AN AUDIT OF ANALGESIC USE FOR HAND INJURIES IN A PRIVATE EMERGENCY DEPARTMENT IN JOHANNESBURG

Jan Rust Maloney

Student Number: 324136

Supervisor: Prof MDJ Wells

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of

Master of Science in Medicine in Emergency Medicine.

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DECLARATION

I, Jan Rust Maloney, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Medicine (Emergency Medicine) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Sign

30/09/2013

Date

DEDICATION

I gratefully dedicate this to my wife Caroline and my family for their love and support. Your patience and enthusiasm has made it possible.

I also dedicate this to the Lord God Almighty through whose love and grace, everything is possible.

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ABSTRACT

Objectives:

To describe the current analgesic practices for hand injuries used at a private hospital emergency department in Johannesburg, Gauteng and to explore any differences in analgesic practice between different doctor groups with different backgrounds, working in the ED.

Design:

Retrospective descriptive review.

Setting:

Private hospital emergency department in Johannesburg.

Patients:

A study sample of 423 patients who presented to the emergency department with hand injuries during 2010.

Methods:

The emergency department register was used to identify patients who presented with hand injuries. The clinical notes and where appropriate, nursing notes of the identified patients were reviewed.

Main Results:

Hand injuries were found to represent 9.3% of patients presenting to the emergency department. The most commonly used form of analgesia for hand injuries was found to be nerve blocks, which constituted 30% of the analgesic use. Digital blocks were the most frequently used block accounting for 69% of all nerve

blocks done. Parenteral analgesia was the second most common form of analgesia implemented with the intramuscular route being most favoured. Specialised techniques such as nerve blocks are possibly underutilised by doctors with less surgical and emergency department experience.

Conclusions:

Analgesic practices between different doctor groups are varied. Standardising pain management for hand injuries should lead to improved utilisation of techniques such as nerve blocks. Guidelines should be available and include nerve block techniques. Training should be provided to doctors who are unfamiliar with the use of additional modalities such as nerve blocks.

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NOMENCLATURE

Abbreviations

ED:

Emergency department

PCA:

Patient controlled analgesia

NSAID:

Nonsteroidal anti-inflammatory drug/analgesic. This includes a variety of drugs that inhibit cyclo-ocygenase activity. All the drugs in this group have analgesic, antipyretic and anti-inflammatory effect.(1)

IM:

Intramuscular

IV:

Intravenous

Definitions

Analgesia:

Absence of sensibility to pain or the relief of pain without loss of consciousness.(2)

Analgesic:

An agent that relieves pain without loss of consciousness.(2)

Opioid analgesic:

Encompasses a class of compounds that bind with a variety of closely related receptors named opioid receptors, that block the perception of pain. The receptors are found in the central nervous system. These agents include opium and its derivatives as well as a number of synthetic agents.(2)

Anaesthesia:

The loss of sensation or the ability to feel pain, caused by a drug or other medical intervention.(3)

Anaesthetic:

A drug or agent that is used to eradicate pain sensation.(4)

General anaesthesia:

This refers to a state of unconsciousness with the complete loss of pain sensation over the entire body. Agents that deliver this are called general anaesthetic agents.(3, 4)

Local anaesthesia:

Anaesthesia that is limited to one area of the body. The agents used to produce this are called local anaesthetics. Their anaesthetic effect is achieved by blocking nerve conduction. The area of the body affected is determined by the site of the agents application.(4)

Epidural (anaesthesia):

Anaesthesia that is the result of injecting the anaesthetic agent between the vertebral spines, into the extradural space.(3)

Retrospective study:

This refers to a scholarly examination based on events that have already occurred and therefore make use of existing data.(5)

Prospective study:

A scholarly study that makes use of data that still have to be generated as it is based on future events.(5)

Vital signs:

Also known as signs of life and include four objective measurements for a person. They are temperature, blood pressure, pulse rate and respiratory rate.(6)

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Chapter 1 INTRODUCTION

1.1 Motivation and rationale for this research

Currently there are no standard protocols available for the analgesic management of hand injuries in the emergency department. Different emergency facilities follow their own protocols and not much data are available to structure these protocols or the ED doctor's approach to analgesia for hand injuries in an evidence based or scientifically sound manner.

Pain management in the ED remains a problem with many reports from international studies showing inadequate analgesic use. Various protocols and guidelines are available to approach pain in general, but as mentioned, nothing specific for hand injuries.

Internationally, certain studies have emerged and lead to recommendations as to what is deemed the appropriate analgesic practices for painful hand injuries. In such a way, the use of loco-regional anaesthesia has been receiving much attention as a recommended form of analgesic management for hand injuries.

The hypothesis in this study is that local/regional anaesthesia techniques are also often underutilised in the South African ED setting, even when equipment and the various local anaesthetic agents are available without any contraindication to their use. There may be many potential factors contributing to this. Some of these may be attributed to the treating doctor's experience and background. This can include years of experience since qualification, previous exposure to the management of hand injuries (courses done in surgical technique and analgesia, field of current and previous clinical practice such as orthopaedic/plastic/general surgery, current and previous emergency department exposure.)

There is little information from South Africa on analgesic practices in the ED, especially with regards to hand injuries, and this study described the current practice in one hospital.

With the available guidelines for pain management in the literature, step wise administration analgesia is advocated. It is interesting to note that regional anaesthesia does not form part of these analgesic ladders and perhaps it is time for this to form part of the guidelines.

1.2 Statement of the problem

Emergency departments often have individual guidelines or protocols that they advise pertaining to analgesic practices in general, but no standardised protocols are available and currently no specific information is readily available on analgesic practices for hand injuries in emergency departments in the Republic of South Africa.

No information is therefore available to assess the range of analgesia used for hand injuries or to ascertain whether available specialised techniques, such as nerve blocks with its associated benefits, are being used. Furthermore, the lack of information makes it impossible to establish if there are any noticeable differences in the prescribing pattern and analgesic techniques used by doctors with different backgrounds or experience. The question beckons if there are differences, should there be standardised protocols available to guide and assist doctors?

1.3 Aim and objectives

This study described and discussed the current analgesic practices for hand injuries in a private ED in Johannesburg.

1.3.1 Study aim

The study aimed to identify the nature of analgesia given to patients presenting to the ED with hand injuries and to identify the variations, if any, in the practice of pain management by different doctors working in the ED with different levels of experience and backgrounds.

1.3.2 Study objectives

1. To describe the spectrum and number of hand injuries treated.
2. To identify the types and methods of analgesia used for pain control in patients with hand injuries and to identify the number and percentage of these patients who were given regional anaesthesia or peripheral nerve blocks.
3. To assess if there was any association between analgesic practices for hand injuries and the experience and background of the treating doctor.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

An injury of the hand, and the resulting pain, is a common reason for patients to present to the emergency department.(7-10) Some studies show that as many as 78% of patients presenting to the ED, do so because of some form of pain and the resultant need for adequate pain relief.(8, 9)

Pain, as a general complaint, is often reported as the number one complaint of patients when presenting to the emergency department, during examination and treatment. As much as 86.4% of patients mention pain as a complaint.(9)

Pain relief is a human right and not a luxury and as such it should be treated appropriately and promptly.(11) Trauma patients in the ED often experience high levels of pain as well as stress, making analgesia one of the key factors in the management of these patients.(12)

Hand injuries are especially common types of injuries sustained in the work or industrial setting and EDs servicing neighbourhoods close to industrial areas often see patients presenting with a variety of different hand injuries. Statistics from various international sources confirm this. In the USA, during 2004, 19% of ED visits were due to upper limb injuries. Of these, the wrist, hand and fingers were involved in 65% of cases.(13) Unfortunately the current statistics for South Africa are not readily available.

Hand injuries are not only very common but also very varied. This includes different mechanisms of injury as well as different degrees of injury ranging from very mild to very severe. Hand injuries are also often very painful and the optimal relief of the patient's pain is one of the main objectives in the initial management of the injury. (10)

When looking at the representation of the hand on the brain's somatic sensory cortex, it accounts for the second biggest involvement. The faces' sensory representation in the brain is the only sensory area of the body that occupies more of the brains' sensory cortex than the hand.(13) This puts the hand's sensory "ability" into perspective.

It is evident that pain and hand injuries, are common problems in the emergency department. Both are challenges that every person working in the ED will be exposed to. The management of the patient's pain is an important first step in the management of their injuries.

There are studies available in the literature investigating hand injuries and there are studies addressing pain in general. There is however very little information available in the literature about the specific topic of interest, namely analgesic practices for hand injuries, and no evidence in the literature about studies conducted in South Africa.

Although the purpose of this study will be purely descriptive and not to evaluate the efficacy of pain control or the lack thereof, the available literature suggests that pain is often undertreated. This was confirmed by Fabienne Karwowski-Soulié and colleagues, whose study found that pain was undertreated in 27% of cases presenting to the ED.(9)

2.2 Pain

2.2.1 Introduction

Pain, according to the Oxford English Dictionary, is “physical or bodily suffering; a continuous, strongly unpleasant or agonizing sensation in the body (usually in a particular part), such as arises from illness, injury, harmful physical contact, etc.”(14)

According to the Dorland’s Illustrated Medical Dictionary, pain is defined as “a more or less localized sensation of discomfort, distress, or agony, resulting from the stimulation of specialized nerve endings. It serves as a protective mechanism insofar as it induces the sufferer to remove or withdraw from the source.”(15) Pain is universally the same and in any language it is an unpleasant experience.

The International Association for the Study of Pain defines pain as “an unpleasant sensation and emotional experience associated with actual or potential tissue damage, or described in terms of such damage”. Pain, as opposed to other sensations, is a warning sign and is very complex.(16)

Pain is considered to be the number one complaint when patients present for emergency medical care. Due to the limited number of studies on the matter at the time, William H. Cordell *et al* decided to investigate pain and the ED. They conducted their study at a teaching hospital in Indianapolis and set out to look at the prevalence of pain in the ED. Although, as per their own narrative, there were a number of factors that could influence over and under estimation of pain in the ED, they still found that the majority of patients treated in the ED during this study, had pain at time of presentation. A total of 1665 patients who presented to the ED during a seven day period were included. Pain as a chief complaint was reported by 52.2% of the patients while 61.2% made note of experiencing pain.(17) Although up to 40% of ED patients may have chronic underlying pain, it is estimated that up to 45% of the patients with pain, have acute pain.(18)

One only has to look at the numerous pain clinics and multiple bodies devoted to pain management to realise that it a very important issue. This is also clear when looking at the many websites devoted to pain related issues when doing a search on the internet.

2.2.2 The pathophysiology of pain

Pain is the physiological response to a potentially harmful or noxious stimulus. The experience of pain differs between individuals due to many factors that influence a person's perception of pain. These include past experiences, emotional factors like anxiety, family attitudes, environmental as well as cultural factors.(18)

Pain is modulated by neurocognitive factors that lead to an unpleasant sensory as well as emotional experience. Pain also involves the release of potent inflammatory mediators.(18)

The discussion will focus mainly on somatic pain as this is the localised type of pain that is encountered with hand injuries. Visceral pain and the pathophysiology thereof are unrelated to the topic of discussion and will not be addressed.

Nociceptors or pain receptors are the type of sensory receptors that responds to painful or potentially harmful stimuli. These receptors form part of the peripheral nervous system that generates the sensation of somatic pain by registering the stimulus and conducting the impulse via the afferent fibres to the central nervous system.(18) Pain sensation (as well as temperature sensation) originates from these nociceptors which are unmyelinated dendrites of the sensory neurons. They are located around the hair follicles of hairy as well as hairless skin and can also be found in deep tissue. Once the pain impulse is generated through the noxious stimuli, the impulse is conducted via the afferent nerve fibres.

There are two different types of afferent nerve fibres involved in the transmission of pain impulses. The one type is myelinated Aδ fibres and the other type is C fibres which are unmyelinated. The Aδ fibres are slightly thicker on crossection than the C fibres and conduct impulses at rates of 12 – 30m/s, where C fibres conduct at a slower rate of 0.5 to 2m/s.(16)

This also relates to the terminology of fast and slow pain. Fast pain is conducted via the Aδ fibres and cause a sharp, localized sensation whereas slow pain is conducted via the C fibres and gives rise to dull, diffuse and intense type sensation.(16)

Pain is not only in itself debilitating but has a variety of effects on different systems in the body. These include a whole array of potential adverse effects on the respiratory, cardiovascular, genitourinary, gastrointestinal, immunological and endocrine systems.(7) Examples of this would be an elevation in the blood pressure, pulse rate and cortisol levels.(10) Effective analgesia is therefore important from both a psychological and physiological perspective.

The goal or endpoint of pain management may be different for different etiologies. Some would require complete pain relief for example, where chest pain is a symptom of cardiac ischaemia, the aim would be complete resolution of the pain. In other instances, for example, whether due to patient or cultural beliefs, the patient may prefer to have analgesia that may only limit or reduce the pain. Ultimately the goal for most types of pain would be the level that satisfies the needs of the individual patient.(18)

During a patient's stay in the ED they may often require further investigations which include physical examination, possibly radiological studies and, depending on the type of injury, even invasive procedures as part of the treatment. This often results in the patient needing to be moved to another location. All these factors can contribute to further discomfort and pain to the patient.(19) This often necessitates further pain management during the patient's stay in the ED or the administration of analgesia where initially, on presentation, the patient declined or did not require analgesia.

2.2.3 Classification of pain

Pain is often classified into two major categories namely acute/ physiological pain or chronic/ pathological pain. Acute pain normally serves as a protective mechanism and usually has a sudden onset and clears during the healing phase. Chronic pain or "bad pain" carries on even after the recovery period. Nerve injury is a cause for such chronic pain.(16)

2.3 Oligoanalgesia

The term for under treating a patient's pain is oligoanalgesia. It is also known by the term "hypoanalgesia". Many factors can lead to oligoanalgesia despite medication/analgesia being available. Two of these factors are the lack of proper assessment of the patient's pain and a lack of knowledge or experience with certain analgesia such as opioids which can lead to their suboptimal usage. Poor interactions between the patient and physician can also impact negatively on the situation. Sex, ethnicity, cultural and socioeconomic background, education and age have all also been found to play a role.(20, 21) The under treatment of pain is ironic as pain relief is one of the main interventions available to the emergency practitioner and it is often the only intervention that can be offered to the patient in the ED before referral for definitive management by the appropriate specialist.(22) Frankly speaking, patients expect and should receive pain relief in the ED.(23)

The parameter that has often been used in studies to investigate oligoanalgesia in the ED is the number of patients presenting to the ED with pain who subsequently did not receive any analgesia. There are potentially some shortfalls with using this parameter as patient's expectations are not taken into account and these could possibly play a very large role, affecting the patient's experience of pain and the satisfaction with treatment received.

Fosnocht *et al* evaluated patients' expectations relating to pain relief. They found that patients presenting to the ED expect a high degree of pain relief. By using scales they determined that patients expected 72% reduction in their pain, with 18% of the patients expecting complete pain relief after their ED visit. This had no correlation to their initial pain intensity on presentation, neither did age or gender influence these expectations.(23)

There are potential pitfalls in the traditional retrospective studies that are generally used to evaluate oligoanalgesia. There are more often than not very contradictory findings from different studies, as highlighted by Steven Green in his review of studies that address oligoanalgesia. The bottom line is that retrospective studies do not do justice to studies in the field of oligoanalgesia and that research in this field should be prospective and evaluate if patients actually desire analgesia, receive it and evaluate the effectiveness of this intervention.(24)

2.4 Improving pain management in the emergency department

Pain is subjective and should be assessed as such. Patients should be believed when they complain about pain. The aim when assessing acute pain in the ED should be to determine the intensity of the pain experienced. Assessing the quality of pain is a longer and more involved process and does not play a role in acute pain management.(11)

The assessment of pain is such an important aspect of patient management that pain is often referred to as the fifth (5^{th}) vital sign. This depicts how important it is to evaluate pain from the start.(11)

2.4.1 Pain assessment scales

Pain assessment scales are valuable tools used to evaluate the patients' experience of pain and can be implemented as a starting point to assess the intensity of the pain and to gauge the patients' response to analgesia.

Multiple different scales are available and discussed in the literature. The scales should be easy to use.(11) The most common ones are expanded on below:

The visual analogue scale (VAS)

This tool consists of a straight line marked from 0 to 100mm. On the left side the 0 mark is labelled “no pain” and on the far right side, the 100mm mark is labelled “worst possible pain”. The patient is asked to mark their pain on the scale which is then given as a ratio. One limitation is that this tool has to be available in printed form in order for the assessment to take place.(11)

Verbal Rating Scale (VRS)

The patient is asked to rate their pain as mild, moderate or severe. This type of scale’s use is limited by language barriers.(11)

Verbal numeric rating scale (VNRS)

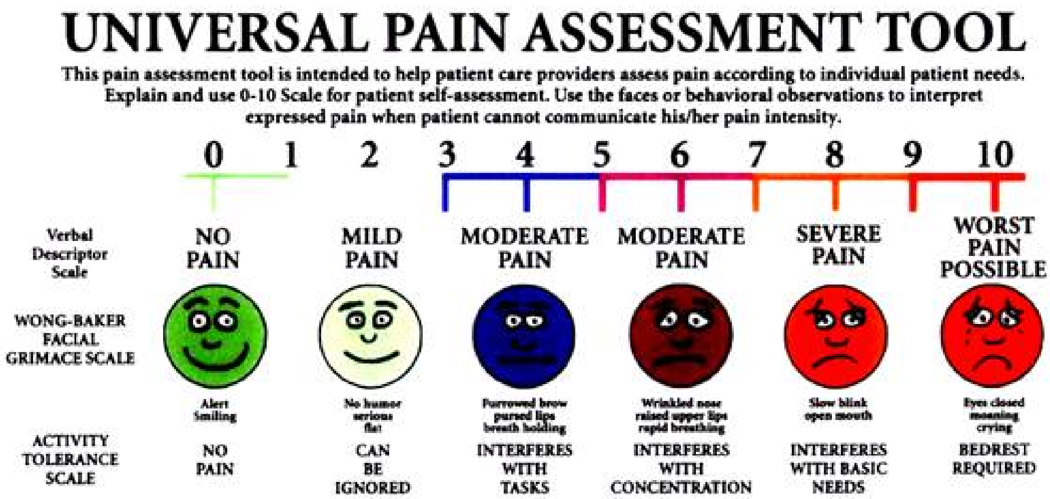
This is a verbal scale and therefore does not require any physical tools or equipment to be available. It is easy and quick to explain, understand and to carry out. The patient is asked to rate their pain on a scale from 0 to 10. Very slight discomfort would be 1 and the most severe pain imaginable or experienced would be 10. This type of scale is very similar to the VAS score.(11)

Faces (Wong Baker)

This scale makes use of drawings or pictures of faces that depict facial expressions consistent with different levels of pain from nil to severe. It has been proven to be valid for children from 5yrs of age and above and can also be used for adults with cognitive impairment.(11)

The Universal Pain Assessment Tool

This tool is a combination of the tools described above.



http://www.pacificu.edu/optometry/ce/courses/22746/images/clip_image002.jpg

Figure 2-1: Universal pain assessment tool

There are also pain assessment scales available that can be used where it would not be possible to use the above scales. The PAINAD scale (pain assessment in advanced dementia) is such a scale as it is based on factors such as breathing, negative vocalisation, facial expression, body language and consolability.(11)

Pain scales are useful as they provide an interactive way of evaluating a patient's pain and the response to treatment. The use of pain scales in the ED has resulted in improved awareness amongst clinicians about the patient's pain and expedited as well as improved analgesic administration, with improved pain relief and satisfaction of the patients.(20, 25-27)

Which tool should be used

In order to provide consistency in pain assessment the same pain assessment tool, as far as possible, should be used for all the patients seen at the institution. This is more important than which specific tool is used. In clinical practice the two tools most commonly used are the VNRS for adults and the faces scale for children or where there is cognitive impairment.(11)

2.4.2. Protocols and regional anaesthesia

Having a formal approach to pain management has been proven to favourably affect the treatment of patients' pain in the ED. The South African Acute Pain Guidelines contain recommendations to achieve this. This includes the recommendation to add the "5th vital sign" monitoring (pain) as part of the nursing chart. Pain should be assessed using an assessment tool and appropriate analgesia should be administered thereafter.(11)

Table 1: South African Acute Pain Guidelines

Pain Scale	***Interpretation***	***Recommended action/analgesia***
0 – 2/10	None	No treatment or NSAID or paracetamol
3 – 5/10	Mild	Paracetamol and weak opioid (codeine or D-propoxyphene)
6 – 8/10	Moderate	Codeine, paracetamol, NSAIDs, morphine
9 – 10/10	Severe	Morphine and paracetamol and NSAIDs, or epidural or PCA

The response to treatment, documentation of findings and actions as well as the monitoring for side effects of medication that was given should take place throughout the pain management process.(11)

The use of epidural is more relevant to post operative and in-hospital management of pain and protocols should therefore be adapted to the ED setting. PCA, although not commonly used in the emergency setting has potential for use in the ED.

The use of regional anaesthesia, where appropriate, is a very valuable option for the pain management of the trauma patient. The use of certain systemic analgesia should be avoided due to the negative effects on the patient's haemodynamic or respiratory function. There are also concerns about using opioids for patients where it is important to monitor mental status. In circumstances such as these, the use of regional anaesthesia can provide early effective analgesia, potentially preventing the side effects of systemic analgesic agents, and thereby facilitating better conditions in which to examine the patient. Achieving adequate and correct initial pain relief with regional anaesthesia can also have long term benefits for the patient such as reduced chances of developing chronic pain and post-traumatic stress disorder.(12)

The use of pain management protocols and guidelines show promise of improving patient analgesic administration. In 1996, Goodacre *et al* looked at the impact of instituting a protocol to improve analgesic administration. They found that by introducing a protocol they were able to improve the administration of analgesia although their study did not evaluate the patient's pain control. Even at that time, noting that this was some time before the implementation of many other types of protocols, they recognised the need for nationally recognised guidelines to make a difference in pain control on a larger scale.(22)

Decosterd *et al* conducted a study amongst adult patients presenting to the ED with pain. Their goal was to evaluate the impact of implementing guidelines for pain management in the ED. They formed a multidisciplinary committee, developed guidelines after reviewing relevant literature and implemented these in their department. Their findings showed remarkable improvement in pain management and they suggested the development of generalised algorithms that could be implemented in the ED.(20)

Guidelines are currently implemented on different levels including those that are developed and locally implemented for a specific department or institution. There are numerous professional bodies that have developed guidelines in order to improve and standardise analgesic administration on a wider level. An example of a local guideline is Froedtert Hospital, Milwaukee, in Wisconsin.(28) Guidelines by the College of Emergency Medicine in the UK that address a wider audience, is an example of a professional body guideline.(29)

In France, the Societies for Emergency Medicine and for Anaesthesiology developed guidelines and since 2002 French law has urged health care providers to follow the recommendations laid out by these societies to adequately evaluate and treat pain, thereby standardising these guidelines nationally.(30)

Also in France, Guéant *et al* published a very interesting article in 2011. They wanted to determine what the status of pain management was in French Emergency Departments. Up to then, numerous researchers had evaluated the situation in other countries, but little was known about the status in France.

What makes this research particularly interesting is the fact that it was a large study, conducted in 50 emergency departments nationwide after national pain management recommendations, as stated above, were introduced some years earlier. The study included 11 670 patients of whom 7 265 reported pain on admission. Various modalities including the visual analogue scale (VAS) and verbal numeric rating scale (VNRS) were used to assess patients' pain severity according to the French Society of Anaesthesiology classification. A number of factors were investigated such as; time lapsed between arrival in the ED and assessment, percentage of patients who received analgesia and time lapsed until analgesia was administered. The last, most important factor investigated was the percentage of patients who experienced pain relief. They found that oligoanalgesia is still "alive and well" despite national guidelines being available. The possible causes presented were multi-factorial. One of the recommendations from this study was a "specific pain treatment strategy in trauma patients, such as loco regional anaesthesia."(30)

Todd *et al* also reached a similar conclusion following a study undertaken in emergency departments in the United States and Canada. The Joint Commission on Accreditation of Healthcare Organizations created a number of standards for pain assessment and management in an effort to address oligoanalgesia. The study showed that despite efforts to improve pain management in the ED, the lack of proper pain management remains a problem.(31)

The American College of Emergency Physicians published their Policy Compendium which is an up to date summary of the bodies' policy statements as of the 31st December 2011. This addresses the issue of optimizing the treatment of pain in patients with acute pain presentation. It contains a joint statement made by the American College of Emergency Physicians, American Pain Society, and Society for Pain Management Nursing and the Emergency Nurses Association.(32)

The studies described above provide conflicting evidence. It is interesting to note that some studies show that implementing standardised guidelines improve pain management while others show less satisfactory outcomes despite guidelines being in place.

New ideas about pain management are emerging in an effort to address the ED current shortfalls. Not only does medication play a role but additional measures such as splinting, ice packs and elevation of the injured limb help to reduce pain. The provision of timeous pain management is just as important as the pain management itself. Protocols can be developed for the ED to address these common problems and having standardised protocols makes the management of pain more efficient.(33)

Different guidelines and approaches have been suggested. Many of the available guidelines are based on or refer to the guidelines developed by the World Health Organisation (WHO). The WHO developed a step wise approach to administering analgesia hence it being referred to as an "Analgesic Ladder". This was initially developed in 1990 with the analgesic management of cancer-associated pain in mind. It has subsequently been adapted to include the management of acute and chronic pain, also arising from non-malignant causes.(34)

http://www.imt.ie/mims/2010/08/who-three-step-analgesic-ladder.html

Figure 2-2: WHO Analgesic Ladder

The step wise approach of administering analgesia involves the administration of less potent analgesia first and then incrementally giving analgesia with higher potency. This tiered approach has the disadvantage that adequate pain control, especially in the acute pain setting, may be delayed in the process.

It is therefore recommended by some authors that the analgesia selection should be done according to the patients' pain severity (mild, moderate and severe) and not using a step wise approach. This should ensure earlier and more appropriate pain control for the patient. Local or regional blocks are very useful if possible and where appropriate.(18) For such an approach to be successful, ranking of the patients' pain is vital. A visual analogue scale (VAS) or numeric rating scale (NRS) can be used successfully for this purpose. Pain severity can then be ranked according the score and the score would then determine the choice of analgesia.

Paracetamol and NSAIDS are adequate for mild to moderate pain. Opioids can be titrated according to desired effect and are used for moderate to severe pain. The routine use of regional anaesthesia for trauma is also encouraged.(18)

Table 2 gives a comparison of how pain severity can be ranked according to scores obtained from using a pain scale scoring system such as discussed in section 2.4.1.

Table 2: Pain severity in relation to pain scale score

Pain Severity	**Score (VAS or NRS)***
Mild	0 – 3 or 4
Moderate	4 – 6 or 7
Severe	6 or 7- 10

*NRS is a score from 0 to 10; VAS is scored from 0 to 100 but should be scaled to NRS

2.5 Hand injuries

2.5.1 Incidence

As mentioned in the introduction, hand injuries are very common. According to J.K Dickson *et al*, hand injuries account for 10% to 20% of all who consult at the ED. This has remained rather constant over the past 20 years but the number of ED consultations have increased dramatically and this has led to a proportional increase of the actual number of patients with hand injuries presenting to the ED.(35) Other studies state the incidence of hand injuries as 6.6% to 28.6% of all injuries seen and 28% of the musculoskeletal injuries seen at the ED.(36)

A study conducted at an ED in Singapore included 504 patients with isolated hand injuries. They found that 51% of the patients were between 20 and 30 years of age and 88% were male. Injuries involving the left hand represented 55% of the total hand injuries with 46% involving the right hand. Four patients in this study had bilateral hand injuries. The most common finger involved in these injuries was the left index finger.(37)

Work related injuries follow the same trend. A review of work related injuries in Turkey revealed that hands were the most frequently injured body part. This type of injury constituted a third of all occupational injuries referred to the ED. Of this, 66% primarily involved the fingers.(38)

Work related injuries are some of the biggest causes of hand injuries and it follows that young manual workers seem to be the group mostly affected by hand injuries.

The mean age of patients' involved did not exceed 40 years of age with some studies presenting a mean age of less than 30 years. Hand injuries can negatively impact numerous hand functions temporarily or even permanently. Impairment of hand functions can impact dramatically on an individual's life due to the variety of functions the human hand has.(39)

The effect of hand injuries can have far reaching economic impact. This can be quantified by looking at factors like time off work in order to recuperate, cost of treatment for these injuries, especially if hospitalisation and surgery is required and disability resulting from hand injuries. The indirect cost due to factors such as sick leave and prolonged treatment are the biggest cost factors and outweigh the initial direct treatment cost. It is in this arena that specialist hand units can positively influence cost cutting by decreasing indirect expenses through shorter treatment duration and improved results.(36)

2.5.2 Anatomy of the hand

An understanding of hand anatomy is important as this will affect the clinical examination, treatment options as well as the choice of analgesia.

The anatomy that we will focus on in this discussion, are the parts relevant to the choice of analgesia. The anatomy of the hand is complex and a comprehensive discussion of the topic is not required for this review but basic anatomy knowledge, especially bone, tendons and sensory nerve innervations are important.

The hand consists of 27 *bones*, namely: 8 carpal bones, 5 metacarpal bones and 14 phalangeal bones.(40) Numerous muscles attach to the bones of the hand and in along with capsular ligamentous structures, collateral ligaments of the interphalangeal joints, are responsible for the multitude of movements possible in the hand and fingers.(40)

Each hand is divided into *zones* (1 to 5). This zoning is primarily used to describe flexor tendon injuries and the level at which they occur, but is a helpful additional way of describing the location of an injury to the hand. (10)

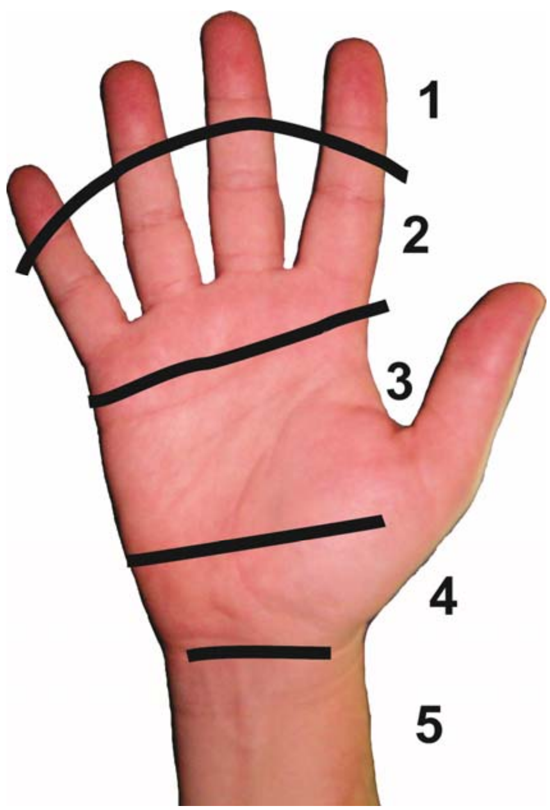


Figure 2-3: Hand Zones

Blood supply to the hand is via a dual system. Both the radial as well as ulnar arteries supply blood to the hand and digits. A combination of deep and superficial arches on the palmar as well as the dorsal aspect of the hand supply blood to the proximal part of the hand while digital arteries supply blood to the fingers.

Each finger has two digital arteries, one on the medial and the other on the lateral aspect of the finger. They arise from the superficial palmar arch.(40)

Nerve supply to the hand and fingers originate from three sources in the forearm and wrist: the ulnar nerve, median nerve and the radial nerve. The ulnar and median nerves have both a sensory and motor function whereas the radial nerve is purely a sensory nerve.(40)

Sensory nerve supply:

Ulnar nerve: The medial or ulnar aspect of the hand, little finger and medial half of the ring finger

Median nerve: The thumb, index finger, middle finger and radial side of the ring finger.

Radial nerve: The dorsal and radial aspect of the hand

There are digital nerves on both sides of the finger and each divide into a volar and a dorsal branch.(40)

Motor function will not be discussed here as it does not play a major role at the level of injury that this study encompasses.

2.5.3 Testing for nerve injury

All injuries to the palm of the hand or the digits should include evaluation of digital sensation and two-point discrimination.(40) Two-point discrimination is a valuable and reliable method of testing the sensory integrity of the digits.

Weber first discovered in 1835 that there is a minimum distance between two points touching the skin that can be identified by the person as two separate points of stimulation. Normal two-point discrimination is less than 6mm.(40, 41)

There are industry standard discs, readymade to use in the evaluation of two-point discrimination such as the "Disc-Criminator" but an unfolded paper clip with its two points calibrated correctly is just as accurate for this purpose. Paper clips are also cheap and usually readily available.(41)

2.6 Analgesia in the Emergency Department

Providing optimal pain relief is a critical component of a doctor's work in the ED. Many different forms of analgesia are available. These include the different groups of analgesics such as non-steroidal anti-inflammatory drugs (NSAIDs), opioids (weak and strong), paracetamol, specific cyclo-oxygenase 2 (COX-2) inhibitors and local anaesthetic agents.

2.6.1 Routes to administer analgesia

Different routes of administration such as oral, rectal, nasal, intravenous injection, intramuscular injection and nerve blocks or regional anaesthesia are available.(7)

Having different routes to administer analgesic agents adds to the convenience of choosing the appropriate form of pain treatment for the specific circumstance. Each has its own risks and benefits that need to be weighed up while choosing the appropriate route and this would also be affected by the choice of agent as some are only available in formulations that can be administered via certain routes.

Enteral administration can be divided into oral, rectal, sublingual and via feeding tube. Parenteral administration includes systemic non-invasive, systemic invasive, regional and neuroaxial. These can be further divided.

Systemic non-invasive route includes

- Intranasal via droplet or atomised spray
- Transdermal

Systemic invasive routes are:

- Subcutaneous
- Intramuscular
- Intravenous
- Intra-osseous

Regional administration includes single injection or indwelling catheters with local anaesthetics (with or without vasoconstrictors, steroids or NSAIDs).

The neuroaxial route would usually not be used in the ED for acute pain management. This consists of intrathecal (spinal) or epidural injections.(11)

2.6.2 Types of analgesics

According to the United States National Health Statistics report, analgesics are the most commonly mentioned type of drug in ED records.(42) This correlates with pain being such a common complaint in the ED.

The selection of the type of analgesia depends on many factors including the patient's subjective pain, the severity of the injury, the types of analgesia available as well as the treating doctor's experience and competencies. Thus different forms of analgesia could be appropriate, depending on the circumstances, as long as adequate pain relief is achieved with a minimum of unwanted side effects.(7) In this study "appropriate analgesia" will not be a measurable entity as this would depend on the availability of data to use for pain scoring. Such data are not available in a retrospective descriptive study and therefore the focus will only be on describing the choice of analgesics used by doctors working in the department.

Scoring systems to assess the severity of hand injuries are available, such as the HISS (hand injury severity scoring system) that was described and devised by Campbell and Kay in 1996. It was primarily developed as a research tool but also has a good prognostic predictive value regarding functional outcome.(43) For the purpose of this study, hand injuries will not be classified according to such a severity scoring system as data to accurately do this may be lacking in a retrospective study.

The discussion of the types of analgesia will be limited to the types of analgesia used in the ED where the study was performed. This discussion will not go into detail about the pharmacokinetics and pharmacodynamics, but will rather serve as an introduction to the most common analgesics available in this specific ED.

The medications can be divided into different classes based on its structure and the mechanism of action.

Paracetamol

Paracetamol is a non-opioid analgesic and is not an anti-inflammatory. It is effective for mild to moderate pain and is also an anti-pyretic. It is said to be as effective as aspirin for pain relief. No dosing adjustments are needed for patients with renal impairment or when there is mild hepatic impairment.

There is also no anti-platelet effect and it therefore has a better safety profile when compared with aspirin. Paracetamol can be used when there is a history of previous peptic ulcer disease, haemophilia, salicylate sensitivity and where there is anti-inflammatory induced bronchospasm.(18, 44)

Paracetamol is available in multiple formulations for enteral use such as tablets, capsules and syrups for oral intake. It has a rectal preparation in strengths suitable for children (125mg and 250mg). Parenteral paracetamol is available to give intravenously. The maximum daily dose for adults is 1g six hourly (4g per day).(11)

NSAID (Non Steroidal Anti-Inflammatory Drug)

This group of drugs includes a number of different drugs from different chemical classes:

Aspirin is usually readily available and can be given orally at 300-900mg every 4 to 6 hours with a maximum dose of 4g daily.(11)

Diclofenac is available in different forms including oral, intramuscular and rectal formulations. The maximum dosage is 150mg per day.(11)

Ibuprofen is available in oral formulation only and can be given at a dose of 200mg to 400mg every 4 to 6 hours with a maximum allowed daily dose of 1200mg.(11)

Ketorolac is commonly known under the trade name “Toradol”. It is available for oral and parenteral administration. The dosage is 10 – 30mg IV or IM every 4 to 6 hours. The oral dose is 10mg every 4 to 6 hours.(11)

Lornoxicam (“Xefo”) can be given orally or parenterally (IM or IV). The dose is 8 to 16 mg daily in 2 to 3 divided doses per day.(11)

Meloxicam is a selective COX-2 inhibitor. It is available in an oral formulation. Common trade names are “Mobic” and “Coxflam”. At higher doses, a degree of COX-1 inhibition also takes place. The prescribed dose is 7.5mg every 12 hours or 15mg once daily. The maximum daily dose is 15mg/day.(11)

Parecoxib (“Rayzon’) is a specific COX-2 inhibitor with no COX-1 inhibition and therefore less of the associated COX-1 inhibition associated gastro-intestinal side-effects. It is available for parenteral administration as an IV or IM injection. The recommended dose is 40mg that can be repeated after 6 to 12 hours with a maximum total daily dose of 80mg. *Celecoxib (“Celebrex”)* is another specific COX-2 inhibitor. It is available in oral formulation at a dose of 100mg to 200mg every 12 hours and a maximum daily dose of 400mg.(11)

Opioids

This group of medication is usually given when there is severe pain. Morphine is available to be given via the oral, IM and IV route. It can normally be titrated according to desired efficacy. Dosage for IM is 0.1 – 0.3mg/kg 4 hourly and for IV is in the form of a loading dose of 1 to 5mg IV followed by titration according to the pain improvement (scale) and sedation, at 3 – 5 mg/hour IV.(11)

Pethidine is given via the IM route at 1 to 1.5mg/kg every 3 to 4 hours.

Tramadol is an atypical opioid that is conveniently available to give orally as capsules, tablets and drops, as rectal preparation of 100mg per suppository and a parenteral formulation that can be administered IM or IV. The maximum dose is 400mg per day in divided doses.(11)

Combination drugs

There are numerous different analgesics available that are a combination of different types of analgesic agents. The reasoning behind this is that, less of each specific agent should be needed due to the added benefit of the combination of drugs and therefore there should be fewer dosage dependant side effects.(11)

Local and regional anaesthesia

Regional anaesthesia or nerve blocks are possibly the most efficient techniques to manage patients' pain resulting from hand injuries and at the same time make it possible for interventions/procedures such as debridement and suturing of wounds to be done. It is therefore recommended by some authors as the first choice for analgesia.(10, 45) Information from international studies postulate that these techniques are generally underutilised.(46)

Nerve block, as a pain relief technique, has the advantage of providing excellent analgesia, avoiding the side effects of systemic analgesics and promoting early mobilisation of patients.(11)

This is also the opinion of Grabinsky and Sharar. They undertook an extensive review on regional anaesthesia for acute traumatic injuries in the emergency room. Apart from experience in emergency rooms, they also reflected on the impact and advances in the field of regional anaesthesia made possible by experience gained in the military setting and on the battlefield. Regional anaesthesia was viewed as a "safe, effective and convenient" technique for pain control in patients with traumatic injuries by medical care providers from both the civilian and military camps. Regional anaesthesia also offers a very effective alternative to procedural sedation while being economical from both a staffing and a cost point of view. They also predicted that in the future, regional anaesthesia techniques will gain use and favour in emergency departments with more emergency medicine providers improving their skills and learning more techniques to provide regional anaesthesia.(19)

Local infiltration into or around the wound with a local anaesthetic agent will give pain relief but its use is limited to small open wounds. This technique is easy to administer and is safe and fast, but it also follows that as the wound gets larger, it will require more of the local anaesthetic agent and this can amount to a substantial dosage for large wounds.(47) Local infiltration is generally used for procedures such as debridement and suturing and although it can give pain relief, pain management is not an appropriate indication for local infiltration.

Regional anaesthesia or nerve blocks are achieved by the local infiltration of a peripheral nerve with a local anaesthetic agent that leads to decreased sensory input and motor output of the nerve involved. By definition this would require an injection site proximal to the wound to allow wound anaesthesia. Knowledge of the anatomy of sensory nerves of the body makes it possible to locate and appropriately infiltrate the nerve to cause anaesthesia of the area required.(47, 48)

This technique has the benefit of giving profound analgesia and as Reichmann *et al* eloquently put it, “with minimal physiologic or anatomic alteration.” These techniques are very useful as they can anaesthetise a larger area with less anaesthetic agent than would be possible with local infiltration. It is therefore particularly useful for large, extensive or multiple wounds where it would require large doses of local anaesthetic to infiltrate if a procedure such as suturing or debridement had to be done. A large dose of local anaesthetic agent can mean a potentially toxic dose.(47, 48)

For cosmetic reasons, nerve blocks are preferable over local infiltration. Due to the fact that the anatomy does not get distorted like it does when infiltration at the wound site takes place, it is easier to keep anatomical landmarks in the correct position for a better cosmetic result.(47)

There are different ways of locating the peripheral nerve to administer the local anaesthetic agent. The most commonly used way in the hand is by using the anatomy and landmarks to identify the nerve and to then infiltrate at the site of the nerve and let it diffuse into the area. The other technique is by using a nerve stimulator to identify the nerve but this can only be used for nerves that have motor fibres. This technique is generally not used in the ED due to the lack of availability of nerve stimulators and the lack of experience with the use of this equipment. (48)

Ultrasound guided nerve blocks are very useful where ultrasound equipment is available.

Apart from local infiltration and nerve blocks, there are other techniques such as intravenous regional analgesia, intra-articular analgesia and topical analgesia, but the discussion of these and other techniques are topics outside the spectrum of this review.(11)

Uses of local anaesthetics in the ED

The techniques relevant to this discussion will be local infiltration (subcutaneous) and selective upper limb regional anaesthesia techniques.

Subcutaneous infiltration

Lignocaine is the anaesthetic agent most commonly used for local infiltration. It can be used with or without adrenaline and is commercially available in both forms. Bupivacaine and ropivacaine can also be used for local infiltration.

Regional anaesthesia

Although there are many different techniques for regional anaesthetics, the techniques that will be discussed will be limited to relevant techniques for hand and finger trauma.

The indication for regional anaesthesia would primarily be pain in an area that can be managed with a regional block, where these techniques have more benefits and less risk than other forms of analgesia. The decision to use regional anaesthesia is made on a clinical basis, between the treating physician and the patient. The patient should be informed about the risks and benefits so that he/ she can make an informed decision. Nerve blocks require the co-operation of the patient.(49)

The risk for systemic toxicity is low at approximately 7.5 per 10 000 and this toxicity is often due to accidental intravascular injection. Although the risk is low, the first important factor is that regional techniques should be performed in a facility or area where there is monitoring and resuscitation equipment available in case of adverse reactions taking place. There is also a small risk of peripheral nerve damage. This risk is however also very low at 1.9 per 10 000.(49)

The "immobile needle" technique can be used. This technique makes use of intravenous tubing between the syringe and the needle thereby making it possible for the clinician to use both hands when placing the needle and using an assistant to aspirate and inject the local anaesthetic. For all the regional techniques, the basics of antiseptic skin preparation before needle insertion, should be performed. (49)

Most of the relevant techniques used for hand and finger injuries are techniques that are performed "blind". This means they are done by identifying the appropriate peripheral nerve through anatomical landmarks. The other aspect to assist with the "blind" techniques is the patients' cooperation. For a nerve block to be successful, the local anaesthetic agent must be injected around or in the proximity of the nerve (perineural) but not inside the nerve (intraneural). Intraneural injections can lead to ischaemic nerve damage as a result of increased pressure inside the nerve when the local anaesthetic is injected. When the needle comes in contact with the nerve, it will produce parasthesia in the nerve's distribution. Injecting local anaesthetic around the nerve can initially increase the parasthesia but injecting into the nerve will cause ongoing pain. By the patient interacting and reporting on sensation during the regional block, the chance of nerve injury can be limited and the success of the block improved.(49)

Different blocks:

Nerve blocks that can be performed for hand injuries include median nerve block, ulnar nerve block, radial nerve block, wrist block, metacarpal and the digital nerve block.(48)

Multiple nerves can be blocked simultaneously when required. This would be determined by the area required to be blocked. Knowing the anatomy and the nerve distribution of the affected area will be the deciding factor when choosing what type of block to perform.

Wrist blocks

These blocks are done by injecting the local anaesthetic agent around the appropriate nerve at the level of the wrist. Three nerves can be blocked at this level. They are the radial nerve, median nerve and the ulnar nerve. These nerves can be blocked individually or all three nerves can be blocked at the same time, depending on the area of the hand and fingers that require anaesthesia.

Radial nerve

This block requires up to 5ml of local anaesthetic. To perform this block, the landmarks to identify are the radial artery and the radial styloid. Local anaesthetic is then injected at this level just lateral to the radial artery and one would then proceed to inject subcutaneously extending over the radial aspect and over the dorsum up to the midline.(48)

Ulnar nerve

The first step in performing this block is to identify the flexor carpi ulnaris tendon. Identification of this tendon is made easier when flexing the wrist against resistance. The ulnar nerve and ulnar artery both run lateral or on the radial aspect and deep to the tendon with the nerve deep relative to the artery. An approach from the medial aspect is therefore recommended. The needle is inserted at the level of the proximal palmar crease on the ulnar side. (48)

Median nerve

The median nerve is located on the volar aspect of the wrist in the carpal tunnel. The Palmaris longus tendon is identified and then infiltration with the needle perpendicular to the skin is done, lateral to the Palmaris longus tendon between the proximal and distal wrist creases. If parasthesia is elicited the needle should be withdrawn a little before the local anaesthetic agent is injected. Between 3ml and 5ml of local anaesthetic is injected and there should be no resistance when injecting within the carpal tunnel.(48)

Digital blocks and metacarpal blocks

There are different techniques used to obtain a digital or finger block. They are the traditional digital block, metacarpal block, transthecal block and the subcutaneous block. All these blocks have risks and benefits.

The traditional digital block (TDB) consists of two separate injections given over the dorsal aspect in the web space, one on each side of the digit, while the hand is on a flat surface with the palm facing down. This results in a block of the proper digital nerves as well as the dorsal sensory nerves of each digit. One of the risks here is potential trauma to the neurovascular bundle.(50)

The metacarpal block (MB) is a modification of the TDB and involves two injections through the dorsum of the hand approximately 1cm proximal to the metacarpophalangeal (MP) joints. The TDB was shown to have a shorter time of onset and to be more effective than the MB.(50)

The transthecal block (TTB) is a technique originally described by Chiu in 1990. This works by administering the local anaesthetic directly into the flexor tendon sheath. The flexor tendon sheath directs the distribution of the local anaesthetic around the neurovascular bundle. This requires only one injection and avoids the risk of direct trauma to the neurovascular bundle. It does, however, carry a risk of infection. The original technique was described giving the injection over the distal palmar crease. A modified technique with the same results would involve injecting at the proximal digital crease.(50)

The subcutaneous block, apart from requiring only a single injection, has the added benefit of avoiding injection directly into the flexor sheath, thereby decreasing the risk of infection that goes with it.(50)

The debate that has arisen as to which of these techniques are superior is to be expected. Studies aimed at these precise questions have hinted that the subcutaneous and the TDB are comparable as far as injection pain is concerned but less so than the TTB. There was some contention regarding this issue but all studies found that patients experienced the TTB to be the most uncomfortable. As far as efficacy is concerned, the TDB proved to be the more effective and the palmar techniques had more chance of failing to block the dorsal aspect of the thumb and the dorsal and proximal aspect of the digits. The other factor counting in favour of the TDB was the faster time of onset when compared to all its rival techniques.(50)

With or without adrenaline?

The answer to this question was undoubtedly a resounding "no" for many years as evidenced by medical school teaching. Many questions have been raised about real scientific evidence that adrenaline is contraindicated in the digit.

There were some cases [21] of digital gangrene where epinephrine was involved. In retrospect, in all these cases, epinephrine was mixed with older type anaesthetic agents such as cocaine, procaine and eucaine. Other compounding factors that played a negative role were excessive volume of injections, prolonged tourniquet use and infection. A popular hand surgery textbook published in 1956, cited some cases to support the omission of adrenaline in digital blocks but, ironically, adrenaline was not even used in the cited cases.(50-52)

Multiple studies have since proven that the use of adrenaline, in concentrations available in commercial preparations, is safe.(49-51, 53)

Adjuvants to analgesic agents

There are many adjuvant modalities available to assist with pain management. It is important to be aware of these although in the emergency setting, some of these techniques may not be applicable or practical.

There are physical and cognitive-behavioural interventions. The physical interventions are heat and cold application, immobilisation, massage, exercise, transcutaneous nerve stimulation and acupuncture. Cognitive-behavioural interventions includes reassurance, education and information, distraction, relaxation, hypnosis, imagery and biofeedback.(11)

Chapter 3 MATERIALS AND METHODS

3.1 Ethics

Permission to conduct the study has been obtained from the Management of Netcare Union Hospital. Furthermore, ethical clearance was obtained from the Human Research Ethics Committee for Research of the University of the Witwatersrand and from the Netcare Research Ethics Committee.

3.2 Study Design

Retrospective descriptive study

3.3 Study Setting and Population

Site of study

Netcare Union Hospital in Alberton, Gauteng.

Study population

All patients presenting to the Netcare Union Hospital with injuries to the hand

Inclusion criteria:

1. All patients who presented to the emergency department with hand injuries during 2010.
2. Hand injuries in this study included any injury distal to the radiocarpal joint.
3. Files were only used where complete data could be obtained.

Exclusion criteria:

1. Patients with multiple system trauma including hand injuries were excluded.

2. Patients who had already received analgesia other than a stat (once off) dose of oral paracetamol or a NSAID, before presenting to the emergency department.

3.4 Study Protocol

3.4.1 Data collection

Data were collected by using the ED attendance registers to identify patients who presented to the emergency department with hand injuries during 2010. Information in this attendance register included the patients' name, hospital number, address and diagnosis. Patients who sustained hand injuries were identified in this way. Using this information; the relevant clinical notes and, where needed, nursing notes were drawn and then reviewed to extract the relevant information.

Patient details were kept anonymous. Relevant information was documented and included:

The demographic variables:

- Age (in years)
- Gender

The hand injury (HI) variables were:

- Time of injury
- Time of presentation to the ED
- Time lapse between injury and presentation to ED

- Where the injury happened (work / private / sport / etc.)
- Injury type
- Mechanism of injury (crush / cut / amputation / etc.)
- Severity of injury (1=least severe; 3=most severe)*.
- Open wound (Y/N)
- Hand area affected (single finger / multiple fingers / hand / wrist)
- Zone of injury (combinations of zones 1-5)
- Hand injured (Right / Left)
- Part (finger) injured (combinations of fingers 1-5)
- Number of fingers injured

The analgesia variables were

- Analgesia type (oral / parenteral / nerve block / etc.)
- Analgesia administration route (oral / IV injection / location of nerve block / etc.)
- Analgesia medication (NSAID / opioid / local anaesthetic / etc.)

Finally, the doctor group was recorded (full-time in ED: partner / full-time locum; part-time in ED: non-surgical locum / surgical locum; doctor with anaesthetics experience (who could originate from any of the other 4 categories)).

*Hand injury severity could not be classified according to a hand injury severity scoring system, as the required information was not available in this retrospective study. We have used a very basic classification of severity for the purposes of this study that was possible with the limited information available in the retrospective study. The injuries were classified as follows: Severity 1 injuries were minor injuries that included abrasions, contusions and superficial lacerations. Severity 2 injuries were moderate injuries and included deep lacerations and minor crush injuries. Severity 3 were more severe crush injuries, amputations, open and closed fractures and other complicated open wounds such as deep lacerations with tendon lacerations.

3.4.2 Sample Size

This study sample included 423 non-consecutive patients with hand injuries presenting to the Union Hospital emergency department during a one year period from 1st January 2010 to 31st December 2010. It was decided from the start of the study protocol to use a convenience sample group of at least 400 patients as initial estimations were that this number of patients would be attainable during the study period of one year. The number of hand injuries seen during the study period had been greatly underestimated as became evident during the data gathering process, however. In order to obtain a group of at least 400 patients, data were captured from the beginning of the study period until the required minimum number of patients had been included. As this was primarily a descriptive study, a sample size of 400 had been determined to be appropriate for the desired objectives. The final sample size was 423 patients as additional patients had been recruited during the data collection process to allow for possible incomplete data.

3.4.3 Data Analysis

All data were captured from the data collection forms and entered into an electronic spreadsheet (Microsoft Excel, Microsoft Office 2007, Microsoft Corporation).

Continuous variables (such as age) were expressed as means and standard deviations as well as medians and interquartile ranges. Categorical or discrete variables (such as sex, nature of injury, nature of treatment) were expressed as frequency distributions and percentages.

The specific analyses that were performed included:

- Analysis of numbers and frequencies of sex, age categories, site of injury (work, home or other), time of presentation, mechanism of injury (crush, laceration, amputation), type of hand injury sustained (soft tissue only, bony injury only, both), extent of the injury (involving one finger, multiple fingers, hand only or fingers and hand), type and route of analgesia given (IV, IM, oral, SC or block; opioids, NSAIDs, paracetamol, lignocaine, ropivacaine, other), category of treating doctor (partner, fulltime ED doctor, part time /locum with anaesthetic experience or surgical experience or limited / non-surgical experience).
- Correlation and subgroup analyses were performed between the type of analgesia and time of injury, mechanism of injury, type of injury, extent of injury (Involving one finger only, multiple fingers, hand only without finger involvement or hand and finger involvement) and category of treating doctor.

Data analysis was carried out in SAS. Citation: SAS Institute Inc., *SAS Software, version 9.3 for Windows,* Cary, NC, USA: SAS Institute Inc. (2002-2010) and the 95% confidence level was used throughout, unless specified otherwise. Tests for significant relationships were carried out using Pearson's X^2 test. Fisher's exact test was used in the case of 2x2 tables, or where the requirements for Pearson's X^2 test could not be met. The strength of the associations was determined by Cramer's V (the Phi coefficient was used in the case of 2x2 tables). The absolute values of these coefficients were interpreted as follows:

- 0.50 and above — high/strong association
- 0.30 to 0.49 — moderate association
- 0.10 to 0.29 — weak association
- below 0.10 — little if any association

3.4.4 Significance level

A $p < 0.05$ was considered to be significant for all statistical tests.

3.5 Software

All data were entered and stored in a Microsoft Excel® (Microsoft Office 2007, Microsoft Corporation) spreadsheet. Data analysis was carried out in SAS. Citation: SAS Institute Inc., *SAS Software, version 9.3 for Windows,* Cary, NC, USA: SAS Institute Inc. (2002-2010).

3.6 Methodological limitations of this study

Retrospective descriptive review.

Chapter 4 RESULTS

4.1 General

There were approximately 2292 new patients with hand and finger injuries out of approximately 24726 patients seen during the year 2010 in the emergency department. There were 423 cases (patients) included in this study. A group of 400 patients was needed. Data collection started by reviewing patients with hand injuries from January 2010 and progressively working chronologically forward. This was done until a group of 423 patients' data were collected that complied with the study criteria. It was noted that approximately 300 other cases were not included in the study due to incomplete case notes/missing data as well as exclusion criteria. It was assumed that this did not introduce any bias into the data set with regards to the nature of injuries or the type of cases attended to by the different groups of doctors as the excluded cases were not time or doctor /doctor group specific.

4.2 Demographic details

Male patients were injured in 83% of the cases. The median age was 33years (interquartile range 26-42 years). Ages varied from 1 year to 79 years of age.

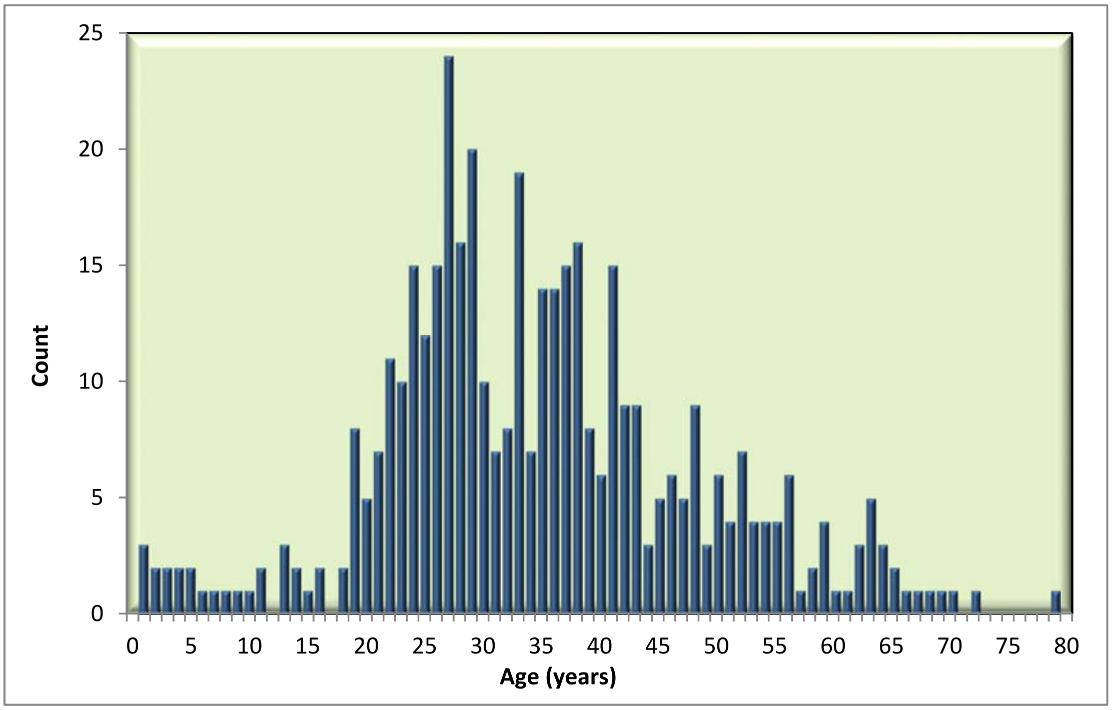


Figure 4-1: Frequency distribution of age

4.3 Hand injury results

4.3.1 Time of injury

An accurate time of injury was only available for a subset (51%) of the patients and these were predominantly the patients who were injured at work. This data were readily available due to completed employer reports that require a time of injury to be documented.

Up to 80% of the injuries took place between 07h00 and 16h59. A further 9% of the injuries took place between 17h00 and 22h59. Due to reasons mentioned earlier, this represents primarily the work related injuries. Therefore this does not give us an overall picture of when the full spectrum of hand injuries took place.

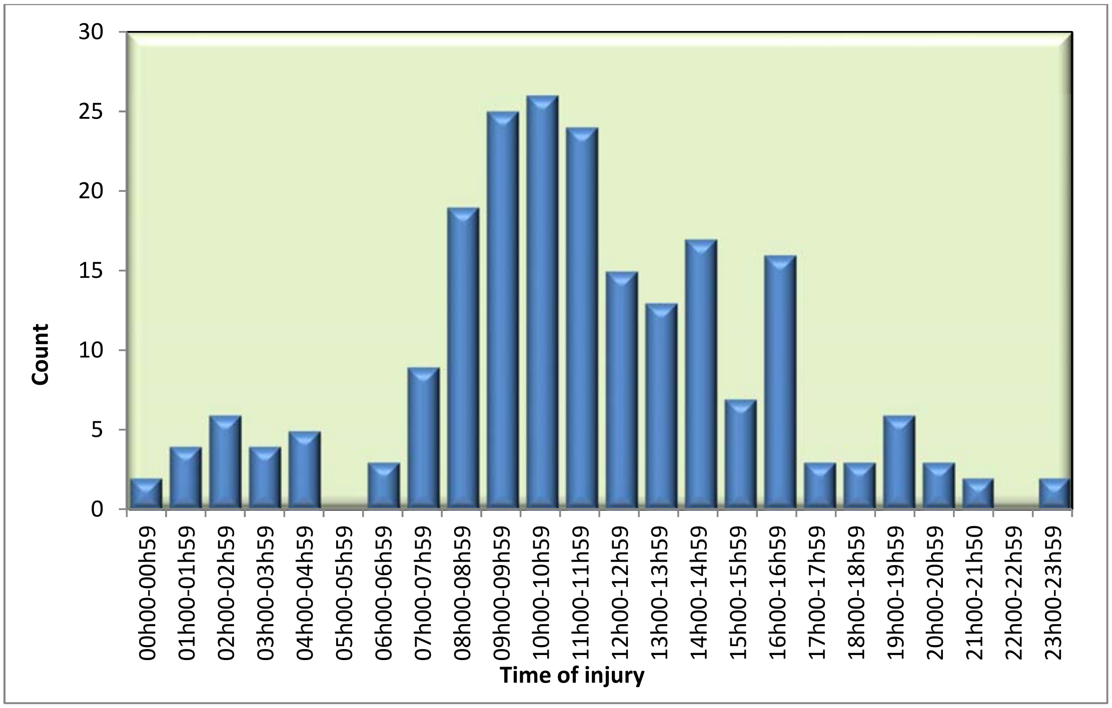


Figure 4-2: Frequency distribution of injury time

4.3.2 Time of presentation to the ED

The frequency distribution of the time of presentation at the ED is shown below. (Each value on the x-axis represent a full hour; e.g. 7 represents 07h00-07h59). A total of 65% of the injuries presented to the ED between 07h00 and 16h59, with 29% presenting between 17h00 and 22h59.

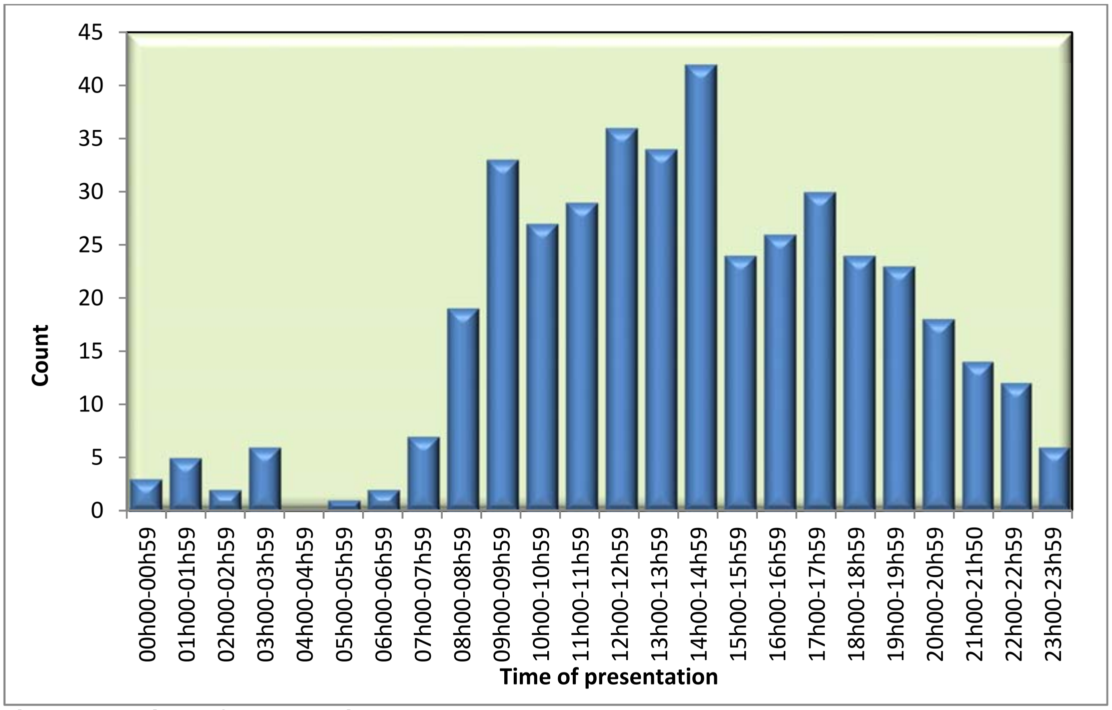


Figure 4-3: Time of presentation to ED

4.3.3 Time of presentation to the ED in relation to where injury occurred

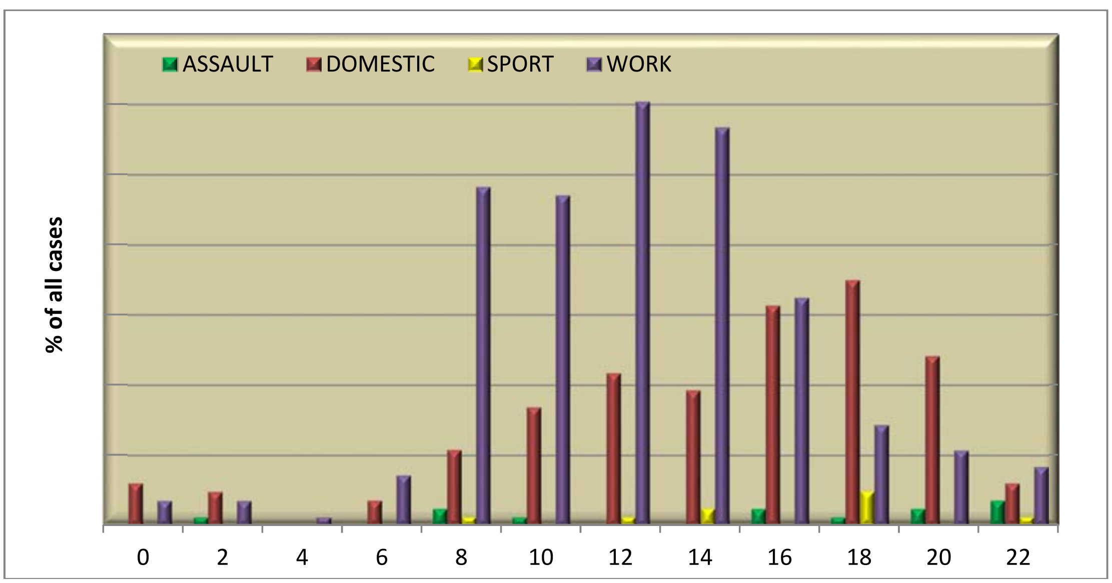


Figure 4-4: Frequency distribution of time presenting to ED

As seen in figure 4-4, 83% of work related injuries presented to the ED during working hours (08h00 till 17h59), while domestic injuries showed a distribution throughout the day and well into the evening. During the day (08h00 to 17h59), 56% of the domestic related injuries presented to the ED and 89% was seen between 08h00 and 21h59.

4.3.4 Time lapse from injury to presentation

The frequency distribution of the time lapse between injury and presentation at the ED is shown below in figure 4-5. (Each value on the x-axis represents a full hour; e.g. 7 represents 7h 0min to 7h 59min). Note that 49% of cases did not have this data recorded due to missing injury time data and so again we are looking at predominantly work-based injury data. Of the cases with available data, 79% came to the ED within 4 hours of injury (83% within 6 hours of injury). Again, it is important to note that the time lapses represented here are not a picture of the overall data set due to the bias in missing data.

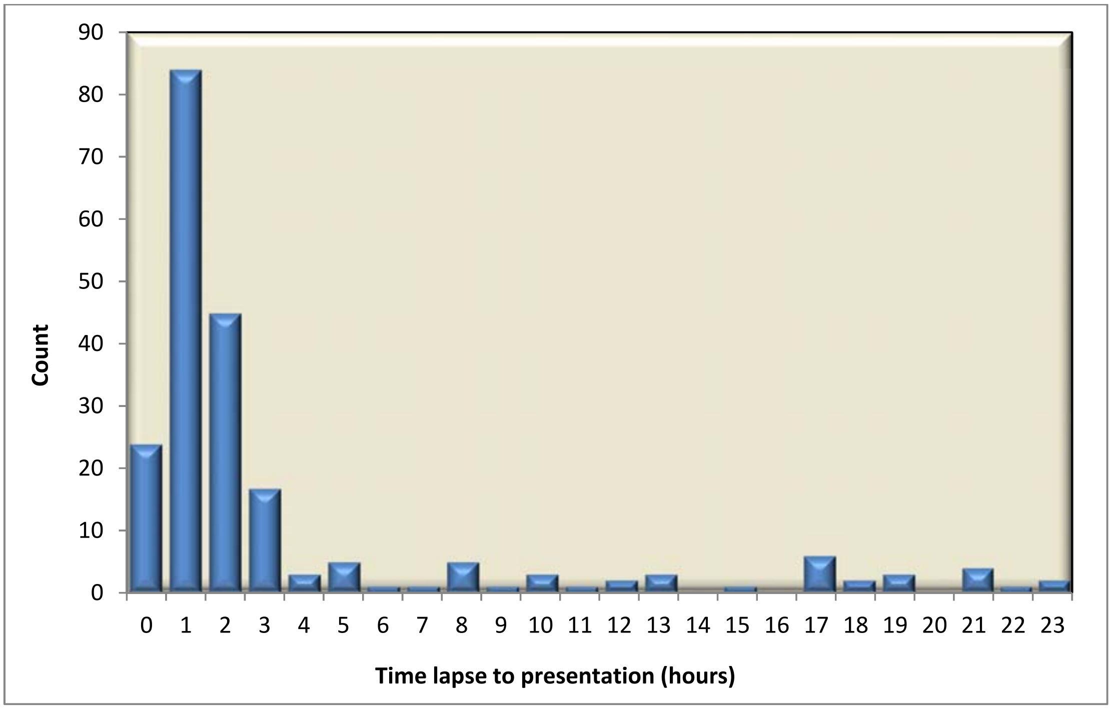


Figure 4-5: Time from injury to presentation

4.3.5 Place where injury occurred

Workplace injuries accounted for 58% of all injuries, followed by injuries at home (35%).

4.3.6 Mechanism of injury

Cut (33%) and crush (30%) were the most common mechanisms of injury.

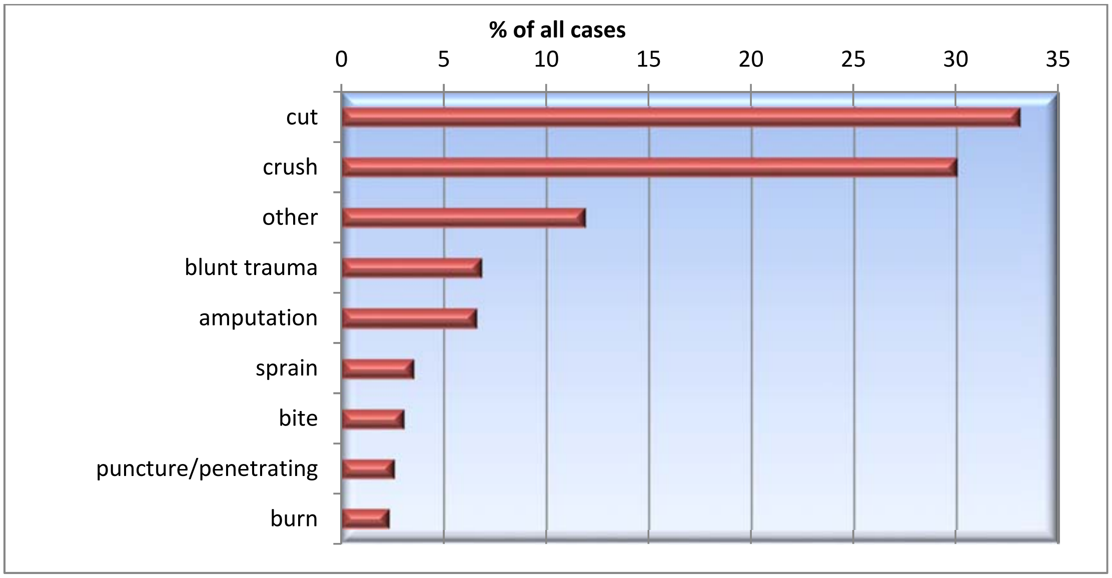


Figure 4-6: Mechanism of injury

4.3.6.1 Mechanism in relation to where injury occurred

Due to the sparseness of data in the cross-tabulation, we can test only for the association between source of injury and mechanism for work and domestic injuries. There was a significant moderate association between source of injury and mechanism (Pearson's X^2 test: $p<0.001$; Cramer's V=0.34). Work injuries were characterised by a higher proportion of crush injuries and a lower proportion of cuts than domestic injuries.

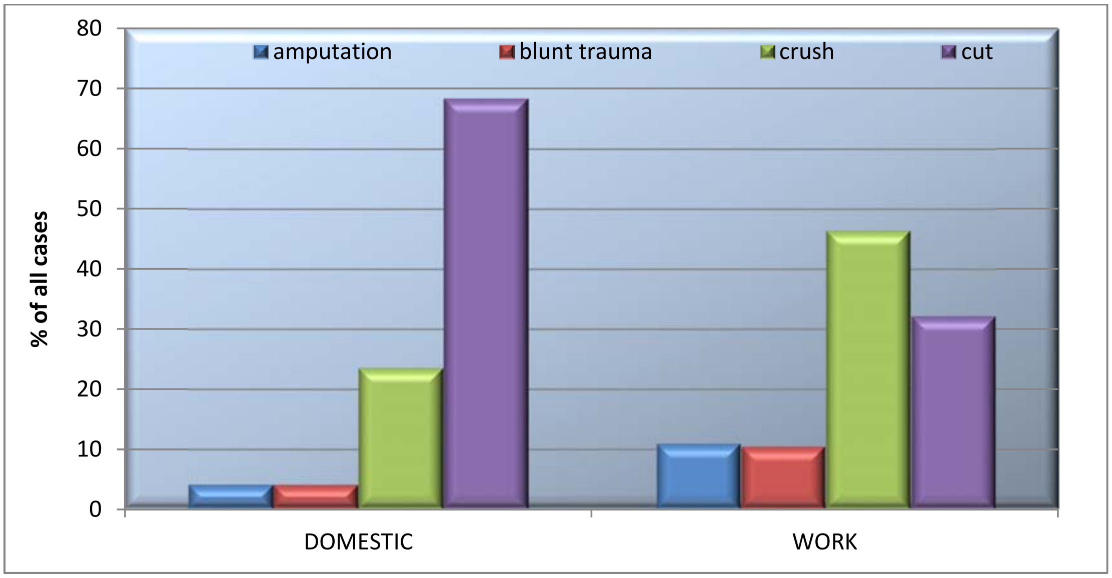


Figure 4-7: Mechanism in relation to where injury occurred

4.3.7 Type of injuries sustained

Lacerations were by far the most common injury type (39% of cases). A combination of injuries accounted for a large variety of injuries.

4.3.8 Open wounds versus closed injuries

Open wounds made up 72% of all the injuries. (Missing data account for 1.0%). Patients with open wounds had a higher proportion of single finger injuries and lower proportion of hand injuries than patients with closed injuries.

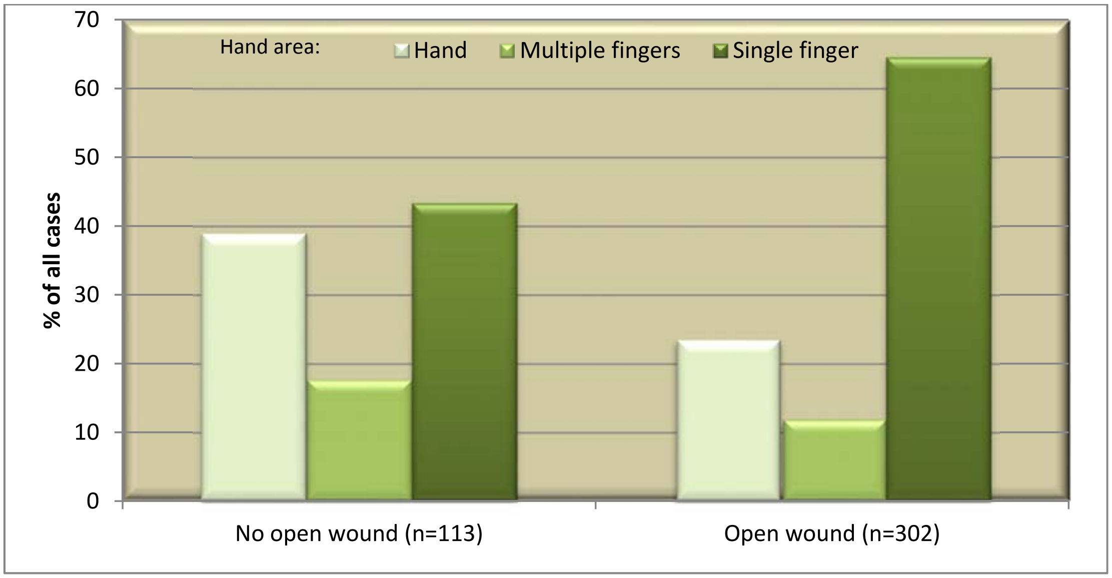


Figure 4-8: Open and closed injuries in relation to hand area

There was a significant but weak association between whether or not patients had an open wound and the number of fingers injured. A higher proportion of patients with one finger injured had an open wound.

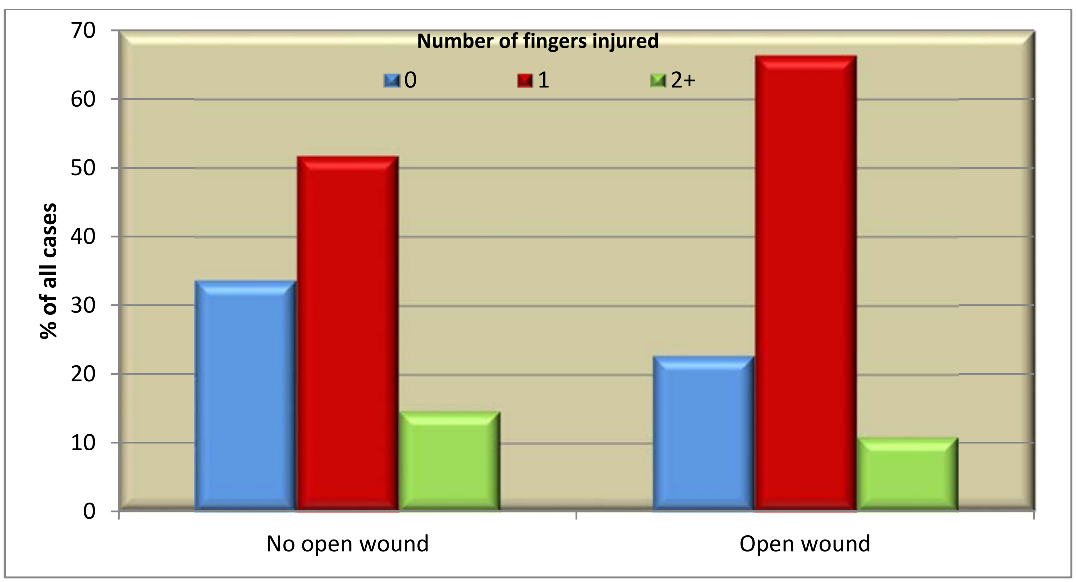


Figure 4-9: Open wound in relation to number of fingers injured

There was a significant but weak association between source of injury and whether or not patients had open wounds (Fisher's exact test: $p<0.001$; Phi coefficient=0.21). All bite injuries had open wounds while a large proportion of sports and assault injuries did not have open wounds.

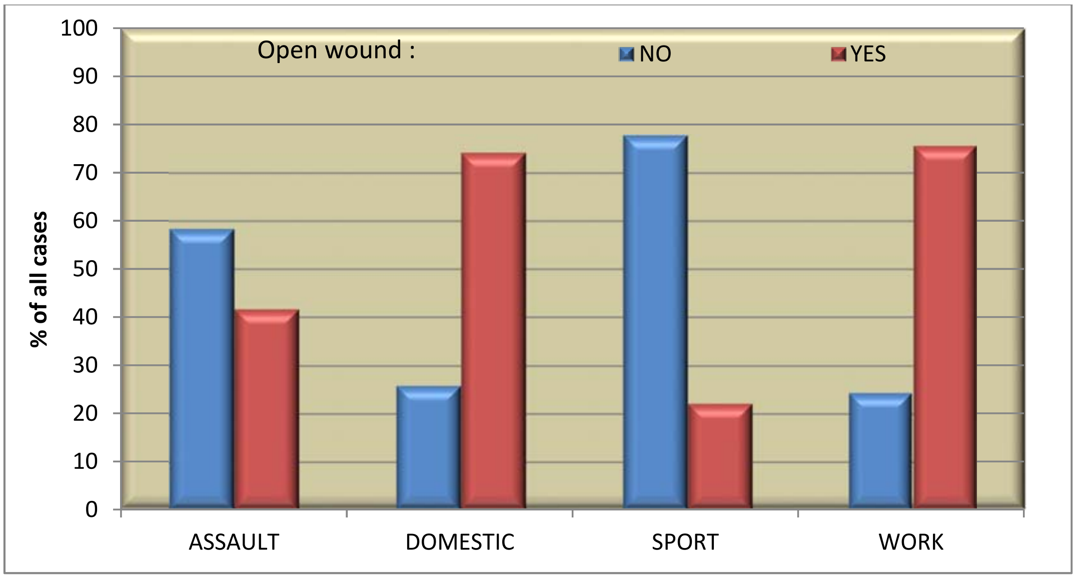


Figure 4-10: Open wounds in relation to where injury occurred

4.3.9 Injury severity

The most severe injuries comprised the smallest group in the data set (25%) while the least severe injuries made up 47% of the data set.

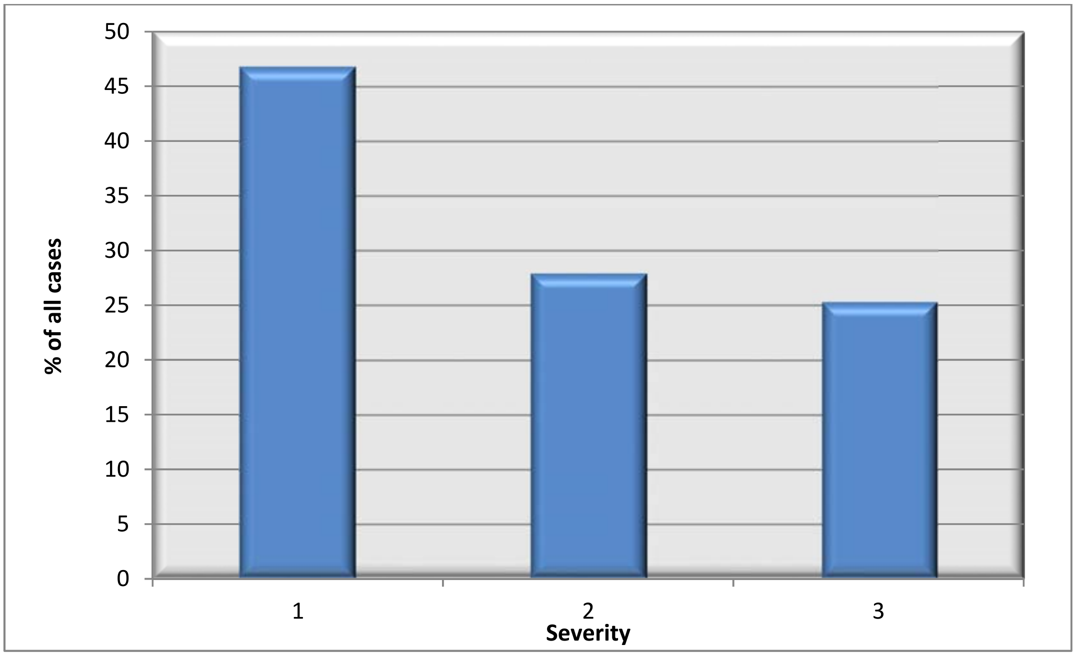


Figure 4-11: Injuries in relation to severity

4.3.10 Right hand versus left hand

The right hand was involved in 54% of the injuries. The left hand injuries made up 44% of the injuries. There was 2% where the data were not available.

4.3.11 Part of hand/fingers most often injured

Single finger injuries made up 58% of all the injuries. This was followed by injuries to the hands (with none or insignificant finger injuries) in 26% of cases. Wrists were injured in only 1% of the patients.

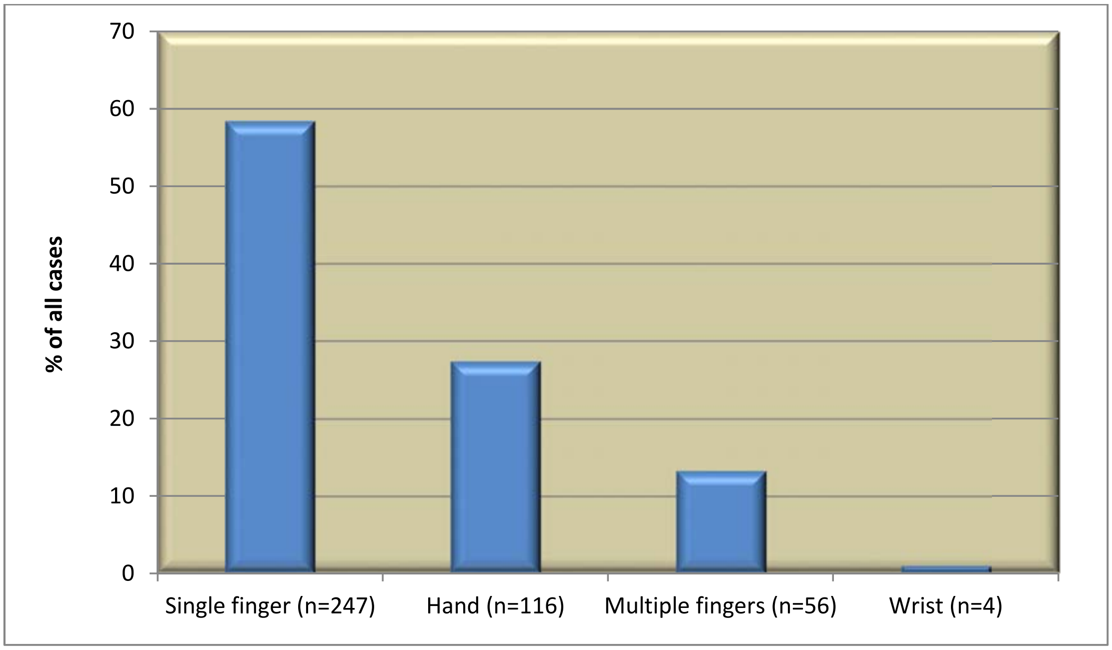


Figure 4-12: Hand Area Injured

4.3.12 Hand area injured in relation to where injury occurred

In both domestic and work place injuries, single finger injuries were the most common injuries, followed by injuries to the hand only and then by multiple finger injuries. There was a significant but weak association between source of injury and hand area (Pearson's X^2 test: $p=0.002$; Cramer's $V=0.18$). Domestic injuries had a higher proportion of injuries affecting the entire hand than work injuries.

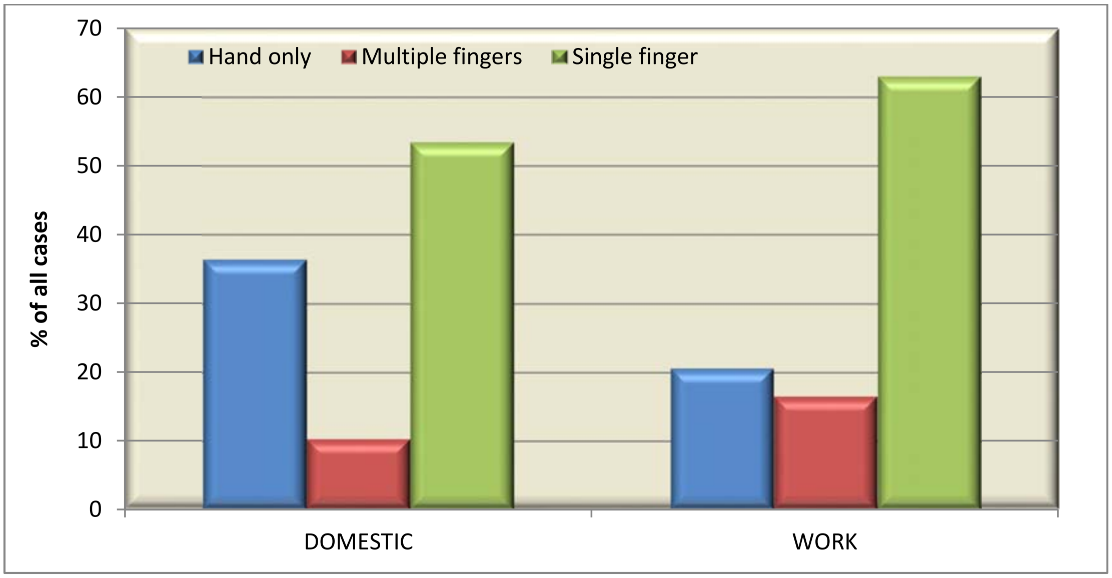


Figure 4-13: Hand area injured in relation to place of injury

4.3.13 Hand area injured in relation to mechanism

Hand area: There was a weak association between mechanism of injury and hand area (Pearson's X^2 test: $p<0.001$; Cramer's $V=0.21$). Crush injuries had a higher proportion of multiple fingers affected than cut injuries; single fingers were more affected by amputation and cut injuries than by blunt trauma.

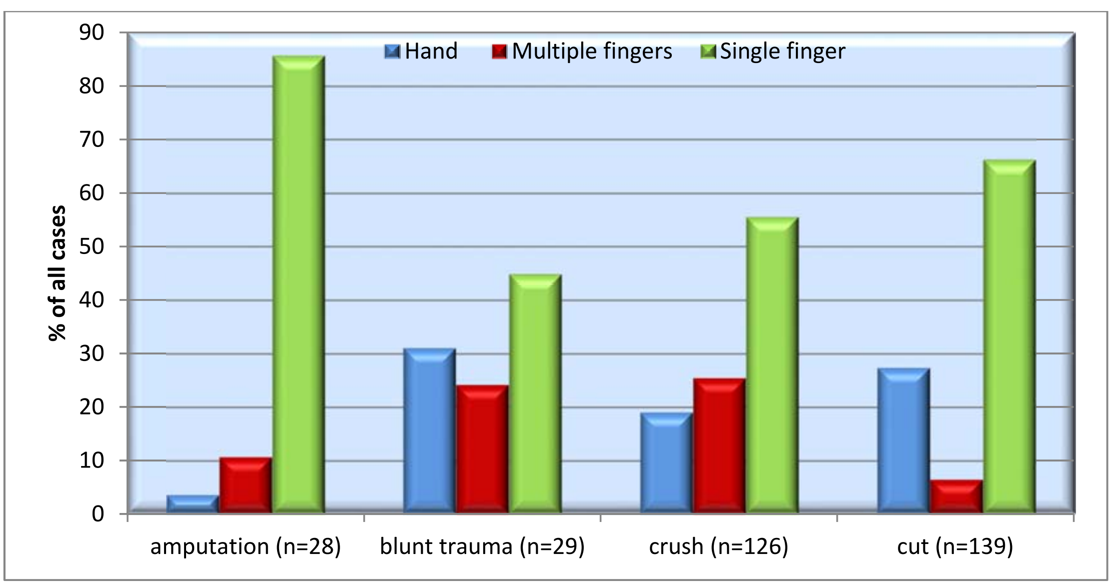


Figure 4-14: Hand area in relation to mechanism

4.3.14 Finger injuries

In 26% of cases, no fingers were injured or injuries were primarily to the hand. In 62% of cases, one finger was injured.

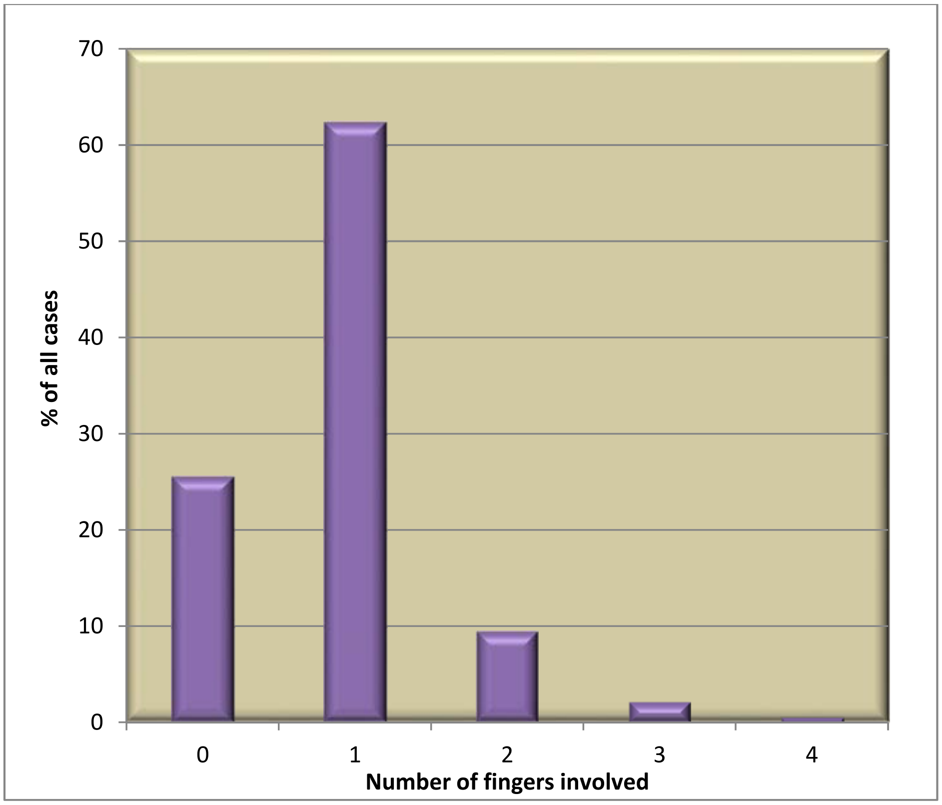
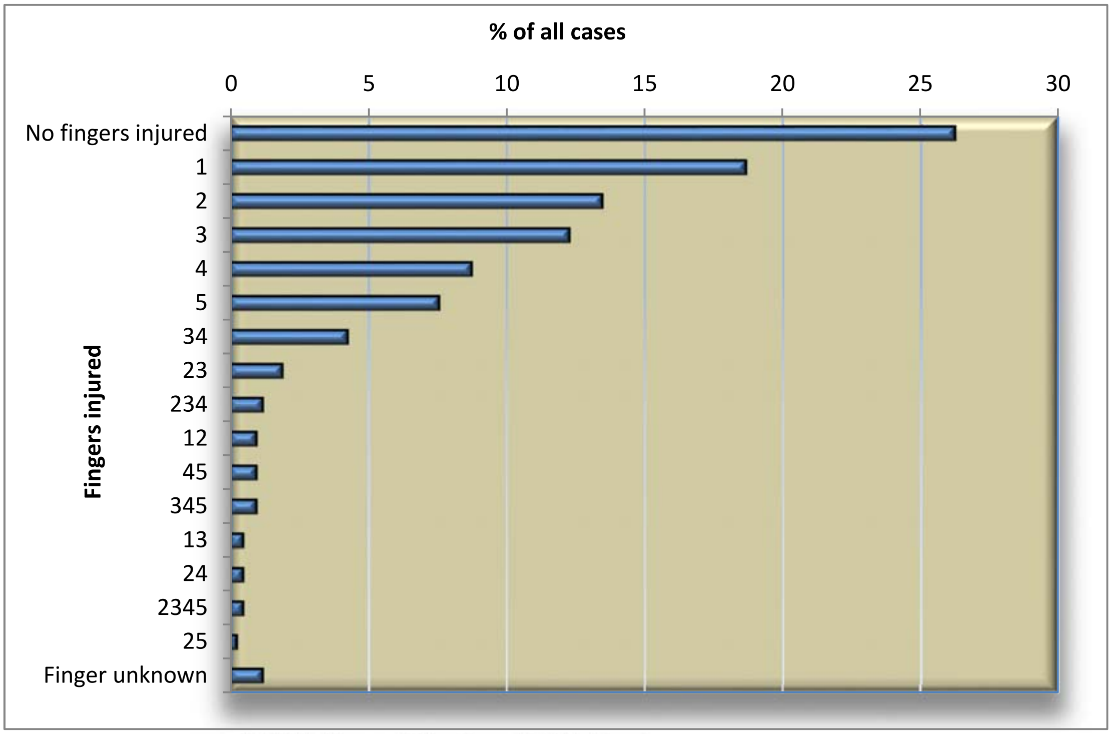


Figure 4-15: Frequency distribution of number of fingers injured

The finger most commonly injured was the thumb and made up 19% of all injuries. This was interestingly followed by other single fingers in order of index, middle, ring and little fingers.



(1: Thumb, 2: Index finger, 3: Middle finger, 4: Ring finger, 5: Little finger)

Figure 4-16: Frequency distribution of finger injuries

4.3.15 Zones involved during hand injuries

The most common injury zone was zones 1 & 2 together (46% of cases).

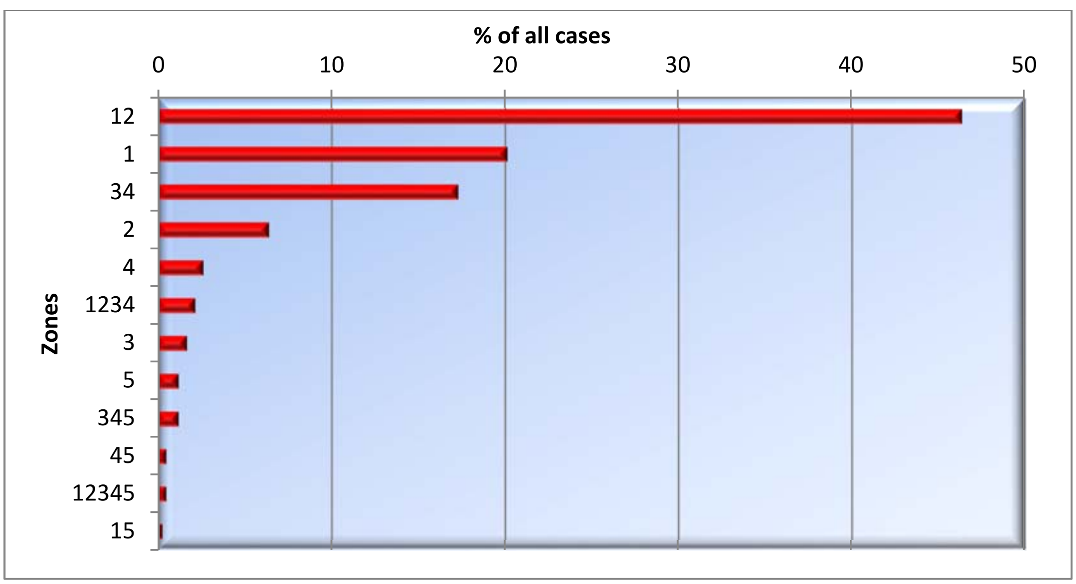


Figure 4-17: Hand zones injured

4.3.16 Doctor groups

Partners treated 53% of the cases. Doctors with experience in anaesthetics treated the smallest number of cases (4.5% of the sample).

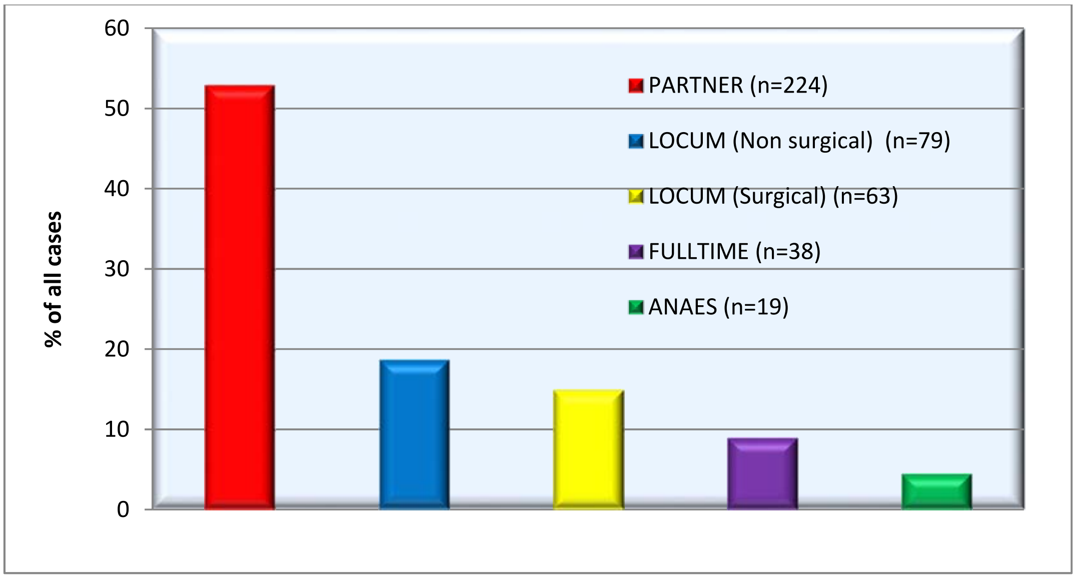


Figure 4-18: Doctor groups

Comparing doctor groups with different subcategories:

Time lapse: We considered less than or equal to 6 hours and more than 6 hours time lapse, bearing in mind that the majority of patients for whom this information was available, had work injuries. There was no significant association between doctor group and time lapse (Fisher's exact test: p=0.26).

Where the injury took place: Due to the sparseness of data in the cross-tabulation, we could test only for the association between doctor group and injury source for work and domestic injuries. There was a significant, but weak, association between doctor group and injury source (Pearson's X^2 test: p<0.001; Cramer's

V=0.27). The non-surgical locums had treated a higher proportion of domestic injuries than the partners.

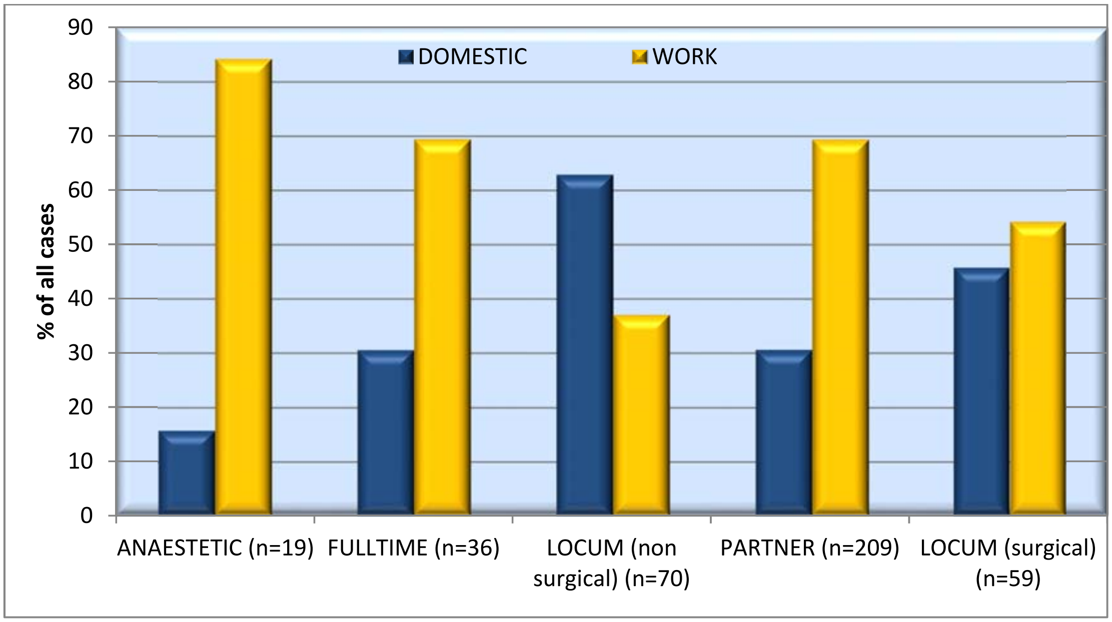


Figure 4-19: Doctor groups in relation to where injuries occurred

Mechanism: Due to the sparseness of data in the cross-tabulation, amputations and blunt trauma injuries were excluded from mechanism (along with the injuries excluded previously), leaving only crush and cut injuries, although this is not ideal for the purpose of the analysis. However, even within these restricted categories, there was a significant moderate weak association between doctor group and mechanism (Pearson's X^2 test: p=0.0049; Cramer's V=0.24). Surgical locums had treated a higher proportion of cuts and a lower proportion of crush injuries than the partners.

Severity: There was a significant, but weak, association between doctor group and injury severity (Pearson's X^2 test: p=0.047; Cramer's V=0.14). Partners had treated a lower proportion of severity 1 cases than surgical locums and fulltime ED doctors.

Open wound: There was no significant association between doctor group and whether or not patients had open wounds (Pearson's X^2 test: p=0.07).

Hand area: There was no significant association between doctor group and hand area (Pearson's X^2 test: p=0.68).

Zone: The data in the cross-tabulation are too sparse to allow testing for association.

Number of fingers: There was no significant association between doctor group and number of injured fingers (Pearson's X^2 test: p=0.71).

We can see that the partners tended to have treated more work / crush injuries and the surgical locums tended to have treated more domestic / laceration / severity 1 injuries. Given the somewhat different presentation time patterns for domestic and work injuries, this possibly relates to different shift patterns for the different doctor groups.

In any event, we cannot say that there were no significant differences between the types of injuries treated by the different doctor groups. We will have to take these into account explicitly when looking at the type, route and nature of analgesics used by the different doctor groups.

4.4 Analgesia

4.4.1 Analgesic route used

Thirty percent of patients received nerve blocks. No analgesia was given or required by 28% of patients. The route of analgesia given the least was oral (1.7%)

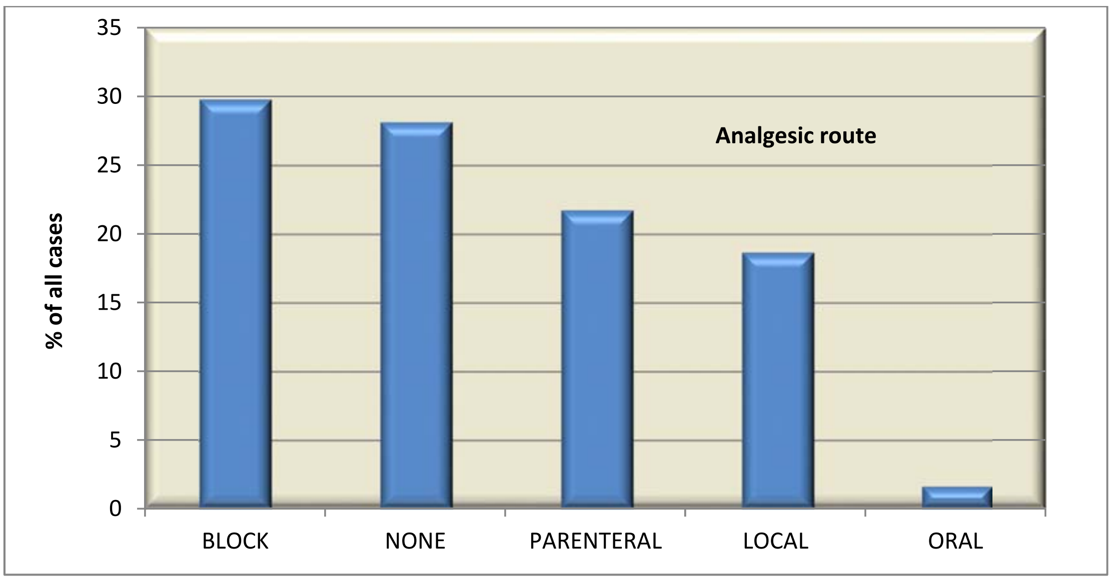


Figure 4-20: Frequency distribution for route of analgesia

Nerve blocks were further divided into categories shown in figure 4-21. Included in this figure is also the breakdown of the two parenteral routes that were used namely IM and IV.

The most common nerve block was the digital block which made up 21% of all cases and 69% of the nerve blocks. Intramuscular injections were the preferred route for parenteral analgesics and was given to 15% of patients and accounted for 72% of the parenteral analgesia given.

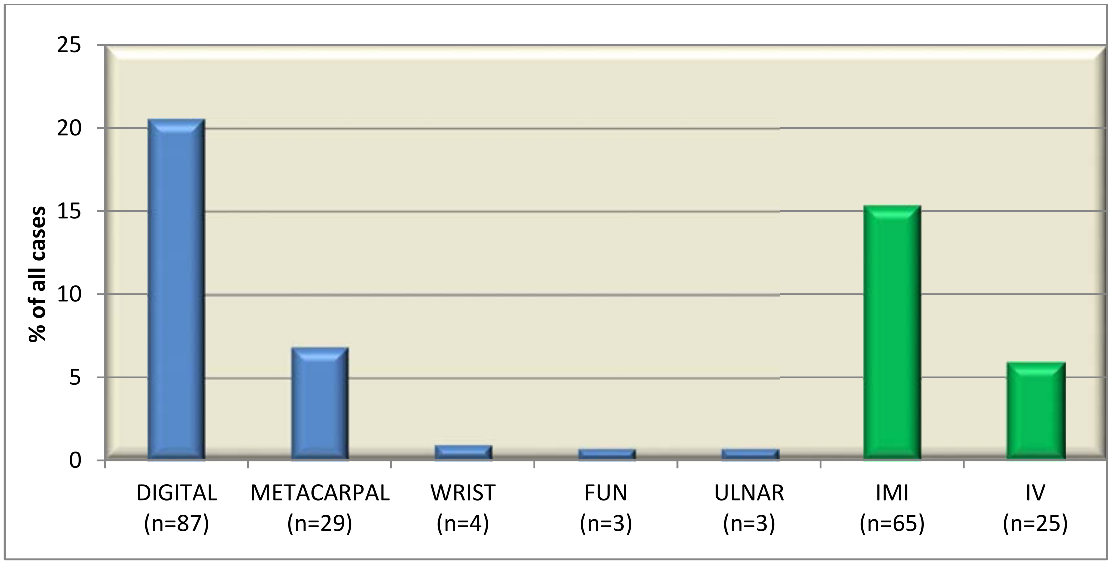


Figure 4-21: Frequency distribution of types of blocks and parenteral analgesia

4.4.2 Types of analgesia

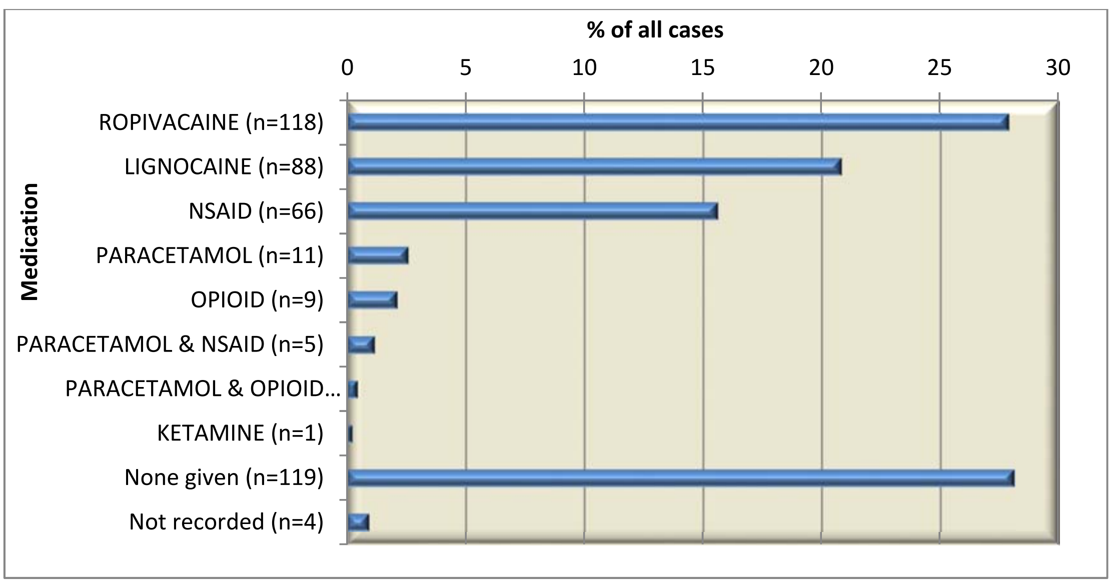


Figure 4-22: Frequency distribution of types of analgesia

As shown in the figure above, Ropivacaine was the local anaesthetic most commonly used for nerve blocks and was used in 92% of nerve blocks.

Lignocaine was the local anaesthetic agent of choice for local infiltration/anaesthesia and was used for 99% of local anaesthetics.

Parenteral analgesia comprised mainly NSAID's which were used in 74% of the parenteral analgesic group. Oral analgesia was primarily given in the form of opioids. Opioids were given 86% of the times where the oral route was preferred. In 26% of these the opioid was given in combination with paracetamol.

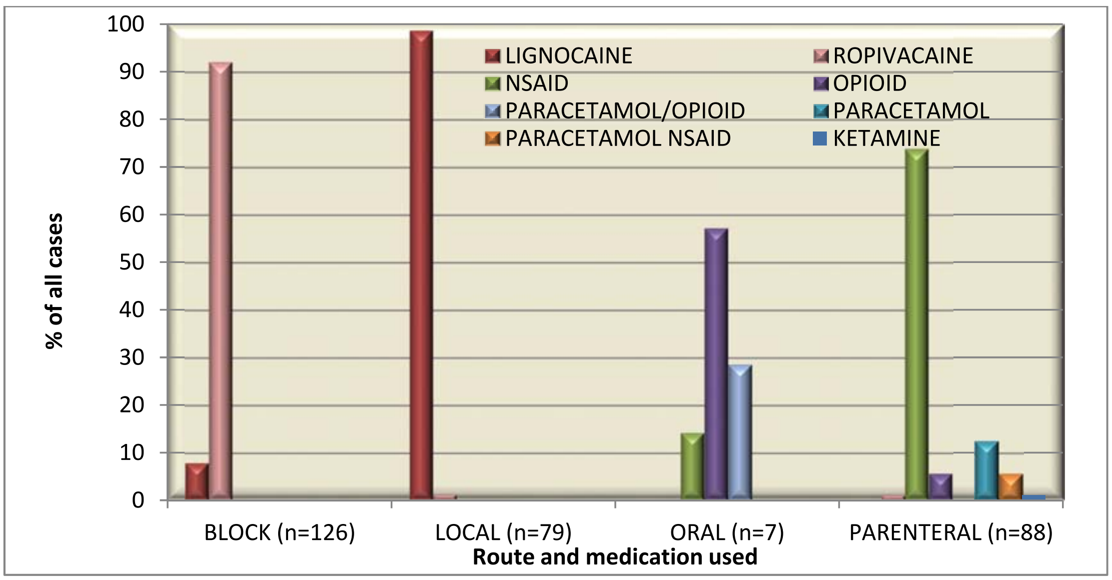


Figure 4-23: Frequency distribution of medication per route

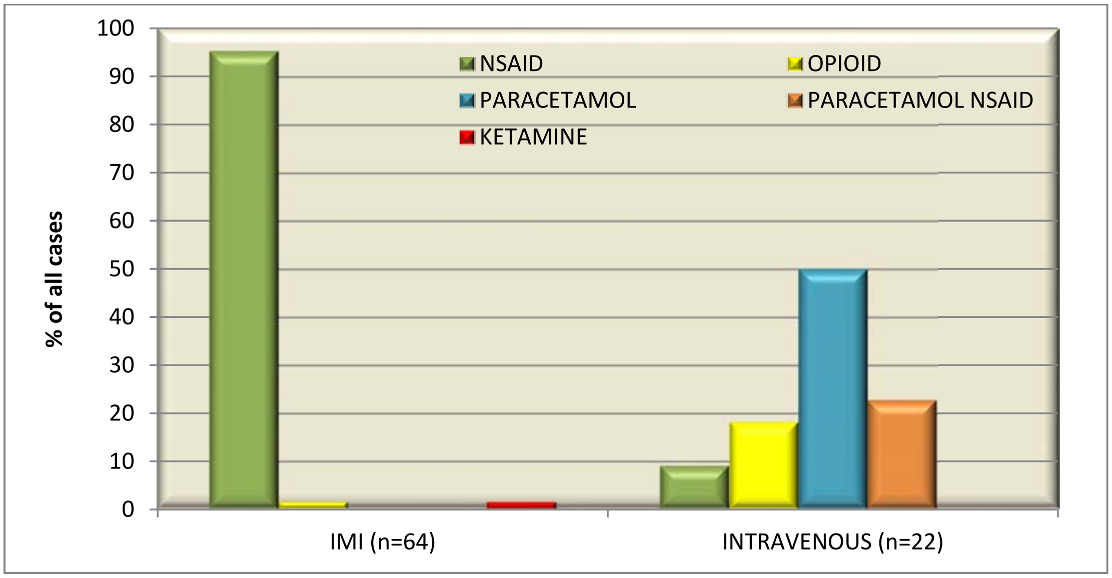


Figure 4-24: Frequency distribution of parenteral analgesia

NSAIDs were almost used exclusively for intramuscular injections (95% of IMI cases). Paracetamol was the most commonly used analgesic for intravenous administration although there were a variety of medications used. Paracetamol was given 73% of the time when the intravenous route was used and paracetamol in combination with a NSAID made up 23%.

Analgesic use by doctor group

The figure below (figure 4-25) gives an overall glance at the analgesic routes preferred by the different doctor groups.

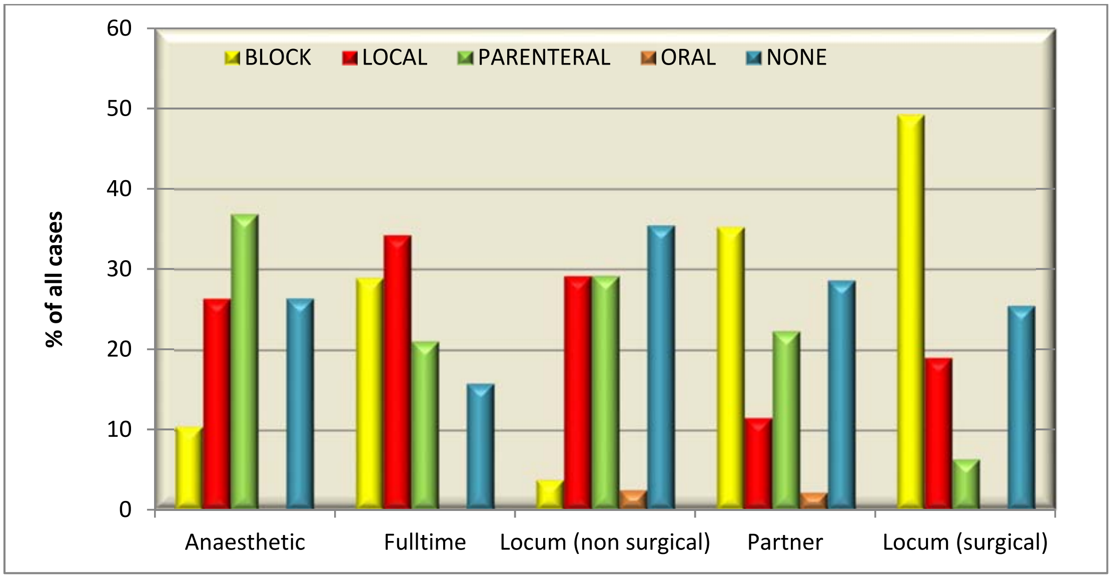


Figure 4-25: Route of analgesia given by doctor group

Given that the doctor groups were not completely balanced with regards to the type of injuries they treated, we must incorporate the key injury variables when we look at whether there is a difference between doctor groups and the analgesic route or analgesic class within a route.

The further breakup of the blocks into digital and metacarpal blocks and the parenteral category into intramuscular and intravenous for the different doctor groups were as follows:

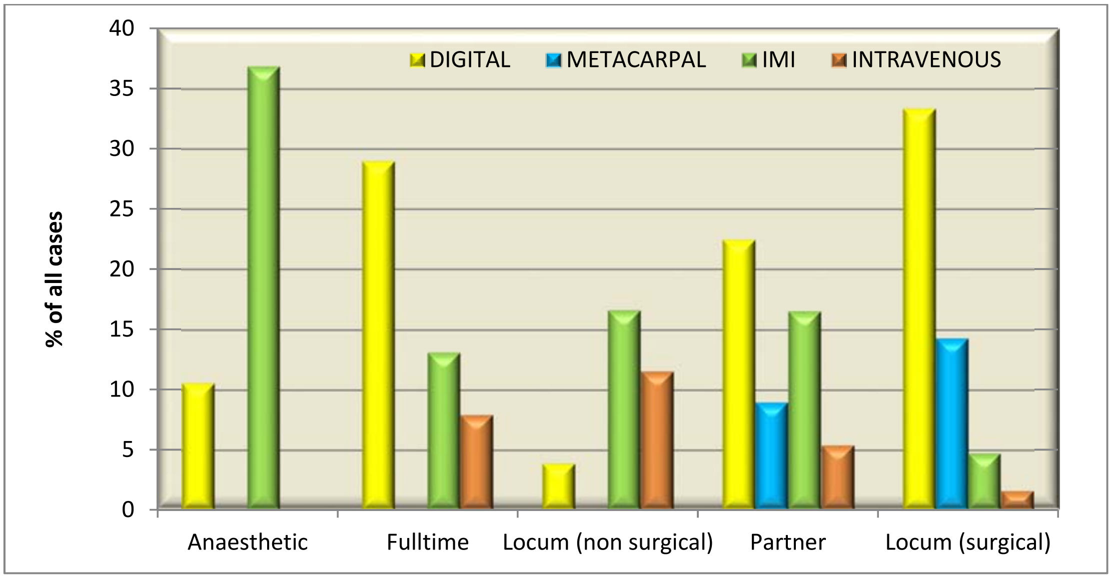


Figure 4-26: Frequency distribution of different blocks and parenteral analgesia by doctor group

Nerve blocks

The following variables were significant at the 95% confidence level:

Inspection of the odds ratios reveals the following (95% confidence limits for odds ratios in brackets):

- Doctors with anaesthetic experience were only 0.16 (0.03-0.87) times as likely (and non-surgical locums 0.03 (0.01-0.15) times as likely) to use a nerve block compared to the partners, controlling for different injury types.
- Surgical locums were 3.2 (1.36-7.7) times more likely to use a nerve block compared to the partners, controlling for different injury types.
- There was no significant difference in the likelihood of nerve block use between the fulltime locums and the partners, taking into account the effect of different injury types.

Digital nerve block

The following variables were significant at the 95% confidence level:

Inspection of the odds ratios reveals the following (95% confidence limits for odds ratios in brackets):

- Surgical locums were 3.6 (1.51-8.5) times more likely to use a digital block compared to the partners, controlling for the effect of different injury types.
- Non-surgical locums were 0.15 (0.04-0.53) times as likely to use a digital block compared to the partners, controlling for the effect of different injury types.
- There were no significant differences between the other doctor groups and the partners.

Metacarpal block

There were no variables that were significant at the 95% confidence level

Other types of nerve blocks

Due to the low frequency, they were not analysed.

Local anaesthetic infiltration

The following variables were significant at the 95% confidence level:

Inspection of the odds ratios reveals the following (95% confidence limits for odds ratios in brackets):

- Full-time locums were 3.8 (1.32-11.1) times and non-surgical locums 5.2 (2.0-13) times as likely to use local anaesthesia compared to the partners, controlling for different injury types.
- There was no significant difference in the likelihood of local anaesthetic infiltration use between the doctors with anaesthetics experience, surgical locums and the partners, controlling for different injury types.

Parenteral analgesia

Intramuscular injection (IMI)

The following variables were significant at the 95% confidence level:

Inspection of the odds ratios reveals the following (95% confidence limits for odds ratios in brackets) :

- Doctors with anaesthetics experience were 3.4(1.1-10) times more likely to use IMI compared to the partners, controlling for the effect of different injury types. There were no significant differences between the other doctor groups and the partners.

Intravenous injection (IVI)

No variables for doctor group were significant at the 95% confidence level.

Analgesia by severity

Nerve blocks

- Severity 2 and Severity 3 injuries were 5.3 (1.46-19) and 19 (4.1-85) times more likely (respectively) to be treated with a nerve block compared to Severity 1 injuries.

Digital nerve block

- Severity 2 and Severity 3 injuries were 4.7 (1.30-17) and 8.8 (2.2-36) times more likely (respectively) to be treated with a digital block compared to Severity 1 injuries.

Local anaesthetic infiltration

- Severity 3 injuries were 0.079 (0.008-0.81) times as likely (respectively) to be treated with a local anaesthetic compared to Severity 1 injuries.

Parenteral analgesia

Intravenous injection (IVI)

Inspection of the odds ratios reveals the following (95% confidence limits for odds ratios in brackets):

- Although injury severity as a whole was not significant, Severity 3 injuries were 11 (1.2-105) times more likely to be treated with an IV analgesic compared to Severity 1 injuries.

Analgesia in relation to open and closed wounds

Nerve blocks

The following variables were significant at the 95% confidence level:

- Injuries with open wounds 7.0 (2.6-19) times more likely to be treated with a nerve block compared to injuries without open wounds.

Digital nerve block

- Injuries with open wounds were 3.0 (1.1-7.9) times more likely to be treated with a digital block compared to injuries without open wounds.

Parenteral analgesia

Intramuscular injection (IMI)

- Injuries with open wounds were 0.39 (0.17-0.89) times as likely to be treated with an IMI compared to injuries without open wounds.

Analgesia by hand area

Nerve blocks

- Injuries with single and multiple finger involved were 12 (1.4-108) and 51 (3.5-727) times more likely (respectively) to be treated with a nerve block compared to hand area injuries.

Local infiltration

Although Hand area was not significant overall, single finger injuries were 0.11 (0.014-0.93) times (less) as likely to be treated with a locally infiltrated anaesthetic compared to hand area injuries.

Chapter 5 DISCUSSION

5.1 Introduction

Hand injuries are common types of injuries and the resultant need for pain relief of these, often painful, injuries forms an important part of the emergency department's responsibilities. During the data gathering in this study, the prevalence of hand injuries was noted from the patient records, in line with the findings of numerous international studies. Although a determination of the prevalence of hand injuries in the unit was not an aim of this study, it was noted as a point of interest. There were approximately 2292 new patients with hand and finger injuries out of approximately 24 726 patients seen during the year 2010 in the emergency department. This did not include Priority 1 patients, but only Priority 2 and 3 patients presenting to the emergency department. This relates to approximately 9.3% of the patients seen in the emergency department.

Although there are many studies available evaluating different aspects of hand injuries, there are no studies that focus on the different analgesic practices for hand injuries or that compare the differences between the prescribing patterns and analgesic management by doctors with various backgrounds.

The research was conducted in a private hospital emergency department, located in Johannesburg. The relevance of this lies in the fact that this ED has a wide variety of medication choices available, has access to an ultrasound machine for nerve blocks (for those that require it), and has access to a wide selection of local anaesthetic medications. It should therefore be possible to draw conclusions about analgesic practices without limiting factors such as access to medications or equipment having played a role.

Clinical notes and, when required, hospital records were scrutinised to gather the required data. It was noted that adequate documentation with regards to the use of analgesic agents was often lacking in the clinical records: both with regards to the choice of agents as well as the reasons for that choice. Routine pain assessment was not performed in this ED at the time of the study. Due to this many patient records could not be used in this study because of missing data. The content of the clinical records and specifically the documentation of pain scoring and analgesic practice were identified as an aspect that needs to be addressed and improved. Other retrospective studies also mention similar difficulties when reviewing quality of clinical notes.(46)

5.2 Hand injuries

Number of hand injuries

Hand injuries are common presenting complaints to the ED. In this study, hand injuries accounted for 9.3% of all the patients seen in the ED. This figure included all new patients in the ED and not only patients with musculoskeletal injuries. This percentage would be higher if comparison was made to patients presenting with injuries only. This is in accordance with the trend in international studies where hand injuries constitute between 6.6% to 28.6% of all injuries to the musculo-skeletal system.(54)

Sex

In this study, 83% of those who sustained hand injuries were male. This is consistent with findings from other studies. A study done in Izmir, Turkey, in a hand and microsurgery hospital showed that males were involved in 83% of cases and a Polish University Hospital study found that men made up 80.6% of those who were injured. (36, 54) In a developing country, Nigeria, the incidence of hand injuries were also higher among men but the ratio of male to female was lower at 2:1.(55) The reasons for this are likely to be multi-factorial. Firstly, when looking at the occupational setting where most hand injuries took place, more males were employed than females. We would therefore expect there to be a predominance of males injured. The South African labour statistics for September 2007 showed that 55.8% of those employed are male. In the industrial setting, the differences are more pronounced. When combining craft and related trade workers, plant and machinery operators, assemblers and those in elementary occupations, the statistics showed that 70.7% of the workers were male.(56)

More males are generally involved with sport activities and the types of sport they are involved with tend to have a higher frequency of injuries: contact sports, motorised vehicle sports and the like. The type of home activities that require power tools (drills, routers, circular saw, angle grinders, chain saw, etc.), blades, axe, manual saws, hammers, hedge trimmers and ladders are more likely to be undertaken by males. These are all tools that, according to the UK Department of Trade and Industry's Home and Leisure Accident database, have a high incidence of causing hand injuries.(57)

Average age

The average age in this study was 33 years and was comparable to the findings in other studies where the mean ages ranged from 30 years to 37 years.(36, 54, 58) Although the ages of patients varied a great deal, the average age was comparable with the age group actively involved in work/labour and sporting activities.

Side of injury

The right hand was more commonly injured and represented 54% of the injuries in this study. This is consistent with other studies showing a predominance of right hand injuries.(55, 59) Hey and colleagues found a predominance of left hand injuries in their study with the left hand being injured in 55% of cases.(37)

Some studies refer to dominant versus non-dominant hand and do not specify left or right hand and therefore direct comparisons could not be made with this study, as hand dominance was seldom recorded in the clinical records. A study done by Trybus *et al* on the "Causes and consequences of hand injuries" showed that the dominant hand was injured 51.2% of the time.(36) The findings of this and previous studies are interesting because it shows that left and right hands are almost exactly equally vulnerable to injury and that handedness or dominance does not appear to influence this vulnerability. Clearly, however, an injury to the dominant hand has greater short and long term impact, especially with severe or disabling injuries.

Where hand injuries took place

Most injuries took place in the work environment (58%). There is some disparity between the findings in different countries with a Turkish study finding that 70.5% of injuries were occupational related and a study from the Netherlands and Denmark showing that up to 60% of hand injuries were related to leisure activities.(54, 60) This was also the finding of a Polish study with injuries occurring at home amounting to 45.3% of the injuries seen.(36)

Multiple factors can influence this variation. An important factor is the location of the receiving hospital. Being in a residential area or close to an industrial area will impact the type of injuries with which patients present to the ED. The availability or lack of medical insurance or “workers compensation” could also determine which hospital (Provincial or Private) a patient will go to. Certainly one aspect that influenced the incidence of work-related injuries in this study is the location of the hospital where this research was conducted. It is located in close proximity to two large industrial areas with many businesses involved in construction, manufacturing, engineering, technical trades, manual labour, maintenance and janitorial services. Another aspect was the availability of workmen’s compensation cover that is a legal requirement in South Africa. Patients who sustain an injury on duty and are covered by workmen’s compensation can be treated for their injuries at a private hospital.

Time of presentation

Injuries that occurred at home presented to the ED throughout the day and well into the night. Patients with work related injuries presented mostly during the day with 83% presenting between 08h00 and 18h00.

This result was expected since the biggest part of the workforce works during the daytime. In addition, injured workers are almost invariably reliant on their employers for transportation to and from the hospital, which accounted for the large proportion of patients presenting during the day even if the injury occurred in the after-hours period. It is important to note that this data were only available for the work related injuries. Most of the injuries (80%) occurred during the day between 07h00 and 16h59 with only 9% between 17h00 and 22h59.

Some of the delayed presentations, injuries that occurred during night shift and domestic injuries made up the 17% of patients that presented to the ED between 18h00 and 08h00.

It is not uncommon that patients present after hours for injuries sustained during the day. Work responsibilities that make it difficult to leave and present for treatment during the day, lack of transport and injuries that were initially assessed by the patient as non-urgent but subsequently worsen are just some of the reasons for patients to present after hours.

Time lapse between injury and presentation to the emergency department

The data used to assess the time lapse between injury and presentation represented predominantly work-related injuries. This data were readily available because workman's compensation documentation requires the employer to complete an injury report that includes the time of injury. The exact times of injury for domestic and sporting injuries were seldom recorded in the clinical records.

It was noted that very few patients presented within one hour of their injury. About one third of patients presented within two hours, two thirds within three hours, three quarters within four hours and about 80% of patients had presented within six hours of the time of injury. These relatively long lag times may have been as a result of a number of factors:

- the patients' own inaccurate assessment of the seriousness of the injury sustained
- delays in the development of symptoms, most importantly pain, from the injury
- delays in the completion of the company injury reports (for injury on duty cases)
- delays in the availability of transport to the hospital

There were no statistically significant associations between time to presentation and type or severity of injury, in the available data. This is somewhat unusual as it would be expected that more serious injuries present in a shorter time-period. This could be due to the lack of data for most of the non work related injuries.

For any patient with a significant lag between the time of injury and the time of presentation to the hospital, it would be reasonable to imagine that this time delay would affect the choice of analgesia and the route of analgesic administration. This might not have been the case in every situation but, in general, we would expect that the more painful an injury was, the sooner a patient would present to the ED. The converse of this is patients who experience less pain would have less urgency to present to the ED. This would be the case if pain was the only deciding factor in urgency of presenting to the ED. Other factors such as active bleeding from a wound, deformity or loss of function would also necessitate an earlier presentation even in the absence of significant pain. Patients' who may have experienced severe pain, could possibly have presented late due to being far away from a hospital or not having transport shortly after the injury to take them to the ED or denial of the significance of the injury. The time delay to presentation should therefore never be the deciding factor when it comes to the choice of analgesia and each individual situation should be evaluated on its own merit. There are unfortunately no studies available at present that evaluate the effect of time delay to presentation on analgesic practices in the ED and there was no evidence from this study to indicate that analgesic practice was modified according to the time delay.

Mechanism of injury

The two most common mechanisms of injury were lacerating injuries with a sharp object (33%) and "crush" injuries (30%). When looking at occupational injuries in isolation, crushing-type injuries were more common. There is a noticeable variation in these findings between different countries. A study done by Trybus in Poland also showed a predominance of lacerating type injuries (33.3%) over crush injuries (7.8%). They however distinguished and listed injuries caused by mechanical tools as the most common type of injury mechanism (34.9%).(36)

Studies investigating hand injuries focussing on specific tools causing the injuries are available but due to the different categorisation of mechanism of injury, will not be used as no direct comparisons to this study can be made.(57) Direct comparisons are difficult to make due to the overlap of injuries that can be sustained such as open crush / closed crush injuries. As the causative instrument or tool is often not known in a retrospective study, it would not be possible to categorise injuries precisely.

Type of injuries

Lacerations were the most common type of injuries sustained (39%). Lacerations have been found in other studies to be the most common type of injuries sustained where up to 72% of patients sustained injuries with open wounds.(58) Many different mechanisms can lead to open wounds, however. A crushing mechanism resulted in a higher proportion of multiple fingers being involved than lacerating injuries. One of the possible reasons for this is the object that caused the injury. Large or heavy objects or machinery that can exert pressure are usually large enough to injure multiple fingers or the whole hand. Thus, because of the size of certain machinery, the likelihood of more than one finger being injured would increase.

Area injured

In both home and occupational related injuries, single/individual fingers was the most commonly affected area (58% of all injuries) followed by hand injuries (26% of cases). A large Danish study also found that fingers were more frequently injured and were involved in 62% of cases.(61) In 27% of cases, no finger was injured but only the hand or wrist was involved. Less than 1% of injuries were to the wrist area alone. The most common injury zones were zones 1 & 2 together (46% of cases). The fingers and therefore zones 1 and 2, are the most "exposed" as these are the areas that are used most often when using the hand. It is therefore understandable that these areas were injured more frequently as they are in "harm's way".

The most commonly injured finger was the thumb (19%) followed by the other single fingers in order of index, middle, ring and little fingers. Not much could be found in the literature to compare these findings with. Seet and colleagues found that the index finger was the most common site of injury in their study.(37) Both these findings makes sense as the thumb and index finger used in opposition is the most common action of the hand when using the hand to hold or manipulate objects.

5.3 Analgesia

The efficacy and adequacy of analgesia and pain relief was not investigated in this study, as this requires prospective evaluation of pain and the subsequent response to analgesia. There may be large variations between patients and between injuries with respect to the degree of pain experienced and the resultant need for analgesia. Similarly there are large variations in patients' response to analgesia which may not be predictive of the magnitude or nature of the painful injury.

It was interesting to note that 28% of patients didn't receive any analgesia in the ED. This did not take into account patients who may have been prescribed analgesia once they left the ED. A number of reasons could have contributed to this apparent 'oliogoanalgesia', such as:

- Interpersonal variation in pain threshold. Pain has a very large subjective component and this may give rise to the situation where one patient will decline analgesia when offered and another patient with seemingly similar injuries would require significant analgesia.
- Personal choices. Patients may have preferred not to have injected analgesia despite having significant pain because of needle phobia or other similar reasons.
- Painless injuries. Even injuries classified as "severe" may have been relatively painless.
- Patients may have received analgesia before presenting to the ED and this fact was not recorded in the clinical notes or this information was not given by the patient.
- It could also have been due to the underestimation and therefore undertreatment of pain i.e. genuine 'oligoanalgesia'

Other factors that may also have influenced the administration and route of analgesia were the need for additional investigations, the need to perform procedures, possible hospital admission for further operative management and delayed presentation. Patients who sustained minor lacerations may have had little pain requiring analgesia *per se*, but would have had local anaesthetic administered prior to wound repair: if these wounds were not repaired by suturing then the records would reflect no analgesia given at all. No conclusions in relation to the potential of oligoanalgesia can, however, be derived from this study since pain scores were not actually measured in the ED.

Oligoanalgesia may be overstated when it comes to actual evidence from the studies that are currently available. As Steven Green states in his article aptly named “There is oligo-evidence for oligoanalgesia”, there are a number of potential flaws in general retrospective “oligoanalgesia” research. Prospective studies are needed with more suitably defined parameters to evaluate the presence or absence of oligoanalgesia in the ED.(24) The experiences in this study support the difficulty in making assessments on the effectiveness of analgesia without detailed information on pain scores or patient experiences.

Addressing patient’s expectations as well as monitoring their response to pain is a valuable approach to achieving patient satisfaction. This has to be mixed with scientific evidence to create a balance in the approach to analgesic administration. More use of pain scales before and after an analgesic intervention would be a good guide. Pain scales are used in studies to evaluate analgesic practices, are easy to use and it would make sense that this would be a easily accessible tool to implement in the ED to initially assess, check the response to given treatment and thereby plan further pain management and treatment or discharge from the department.

Pain should be re-evaluated during the patients stay in the ED, not only to review the response to medication but also to identify patients whose pain may get worse while in the ED. Increasing pain can evolve spontaneously because of the pathology, but could also be as a result of required investigations, transport and interventions the patient could be exposed to during their stay in the ED.

Analgesic route and type of analgesia

The use of an analgesic ladder in the emergency setting is not appropriate as the aim, as mentioned in numerous studies, is to deliver optimal pain control as soon as possible. The use of a laddered approach inevitably delays the use of more potent analgesia and therefore will delay pain control for many patients. It is only useful in the management of chronic pain.

There were no written guidelines for the management of pain in hand injuries in the department where this study took place. Doctors were supported by senior staff, partners were always available for advice and in-service training was provided. The lack of specific attention to pain management is possibly due to the assumption that pain management forms part of undergraduate training and that enough experience would be acquired during the years of clinical practice before qualifying and registration as independent practitioners. Guidelines would be of benefit as, in some instances, they have been proven to emphasise the importance of pain control as a primary function in the ED and lead to improved patient satisfaction with regards to pain management. The implementation of guidelines would not serve a restrictive role but rather as a reference where experience may be lacking and, in a busy department, to streamline pain management for the patient.

Loco-regional anaesthesia

The interest and focus on these techniques in this study stem from the fact that these modalities require additional skills as opposed to most other analgesic routes that require only knowledge, with the doctor's involvement generally entailing the prescription of the analgesia which is then administered by the nursing staff. The use of local anaesthetic agents for regional anaesthesia such as digital, metacarpal and wrist blocks have been reviewed in an increasingly positive light with general consensus that these techniques provide significant benefits and are often underutilised. There are currently no studies available to use as a guideline of what is considered to be an appropriate indication for regional anaesthetic techniques in the ED. Even in the event of studies becoming available, there are a number of parameters that would affect the number of blocks done, such as severity of the injury and the need for further procedures to be done to the patient in the ED or the operating room e.g. wound repair, fracture reduction and so on.

The more severe injuries would generally produce more pain and, in these circumstances, regional anaesthesia would be a good choice since these techniques completely remove pain. Injuries that require further procedures such as debridement, exploration and suturing would also constitute ideal indications for the use of a regional technique. All of this would render loco-regional anaesthesia appropriate but only if the injury was at a site amenable to these techniques (predominantly limbs).

This study showed that nerve blocks were frequently used in this department and constituted 30% of all the analgesic modalities given to patients. Severity 2 and severity 3 injuries were more likely to be treated with a nerve block (all types) than severity 1 injuries. The use of local infiltration with lignocaine was found to be to be used more often in severity 1 injuries than severity 3 injuries. This was probably due to severity 1 injuries being less painful and not requiring a block for pain control but only local infiltration to perform a minor procedure such as suturing. These findings made sense as it would be reasonable to expect that the more severe injuries were likely to be more painful and have a high potential need for therapeutic procedures.

The area of the limb injured was also very important in determining the type of analgesia administered. Injuries that involved the hand area only were more likely to be treated with local anaesthetic infiltration. This could be due to this area allowing local infiltration without too much distortion of anatomical landmarks when having to suture. Another reason could be that nerve blocks to cover the hand area would be at the wrist level and more proximal and these blocks are more complex to perform, requiring more training and experience, whereas digital and metacarpal blocks are easier to perform. Injuries to single and multiple fingers were more likely to receive a nerve block.

Ropivacaine was the agent mainly used for blocks and was used in 92% of all the blocks. Ropivacaine was found to be the drug of choice in the unit where the study was conducted because of its excellent safety profile and long duration of action. Lignocaine and Ropivacaine were readily available in this unit and other agents (such as Bupivacaine) were available if specifically requested. A study by Keramidas *et al* investigated Ropivacaine versus Lignocaine for digital blocks and found Ropivacaine to be an effective and safe agent for digital blocks with a mean duration of action lasting 21.5 hours.(62) Whether or not it is the best agent when compared to its predecessor (in this unit where the study took place), Bupivacaine, is debatable. Nonetheless, the use of a long acting local anaesthetic agent in the ED has many advantages.

Multiple studies have proven the superiority of Bupivacaine over Lignocaine for regional anaesthesia, because of Bupivacaine's longer duration of action, not causing pain on infiltration and the ability to cause a "greater depth" of analgesia when compared to Lignocaine. Bupivacaine has greater cardiotoxicity, but when weighing up the advantages and disadvantages, Bupivacaine is still considered the more appropriate agent for blocks when compared to Lignocaine.(63) Many of these advantages apply equally to Ropivacaine, which has a much lower level of toxicity than Bupivacaine.

There are no studies directly comparing Bupivacaine and Ropivacaine for digital/metacarpal/wrist blocks. There are studies that have compared Bupivacaine and Ropivacaine for nerve blocks at other sites such as interscalene blocks and for epidural anaesthesia. These studies have shown that Ropivacaine had a longer duration of action with regards to its sensory block and less motor block than Bupivacaine. It also showed that the duration of action of Ropivacaine was not dose dependant, whereas Bupivacaine had a dose dependant duration of action. This meant that a higher dose of Bupivacaine would have a longer effect than a lower dose of Bupivacaine.(64, 65) This is very relevant for nerve blocks of the fingers, hand and wrist as these are areas where there is limited space and therefore a limited volume of an anaesthetic agent can be injected. This would suggest that Ropivacaine with its superior safety profile and its prolonged duration of action even at lower doses when compared to Bupivacaine, could be a better choice for nerve blocks of the wrist, hand and fingers.(66, 67) The use of Ropivacaine in the department was, according to the evidence, a good choice.

Lignocaine was the agent used for most (99%) local anaesthetic infiltration and this is consistent with international trends. Lignocaine was predominantly used as an anaesthetic to perform procedures rather than an analgesic agent in its own right. It does not have a long duration of action, thereby making it ill-suited for pain management.(46) This study found that a longer-acting anaesthetic agent (Ropivacaine) was only used once for local infiltration. The use of longer acting anaesthetic agents for local infiltration is safe. There was a concern that long acting anaesthetic could impair wound healing but a study done by Joao Abrao *et al*, have proven that this is not the case.(68) A long acting anaesthetic agent for local wound infiltration can have advantages over the shorter acting local anaesthetics, especially in the ED setting. It would give prolonged pain relief over and above being able to perform a procedure. In an unpredictable environment such as the ED, there is also a chance that the procedure being performed may be interrupted by an emergency such as a resuscitation. Using a longer acting agent would ensure adequate wound anaesthesia to continue with a procedure that was interrupted, without having to administer more medication.

A number of reasons could contribute to the preferred use of Lignocaine over longer acting agents for local infiltration. These can include the fact that using Lignocaine for local infiltration may have become a habit for many practitioners and that the longer acting local anaesthetic agents are more expensive than Lignocaine. The fairly rapid onset of action of Bupivacaine is more suitable for this application than Ropivacaine with its slightly longer onset of action.

As expected, local infiltration anaesthetic was used less for severity 2 and 3 injuries. This was consistent with local infiltration of a short acting local anaesthetic serving no purpose as an analgesic modality on its own but only to allow procedures to be performed. The trend was for more blocks and other routes of analgesia to be used as per the results. This could possibly have been due to pain, size of wounds and the expectation of finding more serious associated injuries that could require surgical intervention.

Parenteral analgesia

Parenteral routes for analgesic administration were the second most common route used and included the intramuscular and intravenous routes of administration. Of these, the intramuscular route was used the most often, accounting for 15% of patients overall. This in effect means that the intramuscular route was the parenteral route of choice making up 72% of all the parenteral analgesia given.

Due to this being a retrospective study and the patient's pain not being a known variable, it is not possible to evaluate the efficacy or the appropriateness of the chosen analgesia. There are no studies available to compare these findings to as no studies on analgesic use in the ED for hand injuries have been published.

Most studies refer to pain management in general with the intravenous route being superior to the intramuscular route and, in general, this would be true. Some of these studies were done before intravenous paracetamol and intravenous/intramuscular COX 2 inhibitors were available and these have expanded the options to provide pain relief. A balance between cost implications, patient choice, doctor experience and benefits and risks is important when deciding on the most appropriate drug to administer. For example: apart from adequate pain relief, factors such as a patient who is likely to be discharged would be more likely to receive NSAIDs than opioids.

NSAIDs were the most common agents used as parenteral analgesia and were used in 74% of the cases. They were used almost exclusively where intramuscular injections were given (95% of IMI cases).

Paracetamol was the most commonly used analgesic for intravenous administration. It was given in 73% of the cases where the intravenous route was used. The combination of paracetamol and an NSAID accounted for 23% of all cases.

Severity 3 injuries were 11 times more likely than severity 1 injuries to be treated with intravenous analgesia. Injuries with open wounds were less likely to be treated with intramuscular analgesia than closed injuries.

As expected, the more severe the injuries and injuries with open wounds increased the likelihood of receiving intravenous analgesia or appropriate blocks. The reasoning behind this would be the faster onset of analgesia with the use of the intravenous route and nerve blocks. Other factors were the expectation of possible procedures that had to be done in the ED or potential admission for further specialist management.

Although opioids were used parenterally (especially via the intravenous route), the use was not as much as expected. Some of the reasons for this could be:

- The patient's indicated pain was at such a level that they did not require a strong analgesic such as an opioid or other analgesia was more appropriate.
- The patient would most likely not be admitted and could not be monitored in the ED for long enough to discharge them safely after an opioid was given.
- A nerve block was done and obviated the need for other strong analgesia where the patient would then unnecessarily be exposed to side effects of opioids without any benefit.

Although the absence of objective evidence of the efficacy of pain management makes it difficult to make definite conclusions, the low level of opioid usage described in this study suggests that peripheral nerve blocks were frequently used for severe injuries that required substantial analgesia. This is an encouraging finding as it constitutes good analgesic practice in the unit studied.

Doctor groups

Partners treated more work/crush injuries and the surgical locums treated more domestic/laceration/severity 1 type injuries. Looking at the distribution of time of presentation, where injuries occurred and type of injuries, with domestic sustained injuries having a higher incidence of lacerations/cuts and this particular group presenting more after hours, the difference noted could be related to the different shifts worked by the doctor groups as day shifts are covered predominantly by partners and the afterhours shifts often by locums.

The different injury types treated by the different groups of doctors, would also affect the choice of analgesia. These factors were taken into account during analyses of the data by controlling for the different injury types. The fact that there was no significant association between doctor groups and hand area involved, injuries with open wounds or the number of fingers injured, was important. These factors can play a big role in the decision of type of analgesia and by having a more even “spread” among doctor groups made the conclusions more likely to be reliable.

Regarding the use of regional anaesthesia, locums with surgical background used nerve blocks more frequently than other doctor groups. There was no difference between partners' and full time locums' use of nerve blocks. Locums with anaesthetic experience were less likely and non-surgical backgrounds were the least likely to use nerve blocks. Differences between the doctor groups could still have been affected by the type of injuries predominantly seen by those doctor groups. Even when controlling for the various injury types, the sample sizes are affected with one group seeing more patients with certain types of injuries than the other group and this could distort the differences. It is also important to note that the categorisation of doctors into groups is not an absolute clear differentiation. Doctors were "sorted" into different groups as best possible according to their main field of work and interest, but there could have been overlapping in experience etc. With interpretation of the results, this should be kept in mind. Unfortunately no studies for comparison are available as none are published that researched different doctor groups similar to those used in this study and their analgesic preferences.

Non-surgical locums and full time locums were more likely to use local infiltration than partners. Non-surgical locums used fewer nerve blocks and therefore had to resort to local infiltration for more of the procedures. Although full time locums and partners were equally likely to use nerve blocks, the difference in using local infiltration was likely due to more wounds being treated by the full time locums that did not require a block for analgesia but only infiltration to perform a procedure.

It was expected that locums with non-surgical backgrounds would perhaps use fewer nerve blocks, possibly due to limited or no exposure to blocks in their field of practice such as general practice or non-surgical specialities. It was unexpected for locums with anaesthetic experience to be using fewer blocks. It is noticeable that even expressed as a percentage of all routes of analgesia, as shown in Fig 4-25, that this doctor group used blocks for a smaller percentage of their patients. This was likely due to the smaller group of doctors in the anaesthetic group and a smaller number of patients treated by this group. Seeing a smaller group of patients could also affect the variety of injuries seen and therefore could relate to less of the patients seen by this doctor group requiring or having injuries where blocks would be appropriate.

The findings did suggest that there is room for improvement. We identified that there were differences in the analgesic preferences between doctor groups. The lack of clear, easily accessible protocols and guidelines could be a contributing factor. It is important to recognise that the results from this study should not be viewed in isolation. There are many other variables to take into consideration that were not possible to evaluate in a retrospective study. Although it identified differences in certain analgesic preferences between doctor groups, this does not translate into a group of doctors inappropriately managing pain. Better evaluation of this would require a prospective study to evaluate the pain management used by doctors where the patient's response to the given treatment can be monitored. With the prior knowledge that regional anaesthetic techniques are a relative safe and very effective way of managing pain, it does suggest that these techniques were possibly underutilised by certain doctor groups.

This study helped to identify that analgesic management by different doctor groups are varied. Although new doctors at the department where the study took place do receive orientation and in-service training, there could be a benefit to implementing guidelines or protocols for hand injury pain management, and making all existing staff as well as new doctors aware of this. Incorporating regional anaesthetic techniques into the guidelines would also be an important step forward as they do not form part of most guidelines currently available. This will contribute to standardising pain management for these injuries. This would not be done as a way of limiting doctors "freedom to choose" what they deem the most appropriate for their patient at the time, but to ensure that it is evidence based best clinical practice. It has already been proven that by providing training, making clinicians more aware of the risk/benefits and techniques available, does improve their use of those modalities.(63)

Adjuvant therapy is often mentioned as part of guidelines/"ladder" but local anaesthetics are not usually mentioned as part of the ladder/recommendations.
Perhaps it is time that regional anaesthesia should form part of the recommendations

5.4 Limitations of this study

Limited patient population – one cannot draw conclusions to the wider community and comparison to international studies can be scrutinised.

This was a retrospective study and as such the appropriateness and efficacy of pain management could not be evaluated in this study. Clinical notes were often lacking appropriate data and therefore many cases had to be excluded and this could create some bias to doctor groups where the treating doctors kept good clinical records.

5.5 Strengths of this study

To my knowledge, this is the first study auditing the analgesic practices for hand injuries in the ED. The study was conducted in a department that sees a fairly large number and variety of hand injuries.

Chapter 6 CONCLUSIONS

The hypothesis that regional anaesthesia is being used too little in the ED is difficult to argue when very little research on this topic is available. This study showed a reasonable amount of regional anaesthetic use for hand injuries in the ED. There were differences in the use of these techniques as well as other analgesic modalities, between the different doctor groups. Although there are multiple factors that affect this choice of analgesia, experience and background do seem to play a role.

Multiple different drugs were available in the ED for each doctor to use as preferred, but analgesia administered was generally limited to a few drugs that were used most often. This could be due to preference of the managing practice and this anecdotally being passed on to other colleagues/locums. It is my opinion that the loco-regional techniques/nerve blocks are being use appropriately when reviewing the available data. The use of Ropivacaine as drug of choice for blocks is evidence based. With current evidence, Ropivacaine seems to be the most appropriate agent to use. Further studies to compare Ropivacaine with other long acting anaesthetic agents for wrist, metacarpal and digital blocks would be beneficial.

Long acting anaesthetic agents for local infiltration are currently underutilised. The cost implications should be evaluated and if found to be cost effective, its use in the ED will not only allow for longer and interrupted procedures to be managed more efficiently but, unlike short acting local anaesthetic infiltration, could additionally be implemented for pain relief.

Although regional anaesthetic techniques have a very important place in the management of pain in hand injuries, its use is not advocated as a blanket solution for all hand injuries. Its use should still be limited to where it would be appropriate. Regional anaesthetic techniques are additional important skills that often do not receive much attention during undergraduate studies. This requires doctors to receive additional training or learning from experienced colleagues while working and gaining practical experience. In this regard, providing training and perhaps including the use of regional anaesthesia in future pain management guidelines, would encourage the appropriate application of this valuable and effective means of analgesia. Identifying groups of doctors who potentially are less experienced with these techniques can help to focus training. In emergency medicine where time constraints are often a limiting factor and there is a relatively high turnover of doctors working in the ED, focussing certain aspects of training such as nerve blocks, on identified doctor groups can assist in improving the skills sets of doctors working in the ED more appropriately and quicker.

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APPENDIX 1 Local anaesthetic agents

History

Local anaesthesia was first used in the 1880's when Halsted demonstrated cocaine's blocking effect on nerve conduction. Karl Koller use cocaine in the eye to cause corneal anaesthesia and Strauss first described the use of a digital nerve block in the management of an ingrown toenail.(47, 48)

As it became more used, its side effects came to light. This included its addiction potential as well as its central nervous system as well as cardiac toxicity and it lost support due to this. The search was therefore on to find a local anaesthetic drug with less side effects.

The discovery and development of benzocaine followed. Due its structure as a hydrophobic compound, its' application is limited to topical analgesic use. Procaine was next in line and was the first useful injectable local anaesthetic. When Einhorn introduced it, its' structure became the blueprint for most of the modern local anaesthetic agents. Unfortunately, it had a very short duration of action. Tetracaine was next in line with a longer duration of action, but still had significant toxicity which was a drawback when used in higher volumes for blocks.

Due to its esther linkage, both procaine and tetracaine have stability issues with the release of an esther group during metabolism. This is believed to contribute to its more frequent allergic reactions when compare to the amide group of local anaesthetic agents.(69)

In 1948 Lignocaine was introduced and till today remains one of the most widely used local anaesthetic agents. It was the first amide local anaesthetic. Bupivacaine was developed in the search for a longer lasting agent. It has significant central nervous system(CNS) and cardiovascular(CV) toxicity though. This prompted the search and development for a long acting local anaesthetic agent with a more favourable side effect profile. After clinical trials, ropivacaine was introduced for use in 1996 and although CNS and CV toxicity is possible, it is rare.(53, 69)

Different types of local anaesthetic agents

There are two classes or types of local anaesthetic agents. As mentioned above, they are the esters and the amides. Ester agents include cocaine, procaine, benzocaine and tetracaine. The amide anaesthetics include lignocaine, bupivacaine, mepivacaine and ropivacaine. If you are allergic to an agent in the one group, such as the esters, it can be substituted for an agent in the amine group and vice versa.(48) It is interesting to note that hypersensitivity reactions are more common to the esther group.(47)

Apart from chemical classification as an ester or an amide, the local anaesthetics can conveniently be classified into short acting and long acting agents. The commonly used short acting agent is lignocaine. The long acting agents are bupivacaine and ropivacaine.(11)

The different types available at the ED where this study was conducted are lignocaine (with and without adrenaline), bupivacaine and ropivacaine.

It is important to be aware of these drugs' toxic dosages and the potential for cardiac and neurotoxicity as these are the two most commonly affected.(11) Most toxic reactions follow accidental intravascular injection. The toxicity of the local anaesthetic agent is related to factors such as the potency of the anaesthetic, the dose that is administered, the protein binding, metabolism and excretion of the anaesthetic. Systemic absorption is related to how vascular the area is.(49)

The ester group of agents are metabolised in plasma by pseudocholinesterase. The result is a water soluble metabolite that is excreted via the urine. A product formed by this reaction is para-aminobenzoic acid and this is a substance that is potentially allergenic. This also explains the increased risk of allergic reactions to esters as opposed to amides. The amides are metabolised in the liver and the overall rate of metabolism is slower and therefore there is more of a risk for cumulative dosing.(49)

Table 3: Local anaesthetic agents

Anaesthetic	Minutes to onset	Duration of Action (min)	Maximum Dose (mg/kg)	Maximum dose with adrenaline (mg/kg)
Lignocaine	2 – 5	30 – 60	5	7.0
Bupivacaine	3 – 7	90 – 360	2 - 3	3.0
Ropivacaine	15 – 20	140 - 200	2 – 3	-

Lignocaine

It is available as a 1% or a 2% solution. The maximum dose is 3 to 5mg/kg when not combined with adrenaline and up to 7mg/kg when combined. The addition of adrenaline both prolong is effect and decreases the systemic absorption. The onset of action is within 4 to 7 minutes and last for an average of 1.5 hours. With the addition of adrenaline, the action can be prolonged to approximately 3.5 hours.(49)

Bupivacaine

The common trade name is "Marcaine". Bupivacaine is a very potent and long acting local anaesthetic agent. It produces anaesthesia equivalent to lignocaine. It is available as a 0.25% or 0.5% solution. The maximum dose is 2 to 2.5mg/kg when used on its own. When adrenaline is combined, the maximum dose is 3 to 3.5mg/kg.

The onset of action can take up to 20 minutes. This is related to its high protein binding and high pK_a. As a long acting local anaesthetic, its effect lasts for 3 to 6 hours.(49) A drawback with bupivacaine is the risk for systemic toxicity related to its potency and protein binding.

Ropivacaine

It is also known by its trade name "Naropin". As far as onset of action and duration of onset is concerned, it is very similar to that of bupivacaine. It has however got the advantage of being 70% less cardiotoxic than bupivacaine.(49)

Pharmacodynamics of local anaesthetic agents

The local anaesthetic agents work by impairing depolarization of the nerve. This is achieved by interfering with the sodium channel, thereby blocking the influx of sodium across the cell's membrane. The order of blockade is unmyelinated and smaller fibres first followed by the larger diameter myelinated fibres. The latter require greater doses of local anaesthetic agents. Local anaesthetic injected near the peripheral nerve, diffuse from the outer or mantle layer to the core layers.(48)

The axons in the peripheral nerves are arranged in a specific order. Axons in the outer/mantle layer innervate proximal structures and the axons to the centre or core layer innervate distal structures.(48) After injecting the local anaesthetic, the effect will therefore spread from the proximal to the distal areas that are innervated by the involved nerve.(48, 69)

APPENDIX 2 Human Research Ethics Committee clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr JR Maloney

CLEARANCE CERTIFICATE	M110452
PROJECT	An Audit of Analgesic Use for Hand Injuries in a Private Emergency Department in Johannesburg
INVESTIGATORS	Dr JR Maloney
DEPARTMENT	Department of Emergency Medicine
DATE CONSIDERED	06/05/2011
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 25/05/2012 **CHAIRPERSON** ....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr MD Wells

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Netcare Limited

Tel: +27 (0)11 301 0000
Fax: Corporate +27 (0)11 301 0499
76 Maude Street, Corner West Street, Sandton, South Africa
Private Bag X34, Benmore, 2010, South Africa

RESEARCH COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: MED-2012-0006

Dr J Rustie Maloney

E mail: rustie@casualty.co.za

Dear dr Maloney

RE: AN AUDIT OF ANALGESIC USE FOR HAND INJURIES IN A PRIVATE EMERGENCY DEPARTMENT IN JOHANNESBURG

The above-mentioned research was reviewed by the Research Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at Netcare Union Hospital, has been approved, subject to the following:

i) Research may now commence with this FINAL APPROVAL from the Academic Board of Netcare (Research Committee).

ii) All information with regards to Netcare will be treated as confidential.

iii) Netcare's name will not be mentioned without written consent from the Academic Board of Netcare (Research Committee).

iv) All legal requirements with regards to patient rights and confidentiality will be complied with.

v) Insurance will be provided and maintained for the duration of the research. This cover provided to the researcher must also protect both the staff and the hospital facility from potential liability

vi) In accordance with MCC approval, that medicine will be administered by or under direction of the authorised Trialist

vii) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2000)

viii) Netcare must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from Academic Board of Netcare (Research Committee) as well as a FINAL REPORT with reference