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2022
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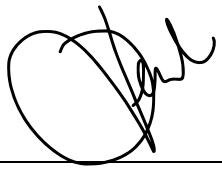
Nadine Venter

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 the branch of Anaesthesiology.

Johannesburg, 2022

Declaration

I, Nadine Venter declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



24 January 2022

Abstract

Background

The use of peripheral nerve blocks (PNBs) as an integral part of a multi-modal analgesic approach has increased in popularity since the advent of nerve stimulators and ultrasound. This study aimed to describe and compare the practice of limb PNBs in adult patients at Chris Hani Baragwanath Academic Hospital over two periods: 1 January – 31 March 2013 and 1 January – 31 March 2018.

Methods

This was a retrospective review of anaesthetic records using consecutive convenience sampling.

Results

In 2013 and 2018, 320 and 374 PNBs were done, respectively (p=0.77). PNBs done under general anaesthesia decreased, from 46.5% in 2013 to 32.0% in 2018 (p=0.01). Nerve stimulation use decreased from 50.3% of PNBs in 2013 to 20.0% in 2018, and ultrasound use increased from 13.1% in 2013 to 70.0% in 2018 (p<0.0005). There was an increase in saphenous, supraclavicular, axillary and wrist blocks in 2018 with decreased use of infraclavicular blocks (p<0.005). In 2013, the mean documented current endpoint was 0.421 mA versus 0.287 mA in 2018 (p<0.0005). The volume of bupivacaine used in 2018 for interscalene (p=0.001), infraclavicular (p=0.47) and sciatic blocks (p<0.0005) decreased. Adrenaline use decreased and dexamethasone use increased in 2018 (p<0.0005). In 2018, documentation of nerve localisation techniques used (p<0.0005), the current endpoint (p=0.02) and the volume of local anaesthesia (p=0.014) improved. Follow up of patients improved in 2018 (p <0.0005).

Conclusion

There was no significant increase in the utilisation of PNBs from 2013 to 2018. However, the practice of PNB has changed significantly regarding nerve localisation technique, the type of PNB used, PNBs performed under general anaesthesia, adjuncts used, the volume of local anaesthetic used, follow up in the ward and documentation of PNBs. Even though challenges exist, the efforts made by championing anaesthesiologists have made an impact.

Acknowledgements

I would like to thank the following people:

Juan Scribante and Helen Perrie as my supervisors for their immense patience, their valuable time and indispensable input. I am most grateful for their support and guidance.

Celeste Quan as my clinical supervisor for her time, contributions and advice.

Gill Hendry for her assistance with the statistical analysis.

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Abbreviations

CHBAH	Chris Hani Baragwanath Academic Hospital
LAST	Local Anaesthetic Systemic Toxicity
PNB	Peripheral nerve block

Statement

The Research Report consists of a literature review, draft article, study proposal and appendices. The study proposal is included for background reference and is not for examination.

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the author guidelines of the South African Journal of Anaesthesia and Analgesia, the journal to which it is intended to be submitted, in order to comply with the University's style guide.

Section 1: Review of the literature

1.1 Introduction

The use of peripheral nerve blocks (PNBs) as an integral part of a multi-modal analgesic approach has increased in popularity since the advent of nerve stimulators and ultrasound. The utilisation of PNBs has been associated with benefits like decreased opioid use (1), post-operative pain (1, 2) and post-operative nausea and vomiting (2).

In a constantly evolving field such as PNBs, it is essential to ensure safety and quality of care since the introduction of new technology does not necessarily translate into improved care. By conducting surveys and audits and creating compulsory reporting registries, quality of care can be monitored and improved if needed. Quality assurance can be ensured by following validated guidelines and recommendations (3).

In this section, the history of PNBs, the development in nerve localisation, the local anaesthetics and adjuncts used in PNBs and PNBs in surgery will be briefly discussed. The concept of quality assessment will be introduced and the quality assessment of PNBs will be discussed.

1.2 History of PNBs

Sir Francis Rynd is credited with developing the first documented PNB in May 1844. In an attempt to alleviate neuropathic pain, he used gravity to “inject” morphine around the supra-orbital nerve through a cannula attached to a trochar (4, 5). In 1855, Alexander Wood introduced a new method of treating neuralgia. He postulated that a more direct application of opioids to the nerve would have greater benefit and used a hollow hypodermic needle and syringe to inject a narcotic around a nerve for the first time (6).

The first recorded application of a local anaesthetic agent to provide intra-operative anaesthesia was by an ophthalmologist, Carl Koller. He performed glaucoma surgery using cocaine in 1884 and published the results in the Lancet (5, 7). In the same year, William Steward Halsted performed the first brachial

plexus block under direct vision after surgical dissection of the brachial plexus at Johns Hopkins Hospital (5, 8). However, it was not until 1902 that the term “regional anesthesia” was coined by Harvey Cushing (9). In 1911, the first percutaneous axillary block was performed by Georg Hirschel (5), and in the same year, Diedrich Kulenkampff (10) performed the first percutaneous brachial plexus block on himself (5, 9). Regional anaesthesia was within the purview of surgeons, and in 1914, Victor Pauchet published his book on regional anaesthesia, L’Anesthésie Régionale. He was the first to propose a new technique where an assistant carried out the PNB before the procedure (5).

Pauchet’s student, Louis Gaston Labat, was assisting with regional anaesthesia during procedures when Charles Mayo recruited him to teach regional techniques at the Mayo Clinic. Labat published one of the first comprehensive English texts on regional anaesthesia, “Regional Anesthesia: Its Technique and Clinical Application”, which became one of the most influential texts in regional anaesthesia (9, 11).

Labat established the first American Society of Regional Anesthesia in 1923 with a former student, Hippolite Wertheim (9). He also had an influence on John Lundy and Emery Rovenstine, who were key figures in establishing the practice of anaesthesiology. Ralph Waters, who established one of the first academic anaesthesiology departments at the University of Wisconsin, was also trained by Labat. All three became members of the American Society of Regional Anesthesia, the group which endorsed the formation of the American Board of Anesthesiologists in 1938 (9, 12).

1.3 Developments in nerve localisation

In a 2005 British Journal of Anaesthesia editorial, Denny and Harrop-Griffiths (13) stated that “regional anaesthesia always works – provided you put the right dose of the right drug in the right place”. The techniques for nerve localisation have evolved from anatomical dissection and needle-to-nerve contact with paraesthesia to needle nerve locators, percutaneous electrical nerve stimulation and direct visualisation using ultrasound (14, 15).

The discovery of the first syringe and the development of the hypodermic injection by Alexander Wood in 1855 (6) allowed for the rapid progression from open dissection performed by William Halsted to percutaneous injection and elicitation of paraesthesia by direct needle-to-nerve contact (9). It was not until 1912 that Georg Clemens Perthes described electrical current to locate nerves (16). However, his method only gained momentum in the 1960s when Greenblatt and Denison used a small portable transistorised nerve stimulator. In the 1980s, a nerve stimulator became the “gold standard” for nerve localisation (14, 17). Provoking muscle twitches by stimulating a specific nerve was theorised to improve needle-to-nerve contact without inducing paraesthesia and improve safety by decreasing the volume of local anaesthesia required (17).

However, in 2006, Perlas et al (18) demonstrated that nerve stimulation does not predict needle tip location accurately. When nerve indentation was visualised on ultrasound, a motor response was only provoked in approximately 75% of patients with a current of 0.5 mA, and only 38% of patients reported paraesthesia with needle-to-nerve contact (18).

Although needle position in relation to a nerve is difficult to predict when using nerve stimulation, the provocation of a motor response by a current of less than 0.2 mA is a sensitive indicator of intraneural needle placement. However, it is not infallible, especially in diabetic patients (19). Chan et al (20) demonstrated a substantial inter-individual variation when it comes to the minimum stimulation needed, and Sauter et al (21) demonstrate that a different stimulus may be required, even among different nerves.

A Doppler ultrasound was first used to help facilitate a supraclavicular block in 1978 (22). The aim was to identify the subclavian artery as it is in close relation to the divisions of the brachial plexus. In 1989, Ting and Sivagnanaratnam (23) studied the spread of local anaesthesia during landmark-based axillary blocks after an ultrasound confirmed cannula placement and reported a 100% block success rate. It was not until 1994 that ultrasound was used as the primary nerve localisation technique by Kapral et al (24), who modified the methods of Ting and Sivagnanaratnam (23) for a supraclavicular block. Ultrasound allowed for visualisation of the nerve, the needle, as well as the spread of the local

anaesthetic agent around the nerve. Kapral et al (24) stated that this reduced the risk of pneumothorax and other complications associated with traditional techniques, like the Kulenkampff technique (10).

The benefit of direct visualisation was demonstrated by Weintraud et al (25) in 2009. The authors demonstrated that using the landmark-based, “single or double pop technique”, local anaesthesia spread was only observed in the correct anatomical plane in 14% of patients. Ultrasound use allows the user to assess anatomical variations, identify the desired location for local anaesthetic injection and observethe spread of local anaesthesia in the right location (26).

Ultrasound has various advantages, including decreased number of skin punctures (27), decreased number of vascular punctures (27), higher block success rates (2) and decreased volume of local anaesthetic needed with a subsequent decrease in the incidence of local anaesthetic systemic toxicity (LAST) (28). However, there was no statistical difference in patient comfort and satisfaction when comparing the various nerve localisation techniques (29, 30).

Advancements in nerve localisation continue as part of constant efforts to improve block success and safety. The use of inline pressure monitoring, real-time three-dimensional ultrasound, multiplane magnetic robotic needle guidance, optical reflectance spectroscopy and bio-impedance are all in various stages of development (15, 30). The New York School of Regional Anesthesia suggests the use of “triple monitoring”, which includes nerve stimulation, ultrasound and inline pressure monitoring to limit the potential peripheral nerve injury (30, 31). Quality assurance and improvement endeavours will hopefully illuminate the best practice in the constantly evolving field of regional anaesthesia.

1.4 Local anaesthetic agents and adjuncts used in PNBs

All local anaesthetic agents have an inherent potential for neurotoxicity. These neurotoxic effects vary, but there is increased potential for neurotoxicity in a dose and time-dependent manner, especially in the case of intrafascicular injection (30, 32). Ropivacaine followed by bupivacaine appears to have the lowest potential for neurotoxicity (32, 33).

In addition to the direct neurotoxic effects, vasoconstriction caused by local anaesthetic agents may also contribute to peripheral nerve injury. Adrenaline can potentiate these effects. In an animal study conducted by Partridge (34), it was found that when lignocaine 2% was used in conjunction with 1:200 000 adrenaline, there was a 60% decrease in neuronal blood flow. It is unclear what the clinical significance of the decrease in neuronal blood flow is in humans, but in general, healthy patients appear to tolerate the decrease in blood flow without adverse effects (35). It has been recommended that the lowest volume of the lowest effective concentration of local anaesthetic agent should be used for all PNBs and that adrenaline must be omitted in patients who already have decreased neuronal blood flow, such as diabetic patients (35, 36). The use of adrenaline could be advantageous, as it can prolong the effects of some local anaesthetics and as an early marker of potential inadvertent intra-vascular injection limiting the amount of local anaesthetic injected into the systemic circulation, especially when no ultrasound is available, and out-of-plane ultrasound techniques are used (37).

Multiple other adjuncts can be used to increase the analgesic effect of PNBs and limit the phenomenon of rebound pain without potentiating neurotoxicity (38). Common adjuncts include dexmedetomidine, clonidine, ketamine, dexamethasone and buprenorphine. Dexamethasone is not neurotoxic and, unlike dexmedetomidine and clonidine, is not associated with bradycardia and hypotension. It may prolong the analgesic effects of PNBs, whether given systemically or perineurally, but clinicians remain unsure as to which application is superior or if there is any difference at all (39, 40). The results regarding dexamethasone are also inconsistent; Marhofer et al (41) indicated no difference in duration of analgesia in their volunteer trial. The method used to assess pain, the definition of prolonged duration of analgesia across studies and the dose used all differ in studies of dexamethasone (42). Ranganath et al (38) stated that the American Society of Regional Anesthesia had not made recommendations on the use of any adjunct due to the risk of adverse events for a modest increase duration of analgesia, the conflicting findings in the literature and the off-label use of all adjuncts. Of these adjuncts, only clonidine has been included in the American Pain Society Guidelines to be used as an adjunct with a single-shot PNB to manage post-operative pain (43).

1.5 Peripheral nerve blocks in surgery

Peripheral nerve blocks allow for anaesthesia to a specific surgical site. Its application has shown benefits in multiple surgical disciplines when compared to general anaesthesia or when used in conjunction (1).

Orthopaedic surgery lends itself to regional anaesthesia. Gabriel and Ilfeld (44) noted that the use of PNBs in orthopaedic cases was considerably more prevalent and increasing in popularity compared to the overall utilisation of PNBs in the United States of America in 2018.

Upper limb blocks are utilised most often (44-46), but the use of lower limb blocks for total knee arthroplasty (46, 47) has significantly increased in the United States of America, from 9.7% – 16.1%, as indicated by Fleischut et al (47). Cozowicz et al (46) postulated that the increase in popularity of lower limb blocks is also the cause of decreased utilisation of neuraxial anaesthesia.

The addition of PNBs to general anaesthesia in orthopaedic patients provide the following benefits:

- good quality analgesia post-operatively (48)
- improved patient satisfaction (48, 49)
- decreased unexpected hospital admissions in ambulatory cases (50, 51)
- decreased workload in the post-anaesthesia care unit (52).

There are still many questions that need to be answered regarding the value of PNBs in clinical practice, especially when it comes to the long-term benefits for orthopaedic patients, like improved or faster rehabilitation in the post-operative period. Further research in this area is needed (1).

1.6 Quality assurance and improvement

Quality is hard to define, as it is often subjective. The Oxford Dictionary (53) defines quality as “the standard of something as measured against other things of a similar kind; the degree of excellence of something”.

Quality assurance in the context of health care has been defined as “ensuring clinical care is consistently practised and delivered to the highest standards” (3). In an editorial, Batalden and Davidoff (54) defined quality improvement as “the combined and unceasing efforts of everyone – healthcare professionals, patients and their families, researchers, payers, planners and educators – to make the changes that will lead to better patient outcomes (health), better system performance (care) and better professional development”.

Batalden and Davidoff’s (54) definition of quality improvement incorporates Donabedian’s framework (55) for quality assessment, which describes health care in terms of structure, process and outcome. Donabedian emphasises (55) the use of measurement to facilitate improvement in the health care system.

In anaesthesia, it is the measure of outcome or the rate of adverse events that are often used to assess the quality and safety of a procedure (56). However, measurements in one area alone may not reflect all the complexities of the health care system. Anaesthesia as a speciality forms part of a multi-disciplinary team working in an intricate environment, and for a complete assessment, the healthcare structure and processes need to be evaluated as well (57).

The context in which health care is delivered refers to the structural component of the Donabedian framework (55). This includes but is not limited to the hospital building, staff, financing and equipment. The available resources can influence processes followed, as well as potential outcome monitoring. The quality of care can be greatly influenced by the structure in which care is provided (58).

Process measures evaluate how healthcare, or a specific service, is delivered to a patient. The outcome in some instances is strongly related to process, and subsequently, a major advantage lies in the process measurement. It can help clinicians identify which processes had a direct impact on outcome and what action can be taken to improve quality and safety (58, 59).

1.7 Quality assessment of PNBs

Efforts have been made in both developed and developing countries to identify areas in which the process, structure and outcome of PNBs can be improved.

1.7.1 Process and structure assessments of PNBs

Europe

To determine what effect the introduction of ultrasound had on the Department of Anesthesiology and Intensive Care in Warsaw, Nowakowski et al (60) conducted a retrospective survey on PNB practice from January 2006 – June 2012. The results show an increase in the use of ultrasound from 8.6% in 2007 to 53.3% in 2012. This increase is attributed to the rising number of anaesthesiologists trained to do PNBs and the availability of ultrasound guidance during this period. Prior to the introduction of ultrasound, nerve stimulation was the most common nerve localisation technique. In 2012, the most commonly employed nerve localisation technique was combined nerve stimulation and ultrasound. With the increase in ultrasound use came a decrease in the total volume of local anaesthetic injected, but there was no observed change in block success or safety. It was concluded that while ultrasound did improve the PNB technique and limited the amount of local anaesthesia used, it did not improve PNB safety (60).

In Greece, questionnaires sent to registered anaesthetic departments reflected 189 703 surgeries performed between March and June 2012 (61). PNBs comprised only 13.64% of all the regional anaesthetic techniques and were done mainly for orthopaedic procedures of the upper or lower limbs. Nerve localisation techniques included eliciting of paraesthesia (16.6 %), nerve stimulation (78.8%), ultrasound guidance alone (1.5%) and ultrasound guidance in combination with nerve stimulation (3.5%). The lack of equipment was the main limitation to the practice of PNBs. Poor anatomical knowledge, ignorance of the benefits and resistance of surgeons were also noted as potential limiting factors. The implementation of formal teaching in the residency program was identified as a potential solution to improve the utilisation of PNBs (61). Argyra et al (61), in a census report on regional anaesthesia use in Greece, also noted that continued education, use of new teaching modalities (such as virtual reality) and reporting regional anaesthesia on an electronic database might improve the quality of care provided.

A survey conducted in 1997 by Bouaziz et al (62) in France showed nerve stimulation alone was used by 83% of anaesthetic residents at the time. Fuzier et al (63) in 2016 stated that 73% of French anaesthesiologists considered ultrasound the new gold standard in care. In most institutions, ultrasound was not only available but dedicated to use in regional anaesthesia. Reasons for not using ultrasound guidance include the belief that it was faster to use a nerve stimulator, blocks (for example, anterior sciatic) that are technically difficult with ultrasound, or no ultrasound machine available at the time of block performance. Despite nerve stimulation still being used, 45% of the responders would not be surprised if the use of nerve stimulation was abandoned. The authors also found that certain blocks, such as supraclavicular blocks, became more popular as ultrasound guidance became more readily available. Axillary, interscalene, popliteal sciatic and femoral blocks were performed by 90% of responders and were mostly done using ultrasound guidance. Of concern was that the practice guidelines for infection control were not adhered to in clinical practice, especially alternative methods such as ultraviolet rays to sterilise probes. The authors concluded that this area requires further research to determine the effect on outcomes (63).

A nationwide survey was conducted in Switzerland in 2019 to review the practice of PNBs (64). Nerve stimulation and ultrasound were used together by most practitioners, especially those with less self-estimated expertise. PNBs were most often administered without a general anaesthetic in the adult population, in accordance with the German Society of Anaesthesiology and Intensive Care Medicine Guidelines published in 2014 (65). The use of sterile gloves, drapes and ultrasound covers appeared to be standard practice, as well as the use of standard monitoring in line with the Helsinki Declaration of Patient Safety in Anaesthesiology (66). The current threshold used by most anaesthesiologists is 0.3 – 0.5 mA; this is lower than the recommended minimum current threshold of 0.5 mA in the German guidelines. The survey results show that anaesthesiologists with more experience used sterile coats less commonly than those with less experience when placing peripheral nerve catheters, despite being recommended by the German guidelines. The results also show that 40% of the anaesthesiologists used multiple adjuncts, including clonidine, adrenaline, fentanyl, bicarbonate and dexmedetomidine. The authors highlighted a need for

the implementation of standard monitoring guidelines when a PNB is utilised, as well as guidelines for training and maintaining skills (64).

United States of America

In 1998, Hadzic et al (67) conducted a nationwide survey in the United States of America. The authors found that more than half of the 409 respondents performed less than five PNBs every month, most of which were upper limb blocks. The conclusion was that PNBs were still under-utilised, which about half of the respondents attributed to inadequate exposure during residency. Subsequently, there has been a significant change in the exposure of residents in the United States of America to PNBs. Helwani et al (68) noted an increase in exposure to and use of ultrasound for PNBs in residency programs in 2012. Thirty-eight residency programs reported that they performed more than 40 single PNBs per week, and 72 programs did more than 20 single-shot PNBs per week. The results reveal that, where available, most of these blocks were done with ultrasound guidance alone, with only 19% of the residency programs surveyed using a combination of nerve stimulation and ultrasound. When ultrasound was not routinely used, it was due to a lack of immediate availability or expertise; some felt it would take longer to perform the block (68).

Moon et al (69), in 2013, showed that more than 90% of residents managed to do at least 40 PNBs during their residency, which is the mandatory goal from the Accreditation Council for Graduate Medical Education (70). These blocks are done, in most cases, using ultrasound as the nerve localisation technique of choice. The residents reported that doing more blocks or even providing simulator training would improve the teaching program (69).

Even though there was increased exposure to PNBs in residency programs, in 2018, Gabriel and Ilfeld (44) found that only 3.3% of the 3,2 million cases in the National Anesthesia Clinical Outcome Registry, which were amenable to PNBs received one. Despite the overall low prevalence, PNBs increased significantly in popularity from 2010 to 2015. Concurring with Hadzic et al (67) in 1998, Gabriel and Ilfeld (44) were not sure why there was such low overall utilisation of PNBs as they allow for safe and effective post-operative analgesia, as well as a high rate of

patient satisfaction in ambulatory patients. Further studies may be needed to identify the barriers preventing utilisation. The authors highlight that the emergence of large databases would make further analysis possible (44).

The Nashville Surgery Centre sheds some light on practice in certain areas of the Unites States of America and reflects the practises seen in residency program surveys (2). Between November 2008 and October 2015, this Centre used ultrasound guidance alone in 80% of cases. Nerve stimulation alone was used in only 9.5% of cases and was associated with an increase in block failure. The decreased incidence of LAST found in the study could be a reflection of the choice of nerve localisation technique (2).

Malchow et al (2) showed other factors associated with outcome, such as an association between block failure and obesity, being male and having a higher American Society of Anesthesiologists classification. Clonidine and dexamethasone as adjuncts improved patient satisfaction and prolonged block duration, but when used in combination, they caused an increase in post-operative neurological symptoms lasting more than 72 hours (2).

Asia

Mohammed et al (71), in 2013, conducted a survey in Saudi Arabia. Among the 211 respondents, 82.5% indicated that they had a special interest in regional anaesthesia as they believed it reduced health care costs, decreased complications and improved patient safety and outcome. Mohammed et al (71), like Huang and Gao (72), found that the block failure rates limited PNB practice. The authors identified another two main barriers, which include the time-consuming practice of PNB and surgeon refusal (71). Furthermore, a significant positive correlation between access to an ultrasound machine and doing PNBs was also demonstrated. This may be why 88.2% of participants practise regional anaesthesia on a daily or weekly basis only. Of the respondents, 26.6% used nerve stimulation and ultrasound, 21.8% used ultrasound alone and 18.5% relied on nerve stimulation alone for nerve localisation. The authors found it surprising that only 7.5% of respondents had received formal training. Most of the respondents attended courses or workshops, and this is possibly related to the

high interest in PNBs among the respondents. The authors concluded that this highlights the need for formal training and possibly a regional anaesthesia fellowship in Saudi Arabia to improve the quality and safety of practice (71).

In China in 2016, Huang and Gao (72) showed that 68% of blocks performed in China were done using anatomical landmarks, despite the global trend (44, 60, 61) to include nerve stimulation and ultrasound either alone or in combination. This was largely due to a lack of training and equipment available in their setting. Of the respondents, 61% had received no training in PNBs. Other barriers to performing PNBs were concern about complications and increased block failure rates, which could improve with adequate equipment and training. Cultural differences were also noted; anaesthesiologists were concerned about violence against doctors and damage to the doctor-patient relationship if complications should occur (72).

Africa

A Nigerian survey conducted in 2010 by Rukewe and Fatiregun (73) showed that 71.8% of anaesthesiologists surveyed at the time had ever seen a peripheral nerve stimulator, and only 31.4% of those had ever used one. However, the anaesthesiologists were all of the opinion that a PNB should not be done without using a nerve stimulator. The underutilisation of PNBs stemmed mainly from the lack of equipment and training. In 2014, in another study, Rukewe et al (74) at the University College Hospital in Nigeria found that 72.1 % of patients undergoing upper limb surgery had PNBs with a nerve stimulator being used for nerve localisation in the majority of cases. The authors concluded that this was a “positive development in a resource limited setting” (74).

The findings of Rukewe et al (74) in 2014 appear to be specific to University College Hospital and not Nigeria as a whole, unlike the 2010 survey by Rukewe and Fatiregun (73). In 2013, Obasuyi et al (75) published a retrospective survey of their practice at the University of Port Harcourt Teaching Hospital. The authors found that regional techniques in upper limb surgery were only utilised in 16.3% of cases and concluded that general anaesthesia was inappropriate. However, without training, equipment and staff motivation, it was inevitable (75).

The only literature identified regarding PNB practice in South Africa is that of Snyman and Goldstein (76) who demonstrated that ultrasound guidance was used in 88% of the PNBs with a success rate of 91% in an academic emergency centre in Johannesburg. The authors reported that, on average, a PNB was done in 10 minutes.

1.7.2 Outcome assessment

If adverse events are rare, as is the case with PNBs, large numbers are needed to make a comprehensive risk assessment (77). Risk is not universal, as there is great variability worldwide in the methods utilised, training and equipment availability (46). It is essential to know the outcome as it does not just reflect quality but will enable adequate patient counselling and obtaining true informed consent (3). Outcome reporting will be discussed as voluntary reporting and clinical registries.

Voluntary reporting

Auroy et al (78) conducted a survey in 1997 to measure the incidence of serious complications of PNBs. At the time, the authors were unable to include the newer nerve block techniques, such as popliteal sciatic blocks. The exclusion of newer nerve block techniques and the twelve-fold increase in the prevalence of PNB over sixteen years, reported by Clergue et al (79) in 1999, prompted Auroy et al (80) to create a hotline (SOS Regional Anesthesia service) where French anaesthetists could report any major complications associated with regional anaesthetic techniques in 2002. Over 10 months, 50 223 PNBs were performed. The incidence of complications among PNBs was rare (0.02%) in 2002; 12 patients developed peripheral neuropathy and 6 still had symptoms after six months. Despite the belief at the time that nerve stimulation decreased the incidence of peripheral neuropathy, 9 out of 12 patients experienced neurological fall-out despite a nerve stimulator being used. The study was, however, not designed to test the differences between nerve localisation techniques (80).

Huo et al (81) conducted a large 106 569-patient prospective survey in 2009 in China. Of these patients, 9 017 received an upper limb block. No lower limb PNBs were mentioned in the study. The anaesthetists anonymously completed “Regional

Anaesthesia Investigation Charts" and were asked to report any adverse events. Patients were followed up within seven days for major complications associated with regional anaesthesia. The type of surgery, as well as the regional anaesthetic techniques, showed varied results. Orthopaedic procedures showed an incidence of 2.3 complications per 10 000 cases done. Complications consisted of inadvertent recurrent laryngeal nerve block or Horner syndrome (81). The rate of complicationswas similar to Auroy et al (80) in France in 2002, despite the lack of training and limited use of ultrasound guidance in China, as demonstrated by Huang and Gao
(72) in 2016. It should be noted that while the rate may have been similar, the types of complications were different; Auroy et al (80) did not comment on the inadvertent recurrent laryngeal nerve or phrenic nerve blocks and Huo et al (81) did not note any peripheral nerve injuries.

Stojadinovic et al (82) found that this ambiguity in the literature made it difficult to accurately assess the outcome and safety of PNBs. Studies that rely on voluntary reporting could also be hampered by under-reporting. Huo et al (81) suggested eliminating this factor by making reporting anonymous. Studies (56, 83, 84) have demonstrated that voluntary reporting rarely accounts for more than a very small fraction of actual complications, as there is uncertainty about what should be reported and a fear of litigation and other repercussions.

Clinical registries

The need for large cohorts of PNBs was evident to Barrington et al (85); therefore, the authors undertook a large prospective audit (Australian Regional Collaboration). Multiple hospitals in Australia participated, and the data relating to PNBs were entered in a single database to assess the quality and safety. In total, 8 189 PNBs were performed between January 2006 – May 2008. Patients were followed up telephonically at 7 – 10 days and 6 weeks post-operatively to identify the presence of peripheral nerve injuries. If neurological injury was suspected, patients were referred to a neurologist for further assessment to ascertain whether the nerve injury was due to the initial trauma, surgery or the PNB itself. The calculated incidence of peripheral nerve injury was 0.4 per 1 000 blocks (85).

The Australian and New Zealand Registry of Regional Anaesthesia, formerly known as the Australian Regional Anaesthesia Collaborative, showed the value of large registries. In 2013 it was demonstrated that complications associated with PNB were rare and that ultrasound use decreases the incidence of LAST (28). The study population included 20 021 patients who received 25 336 PNBs, and LAST was observed in only 22 cases (0.08%). The risk of developing LAST was reduced by more than 65% when ultrasound was used. Barrington and Kluger (28) postulated that this might be due to the decreased volume of local anaesthetic injected when ultrasound was used. In addition, if there was an inadvertent intra-vascular injection, the lack of local anaesthetic spread visualised would prompt the provider to stop injecting. The ability to visualise needle trajectory and avoid vascular structures is another possible explanation for the reduced risk (28).

Large registries also assist in the assessment of process and structure. One of the earliest national databases in the United Stated of America was the National Survey of Ambulatory Surgery, which recognised that anaesthetic practice influenced medical and economic outcomes. It was suggested to include anaesthetic details in their administrative data fields. There was, however, limited clinical data available, leading to initiatives like the American College of Surgeons National Surgical Quality Improvement Program (86). This initiative motivated the American Society of Anesthesia to collect anaesthetic data on a large scale with the help of the Anesthesia Quality Institute, who are the administrators of the National Anesthesia Outcomes Registry (46, 86). The data gathered from the National Survey of Ambulatory Surgery and National Anesthesia Outcomes Registry have been used to assess the utilisation of PNBs in practice and show how anaesthesia practice has evolved in different centres. This sharing of data enables institutions to compare their practise, monitor for “performance gaps”, and adjust training to adapt to the change in practice (44, 87).

1.8 Summary

The practice of PNBs has evolved considerably from the 1800s, and continued quality improvement and assurance methods need to be implemented in both developed and developing countries to ensure that best practise prevails.

In this section, the history of PNBs, the development in nerve localisation, the local anaesthetics and adjuncts used in PNBs and PNBs in surgery were briefly discussed. The concept of quality assessment was introduced and the quality assessment of PNBs was discussed.

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Section 2: Author guidelines

Southern African Journal of Anaesthesia and Analgesia (SAJAA)

Submitted manuscripts that are not in the correct format and without the required supporting documentation specified in these guidelines will be returned to the author(s) for correction and will delay publication.

AUTHORSHIP

Named authors must consent to publication **by signing a covering letter** which should be submitted as a supplementary file. Authorship should be based on substantial contribution to:

(i) conception, design, analysis and interpretation of data;

(ii) drafting or critical revision for important intellectual content; and

(iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org); and

(iv) exact contribution of each author must be stated.

DECLARATION OF CONFLICT OF INTEREST

Authors must declare all sources of support for the research and any association with a product or subject that may constitute a conflict of interest. If there is no conflict of interest to declare please include the following statement: The authors declare no conflict of interest.

FUNDING SOURCE

All sources of funding should be declared. Also define the involvement of study sponsors in the study design, collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication. If the study sponsors had no such involvement, this should be stated as follows: No funding source to be declared.

RESEARCH ETHICS COMMITTEE APPROVAL

The submitting author must provide written confirmation of Research Ethics Committee approval for all studies including case reports. The ethics committee as well as the approval number should be included.

STATISTICAL ANALYSIS

Authors are advised to involve medical statisticians at the protocol stage of their research project: to plan sample size, and the selection of appropriate statistical tests for analysis and presentation.

PROTECTION OF PATIENT'S RIGHTS TO PRIVACY

Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. The patient should be shown the manuscript to be published. Refer to www.icmje.org.

ETHNIC CLASSIFICATION

The rationale for analysis based on racio-ethnic-cultural categorisation should be indicated.

CATEGORIES OF SUBMISSIONS

Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Original articles

Original articles on research relevant to anaesthesia and analgesia should not exceed 3 200 words, no more than 30 references, with up to 6 tables or figures. A structured abstract under the following headings, Background, Methods, Results, and Conclusions is a requirement and should not exceed 300 words.

Clinical Review articles

Review articles relevant to anaesthesia and analgesia should not exceed 2 400 words, with a maximum of 20 references and no more than 6 tables or figures. A summary of 300 words or less is required.

Case reports

Case reports should not exceed 1 800 words with no more than 10 references. Figures are limited to 2 figures and may include images or photographs. The case report should have three headings: Summary (not exceeding 100 words), Case report (with no introduction) and Discussion. Case reports will be published online only. The summary and the URL will appear in the printed version.

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Scientific Letters should not exceed 2 400 words with a maximum of 10 references. Only one table or illustration is permissible. A structured abstract under the following headings, Background, Methods, Results, and Conclusions, is a requirement and should not exceed 250 words.

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Letters to the editor should be 800 words or less with only one image or table.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - www.icmje.org. Manuscripts must be provided in **UK English**.

Qualification, affiliation and contact details

This information must be provided for ALL authors and must be submitted as a supplementary file.

Email addresses of all author must be provided.

ORCID number of **ALL** authors must be provided – if authors do not have ORCID, please register at https://orcid.org/

Abbreviations

All abbreviations should be spelt out when first used and thereafter used consistently, e.g. ‘intravenous (IV)’ or ‘Department of Health (DoH)’.

Scientific measurements

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Section 3: Draft article

The change in practice of limb peripheral nerve blocks at a central hospital over a five year period.

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Keywords: peripheral nerve block, ultrasound, nerve stimulation, quality assurance

Abstract

Background

The use of peripheral nerve blocks (PNBs) as an integral part of a multi-modal analgesic approach has increased in popularity since the advent of nerve stimulators and ultrasound. This study aimed to describe and compare the practice of limb PNBs in adult patients at Chris Hani Baragwanath Academic Hospital over two periods: 1 January – 31 March 2013 and 1 January – 31 March 2018.

Methods

This was a retrospective review of anaesthetic records using consecutive convenience sampling.

Results

In 2013 and 2018, 320 and 374 PNBs were done, respectively (p=0.77). PNBs done under general anaesthesia decreased, from 46.5% in 2013 to 32.0% in 2018 (p=0.01). Nerve stimulation use decreased from 50.3% of PNBs in 2013 to 20.0% in 2018, and ultrasound use increased from 13.1% in 2013 to 70.0% in 2018 (p<0.0005). There was an increase in saphenous, supraclavicular, axillary and wrist blocks in 2018 with decreased use of infraclavicular blocks (p<0.005). In 2013, the mean documented current endpoint was 0.421 mA versus 0.287 mA in 2018 (p<0.0005). The volume of bupivacaine used in 2018 for interscalene (p=0.001), infraclavicular (p=0.47) and sciatic blocks (p<0.0005) decreased. Adrenaline use decreased and dexamethasone use increased in 2018 (p<0.0005). In 2018, documentation of nerve localisation techniques used (p<0.0005), the current endpoint (p=0.02) and the volume of local anaesthesia (p=0.014) improved. Follow up of patients improved in 2018 (p <0.0005).

Conclusion

There was no significant increase in the utilisation of PNBs from 2013 to 2018. However, the practice of PNB has changed significantly regarding nerve localisation technique, the type of PNB used, PNBs performed under general anaesthesia, adjuncts used, the volume of local anaesthetic used, follow up in the ward and documentation of PNBs. Even though challenges exist, the efforts made by championing anaesthesiologists have made an impact.

Introduction

The use of peripheral nerve blocks (PNBs) has been associated with a decreased opioid use, post-operative pain and post-operative nausea and vomiting (1, 2), making it an integral part of multimodal analgesia. The first PNB was performed by Sir Francis Rynd (3) in 1844. Since then, the practice of peripheral regional anaesthesia has evolved. This change in practice was, in part, driven by the progress made in nerve localisation techniques (4, 5). The techniques have evolved from anatomical landmarks and needle-to-nerve contact with paraesthesia to electrical nerve stimulation and direct visualisation using ultrasound (4, 5).

Advancements in nerve localisation techniques have contributed to the increased use of PNBs (6, 7), it is still unclear which practice is safest (8, 9). No human studies identified have proven that one nerve localisation technique is superior to another in preventing peripheral nerve injury (10). However, ultrasound has been shown to have multiple advantages compared to nerve stimulation, such as decreased number of skin punctures, decreased number of vascular punctures and decreased volume of local anaesthetic used (7).

This change in practice and increased utilisation of PNBs have been well documented in some countries. However, new technology does not necessarily translate into improved quality of care. Surveying practice allows for identifying limitations in a specific environment and provides a baseline to assess the impact of change in practice.

No studies were identified on the anaesthetic practice of limb PNBs in South Africa. The aim of this study was to describe and compare the practice of limb PNBs in adult patients at Chris Hani Baragwanath Academic Hospital (CHBAH) over two periods: 1 January – 31 March 2013 and 1 January – 31 March 2018.

Methods

Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (M190613). This study followed a retrospective, contextual, descriptive research design.

The study population consisted of the anaesthetic records of the adult patients who received limb PNBs in the two study periods. The study periods were chosen because a formal follow up process of PNBs was instituted in 2012 and was more established in 2013. The same period was chosen in 2018 to account for any potential seasonal variability and in an attempt to review the change of practice over five years. Consecutive convenience sampling was used to prevent selection bias. The sample size was determined by the number of patients who had received a limb PNB at CHBAH over two study periods. Illegible records were excluded from the study

The anaesthetic records used included all written anaesthetic resources maintained by the CHBAH Department of Anaesthesiology to document patient information. This included but was not limited to the anaesthetic charts and the regional anaesthesia block follow-up books (block book). The anaesthetic chart is a pre-printed chart used at CHBAH that is completed manually by the anaesthetist to record any anaesthetic administered to a patient. The block book is a book available in the recovery room at CHBAH, where anaesthetists record the details of patients who have received a PNB and need follow-up the next day. The follow-up notes are documented in the block book.

A draft data collection sheet was compiled following an extensive review of the literature, the anaesthetic charts and the block book ensuring content validity. The draft data collection sheet was reviewed by three anaesthesiologists to ensure face and content validity. The anaesthesiologists' suggestions were incorporated into the final data collection sheet. The data collection sheet was set up electronically in the REDCap database. The data collected are shown in Table 1.

Table 1: Data collection

General demographics	• total number of limb surgeries done during the study period • total number of limb PNBs during the study period
Patient characteristics	• age • gender • ASA rating
Surgical information	• surgical discipline, • procedure • date of procedure
Anaesthetic administered in addition to PNB	• general anaesthetic • sedation • not specified
PNB	• anaesthetic or sedation before the PNB • type of PNB done • nerve localisation technique • if nerve stimulation is used, the documented current endpoint • local anaesthetic agent used • local anaesthetic agent volume • local anaesthetic concentration • adjunct medication used • documented PNB related intra-operative complications • documented block failure
Follow-up	• record of the patient in the block book • patient found in the documented ward • PNB related complications that are documented in the block book.

In this study, the adjunct medications added to the local anaesthetic agent used were adrenaline, dexamethasone, ketamine and dexmedetomidine. The data were collected by one author (NV).

Data were analysed in consultation with a statistician using the statistical program IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Categorical data were summarised using frequencies and percentages. Continuous variables that were normally distributed were summarised using mean and standard deviation, and those not normally distributed were summarised using medians and interquartile ranges. Comparisons between the number of limb PNBs performed during the two study periods were made using Chi-squared. A p-value of
< 0.05 was considered statistically significant.

Results

Four illegible records were excluded from 2013 and one from 2018, resulting in a sample size of 268 PNBs in 2013 and 333 in 2018. The derivation of the study sample is shown in Figure 1. Of the 268 patients in 2013, 52 (19.4 %) patients received a second PNB during the same procedure, resulting in 320 PNBs. In 2018, 41 (12.8%) second PNBs were done, resulting in 374 PNBs. There was no significant increase in the rate of PNB utilisation; in 2013, 24.7 % of eligible limb surgeries received a PNB and in 2018, 25.2 % (p=0.7). The characteristics of the patients who received PNBs are shown in Table 2.

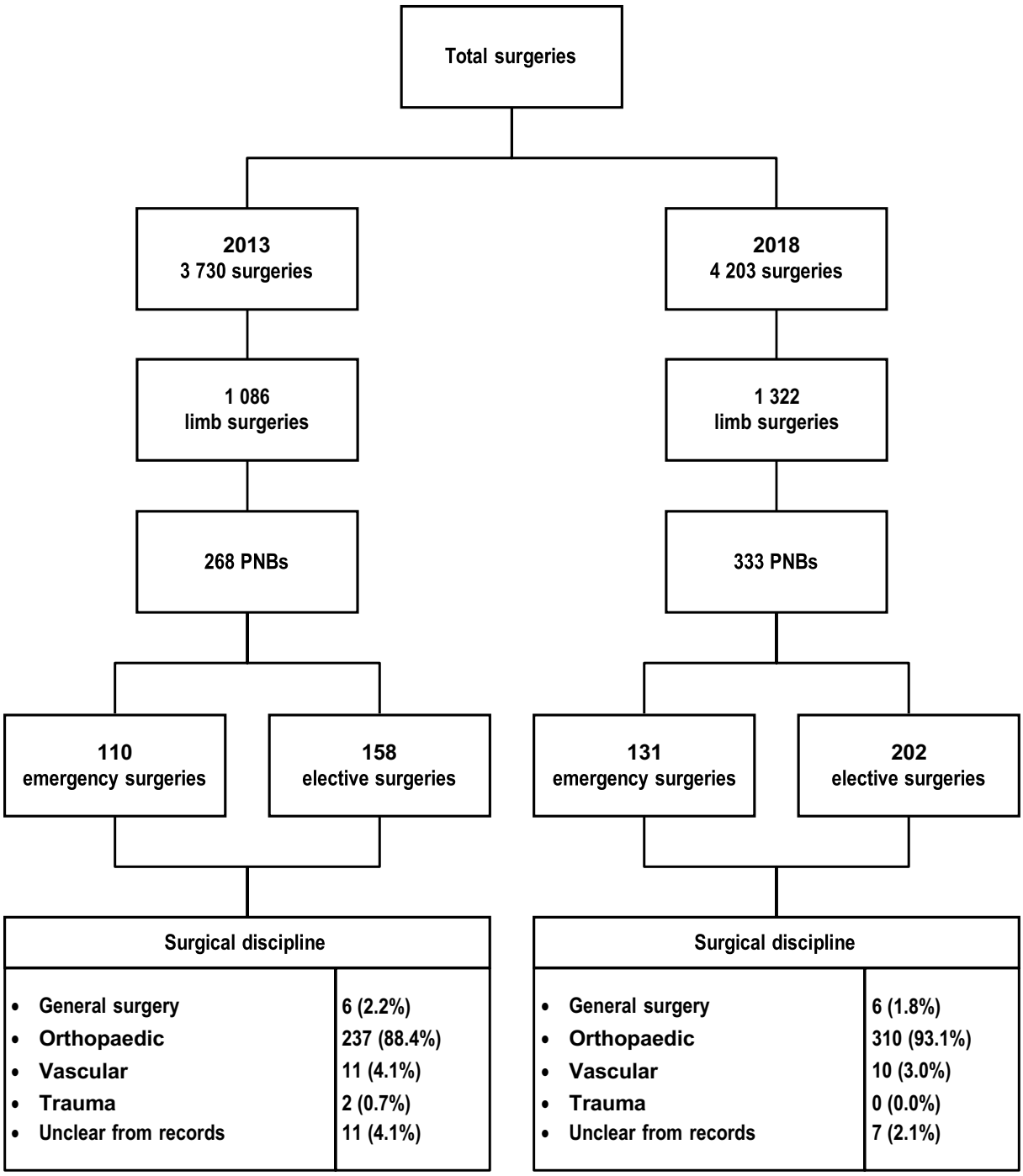


Figure 1: Derivation of study sample

Table 2: Patient characteristics

Characteristic	2013 (n=268)	2018 (n=333)	p-value
	Mean (SD)		
Age (years)	43.2 (16.6)	41.5 (15.5)	0.194
	Number (%)		
Sex			
• Male	177 (66.0)	212 (63.7)	0.544
• Female	91 (34.0)	121 (36.3)	
ASA rating			
• 1	145 (54.1)	170 (51.1)	
• 2	62 (23.1)	105 (31.5)	
• 3	32 (11.9)	40 (12.0)	
• 4	9 (3.4)	8 (2.4)	
• 5	3 (1.1)	0 (0)	
• Not documented	17 (6.3)	10 (3.0)	

No statistically significant differences between the two study periods were found between the number of PNBs performed (p=0.773), the surgical discipline requiring a PNB (p=0.241) or the number of emergency cases done (p=0.437).

The types of PNBs used during the two study periods are presented in Table 3. There was a statistically significant increase in the number of saphenous, supraclavicular, axillary and wrist blocks used in 2018 and fewer infraclavicular, femoral, lateral femoral cutaneous and psoas blocks.

Table 3: Types of PNBs used

Type of peripheral nerve blocks	2013 (n=320)	2018 (n=374)	p-value
	Number (%)		
Interscalene	16 (5.0)	21 (5.6)	<0.0005
Supraclavicular	2 (0.6)	38 (10.2)	
Infraclavicular	75 (23.4)	19 (5.1)	
Axillary	21 (6.6)	71 (19.0)	
Wrist	43 (13.4)	105 (28.1)	
Sciatic	63 (19.7)	57 (15.2)	
Femoral	67 (20.9)	39 (10.4)	
Saphenous	3 (0.9)	13 (3.5)	
Lateral femoral cutaneous	4 (1.3)	1 (0.3)	
Ankle	7 (2.2)	4 (1.1)	
Psoas compartment block	11 (3.4)	1 (0.3)	
Other blocks	8 (2.5)	5 (1.3)	

In 2013, 23.0% of patients who had PNBs were sedated, 59.7% had a general anaesthetic, 7.1% had an additional neuraxial technique and 10.2% received a PNB only. In 2018, 30.0% of patients also received sedation, 53.3% received a general anaesthetic, 9.2 % received a neuraxial technique in addition to a PNB and in 7.6% of patients, a PNB was used alone. There was no statistically significant change in the anaesthetic techniques used with the PNB between the two study periods (p=0.053).

In 2013, 20.8% of patients did not receive an anaesthetic or sedation before a PNB was done, with 23.1% in 2018. A neuraxial technique was done before the PNB in 6.3% of patients in 2013 and 8.6% in 2018. In 2013, 8.6 % of patients were sedated before the PNB, with 12.1 % in 2018. There was a significant decrease (p=0.006) in the number of patients who received a general anaesthetic before the PNB, 46.5% in 2013 versus 32.0% in 2018.

The nerve localisation techniques employed are shown in Table 4. Significantly more PNBs were done using nerve stimulation only in 2013 compared to

increased ultrasound guidance in 2018. There was a significant improvement in the documentation of nerve localisation techniques in 2018.

Table 4: Nerve localisation technique

Nerve localisation technique	2013	2018	p-value
	Number (%)		
Anatomical landmark only	3 (0.9)	14 (3.7)	**<0.0005**
Nerve stimulation only	144 (45.0)	14 (3.7)	
Ultrasound guidance only	25 (7.8)	201 (53.7)	
Nerve stimulation and ultrasound	17 (5.3)	61 (16.3)	
Not documented	131 (40.9)	84 (22.5)	**<0.0005**

Of the 75 PNBs done with nerve stimulation in 2018, the current endpoint was documented in 39 (52.0%) PNBs as opposed to 58 (36.0 %) in 2013. The mean (SD) current endpoint reported in 2018 was 0.287 (0.130) mA, which is statistically significantly lower than the mean (SD) of 0.421 (0.119) mA documented in 2013 ($p < 0.0005$). There was also a statistically significant improvement in the documentation of the current endpoint used with nerve stimulation in 2018 ($p=0.02$).

Bupivacaine was the local anaesthetic agent used most often. In 2013, it was used alone in 296 (92.5%) and in 2018 in 336 (89.9 %) of PNBs. In 2018, there was a statistically significant increase in the use of a mixture of lignocaine and bupivacaine ($p=0.017$), with a mixture being used in 13 (3.5%) in 2018 but in only 2 (0.6%) PNBs in 2013. The documentation of the volume of local anaesthetic used in 2018 showed a statistically significant improvement compared to 2013 ($p=0.014$).

The volume of bupivacaine used in the most common PNBs is presented in Table 5. There was a statistically significant decrease in the volume of bupivacaine used in interscalene blocks, infraclavicular blocks and sciatic blocks in 2018. A significantly lower concentration of bupivacaine was used in 2013 for axillary (p

<0.0005) and sciatic blocks (p=0.02). The median concentration of bupivacaine used in all blocks was 0.5%, except with the psoas compartment blocks in 2013, where 0.375**%** was used.

Table 5: Bupivacaine volume

PNB used	2013 (n=320)	2018 (n=374)	p-value
	Bupivacaine volume (ml) Median (IQR)		
Interscalene	20 (20-25)	15 (10-20)	**0.001**
Supraclavicular	22.5 (20-25)	18 (15-20)	0.145
Infraclavicular	35 (30-40)	30 (20-38)	**0.047**
Axillary	20 (15-40)	20 (20-25)	0.363
Wrist	10 (9-20)	15 (10-16)	0.269
Sciatic	27.5 (20-40)	20 (15-20)	**<0.0005**
Femoral	20 (15-20)	17.5 (10-20)	0.086
Ankle	20 (10-20)	17.5 (13-28)	0.788

Table 6 shows the adjunct used with the local anaesthetic agent. There was a statistically significant decrease in the use of adrenaline in 2018 compared to 2013, with a significant increase in the use of dexamethasone in 2018.

Table 6: Adjunct medication used

Adjunct medication	2013 (n=268)		2018 (n=333)		p-value
	n	%	n	%	
Adrenaline	176	65.7	104	30.7	**<0.0005**
Dexamethasone	0	0	17	5.0	
Dexmedetomidine	0	0	1	0.3	
Ketamine	1	0.4	0	0	
None	91	34.0	217	64.0	

In 2018, block failure was noted in 6 (1.8%) PNBs compared to 12 (4.5%) in 2013. No intra-operative complications were documented across either study period and only one post-operative complication in 2013. There was no statistically significant difference in the documentation of block failures between the two study periods (p=0.056).

Compared to 2013, the follow up of patients in 2018 showed a statistically significant improvement (p <0.0005). In 2018, 155 (47%) patients were documented in the block book for follow up. Of those, 67 (20.3 %) patients were found in the ward. Compared to the 75 (28.2%) patients documented in the block book in 2013 and only 19 (7.1%) patients were found in the ward.

Discussion

In a constantly evolving field such as PNBs, it is essential to ensure safety and quality of care since new technology does not necessarily translate into improved care. By conducting surveys and audits and creating compulsory reporting registries, quality of care can be monitored and improved if needed (11). This

study aimed to describe the change in practice during two study periods at CHBAH.

Few studies have described the overall use of limb PNBs in surgeries that are eligible. This makes comparisons difficult when different populations, surgeries and PNBs are assessed. At CHBAH in 2013, 24.7% of eligible limb surgeries received a PNB, and in 2018, 25.2 %. This is higher than the 3.3% reported in the United States of America in 2015 (6) and 16.3% in a single centre in Nigeria in 2013 (12). However, this is lower than the 72% reported in another single centre in Nigeria in 2014 (13). The relatively high use of PNBs at CHBAH could be attributed to the fact that it is a large teaching hospital.

This study showed no significant increase in the rate of PNB utilisation between the two study periods. Gabriel and Ilfeld (6) reported that despite the low overall prevalence, 3.3%, of PNBs in the United States of America, their popularity had increased significantly from 2010 to 2015. A similar increase in the utilisation of PNBs was expected at CHBAH. However, CHBAH is subject to systemic challenges, such as high patient loads and the inefficient utilisation of available theatre time. There may also be the perception that PNBs are time-consuming and this might limit their use. Huang and Gao (14) also stated that there is a perception that performing PNBs is time-consuming.

There was a significant decrease in the PNBs performed under general anaesthesia, from 46.5% in 2013 to 32.0% in 2018. In 2019, Luedi et al (15) demonstrated that most PNBs were done without a general anaesthetic in Switzerland. A patient's ability to report paraesthesia or pain on infiltration is an additional measure to prevent peripheral nerve injury (16); this might be the reason for the change of practice at CHBAH. The use of ultrasound also decreases the number of needle passes and as such, may improve patient comfort with acceptance of an awake PNB (7).

Between the two study periods, there was a significant change in nerve localisation techniques utilised at CHBAH. Nerve stimulation was used in 50.3% of PNBs in 2013 and only 20.0% in 2018 and ultrasound use increased from 13.1% in 2013 to 70% in 2018. In Warsaw (17), a similar increase in ultrasound use,

8.3% to 53.3% from 2006 – 2012, was reported after ultrasound was introduced. The increased availability of ultrasound machines, the increase in ultrasound PNB training as well as emerging literature on the benefits of ultrasound might account for this (1, 18-20).

The change in nerve localisation practice at CHBAH could be why the types of blocks done also changed. There was a significant increase in saphenous, supraclavicular, axillary and wrist blocks in 2018 with less frequent use of infraclavicular blocks. Fuzier et al (21), in France in 2016, demonstrated a similar increase of supraclavicular and axillary blocks when ultrasound was available. Ultrasound use is associated with a significant decrease in supraclavicular block associated pneumothorax (22); this may be the reason for the increased utilisation of the supraclavicular block at CHBAH. The increased use of axillary blocks could be attributed to the increased utilisation of ultrasound which allows for the more accurate localisation of all the terminal branches of the brachial plexus (23).

Before the introduction of ultrasound, the primary function of nerve stimulation was to locate peripheral nerves. Now it is used as a safety tool to decrease the risk of intraneural local anaesthetic infiltration, as a current endpoint of 0.2 mA is a reliable indicator of intraneural needle placement (24). This change in function could be responsible for the significant decrease in the current endpoint documented at CHBAH. In 2013, the mean current endpoint documented was 0.421 mA versus a mean of 0.287 mA in 2018. The latter is lower than the current endpoint of 0.3 -0.5 mA demonstrated in Switzerland by Luedi et al (15) in 2019. The disparity in practice at CHBAH and that of Luedi et al (15) is likely due to the difference between the German Society of Anaesthesiology and Intensive Care Medicine Guideline (that suggest a minimum current endpoint of 0.5 mA) (25) used in Switzerland and the South African Society of Regional Anaesthesia Guideline (16). The South African Society of Regional Anaesthesia Guideline (16) recommends that when nerve stimulation is used to locate a peripheral nerve, a starting current endpoint of 1 – 1.5 mA should be used and decreased until a motor response is obtained. At this point, local anaesthetic can be infiltrated. When nerve stimulation is used to detect and prevent intraneural injection, local anaesthetic should not be infiltrated if there is a provoked muscle response at 0.2

mA (16). The practice at CHBAH adheres to the South African Society of Regional Anaesthesia Guideline (16).

At CHBAH, there was a statistically significant decrease in the volume of bupivacaine used in 2018 for interscalene, infraclavicular and sciatic blocks which was also clinically significant. In Warsaw, Nowakowski et al (17) also demonstrated a decrease in the volume of local anaesthetic used as ultrasound use increased. Ultrasound allows for greater accuracy of local anaesthetic infiltration around the nerve; therefore, a smaller volume can achieve an adequate block (26).

Between 2013 and 2018, there was a significant change in the use of adjunct medication. There had been a significant decrease in adrenaline use, the predominant adjunct used in this study, between 2013 and 2018 from 65.5% of PNBs to 30.7%. This could be due to concerns of potential neurotoxicity. Adrenaline is associated with dose-dependent decreased neural blood flow at higher doses, which is a concern, especially in patients with peripheral neuropathy (27). Dexamethasone use significantly increased in 2018 in an attempt to prolong block duration. This prolonged duration is appealing, especially at CHBAH, where catheters are limited for continuous PNBs. However, dexamethasone was only used in 5.0% of PNBs in 2018. This might be because a prolonged duration of action is also seen when it is given intravenously, and the use for perineural injection has not been approved by the FDA (28). In 2018, Malchow et al (20) in the United States of America demonstrated higher use of dexamethasone; 10% as a single adjunct and in combination with clonidine in 13% of PNBs. The reason for increased dexamethasone use in the United States of America compared to CHBAH is unclear. The use of dexamethasone as an adjunct in the management of post-operative pain is not included in the American Pain Society Guidelines, however, clonidine is included (29).

There was improved documentation of nerve localisation techniques used, the current endpoint and the volume of local anaesthesia used in 2018. Follow up of patients who receive a PNB at CHBAH remains a challenge even though it had improved significantly by 2018. In 2018, only 47% of patients were recorded in the block book, and of those, only 20.3% were found in the wards. Lack of follow up in

the ward was due to the ward not being documented, patients being moved to another ward or discharged, and there is no formal follow up of PNBs over weekends. Although the documentation and follow up have improved, this is still a concern in the current environment of increased litigation.

The improvement in PNB practice between the two study periods could be attributed to specific anaesthesiologists championing the process of PNBs and formalised teaching of PNBs. Furthermore, a regional anaesthesia rotation was instituted in 2009 at CHBAH. It is recommended that audits and surveys be done on a regular basis to ensure continued improvement of PNB practice. A standardised form could be useful to improve the documentation of practice as a whole. The limitations of this study were the retrospective design and contextual nature.

Conclusion

There was no significant increase in the utilisation of PNBs from 2013 to 2018. However, practice of PNB has changed significantly regarding nerve localisation technique, the type of PNB used, PNBs performed under general anaesthesia, adjuncts used, volume of local anaesthetic used, follow up in the ward and documentation of PNBs. Even though challenges exist, the efforts made by championing anaesthesiologists have made an impact

Conflict of interest

The authors declare that we have no financial or personal relationships, which may have inappropriately influenced us in writing this paper.

Acknowledgement

This research was done in partial fulfilment of a Master of Medicine degree.

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Section 4: Proposal

The change in practice of limb peripheral nerve blocks at a central hospital over a five-year period.

Nadine Venter

2219281

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4.1 Introduction and problem statement

The use of peripheral nerve blocks (PNBs) have been associated with a decrease in opioid use, post-operative pain and post-operative nausea and vomiting (1, 2), making it an integral part of multimodal analgesia.

The first PNB was performed by Sir Francis Rynd (3) in 1844. Since then, the practice of peripheral regional anaesthesia has evolved. This change in practice was, in part, driven by the progress made in nerve localisation techniques (4, 5). The techniques have evolved from anatomical landmarks and needle-to-nerve contact with paraesthesia to electrical nerve stimulation and direct visualisation using ultrasound (4, 5).

Advancements made in nerve localisation techniques have contributed to the increased use of PNBs (6, 7), but it is still unclear which practise is safest (8, 9). No human studies identified have proven that one nerve localisation technique is superior to another in the prevention of peripheral nerve injury (10). However, ultrasound has been shown to have multiple advantages when compared to nerve stimulation (7, 11, 12).

This change in practice and increased utilisation of PNBs have been well documented in some countries. In 1998 Hadzic et al (13) conducted a nationwide survey on the practice of PNB in the United States Of America. An underutilisation of PNBs was demonstrated, and almost half of the respondents attributed the infrequent use to inadequate exposure during training. More than a decade later, Moon et al (14) and Helwani et al (15) showed an increase in residends' exposure. Gabriel and Ilfeld (6) showed an increase in popularity of PNB from 2010 – 2015 using data from 3 200 000 cases in the National Anesthesia Clinical Outcome Registry (16).

In 2013, Moon et al (14) demonstrated that ultrasound alone was the nerve localisation technique of choice in most of the PNBs performed. This practice was also found by Malchow et al (17) in 2018. In 13 897 consecutive regional anaesthetics, 80% of PNBs were done under ultrasound guidance alone. This is similar to the practice in France, as demonstrated by Fuzier et al (18) in 2013.

Ultrasound was considered the new gold standard in care by 73% of French anaesthesiologists, a marked change in practice from the survey published by Bouaziz et al (19) in 1997, which showed that 83% of PNB were done using nerve stimulation alone.

In Greece, 78.8% of PNBs in 2012 were done using nerve stimulation, and the main limitation to the practice of PNBs was the lack of training and equipment (20). In China, Huang and Goa (21) in 2016 also demonstrated a lack of equipment and that 68% of blocks were still being done using anatomical landmarks alone.

Surveying practice allows for the identification of limitations in a specific environment and provides a baseline to assess the impact of change in practice. A lack of resources and training in Nigeria was shown by Rukewe and Fatiregun (22) in 2010. The survey showed that 71.8% of Nigerian doctors had never seen a nerve stimulator. Four years later, Rukewe et al (23) reported a “positive development in a resource limited environment” when 72.1% of upper extremity procedures at the University College Hospital received a PNB with nerve stimulation being used in the majority of cases.

Despite the global trend to survey the practice of PNBs, no studies could be identified on the anaesthetic practice of limb PNBs in South Africa in general or at Chris Hani Baragwanath Academic Hospital (CHBAH).

4.2 Aim and objectives

4.2.1 Aim

The aim of this study is to describe and compare the practice of limb PNBs in adult patients at CHBAH over two three-month periods: 1 January – 31 March 2013 and 1 January – 31 March 2018.

4.2.2 Objectives

The primary objectives of this study are to**:**

- determine the proportion of limb surgeries done during the two study periods
- compare the number of limb surgeries that received a PNB during the two study periods
- describe and compare the type of PNBs utilised in the two study periods
- describe and compare the practice of PNBs utilised in the two study periods
    - describe the number of PNBs used in isolation or with a general anaesthetic or sedation
    - describe the nerve localisation techniques employed
    - describe the documented current endpoint when nerve stimulation was used
    - describe the local anaesthetic agent(s), volumes and concentrations used
    - describe the adjunct medication used
- determine and compare the documented failed PNBs
- determine the documented PNB related peri-operative complications
- determine the follow-up rate and reason for loss to follow up.

4.3 Research assumptions

The following definitions will be used in this study.

Anaesthetic chart: A pre-printed chart used at CHBAH that is completed manually by the anaesthetist to record any anaesthetic administered to a patient.

“Block book”: The book available in the recovery room at CHBAH, where anaesthetists record the details of patients who have received a PNB, to be followed up the next day.

Anaesthetic records: All written anaesthetic resources used and maintained by the CHBAH Department of Anaesthesiology to document patient information. This includes but is not limited to the anaesthetic chart and the block book.

Adjunct medication: Medication added to the local anaesthetic agent used. These include medications such as adrenaline, dexamethasone, ketamine, clonidine and dexmedetomidine.

Adult: any patient 18 years or older.

Upper limb peripheral nerve block: PNB targeting specific nerves that innervate the upper limb, such as the interscalene, supraclavicular, infraclavicular, axillary and wrist blocks.

Lower limb peripheral nerve block: PNB targeting specific nerves in the lower limb, such as the sciatic (anterior, sub-gluteal and popliteal approach), femoral, saphenous, obturator, lateral femoral cutaneous and ankle nerve blocks.

Upper limb surgery: Surgery performed on the upper limb from the shoulder distally.

Lower limb surgery: Surgery performed on the lower limb from the hip joint distally.

Current endpoint: The minimum stimulation current at which no motor response is evoked before local anaesthetic infiltration when nerve stimulation is used.

4.4 Demarcation of study field

The study will be conducted at CHBAH, affiliated to the Department of Anaesthesiology at the University of the Witwatersrand. CHBAH is a 2888-bed central hospital. The hospital has 25 theatres, and on average 65 000 surgeries are done annually.

4.5 Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of the University of the Witwatersrand. Permission to access stored anaesthetic records has been obtained from The Head of the Department of Anaesthesiology at CHBAH (Appendix 1). Approval will be obtained from the Medical Advisory Committee at CHBAH (Appendix 2).

Anonymity will be achieved using a study number, and no identifying information will appear on the datasheet (Appendix 3 and 4). A list of patient names, hospital numbers and the corresponding study numbers will be filed separately. Raw data will be stored securely on a password-protected database for six years. The data will only be seen by the researcher and supervisors, thereby ensuring confidentiality.

The study will be conducted according to the principles of the Declaration of Helsinki (24) and the South African Guidelines for Good Clinical Practice (25).

4.6 Research methodology

4.6.1 Research design

According to Burns and Grove (26), a research design offers a “clearly defined structure in which a study is implemented.” Data are collected, analysed and interpreted within this structure. This study will follow a retrospective, contextual, descriptive research design.

A retrospective study measures variables that have occurred in the past (27). This study design will acquire data from previously completed anaesthetic records from CHBAH.

A contextual study focuses on a particular group (28). This study is contextual as it will examine the practice of limb PNBs at CHBAH.

A descriptive study uses collected variables to answer a specific research question without manipulating the variables or trying to establish a cause-effect relationship (27). This study will describe the practice of PNBs at CHBAH for a three-months in 2013 and 2018.

4.6.2 Study population

The study population will be the anaesthetic charts of the patients who received limb PNBs in two time periods; 1 January – 31 March in 2013 and 2018. Approximately 350 PNBs were done in 2013 and 400 in 2018 during the first three months.

4.6.3 Study sample

Sample size

The sample size will be determined by the number of patients who have received a limb PNB at CHBAH over two time periods; 1 January – 31 March 2013 and 1 January – 31 March 2018. The study periods were chosen as the regional block follow-up book has only been in use since 2012 and was more established in 2013, thereby enabling the researcher to review follow-up of PNBs. The same period was then chosen in 2018 to account for any potential seasonal variability and in an attempt to review the change of practice over five years.

Sampling method

In this study, a consecutive convenience sampling method will be used. Consecutive sampling is a non-random sampling method in which the researcher uses every available incident or subject within the chosen study population. It is a version of convenience sampling which refers to the use of the most readily accessible subjects (29). In this study, consecutive convenience sampling means that every anaesthetic chart of adult patients who received a limb PNB at CHBAH during the study period will be collected.

Inclusion and exclusion criteria

The inclusion criterion for this study is the anaesthetic records of every adult patient who received a limb PNB during the study periods at CHBAH. Illegible records will be excluded from the study.

4.6.4 Data collection

Data collection sheet

A draft data collection sheet was compiled following an extensive review of the literature, the anaesthetic charts and the block book ensuring content validity. The draft data collection sheet was reviewed by three anaesthesiologists to ensure face and content validity. The anaesthesiologists' suggestions were incorporated into the final data collection sheet (Appendix 3 and 4). The data collection sheet will be set up electronically in the REDCap database. REDCap is a password-protected platform for data capture developed by Vanderbilt University. The data collection sheet includes the following information:

- general demographics
    - total number of limb surgeries done during the study period
    - total number of limb PNBs during the study period
- patient characteristics
    - age
    - gender
    - ASA rating
- surgical discipline, procedure and date of procedure
- anaesthetic administered in addition to PNB
- PNB
    - anaesthetic or sedation before the PNB
    - type of PNB done
    - nerve localisation technique
    - if nerve stimulation is used, the documented current endpoint
    - local anaesthetic agent used
    - local anaesthetic agent volume
    - local anaesthetic concentration
    - adjunct medication used
    - documented PNB related intra-operative complications
    - documented block failure
- follow-up
    - record of the patient in the block book

- patient available in the documented ward
- PNB related complications that are documented in the block book.

Data collection

Data will be collected after the relevant permissions have been received.

The completed anaesthetic records will be reviewed, and the patients who received limb surgeries during the two study periods will be identified and the numbers documented. The anaesthetic records of patients who have received a limb PNB will be assigned a study number, and their relevant information will be captured. Data capturing will be done in the Department of Anaesthesiology at CHBAH by the researcher, and records will not be removed from the hospital premises.

4.6.5 Data analysis

An excel spreadsheet will be generated using REDCap from the captured data. Data will be analysed in consultation with a biostatistician using the statistical program STATA version 14.2 (StataCorp, USA). Categorical data will be summarised using frequencies and percentages. Continuous variables that are normally distributed will be summarised using mean and standard deviation, and those not normally distributed will be summarised using medians and interquartile ranges. Comparisons between the number of limb PNBs performed during the two study periods will be made using Chi-squared or Fisher's exact test. A p-value of 0.05 or less will be considered statistically significant.

4.7 Significance of the study

PNBs have been associated with a decrease in opioid use, post-operative pain and post-operative nausea and vomiting (1, 2), and developments in technology have allowed for greater block success rates and led to an increase in popularity (6, 11). However, new nerve localisation techniques do not necessarily translate to improved quality of care. Quality assessment is, unfortunately complex. Donabedian (30) emphasised the relationship between the health care setting

and medical resources, the technical performance of the practitioner and the outcome of care in quality assessment. The author postulated that it was likely that a good health care structure resulted in good technical performance, which would lead to good outcomes. Following this framework, ongoing evaluation of practice in a specific setting is one method to assess quality of care. Surveying practice allows not only for the identification of shortcomings in a specific environment but also provides a baseline to assess the future impact of a change in practice. The result of this study will reflect the practice of limb PNBs at CHBAH during the two time periods studied.

4.8 Validity and reliability of the study

The validity of a study is the degree to which the conclusion represents the measured variables, and reliability of a study refers to the ability to be consistent across the range of measurements over time (31).

Measures taken to ensure validity and reliability include:

- using an appropriate research design
- use of a retrospective design to prevent anaesthetists from changing their practice in response to the study
- using a standardised data collection sheet with face and content validity
- a single researcher collecting data
- checking data entering for accuracy
- data analysis being done in consultation with a biostatistician.

4.9 Potential limitations

The limitations of a study are restrictions or problems that weaken the conclusions drawn from the findings of the study (27).

The findings of this study apply contextually to the practice of PNBs at CHBAH. The findings may not be generalisable to other hospitals.

Limitation of a retrospective study is the reliance on completed anaesthetic records.

4.10 Project outline

4.10.1 Time frame

Activity	May 2019	June 2019	July 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	June 2020
Proposal preparation														
Literature review														
Proposal submission														
Ethics approval														
Postgraduate approval														
Data collection														
Data analysis														
Draft article														
Editing														
Submission														

4.10.2 Budget

Section	Price per unit	Number of pages	Copies	Total
Proposal	R1	21	6	R126
Postgraduate form	R1	2	6	R12
Completed report	R1	100	4	R400
Binding	R200		3	R600
Grand total				R1138

The Department of Anaesthesiology will incur the costs of paper and printing of the postgraduate application.

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4.12 Appendices

Appendix 1: Permission from the Head of the Department of Anaesthesiology at CHBAH.

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University of Witwatersrand

27/05/2019

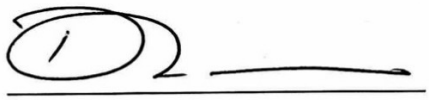
Attention: Dr Lines

Permission to collect data in the Department of Anaesthesia at Chris Hani Baragwanath Academic Hospital and to access anaesthetic records as well as the block book.

I hereby grant permission for data to be collected in the Department of Anaesthesia at Chris Hani Baragwanath Academic Hospital for the following MMED research project: The practice of limb peripheral nerve blocks in adult patients at a central hospital.

In my capacity as record gate keeper I also allow access to the anaesthetic charts and block book.

Kind Regards



Dr D Lines

Head: Clinical unit – Anaesthesiology

Chris Hani Baragwanath Academic Hospital

Appendix 2: Request to the CHBAH Medical Advisory Committee

Dr Nadine Venter

Department of Anaesthesiology

University of Witwatersrand

Attention: The Medical Advisory Committee CHBAH

Re: The practice of limb peripheral nerve blocks in adult patients at a central hospital.

To Whom It May Concern,

I am a registrar in the Department of Anaesthesiology. As part of the research component for my MMED, I would like to look at the of practice of limb peripheral nerve blocks at Chris Hani Baragwanath Academic Hospital.

My research would require permission to access completed anaesthetic charts and the “block book” from 1 January 2013 to 31 March 2013 as well as 1 January 2018 to 31 March 2018. Data collection will take place in a secure location on the hospital premises.

This study has been approved by the Research Ethics Committee (Medical) (number xxx) and the Graduate Studies Committee of the University of the Witwatersrand.

Yours sincerely,

Dr Nadine Venter

0610661590

nadineventer87@gmail.com

Appendix 3: General demographics data collection sheet

General demographic	Total number of limb surgeries done during the study period	2013	
		2018	
	Total number of limb PNBs during the study period	2013	
		2018	

Appendix 4: Patient data collection sheet

Study Number:			
Patient demographics	Age		
	Gender	M/F	
	ASA	1 2 3 4 5 E	
Surgical information	Surgical discipline:		
	Procedure:		
	Date of procedure:		
Anaesthetic administered in addition to PNB	Sedation	Y/N	
	General anaesthesia	Y/N	
	Neuraxial anaesthesia	Y/N	
	None	Y/N	
Peripheral nerve block	Before PNB	General anaesthesia	
		Sedation	
		Fully awake	
		Not specified	
	Type of PNB:	Interscalene	
		Supraclavicular	
		Infraclavicular	
		Axillary	
		Wrist	
		Sciatic (anterior, sub-gluteal and popliteal approach)	
		Femoral	
		Saphenous	
		Obturator	

		Lateral femoral cutaneous	
		Ankle	
		Other, specify	
	Nerve localisation technique	Anatomical landmark	
		Nerve stimulation	
		Ultrasound guidance	
		Not documented	
	If Nerve stimulation, documented current endpoint		
	Local anaesthetic used:	Bupivacaine	
		Lignocaine	
		Mixture	
		Other, specify;	
	Volume of local anaesthetic used		
	Concentration local anaesthetic		
	Adjunct medication used:	Adrenaline	
		Dexamethasone	
		Ketamine	
		Clonidine	
		Dexmedetomidine	
		Other, specify	

	PNB related intra-operative complications	Accidental vascular puncture	
		Suspected intraneural infiltration evidenced by documented increased resistance with infiltration or reported paraesthesia	
		Suspected Local anaesthetic systemic toxicity as evidenced by intralipid administration	
		Other, specify	
	Documented block failure	Y/N	
Follow up	Record of patient in block book	Y/N	
	Patient found in documented ward	Y/N	
	Documented PNB related post-operative complication, if yes details:	Y/N	

Section 5: Annexures

5.1 Ethics approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr N Venter

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M190613

NAME: (Principal Investigator)	Dr N Venter
DEPARTMENT:	School of Clinical Medicine Department of Anaesthesiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	The change in practice of limb periphoral nerve blocks at a central hospital over a five year period
DATE CONSIDERED:	2019/06/28
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Ms H Perrie, Professor J Scribante & Dr C Quan
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2019/10/01

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 on the 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
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 submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **June** and will therefore reports and re-certification will be due early in the month of **June** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES

5.2 Graduate studies 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

19 September 2019
Person No: 2219281
PAG

Dr N Venter
Unit 1, 32 Webb Street
Brackenhurst
Brackenhurst
1448
South Africa

Dear Dr Nadine Venter

Master of Medicine in Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled *The change in practice of limb peripheral nerve blocks at a central hospital over a five year period.* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.3 Turnitin report

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | FACULTY OF HEALTH SCIENCES

5th August, 2021

The Chairperson
Graduate Studies Committee
Faculty of Health Sciences
University of the Witwatersrand

Dear Madam,

Re M Med: The practice of limb peripheral nerve blocks in adult patients at a central hospital

Dr Nadine Venter, student number: 2219281, has submitted her research report to Turnitin which revealed a similarity index of 4%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of the research.

Yours sincerely,

H CPerrie

Helen Perrie
Supervisor

1

2219281:Nadine_turn_it_in.docx

ORIGINALITY REPORT

4%	2%	3%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Regional Nerve Blocks in Anesthesia and Pain Therapy, 2015. Publication	1%
2	hdl.handle.net Internet Source	<1%
3	wiredspace.wits.ac.za Internet Source	<1%
4	"Essentials of Regional Anesthesia", Springer Science and Business Media LLC, 2012 Publication	<1%
5	&NA;, . "Abstracts and Highlight Papers of the 31st Annual European Society of Regional Anaesthesia (ESRA) Congress 2012 :", Regional Anesthesia and Pain Medicine, 2012. Publication	<1%
6	"Essentials of Regional Anesthesia", Springer Science and Business Media LLC, 2018 Publication	<1%
7	josr-online.biomedcentral.com Internet Source	<1%