with the Health Professions Council of South Africa (HPCSA) as a trainee anaesthetist.

Consultant: A qualified doctor who has successfully completed the necessary Colleges of Medicine of South Africa (CMSA) examinations, or equivalent, and meets the criteria required to become a specialist anaesthetist. Career medical officers are included in this group.

Junior anaesthetist: Medical officers and registrars with three or less years of training.

Senior anaesthetist: Fourth year registrars, consultants, and career medical officers.

1.6 Demarcation of study field

This study was conducted in the Department of Anaesthesiology, which is affiliated to the Faculty of Health Sciences, at the University of the Witwatersrand. There are approximately 219 anaesthetists in the Department of Anaesthesiology, working mainly at the following hospitals: Chris Hani Baragwanath Academic Hospital, Charlotte Maxeke Johannesburg Academic Hospital, Helen Joseph Hospital, and the Rahima Moosa Mother and Child Hospital.

1.7 Ethical considerations

Approval to conduct this study was obtained from the Human Research Ethics Committee (Medical) (Appendix 1) and the Postgraduate Committee of the University of the Witwatersrand (Appendix 2). Data collection started after receiving this approval.

A participant information letter (Appendix 3) and a questionnaire (Appendix 4) were distributed to potential participants. The information letter detailed the purpose of the study, ethical approval, and the rights of participants to anonymity and withdrawal. Participation was voluntary, and completion of the questionnaire implied consent.

No identifying information was requested. Questionnaires were returned into a sealed box, and only the researcher and the supervisor had access to the raw data. Anonymity and confidentiality were thus ensured.

1.8 Research methodology

1.8.1 Study design

A prospective, observational, cross-sectional study design was used. It had descriptive and comparative elements.

1.8.2 Study population

Anaesthetists working in the Department of Anaesthesiology at the University of the Witwatersrand formed the population group studied.

1.8.3 Study sample

Sample method

A convenience sampling method was used. All anaesthetists attending departmental academic meetings during the time of this study (March to June 2017) were approached to participate in this study.

Sample size

Of the approximately 219 anaesthetists in the Department of Anaesthesiology at the University of the Witwatersrand, about 30% are unavailable at any given time. Questionnaires were offered to the largest possible accessible population, through attempts at multiple departmental academic meetings. A response rate of 60% (131 participants) was considered adequate, but 80% (175 participants) was targeted.

Inclusion and exclusion criteria

Inclusion criteria:

- Anaesthetists working in the Department of Anaesthesiology at Wits

Exclusion criteria:

- Anaesthetists who declined to participate
- Anaesthetists on leave during the study period
- Interns rotating through the Department

1.8.4 Data collection

Development of a questionnaire

A questionnaire (Appendix 4) was developed by the researcher after an extensive literature review. The research protocol and questionnaire were reviewed and validated by three specialist anaesthetists who are also experts in the field of regional anaesthesia, and their suggestions were incorporated.

Data collection process

Questionnaires with accompanying information letters were distributed at multiple departmental academic meetings, with the permission of the chairperson of each meeting. The questionnaires were numbered to determine the response rate. Participants placed completed questionnaires in a sealed, labelled collection box at the end of the meeting.

1.8.5 Data analysis

Data from the questionnaires were captured in a Microsoft® Excel spreadsheet. The data were then analysed using IBM® SPSS® Statistics 24.0 statistical software, in consultation with a statistician. Descriptive and inferential statistics were used.

1.9 Significance of the study

International studies have explored and documented the experiences and practice of trainees and qualified anaesthetists in regional anaesthesia, and more specifically, peripheral nerve blocks. However, no studies with a local context could be identified. This study describes local experiences and practices, and explores the need for additional training.

1.10 Validity and reliability

Validity and reliability in this study were ensured in the following ways:

- Use of an appropriate study design
- Questionnaire development after an extensive literature review
- Questionnaire reviewed by three experts in the field of regional anaesthesia
- Data entries checked for accuracy
- Data analysis in consultation with a statistician

1.11 Outline of the research report

Chapter 1: Overview of the study

Chapter 2: Literature review

Chapter 3: Research methodology

Chapter 4: Results and discussion

Chapter 5: Summary, limitations, recommendations, and conclusion

1.12 Summary

This chapter introduced the background to this study, followed by the aims and objectives, the research assumptions, demarcation of the study field, ethical considerations, research methodology, the significance of this study, and an outline of this research report. The following chapter presents the literature review.

CHAPTER TWO

LITERATURE REVIEW

Studies conducted in the United States[2, 6, 14, 16-18], the United Kingdom[19], France[15], Greece[9], Chile[12], Turkey[11], and Nigeria[10] have pointed to inadequate training, experience, and confidence among both trainees and qualified anaesthetists in performing regional anaesthesia.

It was noted that trainees graduating from different residency programs in the United States will not necessarily have comparable expertise in nerve blocks because recommendations do not specify which blocks should be in the core curriculum[2, 16]. A similar problem has been identified in Chile where there are no specific recommendations regarding the number and type of peripheral nerve blocks in the residency core curriculum[20].

The South African curriculum for trainees in anaesthesiology, as outlined by the College of Anaesthetists of South Africa, states that trainees need to obtain competency in regional techniques, including peripheral and plexus blocks of the upper and lower limb[21]. The specific blocks and numbers to be performed to acquire competency are not specified.

2.1 Barriers to performing regional anaesthesia

Research conducted internationally has shown that the number of peripheral nerve blocks performed during anaesthesiology training is limited[3, 10, 14, 17]. It has been determined that trainees lack confidence in performing blocks[6, 13, 14, 18].

A lack of experience and training among teaching staff, and consequently their trainees, has been identified as an important limitation in performing peripheral nerve blocks[13, 14]. The consequence is that new consultant anaesthetists have insufficient training and skill in regional anaesthetic techniques[9-12, 18]. This can result in a lack of appropriate teaching and supervision for trainees[14].

The routine use of peripheral nerve blocks could be hindered by surgeons or anaesthetists who do not recognise the benefits of these blocks[3, 9]. Some surgeons have the perception that performing blocks delays surgery and decreases operating theatre efficiency[13, 14]. Anaesthetists may be discouraged from performing peripheral nerve blocks because of time pressure and the rapid turnover of cases[3, 9, 11].

Logistic impedance in the ambulatory surgery or fast-tracking setting has also been cited as a hindrance to the routine application of peripheral nerve blocks[3, 9]. Patient-related factors like a lack of suitable patients, patient refusal, or patient contraindications can limit the use of regional anaesthesia[9-11, 13]. Other reasons for not applying regional anaesthesia in daily practice include the fear of failure, and medicolegal concerns[11]. Regional anaesthetic techniques may be underutilised because of a lack of equipment or supplies[9-11].

2.2 Informed consent

A healthcare practitioner who is performing a procedure, or occasionally a suitably qualified and knowledgeable delegate, has the responsibility to discuss the proposed procedure and the attached risks with the patient, and patients have the right to informed consent[23, 35]. The practitioner must inform the patient of the benefits, risks, costs and consequences generally associated with each option[24].

The desired outcome is that the patient will be given adequate information, in an understandable manner, to enable them to consider their options and make educated choices about their proposed procedure or treatment[23-25, 35, 36]. Patients need an accurate impression of rare but serious complications in addition to the more common minor ones[36].

Disclosure of common minor risks for regional anaesthesia would include local pain or discomfort, infection, and transient neuropathy. Rare major risks would include permanent neuropathy, paralysis, seizure, cardiac arrest, and death[36].

Consent may be verbal or written (express), or given by conduct (tacit)[23, 24, 35]. However, apparent compliance or submission may not necessarily indicate consent[23, 35]. A completed consent form makes it easier to show that consent was obtained. The complexity of the procedure or the nature of the risks involved can make it preferable to have written consent[23, 35]. Patients may still claim ignorance of the risks, despite the presence of a written consent form[36]. There is no evidence to show that a separate written anaesthesia consent form is superior to a handwritten record with the written surgical consent[36].

Frequently, in government hospitals, consent for anaesthesia is an informal interaction between the patient and the anaesthetist[25].

The South African Society of Anaesthesiologists (SASA) Guidelines for Regional Anaesthesia state that providing the patient with an information leaflet before the procedure would be considered good practice. Such an information leaflet should explain the risks and benefits associated with the block, how to take care of the anaesthetised limb, and warning signs requiring a return to hospital[31].

2.3 Locations where blocks are performed

Regional anaesthesia requires time and expertise for its application. A block room can be used to perform nerve blocks in parallel to surgical procedures in the operating room. There are potential benefits to surgeons, anaesthetists, and patients. The implementation of dedicated block areas has been shown to free up operating room time and minimise turnaround time, but it also allows for more ideal teaching opportunities in a less stressful environment[14, 17, 37, 38]. A higher number of blocks can be performed, with an opportunity to refine skills by repetition[13, 14, 17, 38].

Local guidelines state that it is desirable to perform blocks in a dedicated room in the immediate vicinity of the operating room, but acknowledge that this is not always practical[31]. Staffing constraints, equipment constraints, and space constraints within the theatre facility are impediments to having dedicated block rooms.

2.4 Monitoring

Monitoring should begin before injection of any local anaesthetic, and must continue after local anaesthetic injection as delayed local anaesthetic systemic toxicity may occur[31]. Patients should be monitored closely and continuously for at least 30 minutes after performance of a peripheral nerve block[39]. The minimum patient monitoring should include non-invasive blood pressure monitoring (NIBP), electrocardiogram (ECG), and pulse oximetry (SpO_2), but additional monitoring may be employed[31, 39-41]. Capnography is a more sensitive monitor for adequacy of ventilation than pulse oximetry. It is desirable in obese patients and in patients with respiratory problems, and it is recommended that capnography should be used where deep sedation and analgesia are administered[41, 42].

2.5 Lipid emulsion

Local anaesthetic systemic toxicity (LAST) is rare but potentially fatal. Immediate recognition and management are essential[39, 43]. It has neurological and cardiovascular manifestations, and the presenting features can vary widely. The precise incidence of LAST is unknown, but the rate has been reported as between 1.2-11 per 10 000 epidural anaesthetics, and in the region of 2.5-9.8 per 10 000 peripheral nerve blocks[43].

Local anaesthetic enters the systemic circulation by accidental intravascular injection or by systemic absorption. Local anaesthetic toxicity thus displays a biphasic distribution. It should be anticipated during and immediately after performing a block, and 10 to 30 minutes after performing a block. Signs and symptoms of toxicity occurring during or shortly after completion of the injection are due to intravascular injection or channelling of local anaesthetic to the systemic circulation, while the later effects are due to the systemic absorption of local anaesthetic[39, 43].

The CC/CNS ratio is the ratio of the dose of local anaesthetic required to produce cardiovascular collapse (CC) to that required to produce seizures (CNS). Bupivacaine has a CC/CNS ratio of 2.0, while lignocaine has a CC/CNS ratio of 7.1. This indicates that the progression from central nervous system signs and symptoms to cardiovascular collapse occurs more easily with bupivacaine than with lignocaine[43]. The margin of safety with bupivacaine is thus less than with lignocaine.

Intralipid® is an intravenous fat emulsion of soybean oil, glycerine and egg yolk phospholipids[43]. It is used in the preparation of parenteral nutrition, but has been shown to improve resuscitation from cardiovascular collapse in LAST[43].

The American Society of Anesthesiologists (ASA) statement on regional anaesthesia indicates that appropriate equipment and medications, including lipid emulsion, must be immediately available when regional anaesthesia is performed[44]. South African guidelines for regional anaesthesia state that all equipment and drugs necessary for the prevention and management of complications that may relate to the procedure must be immediately available and readily accessible. These guidelines also state that it is mandatory for intravenous lipid emulsion to be readily available in centres using bupivacaine, levobupivacaine and ropivacaine[31].

2.6 Regional anaesthesia awake, under sedation, or asleep

The performance of regional anaesthesia in the awake versus the anaesthetised or heavily sedated patient has been a subject of much debate in the field of regional anaesthesia[26, 27]. It is common practice to combine regional and general anaesthesia, and there is controversy as to whether to perform regional anaesthetic techniques before induction of general anaesthesia or after[28].

Local anaesthetic systemic toxicity and postoperative neurologic symptoms (PONSs) are two serious adverse events associated with regional anaesthesia. Even with well-designed studies, definitive statements about the safest technique will likely never be possible for rare and extremely rare events such as these, because of the enormous size of the study population required[29].

The question of safety of regional anaesthetic procedures in fully awake, sedated, or anaesthetised patients may therefore never be clarified[29].

It is argued that, without general anaesthesia, patients can alert the anaesthetist to possible nerve damage, due to the perception of pain or paraesthesia[29]. This may be applicable for peripheral nerve blocks, but not necessarily for neuraxial techniques, since the brain and spinal cord have no sensory innervation. The assumption that nerve damage caused by the cutting edge of a needle can be reduced if noticed early may be flawed because dissected nerve fibres cannot be restored by removal of the needle[29]. Furthermore, nerve puncture and intraneural local anaesthetic deposition do not necessarily lead to nerve injury[45, 46].

There are no sensitive or specific indicators of nerve damage. Subjective symptoms of nerve injury in awake patients, like pain and paraesthesia, are unreliable[26, 46]. Procedural pain or paraesthesia are not uncommon, but are rarely associated with clinical sequelae[29, 46]. The perception of high injection pressure, suggestive of intraneural needle placement, is influenced by needle make and design, and is also unreliable and inaccurate[26, 46].

Concerns of nerve damage in anaesthetised patients cannot always be justified. There is a constant rate of minor and major complications even when blocks are performed in awake patients. Evidence-based medicine shows that no strategy is unsafe or totally safe, and negative outcomes cannot be prevented with certainty in all circumstances[29]. Performing a block thus carries a risk of nerve injury whether the patient is anaesthetised or awake[29].

A recent multi-institutional study which analysed more than 50 000 paediatric regional anaesthesia blocks confirmed that major complications like PONSs, and LAST are rare, in keeping with previously reported data[27]. The complication rates did not indicate that blocks placed under anaesthesia carry a greater risk than blocks placed in awake or sedated children[27].

The performance of blocks should be individualised to the patient, considering the risk-benefit ratio. Heavy sedation or general anaesthesia may be appropriate for anxious patients, and to prevent movement during procedures in proximity to critical structures. Relative safety would thus be ascertained by the provision of adequate time and an immobile target to trainee anaesthetists[26]. A recent American Society of Regional Anesthesia and Pain Medicine (ASRA) practice advisory on neurological complications associated with regional anaesthesia and pain medicine advises against routinely performing regional anaesthetic or interventional pain procedures in deeply sedated or anaesthetised adult patients[46]. Prohibitive recommendations based on case reports or anecdote cannot be supported[27].

2.7 Infection control

Infectious complications arising from regional anaesthesia are rare[30, 32, 47], but may occur with any regional anaesthetic technique[48]. The frequency of infectious complications related to peripheral nerve blocks remains less well defined than those related to neuraxial techniques[47], and experts assert that single-injection peripheral nerve blocks carry a lower infection risk than continuous catheter techniques[30-32, 47].

There are numerous available infection control practice advisories, guidelines, and recommendations. International guidelines include those of the ASA, ASRA, the Association of Anaesthetists of Great Britain and Ireland (AAGBI), and the Australian and New Zealand College of Anaesthetists (ANZCA), while SASA has provided local guidelines[30, 31, 49-52].

The joint ASA and ASRA practice advisory on infectious complications focusses on neuraxial regional techniques[49]. The ASA recommendations for infection control also address neuraxial regional techniques[50]. These documents advocate the wearing of a cap, mask, and sterile gloves, and the use of sterile drapes, when performing regional anaesthesia techniques[49, 50].

The AAGBI guidelines make a distinction between neuraxial techniques and peripheral regional blocks. These guidelines state that peripheral regional blocks do not require full barrier precautions except in certain high risk patients, but that appropriate aseptic techniques include hand washing, sterile gloves, skin preparation, and the use of small drapes[51]. Maximal barrier precautions include wearing a cap and mask, full hand washing, wearing sterile gloves and a sterile gown, the use of large sterile drapes, and antiseptic skin preparation[51].

Similarly, the SASA guidelines also state that maximal barrier precautions are not necessary for peripheral nerve blocks unless the patient is immunocompromised or a perineural catheter is being placed[30, 31]. These guidelines recommend wearing a mask and a surgical cap for all cases, removal of jewellery, hand washing, wearing sterile gloves, aseptic techniques during preparation of equipment and drugs, antiseptic skin preparation, and aseptic placement of needles and catheters[30, 31].

It is worth noting that the SASA guidelines have referenced the ASA, ASRA, AAGBI and ANZCA documents.

Universally important components of asepsis in regional anaesthesia thus include proper hand hygiene, wearing surgical masks, the application of appropriate antiseptic solutions, and careful preparation of local anaesthetic solutions and equipment[47].

Hand washing is considered crucial for reducing periprocedural infection[32, 48]. Jewellery should be removed before hand washing[30-32, 49-51]. Both chlorhexidine and povidone-iodine scrubs cause a reduction in bacterial count after surgical hand scrub, but the effect of chlorhexidine has been shown to be greater and more sustained[53]. Studies that analysed the reduction in bacterial count or colony forming units after surgical scrub concluded that chlorhexidine is superior[53].

There is no evidence to suggest that chlorhexidine hand scrub reduces surgical site infection. This may explain why the guidelines from the World Health Organisation (WHO), the Centres for Disease Control and Prevention (CDC), and the Association for Perioperative Practice (AfPP) do not recommend one antimicrobial over another for hand scrub[53].

Organisms cultured from the oropharynx, buccal mucosa, and tongue of the practitioner performing the procedure have been implicated and detected in patients with infectious complications after regional anaesthesia[32, 47]. This explains the recommendation that practitioners wear a surgical mask.

Skin preparation with chlorhexidine prior to clean-contaminated surgery resulted in reduced surgical site infection[53]. Chlorhexidine gluconate in alcohol is preferred for skin preparation for regional techniques by the ASA, and SASA[30, 31, 50]. The AAGBI guidelines recommend either chlorhexidine gluconate in alcohol or povidone-iodine in alcohol[51]. The ANZCA guidelines express a concern regarding allergic reactions to chlorhexidine and recommend that it should not be used indiscriminately[52].

Contaminated local anaesthetic solutions have been identified as a potential source of infection both during single-injection and continuous neuraxial or peripheral nerve block techniques[47]. These solutions should be prepared with attention to asepsis[30, 31, 47, 51, 52]. It should be recognised that local anaesthetic boluses, bag changes and catheter hub disconnections may also increase the risk of contamination with the potential for localised or systemic infection[47].

Ultrasound-guided regional anaesthesia techniques require the use of a non-disposable transcutaneous ultrasound probe. There are no universally adopted guidelines for ultrasound machine and probe decontamination in regional anaesthesia[30]. Ultrasound probes are not thermoresistant, therefore disinfection is the only option[32].

The Spaulding classification system, based on their use and risk of transmitting infection and recommended level of decontamination, classifies these probes as either non-critical (in contact with intact skin), or semi-critical (in contact with mucous membranes or non-intact skin) medical devices[30, 32, 51, 52]. Ultrasound-guided regional techniques necessitate skin puncture and thus may cause blood contamination of the probe[30]. The use of sterile protective ultrasound probe covers or sheaths is recommended[30-32]. The use of single-use, sterile ultrasound gel is recommended[30-32, 52].

The ultrasound machine and probe should be decontaminated before and after use. Visible soiling should be wiped off with a single-use towel, and then another single-use towel soaked in disinfectant should be used, after which the machine and probe should be allowed to dry[31]. Specific product information should be consulted as to which cleaning agents are permitted for a particular machine and probe[31].

2.8 Nerve localisation: Peripheral nerve stimulator and ultrasound

Successful regional anaesthesia requires the accurate placement of local anaesthetic around nerve structures[45]. Two techniques which relied on surface landmarks were previously in widespread use: elicitation of paraesthesia and electrical stimulation[45].

The use of a peripheral nerve stimulator (PNS) is an effective tool for determining adequate needle placement in regional anaesthesia[34]. However, landmark techniques have limitations. These so-called blind techniques relying on pops, clicks and twitches lack accuracy and reliability. Block placement times are longer, patient discomfort is greater, and the risk of injury is higher. Success rates and complications are influenced by anatomical variations and nerve physiology, and also by equipment accuracy[34]. These methods are no longer used for many blocks[45]. Techniques based on paraesthesia increase the risk of neurological complications and should no longer be performed[31].

The introduction of ultrasound was one of the biggest advances in the field of regional anaesthesia[33, 34, 45]. Ultrasound-guided regional anaesthesia (UGRA) has been shown to be more efficacious for peripheral nerve block (PNB) than techniques using peripheral nerve stimulation for nerve localisation[34, 45]. It enables the practitioner to image the target nerve and surrounding structures directly, observe anatomical variations, observe needle placement in real-time, avoid hazardous structures, and visualise the appropriate spread of local anaesthetic[34, 45].

The shortcomings of peripheral nerve stimulation have been shown using ultrasound. For nerves that were adequately imaged, a positive motor response with a PNS did not improve success of the block. Also, correct needle position on ultrasound imaging does not necessary elicit a PNS response in a successful block[45]. Even needle-nerve contact and intraneural needle placement may fail to elicit a PNS response in some patients at a current of up to 1.8 milliampere (mA)[45, 46]. A threshold of nerve stimulation lower than 0.2 mA is normally considered to indicate a high likelihood of intraneural needle tip placement. Furthermore, nerve puncture and intraneural local anaesthetic deposition do not always result in functional nerve injury[45, 46].

Meta-analysis of randomised controlled trials comparing peripheral nerve blocks performed under ultrasound guidance to those performed using peripheral nerve stimulation demonstrate various statistically significant advantages of ultrasound guidance: they are more likely to succeed[33, 34], have a faster onset time[33, 34, 45], shorter procedure times[33, 34], a greater proportion of complete sensory block in all involved nerve territories[33, 34, 45], have a longer block duration[34, 45], less volume of local anaesthetic is required[33, 34, 45], less patient discomfort during block performance[34, 45], fewer needle passes required[34], greater patient satisfaction[34], and a reduced risk of accidental vascular injury[33, 34, 45].

The overall frequency of LAST and PONSs is similar for nerve localisation by ultrasound or peripheral nerve stimulator[33, 46]. The reported rate of long-term peripheral nerve injury is 2-4 per 10 000 blocks[46]. Because of the rarity of these complications, a statistically significant difference between nerve localisation techniques, if one exists, will likely never be determined[33].

The graphical information provided by ultrasound imaging may make trainee supervision easier. Staff may be able to determine and direct adjustments in needle position more easily than with peripheral nerve stimulator guidance[34]. Novice behaviour may increase the risk of injury, however[33].

The PNS may be a useful adjunct to UGRA for reasons other than ensuring block efficacy. Where the ultrasound image is less distinct than desired, or where ultrasound-guided deep nerve blocks are being performed, an evoked motor response could be used as a safety monitor to warn against interfascicular injection of local anaesthetic[54]. Where neural structures are challenging to identify by visualisation alone, a specific motor response may assist with precise nerve delineation[54]. Nerves that do not lend themselves to ultrasound visualisation, due to depth or osseous interference of ultrasound transmission, may be identified by PNS while the ultrasound is used to identify local structures to guide the block[54].

South African guidelines state that the practice of regional anaesthesia without ultrasound does not constitute poor or negligent practice, but acknowledge that its use has become an increasingly worldwide trend towards the gold standard in addition to nerve stimulation[31].

2.9 Cost considerations

The initial outlay for ultrasound equipment is significant. This may be used as an argument against ultrasound introduction into a department[45]. However, cumulative time saved in block placement and faster block onset can be shown to save money by reducing theatre time[45]. Efficacious blocks with fewer complications represent a potential reduction in litigation costs[45]. Less local anaesthetic is used[45]. The incidence of unintended conversion to general anaesthesia is lower[45]. There is a lower incidence of postoperative nausea and vomiting[45]. Day case surgery patients are able to bypass recovery and be discharged sooner[45]. Ultrasound can also be used to facilitate safe and swift central and arterial line placement[45]. Point-of-care ultrasound is another modality of increasing utility in the perioperative setting, allowing rapid assessment of a patient's cardiac, vascular, pulmonary, airway, and gastrointestinal status[55].

2.10 Action following inadequate block

Complete or partial block failure are recognised complications of regional anaesthesia, and patients need to be informed of this possibility. Recommendations include repeating the block, performing additional rescue blocks, local anaesthetic infiltration by the surgeon, or converting to general anaesthesia. Where blocks are repeated or supplemented, the total dose of local anaesthetic must not exceed the toxic dose[31].

2.11 Confidence in performing peripheral nerve blocks

A lack of confidence when performing regional anaesthesia techniques may be procedure-related or outcome-related. Procedure-related uncertainties include uncertainties about correct landmarks, needle direction, agent concentration and local anaesthetic volumes. Outcome-related uncertainties relate to whether the desired endpoint will be achieved: whether the block will be successful[17]. It is important to note that confidence does not necessarily imply competence or correlate with success rate[6, 17, 20].

Studies have shown that a considerable number of graduating anaesthesia trainees are not comfortable with performing peripheral nerve blocks autonomously[6, 13]. Anaesthetists will select a more familiar anaesthetic technique like general or neuraxial anaesthesia when they lack confidence or experience in regional techniques[18]. Confidence is thus important for the continued performance of regional anaesthesia[17]. Registrars need confidence so that they can continue to practice and self-learn regional anaesthesia techniques during and after completing their training[17].

The basic manual skills for general anaesthesia have been shown to be significantly easier to learn than regional anaesthetic procedures[13, 22, 45]. There is inter-procedural variation in learning these skills[22]. Learning processes are further influenced by several variables like individual variation, the institution and its environment, and exposure to a sufficient number of cases[22].

Manual anaesthesia skills have been shown to improve rapidly during the first 20 attempts[16, 22]. Block success rates have been shown to correlate well with the number of blocks performed, with the number required depending on the specific technique[18]. However, trainees may still not feel comfortable with a regional anaesthetic technique, despite autonomously performing a technically successful block[22]. Furthermore, the number of blocks performed correlates with trainee confidence level, and with the satisfaction with the quality of teaching received[6].

Periodic American surveys have shown that as technology and techniques in the field have improved, and as exposure and training has been increased, the confidence level of graduating trainees has increased[6, 18].

2.12 Summary

This chapter presented an overview of several aspects relevant to the practice of peripheral nerve blocks by anaesthetists. The following chapter describes the research methodology used in this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a discussion of the methodology used in this study.

3.2 Problem statement

The curriculum for trainees in anaesthesiology, as outlined by the College of Anaesthetists of South Africa, states that trainees need to obtain competency in regional techniques, including peripheral and plexus blocks of the upper and lower limb[21]. The specific blocks and numbers to be performed are not specified.

As with training programs abroad, training programs in South Africa are not uniform. Exposure and training may therefore be inconsistent. The difficulties of ensuring adequate training in regional anaesthesia are well documented[2, 15, 17-19]. Adequate training in regional anaesthesia techniques requires not only a sufficient case load, but also a structured regional anaesthesia rotation, a well-defined training curriculum, and a dedicated team of trained staff[2, 13]. In addition, the varied learning requirements of different individuals must be considered.

Despite being beneficial, peripheral nerve blocks are underutilised for several reasons[3, 9-11]. Ignorance of potential benefits, patient refusal, inadequate training and skill, unpredictable success, lack of equipment or supplies, time pressure to ensure a rapid turnover of cases, and medicolegal concerns, have all been cited as barriers to performing regional anaesthesia[9, 11-14]. Lower limb blocks are used less often than neuraxial techniques or upper limb blocks, possibly due to practitioners having less skill and confidence when performing these blocks[3, 10, 12, 15].

Several procedural aspects related to peripheral nerve blocks can show variation and inconsistencies. International studies have explored and documented the experiences and practice of trainees and qualified anaesthetists in regional anaesthesia, and more specifically, peripheral nerve blocks.

However, no studies with a local context could be identified. This study describes local experiences and practices, and explores the need for additional training.

3.3 Aim of the study

The aim of this study was to describe the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery in the Department of Anaesthesiology at the University of the Witwatersrand.

3.4 Objectives of the study

The primary objectives of this study were to:

- describe the current practice of procedural aspects related to peripheral nerve blocks.
- describe the experiences of anaesthetists of peripheral nerve blocks for limb surgery.
- describe the perceived barriers to performing peripheral nerve blocks.

The secondary objectives of this study were to:

- compare the level of confidence in performing certain peripheral nerve blocks between junior and senior anaesthetists.
- describe the level of satisfaction with training in peripheral nerve blocks.

3.5 Demarcation of study field

This study was conducted in the Department of Anaesthesiology, which is affiliated to the Faculty of Health Sciences at the University of the Witwatersrand. There are approximately 219 anaesthetists in the Department of Anaesthesiology, working mainly at the following hospitals: Chris Hani Baragwanath Academic Hospital, Charlotte Maxeke Johannesburg Academic Hospital, Helen Joseph Hospital, and the Rahima Moosa Mother and Child Hospital.

3.6 Ethical considerations

Approval to conduct this study was obtained from the Human Research Ethics Committee (Medical) (Appendix 1) and the Postgraduate Committee of the University of the Witwatersrand (Appendix 2). Data collection started after receiving this approval.

A participant information letter (Appendix 3) and a self-administered questionnaire (Appendix 4) were distributed to potential participants. The information letter detailed the purpose of the study, ethical approval, and the rights of participants to anonymity and withdrawal. Participation was voluntary, and completion of the questionnaire implied consent.

The questionnaires were numbered for administrative purposes. No identifying information was requested. Questionnaires were returned into a sealed box, and only the researcher and the supervisor had access to the raw data. Anonymity and confidentiality were thus ensured.

3.7 Research methodology

3.7.1 Study design

A prospective, observational, cross-sectional study design was used. It had descriptive and comparative elements.

3.7.2 Study population

Anaesthetists working in the Department of Anaesthesiology at the University of the Witwatersrand formed the population group studied.

3.7.3 Study sample

Sample method

A convenience sampling method was used. All anaesthetists attending departmental academic meetings during the time of this study were approached to participate in the study.

Sample size

Of the approximately 219 anaesthetists in the Department of Anaesthesiology at Wits, about 30% are unavailable at any given time. Questionnaires were offered to the largest possible accessible population, through attempts at multiple departmental academic meetings. A response rate of 60% (131 participants) was considered adequate, but 80% (175 participants) was targeted.

Inclusion and exclusion criteria

Inclusion criteria:

- Anaesthetists working in the Department of Anaesthesiology at Wits

Exclusion criteria:

- Anaesthetists who declined to participate
- Anaesthetists on leave during the study period
- Interns rotating through the Department

3.7.4 Data collection

Development of a questionnaire

A questionnaire (Appendix 4) was developed by the researcher after an extensive literature review.

The research protocol and questionnaire were reviewed and validated by three specialist anaesthetists who are also experts in the field of regional anaesthesia, and their suggestions were incorporated.

The questionnaire covered demographic information; procedure- and practice-related questions; questions relating to exposure, experience and confidence; and questions relating to training. A selection of eight common upper and lower limb blocks was used. The upper limb blocks included in this study were: interscalene, supraclavicular, infraclavicular, and axillary. The lower limb nerve blocks included in this study were: lumbar plexus, femoral, sciatic, and popliteal.

The questionnaire had a total of 32 questions. Of the 32 questions, 29 questions required the responses to be indicated by selecting the relevant option or options, one question required a numerical value to be filled in, four questions provided space for the respondent to elaborate if they so wished, and two questions required a short response. Respondents who did not perform blocks at all could omit a series of practice-related questions.

Data collection process

Questionnaires with accompanying information letters were distributed at multiple departmental academic meetings from March to June 2017, with the permission of the chairperson of each meeting. The questionnaires were numbered to determine the response rate. The questionnaires took approximately ten minutes to complete. The researcher was available to assist with queries. Participants placed completed questionnaires in a sealed, labelled collection box at the end of the meeting.

3.7.5 Data analysis

Data from the questionnaires were entered in a Microsoft® Excel spreadsheet and analysed using IBM® SPSS® Statistics 24.0, in consultation with a statistician. Descriptive and inferential statistics were used.

Numerical data were presented using means and standard deviations, if normally distributed. Medians, ranges, and interquartile ranges were used if the data were skewed. Categorical data were described using frequencies, percentages, or ratios.

Comparisons were made using the Chi-squared test or the Fishers Exact test for categories, and the unpaired t-test or Mann-Whitney test for numerical variables. A p-value of <0.05 was considered statistically significant.

3.8 Validity and reliability

Validity and reliability in this study were ensured in the following ways:

- Use of an appropriate study design
- Questionnaire development after an extensive literature review
- Questionnaire reviewed by three experts in the field of regional anaesthesia
- Data entries checked for accuracy
- Data analysis in consultation with a statistician

3.9 Significance of the study

International studies have explored and documented the experiences and practice of trainees and qualified anaesthetists in regional anaesthesia, and more specifically, peripheral nerve blocks. However, no studies with a local context could be identified. This study described local experiences and practices, and explored the need for additional training.

3.10 Budget

The researcher bore the cost of the research project. Printing costs were the main expense incurred. This included printing of the proposal, the ethics and postgraduate applications, the participant information letters and questionnaires, and the research report submissions with supporting documents.

Item	**Number**	**Cost**	**Total**
Printing	2500	R1/page	R2500

3.11 Project timeline

	2016	2017	2018	2019
Literature review				
Protocol preparation				
Protocol approval				
Ethics approval				
Data collection				
Data analysis				
Writing up				
Submission and marking				
Corrections and final submission				

3.12 Summary

This chapter described the research methodology used in this study. The following chapter presents the results of this study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter contains the results of the data collected, in accordance with the research objectives. The findings are described and analysed using descriptive and inferential statistics.

The aim of this study was to describe the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery in the Department of Anaesthesiology at the University of the Witwatersrand.

The primary objectives of this study were to:

- describe the current practice of procedural aspects related to peripheral nerve blocks.
- describe the experiences of anaesthetists of peripheral nerve blocks for limb surgery.
- describe the perceived barriers to performing peripheral nerve blocks.

The secondary objectives of this study were to:

- compare the level of confidence in performing certain peripheral nerve blocks between junior and senior anaesthetists.
- describe the level of satisfaction with training in peripheral nerve blocks.

4.2 Sample realisation

Data collection for this study was conducted from March to June 2017. Questionnaires were distributed at departmental academic meetings. Of the approximately 219 anaesthetists in the Department of Anaesthesiology at Wits, 165 (65.75%) were reached over the study period.

Of the 165 questionnaires distributed, 144 (87.27%) were returned and were evaluated. This number exceeded the sample size of 131 participants (60% of the department) that was considered adequate.

Where respondents did not complete a question, they were excluded from that analysis. Where respondents were exempt from completing a question, this will be indicated. Where respondents could select more than one option, numbers add up to more than the number of respondents included in the study. Numbers are rounded to two decimal places.

4.3 Results

4.3.1 Gender

Of the 144 respondents, 43 (29.90%) were male and 101 (70.10%) were female.

4.3.2 Age

Figure 4.1 shows the age distribution of respondents.

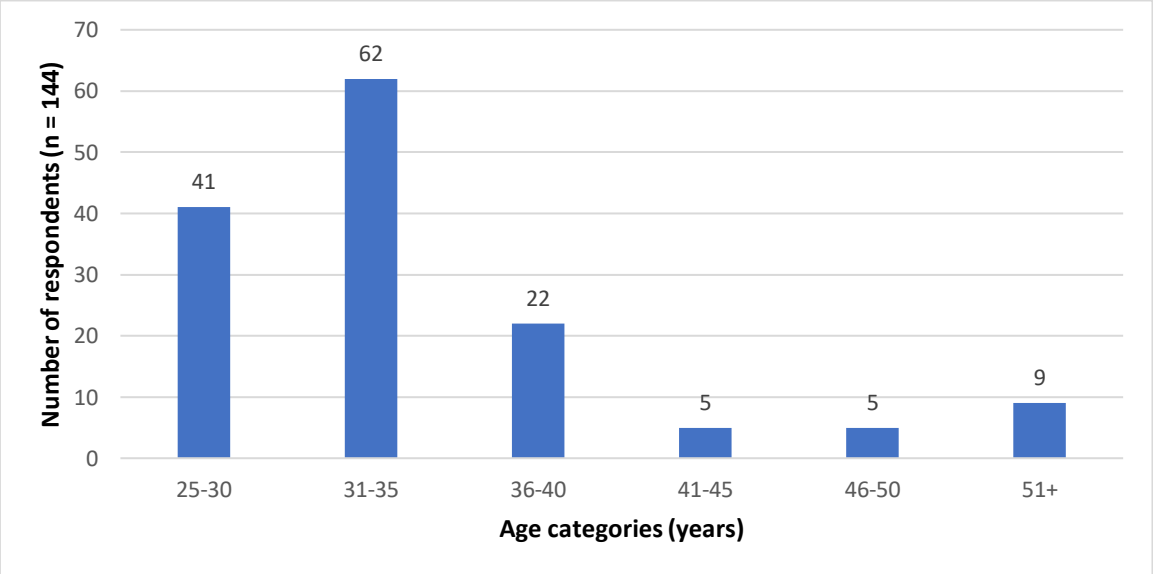


Figure 4.1: Age distribution of respondents

4.3.3 Professional designation

Figure 4.2 shows the respondents by both professional designation and gender.

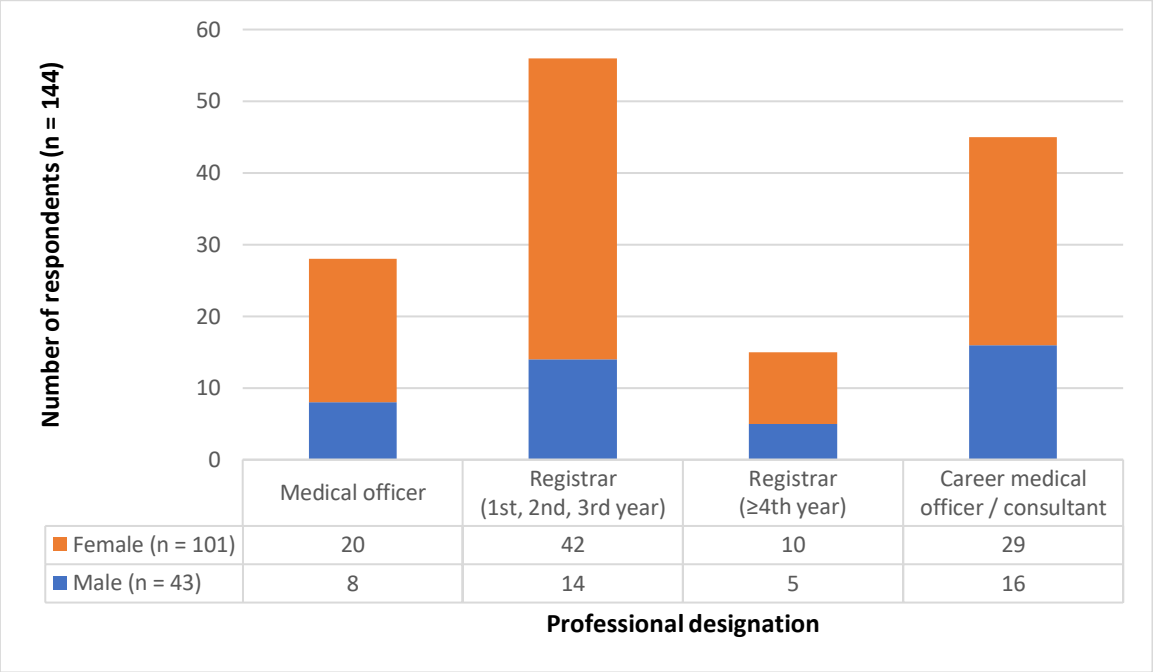


Figure 4.2: Number of respondents by gender and professional designation

4.3.4 Anaesthetic experience

Of the 144 respondents, 123 (85.42%) indicated their anaesthetic experience. This was recorded in years, or in months if less than one year. The remaining 21 (14.58%) respondents had either omitted the question or their responses were not legible, and were excluded from this part of the data analysis.

The mean number of years of anaesthetic experience was 6.27 years, with a standard deviation of 6.03 years. The median was 5 years. Ten respondents indicated less than twelve months of anaesthetic experience, while two respondents indicated thirty years of anaesthetic experience.

4.3.5 Exposure to adult upper or lower limb surgery

Two (1.40%) of the 144 respondents indicated that they had not anaesthetised any adult patients for upper or lower limb surgeries in the preceding year.

Of the 142 respondents that had anaesthetised adult patients for upper or lower limb surgeries in the preceding year, six (4.22%) had done 1-5 cases, nine (6.33%) had done 6-10 cases, 24 (16.90%) had done 11-20 cases, 64 (45.07%) had done 21-50 cases, and 39 (27.46%) had done more than 50 cases. The number of cases by professional designation is shown in Figure 4.3.

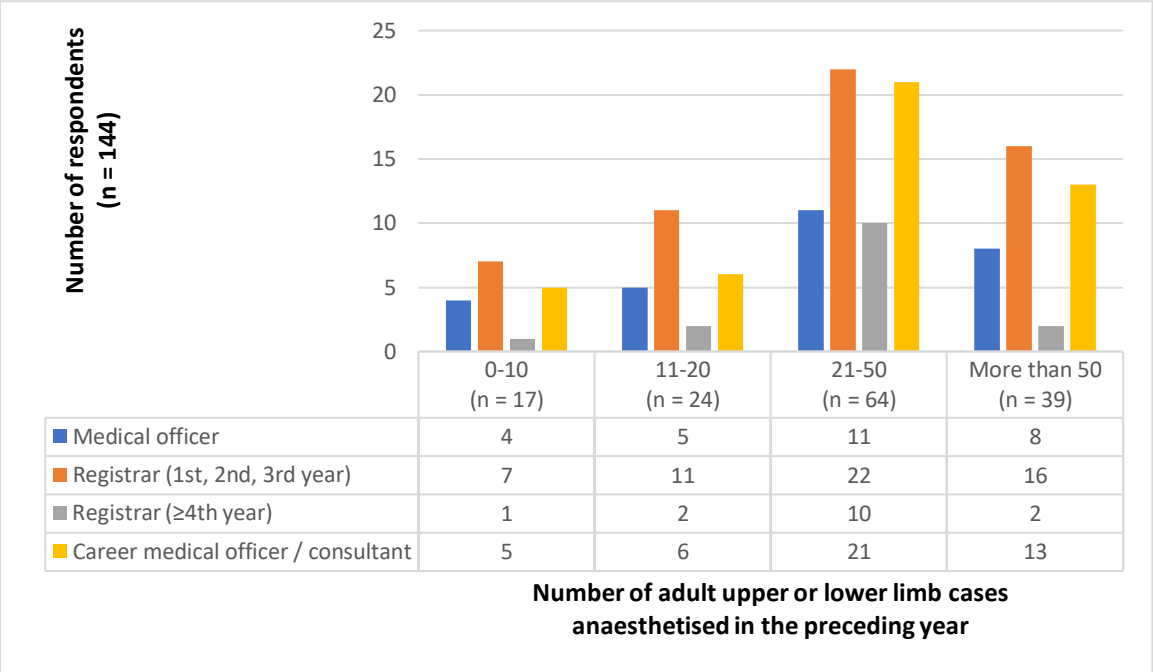


Figure 4.3: Number of adult upper or lower limb cases anaesthetised in the preceding year by professional designation

4.3.6 Exposure to adult upper or lower limb peripheral nerve blocks

A total of 137 respondents indicated that they had performed upper or lower limb peripheral nerve blocks on adult patients in the preceding year, while seven indicated that they had not.

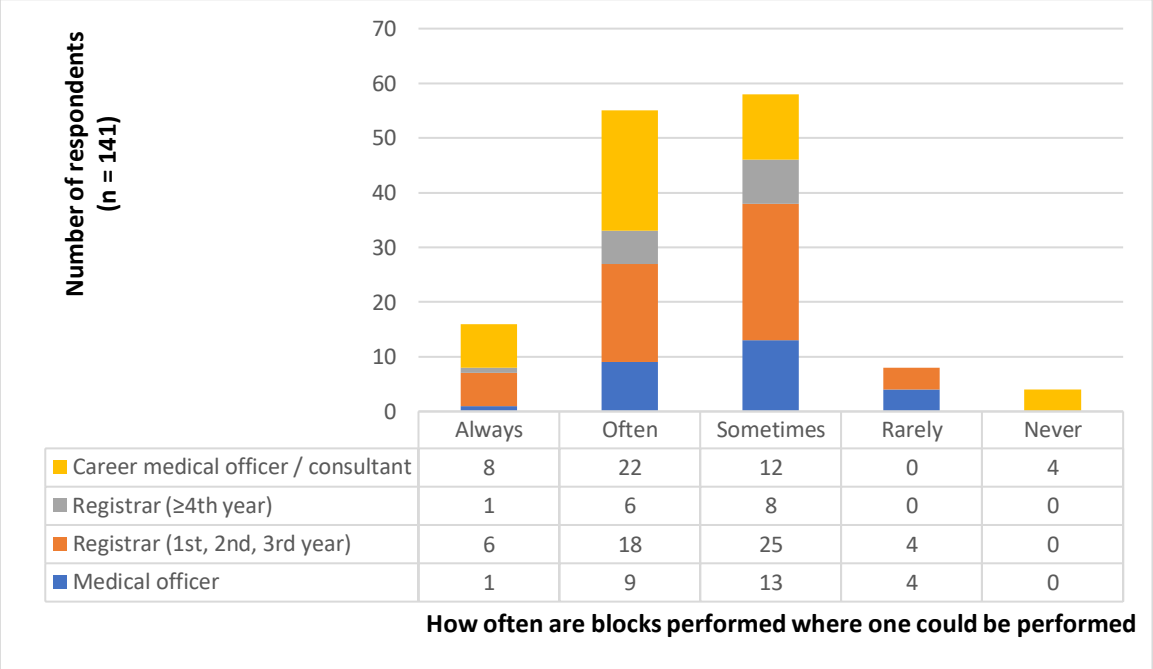
The seven respondents who indicated that they had not performed these blocks in the preceding year also indicated that they did not perform blocks at all, and were then exempt from answering certain practice-related questions. The seven comprised two medical officers, two registrars (1st, 2nd or 3rd year), and three career medical officers and consultants.

Of the 137 respondents who indicated that they had performed upper or lower limb peripheral nerve blocks on adult patients in the preceding year, 24 (17.52%) had performed 1-5, 39 (28.47%) had performed 6-10, 36 (26.28%) had performed 11-20, 29 (21.17%) had performed 21-50, and eight (5.84%) had performed more than 50.

4.3.7 How often blocks are performed where one could be performed

Respondents were requested to indicate how often they perform a peripheral nerve block for adult limb surgery where one could be performed. Only 137 of 144 respondents were supposed to answer this question, because those who indicated that they never performed blocks were exempt from answering, but 141 (97.92%) respondents answered this question, and three (2.08%) omitted the question. However, four respondents indicated that they never perform blocks where one could be performed.

A Pearson Chi-Square test showed no statistically significant differences between the groups when professional level was compared with how often blocks are performed ($p = 0.251$). The results are shown in Figure 4.4.



	Always	Often	Sometimes	Rarely	Never
Career medical officer / consultant	8	22	12	0	4
Registrar (≥4th year)	1	6	8	0	0
Registrar (1st, 2nd, 3rd year)	6	18	25	4	0
Medical officer	1	9	13	4	0

Figure 4.4: How often respondents perform blocks where one could be performed by professional designation

4.3.8 Barriers to performing peripheral nerve blocks

Barriers to performing peripheral nerve blocks were investigated by requesting all respondents to indicate their reasons for not performing blocks. More than one option could be selected, and respondents could add their own reasons, if needed. Figure 4.5 represents the reasons indicated by the respondents.

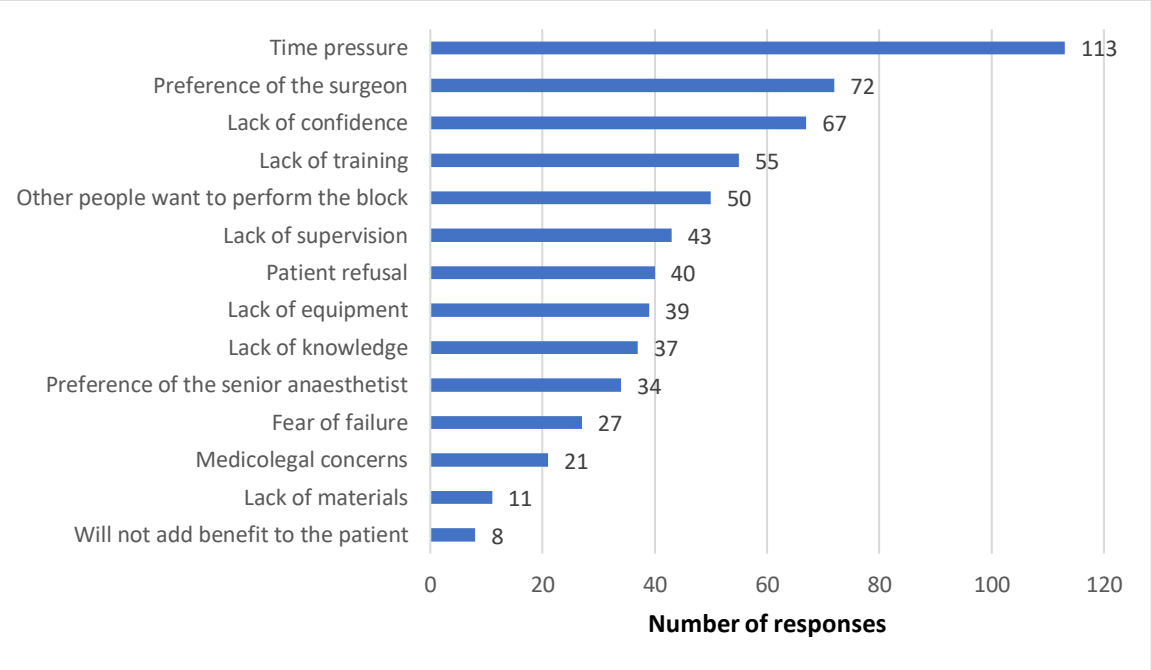


Figure 4.5: Reasons for not performing blocks

4.3.9 Consent for blocks

Of the 137 respondents who indicated that they had performed upper or lower limb peripheral nerve blocks for adult patients in the preceding year, 128 (93.43%) indicated that they obtain verbal consent, nine (6.57%) indicated that their consent also includes written consent, with no respondents indicating that they do not obtain consent when performing blocks.

4.3.10 Locations where blocks are performed

When requested to indicate where they normally perform blocks, of 137 respondents 101 (73.72%) indicated that they performed blocks only in the operating theatre. Fifteen (10.95%) respondents indicated that they perform blocks in the operating theatre or in the recovery room. Fourteen (10.22%) respondents indicated that they perform blocks in the operating theatre or in a block area. Five (3.65%) respondents indicated that they perform blocks in the operating theatre, in a block area, or in the recovery room. Two (1.46%) respondents indicated that they perform blocks only in a block area. This is shown in Figure 4.6.

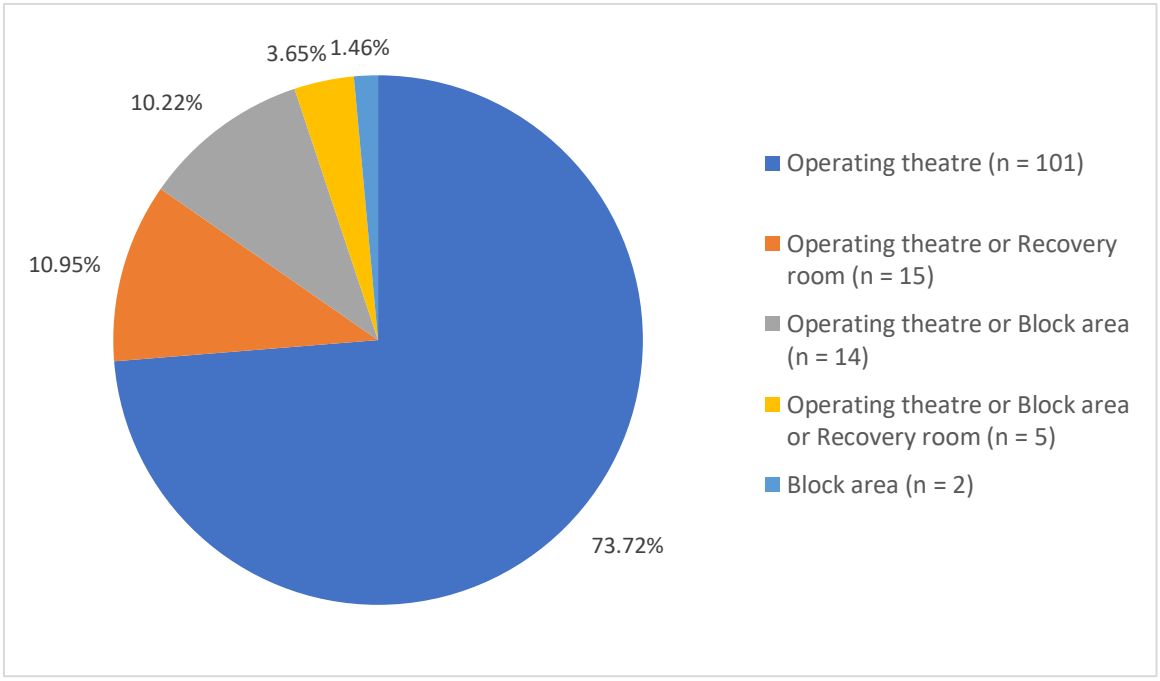


Figure 4.6: Locations where blocks are normally performed

4.3.11 Minimum monitoring used

The minimum monitoring normally used when performing peripheral nerve blocks is represented in Figure 4.7. Of 137 respondents, 114 (79.60%) indicated that their minimum monitoring would normally include non-invasive blood pressure monitoring (NIBP), electrocardiogram (ECG) and pulse oximetry (SpO_2), while 12 (8.76%) respondents indicated that they would normally use only NIBP and SpO_2, five (3.65%) respondents would normally use only SpO_2, and four (2.92%) respondents would normally use only ECG and SpO_2. Seven (5.11%) respondents indicated that they would normally use NIBP, ECG, SpO_2, and capnography. No respondents indicated that they would normally do blocks without monitoring.

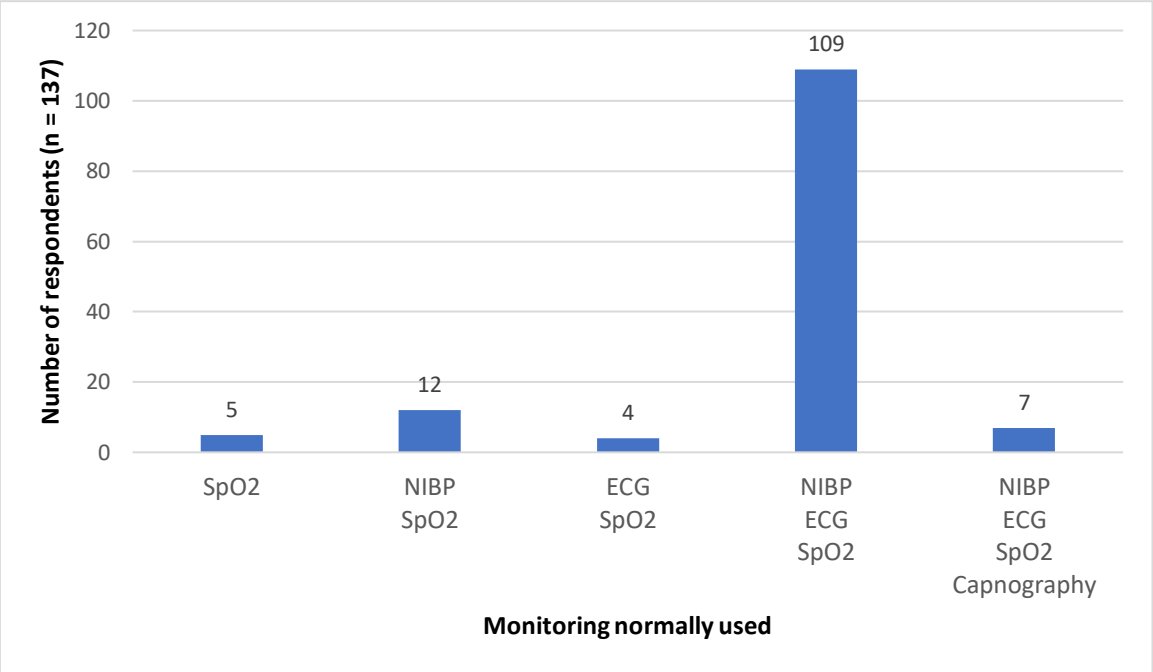


Figure 4.7: Minimum monitoring normally used

4.3.12 Duration of monitored care

It was found that of the 137 respondents, 22 (16.06%) indicated that they would monitor the patient for less than 30 minutes after performing a block, 65 (45.45%) respondents indicated that they would monitor the patient for 30 minutes after performing a block, and 50 (36.50%) respondents indicated that they would monitor the patient for more than 30 minutes after performing a block.

4.3.13 Lipid emulsion for local anaesthetic systemic toxicity

When those respondents who indicated that they do perform blocks were asked about intravenous lipid emulsion (Intralipid®), 100 (72.99%) respondents indicated that it was readily available in their theatre complex, while 10 (7.30%) respondents indicated that it was not, and 27 (19.71%) respondents did not know.

It was found that 93 (67.88%) respondents indicated that they felt confident in the management of LAST, while 44 (32.12%) respondents indicated that they did not feel confident in the management of LAST. Figure 4.8 and Figure 4.9 show the number of respondents who felt confident or did not feel confident in the management of LAST, by professional designation, respectively.

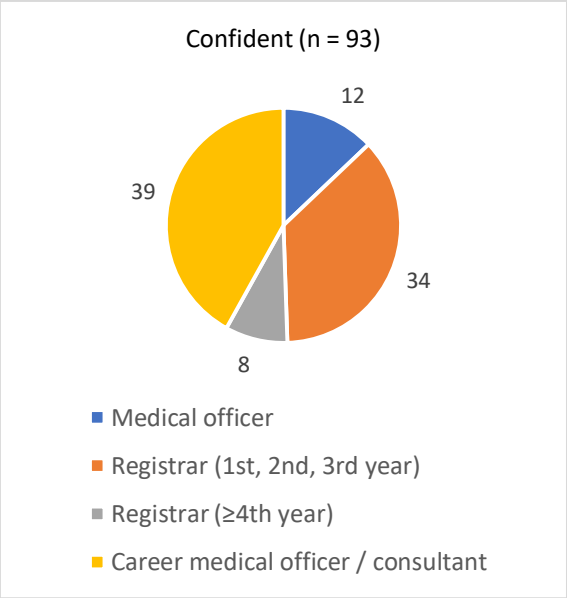


Figure 4.8: Self-rated confidence in the management of local anaesthetic systemic toxicity (LAST) by professional designation

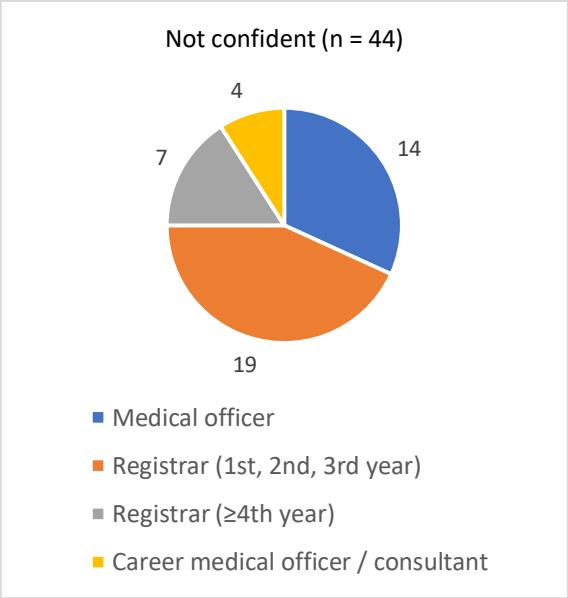


Figure 4.9: Self-rated lack of confidence in the management of local anaesthetic systemic toxicity (LAST) by professional designation

4.3.14 Timing of blocks

When requested to indicate whether they normally perform blocks preoperatively or postoperatively, 136 of 137 respondents (99.27%) indicated that they normally perform blocks preoperatively. One respondent out of 137 omitted this question.

4.3.15 Patient state during block

As shown in Figure 4.10, when requested to indicate their preferred state of the patient during performance of a block, 45 (32.85%) respondents preferred a sedated patient, 41 (29.93%) respondents preferred the patient to be under general anaesthesia, 40 (29.20%) respondents preferred the patient to be awake, while 10 (7.30%) respondents indicated that the state of the patient did not matter. One respondent out of 137 omitted this question.

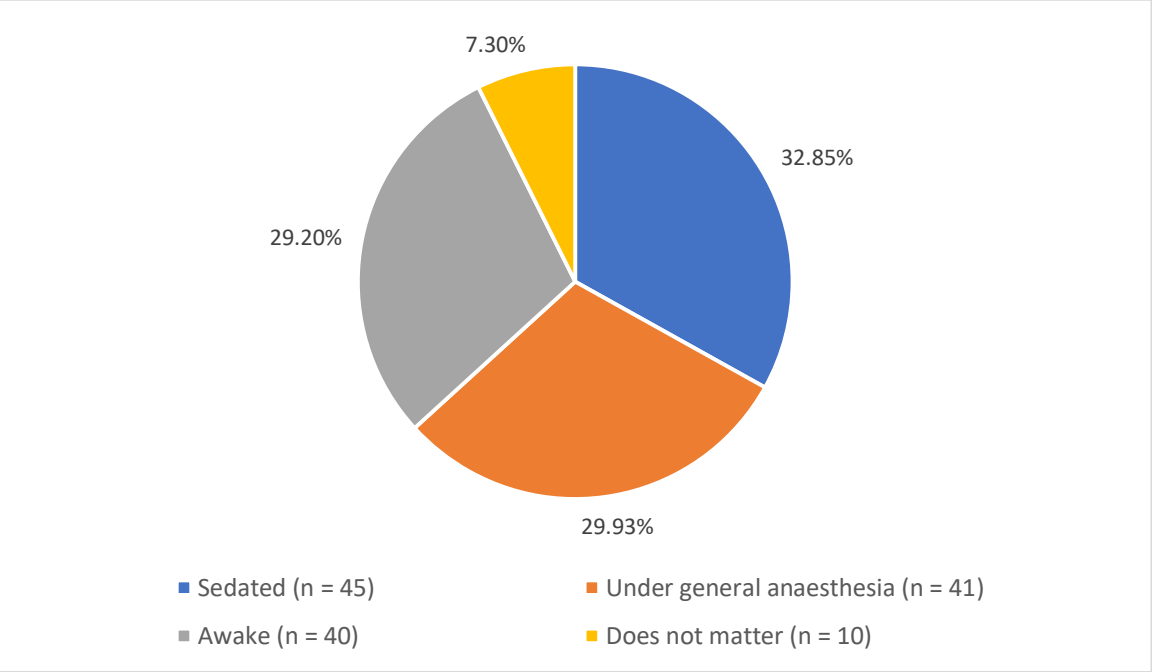


Figure 4.10: Preferred state of the patient during performance of a block

4.3.16 Aseptic precautions

Figure 4.11 shows the variety of aseptic precautions normally taken by the respondents when performing blocks. All 137 respondents who performed blocks answered this question. More than one option could be selected. Eighty-four (61.31%) respondents felt that they were limited in their use of aseptic precautions, while 53 (38.69%) respondents felt that they were not limited. The respondents who felt limited stated distinct reasons for this. Their reasons included a lack of sterile basic packs, a lack of sterile gowns, a lack of sterile drapes, and the use of improvised sterile ultrasound probe covers.

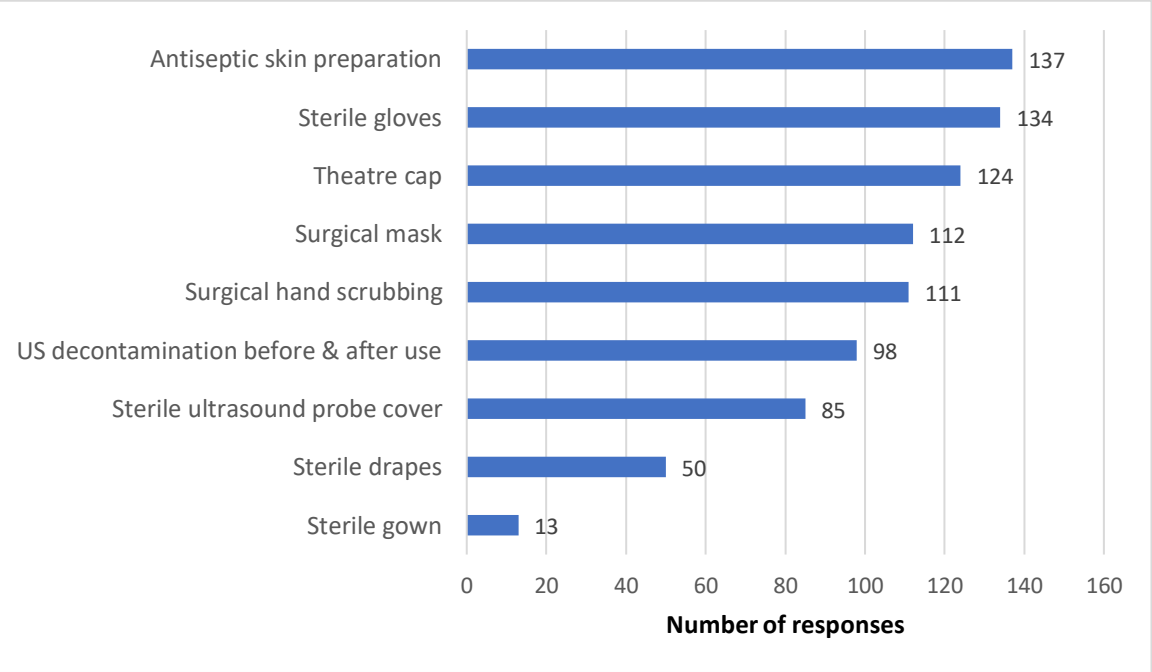


Figure 4.11: Aseptic precautions taken when performing a block

4.3.17 Preferred method of nerve localisation

Out of 137 respondents, 10 (7.30%) indicated that their preferred method of nerve localisation is a peripheral nerve stimulator (PNS), 35 (25.55%) respondents preferred ultrasound (US), while 92 (67.15%) respondents preferred a combination of PNS with US. This is shown in Figure 4.12.

The preferred method of nerve localisation was compared among the professional levels. A Pearson Chi-Square test showed that no statistically significant difference existed between the groups ($p = 0.437$).

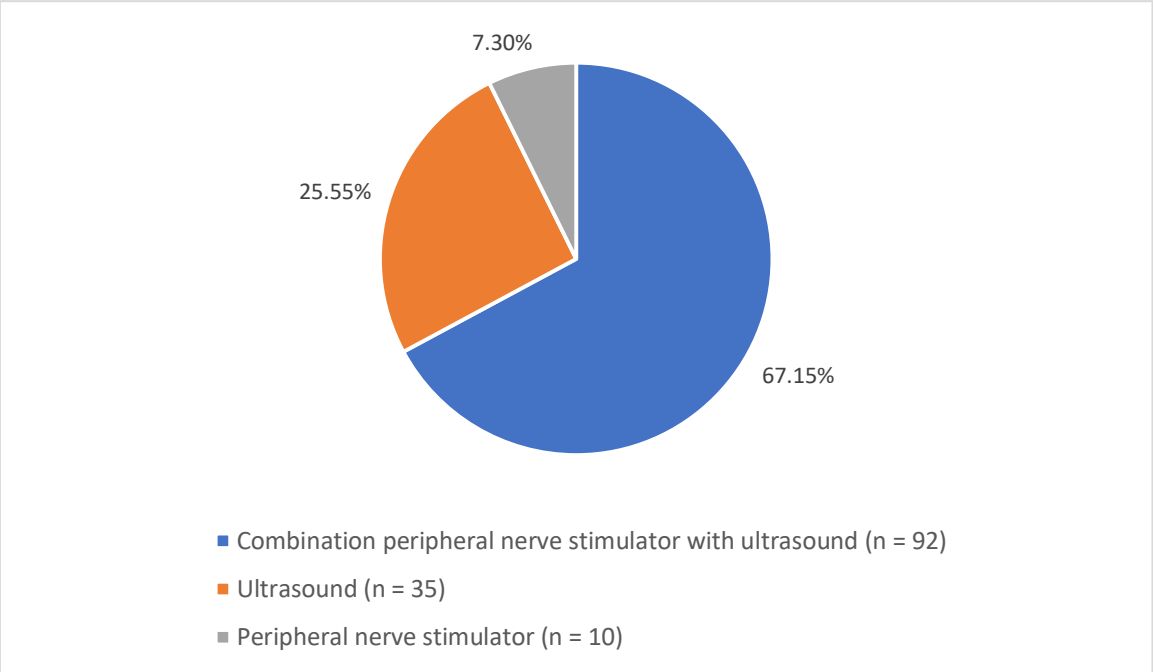


Figure 4.12: Preferred method of nerve localisation

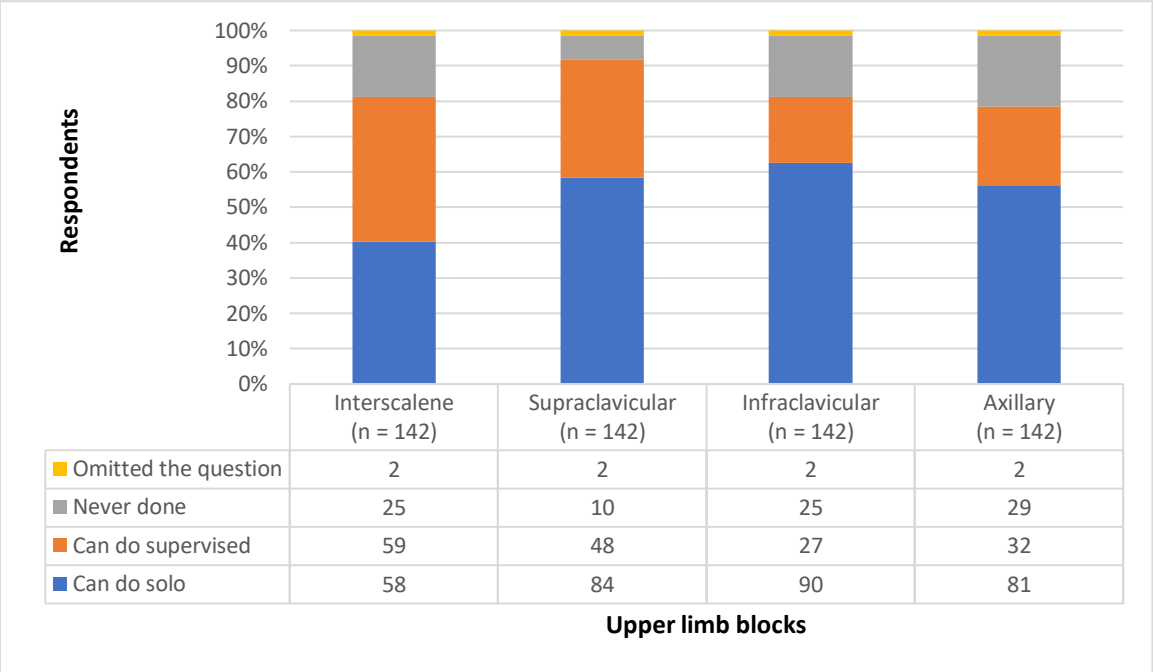
4.3.18 Action taken following inadequate block

When requested to indicate what action they would take if a block was considered to provide inadequate analgesia by the time the patient was in the recovery room, 124 of 137 (90.51%) respondents would administer intravenous analgesia, while 13 (9.49%) respondents would perform alternative rescue blocks.

4.3.19 Experience with blocks

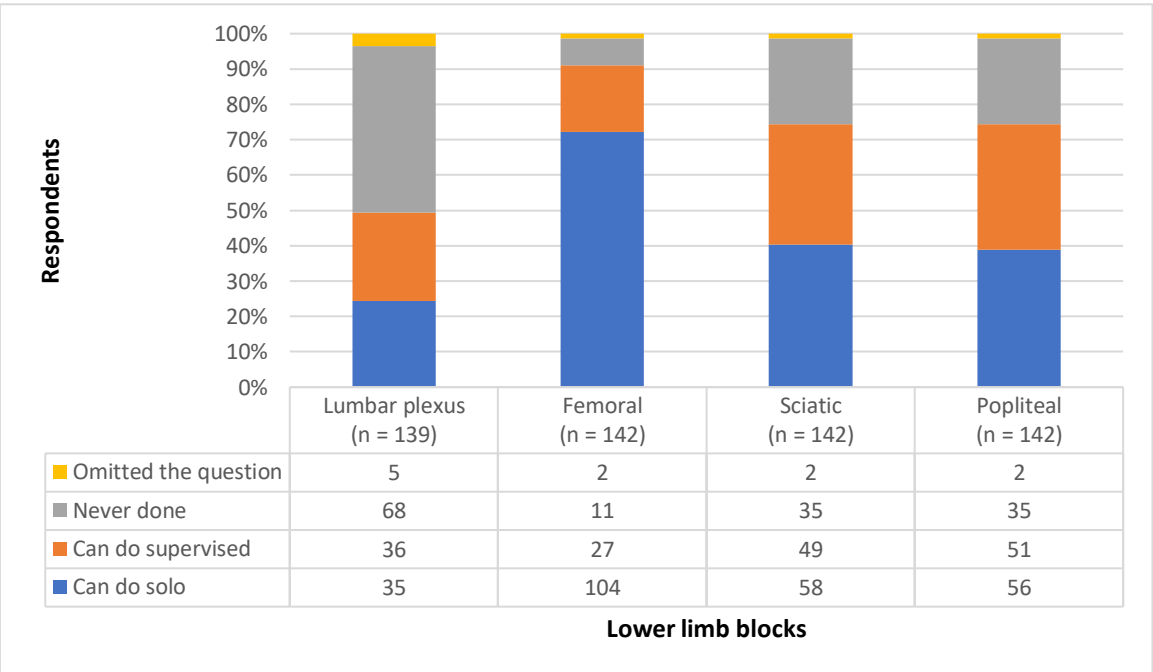
All respondents were requested to indicate their level of experience with a selection of common upper and lower limb blocks. Experience was divided into three categories: never done, can do supervised, and can do solo. Of 144 respondents, two omitted this question. The results for upper limb blocks are shown in Figure 4.13, and the results for lower limb blocks are shown in Figure 4.14.

Pearson Chi-Square tests showed that the difference in experience between junior and senior anaesthetists for upper and lower limb blocks were statistically significant (p=0.001).



	Interscalene (n = 142)	Supraclavicular (n = 142)	Infraclavicular (n = 142)	Axillary (n = 142)
Omitted the question	2	2	2	2
Never done	25	10	25	29
Can do supervised	59	48	27	32
Can do solo	58	84	90	81

Figure 4.13: Experience with upper limb blocks



	Lumbar plexus (n = 139)	Femoral (n = 142)	Sciatic (n = 142)	Popliteal (n = 142)
Omitted the question	5	2	2	2
Never done	68	11	35	35
Can do supervised	36	27	49	51
Can do solo	35	104	58	56

Figure 4.14: Experience with lower limb blocks

4.3.20 Access to nerve localisation devices

Regarding the availability of nerve localisation devices, all 137 eligible respondents indicated that their departments have both a peripheral nerve stimulator and an ultrasound. When requested to describe how often they have access to each device when they want to use them, their response could be: always, often, sometimes, seldom, or never. Their access to these devices is shown in Figure 4.15.

Sixty-six (48.18%) respondents indicated that they always have access to a PNS, while 51 (37.23%) respondents indicated that they always have access to an US. Forty-seven (34.30%) respondents indicated that they often have access to a PNS, while 44 (32.12%) respondents indicated that they often have access to an US. Twenty-three (16.79%) respondents indicated that they sometimes have access to a PNS, while 41 (29.93%) respondents indicated that they sometimes have access to an US. One (0.73%) respondent indicated that they seldom have access to an US. One (0.73%) respondent indicated that they never have access to a PNS.

Figure 4.16 shows access to peripheral nerve stimulator by professional designation, and Figure 4.17 shows access to ultrasound by professional designation. A Pearson Chi-Square test showed that no statistically significant difference exists among the professional levels for access to a peripheral nerve stimulator ($p = 0.091$), but that a statistically significant difference exists for access to ultrasound ($p=0.001$).

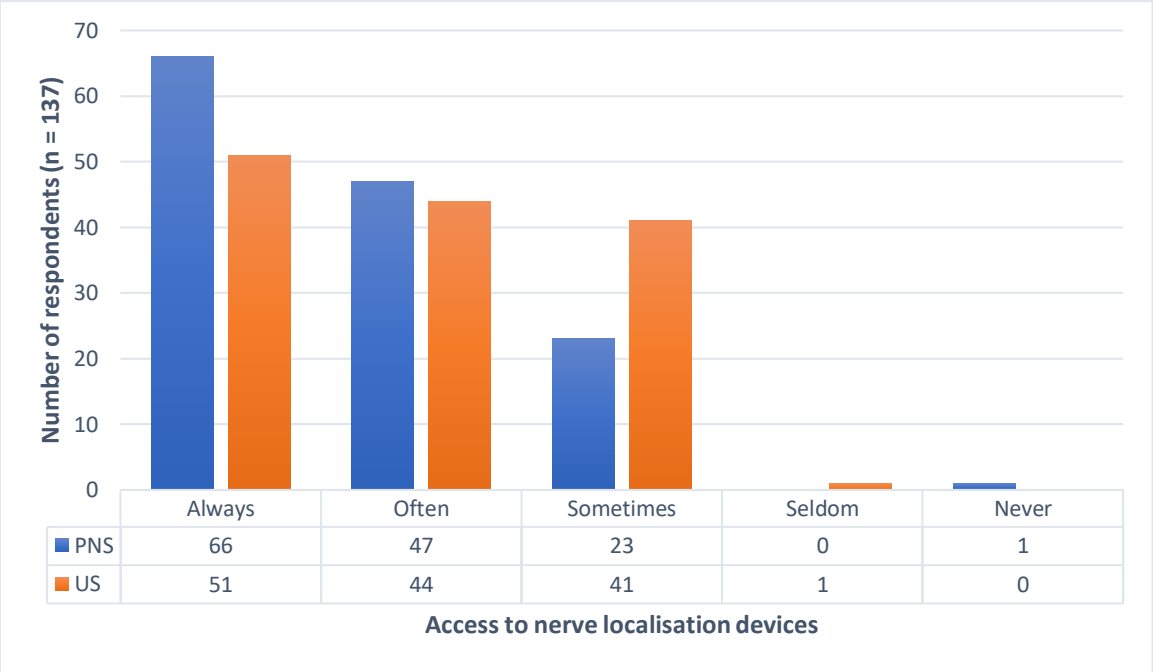


Figure 4.15: Access to nerve localisation devices

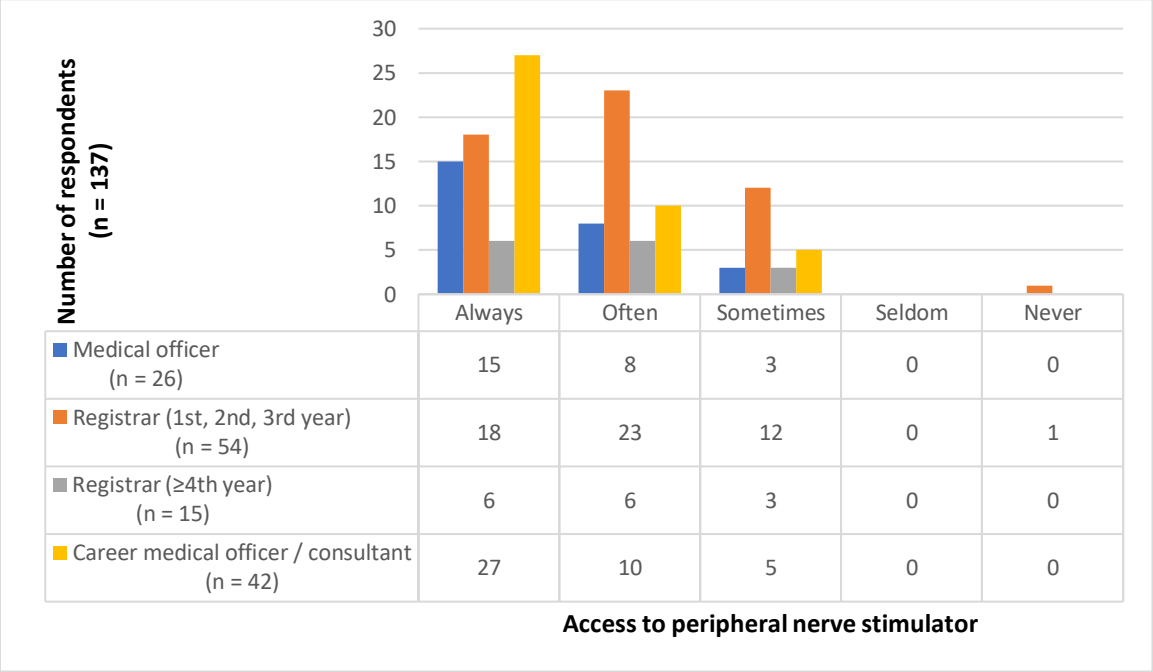


Figure 4.16: Access to peripheral nerve stimulator (PNS) by professional designation

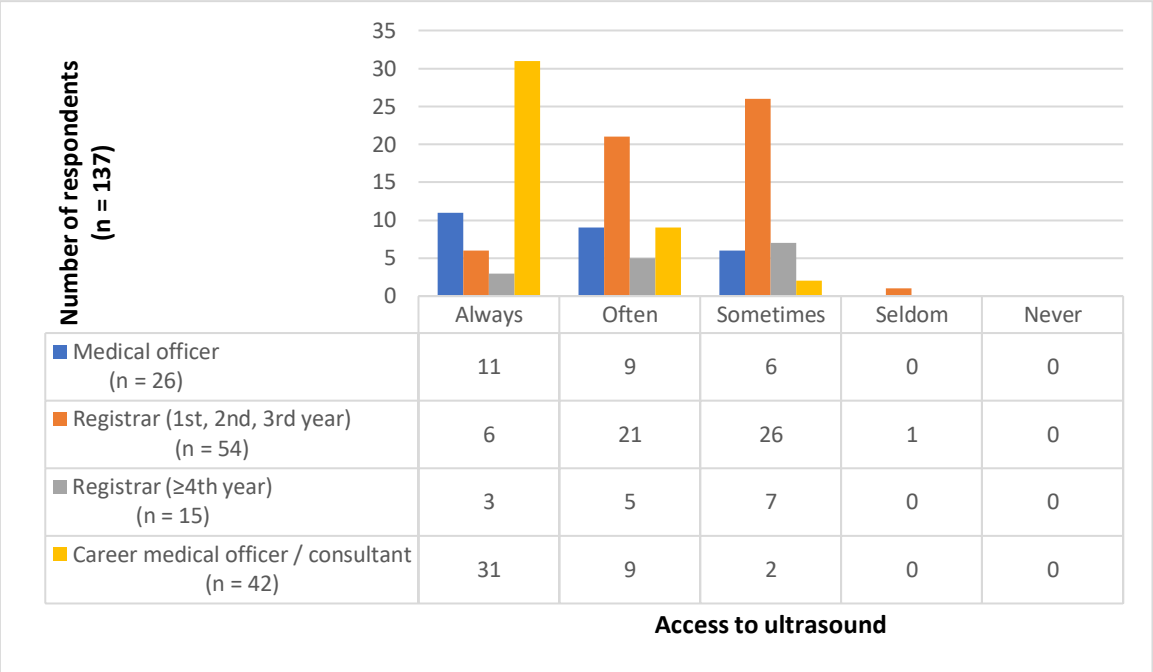
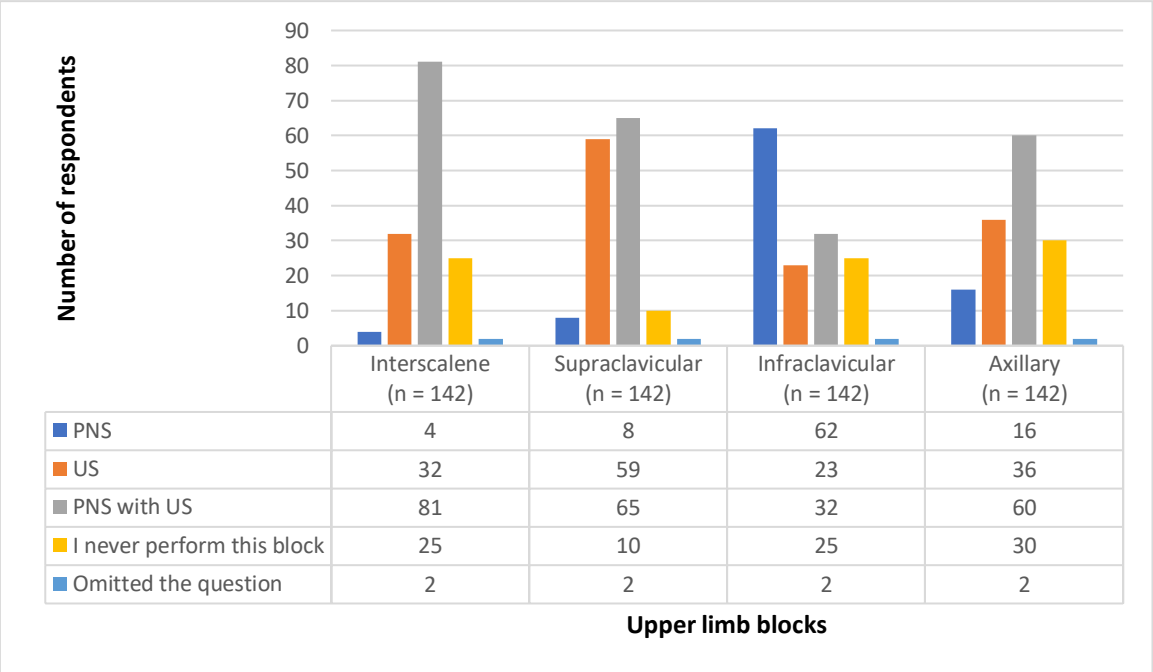


Figure 4.17: Access to ultrasound (US) by professional designation

4.3.21 Nerve localisation technique normally used

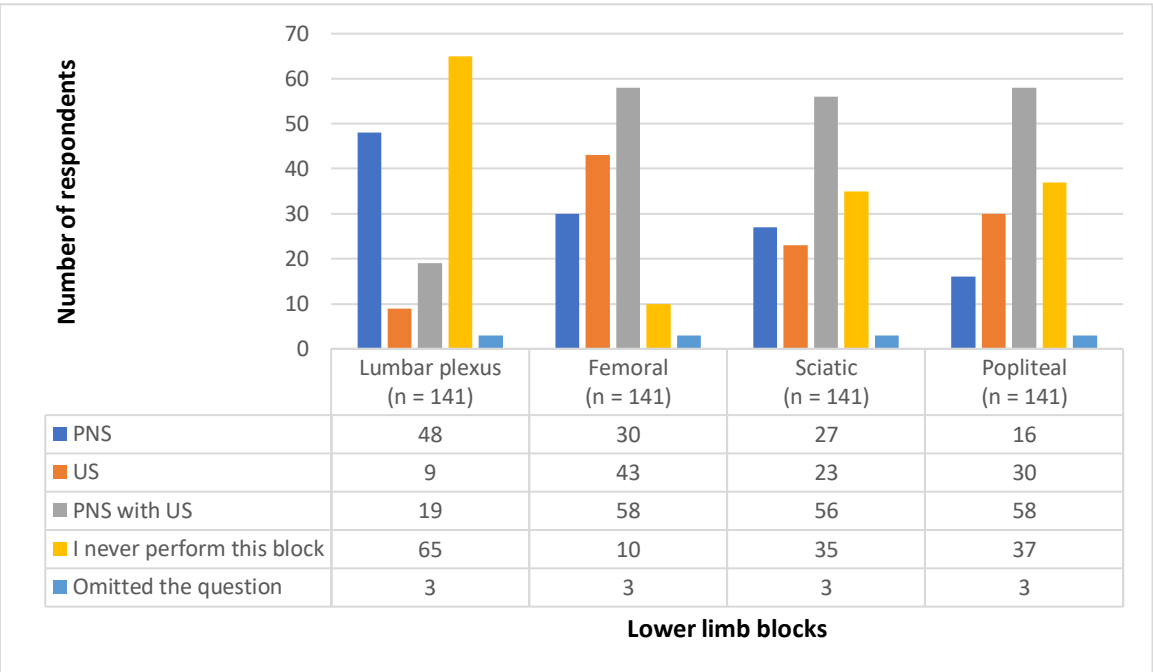
Respondents were requested to indicate which nerve localisation technique they normally employed for a selection of common upper and lower limb blocks. The responses are shown in Figures 4.18 and 4.19.

These data were compared by professional designation by means of Pearson Chi-Square tests. The differences found were statistically significant for interscalene brachial plexus blocks (p=0.008), axillary brachial plexus blocks (p=0.001), lumbar plexus blocks (p=0.001), femoral nerve blocks (p=0.024), sciatic nerve blocks (p=0.002), and popliteal blocks (p=0.001).



	Interscalene (n = 142)	Supraclavicular (n = 142)	Infraclavicular (n = 142)	Axillary (n = 142)
PNS	4	8	62	16
US	32	59	23	36
PNS with US	81	65	32	60
I never perform this block	25	10	25	30
Omitted the question	2	2	2	2

Figure 4.18: Preferred nerve localisation techniques for upper limb blocks

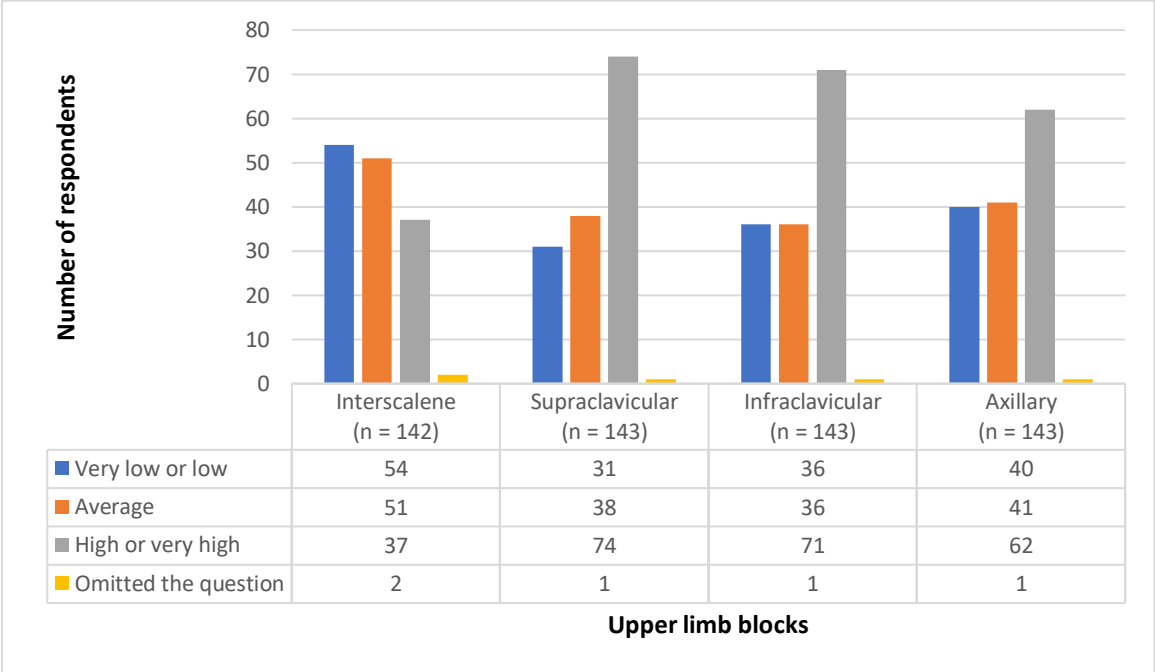


	Lumbar plexus (n = 141)	Femoral (n = 141)	Sciatic (n = 141)	Popliteal (n = 141)
PNS	48	30	27	16
US	9	43	23	30
PNS with US	19	58	56	58
I never perform this block	65	10	35	37
Omitted the question	3	3	3	3

Figure 4.19: Preferred nerve localisation techniques for lower limb blocks

4.3.22 Level of confidence with blocks

Respondents were requested to indicate their level of confidence with a selection of common upper and lower limb blocks. The responses are shown in Figures 4.20 and 4.21. Pearson Chi-Square tests showed that the difference in level of confidence between junior and senior anaesthetists for upper and lower limb blocks were all statistically significant ($p<0.05$). The contrast between the level of confidence of junior anaesthetists (medical officers and 1st, 2nd, 3rd year registrars) and senior anaesthetists (≥4th year registrars and career medical officers and consultants) is shown in Figures 4.22 and 4.23.



	Interscalene (n = 142)	Supraclavicular (n = 143)	Infraclavicular (n = 143)	Axillary (n = 143)
Very low or low	54	31	36	40
Average	51	38	36	41
High or very high	37	74	71	62
Omitted the question	2	1	1	1

Figure 4.20: Level of confidence with upper limb blocks

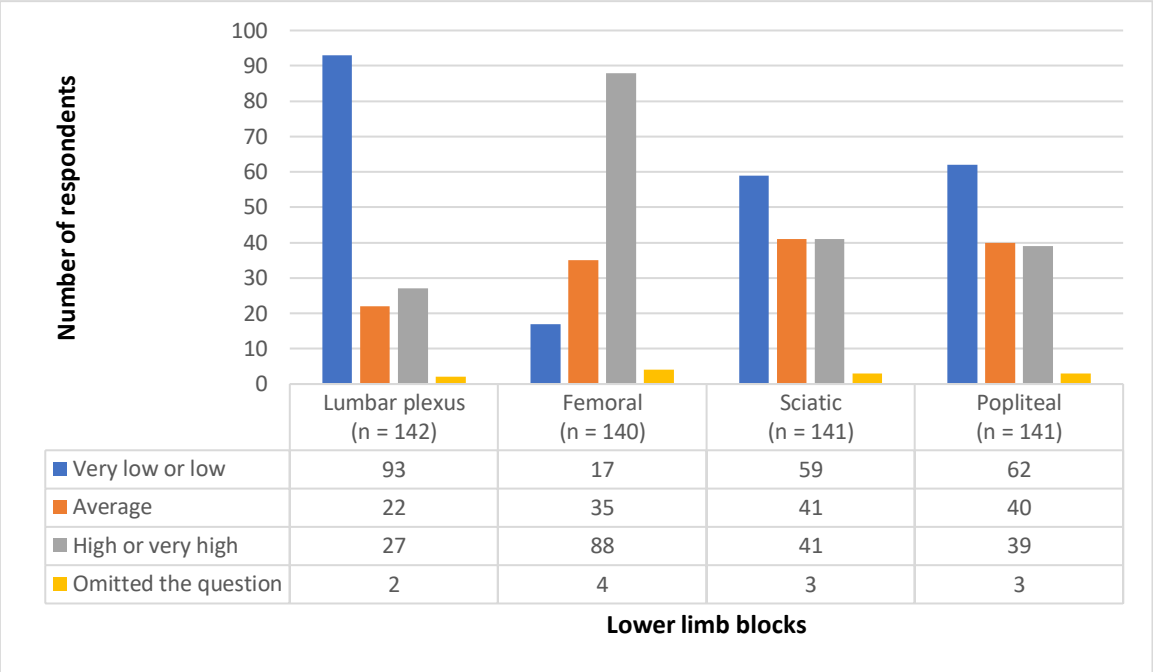


Figure 4.21: Level of confidence with lower limb blocks

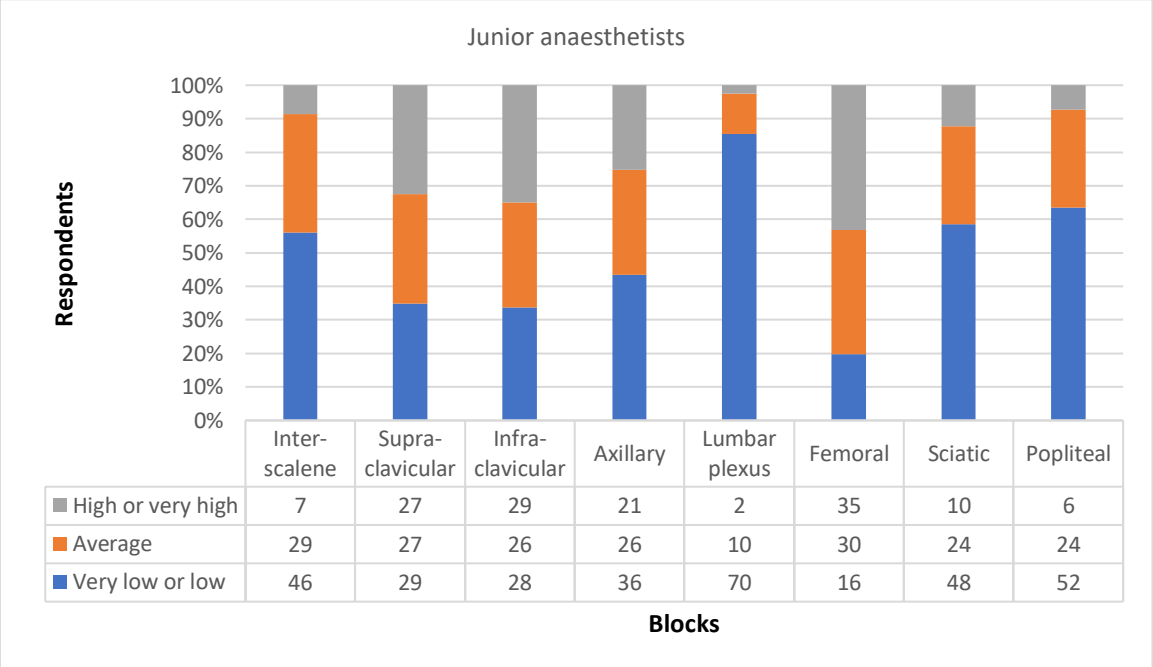


Figure 4.22: Level of confidence of junior anaesthetists

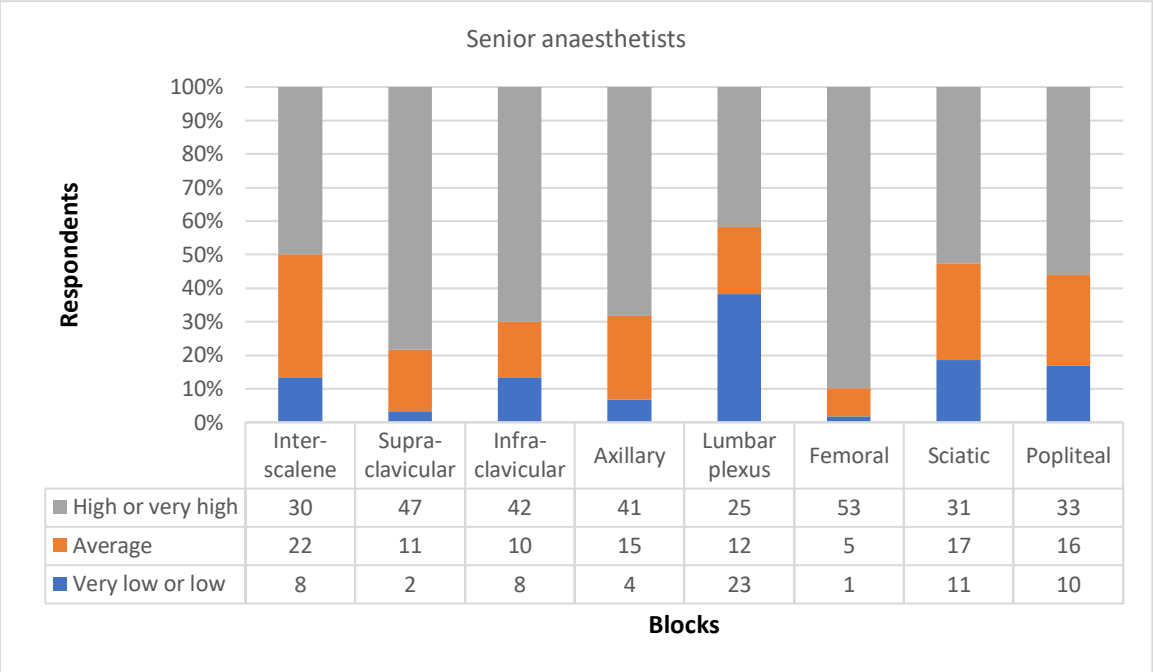


Figure 4.23: Level of confidence of senior anaesthetists

4.3.23 Patient follow-up after block

Regarding the follow-up of patients within 24 hours of surgery to assess their blocks, 23 (16.79%) respondents indicated that they always did this, 40 (29.20%) respondents indicated that they often did this, 42 (30.66%) respondents indicated that they sometimes did this, 25 (18.25%) respondents indicated that they rarely did this, and seven (5.11%) respondents indicated that they never did this. This is shown in Figure 4.24. Some of the respondents who rarely or never followed up their patients did indicate, however, that their institution had a system in place whereby someone else would perform the follow-up.

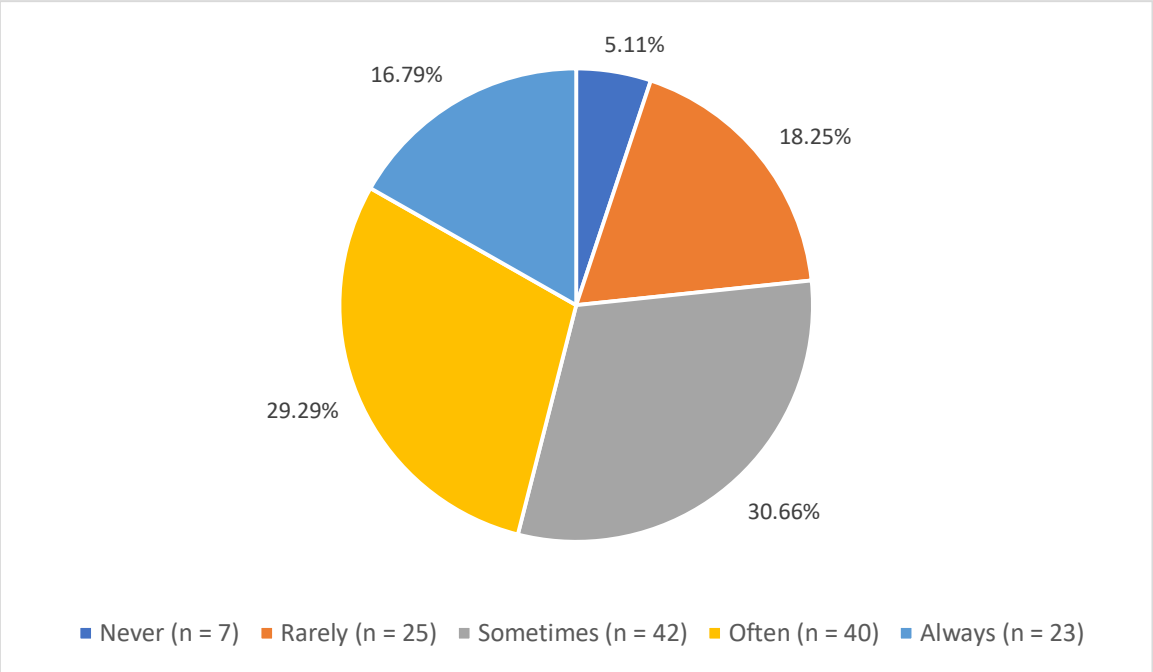


Figure 4.24: Follow-up of patients after a block

4.3.24 Adequacy of training in limb blocks

Respondents were requested to indicate whether they have received formal training in limb blocks. Of 144 respondents, 143 (99.31%) completed this question, with 66 (46.15%) respondents indicating that they had received formal training, and 77 (53.85%) respondents indicating that they had not. Forty-nine out of 143 (34.27%) respondents had undertaken training outside of the Wits Department of Anaesthesiology. Of 142 respondents, 102 (71.83%) felt that they had not yet received sufficient training in peripheral limb blocks. This is shown in Figure 4.25.

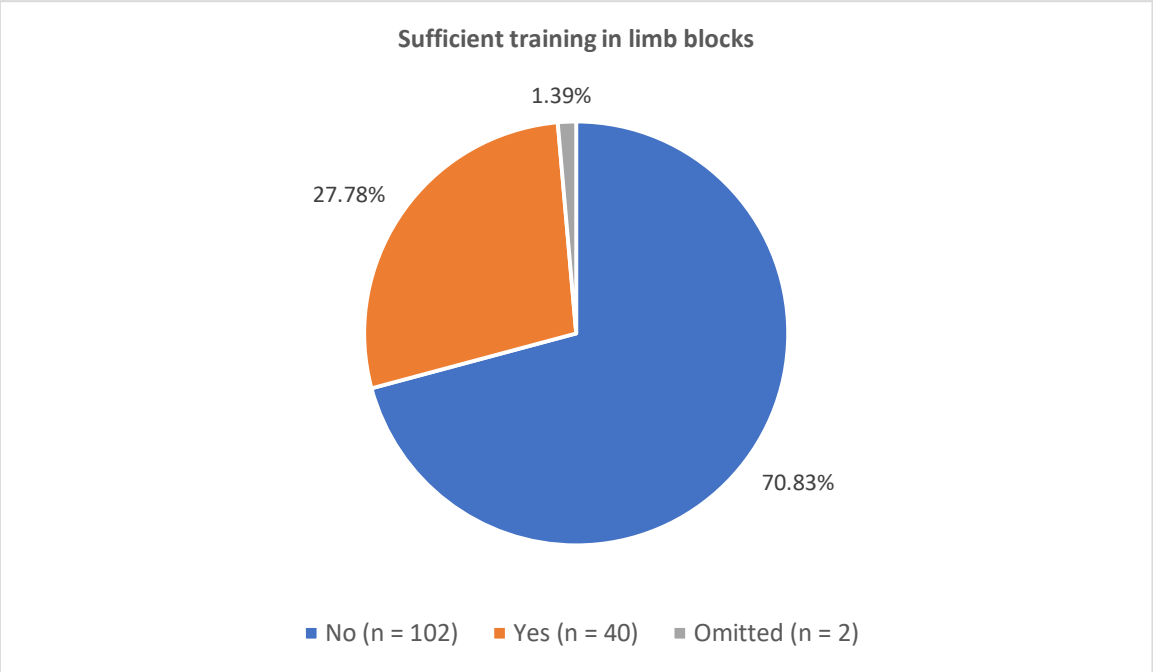


Figure 4.25: Self-rated adequacy of training in peripheral limb blocks

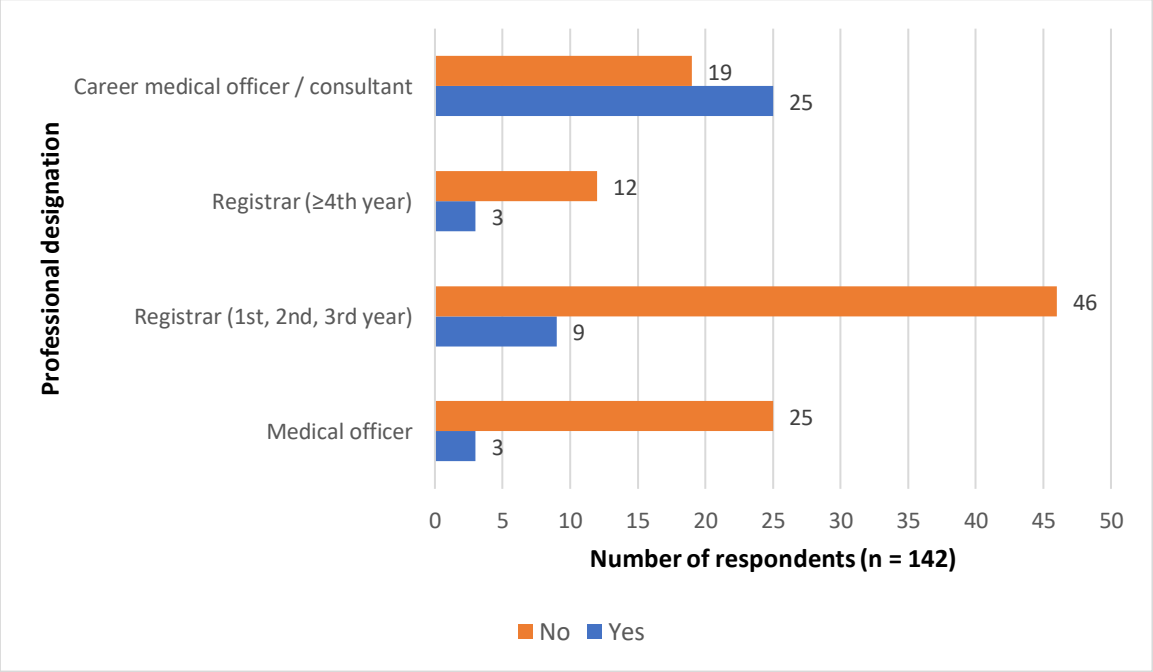


Figure 4.26: Self-rated adequacy of training in peripheral limb blocks by professional designation

When asked how they thought their skills and confidence could be improved, several different responses were given. The most common responses were: by performing more blocks, with more formal training, with more supervised practice opportunities, and with a regional anaesthesia rotation. Other responses included: with more equipment, with regular workshops, and with a less pressurised environment.

4.4 Discussion

A convenience sampling method was used in this study, and 165 (65.75%) of the approximately 219 anaesthetists in the Department of Anaesthesiology at Wits were reached at departmental academic meetings over the study period. Of the 165 questionnaires distributed, 144 (87.27%) were returned and were evaluated. This number exceeded the sample size of 131 participants (60% of the department) that was considered adequate. The reasons for not being able to distribute a larger number of questionnaires include anaesthetists not attending academic meetings or declining to participate in the study.

Registrars with three years or less of training (n = 56), and career medical officers and consultants (n = 45) formed the two largest groups within the study sample. They represented 38.89% and 31.25% of the total number of 144 respondents, respectively.

Most anaesthetists (n = 142, 98.61%) indicated that they had anaesthetised adult patients for upper or lower limb surgery in the preceding year, with most of these anaesthetists having done from 21 to 50 cases.

Most anaesthetists (n = 137, 95.14%) indicated that they had performed upper or lower limb peripheral nerve blocks on adult patients in the preceding year, with most of these anaesthetists having done from 6 to 10 or from 11 to 20 blocks in the preceding year.

Most anaesthetists (n = 58, 42.34%) indicated that they only sometimes performed a peripheral nerve block for limb surgery where one could be performed, while a similar but smaller number of anaesthetists (n = 55, 40.15%) indicated that they often performed a block. No statistically significant difference was found between the groups when professional level was compared with how often blocks were performed.

The most common barrier to performing peripheral nerve blocks was time pressure, 113 (82.48%) anaesthetists. Other common barriers were preference of the surgeon, 72 (52.55%); a lack of confidence, 67 (48.91%); a lack of training, 50 (36.50%); and a lack of supervision, 43 (31.39%).

These results echo the results from studies conducted in other countries. A study conducted in the United States found a lack of training and concerns over surgical delays or decreases in operating room efficiency to be important limitations to performing regional anaesthesia[14]. A lack of training was the major barrier to regional anaesthesia in a study conducted in Chile[12]. Inadequate training and a lack of equipment were common barriers in a study conducted in Greece[9]. A lack of skill was the major barrier to regional anaesthesia in a study conducted in Nigeria[10].

It has been recognised that the consent process for anaesthesia in government hospitals is frequently an informal interaction between the anaesthetist and the patient[25]. While no observations can be made about the amount or depth of information communicated, it is still worth noting that all the anaesthetists who perform regional anaesthesia indicated that they obtain consent from the patient, whether verbal (n = 128, 93.43%), or verbal and written (n = 9, 6.57%).

It is not surprising to note, with most anaesthetists (n = 101, 73.72%) indicating that they normally perform blocks in the operating theatre, that time pressure was cited as the most common barrier to the performance of regional anaesthesia. Performing regional anaesthesia in a block room or holding area, in parallel with surgical procedures in the operating theatre, as a part of a structured regional anaesthesia training programme, has been shown to have numerous benefits[14, 17].

Significantly fewer anaesthetists indicated that they perform blocks in a block area or in the recovery room. The reasons for this may be twofold: firstly, most of the theatre complexes on the Wits anaesthesia circuit do not have a dedicated procedure area, and secondly, there would typically be not be enough anaesthetists to perform regional anaesthesia in a dedicated area and to monitor patients simultaneously under anaesthesia in theatre.

While most anaesthetists (n = 109, 79.56%) indicated that they use the recommended minimum monitoring (NIBP, ECG, SpO_2) when performing blocks, a sizeable number (n = 28, 20.44%) do not. The reasons for this are not known, but may include unfamiliarity with the SASA Guidelines for Regional Anaesthesia in South Africa[31], or a lack of available equipment.

The minimum duration of monitored care of the patient immediately after performing a block is related to an awareness of the possible delayed onset of LAST, and of other immediate complications that may arise undetected if the patient is not adequately monitored in the critical 30 to 60 minutes after block placement. The SASA Guidelines for Regional Anaesthesia in South Africa state that the practitioner must be present until the block is fully established, or must hand over the care of the patient to a competent anaesthetist[31]. Most anaesthetists (n = 115, 83.94%) indicated that they would monitor the patient for at least 30 minutes, which is appropriate.

Resuscitation of cardiac arrest in a patient with LAST may be prolonged. Resuscitation should follow universally recognised resuscitation protocols, but with the additional use of intravenous lipid emulsion. The SASA guidelines place the responsibility of ensuring the immediate availability of equipment and drugs needed for the management and prevention of complications relating to the procedure with the practitioner. They state that readily available lipid emulsion is mandatory in centres using bupivacaine, levobupivacaine and ropivacaine[31]. It would be desirable, therefore, for all anaesthetists performing regional anaesthesia to know where to obtain it in their theatre complex, to know how to recognise the signs of severe toxicity, and how to approach the immediate management and further treatment of toxicity.

It is concerning, therefore, that 10 anaesthetists indicated that lipid emulsion was not readily available in their theatre complex, while 27 anaesthetists did not know; and that 44 (32.12%) anaesthetists indicated that they did not feel confident in the management of LAST.

The state of the patient during performance of a block remains a controversial issue. Eighty-five (62.50%) anaesthetists indicated that they prefer the patient to be awake or sedated, while only 51 (37.50%) anaesthetists indicated that they prefer the patient to be under general anaesthetic or that the state of the patient does not matter. A survey conducted among consultants, non-consultant career-grade anaesthetists, and registrars in the United Kingdom, published in 2001, showed that 70% of respondents felt that it was safer to perform peripheral limb blocks in an awake patient, but that in practice fewer than 32% routinely performed peripheral blocks before general anaesthesia[28]. These results would seem to indicate that a greater percentage of anaesthetists at Wits would perform peripheral limb blocks in anaesthetised patients, compared to their counterparts in the United Kingdom. Local guidelines recommend (but acknowledge that it is not mandatory) that blocks be performed on awake patients, with the optional addition of light sedation[31]. Where complications related to regional anaesthesia have occurred in patients under general anaesthesia, it could not be concluded whether the complications would have been avoided had the patients been awake[31].

Infectious complications related to regional anaesthesia are uncommon.[30, 31] Hand hygiene and effective skin preparation, preferably with alcohol-based chlorhexidine solutions, are the strongest recommendations for preventing infection[30, 31]. Not all anaesthetists indicated that they do surgical hand scrubbing (n = 111, 81.02%) or use sterile gloves (n = 134, 97.81%), but all anaesthetists indicated that they perform antiseptic skin preparation (n = 137, 100%). In the Wits setting, there is frequently no choice of antiseptic agents for skin preparation for regional anaesthesia. Chlorhexidine 0.5% in alcohol 70% is the most commonly available agent. Povidone iodine 10% aqueous solution is used less commonly.

Maximum barrier precautions are generally not necessary for single-injection peripheral nerve blocks[30, 31]. This is reflected by fewer anaesthetists indicating the use of sterile gowns (n = 13, 9.49%) and drapes (n = 50, 36.50%). Of concern, however, are the relatively small number of anaesthetists indicating that they decontaminate the ultrasound before and after use (n = 98, 71.53%), and who use a sterile ultrasound cover (n = 85, 62.04%), since these are both recommended practices[30, 31]. Commercially available sterile ultrasound covers are not available in the Wits setting, therefore improvised sterile covers may be used.

Nerve localisation in regional anaesthesia has evolved over the past four decades, from techniques using either landmarks or patient-reported sensations of paraesthesia prior to the 1980s, to methods using peripheral nerve stimulation in the 1980s, to ultrasound guidance in the early 2000s[56]. The preferred method of nerve localisation of the anaesthetists in this study most closely resemble recent studies conducted in the United States and Chile, in which ultrasound-guided or combined techniques were more prevalent than peripheral nerve stimulation techniques[6, 20]. Earlier studies conducted in Chile and Nigeria reported peripheral nerve stimulation techniques to be the most common, as did later studies conducted in Greece and Turkey, which showed limited ultrasound use[9-12]. The earlier study from Chile and the study from Nigeria did not report the use of ultrasound at all.

Of the upper limb blocks included in this study, the interscalene brachial plexus block could be performed independently by the least number of anaesthetists (n = 58, 40.85%). It is also the block that the greatest number of anaesthetists would want supervision to perform (n = 59, 41.55%). The greatest number of anaesthetists reported low or very low confidence levels with this block (n = 54, 38.03%). A possible explanation for this may be that the interscalene brachial plexus block has very specific indications, being particularly useful for shoulder and upper arm surgery[57].

The supraclavicular (n = 84, 59.15%) and infraclavicular (n = 90, 63.38%) approaches could be performed independently by the greatest number of anaesthetists. The greatest number of anaesthetists reported high or very high confidence levels with these blocks, (n = 74, 51.75%) and (n = 71, 49.65%), respectively. The supraclavicular and infraclavicular brachial plexus blocks are versatile, and may be used for any surgery distal to the shoulder and the axilla[57], respectively. The axillary approach could be performed independently by a similar number of anaesthetists (n = 81, 57.07%), but was the upper limb block that the greatest number of anaesthetists had never performed (n = 29, 20.42%). The axillary brachial plexus block is useful for surgery on the elbow or below[57], where one could opt for the supraclavicular or infraclavicular approach instead. These findings are in contrast with the findings of a survey conducted at four academic hospitals in Canada[58]. This survey found that the interscalene brachial plexus block was performed by a substantial proportion of anaesthesiologists (45%). The axillary brachial plexus block (32%), supraclavicular brachial plexus block (14%), and infraclavicular brachial plexus block (14%) were performed by fewer anaesthesiologists[58].

Of the lower limb blocks included in this study, the lumbar plexus block could be performed independently by the least number of anaesthetists (n = 35, 25.18%). It is also the block that the greatest number of anaesthetists had never performed (n = 68, 48.92%). The greatest number of anaesthetists reported low or very low confidence levels with this block (n = 93, 65.49%). A possible explanation for this may be that it shares many indications with the femoral nerve block, as the femoral nerve is the largest branch of the lumbar plexus. The lumbar plexus block is a deep block, performed with the patient in the lateral position. By contrast, the femoral nerve block is a superficial block, technically easier to perform, and is performed with the patient in the supine position. Both blocks are useful for hip, anterior thigh, and knee procedures[57].

The femoral nerve block could be performed independently by the greatest number of anaesthetists (n = 104, 73.24%), and was the lower limb block that the least number of anaesthetists would need supervision to perform (n = 27, 19.01%). It was also the block that the least number of anaesthetists had never performed (n = 11, 7.75%). The greatest number of anaesthetists reported high or very high confidence levels with this block (n = 88, 62.86%).

A nationwide survey among residents in anaesthesiology training programmes in the United States showed the following results among senior residents: 49% were not confident with the interscalene brachial plexus block, 76% were not confident with the sciatic nerve block, and 61% were not confident with the femoral nerve block[18]. A later study among senior residents in the United States found the following: 9% were not confident with the interscalene brachial plexus block, 22% were not confident with the axillary brachial plexus block, 68% were not confident with the lumbar plexus block, 7% were not confident with the femoral nerve block, 24% were not confident with the sciatic nerve block, and 8% were not confident with the popliteal block[6]. In comparison, the percentage of senior registrars with low or very low confidence in this study were as follows: the interscalene brachial plexus block 20%, the axillary brachial plexus block 20%, the lumbar plexus block 66.67%, the femoral nerve block 0%, the sciatic nerve block 33.33%, and the popliteal block 33.33%. Senior registrars at Wits, therefore, seem to be less confident than their counterparts in the United States when performing the interscalene brachial plexus block and the popliteal block. Senior registrars at Wits and senior residents in the United States seem to have a similar lack of confidence when performing the axillary brachial plexus block, the lumbar plexus block, the femoral nerve block, and the sciatic nerve block. Both groups were the least confident with the lumbar plexus block.

Although all anaesthetists indicated that their departments have both peripheral nerve stimulators and ultrasound, they did not always have access to these devices when they needed to use them. Less than half of the anaesthetists indicated that they always had access to a nerve stimulator or ultrasound when they wanted to use them.

Interestingly, only 39 of 137 (28.47%) anaesthetists indicated a lack of equipment as a reason for not performing blocks as often as they could. A recent report on regional anaesthesia in Greece found that a lack of the necessary equipment was a major limitation to regional anaesthesia application, reported by 58.23% of their respondents[9]. The difference in the availability of nerve stimulators between professional levels was not found to be statistically significant, while the difference in the availability of ultrasound between professional levels was found to be statistically significant. There is a major difference between the 73.80% (n = 31) of career medical officers and consultants who indicated that they always have access to an ultrasound when they want to use it, and the 11.32% (n = 6) registrars (1st, 2nd, 3rd year), especially considering that 42 career medical officers and consultants, and 53 junior registrars, were included in this analysis. Reasons for this discrepancy may be that expensive equipment is locked away for safety, with the more senior members of staff having preferential access.

The combination of peripheral nerve stimulation with ultrasound was shown to be the most commonly used nerve localisation technique for all the upper limb blocks except the infraclavicular approach. The infraclavicular approach was traditionally performed using a nerve stimulator, and it remains a simple and reliable way to achieve anaesthesia or analgesia of the distal arm, elbow, forearm, wrist, and hand[57].

The combination of peripheral nerve stimulation with ultrasound was shown to be the most commonly used nerve localisation technique for all the lower limb blocks except the lumbar plexus block. The lumbar plexus block is traditionally performed using surface anatomical landmarks and nerve stimulation. A technique using a combination of nerve stimulation with ultrasound has more recently been described, but it is challenging because it is a deep block and the lumbar plexus is covered by the transverse processes of the lumbar vertebrae which create an acoustic shadow[59]. A recent study in the United States also found that ultrasound-guided techniques were utilised more frequently than nerve stimulator-guided techniques, with the exception of the lumbar plexus block[6].

A large number of anaesthetists indicated insufficient training in limb blocks. Overall, 70.83% (n = 102) of anaesthetists indicated that they had not received sufficient training in limb blocks. Of these, 25 (24.51%) were medical officers, 46 (45.10%) were registrars (1st, 2nd, 3rd year), 12 (11.76%) were registrars (≥4th year), and 19 (18.63%) were career medical officers and consultants. These numbers represented 89.23% of all medical officers, 83.64% of all registrars (1st, 2nd, 3rd year), 80% of all registrars (≥4th year), and 43.18% of all career medical officers and consultants in this study. In contrast, a recent study in the United States showed that only 12% of residents were not satisfied with the peripheral nerve block training received during residency. The remaining residents were somewhat satisfied (9%), and mostly satisfied or very satisfied (79%)[6]. An earlier survey among anaesthesiologists in the United States revealed that 51.1% rated their training in peripheral nerve blocks as adequate, while 48.9% rated their training in peripheral nerve blocks as inadequate[3]. These results would seem to indicate that Wits anaesthesiology trainees are less satisfied with their training in limb blocks than their counterparts in the United States. A study among anaesthesiologists in Nigeria found that 89% of respondents rated their exposure to peripheral nerve blocks during their residency training as poor and in need of more education[10], which more closely resembles the findings of this study.

4.5 Summary

This chapter presented an analysis of the results of this study, in accordance with the study objectives. The following chapter presents a final summary, recommendations, limitations, and the conclusion of this study.

CHAPTER FIVE

SUMMARY, LIMITATIONS, RECOMMENDATIONS, AND CONCLUSION

5.1 Introduction

This chapter will briefly review the purpose, objectives, study design, and results of this study. The limitations of this study will be addressed, recommendations will be made, and a conclusion presented.

5.2 Summary of the study

5.2.1 Aim of the study

The aim of this study was to describe the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery in the Department of Anaesthesiology at the University of the Witwatersrand.

5.2.2 Objectives of the study

The primary objectives of this study were to:

- describe the current practice of procedural aspects related to peripheral nerve blocks.
- describe the experiences of anaesthetists of peripheral nerve blocks for limb surgery.
- describe the perceived barriers to performing peripheral nerve blocks.

The secondary objectives of this study were to:

- compare the level of confidence in performing certain peripheral nerve blocks between junior and senior anaesthetists.
- describe the level of satisfaction with training in peripheral nerve blocks.

5.2.3 Summary of the methodology used in the study

Approval to conduct this study was obtained from the Human Research Ethics Committee (Medical) (Appendix 1) and the Postgraduate Committee of the University of the Witwatersrand (Appendix 2). Data collection started after receiving this approval.

A prospective, observational, cross-sectional study design was used. Anaesthetists working in the Department of Anaesthesiology at University of the Witwatersrand formed the study population.

A convenience sampling method was used. The sample size was realised from the number of respondents.

A questionnaire was developed by the researcher after an extensive literature review. This was followed by consultation with experts in the field of regional anaesthesia. Their suggestions were incorporated. Information letters (Appendix 3) and questionnaires (Appendix 4) were distributed at departmental academic meetings from March to June 2017. Questionnaires were completed anonymously. At the close of the meeting, the questionnaires were collected in a sealed box.

The questionnaire included demographic information; procedure and practice related questions; questions related to exposure, experience and confidence; and questions related to training. A selection of common upper and lower limb blocks was used. The upper limb blocks included were: interscalene, supraclavicular, infraclavicular, and axillary. The lower limb blocks included were: lumbar plexus, femoral, sciatic, and popliteal. Respondents who did not perform blocks at all could omit a series of practice-related questions.

Data from the questionnaires were entered in a Microsoft® Excel spreadsheet and analysed using IBM® SPSS® Statistics 24.0, in consultation with a statistician. Descriptive and inferential statistics were used.

5.2.4 Summary of the results

There are approximately 219 anaesthetists in the Department of Anaesthesiology affiliated to the Faculty of Health Sciences at the University of the Witwatersrand. Questionnaires were offered to anaesthetists, using a convenience sampling method at departmental academic meetings, over a four-month period. Questionnaires were distributed to 165 anaesthetists, and 144 questionnaires were returned and evaluated.

Only two anaesthetists indicated that they had not anaesthetised adult patients for upper or lower limb surgeries in the preceding year. Most anaesthetists (n = 103, 71.53%) who had anaesthetised these cases indicated that they had done 21 or more such cases in the preceding year. A large number of upper or lower limb peripheral nerve blocks were performed in the preceding year, with only seven anaesthetists indicated that they had not performed any.

The most common barrier to performing these blocks was time pressure (n = 113, 82.48%). Most anaesthetists indicated that they normally perform these blocks preoperatively (n = 136, 99.27%) in the operating theatre (n = 101, 73.72%). It is significant to note that a lack of confidence, a lack of training, and a lack of supervision were also among the most frequently cited barriers to performing peripheral nerve blocks.

While most anaesthetists met or exceeded the recommended minimum monitoring requirements when performing blocks, there were some anaesthetists (n = 21, 15.33%) who routinely employed inadequate monitoring.

An alarming number of anaesthetists practicing regional anaesthesia indicated that they would not feel confident in the management of local anaesthetic systemic toxicity (n = 44, 32.12%). Approximately twenty percent of respondents did not know whether intravenous lipid emulsion, a crucial adjunct in the management of LAST, was available in their theatre complex.

The state of the patient during the performance of regional anaesthesia remains a controversial issue. This was reflected by the fact that anaesthetists were almost evenly divided in their preferences; the awake patient (n = 40, 29.20%), the sedated patient (n = 45, 32.85%), and the patient under general anaesthesia (n = 41, 29.93%).

It is concerning that many anaesthetists (n = 84, 61.31%) felt that they were limited in their use of aseptic precautions for regional anaesthesia. All anaesthetists routinely performed antiseptic skin preparation. Other recommended infection control precautions such as surgical hand scrubbing, sterile gloves, a theatre cap, and a surgical mask were not routinely implemented by all anaesthetists.

A combination of peripheral nerve stimulator and ultrasound was the preferred method of nerve localisation for the majority of anaesthetists (n = 92, 67.15%). A smaller number preferred to use ultrasound only (n = 35, 25.55%), and even fewer preferred a PNS only (n = 10, 7.30%). Access to ultrasound seemed to be problematic, with career medical officers and consultants having more frequent access than registrars and medical officers.

Senior anaesthetists were more confident in performing both upper and lower limb blocks than their junior colleagues. Both groups were the least confident with lumbar plexus blocks, and the most confident with femoral nerve blocks, which are both lower limb blocks. For upper limb blocks, junior anaesthetists were the most confident with the infraclavicular approach to the brachial plexus, while senior anaesthetists were the most comfortable with the supraclavicular approach.

Training in peripheral limb blocks emerged as a problem. Many respondents indicated that they had not received formal training. The majority of anaesthetists felt that their training in peripheral limb blocks was insufficient (n = 102, 71.83%). The only professional designation where the majority of anaesthetists felt that their training was adequate was the career medical officer and consultant category. Medical officers, junior registrars, and senior registrars overall felt that the training was inadequate.

5.3 Limitations of the study

The findings of this study should be considered with an appreciation of certain limitations.

A considered selection of eight blocks was used to represent the spectrum of blocks commonly utilised in regional anaesthesia for upper and lower limb surgeries. The inclusion of additional blocks may have enabled a more comprehensive assessment of experiences and confidence, but would have prohibitively lengthened the study, and may have reduced the response rate due to the complexity of the questionnaire, and diminished the quality of the data collected.

Convenience sampling meant that this study did not achieve a 100% response rate. Participation was voluntary, and the decision to participate or decline could have been influenced by an individual's perception of their confidence, skill or clinical practice, and their interest or lack thereof in the study field.

A self-administered questionnaire relies on the honesty and quality of responses obtained. Not all questions were fully completed, and were therefore excluded from the data analysis.

Perceived confidence level is subjective and varies between individuals. It does not necessarily correspond with level of skill or success rate in clinical practice.

The contextual nature of this study means that it is limited to one department at one university at a particular time, and may not be generalised or extrapolated more widely. The methodology used may easily be replicated, however.

5.4 Recommendations

5.4.1 Recommendations for clinical practice

This study has identified areas where knowledge and current practice may be improved within the Department of Anaesthesiology at Wits, and at the various hospitals on the academic circuit.

Findings regarding experiential aspects included the following: there are numerous barriers to performing peripheral nerve blocks, experience and confidence with certain blocks is lacking, and training was rated as inadequate overall. The need for more or better training in regional anaesthesia at Wits has been identified. This may require the development of systems to improve work flow and innovative ways to make training opportunities more ideal.

Findings regarding procedural aspects related to peripheral nerve blocks included the following: monitoring can be inadequate, aseptic precautions are not optimal, and the knowledge about intravenous lipid emulsion availability and confidence in the management of severe local anaesthetic systemic toxicity can be improved. A better knowledge of, and adherence to, local guidelines would improve this.

Findings regarding practice-related aspects included the following: access to nerve localisation devices can be problematic, and nerve localisation techniques using ultrasound or combining peripheral nerve stimulation and ultrasound are utilised most frequently. Easier access to equipment, and the acquisition of more equipment, may need to be considered.

5.4.2 Recommendations for further research

Similar studies may be conducted involving the multitude of other regional anaesthesia techniques.

Follow-up studies after addressing the clinical practice recommendations would be useful to audit improvements and to identify unresolved or further deficiencies.

5.5 Conclusion

This study relating to perioperative peripheral nerve blocks for adult limb surgery was performed among anaesthetists in the Department of Anaesthesiology at the University of the Witwatersrand.

This study has described several procedural aspects pertaining to peripheral nerve blocks, and has described the barriers to performing these blocks.

The exposure, experience, and level of confidence of the sample population relating to a selection of upper and lower limb blocks has been determined.

The level of satisfaction of the sample population with training in peripheral nerve blocks has been determined.

Notable findings of this study are that the training in peripheral nerve blocks should be enhanced, and that the various barriers to performing peripheral nerve blocks need to be addressed.

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Appendix 1: Human Research Ethics Committee (Medical) Approval

R14/49 Dr Liesel Anne Scharf

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160704

NAME: (Principal Investigator)	Dr Liesel Anne Scharf
DEPARTMENT:	Anaesthesiology
PROJECT TITLE:	Anaesthetists' Experiences and Practices of Perioperative Peripheral Nerve Blocks for Adult Limb Surgery
DATE CONSIDERED:	29/07/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Nadav Ravid
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	12/08/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004, 10th floor, Senate House/3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in July and will therefore be due in the month of July each year.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 2: University of the Witwatersrand Postgraduate Committee Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

17 July 2019
Person No: 1242325
TAA

Dr LA Scharf
8 Purdey Place
239 Kessel Street
Fairland
2170
South Africa

Dear Dr Liesel Scharf

Master of Medicine: Change of title of research

I am pleased to inform you that the following change in the title of your Research Report for the degree of **Master of Medicine** has been approved:

From:	**Anaesthetists' experiences and practice of peripheral nerve blocks for adult limb surgery**
To:	**Anaesthetists' experiences and practices of perioperative peripheral nerve blocks for adult limb surgery**

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 3: Participant information letter

Dear colleague

My name is Liesel, and I am a registrar in the Department of Anaesthesiology at Wits. I would like to invite you to participate in a study that I am conducting as part of my MMed degree. The research project is entitled "*Anaesthetists' experiences and practices of perioperative peripheral nerve blocks for adult limb surgery*". The study has been approved by the Postgraduate Committee and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (Certificate M160704).

The aim of this study is to describe the experiences and practices of perioperative peripheral nerve blocks for adult limb surgery among anaesthetists in the Department of Anaesthesiology at Wits. The benefits of regional anaesthesia are well known. Peripheral nerve blocks can be used in conjunction with general anaesthesia, or offer an alternative to neuraxial techniques or general anaesthesia for limb surgery, where these are undesirable or unsafe. They can involve single nerves, multiple nerves, or a plexus. A selection of upper and lower limb blocks is included in this study.

You are invited to complete a self-administered questionnaire. Participation is voluntary, and there is no penalty for not participating. You can withdraw from this study at any time. Consent will be implied by completion of the questionnaire. All information is confidential and is collected anonymously. There are no personal identifiers on the questionnaire. They are numbered for administrative purposes.

The questionnaire should take about 15 minutes to complete. Please place your completed questionnaire into the labelled box provided.

Please make sure that you understand the above information before you complete the questionnaire.

Any questions regarding this study can be directed to Liesel Schärf (researcher) on 076 471 5811, or Professor Peter Cleaton-Jones (Chair of the Human Research Ethics Committee (Medical) of the University of the Witwatersrand) on 011 717 1234.

Thank you for your time.

Sincerely,

Liesel Schärf

Appendix 4: Questionnaire

Anaesthetists' experiences and practices of perioperative peripheral nerve blocks for adult limb surgery

- This questionnaire pertains to peripheral nerve blocks for adult limb surgery performed at the hospitals on the Wits anaesthesia circuit.
- Peripheral nerve blocks are a form of regional anaesthesia that can involve a single nerve, multiple nerves, or a nerve plexus.
- Please indicate your responses where applicable.
- Please answer the questions as honestly as possible.

1. Gender

Male	
Female	

2. Age in years

25-30	
31-35	
36-40	
41-45	
46-50	
>50	

3. Professional designation

Medical officer	
Registrar (1st, 2nd, 3rd year)	
Registrar (≥4th year)	
Career medical officer / consultant	

4. Anaesthetic experience

Years	
Months (if less than 1 year)	

5. Have you anaesthetised adult patients for any upper or lower limb procedures in the past year?

Yes	
No	

6. Approximately how many adult limb surgery cases have you done in the past year?

Nil	
1-5	
6-10	
11-20	
21-50	
>50	

7. Have you performed upper or lower limb peripheral nerve blocks on adult patients in the past year?

Yes	
No	

8. Approximately how many limb blocks have you performed on adult patients in the past year?

Nil	
1-5	
6-10	
11-20	
21-50	
>50	

If you do not perform blocks at all, you may omit questions 9 to 22 and proceed to answer questions 23 to 32.

9. How do you obtain consent for blocks from patients?

Verbal consent	
Written consent	
No specific consent	

10. What *minimum* monitoring equipment would you normally use when performing a peripheral nerve block? More than one option may apply.

NIBP	
ECG	
Pulse oximeter	
Capnography	
None	

11. Where do you normally perform blocks?

Recovery room	
Block area	
Operating theatre	
Ward	

12. When do you normally perform blocks?

Before surgery	
After surgery	

13. Which of the following represents your preferred state of the patient during performance of the block?

Awake	
Sedated	
Under general anaesthesia	
Does not matter	

14. Which of the following aseptic precautions do you normally take when performing peripheral nerve blocks? Multiple answers are possible.

Theatre cap	
Surgical mask	
Surgical hand scrubbing	
Sterile gloves	
Sterile gown	
Sterile drapes	
Antiseptic skin preparation	
Sterile ultrasound probe cover	
Decontaminate ultrasound before and after use	

15. Are you ever limited in your use of aseptic precautions?

Yes	
No	

If yes, how?

_____

_____

_____

16. What is your *minimum* duration of monitored care of the patient immediately after performing a block?

Less than 30 minutes	
30 minutes	
More than 30 minutes	

17. Which nerve localisation devices do you have in your department?

	Yes	No
Peripheral nerve stimulator (PNS)		
Ultrasound (US)		

18. What is your preferred method of nerve localisation?

Peripheral nerve stimulator (PNS)	
Ultrasound (US)	
Combination of PNS with US	
Other	

If other, please specify.

_____

_____

19. How often do you have access to these devices when you want to use them?

	Always	Often	Sometimes	Seldom	Never
PNS					
Ultrasound					

20. The following questions pertain to lipid emulsion (Intralipid®):

	Yes	No	Do not know
Is lipid emulsion readily available in your theatre complex?			
Do you know where to obtain lipid emulsion in your theatre complex?			
Do you feel confident in the management of local anaesthetic systemic toxicity?			

21. What action would you take if your block is not adequate when the patient is in recovery?

Administer intravenous analgesia	
Repeat the block	
Perform alternative rescue blocks	
Other	

If other, please specify.

_____

_____

22. Do you follow up your patients within 24 hours of surgery to assess your blocks?

Always	
Often	
Sometimes	
Rarely	
Never	

23. Please indicate your *experience* with *each* of the following blocks.

	Never done	Can do supervised	Can do solo
Interscalene			
Supraclavicular			
Infraclavicular			
Axillary			
Lumbar plexus			
Femoral			
Sciatic			
Popliteal			

24. Please indicate your *level of confidence* with *each* of the following blocks.

	Very low	Low	Average	High	Very high
Interscalene					
Supraclavicular					
Infraclavicular					
Axillary					
Lumbar plexus					
Femoral					
Sciatic					
Popliteal					

25. Please indicate which nerve localisation technique you *normally* employ when performing each of the following blocks.

	PNS alone	US alone	PNS with US	I never perform this block
Interscalene				
Supraclavicular				
Infraclavicular				
Axillary				
Lumbar plexus				
Femoral				
Sciatic				
Popliteal				

26. How often do you perform a peripheral nerve block for limb surgery where one could be performed?

Always	
Often	
Sometimes	
Rarely	
Never	

27. Please indicate your reason(s) for *not* performing blocks as often as you could? Multiple answers are possible.

Lack of knowledge	
Lack of training	
Lack of supervision	
Lack of confidence	
Medicolegal concerns	
Time pressure	
Fear of failure	
Preference of the senior anaesthetist	
Preference of the surgeon	
Other people want to perform the block	
Patient refusal	
Lack of equipment	
Lack of materials	
Will not add benefit to the patient	
Other	

If other, please specify.

_____

_____

28. Have you received formal departmental training in limb blocks?

Yes	
No	

29. Have you ever undertaken additional training in limb blocks outside of the department?

Yes	
No	

30. Do you feel that you have received sufficient training in limb blocks?

Yes	
No	

31. How do you think your skills and confidence could be improved?

_____

_____

_____

32. Which upper or lower limb block(s) would you like to master, but are currently not comfortable with?

_____

_____

_____

Thank you for your time.