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THE FIREWORK INJURED HAND

PROFILE AND MANAGEMENT

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ABSTRACT

***Aim**: The study aimed to profile the firework injured hand and review of the management of such injuries from a surgical and rehabilitation perspective. **Methodology:** A quantitative methodological approach using a retrospective file audit was employed in order to address the objectives of the study. The study population was sampled from two identified provincial hospitals in the uMgungundlovu district and comprised of all patients who had sustained firework injuries from the 30th of December to the 5th of January during 2009-2014 (n = 65). Results were analysed using non-parametric statistics (viz. frequency counts and percentage matrices) through SPSS version 21 and Microsoft Excel 7. **Results and Discussion**: The analysis and discussion are organized across three content areas, namely, the profile of the firework injured hand, medical and surgical interventions and rehabilitative interventions. The results showed that the profile of the firework injured hand is varied depending on the blast capacity; however the thumb, index and middle fingers are predominantly affected at the level of the distal phalanges and distal interphalangeal joints resulting in amputation due to severe soft tissue injury and fractures. Hand Injury Severity Scores were completed retrospectively to ascertain the level of injury of which nearly half the cases surveyed fell within the severe category. Medical and surgical interventions were found to occur within the first three to six hours after injury and involved primarily washout, cleaning, debridement and suturing with formalization of amputation being the predominant course of action rather than reconstruction. Rehabilitation was focused on assessment and hand therapy to ensure functional outcomes. It was noted that there were inconsistencies in assessment procedures however the treatment modalities appeared consistent. **Conclusions**: On the basis of this study, it is recommended that the firework injured hand be treated according to the resulting diagnosis, that is, digital amputation, fracture, soft tissue injury and the coinciding symptoms of oedema, pain and stiffness which negatively impact on the outcome of hand function after this devastating injury. The limitations of the study are discussed and recommendations for future research in this field are offered.*

Keywords: firework injured hand; firework injuries; hand therapy; hand profile; management; hand injury severity score; retrospective file audit

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ABBREVIATIONS

ADL	Activities of Daily Living
Amp	Amputation
DASH	Disability Assessment of Shoulder to Hand
DP	Distal Phalanx
DIPJ	distal interphalangeal joint
DOH	Department of Health
Frac	Fractures
HISS	Hand Injury Severity Scoring System
IPJ	Interphalangeal Joint of the Thumb
KZN	KwaZulu-Natal
MP	Middle Phalanx
MPJ	Metacarpo-phalangeal joint
NGO	Non-governmental organisation
NV	Neurovascular
OT	Occupational Therapist
PP	Proximal Phalanx

PIPJ	Proximal interphalangeal joint
SSG	Split Skin Graft
STI	Soft Tissue Injuries
TA	Traumatic Amputation
UKZN	University of KwaZulu-Natal
WCS	Washout, Clean and Suture
WHO	World Health Organisation
WASP	Work Ability Screening Profile

OPERATIONAL DEFINITIONS

Activities of Daily Living: Activities which are performed on a daily basis, these activities can be explained as self-care activities such as grooming, eating or feeding, bathing and un/dressing; leisure activities such as a sport/leisure activity; home making and work/school activities.

Base Hospital: Refers to a general hospital, classified as a community or district hospital by the Department of Health where specialty services are not provided, will refer to a regional or tertiary facility for specialized care.

Degloving (Injury): An injury most commonly to an extremity or digit in which the skin and subcutaneous tissue are separated from the deeper tissue layers thereby depleting its blood supply and increasing the risk of tissue necrosis (Farlex Partner Medical Dictionary © Farlex 2012). Management Clean, debride, sew clean flaps, light compressive dressing, antibiotics—e.g., cefazolin—hospitalize (Segen's Medical Dictionary. © 2012 Farlex, Inc)

Denuding (Injury): To divest of a covering, as myelin (The American Heritage® Medical Dictionary Copyright © 2007). Also used to describe a severe degloving where bone is exposed.

Disability: “Covering impairments, activity limitations, and participation restrictions. Impairment is a problem in body function or structure; an activity limitation is a difficulty

encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations" (World Health Organization, 2012).

Dysfunction: "According to the biomechanical model, dysfunction exists when there is an impairment of bone, joint, muscle or tendon, peripheral nerve… or skin that restricts range of motion (movement), strength and endurance that prevents the person from engaging in occupational activities or tasks**"** (Trombly, 1997)

Hand Function: a combination of prehensile and non-prehensile functions that are performed accurately to successfully complete a task against a functioning sensory background.

Non-prehension: The ability of the functional arm to perform the reach, carry/hold and release an object that has been grasped by the functional hand. (International Encyclopaedia of Rehabilitation)

Physical Disability: Disability refers to "impairment" in "body form or structure", and "activity limitations." Physical disability refers to the impairments affecting the person(s) ability to perform activities of daily living. Physical disability may be in the form of mobility or any impairment which impairs their ability to perform ADL activities functionally and or independently (World Health Organization, 2012).

Prehension: a series of grips, grasps and pinches performed by the functional hand to grasp an object, using accurate joint range of movement and muscle strength against a sensory background (International Encyclopaedia of Rehabilitation)

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Fireworks are a sight to behold when displayed safely and correctly, but as the name suggests, are dangerous. When used by untrained persons and children, fireworks are especially dangerous, having the capacity to explode unpredictably. The injury caused by a firework exploding while being held, can have a devastating effect on the functional status of the hand.

There have been numerous studies internationally showing that firework-related injuries have devastating effects in terms of the wide range of injuries sustained, the costs involved in treating these injuries in addition to a call to alter legislation to prevent these injuries from occurring[1]. The situation in South Africa has been no different. In the last ten years there has been few research studies directly related to firework injuries, with most studies revolving predominantly around a call for changed legislation. KwaZulu-Natal (KZN) as the second most populated province in South Africa has its fair share of firework related injuries, partly due to the availability of fireworks as a result of the diverse demographics and various religious and cultural celebrations with the use of fireworks.

[1] Matshidza S, 2005; Mohan & Varghese, 1990; Puri V, 2009; Wilson, 1999; Smittenberg MN, 2010

In the researcher's experience, firework injured hands are common at specific times of the year that are normally associated with festivities in which fireworks are used, this occurring most often over the New Year period. In public health facilities, once the hand has been treated, the person is referred to occupational therapists and physiotherapists for rehabilitation and management, which can take an extended period of time if the injuries are severe. Over the last eight years, the researcher has seen a gradual rise in the incidence of firework injuries to the hand. The injuries sustained by an exploded firework have been varied, the rehabilitation thereof compounded by the limited training in this particular injury and the resultant functional impairment.

Anecdotally, from the researcher's experience, due to the high number of patients needing attention during the New Year period (between 31 December and 02 January), the doctors who are on call in the trauma and orthopaedic disciplines have little time to focus on repair and reconstruction for those with hand injuries. Surgical management is often not orientated towards reconstruction, but towards saving what is left of the firework injured hand, resulting in finalization of traumatic amputations and debridement of torn tissues. Rehabilitation is required to focus on all areas when providing hand therapy services, although the injury may be a composite of the following; (i) multiple digital amputations; (ii) the painful and oedematous hand; (iii) the burnt hand; (iv) the fractured hand.

1.2 PROBLEM STATEMENT

A firework injury is essentially a blast injury on a smaller scale, causing a range of injuries that can affect any part of the human body, not only the hand, depending on where it is being held in proximity to the body and the type of firework as well as the situation as the firework exploded[2].

The researcher acknowledges that the firework injured hand results in varied degrees of functional impairments due to the combination of injuries sustained, however was interested in determining what the profile of a firework injured hand look like as well as the trends in managing such an injury. Thus, this study serves to answer the question of "What does the firework injured hand present as and what are the management trends in retaining and maintenance of hand function after injury?"

1.3 AIM AND OBJECTIVES

The aim of the study was to profile the common patterns of injury in cases of firework injuries to the hand as well the management of these injuries from the medical and rehabilitative perspectives. Specific objectives were:

- To determine the demographic profile of patients who present with firework injuries
- To determine the profile of injuries sustained by a patient with a firework injury
- To determine and profile the surgical procedures involved in the management of the firework injured hand

[2] Adhikari, et al., 2013

- To determine and describe the content of the therapy programme (including rehabilitation protocols, media and modalities) used in the management of the firework injured hand

The above aims and objectives were realized through the use of a retrospective file audit at two public sector hospitals in the uMgungundlovu District of KwaZulu-Natal.

1.4 OVERVIEW OF THE STUDY AND METHOD

This study is centered on a retrospective file audit of medical records covering a five year time frame (2009 - 2014), specifically from the 30 December to 5 January of each year. The researcher extracted data on a survey form for each medical record which included information on the facility, biographical information, date and time of injury, type of injuries sustained, surgical interventions and rehabilitative intervention/s.

The data extraction tool (Annexure 10) was comprised primarily of closed ended questions, however, descriptive notes were recorded in terms of the quality of information within the medical record, the descriptions of the injuries sustained according to the doctors and any information recorded by the rehabilitation provider. The data was then coded and entered into SPSS version 21 as well as Windows Excel 7, the findings of which are reported in chapter 4 and discussed in chapter 5.

1.5 SIGNIFICANCE OF THE STUDY

The profile of the firework injured hand appears to be poorly documented in the South African context[3], as is the knowledge and understanding of priorities in rehabilitation regarding the outcomes of this injury. However, there is consensus that the prevention of dysfunction is of the utmost importance and that the hand therapist is a key roleplayer in managing such a hand injury[4]. This study serves to document the profile of the firework injured hand, in an attempt to describe this complex injury as a starting point towards the development of a protocol for the management of this severely injured hand. This study is also currently significant as legislation in South Africa concerning consumer purchased explosives has not been changed as per the Explosives Act (Act 26 of 1956) and this study may thus assist in creating an awareness of the potential dangers and multiple injuries that may be sustained should there be a negative incident in the use of fireworks. The study may also be relevant for rehabilitation therapists as well as trauma and orthopaedic specialists as the final outcomes of these injuries are influenced by the medical intervention, received directly after injury.

Finally, the researcher envisages this study to be beneficial to future clients who sustain firework injuries to the hand. The outcomes of this study may serve to extend the knowledge, need for skill acquisition and possible change of attitude of rehabilitation therapists and doctors to ensure the best possible outcome for the patients in terms of identifying the firework injured hand, clinical guidelines for immediate and rehabilitative intervention and multidisciplinary management of the patient by having raised

[3] Wilson, 1999
[4] Chong, 2011

awareness of the impact of these injuries on day to day life. It will also serve to have identified challenges within the public health service that have impacted negatively on service delivery in the past management of these injuries in order to promote improved standards of care of the firework injured hand.

1.6 OUTLINE OF THE STUDY

The study has been outlined as follows:

Chapter 2 describes a review of the literature around past firework-related injury studies, explosives legislation in South Africa, the human hand and its functional ability as well as the impact of impairment.

Chapter 3 is a review of the methodology used in this study.

Chapter 4 outlines the descriptive results in the form of tables and graphs

Chapter 5 is a culmination of findings with a discussion in the context of available empirical research.

Chapter 6 highlights the limitations of the study

Chapter 7 concludes of the study with some recommendations.

1.7 CONCLUSION

As beautiful, eye catching and exciting as fireworks may be, they pose an imminent and real danger to the inexperienced user, be they a child or an adult. This study which is a profile of these injuries to the hand and a review of the management is thus an essential first step towards ensuring effective management protocols for the best functional outcomes in patients who sustain these injuries.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

There have been few studies with respect to the firework injured hand in the South African context. International and national studies have looked at legislation, the types of injuries sustained and the types of explosives that caused them. The researcher will provide a review of some of this literature in addition to details of the human hand and its functional ability as well as the impact of impairment.

2.2 THE FUNCTIONAL HAND

The human hand is an intricately designed tool used to grip and grasp a myriad of objects when placed in any position. The ends of the fingers contain some of the densest areas of nerve endings, these being used to provide continual feedback about touch, texture, weight, shape and temperature of the object that is to be picked up, manipulated, held, placed or released in order for the person to complete the task accurately. The human hand is also significantly used in day to day non-verbal communication such as gesturing, and is an integral aspect of sign language[5]. The hand can be used on its own, or with its partner, depending on the task it is required to achieve (Kimmerle Mainwaring and Borenstein (2000)[6]. The structure of the hand is

[5] Adhikari, et al., 2013; Kimmerle, et al., 2000; Mennen & Van Velze, 2008
[6] Kimmerle, et al., 2000

such that, should any one aspect be compromised in any way, it results in some level of dysfunction, which compromises daily tasks in all spheres of life.

In order for the hand to function successfully, numerous components must work together i.e. bones and joints, tendons, muscles and ligaments, blood vessels and nerves and, appropriate skin covering. In their manuscript on the functional repertoire of the hand, Kimmerle et al (2000) devised a theoretical hand model for a structured assessment process, reasoning behind the choice of assessment and rehabilitation (therapy tasks) of the injured hand, in which the key components regarding hand function are stated according to (1) personal constraints, (2) hand roles, (3) hand actions and (4) task parameters. Their model also includes a psychological aspect of hand function which explores the impact of the injured hand on daily functioning, and the affected persons' psyche. The model gives significant insight into why the hand is so important for the successful completion of daily tasks and functions, that is, "the individual's functional repertoire includes what the hands can do and how well they perform". The model is explained further.

This model of the functional repertoire of the hand used a developmental approach to hand skill acquisition. As stated above, the model has four key components.

The first component of the model, personal constraints refers to the starting point of any hand assessment viz. physical status, level of functioning and psychological status which identify those challenges which have affected hand function. These limitations do not define a person's ability to function, for example, "a client is missing four digits of the

dominant hand and only retains a functional thumb; this physical condition typically limits object grasp and manipulation, however, on assessment, the client is able to grasp different objects in a variety of unimanual and bimanual manipulations. The psychological status of the client is important as it may not dictate function but has the ability to limit it.

The second component, hand roles, refers to “whether one hand is used alone or is capable of different types of collaborative actions with its partner” (Kimmerle et al, 2000). This model strives to focus on right versus left unimanual hand function as well as bimanual hand function.

The third component, hand actions, can be separated into object-related actions and gesturing. Kimmerle et al, propose that the fundamental actions of the hand, reach, grasp, manipulation and release, are applied in a variety of functions in a variety of contexts.

The fourth component, task parameters, refers to the demands of the task being performed by the hand with reference to object characteristics (shape, size, weight), movement patterns (grasp, carry, release, writing) and performance demands (speed, accuracy, force control, endurance), and how well the hand actions are performed.

The model may be summarized as follows, “a complete assessment of the functional hand repertoire includes: the physical and psychological constraints limiting hand function; the use of the hands alone and together; the ability to reach, grasp and carry out a variety of manipulations with a number of objects using different movement patterns; and finally an evaluation of the ability to control timing, accuracy, and force of movements” (Kimmerle et al, 2000).

2.3 FIREWORKS AND THEIR MECHANISMS

An important aspect in the literature was the mechanism involved in how a firework works i.e. the powder charge used in fireworks weighed ± 50 mg to 130 mg and generate temperatures exceeding 500°C. The primary danger of fireworks is the unpredictable nature of the explosion in terms of timing & intensity[7]. Heimbach (2006) was useful in explaining "how" fireworks elicit burn injuries caused by the use of white phosphorous, which is found in fireworks, military ammunitions as well as in industrial and agricultural products. The danger caused by white phosphorous includes the following:

White phosphorous ignites spontaneously when it comes into contact with oxygen; when in contact with skin it causes deep thermal burns. White phosphorous may give rise to multiple organ failure due to the toxic effects on erythrocytes, liver, kidneys and heart. Lastly, during debridement, exposure to air may reignite particles and thereby endanger the patient and operating team[8].

Smittenberg (2010) indicated that gun powder stippling caused cosmetic disfigurement and scarring.

Adhikari, Bandyopadhyay, Sarkar and Saha (2013) as well as Puri, Mahendru, Rana and Deshpande (2007) investigated the pathomechanics of firework injuries explained how the various types of fireworks caused different injuries, that is:

Readily available fireworks such as flares, ground spinners, sparklers caused soft tissue burns .

[7] Adhikari, et al., 2013; Wilson, 1999
[8] Heimbach DM, 2006

Gun powder obtained by tearing the paper wrapping and pouring out the chemical from a firecracker also caused soft tissue damage when lit.

Less readily available fireworks such as string bombs (high intensity firecracker made by wrapping chemicals with string in layers) and rockets caused blast injuries which resulted in soft tissue disruption and bony injuries

The unpredictable nature of the firework or firecracker requires extremely careful use.

Improper ignition[9] of fireworks by children (without adult supervision) and adults was seen to be the leading cause in firework injuries, that is 55% of injuries identified by Wilson in Durban in1990 were due to *improper ignition*, similarly, 41% of cases identified by Puri et al in 2007 and 68% of cases identified by Wang in 2014.

Device malfunction is the second most common cause in firework injuries as evidenced by 15% in Wilson, 1990 and 35% in Puri et al, 2007.

In the study by Smittenberg et al, 2010, it was found that 32 of the 55 cases of firework injuries were caused by a lit *firework being thrown* to or at another child or passerby.

As indicated in the introduction, South African legislation regarding fireworks has not been changed (The Explosives Act, Act 26 of 1956). Many of the studies called for a change in legislation regarding the guidelines for the control of manufacturing, distribution, sales and storage of fireworks[10]. The importance of public education[11] and

[9] Adhikari, et al., 2013; Ahmad, 2010; Matheron, et al., 2014; Wilson, 1999; Witsaman, et al., 2006; Wang, et al., 2014 ; Puri, et al., 2009

[10] Al-Qattan MM, 2008; Matshidza S, 2005; Smittenberg MN, 2010; Wilson, 1999; Witsaman RJ, 2006

[11] Puri V, 2009; Mohan & Varghese, 1990; Smittenberg MN, 2010

legislative reform to assist in the prevention of this mechanism of injury that result in permanent hand impairment is a strong theme throughout the literature.

2.4 IMPACT AND TYPE OF FIREWORK INJURIES ON HAND FUNCTION

It has been noted in the literature that the preservation of hand function is of utmost importance**.** The term "function" has numerous definitions. For the purpose of this study, it is used operationally to define the manner in which the human hand is able to perform (assume, use, maintain and release) the necessary grips and grasps in a range of activities for task completion against a sensory background[12]. Additionally, the arm (shoulder to wrist) is essential in positioning the hand for functional task completion against this intact sensory background. Thus, an impairment of hand function creates an alteration in the overall functional status of the individual. Furthermore, the human hand is described by Mennen and Van Velze (2008, pp1) as "the most developed prehensile organ among all living creatures."

2.4.1 Types of injuries

The patient demographics[13] involved in these types of injuries were remarkably similar in a number of studies, that is, the injured party is three times more likely to be male. The age group involved is divided between 5 – 14 years old in children and 27 – 45 years of age in adults. The injuries predominantly sustained were burns, contusions and lacerations, fractures and traumatic amputations. Hand dominance was not a consistent

[12] Adapted from Mennen U & van Velze C, 2008. *The Hand Book* 3rd ed. Pretoria: Van Schaik Publishers

[13] Adhikari, et al., 2013, Al-Qattan & Al-Zahrani, 2008; Bagri, et al., 2013; Giessler, et al., 2006; Grassi, et al., 1996; Matheron, et al., 2014; Matshidza, et al., 2005; Phillipson & Southern, 2004; Pikor, et al., 2013; Puri, et al., 2009; Witsaman, et al., 2006; Wilson, 1999; Wang, et al., 2014

variable in the literature, however, the dominant a hand was injured more often than the non-dominant hand in three of the studies reviewed. Length of stay following hospital admission was also not a consistent variable in the literature, however, what was evident was that in “first world” countries the rate of admission was significantly lower than in “third world” countries, for example, the United States of America and United Kingdom, 5% - 27% were admitted for management compared to South Africa and India where 45% of cases were admitted for 3.5 days to 2 weeks. In the USA and UK most patients were referred to burn centres for continued management.

The types of injuries found to occur in the firework injured hand are soft tissue injuries, fractures, burns, traumatic amputations and disruption of the neurovascular supply[14]. Groundspinners, sparklers, and flares have wicks that need to be lit, they are the primary culprits of burns and soft tissue injuries. Stringbombs and rockets caused blast injuries which resulted in fractures, amputations and the disruption of the hand’s neurovascular supply[15].

Soft tissue injury is a term used to collectively group abrasion and lacerations that affect the skin and underlying fascia[16]. These tissues are essential in covering the underlying blood supplies, nerves, muscles and tendon, ligaments, bones and joints. The skin as an organ in its own right is essential for successful hand function as pliable skin allows for tendons to glide under the skin, it stretches over joints to allow for movement and is essential for tactile functions of the hand. Any soft tissue injury undergoes a healing a process which commences at the time of injury. The resulting scar tissue, if left

[14] Cheema T, 2014; Giessler, et al., 2006
[15] Puri, et al., 2009; Mohan & Varghese, 1990; Wang, et al., 2014; Witsaman, et al., 2006
[16] As defined by Farlex Partner Medical Dictionary, 2012 (online)

untreated, can have a significant negative impact on hand function by limiting the amount of pliability and elasticity, and reducing the range of movement.

Fractures occur when the vibration of the blast component causes the phalanges to break while the distal volar plates of the interphalangeal joints (IPJ's) give way which results in dislocations and avulsion fractures of the IPJ's[17]. In most cases, these joints underwent formal amputation. In cases where the joint underwent repair or reconstruction, the complications included infection, stiffness from long term immobilization and pain. The stiff and fixed joint has a direct implication on the ability of the patient to assume a specific grip or pinch.

Traumatic amputation occurs when the soft tissues, bones, tendons and ligaments are unable to withstand the explosive force of the firecracker resulting in a shattering of bone, disruption of the joint, and irreparable damage to the blood vessels and digital nerves as well as insufficient skin coverage. It is common that the patient presents with denuding and degloving injuries of the fingers with exposed bone. In these cases, the patient undergoes formalization of amputation to ensure that there is sufficient skin and soft tissue coverage and the exposed bone is trimmed. It is imperative for the surgeon to ensure adequate soft tissue coverage so as to prevent neuromas which cause hypersensitivity in the stump and render the stump useless.

[17] Adhikari, et al., 2013

Previous studies indicated that firework injuries are initially treated onsite or at an emergency room. Giessler[18], Leopold, Germann and Heitmann, 2006 indicated that "blast injuries to the hand need a fast, strategically planned surgical approach…. In a multipatient scenario, triage based on surgical urgency may be necessary". Lengthy waiting times have direct implications on the firework injured hand as devitalised tissues require further debridement or amputation, thus, preservation of finger length and function becomes compromised for reconstruction[19] as well as further complications such as compartment syndrome[20] and infection[21] may ensue. The primary causative factor for lengthy waiting times after a firework injury was attributed having sustained injuries at or around midnight on 31 December which is in keeping with findings from other studies[22]. The delay to the following patients could be attributed to the number of staff on duty in the emergency departments versus the high number of patients arriving for emergency treatment. A number of patients presented at the sampled hospitals on the days following injury (cf. Figure 4.3) as they were transported by Emergency Medical and Rescue Services (EMRS) (cf. Figure 4.4) as one of their service provisions is to provide patient transport[23] to referring hospitals for a higher level or specialized level of management.

[18] Giessler, et al., 2006

[19] Vedder, NB., and Hanel, DP., 2011 The Mangled Upper Extremity, pp 1606 In: *Green's Operative Hand Surgery* 6th ed, London: Churchill Livingstone

[20] Phillipson & Southern, 2004

[21] Matshidza, et al., 2005 showed that further surgery was needed in 50% of cases due to the development of sepsis

[22] The studies concerned did not publish specific time frames for injury, only that injuries predominantly occurred over the Festive season and predominantly, New Years' celebrations. Matshidza S et al, 2005; Adhikari, et al., 2013; Puri V et al, 2009; Mohan & Varghese, 1990; Smittenberg MN et al, 2010; Wilson, V., 1999 and Pikor et al, 2013

[23] Ramdas, 2003

These are the important factors taken into consideration over and above the extent of the injury as the doctor will be unable to perform reconstructive surgery on a hand that has impaired circulation[24].

In their study, Mohan and Varghese[25] indicated that a health promotion exercise promoted the use of cold water in the immediate treatment of firework-related burn injuries. The number of patients treated by cold water increased, however, the number of firework related injuries did not

In the most severe cases, as described above, the injuries are described as mutilating, mangled and crushed. These injuries have the most devastating effect on long term hand function as they result in proximal amputations[26]. The more proximal the amputation of the thumb, index and middle fingers, the greater the impact on hand function, specifically, prehension as the patient would be unable to assume the most basic of pinches, grips and grasps. According to Kaplan (1969), “the critical level of amputation is the proximal interphalangeal joint. At, or proximal to, this (level), pinch function is lost”. Amputations of digits not only affect the precision pinches, but also the width of the hand as used in grasps such as the ball grasp.

2.4.2 Anatomical impact of injuries

The anatomical structure of the distal components of the hand, the distal phalanx and distal interphalangeal joint, impact directly on prehension in the following manner[27]

[24] Chong, 2011
[25] Mohan & Varghese, 1990
[26] Kaplan , 1969
[27] Mennen and Van Velze, 2008

- The pulp is the developed part of the finger essential for prehension and has a combination of all sensory modalities which for the performance of most sophisticated activities.
- The convolutions of the skin, fingerprints, are used to assist with grip and increase the surface area of the pulp
- The distal phalangeal tuft broadens the pulp area to increase the surface area for pulp to pulp pinches.
- The construction of the pulp includes fat globules which are divided into tight compartments by vertical fascial septae under the skin.
- The DIPJ has the ability to passively hyperextend so that the pulp to pulp grip increases in surface area by the nails flattening and broadening to clear the tip of the finger and allows for a tactile function
- This relationship between the pulp and nail is co-dependent, in a destroyed pulp results in a hooked nail, and an absent nail results in a sensitive, tender and useless tip. Both scenarios impact negatively on tip, tripod and pincer grips which are performed by the thumb, index and middle fingers.
- Palmar skin is highly specialized as it is required to convey all modalities to the brain for interpretation and protects the underlying flexor tendons, intrinsic muscles and neurovascular systems.

Impacts of injuries on the anatomical structures and functions are discussed hereunder.

The fingertips

The fingers and thumb meet pulp to pulp to perform a variety of pinches, grips and grasps. An injury to the pulp or distal phalanx results in oedema which causes an increase in pressure within the compartment and causes extreme pain. In cases where the pulp or distal phalanx has been amputated the finger, especially the index and middle finger are unable to successfully perform tip and tripod pinches which are essential for writing (holding a pen), picking up money (coins and notes), donning and doffing clothes (buttons, zips and laces). It is well documented that the fingertips contain the highest density of axons in the human body which renders the human hand capable of the most intricate tasks. An explosive injury resulting in damage to the pulp or amputation of the distal phalanx resulting in a disrupted nerve supply can lead to hypersensitivity of the fingertip or stump and thus result in a dysfunctional hand as the person would have difficulty with typing, sewing, picking up coins

Total Active Range of Movement

This may be described as composite flexion of the fingers from the MPJ's to the digit pulps and thumb opposition at the CMCJ, for example when forming a fist or cylindrical grasp, and extension for release of the object.

This movement pattern is essential for power grasps in all settings e.g holding an iron, gripping a spade, pulling a fire hose, carrying a laden tray, picking up a baby. An amputation at any level of the finger reduces the power of the grip. Kaplan (1969) described functional levels of amputation of fingers and summarized as follows, "anatomical sites of amputation may not correspond to functional levels, and, depending

on the individual needs of the patient, improvement in the function and the appearance of the hand can be achieved by appropriate functional levels of amputation." Traumatic amputation was seen primarily in the thumb, index and middle fingers which can be attributed to the tip and tripod pinches being used to hold objects[28].

Furthermore, the extensive soft tissue injuries impact directly on the range of active flexion as the skin creases over the IPJ's develop scar tissue and adhesions early on in the healing process. Scar tissue impacts on the hand's ability to assume, use and maintain pinches, grips and grasps at the fingers and the palm.

Palmar Skin

The palm is often injured in smaller firework explosions resulting in lacerations and abrasions of varying depths and size[29]. However, an injury to the palmar surface of the hand can result in significant functional impairment. Palmar skin[30] covers the intrinsic and extrinsic muscles of the hand which are essential to positioning of joints for prehension. Scar tissue in the palmar skin severely impairs the easy glide of tendons beneath the skin which impacts negatively on grips and grasps by reducing active range of movement, increasing pain and stiffness. Furthermore, scar tissue in the palm, if left untreated results in skin contractures which narrows the longitudinal and transverse carpal arches. A skin contracture at the first web space impairs the thumb's opposition function.

[28] Adhikari, et al., 2013; Giessler, et al., 2006; Matshidza, et al., 2005; MacKenzie, et al., 2001; Witsaman, et al., 2006
[29] Cheema. T, 2014
[30] Mennen & Van Velze, 2008; Trybus, et al., 2006; Trybus, et al., 2008

Cosmesis.

The hand is always visible and is used in greetings, shaking a person's hand on meeting them, hugging a child, serving a plate of food. An aesthetically damaged hand where there are scars and digits missing can have a devastating psychological impact on the patient as it is a constant reminder of the trauma[31].

2.5 THE FIREWORK INJURED HAND AND SURGICAL INTERVENTION

Wilson (1999) highlighted a number of risk factors related to the use of fireworks that resulted in injuries to the hand as follows:

The "relighting of an unexploded firework", "holding the firework in the hand and exploding in the hand" and the firework being "thrown at a passer-by" were examples of direct hand injuries. "Lighting gunpowder on ground", a "lack of adult supervision", placing of a "lit firework placed in metal or glass container" and the "malfunction of fireworks" are further examples of risk factors that result in firework related injuries.

The firework injured hand is a description of the mechanism of injury that results in severe injuries. Literature has described this mechanism of injury as mutilating, mangled and debilitating[32]. However, there was limited literature on the rehabilitation of this type of injury, this being described with respect to the resulting injury and hand dysfunction.

[31] Mennen & Van Velze, 2008
[32] Chong, 2011; Puri V, 2009; Adhikari, et al., 2013

International and National studies[33] conducted on firework injuries showed that the hands were mostly affected. The most frequent injuries sustained were partial thickness burns, lacerations, dislocations, amputation of fingers and fractures. Emergency surgical intervention[34] was undertaken depending on the severity of the injury according to the doctors' assessment, in some cases, surgery was completed a few hours later. Surgical interventions[35] comprised of debridement and washout, ensuring sufficient skin coverage and formalization of amputation, reconstruction was not seen as the primary objective in many cases i.e. for tendon, bony and neurovascular repair, flap cover or amputation, while superficial burns were treated with dressings. Some wounds required only thorough cleaning and primary suturing. Much of the literature showed that after hand injuries, the next most common firework injury sustained was opthalmological, particularly in paediatrics, as evidenced in Smittenberg et al, 2010 where 44% of 55 paediatric firework injuries were hand based and 42% were ophthalmological; Matshidza et al 2005 sustained 26 and 1 respectively and Wilson in 1999 showed 42 and 14 injuries respectively.

An article by Wilhelmi in June 2009, stated that "As the terminal extension of the fingers and hand, the fingertips are the portions of the upper extremity through which we touch, feel, write, draw, and perform activities of daily living. With the advent of new technology, our dependence on our fingertips for everyday living continues to increase." He further acknowledged that in the USA, the fingertips are the most frequently injured

[33] Mohan & Varghese, 1990; Matshidza S, 2005; Wilson, 1999; Witsaman RJ, 2006; Smittenberg MN, 2010
[34] Giessler, et al., 2006; Adhikari, et al., 2013
[35] Adhikari, et al., 2013; (Pikor, et al., 2013; Giessler, et al., 2006

portion of the hand, this article acknowledging the need for successfully treating the hand injury to ensure its ongoing functionality. This links well with Campbell-Reid's[36] distal amputation category.

2.6 THE HAND INJURY SEVERITY SCORING (HISS) SYSTEM

There are numerous assessments and injury severity scoring systems available that one can use to determine the level of injury. As fireworks cause a wide range of injuries, it was important to find a scoring system that looked at the injuries sustained rather than the mechanism. Injuries sustained are divided into mild, moderate, severe and profound, and is dependent on the amount of damage sustained.

The most applicable classification system for this mechanism of injury is Campbell and Kay's Hand Injury Severity Score (HISS). The researcher found this classification system most appropriate in that it is a descriptive severity scoring system which compares "like with like" in that it specifically focuses on hand injuries distal to the carpus and mechanism of injury is irrelevant. The HISS is specific to each patients' injury, in that each ray of the hand is separately assessed (and weighted according to functional importance) in terms of the integument (skin), skeletal component, motor component and neurovascular component. The combined scores from each weighted ray are then added together to obtain an overall total injury score (Campbell & Kay, 1996). Further to this, wound contamination is included by doubling the score; other scores are doubled for open fractures. In cases where there has been an amputation, the absolute value is given as all components are affected (Annexure 11).

[36] Campbell and Kay, 1996

The HISS classification system has four levels of severity that are closely linked and correlate to (1) possible functional implications[37], and (2) the patient's return to work rate[38]. It was noted that this scoring system was designed to be a research tool[39] however, it can also be used practically in the clinical context as a measure of severity and a guide to likely outcomes[40]. Campbell & Kay's HISS can be used as a measuring tool or as a retrospective measuring tool for research purposes. Validity and reliability[41] of the Hand Injury Severity Scoring system was tested in three studies[42]. The HISS was found to have positive content validity with limited construct and criterion validity, as the latter two were not tested. Reliability was limited as internal consistency was not tested and the HISS was found to be limited in reproducibility. Further to this, responsiveness was not tested, however, the HISS was found to be strong in terms of patient friendliness but clinician friendliness was limited.

The four levels of severity are mild, moderate, major and severe, and can be interpreted as follows:

Mild injuries referred to soft tissue involvement where no bones or joints were affected.

Moderate injuries referred to involvement of bones and joints in addition to soft tissue injury.

Severe injuries included neurovascular involvement in addition to bones, joints and soft tissues being affected

Major injuries resulted in the amputation of part or whole of the hand.

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[37] Mink van der Molen, et al., 2003
[38] Matsuzaki H, 2009
[39] Campbell & Kay, 1996
[40] Campbell & Kay, 1996; Saxena , et al., 2004; Urso-Baiarda, et al., 2008
[41] Suk. M, Hanson. B, Norvell. DC and Helfet. DL. *Musculoskeletal Outcomes: Measures and Instruments.* Chapter 9 subsection 4, pp 322 – 324.
[42] Campbell & Kay, 1996; Mink van der Molen, et al., 2003; Saxena , et al., 2004

Hand injuries can be further divided into five separate groups[43] i.e. dorsal, palmar, radial hemi-amputations, ulnar and distal amputations. The firework injured hand falls primarily into the category of distal amputations with some palmar injuries.

A study by Giessler, Leopold, Germann and Heitmann, 2006 titled "Blast injuries of the hands: Patterns of trauma and plastic surgical treatment" used the HISS to determine injury severity in 50 cases of firework injuries from 1995 – 2005. In this study, it was found that 18 patients were classified as having "minor" injuries (HISS<20), 16 patients sustained "moderate" injuries (HISS 21 – 50), 7 were severely injuried (HISS 51 – 100) and 9 patient sustained profound injuries (HISS >101). In this study, it was also evident that the smaller firecrackers resulted in mostly soft tissue injuries, minor and moderate categories, while the larger shells resulted in more severe and profound injuries.

The HISS can be used in conjunction with functional assessments. Functional impairments of the hand are assessed using standardized assessment tools and are both subjective and objective in nature. The acute phase of hand assessment for rehabilitation was not included in the majority of studies, however, certain areas for rehabilitation were inferred viz. joint range of movement and oedema reduction to prevent stiffness. Current formal assessments[44] e.g.: Disability Assessment of the Shoulder and Hand (DASH) and the Work Ability Screening Profile (WASP) for functional impairment are aimed at the chronic or stabilized phase of injury and are patient directed.

[43] Saxena , et al., 2004 citing Campbell-Reid 1996
[44] Mennen & Van Velze, 2008; Trombly, 1997

2.7 HAND REHABILITATION PROGRAMMES

As indicated previously, the treating therapist does not treat the mechanism of injury, but rather the outcome. The hand therapist is seen as a key role player in returning the function of the injured hand, the earlier the rehabilitation commenced the better the outcome[45]. Anecdotally, rehabilitation in itself is tailor-made to address the resultant dysfunctions after injury and the treatment programme is determined once assessment has been completed, thus, a patient-directed rehabilitation programme within an accepted clinical protocol is expected. A current trend in the literature was to treat the firework injured hand as a severely injured hand[46], and while this is not a standardized treatment protocol specific to firework injuries it did take into account the different healing times of the affected tissues.

As summarized from Mennen and van Velze (2008), there are three primary phases of tissue healing:

The first phase or inflammatory response occurs during the first six days. During this time there is a vascular and cellular response which causes oedema and pain. The soft tissues should be allowed to rest as any movement will be extremely painful and could impact negatively on the hand as well as impair the trust relationship that is being developed between the therapist and the patient.

The second phase or fibroplasia phase occurs from five to 36 days. During this time, granulation tissue, regrowth of capillaries and scar tissue starts to form. This is the phase where referral to rehabilitation should be of utmost importance to ensure the best

[45] Chong, 2011; Trybus, et al., 2008; Starck-Schier J, 2006
[46] Mennen & Van Velze, 2008

possible outcomes for hand function. Movement with minimal stress through the available range and pain level of the affected tissues is required in order to reduce oedema and assist with the healing process. During this phase, oedema and the ensuing stiffness cause the most damage.

The third phase, or scar maturation occurs from 4 weeks to 2 years. During this phase the scar tissue which has been laid down as randomly layered collagen fibers becomes more organized and the scar tissue is strengthened. The therapist is able to provide the most active rehabilitation using a range of modalities during the scar maturation phase where the more breakdown of scar tissue there is the more collagen fibers are produced but the new fibers are laid down in a more organized manner resulting in a softer, smoother and less bulky scar.

2.8 CONCLUSION

In conclusion, many studies have shown that fireworks often result in hand injuries. The immediate medical attention varied according to the level of injury. It was acknowledged that the primary aim of rehabilitation was to return the client to their former functional capacity within a meaningful and purposeful context. Rehabilitation could not be commenced until an assessment of functional capacity and limitations had been conducted[47]. This also applied to the firework injured hand.

[47] Kimmerle, et al., 2000

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology of this research project is provided in this chapter. Research design, data collection and analysis, reliability and validity as well as ethical considerations are covered below.

3.2 RESEARCH DESIGN

A historical research design was considered to be most appropriate as its purpose, "is to collect, verify and synthesize past evidence to defend or refute a current hypothesis"[48]. According to Gall (2007), the historical design uses secondary sources and primary documentary evidence as evidenced by the retrospective file audit of medical records using a questionnaire.

3.2.1 Overview of Study

The aim of the study was to describe the profile and management of the firework injured hand using a quantitative design in the form of a retrospective file audit. Purposive sampling was used. Data was coded and analysed using SPSS version 21 and Microsoft Excel 7

[48] Gall, 2007

3.2.2 Justification for choice of Research Design

The firework injured hand has been studied previously and the resultant injuries have been documented. The use of the retrospective file audit lends itself well to the historical research design in that:

A retrospective file audit was unobtrusive and did not impact negatively on the results of the study and this approach was well suited for trend analysis in the profiling process.

The researcher was able to obtain relevant contextual background information while researcher-subject interaction that could affect the findings was reduced. Lastly, historical sources can be used over and over to study different research problems or to replicate a previous study"[49]

The file audit was carried out retrospectively. Whilst some researchers are of the opinion that retrospective file audits have many limitations due to inconsistent record keeping by clinicians (therapists, doctors, nurses)[50], there is a positive opinion that there is a wealth of untapped information in historical records for research purposes, however, ethical considerations of the information still apply[51]

Ethical clearance was obtained from the University of KwaZulu-Natal (BE 329/13) (Annexure 6) and the KZN Department of Health, Health Research and Knowledge Management sub-component (Annexure 5). The process included obtaining gatekeeper approval from the two identified Provincial facilities to review medical records for patients within a specific time frame:

[49] Gall, 2007
[50] Gradidge K, 2010
[51] Gearing RE, 2006; Junod V, 2010

- 30 December – 5 January of each year
- 2013/2014, 2012/2013, 2011/2012, 2010/2011, 2009/2010

It should be noted that during the study development (proposal) phase, the retrospective file audit was intended from 2007 – 2012, however, due to legislation and policies around medical records being kept for five years, this time frame was adjusted to 2009 – 2014.

3.3 SELECTION CRITERIA AND SAMPLING

3.3.1 Selection criteria

Patient registers at the Casualty and Emergency departments were screened to obtain the details of medical records to be accessed. The timeframe focused on was 30 December to 5 January from 2009 to 2014. All medical records where the mechanism of injury or diagnosis referred to “firecracker” or “hand” were extracted from the patient registers.

3.3.2 Accessing Patient Files

It was initially envisaged that the medical records would be obtained from the Occupational Therapy departments themselves via patient statistics, however, this avenue proved to be overly time consuming and yielded limited results as (1) the OT departments do not record mechanism of injury in their patient registers, rather they record the diagnosis or reason for referral; and (2) patients having this mechanism of injury are not necessarily referred for rehabilitation within this time frame.

Thus the process was altered, with gatekeeper approval, to commence data collection by first viewing patient registers in the Emergency Departments (also known as Casualty or Accident and Emergency) of the identified facilities, as this is the patients' first port of call in the Hospital following an injury. Patient details pertaining to upper limb injuries were extracted.

The patient registers at the Emergency Departments (ED) record the patients' biographical data and the site of injury. Since 2012, they also recorded the mechanism of injury. Furthermore, the Emergency Departments at both facilities are open on the 31st December and the 1st January.

It was also suggested that the researcher review the Orthopaedic Out Patient Departments' patient registers as a percentage of patients are referred from their base hospitals to the sampled hospitals. In this case, the patient was directed to the Orthopaedic outpatient department (OOPD) rather than the Emergency department. In both cases, the time frames remained identical.

Once the patient details had been extracted, the lists were submitted to the Patient Administration and Medical Records departments to obtain the patient files. It should be noted that in most cases, both inpatient and outpatient files were reviewed. Furthermore, in a large percentage of cases, the patient list extracted was duplicated showing that after primary treatment at the ED, the patient was referred to OOPD. Thus, the patient list was refined before being handed over to the Medical Records

department to prevent unnecessary file searches. Once the patient files were obtained, they were audited according to the data extraction tool.

3.3.3 Sampling

Purposive sampling was used to select the two Provincial hospitals from the uMgungundlovu district (Annexure 7 and Annexure 8) as they are known to have on-site Trauma units as well as specialized orthopaedic units, occupational therapy and physiotherapy departments which are involved in the management of the firework injured hand.

Inclusive sampling of patient files for the retrospective file audit was used as all the files related to this study for the specified time frames were included for data collection.

3.4 PILOT STUDY

A pilot study[52] is also known as a feasibility study as it is considered to be a smaller version of a larger study and serves to give advance warning of where the main research study could fail and also directed the researcher's attention to challenges and gaps within the research instrument.

The pilot study was administered for a number of purposes, firstly, to test the adequacy of the file audit questionnaire; secondly, to assess whether the research protocol was realistic and workable given the allocated time frame for completion; and lastly to identify challenges that may occur during data collection using the proposed methods

[52] Van Teijlingen & Hundley, 2002

Due to the relatively small sample size anticipated, a pilot study was conducted using three medical records from one of the identified facilities, outside of the 5 year time frame i.e. December 2007 to January 2008 in order to test the appropriateness of the data extraction tool. Three qualified experienced occupational therapists used the data extraction tool when accessing data from the files for the pilot study.

The findings from the pilot study were found to strengthen the data extraction tool by including categories of levels of injury where the HISS was found to be most suitable, easily reproduced and user friendly; rehabilitation assessments and rehabilitation interventions. Further to this, time allocations for data extraction were set at 20 – 30 minutes per file.

3.5 DATA COLLECTION

Medical records from the two sampled hospitals were accessed following Gatekeeper permission. The following criteria were used to identify patient records for survey using the patient statistics book, (1) timeframe 30 December to 5 January; (2) between the years 2009 to 2014; (3) the diagnosis or mechanism of injury relating to the “hand”, “upper limb”, “firecracker”, “cricket” or “firework”.

3.5.1 Data Extraction Form

The data extraction tool (Annexure 10) or survey form was designed by the researcher as alternative tools available did not address specific variables taken into consideration for this study, that is, the rehabilitation category.

The purpose of the data extraction tool was to profile the injuries sustained by the hand in a firework explosion as well as to identify the surgical and rehabilitation interventions following this mechanism if injury. The data extraction tool was designed in a pre-coded structured format, comprised primarily of closed ended questions with a variety of choices per question or statement, as it was quantitative in nature. The time allocation per patient file undergoing data extraction was difficult to determine until a pilot study of 3 files had been completed.

The data extraction tool was organized across the following information categories:
Facility Information where it was determined which of the two hospitals the file audited was obtained from, the manner in which the patient accessed the hospital. Patient demographics included the age and gender of the patient as well as date and time of injury and time to treatment of injuries sustained. Handedness in terms of dominance and injury was also included.
Types of injuries and surgical interventions were obtained from reading the literature. Injuries were further categorized according to area of hand injured and type of injury sustained.

Time variables included in the data extraction tool included length of in-patient stay as this had been mentioned in three previous studies. Length of time taken to refer the patient for rehabilitation was included as it is well documented that the injured hand requires a multidisciplinary approach. Amount of time spent in the rehabilitation programme at the primary site was included as this is not equal to the number of sessions a patient is able to participate in.

Referrals were included as both hospitals are the domain of the Department of Health where there are specific guidelines for referrals for continuity of care, this included the type of referral as written referrals are the standard operating procedure in public service hospitals.

The last category was particularly important to the researcher from a rehabilitation perspective, that is, functional assessment completed on discharge and the level of functional impairment at discharge.

An individual Hand Injury Severity Score was obtained for each completed data extraction tool as explained in the literature review. The score was obtained by applying the scoring system (Annexure 11) using a template (Annexure 12) according to the description of the injuries as recorded from the patient files.

3.6 DATA ANALYSIS

Due to the relatively small sample size (n = 65), the use of inferential statistics was precluded. Once data was collected, it was then coded and analysed descriptively using

The Statistical Package for the Social Sciences (SPSS), version 21. A portion of the data was also analyzed using a basic Excel Microsoft 7 programme.

3.7 VALIDITY AND RELIABILITY

Validity[53] is defined as “how well a test measures what it is purported to measure”. Construct validity was achieved as the results obtained were in line with previous studies, that is, it was found that firework explosions in the hand were the same or similar to previous studies. The survey form was appraised by colleagues working in the field to ensure content validity.

Reliability is defined as “the degree to which an assessment tool produces stable and consistent results”. Inter-rater reliability was achieved by using a pilot study in which 3 occupational therapists in different fields of practice in the arena of physical rehabilitation achieved the same conclusions. The pilot study ensured that the survey form was reliable and could be used in other studies. The researcher was consistent throughout the data gathering process by utilising the same researcher to complete all survey forms.

3.8 ETHICAL CONSIDERATIONS

There are principles and professional responsibilities that were adhered to when conducting research in clinical settings, thus research integrity was maintained at all times.

[53] Phelan & Wren, 2005 - 2006

The researcher obtained ethical clearance from the UKZN Human and Social Sciences Committee following the submission of a completed research proposal (Annexure 6)
The researcher obtained permission from Department of Health Head Office prior to obtaining gatekeeper approval from the relevant facilities (Annexure 5).
Gatekeeper approval was obtained in order to access patient records from the Department of Health and CEO of the hospitals to access the relevant medical registry departments. (Annexure 2 and 4).

Confidentiality was maintained by assigning numerical codes to each survey form.

According to literature on retrospective file audits, informed consent should be obtained from each patient. However, in this study, blanket consent was obtained from the Gatekeepers. As it would have been extremely difficult to obtain informed consent from each patient, the signed blanket consent on opening a file at the sampled hospitals was accepted as informed consent.

The study followed principles of veracity or truthfulness as rules were put into place in order to protect the review of the medical records in that (1) sources and references consulted during the research process were acknowledged; (2) an accurate record of all data collected during the research process was maintained; (3) honesty and integrity was displayed throughout the research process

Data management was ensured adhering to the standard operating procedures that apply to patient records, that is, no documents were removed from the patient files, the patient files were not photocopied or scanned, the patient files were not removed from the sampled Hospital premises. The researcher maintained a data trail.

All hard copy data has been locked in a filing cabinet and will be destroyed by shredding after 5 years while electronic data has been saved on a separate USB.

3.9 CONCLUSION

The study employed the use of a retrospective file audit from two sampled hospitals. Sixty-five medical records were made available for data collection. The data was coded and analysed using the SPSS version 21 and Windows Excel 7.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

This chapter will outline the results obtained from the file audit. Graphic representations have been used to highlight descriptive statistics. Results on the referral sources, nature of injuries and rehabilitation received will be covered in this chapter, amidst others. This will be followed by an ensuing discussion to place these findings in context.

4.2 STATISTICS OF CASES REPORTING FIREWORK-INJURED HANDS

Both facilities were situated within the uMgungundlovu district which services approximately 1.4 million people as the second most populated district in the province of KwaZulu-Natal. A total of 65 case files were accessed, which reported incidents of firework related hand injuries over a 5 day period (30 December to 05 January) over a five year period i.e. 65 cases over 25 days. Fifty of the 65 cases presented at the regional hospital while 15 presented at the tertiary facility. All 65 cases presented at the Casualty or Trauma departments prior to being referred for orthopaedic consultation.

4.3 REFERRAL SOURCE

Figure 4.1 below indicates, 56.9% of the patients' accessing the identified facilities following firework related hand injuries presented directly from home; 10.7% presented

from surrounding clinics. 29.2% were referred from other district or base hospitals. The source of referral was unaccounted for in approximately 3% of the cases.

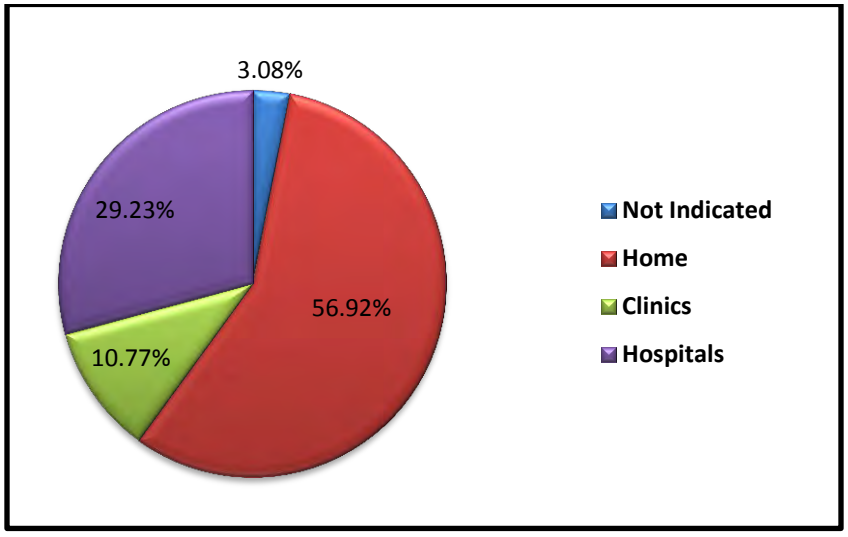

Figure 4.1 Referral Source (n=65)

4.4 TIMEFRAMES OF PRESENTATION AFTER INJURY

Most of the patients were injured between the 31st of December and the 1st of January, however patients presented to the facility up to the 4th of January. The greatest number of injuries (67.7%) occurred on the 01 January (Figure 4.2).

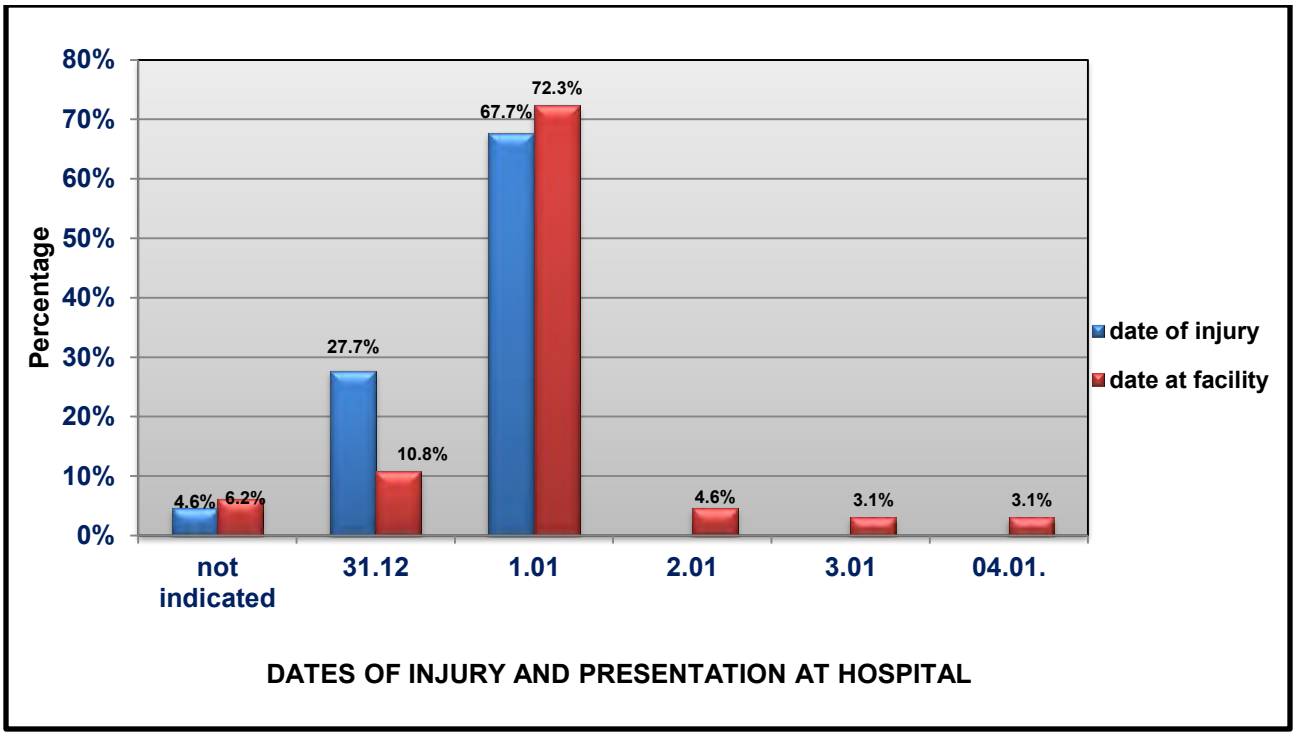

Figure 4.2 Date of Injury compared to Date of Presentation at Hospital (n=65)

Figure 4.3 below indicates the time of injury against the time of treatment. 27.7% of patients were injured on the 31st of December between 21h00 and midnight as compared to 67.7% having sustained injuries between midnight and 03h00. 26.2% of patients were treated within the first 3 hours of injury on the 1st of January as compared to 3.1% on the 31st of December. Surprisingly, in 34.1% of cases the time that treatment commenced was not indicated in the file.

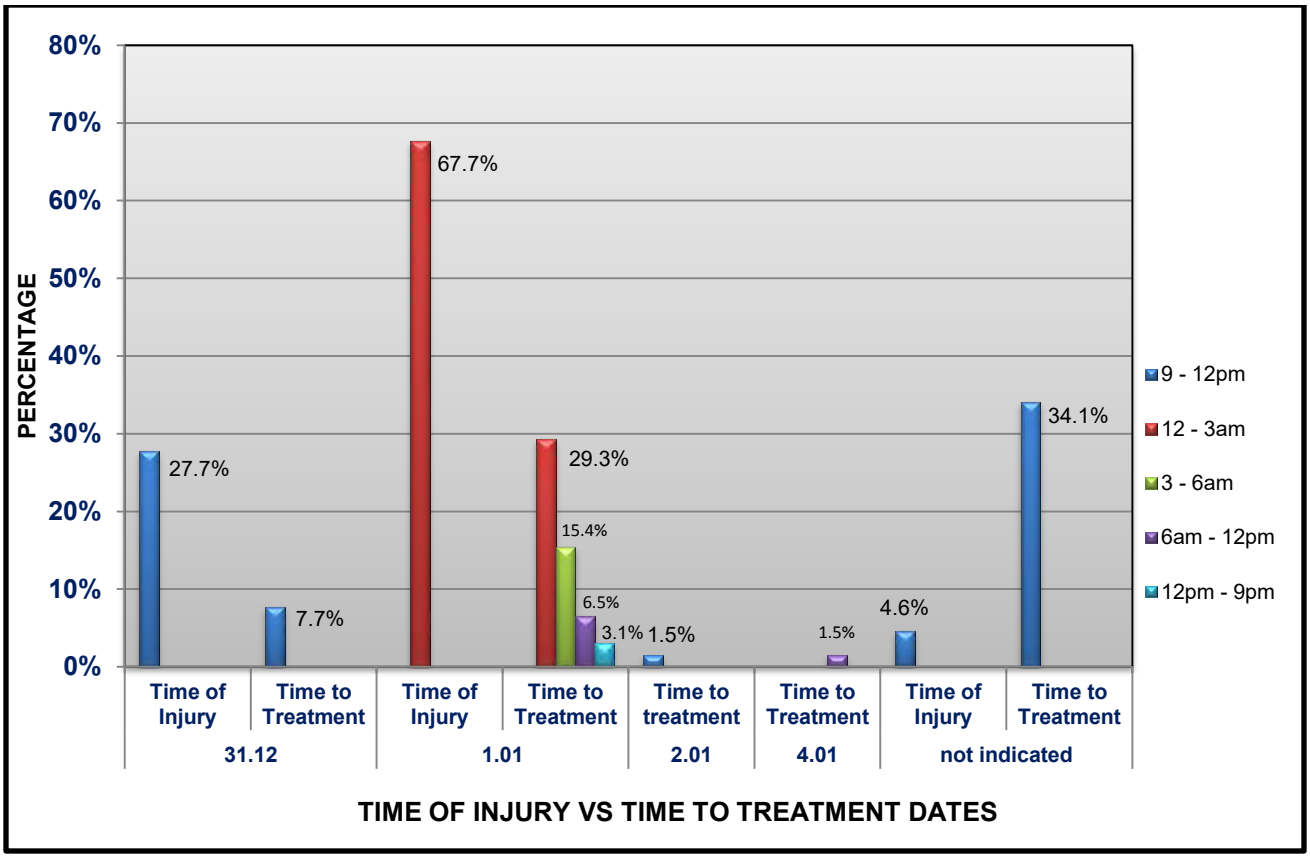

Figure 4.3 Number of patients presenting at the sample hospital within a timeframe (n=65)

Of the 67.7% of firework injuries sustained on the 1st of January, 15.4% were treated three to six hours after the injury, whilst 6.5% were treated up to 12 hours after injury. 3.1% of the patients received treatment more than 12 hours after injury.

On the days following the New Years' celebrations, 1.5% of patients presented at the hospitals between 09h00 and 00h00 on the 2nd of January; 1.5% presented between 06h00 and 00h00 on the 4th of January.

4.5 MODE OF TRANSPORTATION TO THE HOSPITAL

Patients accessed the facilities via ambulances, private vehicles as well as walk-ins.

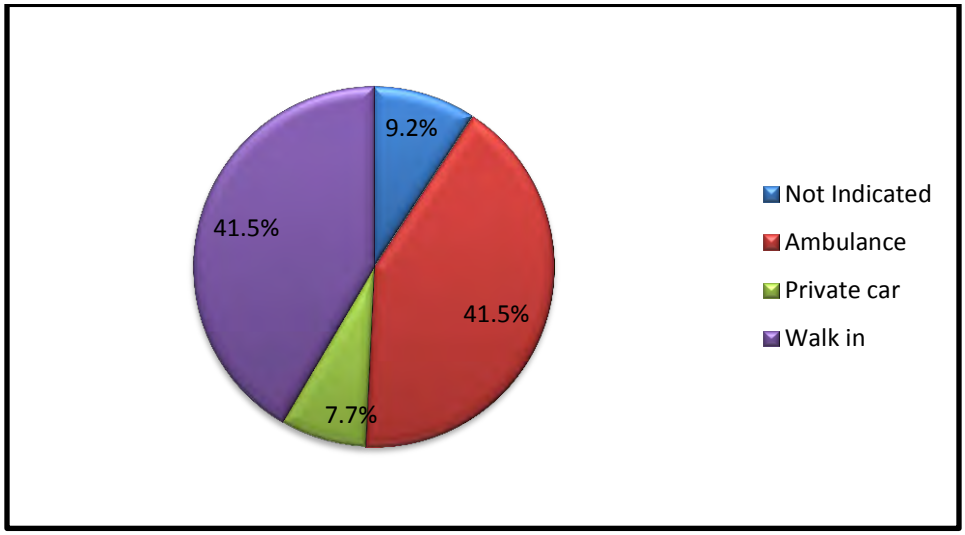

Figure 4.4 Mode of Transportation used to access the Hospitals (n=65)

4.6 PATIENT DEMOGRAPHICS

4.6.1 Age and Gender Distribution

The youngest patient was 6 years old, and the oldest patient 83 years, the mean age was 31 years (Figure 4.5). Seventy point seven-seven percent of patients were male compared to 29.23% who were female.

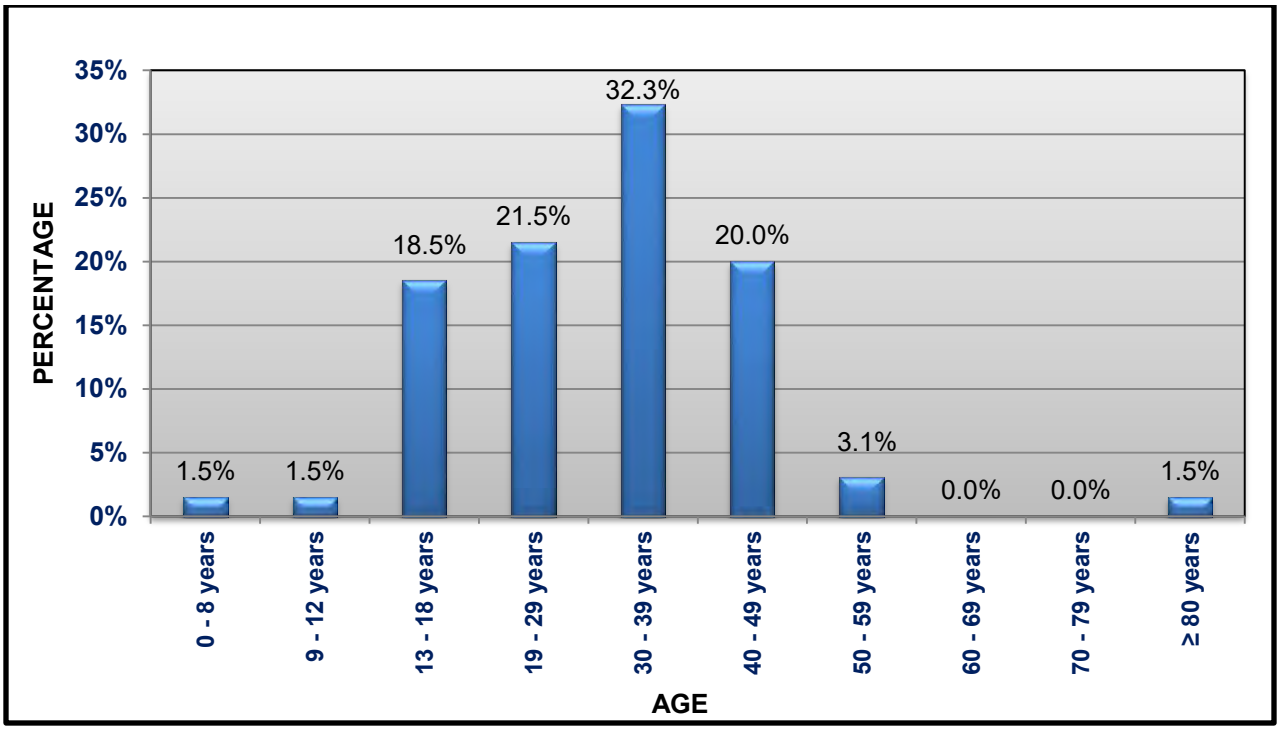

Figure 4.5 Age ranges of injured patients (n=65)

4.6.2 Occupations of Patients

The patients' occupation in 55% of cases was not indicated or recorded (Figure 4.6). Of the cases, where the patients' occupation was recorded, 20% were either in school or studying further, 6.2% were unemployed, employed as drivers or involved in manual labour. The remaining patients were either gainfully employed in office-based employment (3.1%) and professional or skilled employment (1.5%); or in receipt of a pension (1.5%).

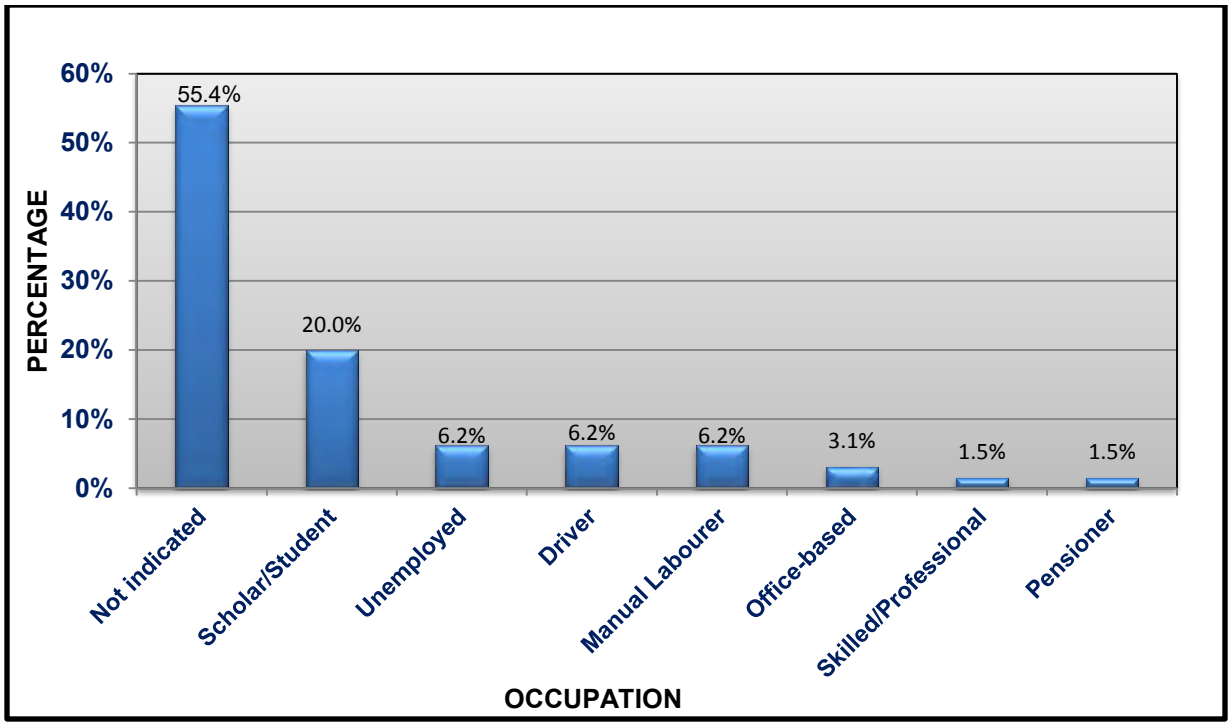

Figure 4.6 Occupations of patients that sustained firework injuries to the hand (n=65)

4.6.3 Dominance versus Injured Hand

Hand dominance in 63.1% of cases was not recorded (Figure 4.7). Additionally, 13.8% of the case reports did not indicate which hand was affected. The right side was recorded as being most dominant (29.2%) and most affected (61.5%). It must be noted that injury to the dominant hand has a significant impact on functionality.

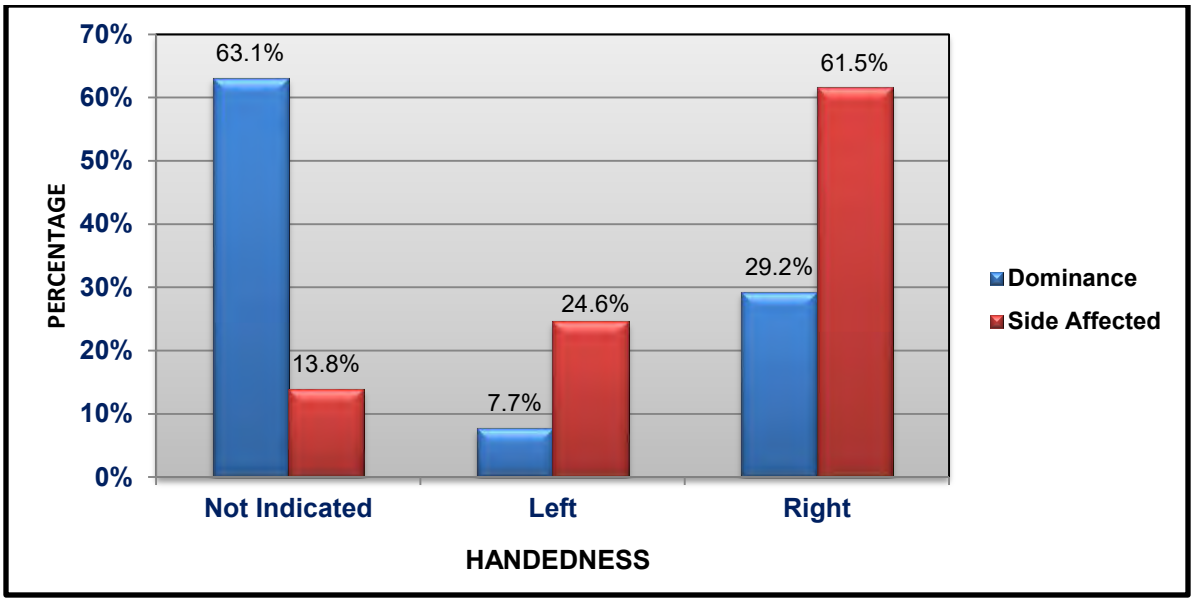

Figure 4.7 Dominance against hand affected by injury (n=65)

4.7 INJURIES SUSTAINED AND SURGICAL MANAGEMENT

The graph overleaf (Figure 4.8) highlights the type of injury sustained per digit. The thumb, index and middle fingers sustained the greatest trauma, comprising mainly of soft tissue injuries, i.e thumb (64.6%), index finger (75.4%) and middle finger (72.3%). Fractures were also frequent with thumb (29.2%), index finger (29.2%) and middle finger (23.1%). The percentage of traumatic amputations was highest for the index finger (23.1%) and thumb (20%). The category “other” pertained to webspaces and the palm which sustained injuries in 20% of cases. The ring and little fingers also sustained soft tissue injuries predominantly, i.e. 27.7 % and 16.9% respectively, and this was significantly lower than the number of cases with injuries in the thumb, index and middle fingers. In most cases, tendon (7.6%) and neurovascular (1.5%) injuries were not assessed or indicated in the patient files and is hence poorly represented on the graph.

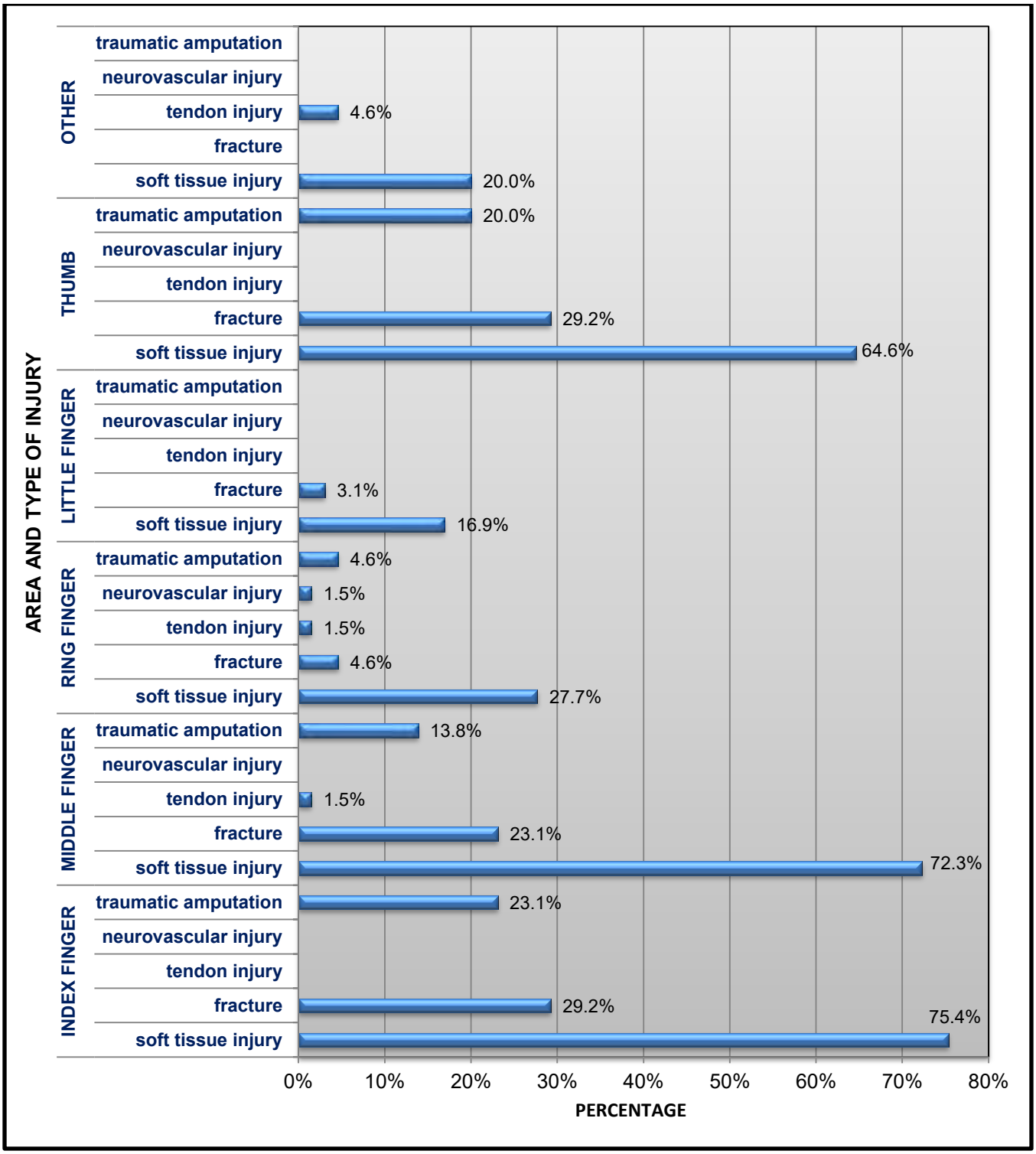

Figure 4.8 Types of injuries per digit (n=65)

Figure 4.9 below reveals that the thumb, index and middle fingers sustained the most trauma at the level of distal phalanx (DP) and distal interphalangeal joint (DIPJ). Less frequent trauma occurred at the proximal phalanx (PP) and proximal interphalageal joint (PIPJ) and metacarpal (MP) and metacarpalphalengeal joint (MPJ). Possible reasons for this will be addressed in chapter 5.

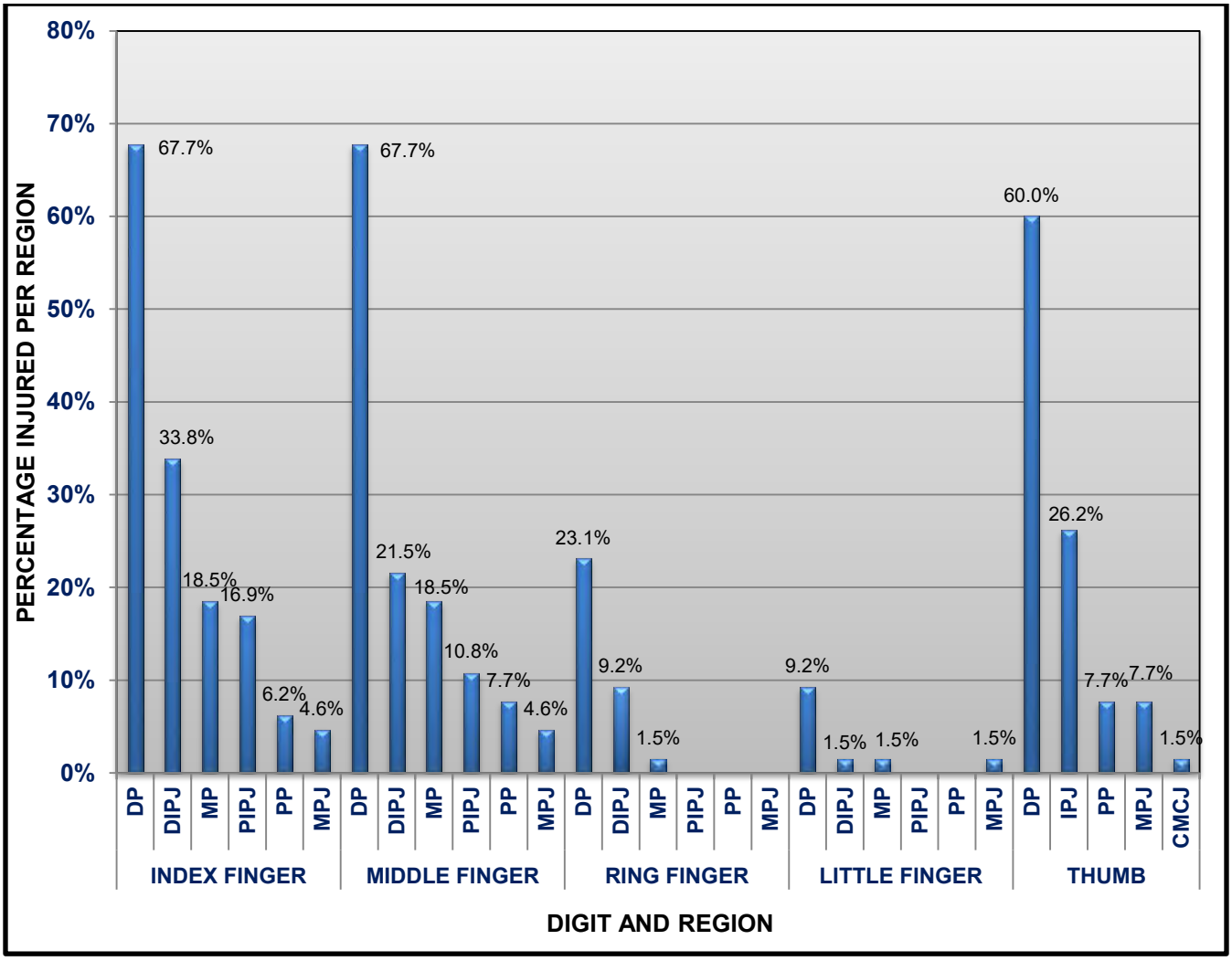

Figure 4.9 Levels of injuries per region of each digit (n=65)

Figure 4.10 below indicates that the digits were not the only areas of the hand that sustained injury. In 12.3% of cases, the injured area was not specified. The palm sustained injuries in 12.3% of cases. The first webspace (7.7%) also sustained injuries in addition to the second (3.1%) and third (1.5%) webspaces. The thenar eminence was reported to have been injured in 3.1% of cases. Injuries to other body parts such as the eye and the foot constiuted 1.5% of injuries each.

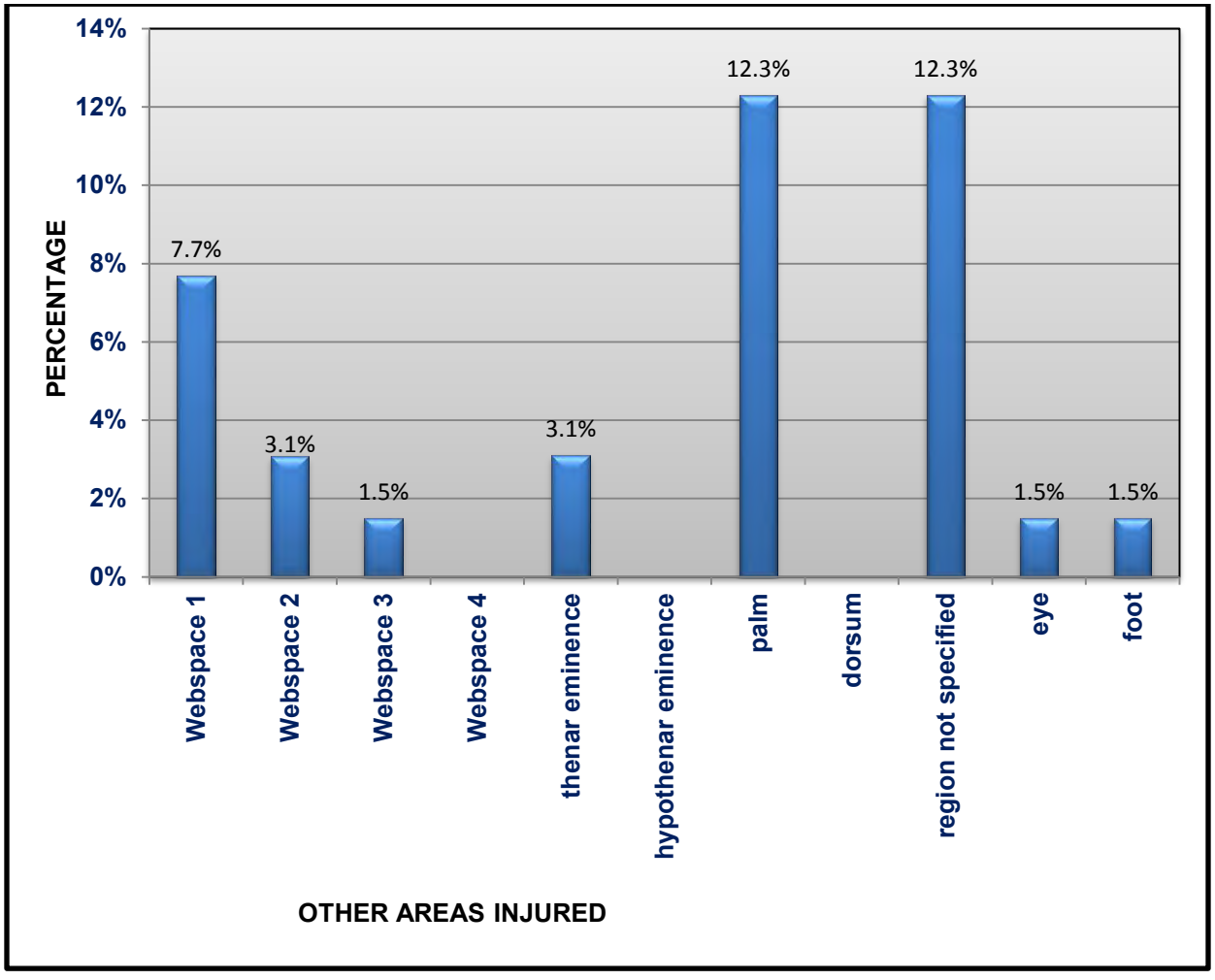

Figure 4.10 Other areas of injury (n=65)

Approximately 90.8% of patients underwent basic washout, clean and suturing with 80% also undergoing debridement. A staggering 72.3% further had the affected areas amputated, this included formalization of traumatic amputations. It is also significant that only 10.8% of patients underwent reconstruction and 9.2% required split skin grafts (Figure 4.11).

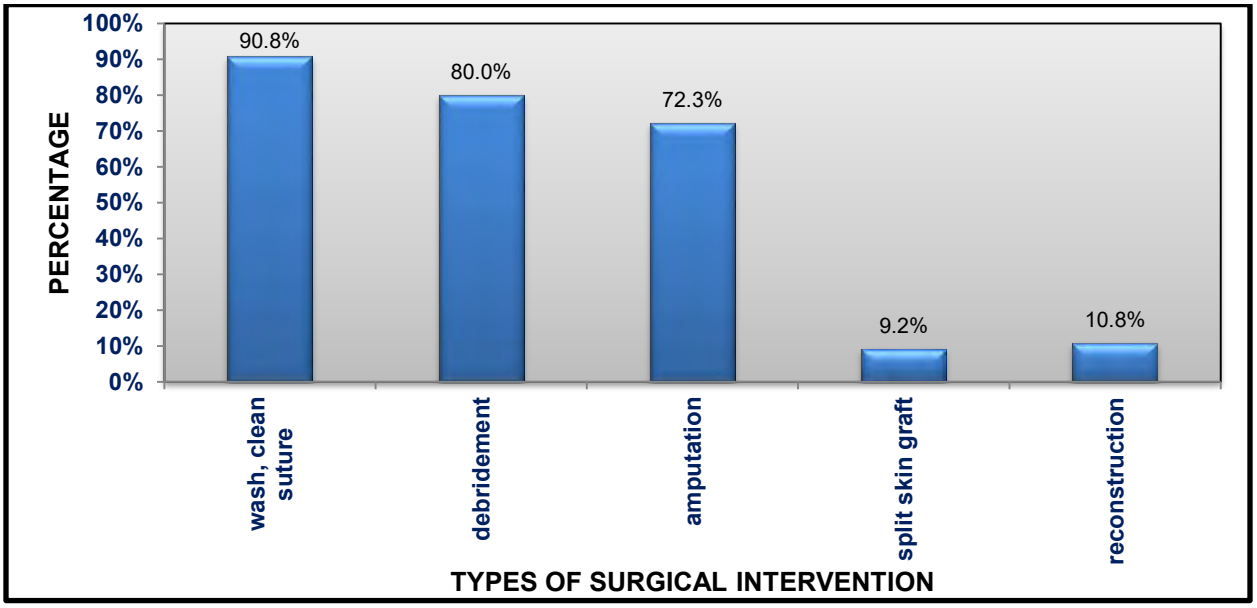

Figure 4.11 Surgical intervention (n=65)

4.8 ADMISSIONS AND LENGTH OF STAY FOLLOWING FIREWORK INJURY

The average length of stay was calculated as 7.69 days. Figure 4.11 highlights the length of stay of patients with firework injuries. 29.2% of patients were not admitted, with 18.5% of the patients staying between 0-5 days. The maximum period a patient was admitted for was 17 days. A large percentage of patients (35.4%) were admitted for between six and ten days (Figure 4.12).

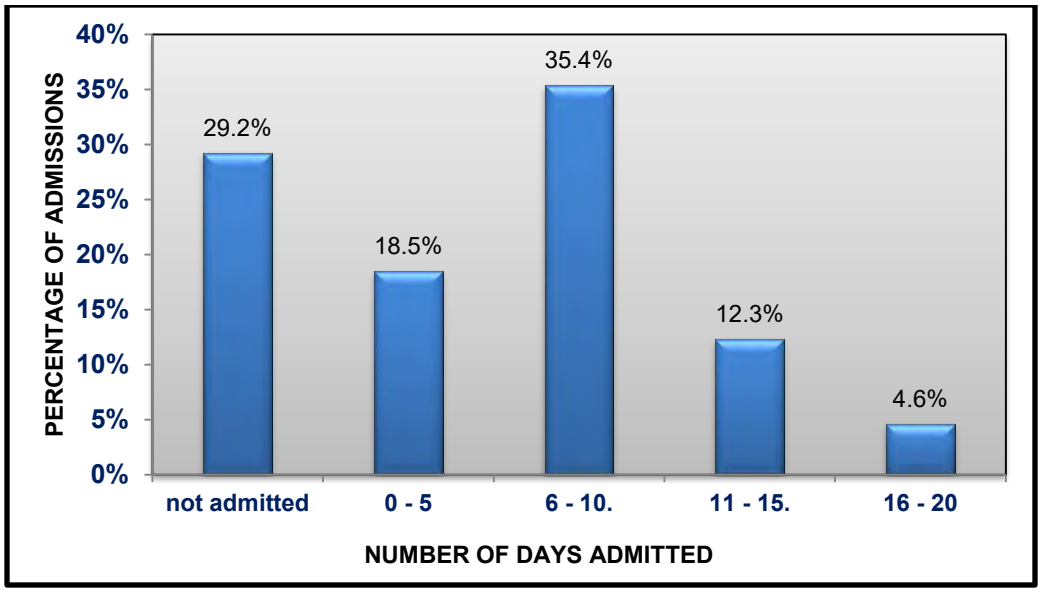

Figure 4.12 Length of Stay following firework injuries (n=65)

4.9 FOLLOW UP AND FORMAL DISCHARGE

Forty-one point five percent of patients did not return for follow up assessments and formal discharge. In 35.4% of cases, an assessment by the doctor was not completed prior to discharge. A total of 20% of patients had some form of screening assessment on discharge and in 3.1% of patients the discharge assessment was not indicated (Figure 4.13).

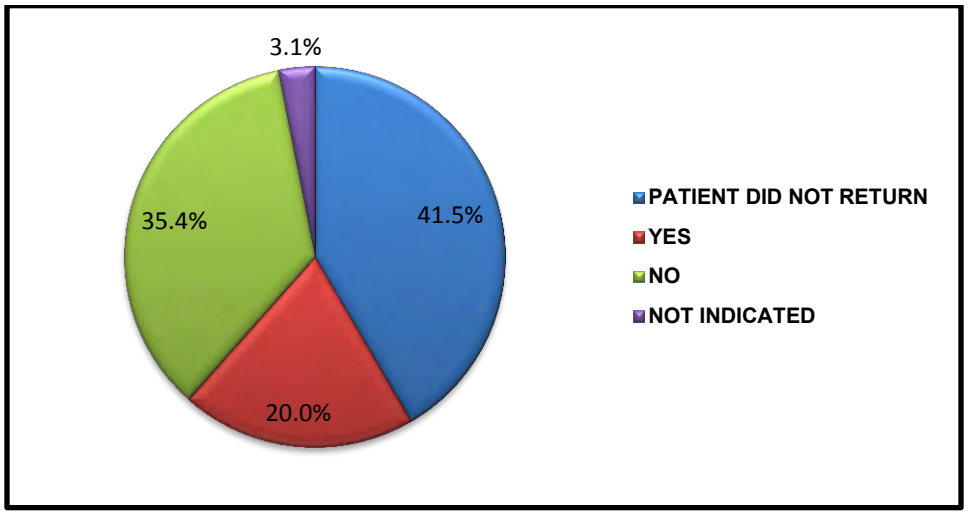

Figure 4.13 Number of Assessments on Discharge (n=65)

4.10 REHABILITATION

4.10.1 Time taken to refer for Rehabilitation

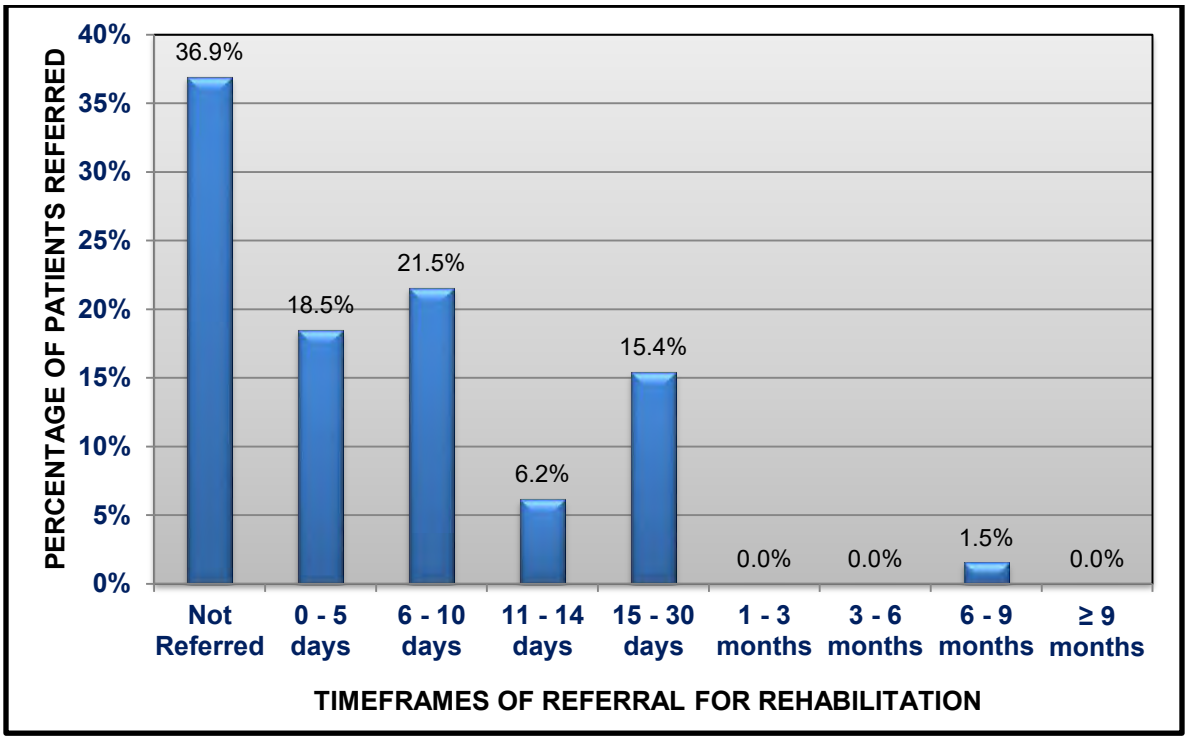

Figure 4.14 Time taken to refer patients for rehabilitation (n=65)

Figure 4.14 indicates that referral for rehabilitation following hand injuries as a result of fireworks. 36.9% of cases were not referred for rehabilitation. A combined total of 63.1% of patients were referred for rehabilitation, of this 18.5% of patients were referred within the first 5 days, 21.5% within the first 10 days, 6.2% within the first two weeks and 15.4% of patients in the first month. One point five percent of patients were referred 6-9 months after the injury.

4.10.2 Number of patients who received rehabilitation

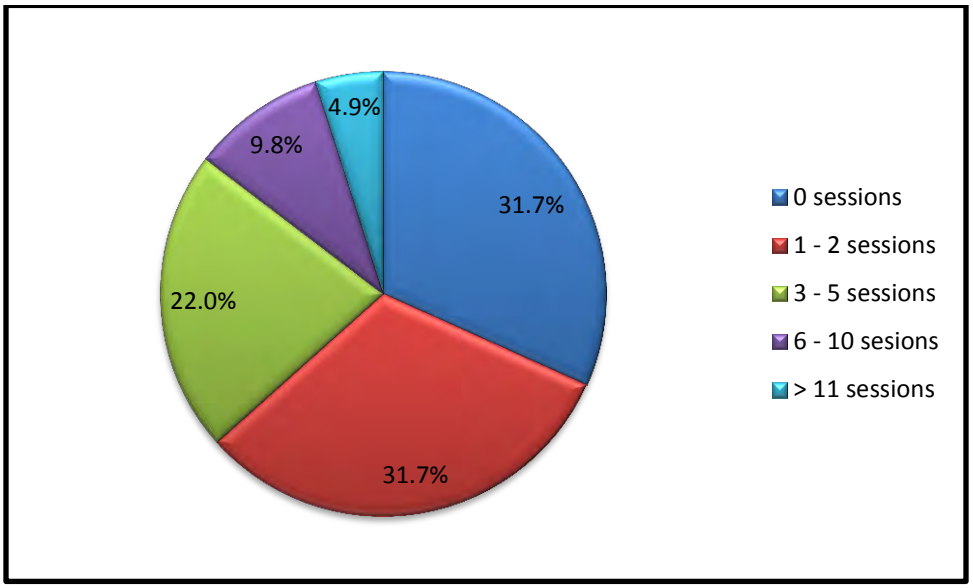

Figure 4.15 Patients who received rehabilitation (n=29)

Rehabilitation sessions included interventions by either a physiotherapist or occupational therapy or both professionals. Sixty-three point one percent of patients were referred for rehabilitation at some stage of their surgical and orthopaedic management (cf. Figure 4.12). Of this total, 31.7% never attended rehabilitation, 31.7% attended 1-2 sessions while 22% attended 3-5 sessions and 9.8% received 6-10 sessions. A minimum percentage of patients (4.9%) received more than eleven rehabilitation sessions. Therapy sessions were conducted by both occupational therapists and physiotherapists.

4.10.3 Assessments conducted during the Rehabilitation phase

Assessment of the injured hand forms a large part of the rehabilitation process and normally occurs at the first session. The assessment takes into account injuries sustained and the functional impact on activities of daily living which guides the rehabilitation process in terms of aims and objectives of treatment in order to restore hand function. Further to this, the assessment that is conducted at the end of the rehabilitation process serves to ascertain progress and readiness for discharge, or in this study, level of available hand function or impairment of hand function. Figure 4.16 below outlines the areas of assessment that were undertaken at the start of the rehabilitation process.

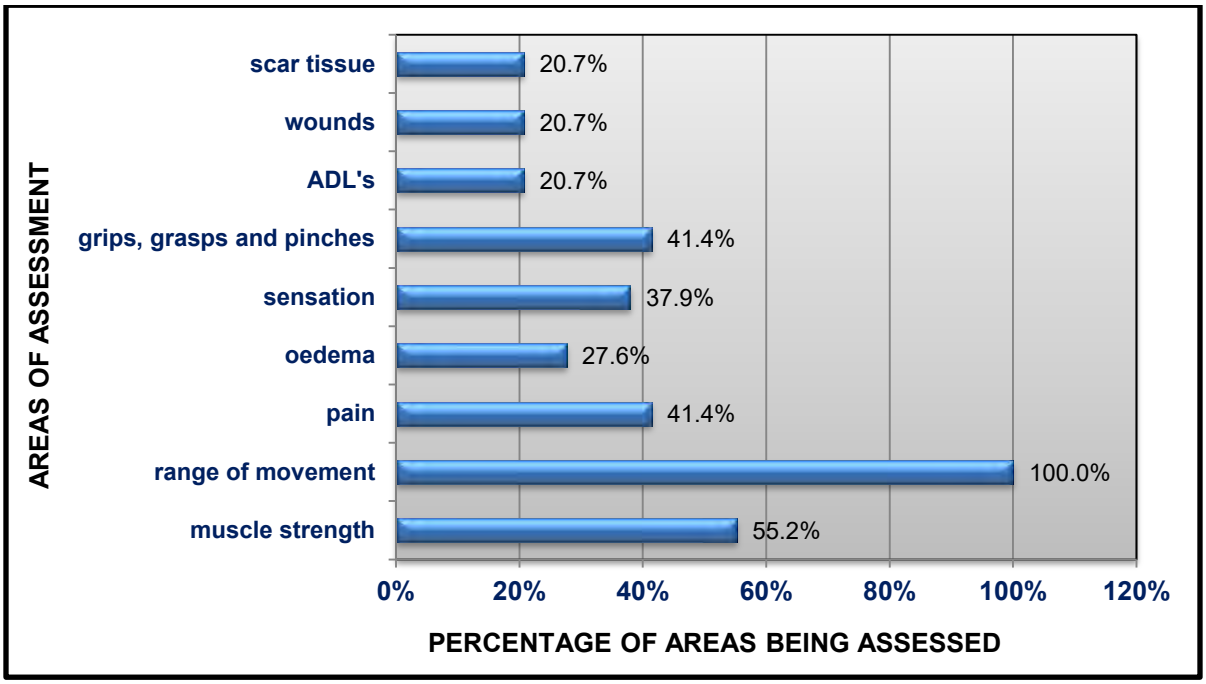

Figure 4.16 Areas of assessment undertaken at the start of rehabilitation (n=29)

All patients who attended rehabilitation were assessed in terms of joint range of movement (JROM) this encompassed active and passive JROM. Muscle strength was assessed in 55.2% of cases. Grips and grasps as well as pain were assessed in 41.4%

of cases while sensation in 37.9%. Scar tissue, wounds and activities of daily living (ADL's) were assessed in 20.7% of cases with oedema being assessed in 27.6% of the cases.

4.10.4 Modalities of treatment during the Rehabilitation phase

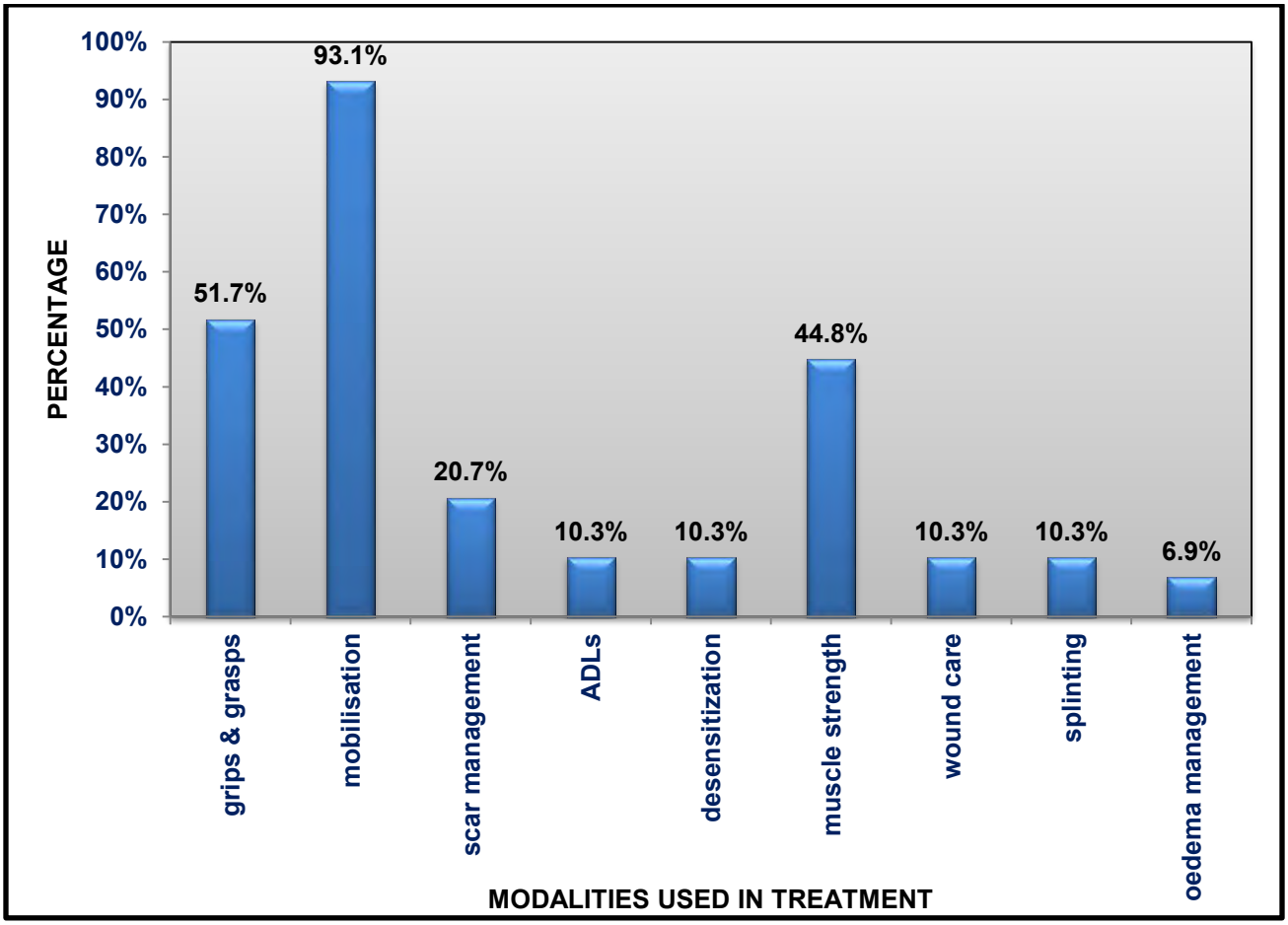

Figure 4.17 Modalities used in treatment (n=29)

As Figure 4.17 indicates, mobilisation occurred in 93.1% of cases, followed by 51.7% using grips and grasps and muscle strength at 44.8%. Scar management was

addressed in 20.7% of cases whilst splinting, wound care, desensitization and ADL's were addressed in 10.3% of cases.

4.11 FUNCTIONAL IMPACT OF THE FIREWORK-INJURY ON THE HAND

The functional impact of each hand injury was assessed using the Hand Injury Severity Scoring (HISS) scale. The HISS is specific to each patients' injury, in that each ray of the hand is separately assessed according to the integument, skeletal component, motor component and neurovascular component. The combined scores from each weighted ray are then added together to obtain an overall total injury score. The scores were as follows:

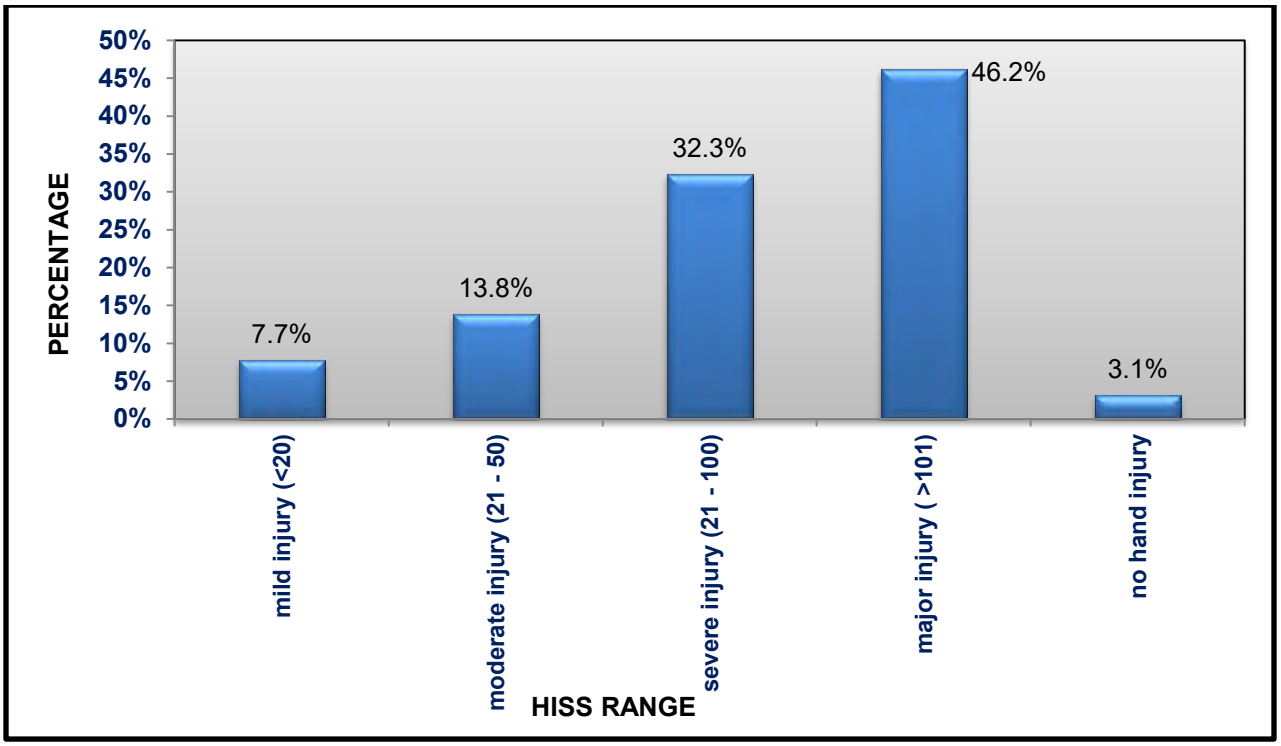

Figure 4.16 HISS ranges for patients sustaining firework injuries to the hand (n=65)

These scores indicate that the firework injured hand has a wide range of injuries from mild (<20, 7.7% of cases), moderate (21 – 50, 13.8% of cases), severe (51 – 100, 32.3% of cases) and major (>101, 46.2% cases).

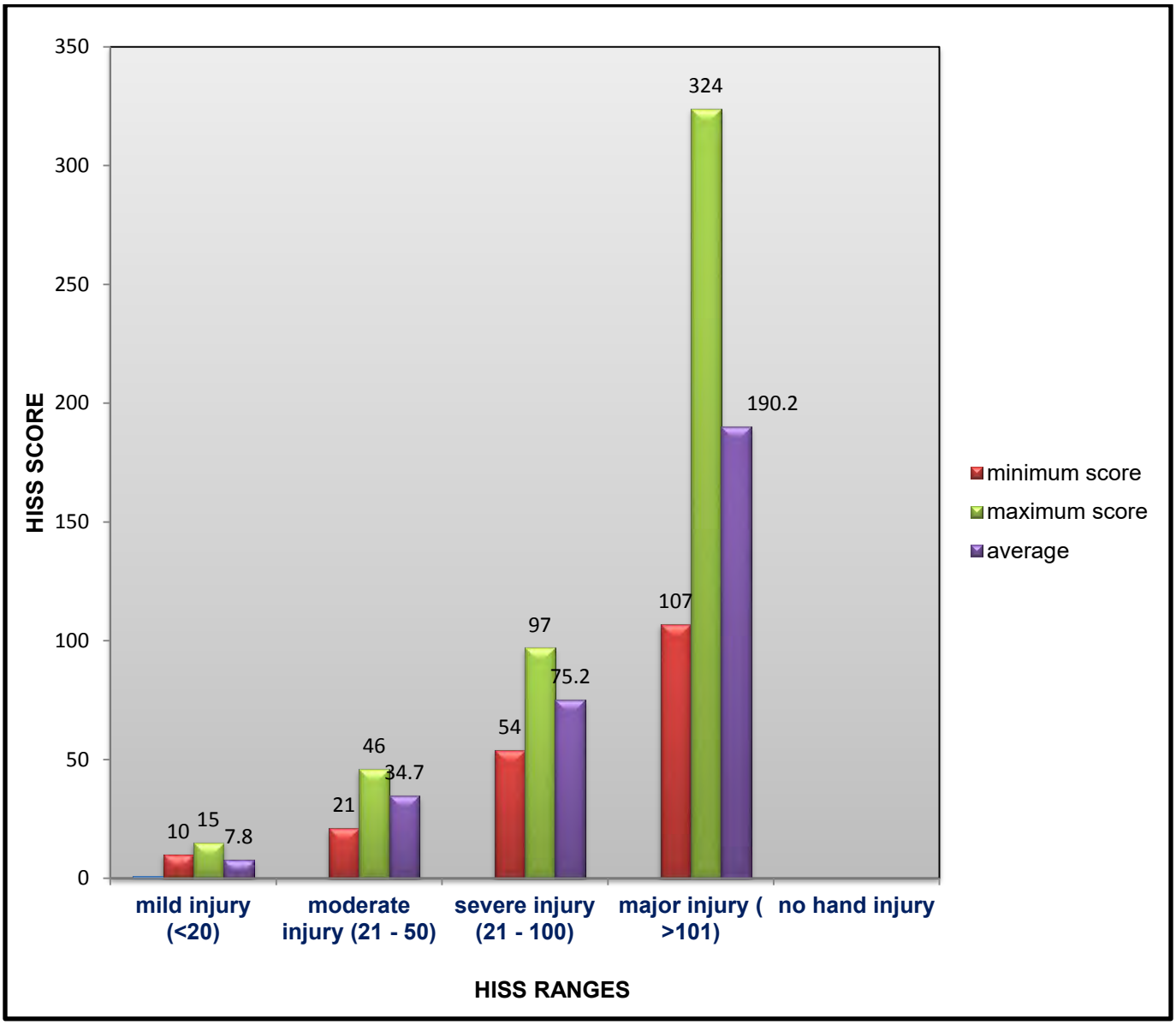

Figure 4.18 HISS scores within the ranges

The graph above depicts the minimum, average and maximum scores for each of the severity ranges. The minimum score for the HISS was 10 and the maximum was 324,

while a mean score of 117 was obtained. This indicates that the maximum score was achieved in most of the cases reviewed (indicated in the green bar in Figure 4.18), which highlights the severity of the injuries within each category.

4.12 RESIDUAL FUNCTIONAL IMPAIRMENT AFTER REHABILITATION

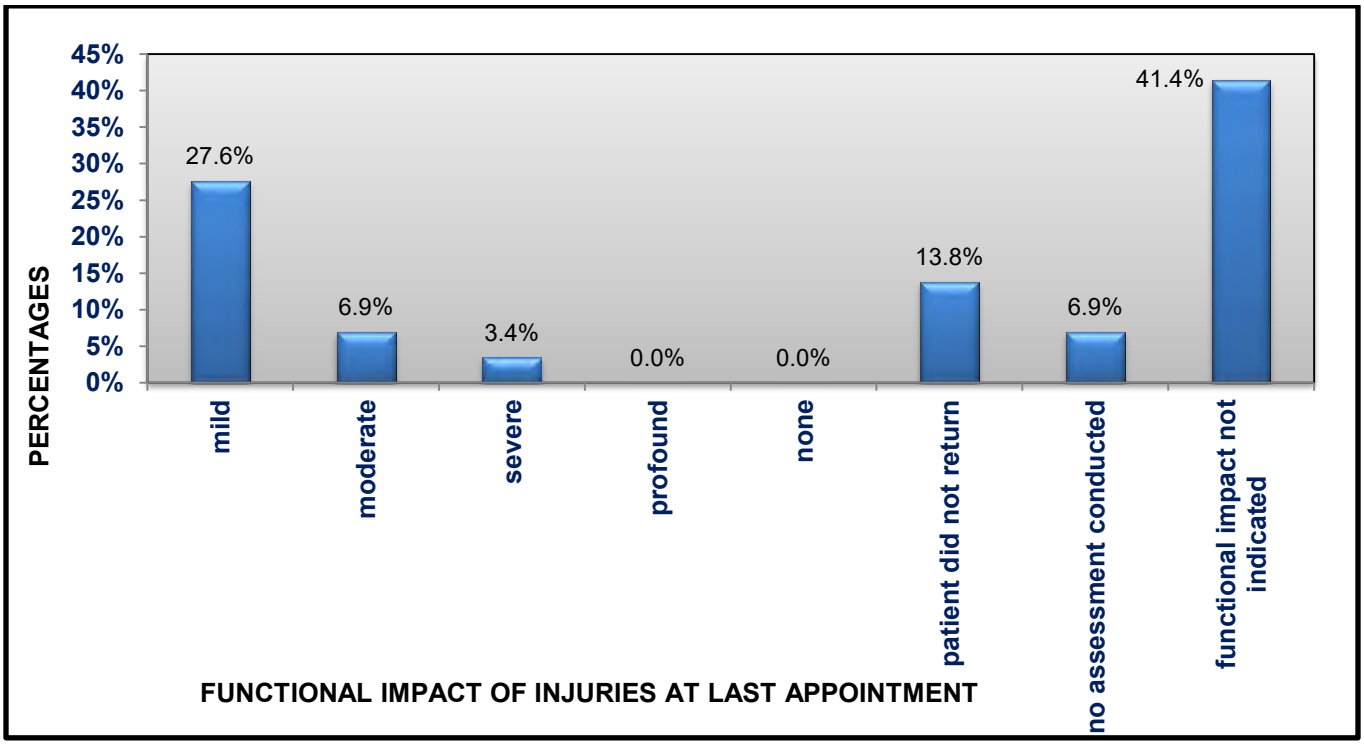

Figure 4.19 Functional impact after rehabilitation (n=29)

As noted previously, only 63.1% of cases were referred for rehabilitation (cf. Figure 4.15). Of these, 13.8% of the patients did not return for formal discharge thus the functional impact of their injuries could not be ascertained. In 6.9% of cases, a functional hand assessment was not conducted while 41.4% did not indicate level of functional impairment. Of the 37.9% of cases where the functional impairment was indicated, 27.6% retained a mild impairment, 6.9% a moderate impairment and 3.4% a severe impairment of function.

4.13 CONCLUSION

This chapter outlined the results of the study from data obtained using a file audit, which has covered the referral source, date of injury and presentation at the facility, demographic information of the patients, types of injuries sustained, surgical and rehabilitative intervention and overall functional impact assessed via the HISS System. These were analyzed and presented descriptively.

As an overview of the results in this chapter, patient demographics showed that men were three times as likely to sustain a firework injury to the hand when compared to women; the age range most affected was the working class viz. 30 years – 39 years, 20 years – 29 years and 40 years – 49 years. The right hand was more likely to be affected than the left hand. Handedness was predominantly not recorded.

The injuries sustained were predominantly soft tissue injuries to the thumb, index and middle fingers, closely followed by fractures and amputations, traumatic and surgical. These injuries were predominantly managed surgically using debridement and washout, suturing and amputation, which included formalization of traumatic amputations. Reconstructive surgery featured minimally.

Rehabilitation was seen to be of importance to the medical staff but not to the patients as evidenced by two-thirds of the patients being referred for rehabilitation but only half of this number actually attended. Rehabilitation of the hand was focused predominantly

on regaining active joint range of movement for prehension in the completion of ADL's during the assessment and treatment phases.

The next chapter will assist in placing these findings within context as part of the overall discussion.

CHAPTER 5

DISCUSSION

5.1. OVERVIEW

The preceding chapter is littered with graphs and tables dedicated to profiling the injuries in a firework injured hand, the demographics of the patients, the extent of injuries, as well as medical and rehabilitative interventions. The following discussion serves to contextualize the results that have been described in chapter four.

5.2. THE BLAST CAPACITY

The nature of a firework explosion is such that the chemicals inside the firework are designed to burn brightly, in a myriad of colours and sometimes make a loud noise. By using fire to ignite the chemicals which reach extreme temperatures[54] and cause the casing to explode, the unprotected soft tissues of the hand are exposed to intense heat and vibration which absorb the blast[55]. This results in the "explosion" of the soft tissues, subsequent fractures and traumatic amputations.

5.3. FIREWORK INJURIES IN THE SOUTH AFRICAN CONTEXT

Firework injuries continue to be underestimated in South Africa. The researcher was only able to access four articles[56] written about these injuries in the human context in South Africa, compared to the much publicized danger that fireworks pose to animals.

[54] Smittenberg, et al., 2010
[55] Adhikari, et al., 2013
[56] Wilson, V., 1999; Matshidza, S.et al 2005.; Smittenberg, MN., et al, 2010.; Pikor, T., et al, 2013.

Further to this, South African legislation[57] serves to control only the storage, sale and discharge of fireworks. Despite the legislation in place, fireworks have continued to be poorly controlled in the national and international contexts. Smittenberg et al (2010) recommend a comprehensive approach with stricter regulations including education and supervision, permits for a specified time duration. It was cited in Smittenberg et al (2010) that "a legislative ban on private fireworks displays" in Hungary reduced the incidence of firework injuries sustained by children[58]. International studies[59] called for awareness campaigns about the safe use of fireworks in schools and various media. A study by Saadat, Naseripour and Rahimi, (2009) on the "Safety preparedness of urban community for New Year fireworks in Tehran" showed that 98.4% of the 2 475 families interviewed were not sufficiently prepared for a safe festival in terms of firework use, first aid and extinguishing fires.

It should be noted that this study did not collect data regarding the use of fireworks amongst the cases as affected patients were not interviewed due to the retrospective nature of the study.

5.4. REFERRAL SYSTEMS

As with any Public Health System, there are different levels of care[60] which are rendered according to the diagnosis, that is, the more severe the injury the higher the level of care, patients are thus referred from one facility or level of care to another

[57] Provincial Gazetter for KwaZulu-Natal, 2009

[58] Kuhn FC, Morris RC, Witherspoon CD et al. Serious fireworks-related eye injuries. *Opthalmic Epidemiol* 2000; 7(2): 139 – 148 was cited in Smittenberg et al (2010)

[59] Witsaman, et al., 2006 referred to community education and intervention; Wang, et al., 2014 stated that "We can minimize the number and severity of accidents by raining awareness of safety practices, encouraging professional displays only and motivating manufacturers to adhere to strict quality control."

[60] Ramdas, P. 2003, "The Framework for a referral system for health service delivery in KZN"

following a specified referral pattern for that area (Annexure 9). This is clearly seen in the percentage of cases referred to the sampled hospitals which were at a regional and tertiary level as 10.77% (cf. Figure 4.1) were referred from clinics which offer health services at a primary health care level. Clinics are not equipped to manage emergencies such as the firework injured hand due to the level of injury. In his framework on referral systems for health service delivery, Ramdas (2003) in his report on the framework for a referral system in KZN, provided a generic referral pattern which is revised periodically. The sampled regional facility received most of their referrals directly from "home" as the facility has an Emergency Department. The sampled tertiary facility received only referred cases as indicated by their status[61].

Access to health services was not refused in any of the cases, however, waiting times for services (cf. Figure 4.3) reflected that only 29.3% of cases were treated within the first three hours of injury. Lengthy waiting times have direct implications on the firework injured hand as devitalised tissues require further debridement or amputation, thus, preservation of finger length and function becomes compromised for reconstruction[62] as well as further complications such as compartment syndrome[63] and infection[64] may ensue. The primary causative factor for lengthy waiting times after a firework injury was attributed to 67.7% of cases (cf. Figure 4.3) having sustained injuries at or around

[61] a patient may only access the tertiary hospital on a referral basis within the catchment area via the lower level facilities that refer to them

[62] Vedder, NB., and Hanel, DP., 2011 The Mangled Upper Extremity, pp 1606 In: *Green's Operative Hand Surgery* 6th ed, London: Churchill Livingstone

[63] Phillipson & Southern, 2004

[64] Matshidza, et al., 2005 showed that further surgery was needed in 50% of cases due to the development of sepsis

midnight on 31 December which is in keeping with findings from other studies[65]. The delay to the following patients could be attributed to the number of staff on duty in the emergency departments versus the high number of patients arriving for emergency treatment. A number of patients presented at the sampled hospitals on the days following injury (cf. Figure 4.3) as they were transported by Emergency Medical and Rescue Services (EMRS) (cf. Figure 4.4) as one of their service provisions is to provide patient transport[66] to referring hospitals for a higher level or specialized level of management.

These are the important factors taken into consideration over and above the extent of the injury as the doctor will be unable to perform reconstructive surgery on a hand that has impaired circulation.

5.5. CASE DEMOGRAPHICS

In this study, 70.77% of patients who had sustained firework injuries to the hand were male which was in keeping with South African studies by Smittenberg et al (2010) and Matshidza et al (2005). In two international studies, Witsaman et al, (2006) and Adhikari et al (2013), the majority of firework injuries were sustained by males which perhaps allude to more males engaging in firework use as a recreational activity.

[65]The studies concerned did not publish specific time frames for injury, only that injuries predominantly occurred over the Festive season and predominantly, New Years' celebrations. Matshidza S et al, 2005; Adhikari, et al., 2013; Puri V et al, 2009; Mohan & Varghese, 1990; Smittenberg MN et al, 2010; Wilson, V., 1999 and Pikor et al, 2013

[66] Ramdas, 2003

Ages ranges (cf. Figure 4.5) of cases in this study was disturbing as the maximum percentage occurred in the workforce age bracket of 30 – 39 years (32.3%), 19 – 29 years (21.5%) and 40 – 49 years (20%). This is not in keeping with previous studies where the primary age groups affected were 5 – 14 years old and 26 – 45 years of age. The direct impact on occupation (cf. Figure 4.6) of this was not discussed as in 55.4% of cases the occupation was not indicated and 20% of cases were recorded as being a scholar or student. It was noted in Pikor et al (2013) that contributing factors to firework injuries during New Years' celebrations included alcohol intoxication which may have a direct effect on the misuse and dangerous handling of fireworks. Anecdotally, intoxication was noted in some of the medical records surveyed.

Hand dominance (cf. Figure 4.7) was not recorded in 63.1% of cases, however, 61.5% of injuries were sustained in the right hand. In the study by Adhikari et al (2013), 82% of injuries occurred in the dominant hand. The pathomechanism[67] was explained as the person holding the firework in the dominant hand after lighting it in order to place or throw it and was inferred to this study. An injury to the dominant hand poses immediate functional implications for fine motor functions such as writing, buttoning and unbuttoning, picking up coins or applying cosmetics; as well as bilateral hand functions such as tying laces or food preparation.

The implications of not knowing the patient's occupation and hand dominance has a direct impact on surgical decision making viz. level of amputation[68] or reconstruction.

[67] Phillipson & Southern, 2004; Adhikari, et al., 2013
[68] Kaplan , 1969

Knowledge of the patient's occupation and hand dominance has a greater impact on the treating therapist as (1) the patient's occupation will determine the treatment plan, time frames and treatment modalities to be used in rehabilitation i.e the therapist has to match the rehabilitation activities to the patient's occupational areas of work, domestic, leisure and ADL's; and (2) the patient's hand dominance, diagnosis and aim of treatment will affect the type of activity; and the structuring of the treatment activity and area i.e placement of equipment, tools and materials.

5.6. IMPACT AND TYPE OF FIREWORK INJURIES ON HAND FUNCTION

It has been noted in the literature that the preservation of hand function is of utmost importance**.**

5.6.1. Types of injuries

The types of injuries found to occur in the firework injured hand are soft tissue injuries, fractures, burns, traumatic amputations and disruption of the neurovascular supply. The impact of these injuries has been discussed in the literature review.

The surgical intervention for these injuries has been described throughout the literature with the findings of this study mostly in keeping with international trends[69] for example, Adhikari et al 2013 showed that depending on the types of injuries sustained, surgical intervention was centered around primary debridement and closure, serial debridement, amputation and reconstruction. Figure 4.10 showed that 90.8% of patients underwent a washout, mechanical cleaning of the injuries and suturing. Of these, 80% underwent debridement which involves surgical removal of devitalised tissues and resulted in formal amputations.

[69] Adhikari, et al., 2013; Grassi, et al., 1996; Matshidza, et al., 2005; Matheron, et al., 2014; Puri, et al., 2009

5.6.2. Anatomical impact of injuries

The anatomical structure of the distal components of the hand, the distal phalanx and distal interphalangeal joint, impact directly on prehension.[70]

According to the literature[71] and as shown in the results, the fingers are primarily affected in the firework injured hand (cf. Figure 4.8). In this study, it was shown that it is predominantly the thumb, index and middle fingers and the palm which are affected (cf. Figure 4.8); the ring and little fingers are used more for power grasp and were thus not as significantly affected. The distal components of the fingers were predominantly affected in the firework injured hand[72]. A second significant area of injury reported was where 12.3% of patient sustained palmar injuries.

In this study, as with other studies concerning the firework injured hand, the injuries sustained included burns, soft tissue injuries, fractures and traumatic amputations[73]. Impacts of injuries on the anatomical structures and functions are discussed hereunder.

<u>The fingertips</u>

In this study, it is seen as significant that 72.3% of cases underwent amputation (cf. Figure 4.11) as compared to 20% who underwent reconstruction and skin grafting. Traumatic amputation was seen primarily in the thumb, index and middle fingers (cf. Figure 4.8) which can be attributed to the tip and tripod pinches being used to hold objects.

[70] Mennen and Van Velze, 2008
[71] Adhikari, et al., 2013, Matshidza, et al., 2005; Mohan & Varghese, 1990; Puri, et al., 2009; Smittenberg, et al., 2010; Wilson, 1999
[72] Matshidza S, 2005
[73] Adhikari, et al., 2013; Ahmad, 2010; Al-Qattan & Al-Zahrani, 2008; Bagri, et al.; 2013, Grassi, et al., 1996; MacKenzie, et al., 2001; Matshidza, et al. 2005; Smittenberg, et al., 2010; Wilson, 1999; Wang, et al., 2014

Furthermore, the extensive soft tissue injuries reported (cf. Figure 4.8) impact directly on the range of active flexion as the skin creases over the IPJ's develop scar tissue and adhesions early on in the healing process.

Figure 4.10 showed that 12.3% of cases involved soft tissue injuries to the palm.
In this study, it is seen as significant that 72.3% of cases underwent amputation (cf. Figure 4.11) as compared to 20% who underwent reconstruction and skin grafting. Traumatic amputation was seen primarily in the thumb, index and middle fingers (cf. Figure 4.8) which can be attributed to the tip and tripod pinches being used to hold objects.

Furthermore, the extensive soft tissue injuries reported (cf. Figure 4.8) impact directly on the range of active flexion as the skin creases over the IPJ's develop scar tissue and adhesions early on in the healing process. Scar tissue impacts on the hand's ability to assume, use and maintain pinches, grips and grasps at the fingers and the palm.

5.7. INJURY SEVERITY

The manner in which the intake and assessment notes have been recorded were inconsistent. In order to ascertain the profile and level of injury, the Hand Injury Severity scoring system was used. This scoring system as described earlier takes into account the four organ systems of the hand, skin, skeleton, muscle and neurovascular; and the degree to which they have been injured. Campbell and Kay (1996) reported, the lower the HISS the less severe the injury, the better the prognosis for functional recovery and

return to work. The high percentage of injuries in the severe and major categories, 32.3% and 46.2% respectively (cf. Figure 4.16) is a testament that the danger component of fireworks not be underestimated. This is reflected in and in keeping with firework injury studies that have been conducted nationally and internationally.

It was significant that within the severe and major categories of injury, the maximum score was achieved in most of the reviewed cases. This is directly attributed to the high number of traumatic amputation, open fractures; exposed bone, degloving injuries and wound contamination (cf. Figure 4.8).

Despite the HISS being able to propose a functional prognosis and estimate time off from work, it was unable to definitively give input on the patient's resulting level of function. This is predominantly due to functional capacity being subjective. The patient's response to injury cannot be definitively determined, that is, a soft tissue injury may result in Chronic Regional Pain Syndrome (CRPS) which is debilitating and conversely, a hand with multiple amputations may return to work with little functional impact. Functional capacity of the hand following injury is the realm of the hand therapist[74], occupational therapist and physiotherapist. In this study, it was noted that functional capacity evaluations were not formally conducted in 41.4% of cases (cf. Figure 4.19) and 13.8% of patients did not return.

[74] Mennen & Van Velze, 2008; Matheson, 2003

5.8. REHABILITATION

It is essential that rehabilitation processes take into account the phases of healing[75] of the various tissues involved. Most importantly in this study, are the healing processes of the affected soft tissue, especially as a significant percentage of patients sustained soft tissue injuries or underwent formalization of amputation in which the stump is covered by soft tissue and skin.

As indicated in the literature review, there are 3 stages of tissue healing during which the hand therapist is required to "tailor-make" the rehabilitation programme for best possible outcomes. It can be seen in figure 4.12 that this is true for this study as 21.5% of patient who sustained firework injuries were referred for rehabilitation from six to ten days post injury, that is the second stage, 6.2% at 11 – 14 days and 15.4% at 15 – 30 days post injury ie: the third stage. It is also noted that 18.5% of patients were referred for rehabilitation during the first phase of tissue healing (0 – 5 days) where little or no rehabilitation of the affected joints is warranted as this is a time for immobilization of affected joints and tissues to allow for healing and the passing of the inflammatory response. Significantly, 36.9% of patients were not referred for any hand rehabilitation

Other studies around the firework injured hand were not focused on the rehabilitative aspect of management. The multidisciplinary approach is essential in the management of this mechanism of injury and, as with any form of medical intervention, begins with an assessment. As indicated above, a total 63.1% of cases were referred for rehabilitation across a number of timeframes (cf. Figure4.14). It was significant that 31.7% of referred

[75] (Mennen & Van Velze, 2008) (Trombly, 1997)

cases never attended rehabilitation. A variety of pre-functional assessments were conducted on the remaining 68.3% of referred cases who had attended (n = 29), (cf. Figure 4.16). There are standardized assessments for the assessed pre-functional areas of hand function, however, it was noted in the medical records that the assessment findings were not standardized which was seen as a limitation and is the reason behind the unequal percentages of assessments undertaken.

An in depth history was not taken in terms the patients' pre-morbid levels of functioning in work, leisure and ADL's. Psychological impact was also not included in the rehabilitation assessment. This was of concern as the primary aims of assessment[76] are to ascertain areas to be addressed, set aims and objects, treat the patient holistically and to be able to identify progression or regression during the rehabilitation process and to ready the patient for termination of therapy once their functional capacity has been achieved.

Rehabilitation of the hand serves to improve or maintain the patient's hand function as was evidenced by the modalities of treatment recorded and included, range of movement, muscle strengthening, grips and grasps and scar management. These modalities included the use of hand therapy equipment, pressure garments, splints and ADL's (cf. Figure 4.15).

It was difficult to ascertain the outcomes and effects of rehabilitation as the records were inadequately maintained in terms of recorded information. Anecdotally, much of

[76] Trombly, 1997; Mennen & Van Velze, 2008

the assessment and re-assessment findings included terms such as “AROM improved”, “able to make a fist”, “scars hard”. While these terms are understood by the treating therapists, it would be difficult for another therapist to continue with management should the treating therapist be indisposed or unavailable.

5.9. CONCLUSION

The blast component involved in firework injuries have not been taken lightly. The firework injured hand has a range of injuries that fall predominantly in the categories of severe and major injuries which affect the fingers, significantly, the thumb, index and middle fingers which is in keeping with previous studies. It was evident that surgical management is in favour of skin coverage and amputation over attempts to reconstruct which is also in keeping with other studies. There were external factors which influenced the surgical intervention decisions i.e waiting times and referral patterns.

Rehabilitation of the firework injured hand was not a primary objective in half the cases. Rehabilitative management was concerned with the return of function, however the data collected in this study did not show the processes that took place and the outcomes thereof. Level of functional impairment was predominantly not conducted. Rehabilitation was alluded to in previous studies with regard to this mechanism of injury but has not been the focus.

CHAPTER 6

CONCLUSION

This study is in keeping with previous international studies regarding firework injuries to the hand.

In terms of the patient demographics of the firework injured hand, it was predominantly the male population who sustained injuries. The age range in this study differed to previous studies in that the former predominant age range was 30 – 39 years and the latter was in children aged 5 – 14 years. As with previous studies, the dominant hand was primarily affected.

The areas injured were in keeping with previous studies, that is, the thumb, index and middle fingers, first web space and palm were the primary sites of injury at the level of the distal phalanx and distal interphalangeal joint of the thumb and index and middle fingers respectively.

The injuries sustained were also in keeping with the literature, that is, soft tissue injuries comprising of burns, lacerations, abrasions and contusions; fractures; deglovings, denudings and partial or total traumatic amputation is a feature of firework injuries to the hand.

This study did not focus on the mechanism of fireworks resulting in an untimely explosion due to the retrospective nature of the file audit and the fact that the type of firework or firecracker was not recorded in the patient's medical record.

Surgical interventions around debridement and primary closure, skin cover, amputation and the slight attempt at reconstruction is also in keeping with international trends.

Injury severity scoring is commonly found in all emergency and trauma units, however, a specific hand injury score is difficult to obtain. The HISS was found to be a competent indicator of level of injury and may have given insight into functional levels post injury had hand function assessments been conducted consistently in this study.

Rehabilitation interventions have not been a significant variable in previous studies consulted in this study. It was stated in all previous studies that early rehabilitation of the hand was essential for functional recovery, however, the rehabilitation programme, guideline or accepted protocol was not found. It is expected that therapists take into account the phase of tissue healing, pain and patients pre-morbid level of physical and mental functioning in order to tailor a specific patient orientated rehabilitation programme that addresses the patients' needs in all areas of life such as work, leisure and activities of daily living. Despite literature in previous studies indicating the importance of rehabilitation, it was evident in this study that rehabilitation is not given the same priority.

As the literature indicated, any form of medical or rehabilitative intervention commenced with an assessment. What was evident in this study was that the assessments of these patients and mechanisms of injury were centered around non-standardised or informal tests where only joint range of movement was common throughout. Other areas of hand assessment were addressed inconsistently in the study.

CHAPTER 7

LIMITATIONS AND RECOMMENDATIONS

6.1 OVERVIEW

Despite the number of limitations that have been identified in this study, there are also a number of recommendations that may potentially have a positive impact. This chapter discusses the limitations and recommendations further.

6.2 TIMEFRAME SURVEYED

The researcher should have extended the time frame under investigation to include the Diwali festival and Guy Fawkes. Various studies had been conducted around numerous religious festivals and cultural celebrations and were shown to have high incidences of firework injuries; however, this was not the researcher's experience. The former religious festival does not appear to play a major role in injuries referred to the regional hospital, but some referrals were made to the tertiary hospital. Guy Fawkes (5 November) is not a strictly South African tradition; however, as the digital world gets smaller, first world traditions are starting to play a greater role in the South African context. It is recommended that should this study be duplicated, future projects should collect data from October to February.

6.3 SAMPLED HOSPITALS

Lower level hospitals referred severe injuries to the sampled hospitals, thus, the minor firework injured hands may not have formed the sample. It is unrealistic to advise that

any blast injured hand be referred to the sampled hospitals as the resources would be insufficient, thus, district level hospitals should be included as this would yield more cases from which to collect data as was evidenced by the small sample size (n = 65) and the number of referred cases. Data collection at tertiary and regional institutions should not be excluded in future projects; however, it would create a more specific view of the uMgungundlovu district if all the hospitals within the district were sampled. This would also impact on resource allocation for awareness campaigns around the danger of fireworks.

6.4 ACCESSIBILITY TO RECORDS

The manner in which medical records were obtained differed greatly between the two sampled hospitals. It was much easier and less time consuming to obtain medical records at the regional hospital as the mechanism of injury or the resulting injury was indicated in the patient statistics book. This made it much quicker to ascertain which files should be requested for data collection. The process at the tertiary facility allowed for mechanism of injury to be recorded at the casualty department, however, at the out-patient orthopaedic department, there was no indication of mechanism of injury or diagnosis which resulted in a fruitless exploration of more than 300 patient files. It is thus recommended to the KZN DOH that all hospitals within the district record patient statistics to include the mechanism of injury or diagnosis. This will ensure that data collection is less tedious and time consuming and will also directly reduce the amount of time spent by Medical Record staff collecting and re-filing irrelevant case files as the researchers will be more specific in their requests.

Both surveyed hospitals had lost patient statistic books from the Emergency departments and out-patient orthopaedic departments which impacted on the number of cases for data collection. It is suggested that as medical records, including patient statistic books have to be kept for five years that the books are kept in the Medical Records department rather than the clinical departments as the Medical Records departments have a higher level of security due to the sensitivity and confidentiality of case files.

6.5 RECORD KEEPING

As noted in literature and in the findings of this study, standardized records were not a strong suit in both the medical and rehabilitative notes. This had a direct impact on the quantity and quality of information obtained with regards to the profile of the injury. There are specific guidelines in the public service as to what information is required from the medical and rehabilitation perspectives. The medical records are further audited according to clinical guidelines and quality improvement programmes. Document inconsistencies have impacted negatively on the continuity of therapy and medical management. This is further impacted on by the paucity of information in the referrals from base hospitals and clinics. The standard expectation is that any therapist from any facility is able to read through the notes and deliver the prescribed treatment plan. This however is not the case and may be attributed to a number of extenuating circumstances. A positive recommendation is that a formal hand assessment form, which is readily available, could be used for all hand injured patients irrespective of the

injury as this would ensure standardized levels of assessment and treatment. This would further ensure capacity building of the treating therapists and new therapists.

6.6 CHALLENGES TO COMPLIANCE

It was noted in the data collection phase that 41.5% of patients did not return for medical follow up and discharge as compared to 13.8% not returning for rehabilitative discharge. This was not explored in the study and is seen as a limitation as challenges to compliance directly affect the outcome of the affected hands' level of function. It is recommended that future studies include challenges to compliance such as psychological impact, patient compliance (knowledge, attitude, and understanding) and socio-economic status of the affected patient. It is also recommended that focus groups amongst therapists be conducted to explore clinical protocols, modalities of treatment and challenges to compliance.

6.7 RETROSPECTIVE FILE AUDIT

As with previous studies, there are challenges with retrospective file audits including that it may not have been representative of all cases as only two hospitals were sampled. Further to this, a prospective file audit including patient interview would yield more qualitative data for collection. It is recommended that a future study compare findings retrospectively and prospectively in a concurrent manner at one hospital.

6.8 LEGISLATION

As with previous studies, there is a call for stricter control on the sale of fireworks as currently, the law is not sufficiently enforced. It is recommended that this study be duplicated over a number of years in order to enforce change. It is also recommended that community awareness campaigns increase in number and frequency in order to reduce the incidence of these preventable injuries.

6.9 INJURY SCORING

Injury severity scores are used on a daily basis in Emergency departments. There should be a place for specific hand injury severity scoring as this will inform the doctor of the level of injury and the need for specialized referral eg: plastic surgeon, hand specialist, hand therapist.

6.10 MULTIDISCIPLINARY TEAM APPROACH

The multidisciplinary team should be available for all firework injured hands. This team should include the doctor, hand therapist (occupational therapist and physiotherapist) as well as the Psychologist to assist with the psychological impact of hand impairment and hand disfigurement. It is acknowledged that the rehabilitation therapist does not treat the mechanism of injury; rather, the focus is on the resulting impairment or diagnosis. It is the realm of the rehabilitation team to treat the patient holistically, thus, the mechanism of injury is very important and will directly influence patient compliance, thus, an MDT approach is recommended.

7.11 RECOMMENDATIONS FOR OCCUPATIONAL THERAPY

The researcher would recommend that this study be replicated on a larger scale to include all hospitals per district within the province of KwaZulu-Natal. Besides using only a quantitative research design, it would reveal more information if a qualitative aspect were introduced, that is (1) a focus group centered around the perceptions of the treating therapists, (2) the perceptions of the affected patients regarding injuries, cosmesis, expectations of rehabilitation and their reintegration to work and community activities, (3) individual patient surveys which are directly linked to functional assessments.

A clinical guideline or protocol for the assessment and treatment of the severely injured hand is available, however, it is recommended that a standardized assessment tool and range of rehabilitation activities be developed and made available to all facilities where the firework injured hand is referred to for continued management. This tool would be applicable to all hand injuries and will assist with capacity building of therapists and allow for improved therapy continuation. Further to this, it will ensure a standard and expected level of care which is of paramount importance in the public service.

7.12 CONCLUSION

This study was relevant as this particular mechanism of injury has a range of devastating outcomes. Management was seen to be surgical and rehabilitative in nature. The limitations of this study do not outweigh the findings and recommendations as they can be instituted immediately in the sampled hospitals to effect a positive change.

CHAPTER 8

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ANNEXURE 1: GATEKEEPERS' LETTER TO EDENDALE HOSPITAL

The CEO & Medical Manager
Edendale Hospital
Edendale Road
Edendale
Pietermaritzburg

14 June 2013

Dear Sir/Madam

RE: Permission for Employee(s) to participate in Research Study

I am currently a Masters candidate within the School of Health Sciences at the University of KwaZulu-Natal. My research is centered around the **profile of the firework injured hand and the perceptions of the treating Occupational Therapists**.

There is little evidence in the literature to indicate that any specific clinical guidelines are used in the care & rehabilitation of the firework injured hand by OT's – irrespective of the amount of experience the OT's have.

The research will contribute to a multi-disciplinary team approach to the firework injured hand and will speak towards future development of a non-standardised protocol for rehabilitation following this injury.

I therefore require input from OT's who have treated the firework injured hand in an acute setting in order to gain their perceptions and experiences regarding the rehabilitation of this injury.

It is for this reason that I hereby request permission for members of your staff to form part of this focus group. The necessary processes for achieving ethical clearance have been followed and informed consent will also be obtained from these individuals.

Should you require further information on the research process, research question or expectations of the experts to be used within this study please do not hesitate to contact the researcher or supervisor of the project (details provided below).

If permission is granted, may I kindly request this in writing.

Your assistance is greatly appreciated.

Yours sincerely,

Tasha Pilling ***BOT (UDW)***

Researcher / Masters Candidate

Tel: 033 3954218

Cell: 082 878 4149

E-mail: tashapilling@hotmail.com

Ms P. Naidoo

Lecturer / Supervisor

Tel: 031 2607310

E-mail: naidoopg@ukzn.ac.za

Ms Phindile Nene

Postgraduate Administration

Tel: 031 2608280

E-mail: nenep1@ukzn.ac.za

ANNEXURE 2: GATEKEEPER APPROVAL EDENDALE HOSPITAL

Department:
Health
PROVINCE OF KWAZULU-NATAL

Edendale Hospital
Private Bag X 509, Plessislaer, 3216
Tel: 033 395 4005, Fax: 033 395 4060
email: ojo.gideon@kznhealth.gov.za
www.kznhealth.gov.za

OFFICE OF THE SENIOR MANAGER MEDICAL SERVICES

Enquiries: Dr O.G.Ojo
Tel: 033-3954005

Date: 3rd April 2014

Mrs T Pilling
Occupational Therapy Manager
Edendale Hospital

Dear Mrs T Pilling,

RE: LETTER OF SUPPORT FOR APPROVAL OF RESEARCH: MANAGEMENT OF THE FIREWORK – INJURED HAND

Your letter dated 14TH June 2013 refers:

Your request to conduct the above mentioned protocol is supported by Edendale Hospital Management, subject to approval by the Biomedical Ethics Research at Provincial Department of Health.

Yours Sincerely,

DR O.G OJO
SENIOR MANAGER MEDICAL SERVICES
EDENDALE HOSPITAL

ANNEXURE 3: GATEKEEPERS' LETTER GREYS' HOSPITAL

The CEO & Medical Manager
Greys' Hospital
Townbush Road
Pietermaritzburg

14 June 2013

Dear Sir/Madam

RE: Permission for Employee(s) to participate in Research Study

I am currently a Masters candidate within the School of Health Sciences at the University of KwaZulu-Natal. My research is centered around the **profile of the firework injured hand and the perceptions of the treating Occupational Therapists**.

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If permission is granted, may I kindly request this in writing.

Your assistance is greatly appreciated.

Yours sincerely,

Tasha Pilling ***BOT (UDW)***

Researcher / Masters Candidate

Tel: 033 3954218

Cell: 082 878 4149

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Ms P. Naidoo

Lecturer / Supervisor

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E-mail: naidoopg@ukzn.ac.za

Ms Phindile Nene

Postgraduate Administration

Tel: 031 2608280

E-mail: nenep1@ukzn.ac.za

ANNEXURE 4: GATEKEEPER APPROVAL GREYS' HOSPITAL

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

GREYS HOSPITAL
OFFICE OF THE CEO
Private Bag X 9001, Pietermaritzburg, 3200
Town Bush Road, Chase Valley, Pietermaritzburg, 3201
Tel.:033 – 897 3321 Fax.: 033 - 8973398
www.kznhealth.gov.za

To:	**Tasha Pilling** **School of Health Sciences** **UKZN**
From:	**Dr. K. B. Bilenge** **CEO- Greys Hospital**
Date:	**8 May 2014**
Re:	**Request for permission to conduct research at Grey's Hospital: *The Profile of the Firework Injured hand, Perceptions & Expectations of the Occupational Therapists***

Dear Tasha Pilling

Your request to conduct a study entitled "***The Profile of the Firework Injured hand, Perceptions & Expectations of the Occupational Therapists***" refers.

Permission to conduct the above study is hereby granted under the following conditions:

- Your provisional ethical clearance and research protocol is assumed to be valid and final ethics approval is a prerequisite for conducting your study at our hospital. Once obtained from BREC, please submit a copy of the full ethics approval.
- You are also required to obtain approval for your study from the Provincial Department of Health KZN Health Research Unit. You will find more information on their website: *http://www.kznhealth.gov.za/hrkm.htm*
- Confidentiality of hospital information, including staff and patient medical and/or contact information, must be kept at all times;
- You are to ensure that your data collection process will not interfere with the routine services at the hospital;
- Informed consent must be obtained from all participants in your study, if applicable.
- Policies, guidelines and protocols of the Department of Health and Grey's Hospital must be adhered to at all times;
- Professional attitude and behaviour whilst on the hospital premises must be exhibited;
- The Department of Health, hospital and its staff will not be held responsible for any negative incidents and/or consequences, including injuries and illnesses that may be contracted on site, litigation matters, etc. that may arise as a result of your study or your presence on site;
- You are required to submit to this office a summary of study findings upon completion of your research.
- You are requested to report to the Head of Department of Occupational Therapy, Angela Chetty, at Grey's hospital once you are ready to commence data collection.

Recommended by:

Dr L. Naidoo
Senior Manager: Medical Services
8/5/2014
Date

Approved by:

Dr. K. B. Bilenge
Hospital CEO
08/05/2014
Date

ANNEXURE 5: KZN DEPARTMENT OF HEALTH APPROVAL

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM 68/14
Enquiries : Mr X Xaba
Tel : 033 – 395 2805

Dear Mrs T. Pilling

Subject: Approval of a Research Proposal

1. The research proposal titled **'Management of the Firework-Injured hand'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at Edendale and Grey's Hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

Dr E Lutge
Chairperson, Health Research Committee
Date: 13/05/14

ANNEXURE 6: ETHICAL CLEARANCE BE 329/13

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

21 May 2014

Mrs Tasha Pilling
P.O Box 809
Kloof
3640
tashapilling@hotmail.com

Dear Mrs Pilling

PROTOCOL: Management of the Firework-Injured Hand: BE329/13

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 27 August 2013.

The study was provisionally approved pending appropriate responses to queries raised. Your responses received on 13 May 2014 to queries raised on 07 February 2014 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 21 May 2014.

This approval is valid for one year from **21 May 2014.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its meeting taking place on **10 June 2014.**

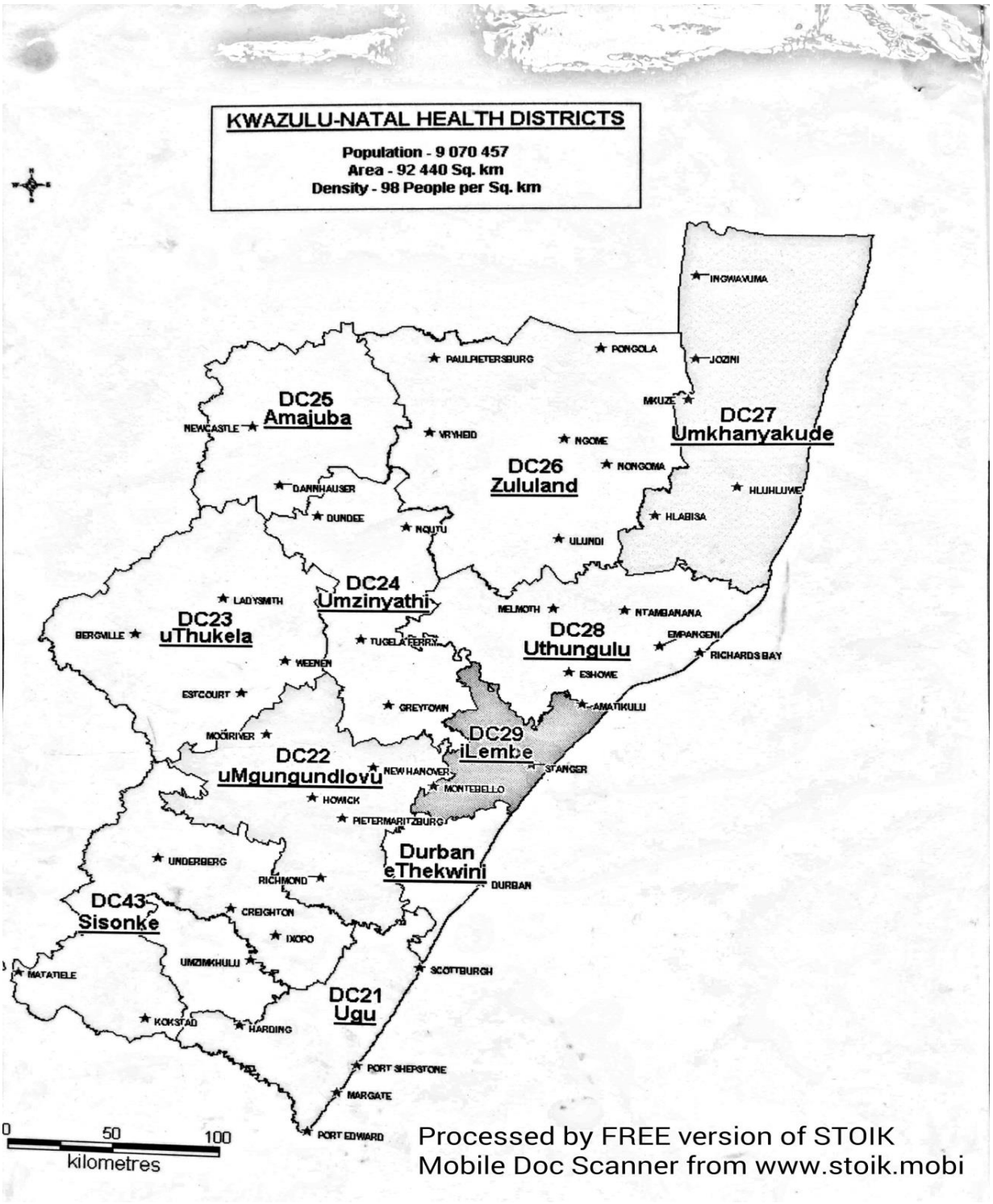
We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor D.R Wassenaar
Chair: Biomedical Research Ethics Committee

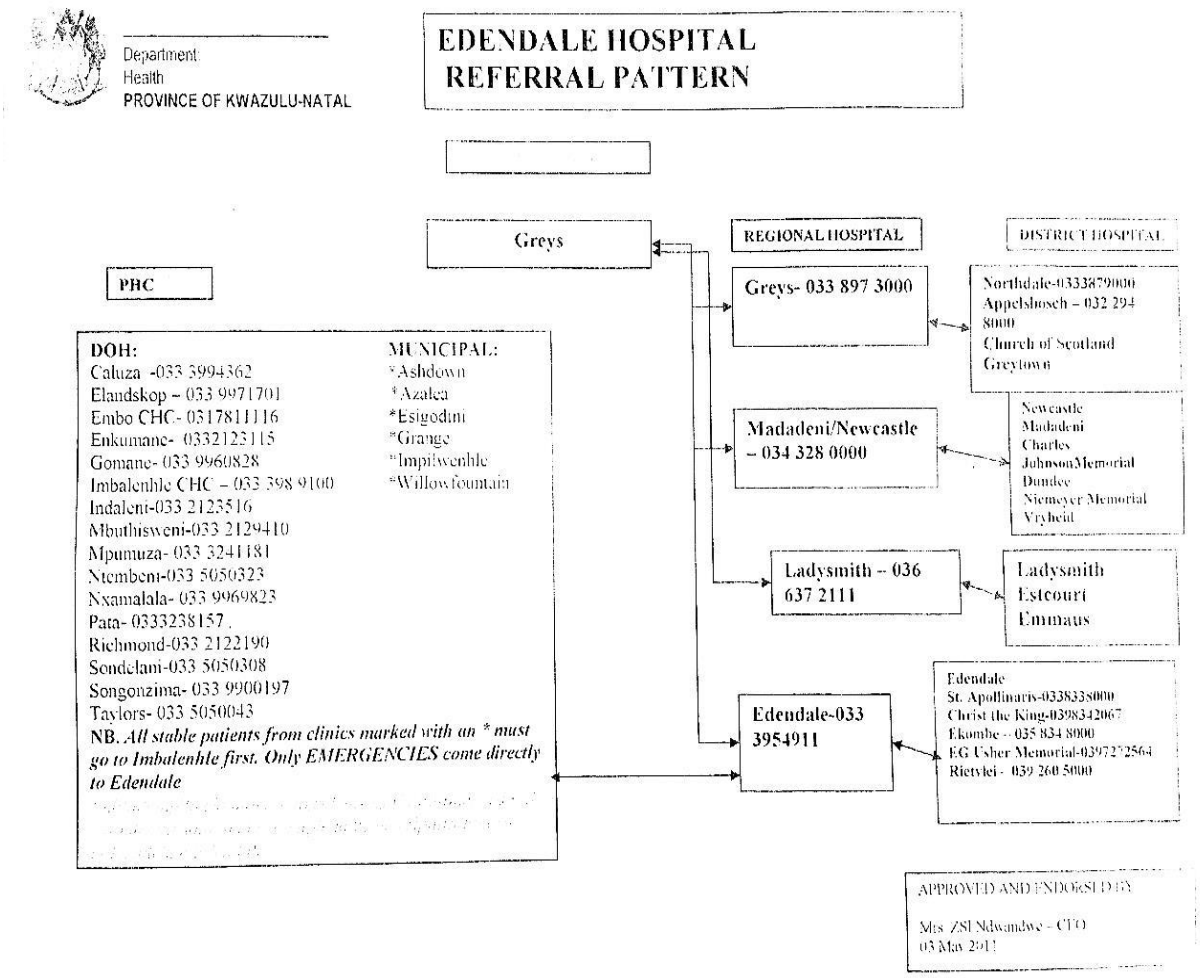
ANNEXURE 7: CATCHMENT AREA MAP 1

ANNEXURE 8: OUTLINE OF DISTRICT 22 AS PER KZN DEPARTMENT OF HEALTH



OBTAINED FROM KZN DEPARTMENT OF HEALTH

ANNEXURE 9: REFERRAL PATTERN FOR REGIONAL AND TERTIARY HOSPITAL DISTRICT 22



OBTAINED FROM KZN DEPARTMENT OF HEALTH

ANNEXURE 10 DATA EXTRACTION TOOL

A: Facility Information:							**No:**
Facility category	A	Regional	B	Tertiary			
Referred from	A	Hospital	B	Clinic	C	Home	
Brought by	A	Ambulance	B	Private car	C	Walked in	
Date of Injury							
Time of Injury							
B: Patient Demographics							
Age							
Gender	A	Male	B	Female			
Occupation of Patient							
A	Scholar/student	B	Office-based	C	Domestic-based	D	Manual Labour
E	Professional	F	Self-employed	G	Unemployed	G	Not recorded
Dominance	A	Right	B	Left	C	Not recorded	
Side affected	A	Right	B	Left	C	Both	

C: Injuries sustained

	IF DP	IF DIPJ	IF MP	IF PIPJ	IF MPJ
Amputation					
STI					
Fractures					
Tendons					
Nerves					

	MF DP	MF DIPJ	MF MP	MF PIPJ	MF MPJ
Amputation					
STI					
Fractures					
Tendons					
Nerves					

	RF DP	RF DIPJ	RF MP	RF PIPJ	RF MPJ
Amputation					
STI					
Fractures					
Tendons					
Nerves					

	LF DP	LF DIPJ	LF MP	LF PIPJ	LF MPJ
Amputation					
STI					
Fractures					
Tendons					
Nerves					

	TH DP	TH IPJ	TH PP	TH MPJ	TH CMCJ
Amputation					
STI					
Fractures					
Tendons					
Nerves					

Other injuries sustained:

_____
_____
_____
_____

D: Surgery Conducted:	
A	Amputation
B	Debridement
C	SSG
D	Wash, clean & suture
E	Tendon repair
F	Nerve repair
G	Reconstruction

E: Time to OT referral/Rehab started:	
A	1 day (24 hrs)
B	2 days (48 hrs)
C	3 days (72 hrs)
D	4 – 5 days
E	6 + days
F	Not recorded

F: Length of in-patient stay			
A	1 day (24 hrs)	D	4 – 5 days
B	2 days (48 hrs)	E	6 + days
C	3 days (72 hrs)	F	Not recorded
H	Not admitted		

G: Length of Rehab Participation at Primary Site	
A	1 week (5 – 7 days)
B	2 weeks (7 – 14 days)
C	3 weeks (15 – 21 days)
D	1 – 2 months
E	2 – 3 months
F	3 – 4 months
G	5 months <
H	More than 6 months

H: Referral to clinic/referring hospital for continued management					
A	Yes	B	No	C	Not recorded

I: Type of Referral					
A	Written referral given	B	Verbal referral given	C	Not recorded

J: Assessments conducted

K: Treatment interventions

L: Functional assessment completed on discharge or at last appointment					
A	Yes	B	No	C	Patient did not return

M: Level of functional impairment at discharge					
A	None	B	Mild	C	Moderate
D	Severe	E	Profound	F	Not recorded

ANNEXURE 11 HAND INJURY SEVERITY SCORING SYSTEM

Integument				
	value	**region**	**size**	**score**
skin loss	absolute (hand)	dorsum	<1cm2	5
			>1cm2	10
			>5cm2	20
		palm	<1cm2	10
			>1cm2	20
			>5cm2	40
	weighted (digit)	dorsum	<1cm2	2
			>1cm2	3
		pulp	<25%	3
			>25%	5
skin laceration	if across more than 1 ray then incl on both		<1cm	1
			>1cm	2
nail damage				1
Skeletal				
fractures			simple shaft	1
			comminuted shaft	2
			intra-art dipj	3
			intra-art pipj/ipj of thumb	5
			intra-art mcpj	4
dislocations			open	4
			closed	2
ligament injury			sprain	2
			rupture/avulsion	3
Motor				
		extensor tendon	proximal to pipj	1
			distal to pipj	3
		FDP & FPL	zone 1	6
			zone 2	6
			zone 3	5
		FDS		5
		Intrinsics		2
Neurovascular				
	absolute	rec br Median n		30
		deep br ulnar n		30
	weighted	digital n	one	3
			both	4
		crush/avulsion of nv bundle = double score		

weighting factors	
Thumb	x6
Index	x2
Middle	x3
Ring	x3
Little	x2

Injury Grade

Grade 1	Minor	<20
Grade 2	Moderate	21 - 50
Grade 3	Severe	51 - 100
Grade 4	Major	>100

ANNEXURE 12 EXAMPLE OF HISS PER COMPLETED DATA EXTRACTION TOOL

Case No		I	S	M	NV	Score	Weight	Total
		dirty x 2	open x 2				x	
	IF						2	
	MF						3	
	RF						3	
	LF						2	
	T						6	
						Total score		