

CHAPTER 1
LITERATURE REVIEW

1.1. INTRODUCTION

Injury to the spine is complex affecting many South Africans. Although loss of motor and autonomic function are considered to be the principle effects of spinal cord injury (SCI) (Siddall *et al.*, 1999), secondary complications such as pain, sleep disturbances, and depression can also affect the quality of life of affected individuals.

The bulk of research concerning SCI-related pain, sleep disturbances, restless-leg syndrome (RLS) and mood have so far focused on patients with chronic SCI. On the other hand, consideration ought to be given to discovering variables found amid the different phases of SCI, which could impact the advancement of chronic pain, sleep disturbances, RLS and changes in mood (Bonica, 1991; Siddall *et al.*, 1999). To date, pain, sleep disturbances, RLS and mood changes experienced during the acute phase of injury has received limited attention (Siddall *et al.*, 1999). This gap in knowledge may be due to the difficulty in conducting research during this sensitive period, for example, the patient is still dealing with acceptance of their injury and possibly due to various complications present during the acute phase of recovery such as deep vein thrombosis.

Gaining understanding and knowledge of the different types of pain experienced and the relationship between pain and sleep in SCI patients will be a valuable key in unlocking appropriate pain and sleep management in SCI individuals in the acute phase.

Therefore the study aim of this project was to characterise pain, mood, RLS and sleep disturbances during the acute stages of SCI, including short-term changes.

STUDY OBJECTIVES

The purposes for this study were to:

1. Describe the pain, sleep, depression symptoms and quality of life during acute SCI.
2. Identify factors associated with pain and sleep disturbances in patients with SCI.
3. Compare changes in pain, sleep, mood, and quality of life between two time periods (from admission to discharge).

1.2. MORPHOLOGY AND PHYSIOLOGY OF NORMAL SPINAL CORD

The spinal cord is part of the central nervous system and is a continuation of neuronal tissue of the brain. The spinal cord begins at the level of C1 where the medulla oblongata ends and terminates below the first or second lumbar vertebrae in an adult. The conus medullaris forms at the L1-L2 vertebral level. The cauda equina is the neural tissue identified as nerve roots and occupies the remainder of the lumbar canal. The spinal cord length is approximately 43-45cm in the vertebral column. The cord, cauda equina and conus medullaris are surrounded by the meninges. The vertebral column is composed of 33 vertebrae: seven cervical, twelve thoracic, five lumbar, five sacral that are fused and a coccygeal vertebrae

(Fletcher *et al.*, 1992). There are 31 pairs of spinal nerves (8 cervical pairs, twelve thoracic pairs, five lumbar pairs, five sacral pairs and one coccygeal pair).

The arterial supply of the spinal cord is from the spinal arteries arising from the vertebral artery (anterior and posterior spinal arteries). Cross sectional anatomy of the spinal cord is characterised by a centre of spinal grey matter consisting of nerve cell bodies, their dendrites and synaptic contacts. The outer part of cord consists of the white matter, which contains ascending and descending nerve fibres (Table 1.1).

Table 1.1: Sensory and motor spinal tracts

| Tracts | Name | Function |
|----------------|------------------------|--|
| Motor | Lateral corticospinal | Voluntary movements (limbs) |
| | Ventral corticospinal | Voluntary movements (axial) |
| | Vestibulospinal | Postural reflexes |
| | Rubrospinal | Controls limb flexor muscles |
| | Tectospinal | Reflex responses to visual input |
| | Reticulospinal | Modulation of spinal reflexes |
| Sensory | Lateral spinothalamic | Pain and temperature |
| | Anterior spinothalamic | Light touch and pressure |
| | Dorsal columns | Proprioception, discrimination, vibration and fine touch |
| | Spinocerebellar | Posture and coordination |

1.3. INJURY TO THE SPINAL CORD

1.3.1. Classification of spinal cord injury

SCI is classified into five types by the American Spinal Cord Injury Association (ASIA) as shown in Table 1.2 based on neurological levels, touch and prick sensations tested in each dermatome, and the strength of muscles on each side of the body (American Spinal Injury Association, 2003).

Table 1.2: ASIA Classification A-E, type of SCI and depression

| ASIA grade | SCI | Description |
|------------|------------|---|
| A | Complete | Motor and sensory function not preserved in the sacral segment |
| B | Incomplete | Sensory function preserved below injury but not motor function |
| C | Incomplete | Motor function is preserved below the neurological level and more than half of the key muscles below the neurological level have a muscle grade less than 3 |
| D | Incomplete | Motor function is preserved below the neurological level and at least half of key muscles below the neurological level have a muscle grade of 3 or more |
| E | Normal | |

Classification of Completeness of injury

The neurologic level and completeness of injury are important factors in predicting neurologic recovery and, therefore, functional outcome after SCI. To determine the recovery process of a patient with SCI, the patient has to be classified as having either a complete or incomplete injury. A complete cord injury is characterized clinically as a complete loss of motor and sensory function below the level of the injury (Waters *et al.*, 1991).

Incomplete cord syndromes have variable neurologic findings with partial loss of sensory and/or motor function below the level of injury. The prognosis for enhanced functional outcomes is most favourable for patients with incomplete SCI compared to complete SCI patients. There are five distinct syndromes that can be classified within the spectrum of incomplete injury to the neural structures within the spinal cord. These are the central cord syndrome, Brown-Sequard syndrome, the anterior cord syndrome, the conus medullaris syndrome and the cauda equina syndrome.

The **central cord syndrome** was first described by Schneider et al. in 1954: the injury occurs in the middle of the spinal cord (figure 1.1). The outcome of this injury is the loss of function to the upper limb, with some lower limb mobility preserved, urinary dysfunction, bladder retention and variable degrees of sensory loss below the level of injury (Schneider *et al.*, 1954). Considered to be the most frequent of incomplete SCI syndrome, representing approximately 9% of all traumatic SCI (Bosch *et al.*, 1971)

Brown-Sequard syndrome (hemisection) is a lesion, which is characterized by damage to the ipsilateral spinal cord, at the injured side (figure 1.1.), there is impairment of mobility, the pain and temperature sensation is preserved, however, at the contralateral side of the injury there will be normal mobility, pain and temperature sensation will be impaired, represents 1% to 4% of all traumatic SCIs (McKinley *et al.*, 2007; Bohlman, 1979; Bosch *et al.*, 1971).

Anterior cord syndrome is an injury that happens at the anterior part of the spinal cord, characterized by the failure to sense pain, temperature and touch sensations below the level of lesion (figure 1.1.). Pressure and joint sensation may be preserved. It is possible for some patients with this lesion to later improve and gain some mobility (Bosch *et al.*, 1971; Bohlman, 1979). Incidences of 2.7% have been reported to occur in traumatic SCIs (McKinley *et al.*, 2007). Anterior cord syndrome has been associated with flexion injuries, direct damage by bone fragment or disk compression, or from vascular insufficiency produced by the occlusion of the anterior spinal artery (McKinley *et al.*, 2007).

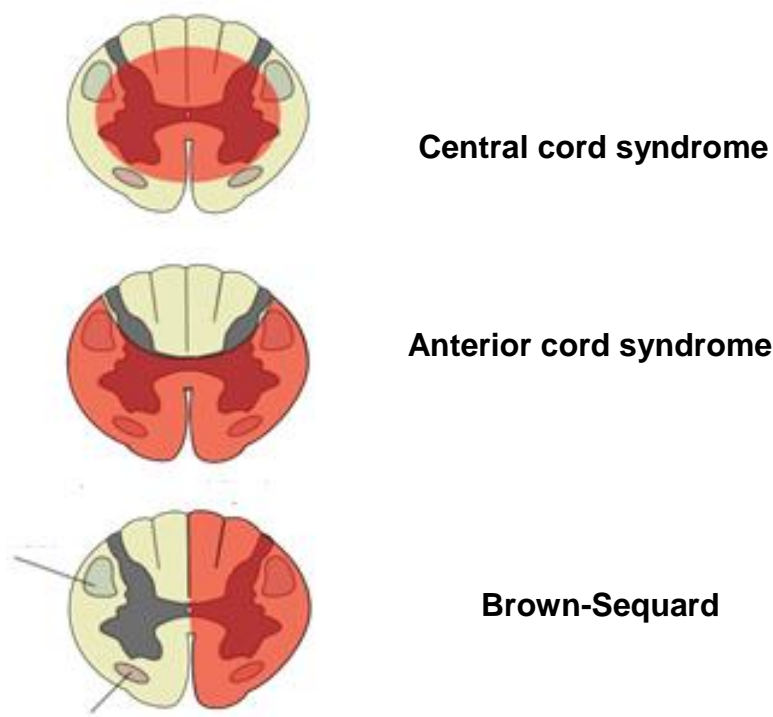


Figure 1.1. Anatomical representation of the incomplete lesions of the spinal cord

Conus medullaris syndrome is described by a lesion to the sacral cord and to the lumbosacral nerve roots (figure 1.2). The result is symmetrical and presents with complete saddle anesthesia, bladder and bowel dysfunction, and lower-extremity motor weakness. The functional prognosis for mobility is good, although bladder or bowel function is less likely to recover than in other conditions, and neurologic recovery is limited (McKinley *et al.*, 2007).

Cauda equina syndrome is a lesion, characterized by injury to the lumbosacral nerve roots in the neural tube (figure 1.2). Damage to these nerve roots can result in incomplete or complete impairment of mobility and sensation (McKinley *et al.*, 2007). A study by Kennedy and colleagues (1991) reported that early diagnosis and surgical decompression are important predictors for a favourable outcome in this ailment.

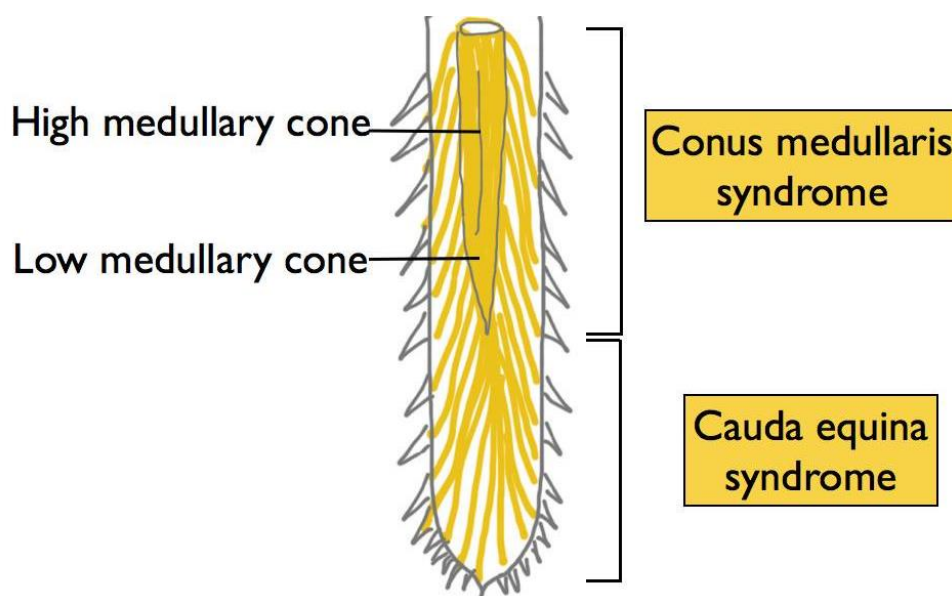


Figure 1.2. Anatomical representation of the Conus medullaris and Cauda equina syndrome. Sourced from <http://t.co/p8TT8cs0ia>

1.3.2. Epidemiology and demographics

SCI results in disability that may be permanent or the patient may recover function depending on the completeness of injury, this life changing consequence as a severe impact on the person and their family. Due to the severity of such an injury, the impact on quality of life, long and short-term, is tremendous (Wyndaele and Wyndaele, 2006). The understanding of SCI epidemiology is thus vital for public resource allocation and primary prevention.

A. International information

In the USA the prevalence of SCI has increased from 30 to 40 per million population (Go *et al.*, 1995) to 30 to 60 per million population per year as reported by Dawodu (2005). The current prevalence of SCI was reported by Singh *et al* (2014) to be the highest in the United States of America (906 per million population) in comparison to that reported 20 years ago by Go and colleagues (1995). This demonstrates that the incidence of SCI is increasing drastically and may suggest that management and preventative strategies need to be tailored to this region. The management of SCIs requires significant health care resources and can place a substantial financial burden on patients, their families, and the community. These costs are largely due to a need for high-level acute care in the short term and associated secondary complications that occur in the long term. To improve injury management, it is necessary to quantify the incidence and prevalence of SCI to better understand rates of occurrence and delineate

ways of prevention. Furthermore, this knowledge enables health care providers to estimate both the cost and psychosocial burden of this disease and the resources required for its management.

Furthermore, Wyndaele and Wyndaele (2006), in their systematic review reported prevalence rates ranging from 10.4 to 29.7 per million population in Europe, 27.1 to 83 per million population in North America, 18 to 40.2 per million population in Asia and 16.8 per million population in Australia.

The studies used in the review did not include pre-hospital mortalities. With pre-hospital mortalities included incidence rates that are much greater ranging from 52.5 per million population in Alberta, Canada to 77 per million population in Mississippi, USA. Wyndaele and Wyndaele (2006) could not find any studies on SCI incidence in South America or Africa.

Aetiology

The aetiology of SCI varies from place to place depending on social and economic factors. The main cause of traumatic SCI reported in economically developed countries are road traffic accidents (Dawodu, 2005; Burt, 2004). Road traffic accidents accounted for 39% of reported SCI cases in USA, followed by falls (28.3%) and acts of violence (14.6%) (NSCISC, 2012).

Age

Traumatic SCI primarily affects young adults. The average age at which SCI occurred in the United States between 1973 and 1979 was 28.7 years, with most of the injuries occurring between the ages of 16 and 30 years. However, the average age at which SCI occurs has risen to 41 years since 2005 (NSCISC, 2012). Wyndaele and Wyndaele (2006) reported in their literature surveys that the mean age of patients sustaining spinal cord injuries to be 33 years, except for Portugal where the mean was 50 years. The percentage of persons older than 60 years at the time of injury has increased from 4.7% before 1980 to 11.5% since 2000 (NSCISC, 2012). The increase in older adults affected by SCI in recent years could be attributed to the increase in survival rate in this population.

Sex

Since 2000, approximately 80% of all traumatic SCI reported in the USA and elsewhere in the world has occurred in males. The percentage of women' who sustained an SCI has increased marginally from 18.2% prior to the 1980 to 22.2% since 2000 (NSCISC, 2012).

Race

According to the NSCISC (2012), a significant trend over time has been observed in the racial/ethnic distribution of persons in the database. Among persons injured between 1973 and 1979, 76.8% were Caucasian, 14.2% were African American, 1.9% were Native American and 0.9% were Asian. However, among those injured since 2010, 67.0% are Caucasian,

24.4% are African American, 0.8% are Native American and 2.1% are Asian. Hispanic origin increased from 5.9% in 1970's to 12.5% in 2000-2004 and 7.9% since 2010. This trend is due in part to trends in the United States general population and also possibly explained by the changing locations of model systems, referral patterns to model systems, or race-specific incidence rates.

B. SCI in South Africa

To date there are only two studies that have studied the incidence of SCI in South Africa. A retrospective study by Hart and Williams in 1994 reported on the epidemiology of SCI in the East Rand of Johannesburg. The study comprised 492 males and 124 females that had undergone rehabilitation during the period of January 1988 and December 1992. They reported that traumatic SCI represented 89% of the total number of SCI between 1988 and 1992. Additionally, they indicated that violence (56%) was the most frequent cause of trauma, followed by motor vehicle accidents (25%) and fall from height (2.5%). Males represented about 60% of SCI, the average age of patients was 28 years, 66% of injuries were complete, 26% of the patients were quadriplegic and 74% were paraplegic (Hart and Williams, 1994). The data presented in this study was similar to studies internationally with the exception that the cause of injury internationally was greatest due to motor vehicle accidents (NSCISC, 2012, Hart and Williams, 1994)

In the second study, Velmahos et al. (1995) reported on 551 SCI patients data was collected from two Johannesburg hospitals from, one of which also was used by Hart and Williams (1994). Violence was recorded as the reason for most injuries in this study (violence, 61%; motor vehicle accidents, 30%). All injuries were in men, the age ranges from 20 to 30 years, one quarter of the patients were quadriplegic and three quarters of the patients were paraplegic. Their study didn't report on the completeness of injury.

Both South African studies included hospitals that were situated in areas, which according to the investigators were characterized by an above average degree of violence, possibly, as a result of social upheaval that occurred during the transition from Apartheid to universal democracy in South Africa (Hart and Williams, 1994; Velmahos *et al.*, 1995).

Presently there are no official statistics regarding the epidemiology of SCI in South Africa. However, the Quadpara Association of South Africa (QASA) estimates a total of 400-500 new SCI individuals per year (Gore 2006).

Hart (2000) reports in a study done over an eleven-year period that 90% of new spinal cord injuries are related to trauma. A statement made in the South African Parliament by Mr Gore on 19 September 2006 reads as follows: "According to the Quadpara Association of South Africa, South African roads produce an average of 200 quadriplegics and paraplegics per annum (50% of all traumatic spinal cord injuries in SA)" (Gore 2006).

Motor vehicle accidents thus seem to be the major cause of traumatic SCI in both South Africa, as well as internationally (Blackwell *et al.*, 2001). To date research concerning this injury in South Africa has reported on the aetiology, age, sex, incidence of cervical injury in rugby players and completeness of injury in Johannesburg.

1.3.3. Changes that occur soon after a spinal cord injury

A. Acute management of SCI

Immediately after injury the patient with an SCI is stabilized and then admitted to an acute hospital where they are further stabilized. In the acute post-injury phase, specialized management of spinal cord fractures and other injuries occurs concomitantly with the prevention of pressure sores, deep vein thrombosis and infections.

Spinal shock (Ditunno *et al.*, 2004) is a condition that occurs soon after SCI. Full assessment of the SCI can be done after recovery from spinal shock.

If the patient has an injury at T6 or above, the patient will also sustain a condition called neurogenic shock. In this injury there has been a major disconnection between the brain and the autonomic nervous system (Guly *et al.*, 2008). Thus the patients' blood pressure, heart rate and body temperature are affected, causing bradycardia, hypotension and

hypothermia to occur which need to be managed immediately at the scene of the accident (Guly *et al.*, 2008).

Spinal shock

Whytt in 1750 was the first to define spinal shock (as cited in Ditunno *et al.*, 2004) as “a loss of sensation accompanied by motor paralysis with the initial loss but gradual recovery of reflexes.” Reflexes in the spinal cord caudal to the SCI are depressed (hyporeflexia) or absent (areflexia), while those rostral to the SCI remain unaffected.

Ditunno and colleagues (2004) proposed a four phase model for spinal shock as follows:

Phase 1: lasts 0-24 hours, this phase is known as the areflexia/hypoflexia below the SCI. After the SCI, the neurons are involved in various reflex arcs lose the basal level of excitatory stimulation from the brain, the neurons involved become hyperpolarised and thus less responsive to stimuli.

Phase 2: lasts 2 to 3 days, this phase is known as the reflex return phase. Reflexes are restored from polysynaptic to monosynaptic reflexes. The first reflex to return is the bulbocavernosus reflex, which is polysynaptic in nature. Monosynaptic reflexes such as the deep tendon reflexes are not restored until phase 3. The hypersensitivity of the reflex muscles following denervation is the reason that reflexes return.

Phase 3 and 4: are both known as the hyperreflexia phase. Phase 3 is the early hyperreflexia which lasts 1 to 4 weeks. Interneurons and lower motor neurons below the SCI begin to sprout, attempting to re-establish synapses. The first synapses to form are from the short axons, this is a characteristic of phase 3. Phase 4 lasts 1-12 months (late hyperreflexia). Phase 4 is categorized as the soma –mediated phase; there is a new synapse growth by long-axoned neurons and soma-supplied synapse growth is via axon transport.

The period of spinal shock normally lasts from 48 hours to 6 weeks depending on the severity of the injury. A change from spinal shock to establish SCI can be documented by the return of spinal reflexes, particularly the bulbocavernosus reflex, this is an anal sphincter contraction in response to squeezing the glans penis or tugging on the urinary catheter; involving S2-S4 nerve roots and is a spinal cord mediated reflex arc.

1.3.4. Level of injury

The neurological level of injury is a significant factor in predicting the extent of neurologic damage and, therefore, functional outcome after SCI (Table 1.3), is defined as the most caudal (lowest) level of the spinal cord, which has normal motor and sensory function. The motor level, which is a predictor of the individual's functional capabilities, is resolved by the physical testing of key muscle groups of the body, bilaterally (Siddall *et al.*, 1997). The International Standards for Neurological Classification of SCI,

including the American Spinal Injury Association Impairment Scale, is a standardized assessment and classification scale used for determining the extent of SCI.

Table 1.3: The neurological level of injury and areas that are affected in reference to spinal levels

| Spinal Region | Location | Area Effected | Spinal Levels |
|----------------------|-----------------|-------------------------------|----------------------|
| Cervical | Neck | Neck, arms, hands | C1 - C7 |
| Thoracic | Chest | Torso, parts of the arms | T1 - T12 |
| Lumbar | Low Back | Hips, legs | T12 - L5 |
| Sacral | Pelvis | Groin, toes, parts of the leg | S1 - S5 |

1.3.5. Secondary complications after SCI

SCI results in changes in body systems, which affect the normal functions of the autonomic nervous system, which causes various complications in the injured person, resulting in problems with the following, sexual function, bladder function, bowel function, blood pressure maintenance and temperature regulation (Karlsson, 2006).

Bladder and Bowel problems: SCI patients that have problems with their bladder may require the use of long term bladder drainage with the purpose of avoiding damage to the kidney, for example kidney stone formation and infections (Burt, 2004).

Depending on the type of spinal cord injury, the bladder may either be "floppy" (flaccid) or "hyperactive" (spastic or reflex). The flaccid bladder results in the impairment of the detrusor muscle strength and the consequence is the inability to contract for voiding. Increase risk of infection can occur when the flaccid bladder contains too much urine, causing it to be overstretched; this can result in damage to the wall of the bladder. Intermittent catheterization allows for voiding to occur in the flaccid bladder. In the reflex bladder, the detrusor muscles may have increased tone, and may contract automatically, causing incontinence.

Bowel mobility is reduced and treatment is from administering laxatives and suppositories, to prevent incontinence (Burt, 2004).

Cardiovascular and pulmonary problems:

There is an increased risk for SCI patients to develop, deep vein thrombosis (15-20%) and pulmonary embolism (5%) as indicated by Burt in 2004. Furthermore, SCI patients with complete injuries are at a higher risk to develop these complications during the first year after acquiring a SCI than those patients with incomplete lesions (McKinley *et al.*, 1999). SCI patients have reduced pulmonary function, which can be seen also in paraplegic patients (Linn *et al.*, 2000). Additionally, SCI patients have decreased blood pressure, bradycardia, and postural hypotension, which results in symptoms of loss of consciousness (Burt, 2004). Autonomic dysreflexia is a condition in which there is an unexpected onset of extremely high blood pressure. It is common in patients with SCI involving

the thoracic nerves of the spine a stimulus originating below T5 triggers these conditions. It is a chronic issue, which is a growing concern for the SCI population. For long-term SCI, morbidity and mortality from cardiovascular causes now exceeds that caused by renal and pulmonary conditions, the primary causes of mortality in previous decades (Burt, 2004).. Although risk estimates commonly used for ambulatory individuals have not been established from follow-up studies in SCI, nearly all risk factors tend to be more prevalent in SCI subjects compared with ambulatory subjects. These risks include a greater prevalence of obesity, lipid disorders, metabolic syndrome, and diabetes. Daily energy expenditure is significantly lower in SCI individuals, not only because of a lack of motor function, but also because of a lack of accessibility and fewer opportunities to engage in physical activity. Autonomic dysfunction caused by SCI is also associated with several conditions that contribute to heightened cardiovascular risk, including abnormalities in blood pressure, heart rate variability, arrhythmias, and a blunted cardiovascular response to exercise that can limit the capacity to perform physical activity. Thus, screening, recognition, and treatment of cardiovascular disease should be an essential component of managing individuals with SCI, and judicious treatment of risk factors can play an important role in minimizing the incidence of cardiovascular disease in these individuals.

Established symptoms in these patients include, headaches, paraesthesia, thoracic tightness, dyspnoea, sporadically cardiac arrhythmias (Burt, 2004).

Pressure sores

This can be a lifelong complication with SCI patients; characterized by pressure over skeletal areas resulting in tissue impairment (Garber and Rintala, 2003). Pressure sores has been reported as a frequent secondary impediment, presenting in 15% of SCI patients in the first year of injury and more individuals are affected in the years to follow (McKinley *et al.*, 1999). Pressure sores frequently occur in SCI because of the immobility of patients, decreased oxygenation of pressure points, which may lead to the sores impairment (Garber and Rintala, 2003).

Spasticity

Is a result of SCI and tolerance to it varies from patient to patient (Burt, 2004), interferes with transfer abilities of patients and may result in patients falling (Burt, 2004). Refer to subsection of types of pain pg. 24

1.4. ASSOCIATED DISORDERS OF SCI

1.4.1. Pain

To date the bulk of the studies on this niche area has been on chronic SCI pain (New *et al.*, 1997). The prevalence of chronic pain in SCI patients has been reported to vary between 18% and 94%. The reason for this lack of consistency regarding the incidence of pain following SCI has been difficult to ascertain. There are a number of methodological differences between studies that may account for the discrepancy such as: different definitions of pain following SCI with reference to specific pain types and

abnormal sensations regarded as pain, different pain assessment tools used, time of the initial assessment and duration of the assessment after injury, for example, initial assessments can be as early as 2 weeks or later than 6 months or a year after injury. Furthermore, some studies do not follow up on the assessment of the SCI patient after discharge from the Rehabilitation Hospital (Bonica, 1991; Beric *et al.*, 1988; Summers *et al.*, 1991).

Even though research in SCI pain is far from complete a substantial amount of advancement has been made within the last two decades as a consequence of epidemiologic, experimental, and treatment trials in patient volunteers, and animal models of SCI.

Classification of SCI pain

Numerous researchers in the field of SCI have set out to classify the diverse categories of pain associated with injury to the spinal cord in an effort to promote mechanism based taxonomy for SCI pain (Donovan *et al.*, 1982; Siddall *et al.*, 2000; Bryce and Ragnar son, 2003; Cardenas *et al.*, 2002). Despite these classifications differing significantly in their details, they all include a division between nociceptive pain and neuropathic pain.

Recently, an international conference was held to reach consensus on an accepted international classification of SCI pain, the International Spinal Cord Injury Pain Classification (ISCIPC) (Bryce *et al.*, 2012) (table 1.4.), largely adopts the proposed classification of Siddall *et al.* (1997)

and subsequent IASP classification (table 1.5.) (Siddall *et al.*, 2000), which covers pain that is associated and unrelated to SCI. The ISCIPC is divided into three tiers; the classification is comprehensive and mechanism based. Tier 1, division of pain into nociceptive, neuropathic, and other pain, and identifies that not all pain can be categorized and included the option to classify unidentifiable pain as ‘unknown’ that differs from the classification system of Siddall et al. (2000). Tier 2 describes pain subtypes (e.g., musculoskeletal pain) and tier 3, the primary pain cause if identified, is similar to Siddall et al. (2000) study. However, compared to the Siddall et al. (2000) the ISCIPC classification has omitted the term “above-level neuropathic pain.”

Table 1.4.: Current Classification system of SCI pain

| Tier 1: Pain type | Tier 2: Pain subtype | Tier 3: Primary pain source and/or pathology |
|----------------------------|-----------------------------|---|
| <i>Nociceptive</i> | Musculoskeletal | e.g. glenohumeral arthritis, lateral epicondylitis, comminuted femur fracture, quadratus lumborum muscle spasm. |
| | Visceral | e.g. myocardial infarction, abdominal pain due to bowel impaction, cholecystitis. |
| | Other nociceptive pain | e.g. autonomic dysreflexia headache, migraine headache, surgical skin incision. |
| <i>Neuropathic</i> | At Level SCI pain | e.g. spinal cord compression, nerve root compression, cauda equine compression |
| | Below level pain | e.g. spinal cord ischemia, spinal cord compression |
| | Other neuropathic pain | e.g. carpal tunnel syndrome, trigeminal neuralgia, diabetic polyneuropathy. |
| <i>Other pain</i> | | e.g. fibromyalgia, Complex Regional Pain Syndrome type I, interstitial cystitis, irritable bowel syndrome |
| <i>Unknown pain</i> | | |

Table 1.5 Classification of SCI (Siddall et al., 2000)

| BROAD TYPE (TIER 1) | BROAD SYSTEM (TIER 2) | SPECIFIC STRUCTURES/ PATHOLOGY (TIER 3) |
|--------------------------------|----------------------------------|--|
| Nociceptive | Musculoskeletal | Bone, joint, muscle trauma or inflammation, Mechanical instability Muscle spasm Secondary overuse syndromes |
| | Visceral | E.g. renal calculus, bowel, sphincter dysfunction, etc. |
| Neuropathic | Above- level | Compressive mononeuropathies Complex regional pain syndromes |
| | At- level | Nerve root compression (including cauda equina) Syringomyelia Spinal cord trauma/ischemia (End zone, border zone, etc.) |
| | Below- level | Spinal cord trauma/ischemia |

Types of Pain

A. Nociceptive pain

Nociceptive pain is the consequence of the normal processing of stimuli that impair or disturb normal tissues. Nociceptors are nerve fibers carrying signals to the spinal cord. This pain type is divided into musculoskeletal (bone fractures and rotator cuff tears) and visceral pain (abdominal) problems (Siddall *et al.*, 2000). Some musculoskeletal pain is also associated with structural spinal lesions and instability. (Siddall *et al.*, 1997).

Spasticity is an example of nociceptive pain, according to the current and previous classification systems it is characterised to be a musculoskeletal type of pain (Bryce *et al.*, 2012; Siddall *et al.*, 2000) a condition seen commonly in people with incomplete injuries and often happens after SCI following resolution of spinal shock (Siddall *et al.*, 1997). This condition also continues well after the injury and is best relieved by alleviating the muscle spasms. Analgesics are rarely helpful (Siddall *et al.*, 2000)

Musculoskeletal pain can also occur with the over-use of structures such as arms and shoulders; this type of pain is described as aching in the area of pressure or overuse and is worse with the use of the involved joints (Dalyan *et al.*, 1999). This type of musculoskeletal pain is often seen in the shoulders of SCI patients that use wheelchairs (Koyama *et al.*, 1998). It is a condition found mainly in paraplegic patients rather than those with

quadriplegia. Additionally, it has been reported that as many as 72% of paraplegics have evidence of shoulder joint degenerative changes (Lal, 1998).

Visceral pain is a secondary complication in SCI resulting from visceral structures such as urinary tract infections, bowel impaction and renal calculi. This type of pain is contained in the abdomen, the pain quality is characterised as dull, poorly localized, bloating or cramping in nature. (Davis and Martin, 1947). With this type of pain, the level and completeness of injury will affect the quality and intensity of pain described by the patient (Siddall and Middleton, 2006).

B. Neuropathic pain

The most common type of SCI pain reported is neuropathic pain, resulting from the unusual processing of sensory input due to the impairment of the nervous system. It is often challenging to find a particular cause of neuropathic pain and this type of pain is extremely unresponsive to various treatment regimens. It is divided into at-level and below-level (Siddall *et al.*, 2000).

At-level neuropathic pain is described as electric, shooting or burning pain in a segmental pattern within two segments above or below the level of injury. Due to the characteristic distribution of this type of pain, it is also referred to as the radicular, segmental, transitional zone, border zone, end zone or girdle pain. This pain is often linked with allodynia (pain evoked by

a non-noxious stimulus, such as light touch, that does not normally evoke a sensation of pain) or hyperesthesia (painful response to normal stimulus) of the affected dermatomes (Siddall *et al.*, 2003). At-level neuropathic pain may be the result of damage to nerve roots or the spinal cord itself.

Below level neuropathic pain, (Davis and Martin, 1947; Davidoff *et al.*, 1987; Beric *et al.*, 1998; Segatore, 1992) the quality of this pain is often described as burning, aching, stabbing or electric like shocks (Siddall *et al.*, 1997) characterized with spontaneous and/or evoked pain, present diffusely and caudal to the level of SCI (Davis and Martin, 1947; Davidoff *et al.*, 1987; Beric *et al.*, 1998; Segatore, 1992.). Hyperalgesia may also be present. The pain is described as continuous, but may vary with mood, general activity, infections or other influences (Davis and Martin, 1947; Davidoff *et al.*, 1987; Beric *et al.*, 1998; Segatore, 1992).

Although it is challenging to allocate pain types to specific categories, it seems that of all the pain types; below-level neuropathic pain is the most frequent and the most refractory to treatment (Davis, 1954; Bonica, 1991). It is described in approximately in one-third of SCI patients who complain of constant pain (Beric, 1997; Siddall *et al.*, 1999; Siddall *et al.*, 2003).

Predictors of pain post SCI

Although SCI pain is a serious secondary complication, a clear understanding of the predictors related with the development of pain and the impact of pain in SCI has been limited chiefly by three factors (Putzke

et al., 2001). The first factor is that there is little agreement on the definition of the pain types (e.g. neuropathic, musculoskeletal) and qualities (e.g. sensory, intensity, frequency, and duration) of SCI pain because of the lack of a gold-standard assessment instrument, making evaluations across studies complex. Secondly, few studies have performed longitudinal examination of SCI pain predictors (New *et al.*, 1997). Thirdly, studies have used cross-sectional designs; and therefore firm assertions regarding the causal nature of the factors associated with the development of pain have been limited (Putzke *et al.*, 2001).

Many studies in the past have sought to identify physical factors that are more expected to be related with pain, but have reported them to be conflicting or diverse (Levi *et al.*, 1995; New *et al.*, 1997, Siddall *et al.*, 2003). The injury level is not a predictor for the development of SCI pain in some studies (Davis and Martin, 1947; Nashold, 1991) or the pain severity (Richards *et al.*, 1980; Summers *et al.*, 1991, Siddall *et al.*, 1999).

Furthermore, it has been suggested that injuries resulting from gunshot wounds are more likely to result in pain (Richards *et al.*, 1990 and Nashold, 1991). Thus there is no clear guidance of this topic since the findings in research is very contradictory.

Similarly, completeness of SCI may be a cause in the development of pain. From clinical examination it has been suggested that neuropathic pain is more common with people with incomplete injuries (Budh *et al.*, 2003). A postal survey by Ravenscroft (2000) reported that completeness

was significantly related to the presence of pain, others have found no such association between the degree of injury and the presence of pain (Richards *et al.*, 1980; Summers *et al.*, 1991; Siddall *et al.*, 1999).

The relationship of pain and physical factors may be more difficult to determine when the presence of any pain is considered. Alternatively, it may be simple to establish an association when specific subtypes of pain are examined. For instance, there appears to be an association between damage to the spinothalamic tracts and the development of neuropathic pain (Eide *et al.*, 1996; Defrin *et al.*, 2001). Furthermore, there appears to be an association between central cervical lesions and the development of spontaneous and evoked segmental neuropathic pain in the arms and legs (Eide *et al.*, 1996; Defrin *et al.*, 2001). A prospective, longitudinal study reported that the only significant link between any physical factor and pain was that allodynia was more frequent in patients who had incomplete, cervical and central cord lesions. (Siddall *et al.*, 1999).

1.4.1.1. Pain Catastrophizing and Negative Self Statements

The term catastrophizing was coined by Ellis et al. (1962) five decades ago and it was redefined by Beck in 1979 to define a maladaptive cognitive style seen in patients with anxiety and depressive disorders. This phenomenon was characterized by emotions of exaggerated helplessness, rumination and magnification of emotions and cognition toward painful situations has seen in traumatic SCI.

It has been reported in the literature (Engel *et al.*, 2006; Lame *et al.*, 2005; Jensen *et al.*, 2002; Sullivan *et al.*, 2001) that catastrophizing is associated with higher pain intensity and pain interference, psychological findings such as depression and anxiety. To-date there is no reported literature of catastrophizing in the acute stages of SCI. However other studies (Buenaver *et al.*, 2012) have reported on catastrophizing in chronic pain populations

A study by Buenaver and colleagues (2012) reported that patients with myofascial temporomandibular disorder (TMD) who ruminate about their pain have more negative feelings about their pain and have poor sleep, and as a consequence they feel more pain. A significant relationship between pain catastrophizing and self-reported sleep disturbance was reported in this study, and that a significant percentage of variance in pain severity and pain related interference attribute to pain catastrophizing was mediated by sleep disturbance. Furthermore, the rumination component of catastrophizing seemed to be indirectly related to clinical outcomes of sleep disturbance, no evidence for indirect effects for the helplessness and magnification components were observed (Buenaver *et al.*, 2012). These results by Buenaver and colleagues (2012) may suggest that rumination about pain may contribute to pain indirectly through alterations in sleep, however, this yet, to be seen in SCI patients.

PAIN ASSESSMENT TOOLS

A. There are two types of pain measurements: unidimensional and multidimensional scales (Gracely, 1990) used to measure SCI pain. This subsection contains all the pain instruments that are used in the study of SCI pain. The reason I chose certain pain measures from others in the methodology section is due to the fact that self-reported pain assessments must be simple to administer, easy for patients to understand, and responsive to changes in pain over time. Additionally, these instruments are the most commonly used pain assessment measures in most studies. Additionally, these measures have high internal consistency (Cronbach α 0.85 or greater) and at least fair test–retest reliability ($r > 0.5$).”

B. Unidimensional

Unidimensional scales are measures of pain intensity and may be either, numerical, verbal and visual. The Numerical rating scale is one of the common approaches to quantifying pain. Patients indicate their pain intensity on a scale of 0 (with 0 indicating no pain) to 10 (the worst pain imaginable). The verbal descriptor scale where patients choose one word to describe their pain intensity: mild, moderate or severe pain. The visual analogue scale consists of a line with one end labelled “no pain” and the other end labelled “worst pain imaginable (McGurie, 1984, Jensen *et al.*, 1986). Unidimensional scales are simple to use and do not take much time to complete (5-10 minutes), however, they focus on pain intensity, reducing the pain experience into one dimension. These scales do not

include the emotional, cognitive and sensory features of the pain experience which is important for evaluating the nature and impact of pain.

C. Multidimensional

Multidimensional pain scales determines the other characteristic of pain such as location and quality, and its effect on mood and function.

The McGill Pain Questionnaire is a validated multidimensional tool that was developed by Ronald Melzack and Warren Torgerson in 1971, and was the first multidimensional tool to assess the quality of spontaneous pain; pain is assessed in three dimensions; sensory, affective and evaluative. This is based on 20 sets of words that the patients select to describe their pain (Melzack, 1975). MPQ consists of 78 words, obtained from pain-patient interviews and the clinical literature, which describe distinctly different aspects of the experience of pain. The words are categorized into three major classes:

Words that describe the sensory qualities of the experience in terms of temporal, spatial, pressure, thermal, and other properties

Words that describe affective qualities in terms of tension fear, and autonomic properties that are part of the pain experience.

Evaluative words that describe the subjective overall intensity of the total pain experience.

The words selected by the patient can be used to describe their pain quality such as burning, sharp, aching or throbbing. The description of this type of pain can suggest underlying nociceptive and neuropathic mechanisms.

There are tools that help to determine the influence of pain on function such as the Brief Pain Inventory Interference scale and the Life Interference subscale of the Multidimensional Pain Inventory.

The Brief Pain Inventory Interference scale (Cleeland and Ryan, 1994) and a modified version of this scale (where “walking” an original interference item was replaced by a interference item “mobility”) has demonstrated validity for measuring pain interference in patients with SCI (Raichle *et al.*, 2006). This scale was recommended by the IMMPACT consensus group for the use in pain clinical trials (Dworkin *et al.*, 2005).

The Life Interference subscale of the Multidimensional Pain Inventory is a scale that assesses daily living activities and social aspects (relationships with family and friends) regarding the impact that pain has on the satisfaction or enjoyment of each activity/relationship (Widerstrom-Noga *et al.*, 2006).

Recently, a number of multidimensional measures have been established to determine specific types of pain. For example there are a number of measures that screen for neuropathic pain such as:

The Neuropathic Pain Questionnaire, this is a 12 item scale assessing the presence and severity of different qualities of pain, including 2 affective aspects (unpleasantness and overwhelming) (Galer and Jensen, 1997).

The Pain Detect scale is a scale that has 9 items self-report questionnaire. Sensory, spatial and temporal characteristics used in the screening of neuropathic pain a score >19 suggests that pain is likely to be neuropathic in origin (Freyenhagen *et al.*, 2006).

ID Pain Scale is a 6 item scale used to differentiate between neuropathic and nociceptive pain. A score >3 indicates the presence of neuropathic pain (Portenoy, 2006).

The Leeds Assessment of Neuropathic Symptoms and Signs Scale is a 7 items scale used to describe the difference between nociceptive and neuropathic pain. Positive scores indicate pain is predominately neuropathic in origin (Bennett, 2001).

The Douler Neuropathique 4 Scale is a 4 item scale it is an assessment tool used to differentiate nociceptive and neuropathic pain. This scale requires both a patient interview of the presence of specific pain qualities associated with neuropathic pain and physical examination to detect for hypaesthesia (touch and pin-prick) or allodynia. A score >4 suggests neuropathic pain (Bouhassira *et al.*, 2005).

Additionally, there are tools that determine the severity of different emotional and psychological aspects of patients with pain such as:

The Pain Catastrophizing Scale is a 13 item scale rated on a 5 point Likert scale to determine the extent the individual engages in catastrophic thinking regarding pain, a total score and 3 subscale scores can be calculated (rumination, magnification and helplessness).

1.4.2. SLEEP

Limited number of studies has focused on sleep quality in chronic SCI individuals, and none in the acute stages of SCI. In these chronic studies, SCI individuals complained of difficulty in sleeping (Bonekat *et al.*, 1990; Burns *et al.*, 2000; Hyypä and Kronholm, 1989; Klefbeck *et al.*, 1998). Research conducted by Bonekat et al. (1990) reported that patients with SCI commonly report having difficulty in sleeping due to spasms, restless sleep, snoring, waking early, and difficulty in falling asleep.

Normal sleep

Normal sleep is an intricate and critical physiological activity characterized by two forms, referred to as rapid eye movement (REM) and non-rapid eye movement (NREM). These sleep states alternate throughout the sleep cycle, and are associated with specific electroencephalogram (EEG) patterns; altered skeletal tone, eye movements and respiratory patterns the two main types of sleep are rapid-eye-movement (REM) sleep and non-rapid-eye-movement (NREM) sleep. On an EEG, REM sleep, often

called "active sleep," is identifiable by its characteristic low amplitude (small), high-frequency (fast) waves and alpha rhythm, as well as the eye movements for which it is named. During REM sleep muscles in the arms and legs are temporarily paralyzed. This is thought to be a neurological barrier that prevents us from "acting out" our dreams (Aserinsky and Kleitman, 1953; Iber *et al.*, 2007).

NREM sleep can be broken down into three distinct stages: N1, N2, and N3. In the progression from stage N1 to N3, brain waves become slower and more synchronized, and the eyes remain still. In stage N3, the deepest stage of NREM, EEGs reveal high-amplitude (large), low-frequency (slow) waves and spindles. This stage is referred to as "deep" or "slow-wave" sleep. The pattern of clear rhythmic alpha activity associated with wakefulness gives way to N1, the first stage of sleep, which is defined by a low-voltage, mixed-frequency pattern (Aserinsky and Kleitman, 1953; Iber *et al.*, 2007). The transition from wakefulness to N1 occurs seconds to minutes after the start of the slow eye movements seen when a person first begins to nod off. This first period of N1 typically lasts just one to seven minutes. The second stage, or N2, which is signaled by sleep spindles and/or K complexes in the EEG recording, comes next and generally lasts 10 to 25 minutes (Aserinsky and Kleitman, 1953; Iber *et al.*, 2007). As N2 sleep progresses, there is a gradual appearance of the high-voltage, slow-wave activity characteristic of N3, the third stage of NREM sleep. This stage, which generally lasts 20 to 40 minutes, is referred to as "slow-wave," "or "deep" sleep. As NREM sleep progresses, the brain

becomes less responsive to external stimuli, and it becomes increasingly difficult to awaken an individual from sleep. Following the N3 stage of sleep, a series of body movements usually signals an "ascent" to lighter NREM sleep stages. Typically, a 5- to 10-minute period of N2 precedes the initial REM sleep episode. REM sleep comprises about 20 to 25 percent of total sleep in typical healthy adults (Aserinsky and Kleitman, 1953; Iber *et al.*, 2007).

NREM sleep and REM sleep continue to alternate through the night in a cyclical fashion. Most slow-wave NREM sleep occurs in the first part of the night; REM sleep episodes, the first of which may last only one to five minutes, generally become longer through the night. During a typical night, N3 sleep occupies less time in the second cycle than the first and may disappear altogether from later cycles. The average length of the first NREM-REM sleep cycle is between 70 and 100 minutes; the average length of the second and later cycles is about 90 to 120 minutes (Aserinsky and Kleitman, 1953; Iber *et al.*, 2007).

1.4.2.1. Sleep disorders

SCI patients commonly complain of sleep disturbances. It usually depends on the level and completeness of the cord injury (Devivo *et al.*, 1999). There are various sleeping disorders seen in SCI such as sleep related breathing disorders, insomnia, hypersomnia, circadian rhythm sleep

disorders, parasomnia, and sleep related movement disorders (Go *et al.*, 1995)

Insomnia

Insomnia is a sleep condition that is characterised by difficulties with sleep onset or maintenance, and subjective complainants of non-restorative sleep. Insomnia is a serious problem affecting both the general population and patients with SCI and is often related to other clinical and psychological disorders (Brown, 2009). There are three classification systems for insomnia; International Classification of Diseases (this classification requires that sleep disturbance be present at least three nights a week) (AASM, 2005) ; Diagnostic and Statistical Manual Treatment Revision (similar to the International classification of sleep disorders , the difference is that this classification as a cut-off time, requiring symptoms to be present for at least one month) and the International Classification of Sleep Disorders (have a symptom of sleep disturbance defined as difficulty initiating sleep, difficulty maintaining sleep, early morning awakenings and sleep of poor quality) (AASM, 2005).

A study in Finland (Hyypä and Kronholm, 1989) assessed sleep in 80 paraplegic patients. Sleep quality was worse in the paraplegic group than the control group, regarding insomnia (13.8% vs 4.4%); sleep latency (from lights out to first appearance of N2 (Richardson *et al.*, 2008).

There were 22 patients that had sleep above 30 minutes (22.5% vs 4.4%), maintaining sleep (33.8% vs 17.9%), morning irritability (46.7% vs 24.2%),

and willingness to go to bed (56.3% vs 77.55). There were 22 patients that had sleep above 30 minutes. The control group comprised of individuals from the Finnish population of similar age and sex.

Biering-Sorensen and colleague (2001) assessed sleep quality using the Nordiac Sleep Questionnaire. The control group comprised of a selection of the normal population of Denmark consisting of 339 individuals, 222 men and 117 women. The results in this study were that SCI patient's experienced poorer sleep quality (55%) than the control group (Biering-Sorensen and Biering-Sorensen, 2001). These patients were also asked for the key problems associated with their poor sleep, the most troublesome factors cited by these patients was pain, spasms, paraesthesia and problems with urine voiding.

Widerstrom-Noga et al. (2001); the mean intensity of pain was 8.2 ± 1.8 when most painful and 3.0 ± 2.4 when least painful. Almost 30% of the subjects rated intensity when their pain hurt the most as 10 ("the most intense pain imaginable"). The mean of most and least pain was 5.6 ± 1.8 . No significant differences existed between cervical and below-cervical injuries in the pain intensity ratings in this study. With regards to falling and staying a sleep, two variables were significantly predictive of whether a person would have high or low frequency interference with falling asleep. Persons more likely to experience frequent interference used more descriptors when describing their pain and reported high average pain intensity. Four variables significantly predicted whether a person would have high or low frequency interference with staying asleep. Persons more

likely to experience frequent interference were men, who were older at time of injury ($p=0.05$), who had experienced anxiety the last 3 months, and had high average pain intensity. Higher pain intensity was associated with poorer subjective sleep quality, i.e. increased time to fall asleep (57.9%) and problems staying asleep.

Rintala et al. (1999) reported chronic SCI pain to interfere with sleep. In addition, Budh et al. (2005) also using Nordiac Sleep Questionnaire reported that; sleep quality was worse in individuals with constant pain (33%) than patients with occasional pain (21%) and without pain (6%). Individuals with incomplete injuries reported worse sleep quality (45%) than those with complete injuries (15%). Furthermore, their study showed the predictors of poor sleep to be pain severity, unpleasantness, anxiety and depression.

Sleep disordered breathing

Sleep related breathing disorders are categorized by altered respiratory function during sleep (AASM, 2005). The most common of these is obstructive sleep apnea where, pauses in breathing are associated with arousals, blood oxygen desaturations or both. While a high proportion of the general population experiences breathing pauses during the night, to be considered abnormal or pathological, the number of respiratory events has to be equal or greater than five per hour (AASM, 2005). The diagnosis of sleep apnea has to be confirmed by overnight polysomnography recordings. High proportions of sleep related breathing disorders have

been seen in SCI, with rates oscillating between 15 and 62% according to different studies (Burns *et al.*, 2000). Sleep apnea is more common in quadriplegia than in paraplegia (McEvory *et al.*, 1995), chiefly in individuals with C1-C4 injuries.

Restless legs syndrome

Another common sleep disorder that interrupts sleep and which may be found in individuals with SCI is restless legs syndrome (RLS) and periodic limb movements (PLM). RLS is regarded as a syndrome presenting, the need to move the limbs, accompanied by painful or unpleasant sensations (AASM, 2005). Periodic leg movement (PLM) are repetitive leg movements occurring during sleep, generally at the lower extremities. The movements involve the extension of the big toe with partial flexion of the knee and ankle (Yokota *et al.*, 1991).

There are case studies of patients with spinal cord injuries that have indicated RLS and PLM have developed following SCI. Ten patients with myelopathy reported associated PLM (Yokota *et al.*, 1991) and three patients reported PLM accompanying a focal thoracic spinal cord injury (Lee *et al.*, 1996). Hartmann and colleagues (1999) reported that three patients with SCI presented with RLS, and RLS developed in one patient after a vascular injury of the spinal cord (Tings *et al.*, 2003).

Other reasons for sleep interference

Other factors that may interrupt sleep include an assortment of exogenous factors found in the hospital such as noise, temperature, lights as well as repetitive staff interventions or endogenous influences such as an inability to lie comfortably, anxiety and restlessness (Roehrs and Roth, 2005). Additionally, medication prescribed during the recovery process, specifically type and dose of analgesics are vital factors (Hauri, 1993).

The administration of opiates to alleviate pain may turn out to be counterproductive, as these medications are REM suppressants, and loss of REM sleep increases pain sensitivity (Roehrs and Roth, 2005; Moore and McQuay, 2005; Woolar *et al.*, 2012).

Pain, sleep, psychological distress, causes major secondary complication to SCI patients, interfering with their daily activities thereby reducing their quality of life. It is, therefore, necessary to establish treatment regimens in these patients to increase their quality of life.

1.4.3 THE PSYCHOLOGICAL IMPACT OF SPINAL CORD INJURY-RELATED PAIN AND SLEEP DISTURBANCE

Despite significant improvements in survival rates in SCI, understanding of the psychological effects of SCI has not necessarily kept abreast. The immediate psychological concerns of SCI may be poorly understood,

possibly because the early stages of SCI are complicated by the effects of sensory and motor deprivation, and secondary complications such as pain and sleep issues.

Anxiety and depression

Historically, anxiety and depression have been an expected consequence of SCI (Orbaan, 1986; Richards, 1985; MacDonald *et al.*, 1987; Judd *et al.*, 1991; Hancock *et al.*, 1993, Krause, 1997). Nearly 25% of patients with SCI experience clinically significant levels of anxiety, compared to controls (5%). The subjects with SCI were also shown to have depression in about 27% of cases and 3% in controls, which comprised 41 able bodied controls matched for age, sex, education and, as far as possible, occupation (Hancock *et al.*, 1993).

One study attempted to predict mood disorders over time after SCI and found that higher pain levels experienced post injury and the knowledge of loss of control of their life before discharge tend to predict higher levels of depression in these patients (Craig, 1994).

An increased burden of anxiety and depression in persons with SCI becomes even more vital when reviewing studies of suicide rates in SCI patients. It has been suggested that the suicide rate amongst persons with SCI may be 4 to 5 times greater than that of age, sex and race specific rates for the general population (DeVivo, 1991; Kennedy *et al.*, 2000).

Pain and sleep related to depression and anxiety

Constant pain has been shown to be linked with mood (Craig, 1994) and quality of life following SCI (Widerstrom-Noga *et al.*, 2001). Furthermore, it has been shown by Carins and colleagues (1996) that the association between pain and mood tends to progress over time. Patients admitted to a rehabilitation hospital after sustaining traumatic SCI, 46% had moderate to severe pain intensity and experienced symptoms of emotional distress greater than patients without pain (Anke *et al.*, 1995).

Higher pain severity was related with psychological factors and not with physiological issues such as completeness and level of injury (Summers *et al.*, 1991). Summers and colleagues (1991) also indicated in their study that patients who were more accepting of their SCI expressed poorer levels of pain severity.

The co-morbidity of pain and mood is well documented, however, the causal nature of this association is uncertain as changes in pain affect mood more than changes in mood affect pain (Wegener and Harythornthwaite, 2001). These authors showed that the association concerning pain and depression may change over time in SCI.

1.4.4. QUALITY OF LIFE IN SCI

The issue of quality of life is pertinent because, of the chronicity of SCI. Quality of life is defined as the "individuals' perceptions of their position in

life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” Skevington (1998).

Persons with SCI tend to have changes in their quality of life. If objective measures are considered, for example, interference with daily activities, pain and sleep disturbances, individuals with SCI disabilities have a worse quality of life than people without disabilities since their injuries almost always lead to activity limitations and often influence cognitive and affective functioning (Tate *et al.*, 2002).

Chronic pain was reported as the only problem that predicted lower quality of life scores in non- hospitalized SCI patients by a study by Lundquist and colleagues (1991).

Current measures of quality of life have many restrictions with respect to their use in SCI individuals. Many of the quality of life measures have not been established specifically for individuals with disabilities, the significance and importance of the measures' content is often questionable, lacking enough consistency and sensitivity to be able to capture changes in internal standards and personal values among SCI individuals (Tate *et al.*, 2002).

Quality of life issues have become an important element in the management of SCI patients since the life expectancy for these individuals has increased significantly over the last 30 years (Tate *et al.*, 2002). Insight into the relationships between the various consequences of SCI

such as pain, sleep, RLS, psychological issues, etc. will serve to be a valuable tool in establishing appropriate treatment regimens in these individuals.

1.4.5. The general interaction of pain, sleep and mood

Pain, especially chronic pain, is an emotional condition as well as a physical sensation. It is a complex experience that affects thought, mood, and behaviour and can lead to isolation, immobility, and drug dependence. In these ways, it resembles depression, and the association is intimate. Pain is depressing, and depression causes and intensifies pain sensation. People with chronic pain have three times the average risk of developing psychiatric symptom and usually mood or anxiety disorders and depressed patients have three times the average risk of developing chronic pain.

Sleep is a critical outcome for subjects with chronic pain because sleep disturbances increase pain sensitivity and risk for pain-related impairment depression, and overall health issues (Campbell et al., 2013; Naughton et al., 2007; Smith and Haythornthwaite, 2004). The relationship between sleep and depressive illness is complex since depression may cause sleep issues and sleep issues may cause or contribute to depressive disorders. For some people, symptoms of depression occur before the onset of sleep problems. For others, sleep problems appear first. Sleep problems and depression may also share risk factors and biological features and the two conditions may respond to some of the same

intervention strategies. Sleep problems are also associated with more severe depressive illness.

A number of studies focused on the effects of mood on both pain and sleep suggest that daily negative and positive moods are likely to affect sleep in different ways. Greater anxiety and fear about pain is associated with greater pain and sleep disturbances among chronic pain patients (Morin et al., 1998). Short-term mood changes are also known to affect pain perception among those with chronic pain, and short-term changes in pain in turn appear to affect daily sleep (Alsaadi et al., 2014; Newth and Delongis, 2004; Zautra et al., 2001, 2005). Also, daily pain ratings and negative mood are associated with the night's poor sleep among adults with back pain, facial pain, and fibromyalgia syndrome (Alsaadi *et al.*, 2014; Hamilton et al., 2008; O'Brien et al., 2011). Taken as a whole, these studies suggest that daily negative mood may contribute to disturbed sleep, whereas daily positive affect may lead to improved sleep. A study by Song et al., 2015 results demonstrate that daily fluctuations in negative and positive mood among individuals with chronic pain can carry over to their night's sleep, with negative mood relating to worse sleep quality and positive mood relating to reports of more refreshing sleep. The findings of this study suggest that daily sleep of older adults with chronic pain may be improved by helping them regulate their moods and by providing their partners with advice on how to regulate their own responses to pain behaviours to promote the health of chronic pain patients.

1.4.6 Conclusion of literature review

Presently in South Africa there is no data regarding pain, sleep disturbances and mood changes in SCI during the acute phase. It is apparent from the preceding chapters in the literature review that these complications are major secondary complications in SCI and therefore the aim of this project is to characterise pain, mood, and sleep disturbances during the acute stages of SCI, including short-term changes.

STUDY OBJECTIVES

The objectives for this study were to;

1. Describe the pain, sleep, depression symptoms and quality of life during acute SCI.
2. Identify factors associated with pain and sleep disturbances in patients with SCI.
3. Compare changes in pain, sleep, mood, and quality of life between two time periods (from admission to discharge).

CHAPTER 2
METHODOLOGY

2. DESIGN OF STUDY

2.1. SITE OF STUDY

Following traumatic SCI, patients were admitted first to an acute care facility (Netcare Milpark Hospital) for stabilisation and treatment of the acute lesion. Once the patients overcame spinal shock (48 hours or up to a few weeks after the initial injury depending on the severity of the lesion) and were stabilised, they were transferred to the Hope Unit of the Netcare Rehabilitation Hospital, Johannesburg, South Africa. This Unit is used for the treatment of both traumatic and non-traumatic post-acute and chronic SCI treatment and rehabilitation. There is a specialist team of physiotherapists, occupational therapists, recreational therapists, psychologists, neurologists, social workers, nurses, and other specialists that work with the patients.

2.2. STUDY PARTICIPANTS

Every adult admitted to the unit from October 2011 to September 2012 with acute SCI was invited to participate in the study. Once the Netcare team were satisfied that the patient was psychologically stable the patients were approached and asked whether they would be willing to participate in this study. The patients were assessed regarding the following inclusion/exclusion criteria:

Inclusion criteria: participants' must have had a recent confirmed SCI (≥ 3 months ago) and be experiencing SCI pain. Exclusion criteria: difficulty in

communicating (e.g. on a ventilator, unconsciousness). A total of 35 eligible patients were approached and 17 consented to participate in the study; however three participants withdrew from the study during assessment 2.

The recruitment process and interviews were only allowed to be from 15:00 onwards, when the patients were finished with their rehabilitation programme for the day.

2.3. ETHICS

Ethical clearance was obtained from the Human Ethics Research Committee (Medical) of the University of Witwatersrand (M110405). Permission also was obtained from the hospital to access the rehabilitation facility, the patients and their hospital files. Written consent was obtained from all participants who were able to write. Participants with a high level SCI and were thus unable to write provided verbal consent; the nurse on duty was used as a witness for the verbal consent

2.4. STUDY PROTOCOL

Participants were assessed twice; the first assessment was done on the day participants were recruited. The second assessment was conducted a day before participants were discharged. These were face-to-face assessments which involved reading the questions to the participants and transcribing the answers for them. During both assessments the participants' pain and sleep characteristics were assessed using standard questionnaires.

Demographic information (Appendix A) (e.g. age, sex, ethnicity, employment status, marital status) was obtained from participants during the first interview. Details of the level, completeness and degree of injury and any medication or treatment participants were receiving were collected from the participant's hospital files at both first and second assessments.

In the second assessment, two additional questions were asked and the answers recorded and transcribed for analysis of content. The two questions were:

1. Do you foresee any fears in dealing with your disabilities outside the rehabilitation unit?
2. How do you intend to deal with any pain and sleep disturbances experienced outside the rehabilitation unit?

2.5. STUDY INSTRUMENTS:

Five pain assessment tools, two sleep assessment tools, and one psychological assessment were used in both assessments (Appendix B). Before the assessment, the content of each measure, and nature of the various rating scales were thoroughly explained to the participant. Any words and phrases the participant did not understand were explained to them.

2.5.1. Pain tools

The McGill Pain Questionnaire (MPQ). The MPQ was administered to measure the quality of pain and intensity of pain. The MPQ is a validated multidimensional clinical tool that assesses pain quality in three dimensions (sensory, affective and evaluative) based on 20 sets of words. Participants select one word from each set of words to describe their pain (Melzack, 1975). The MPQ is composed of 78 words, of which respondents choose those that best describe their experience of pain. Seven words are selected from the following categories: dimension 1 to 10 (sensory pain descriptors), three words; dimensions 11 to 15 (affective components of pain), dimension 16 (evaluation of pain) one word, and dimension 17 to 20 (miscellaneous) one word. Scores are tabulated by summing values associated with each word; scores range from 0 (no pain) to 78 (severe pain). Qualitative differences in pain may be reflected in respondent's word choice (Melzack, 1975).

Each word within the PRI has an assigned value based on its placement within the subclass. The PPI is a 5-point scale. *Score range.* Scores on the PRI can range from 0 to 20 words chosen (number of words chosen [NWC]), 0–78 for the total score based on rank value. Scores on the PPI can range from 0 to 5. The PPI (now) score is the present pain intensity at the time of the interview.

Interpretation of scores. The PRI is interpreted both in terms of quantity of pain as evidenced by the number of words used and the rank values of the words, as well as the quality of pain as evidenced by the particular words that selected. **Method of scoring:** The MPQ is scored by first counting the number of words used to obtain a total word score (number of words chosen). Then the rank values of the words chosen are summed to give a total PRI score and scores on each of the 4 subscales. The PPI is scored by noting the number-word combination chosen by the respondent.

. For the internal consistency reliability a Cronbach's alpha of $r > 0.75$ has been reported for the MPQ (Melzack, 1975).

Brief Pain Inventory Scale (BPI). The 12-item of the modified BPI for SC individuals, (Raichle *et al.*, 2006), was used to measure pain severity and the degree to which pain interfered with day-to-day activities during the previous week (the term "walking" was modified to "mobility"). All 12-items are rated using 11-point numerical rating scales, anchored 0= "no pain" or, "no interference" and 10 = "pain as bad as you can imagine" or, "completely interferes" This scale also assessed pain severity at its "worst", "least", "average", and "now" in the last week. It also measures how pain interferes with seven daily activities namely: general activity, mobility, work, mood, enjoyment of life, relations with others and sleep. The item "work" was removed in the scale in our study on recommendation of the University's Protocol Assessment Committee. Therefore the BPI pain interference scale was scored as the mean of the six instead of seven interference items in the scale. The BPI has been shown to have good

internal consistency, with Cronbach alpha values ranging from 0.80 to 0.87 for the pain severity items and from 0.90 for the pain interference items and it takes 5 -10 minutes to administer (Raichle *et al.*, 2006).

The Pain Catastrophizing Scale (PCS): is a 13-item scale established to find catastrophic thoughts, which patients experience in association to pain (Sullivan *et al.*, 1995). The scale entails participants to reflect on previous painful experiences, and to show the degree to which they experienced each of 13 thoughts when experiencing pain, on 5-point Likert scales with the end points 0 = “not at all”, and 4 = “all the time”. The PCS yields a total score and three subscale scores assessing rumination, magnification and helplessness. The PCS has been reported to have adequate to excellent internal consistency. The Cronbach alpha value reported for the PCS was 0.87 (Sullivan *et al.*, 1995). The PCS total score range is 0 to 52; scores >30 suggests that the patient is catastrophizing. The questionnaire takes about five minutes to administer.

Neuropathic Pain Scale (NPS): is a 10-item assessment that comprising, six pain qualities (sharp, dull, sensitive, hot, cold, and itchy pain), indicates the temporal nature of pain experience by the patient (provides information on the number of hours of spontaneous pain in the past 24 hours and the number of paroxysms during the past 24 hours), and asks whether the patient is experiencing deep or surface pain, scored on an 11-point numerical rating scale anchored at 0 = “sensation absent”,

and 10 = “most intense sensation imaginable”. In validation studies, it has been found to have a good predictive power in discriminating between subgroups of patients with neuropathic pain (e.g. multiple sclerosis). Cronbach's alpha was 0.78, implying a high degree of internal consistency (Galer and Jensen, 1997).

Pain Classification

Classification of pain in this study was based according to type and site of pain in relation to the level of the SCI and the verbal descriptors that the participants chose to describe the quality of pain that they were experiencing. There are two types of pain, nociceptive and neuropathic pain. The classification used in this study was that proposed by the International Association for the Study of Pain (Siddall *et al.*, 2000). Verbal descriptors that indicate nociceptive pain is “dull, tiring, cramping, aching, heavy”. Verbal descriptors commonly used to describe neuropathic pain include, “burning, sharp, hot, shooting, cold, pressure, squeezing, itching, electric shock, tingling”

2.5.2. SLEEP INSTRUMENTS

The Pittsburgh Insomnia Rating Scale (PIRS). Is a 65-item scale, comprising 3 broad sections. 1. The subjective distress score (46 items), measured in a 0-3 Likert scale (0 = not at all bothered, 1 = slightly bothered, 2 = moderately bothered, 3 severely bothered), scoring of this section is the summation of the answers obtained. 2. The subjective sleep

score parameter (10 items) answered on a 0-3 Likert scale with variable answers depending on the question, scoring of this section is the summation of the answers. 3. The quality of life (9 items), also answered in a 0-3 Likert scale (0 = excellent, 1 = good, 2 = fair, 3 = poor), scoring of this section is the summation of the answers. The final score is the grand total of all the three components. Minimum score is 0 (good) and maximum is 195 (bad). It takes ~20 minutes to complete.

The scale has a 10 cm line to mark the quality of sleep in the past week and an area for general comments; these items in the scale are not included in the scoring.

This scale is still under development, preliminary data was published in an abstract, which showed the PIRS to have good test-retest reliability as a measure of insomnia severity in the past week (Moul *et al.*, 2002).

The International Restless Leg Syndrome Study Group (IRLSSG) Severity Questionnaire. Patients had to meet IRLSSG criteria for the diagnosis of Restless Legs Syndrome and the following questions were asked to confirm a diagnosis. Any patient that answered 'Yes' to all four questions was then asked to complete the IRLSSG severity questionnaire (Walters, 1995; Allen *et al.*, 2003):

1. Do you have an urge to move your legs usually accompanied or caused by uncomfortable and unpleasant sensation in the legs?

2. Does the urge to move or unpleasant sensation begin or worsen during periods of rest or inactivity such as lying or sitting?
3. Is the urge to move or unpleasant sensation partially or totally relieved by movement, such as walking or stretching?
4. Is the urge to move or unpleasant sensation worse in the evening or night than during the day?

The IRLSSG questionnaire is a scale that contains 10 questions administered to determine the severity of RLS. The scale measures two domains: sensory quality (symptoms) of RLS, and the intensity and frequency of RLS. The IRLSSG total score, symptoms and symptoms impact subscales have been reported to have acceptable, internal consistency (0.80) and reliability (0.76). (Very severe=31-40 points, Severe=21-30 points, Moderate=11-20 points, Mild=1-10 points, none=0 points). It takes 5 -10 minutes to administer

MOOD

Centre for Epidemiological Studies-Depression Scale (CES-D). Is a 20-item scale produced to determine symptoms of depression in the general population, scoring occurs on a 0-3 Likert scale, 0 = “Rarely or none of the time (less than 1 day)” to, 3 = “All of the time (5-7 days)” according to how frequently the individual experienced certain feelings (e.g. depression and hopefulness) during the past week. The scores on items 4, 8, 12 and 16 are negatively poled so that evaluation is reversed when adding these items to the total (e.g. “0 counts for 3”, “2 counts as 1”). Otherwise, evaluation is done by simple addition of the answers

selected. The CES-D total score range is 0-60 where a score of 16 or greater is used as a cut-off to classify the participant as having “depressive symptoms”. The CESD has adequate internal consistency at all measurement points (Cronbach $\alpha > 0.70$) (Radloff and Teri, 1986). It takes 5 -10 minutes to administer

2.6. Data Analysis

- The data analyses of this study are based on both quantitative and qualitative data analysis. The quantitative analysis was performed using SAS software, version 9.3, for Microsoft Windows, Cary, NC, USA: SAS Institute Inc. (2002-2010).
- Descriptive statistics are reported as means (standard deviation) or median (interquartile range) for parametric and non-parametric data, respectively. Frequency data are reported as the number of participants affected by categorical data (percentage).
- Since the data was not normally distributed and due to the small sample non-parametric tests were used:
 1. Wilcoxon Signed Rank sum test was used to test for differences in changes of pain, sleep disturbances and mood between the two interviews
 2. Spearman’s Rank correlation was used to assess the relationship between pain, RLS and sleep variables.
 3. Data are depicted graphically as bar graphs (e.g., frequency data) or box-and-whisker plots. In all cases, box-and-whisker plots, the lower and upper edges of the box indicate the inter-quartile range (IQR), which

is the range of values between the 25th and 75th percentiles. The mean value is specified by the marker found inside the box. The median value is shown by the line inside the box. The whiskers that extend from each box indicate the range of values that are outside of the IQR. However, the values are close enough to be considered outliers (a distance \leq to 1.5 IQR).

- In the qualitative analysis the answers to the questions in interview 2 that were recorded were analysed for content. This served to represent the thoughts and fears that the participant is actually feeling about coping with their injury at home. Representative quotes were selected to indicate the content themes.

CHAPTER 3

RESULTS

3.1. DEMOGRAPHIC DETAILS

The demographic characteristics of the cohort are summarized in Table 3.1. There were 17 participants and the mean (SD) age was 36(10) years. The majority of the participants were Black males and were employed at the time of their injury.

3.2. INJURY CHARACTERISTICS

The injury characteristics of the cohort are summarised in Table 3.2. Most of the injuries occurred at the thoracic level, and most of the participants in the study were incomplete paraplegics. The cause of injury was trauma in all cases, with motor vehicle accidents accounting for the majority cause of SCI, followed by falls and gunshot wounds.

Table 3.1: Demographic characteristics of the 17 patients with acute SCI

| | N (%) |
|--------------------------|--------------|
| Sex | |
| Male | 14 (82) |
| Female | 3 (18) |
| Ethnicity | |
| Black | 12 (71) |
| White | 3 (18) |
| Indian | 2 (11) |
| Employment status | |
| Employed | 14 (82) |
| Unemployed | 2 (12) |
| Scholar | 1 (6) |

Table 3.2: Injury characteristics reported by participants with regards to: completeness, level and cause of spinal cord injury.

| Variable | N (%) |
|-------------------------------|--------------|
| Completeness of injury | |
| Incomplete paraplegic | 9 (53) |
| Complete quadriplegic | 5 (29) |
| Complete paraplegic | 3 (18) |
| Level of Injury | |
| Thoracic | 9 (53) |
| Cervical | 6 (35) |
| Lumbar | 2 (12) |
| Aetiology | |
| Motor vehicle accident | 10 (59) |
| Fall | 4 (24) |
| Gunshot wound | 3 (18) |

3.3. ASSESSMENT 1

The mean (SD) time between spinal cord injury and the first interview was 12 (3.0) weeks.

3.3.1. Pain

Fifteen participants reported pain due to their injuries at the time of the interview two participants were not experiencing pain due to medication taken prior to assessment 1, otherwise, they did experience pain.

3.3.2. Sites of pain

The distribution of pain at different body sites is illustrated in figure 3.1. Participants indicated having one to two pain sites. Pain was most frequently indicated in the legs region. Other frequently marked areas

were the neck/shoulder area and the back area. The least frequently marked area was the abdominal region.

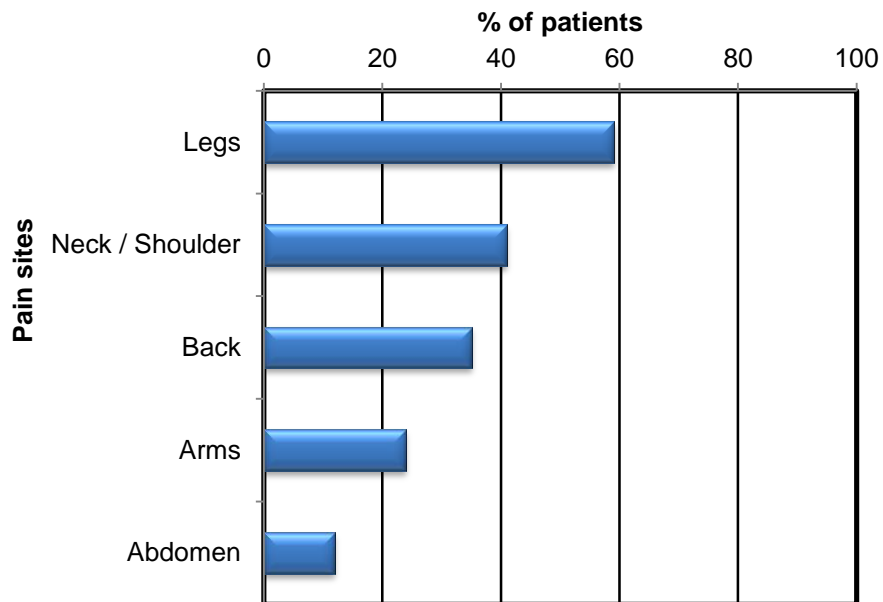


Figure 3.1.: Pain sites as reflected in the body charts. Total percentage was greater than 100% as patients could indicate multiple pain sites.

3.3.3. Pain classification

Each separate pain identified by participants was classified based on its location relative to the neurological level of injury and verbal descriptors chosen. Pain that was reported by the participants was divided, into nociceptive and neuropathic pain. Four (33%) participants indicated only nociceptive pain, 7 participants (41%) indicated only neuropathic pain, and 6 (35%) participants indicated both nociceptive and neuropathic pain.

The nociceptive pain was then classified into musculoskeletal pain and visceral pain. 3 participants had only musculoskeletal pain and 1 participant had only visceral pain.

Participants showing signs of only neuropathic pain were further classified into below- level neuropathic pain (n=6) and at level neuropathic pain (n=1).

Participants presenting with both nociceptive pain and neuropathic pain (n=3) were further classified into experiencing either musculoskeletal pain and below-level neuropathic pain.

3.3.4. Pain intensity

This result is based from the pain severity section from the Brief Pain Inventory Interference scale. On average, participants experienced moderate pain (4-6 on 11-point NRS), but at its worst the pain was severe (7-10, on 11-point NRS) (Figure 3.2).

3.3.5. Pain quality

Participants chose pain descriptors from the McGill Pain Questionnaire (Figure 3.3) to describe the quality of pain they were experiencing. The descriptors most commonly chosen were sharp, tight, hot, shooting, and throbbing, which were all chosen by more than 50% of the participants. Other quantitative data analysed in the MPQ included, Number of words chosen (NWC), Present Rating Index(PRI), Present pain intensity (PPI) and PPI (now) presented as mean (SD), NWC=12.41(4.37); PRI (total) = 30(7.6); PPI= 15.4(3.4) and PPI (now) = 3.2(1.5)., suggesting that the

participants pain at the time of interview was scored 3 on average on the 0-5 Likert scale. The score for the NWC indicates that the pain intensity experienced by the participants to be moderate.

3.3.6. Pain interference

The pain experienced by participants had a detrimental effect on activities of daily living. On average, participants reported moderate pain interference (4-6, 11-point NRS), with sleep, enjoyment of life, mobility and general activity been the most affected by pain. Participants rated “relationship with other people” as the least affected activity of daily living (Figure 3.4.).

3.3.7. Neuropathic Pain

Six pain qualities were measured (sharp, hot, dull, cold, sensitive and itchy pain), represented in figure 3.5. In this cohort participants experienced severe pain (7-10 on 11-point NRS). With regards to sharp, hot, dull and sensitive pain, participants were experiencing moderate pain (4-6 on 11-point NRS). Two participants indicated a score of 9 for itchy pain on the 11-point NRS, the rest of the cohort experienced no itchy pain. Three participants indicated cold pain on the (1-3 on 11-point NRS), suggesting mild pain.

The results regarding the temporal nature of pain reported by the participants were as follows, 65% described having a single type of pain

all the time, whereas, 35% described having a single type of pain only sometimes, other times, pain free.

The overall unpleasantness of pain reported by this cohort was 7.4(1.11) which may suggest the most unpleasant sensation imaginable (7-10 on 11-point NRS). The participants experienced a combination of deep 6.5 (1.8) and surface pain 4(1.32) and the results suggests that the participants were experiencing moderate pain with respect to deep and surface pain respectively (4-6 on 11-point NRS).

3.3.8. Pain Catastrophizing

The scores for each subscale and the total are indicated in figure 3.6. The data reported on the PCS from this cohort of patients may suggest that pain catastrophizing had no effect on SCI pain due to the participants obtaining scores below the cut off scores for the PCS scale. Furthermore the subscales of the PCS, “rumination and helplessness” also obtained scores below the cut off scores exception to this is for the subscale for “magnification” (I worry that something serious may happen). This may suggest that these cohorts of patients are still worrying that something else may occur.

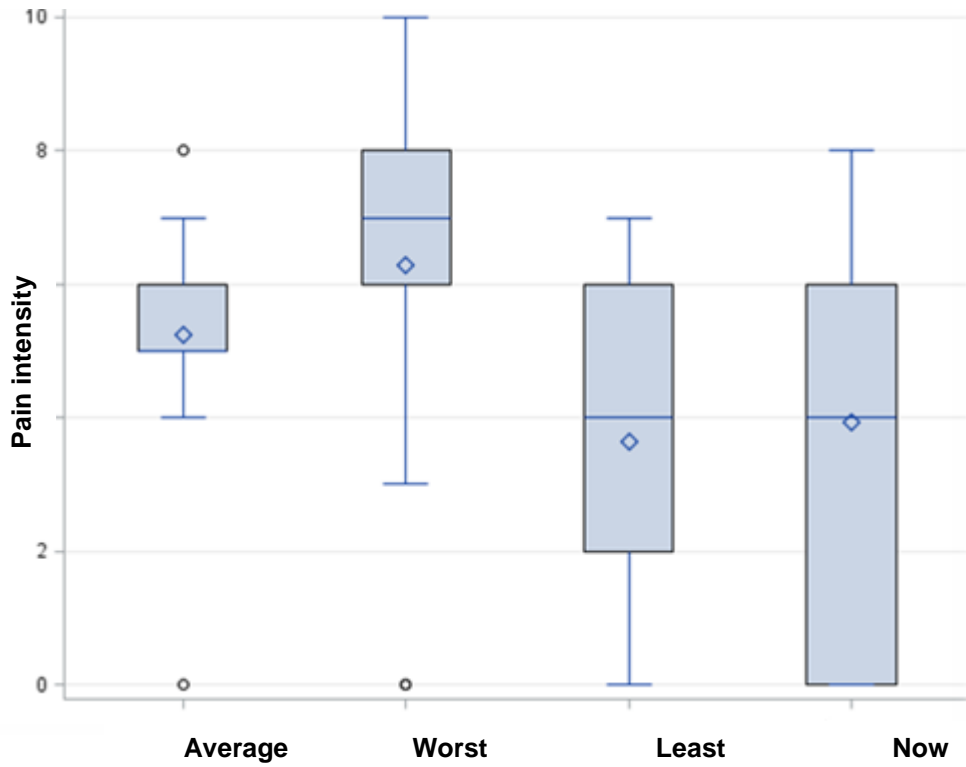
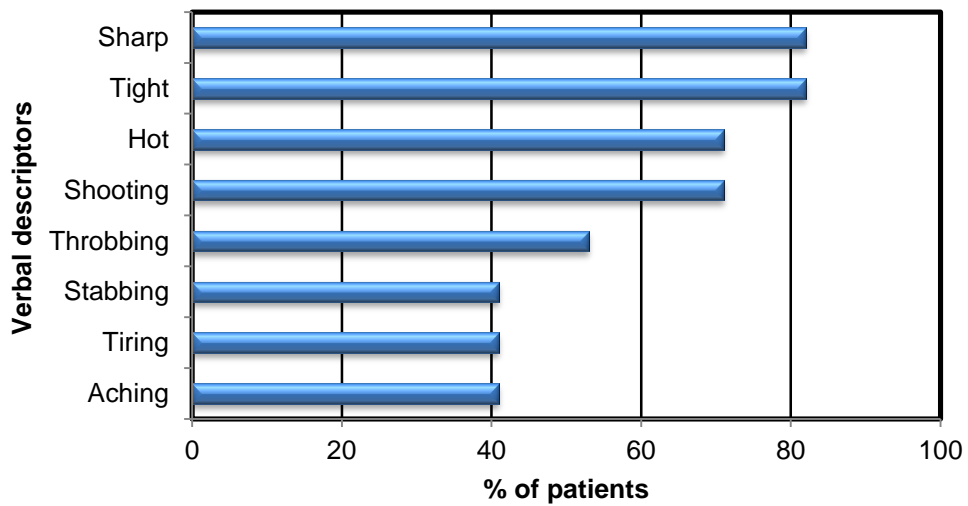


Figure 3.2.: Pain intensity at the time of the interview on an 11-point Likert scale, and on average, at its least and at its worst in the past week.



- **Figure 3.3.:** The verbal descriptors patients chose from McGill Pain Questionnaire to describe their quality of pain. 50% of the participants selected these verbal descriptors

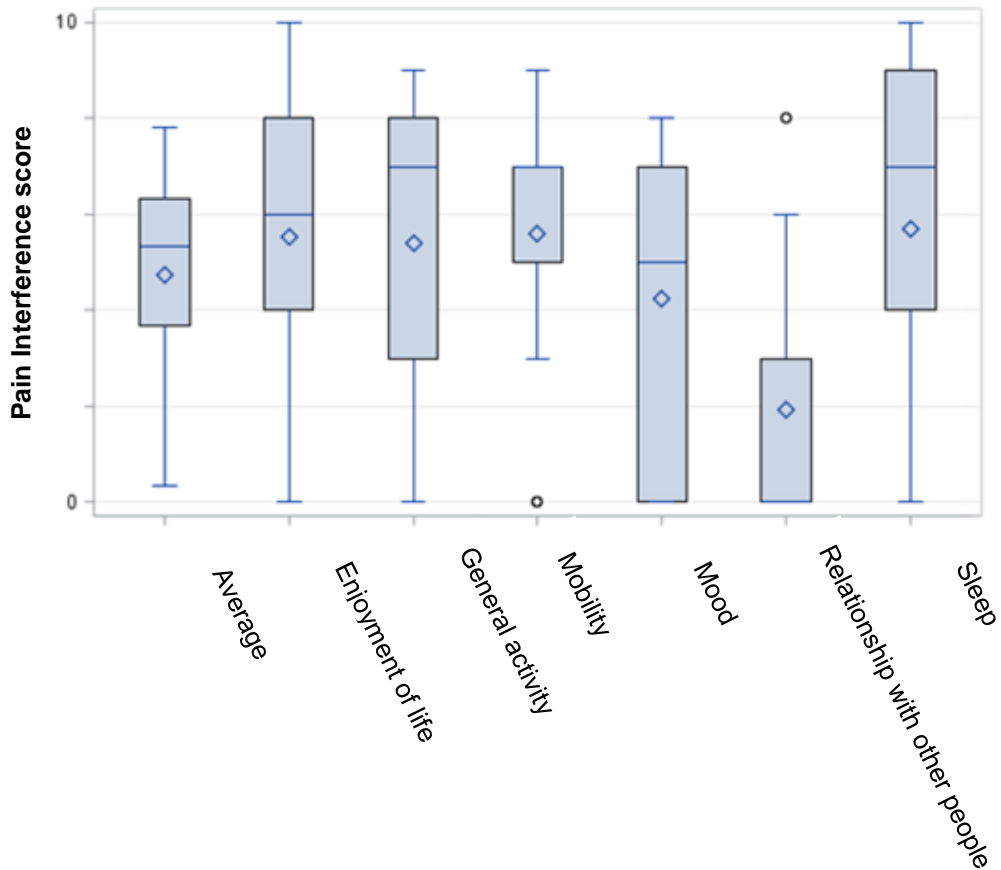


Figure 3.4.: Box and whisker plots of pain interference scores for individual items and the average score across all six items. Pain interference score measured on 11-point NRS from BPI

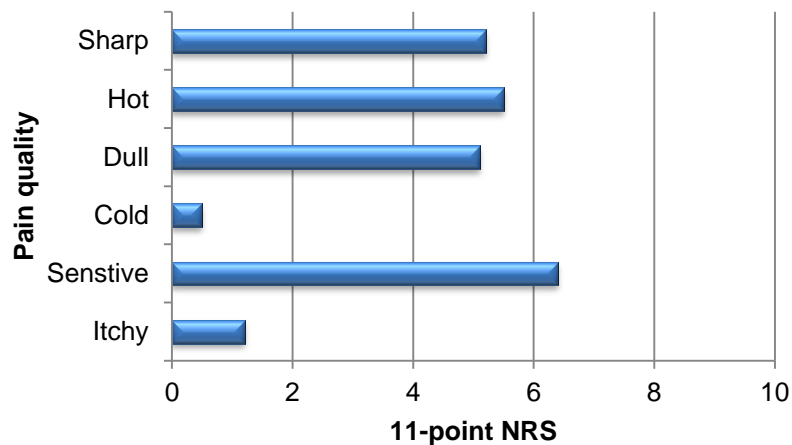


Figure 3.5.: Pain intensity on an 11-point NRS to measure six pain qualities on the NPS

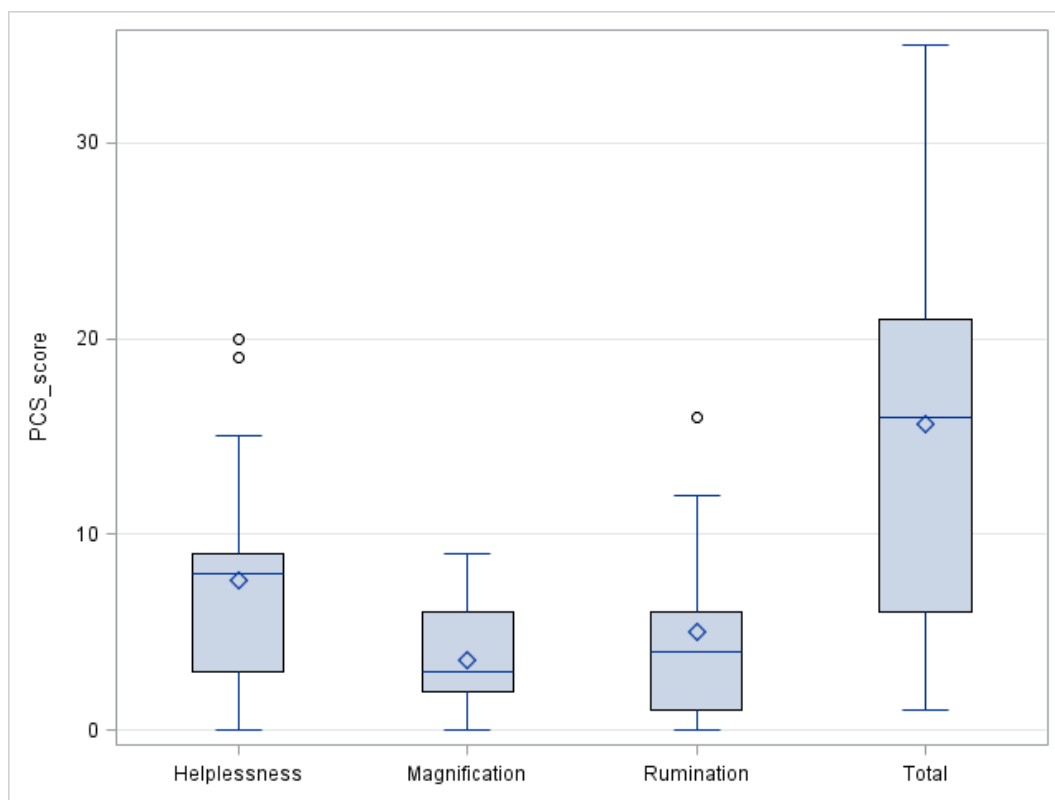


Figure 3.6: Box and whisker plots of pain catastrophizing subscales and total score.

3.3.9. Medication the participants received in the study for pain

The participants in this study received various pain medication to alleviate neuropathic and nociceptive types of pain from opioids, analgesics, antiepileptic and others (Table 3.3)

Table 3.3: Pain medication treatment of the respondents

| Opioids | Anti-epileptics | Analgesics | Others |
|-------------------|------------------|------------------|-----------------------|
| Morphine(n=1) | Gabapentin (n=7) | Paracetamol(n=3) | Baclofen (n=6) |
| Hydrocodone (n=1) | | | Cyclobenzaprine (n=1) |
| Tramadol (n= 11) | | | Ibuprofen (n=2) |
| | | | Cataflam (n=6) |

3.4. SLEEP AND RESTLESS LEG SYNDROME

3.4.1. PIRS scale

The PIRS (Total) were reported to have a median and range of 41(27-58). Overall in this cohort the PIRS (Total) suggests that this cohort did not appear to experience insomnia in the last 7 days. The subscales for PIRS are represented in figure 3.7. The PIRS subscale scores were low in comparison to the PIRS scale. The scores obtained for the distress parameter were particularly low, in keeping with the fact that their sleep subscale reflected low sleep disruption; their distress from sleep disturbances was also low. The sleep parameters subscale (Figure 3.7) suggests that this cohort were mild insomniacs and the quality of life scores obtained were also moderate in this group. Table 3.4 represent the sleep parameter questions in the Pittsburgh Insomnia Rating Scale and the scoring that were reported on a 0-3 Likert scale respectively.

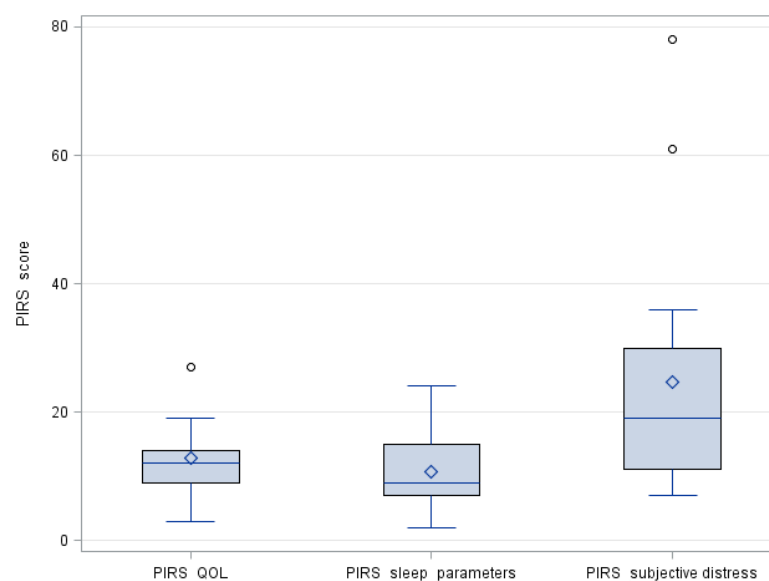


Figure 3.7.: Box and whisker plots of descriptive information of sleep according to PIRS subscales.

Table 3.4.: Descriptive analysis of the sleep parameter subscale questions (Admission)

| | |
|---|-----------|
| 47. From the time you tried to go to sleep. How long did it take to fall asleep on the worst night | |
| 0 less than ½ hr | 1 (5.88) |
| 1 between ½ to 1 hr | 4 (23.53) |
| 2 between 1 to 3 hrs | 8 (47.16) |
| 3. more than 3 hrs or I didn't sleep | 5 (29.41) |
| 48. From the time you tried to go to sleep, how long did it take to fall asleep on the most nights? | |
| 0 less than ½ hr | 7 (41.18) |
| 1 between ½ to 1 hr | 6 (35.29) |
| 2 between 1 to 3 hrs | 4 (23.53) |
| 3. more than 3 hrs or I didn't sleep | |
| 49. If you woke up during the night, how long did it take to fall back to sleep on the worst night? | |
| 0 less than ½ hr | 4 (23.53) |
| 1 between ½ to 1 hr | 2 (11.76) |
| 2 between 1 to 3 hrs | 6(35.29) |
| 3. more than 3 hrs or I didn't sleep | 5 (29.41) |
| 50. If you woke up during the night, how long did it take to fall back to sleep on most nights? | |
| 0 less than ½ hr | 9 (52.94) |
| 1 between ½ to 1 hr | 4 (23.53) |
| 2 between 1 to 3 hrs | 4 (23.53) |
| 3. more than 3 hrs or I didn't sleep | |
| 51. Not counting times when you were awake in bed, how many hours of actual sleep did you get during the <u>worst</u> night? | |
| 0 more than 7 hrs | 1 (5.88) |
| 1 between 4 to 7 hrs | 6 (35.29) |
| 2. between 2 to 4 hrs | 8 (47.16) |

| | |
|--|------------|
| 3. Less than 2hrs or I didn't sleep | 2(11.76) |
| 52. Not counting times when you were awake in bed, how many hours of actual sleep did you get during most nights? | |
| 0 more than 7 hrs | 6 (35.29) |
| 1 between 4 to 7 hrs | 10 (58.82) |
| 2. between 2 to 4 hrs | 1 (5.88) |
| 3. Less than 2hrs or I didn't sleep | |
| 53. On how many nights did it take longer than 30 minutes to fall to sleep? | |
| 0. None or 1 night | 6 (35.29) |
| 1 on 2 or 3 nights | 5 (29.41) |
| 2 on 4 or 5 nights | 2 (11.76) |
| 3. on 6 or all nights | 4 (23.53) |
| 54. On how many nights did you wake up and have trouble falling back to sleep? | |
| 0. None or 1 night | 7 (41.18) |
| 1 on 2 or 3 nights | 4 (23.53) |
| 2 on 4 or 5 nights | 1(5.88) |
| 3. on 6 or all nights | 5 (29.41) |
| 55. On how many mornings did you wake up not fully rested? | |
| 0. None or 1 mornings | 7 (41.18) |
| 1 on 2 or 3mornings | 6 (35.29) |
| 2 on 4 or 5 mornings | 1 (5.88) |
| 3. on 6 or all mornings | 3 (17.64) |
| 56. On how many days did you have trouble coping because of poor sleep? | |
| 0 none or 1 day | 11 (64.71) |
| 1 On 2 or 3 days | 5 (29.41) |
| 2 on 4 or 5 days | 1(5.88) |
| 3 on 6 or all days | |

Regarding initiation of sleep (falling to sleep), during most nights the participants reported good sleep, however, sleep deteriorated during the worst night to moderate and poor sleep. Falling back to sleep once awoken in the night was reported to be good and moderate with 29.41% reporting poor sleep during the worst night. With respect to the actual sleep, the participants reported good sleep during most and worst nights and poor sleep was also reported in both most and worst nights in this category. Good and poor sleep was reported for participants falling to sleep greater than 30 minutes during the night (Question 53, Table 3.4c). Good sleep was described by participants that woke up during the night, they reported no trouble to falling back to sleep. Majority (76.47%) of the participants reported been rested when they woke-up in the morning, however, there were a few participants (17.65%) that indicated that they were not fully rested in the morning once awake (Table 3.4). Additionally, moderate and poor sleep did not result in the inability for the participant to cope with daily activities; furthermore, majority of the participants in this category reported good sleep.

Participants also commented that environmental factors such lights, noise, being woken up too early in the morning by nursing staff and during the night to check blood pressure, bowel and bladder activity also caused disturbance in their sleep. Furthermore, four of the patients were on hypnotics with two patient's receiving Zopiclone and two patients' receiving Zolpidem which, may also account for the insomnia severity.

3.4.2. Restless leg syndrome

All 4 participants (24%) answered yes to the 4 questions on RLS, which suggests that they have this condition and therefore I gave them the IRLSSG scale to fill in. Three (18%) patients reported moderate RLS and 1(6%) patient reported having severe RLS.

3.5. Mood. Most (76.5%) participants according to the data obtained from CESD Scale scores indicated signs of depression. The rest of the participants scored below the threshold for depression (obtaining a CES-D score ≤ 16). Most participants (64%) were being prescribed medication for depression such as [Amitriptyline (n=7)], [Duloxetine (n=1)], [Citalopram (n=2)].

3.6. Associations between pain intensity, pain interference, sleep, psychological measures.

The table below (Table 3.5.) shows the correlations between the measures of pain, sleep and mood. A moderate positive relationship could be observed between pain interference and pain intensity, higher pain interference was associated with higher pain intensity. PIRS sleep correlated well with all pain scales, a moderate positive relationship could be observed. Increased depression as measured by the CESD correlated positively with pain interference and intensity and sleep scales. Pain and sleep did not correlate with all pain measures (example the NPS).

Table 3.5.: Correlation matrix between pain, sleep, and mood. The correlation coefficients are on the top row in each block with the p-value underneath

| | Pain intensity | Pain interference | PCS | PIRS sleep | CESD |
|-------------------|-----------------------|--------------------------|-------------------|-------------------|-----------------|
| Pain interference | 0.67 (0.003) | | | | |
| PCS | 0.60 (0.011) | 0.64 (0.049) | | | |
| PIRS(T) | 0.59 (0.013) | 0.52 (0.034) | 0.89 (<0.0001) | 0.82 (<0.0001) | 0.52 (0.034) |
| PIRS sleep | 0.69 (0.002) | 0.68 (0.034) | 0.81 (<0.0001) | | |
| CESD | 0.53 (0.0287) | 0.5 (0.041) | 0.41 (0.81) | 0.48 (0.050) | |

3.7. SECOND ASSESSMENT

The mean (SD) time between assessment 1 and assessment 2 was 8 (2.4) weeks. At assessment 2 there were only 14 participants, 3 withdrew from the study following early discharge from the hospital.

3.7.1. Pain

Eighty-six percent (12) of the participants reported experiencing pain at this assessment. Two respondents were pain free without the need for analgesic medication.

3.7.2. Pain sites

The distribution of pain by body area is indicated in figure 3.8. There were no significant differences found in the proportion of patients experiencing any pain or pain in a particular location between the two interviews (Table 3.6).

Table 3.6: Wilcoxon signed-rank test to test for differences between assessment 1 and 2 regarding pain location

| Pain Location | p-value for differences between the two interviews |
|-----------------|--|
| Any pain | 0.50 |
| Lower Limb | 1.00 |
| Neck / Shoulder | 0.25 |
| Back | 0.73 |
| Upper Limb | 1.00 |
| Abdomen | 1.00 |

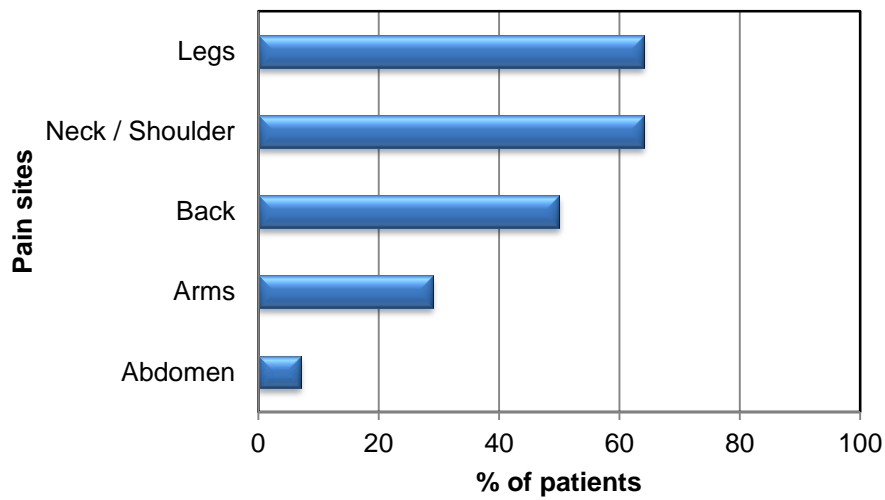


Figure 3.8: Pain sites as reflected in the body charts (n=14). Total percentage was greater than 100% as patients could indicate multiple sites.

3.7.3. Pain classification

At this assessment, 2 participants were pain free, 4 participants were classified with below-level neuropathic pain and, 8 participants presented with both nociceptive and neuropathic pain. This was then further classified into 1 participant presenting with visceral pain and at-level neuropathic pain; 1 participant had musculoskeletal pain and at-level neuropathic pain; 6 participants were classified into musculoskeletal and below-level neuropathic pain.

3.7.4. Pain intensity

Pain intensity is indicated in figure 3.9. The result is based from the pain severity section from the BPI. Participants, on average experienced moderate pain (4-6 on the 11-point NRS). The pain at the time of the interview and at its worst, participant's pain was severe (7-10) on an 11-point NRS). The pain at its least in the past week was moderate pain (4-6 on the 11-point NRS).

3.7.5. Pain quality

During this assessment, the words commonly selected by the participants to describe their quality of pain can be seen in figure 3.10. In comparison to assessment1 "tight" was the word most commonly chosen to describe the participants quality of pain, with "hot" been the least common word chosen. The NWC= 10.07(5.31); PRI (total) =22.4, PPI (total) = 16.6(2.5), PPI (now) = 3.1(1.6), represented as the mean (SD) respectively.

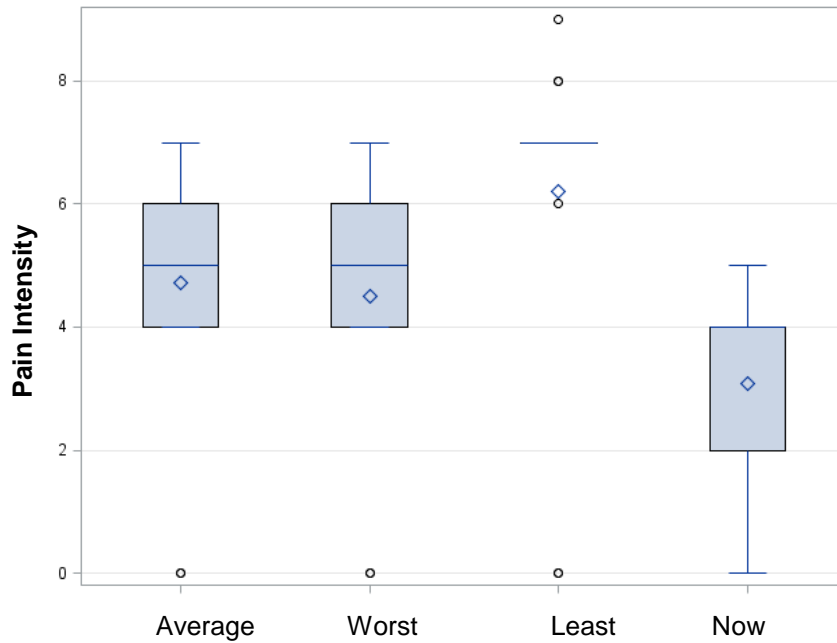


Figure 3.9.: Intensity of pain at its worst, least and average in the past week, and pain at the time of the interview. Outliers account for the patients that were pain free at the time of the assessment (n=14). The box whisker plot at worst has the median and IQR all at 7 therefore it appears as a squashed box.

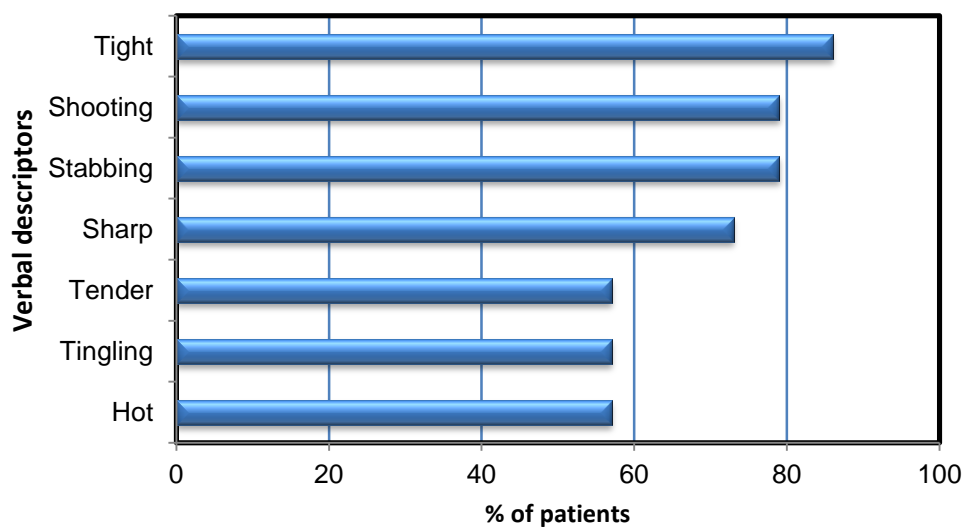


Figure 3.10: Verbal descriptors the patients chose from MPQ to describe their quality of pain.

3.7.6. Pain interference

The mean pain interference was greatest in sleep as in assessment 1, followed by enjoyment of life, mobility, mood and general activity (Table 3.11). On average, participants reported moderate pain interference (4-6, 11-point NRS).

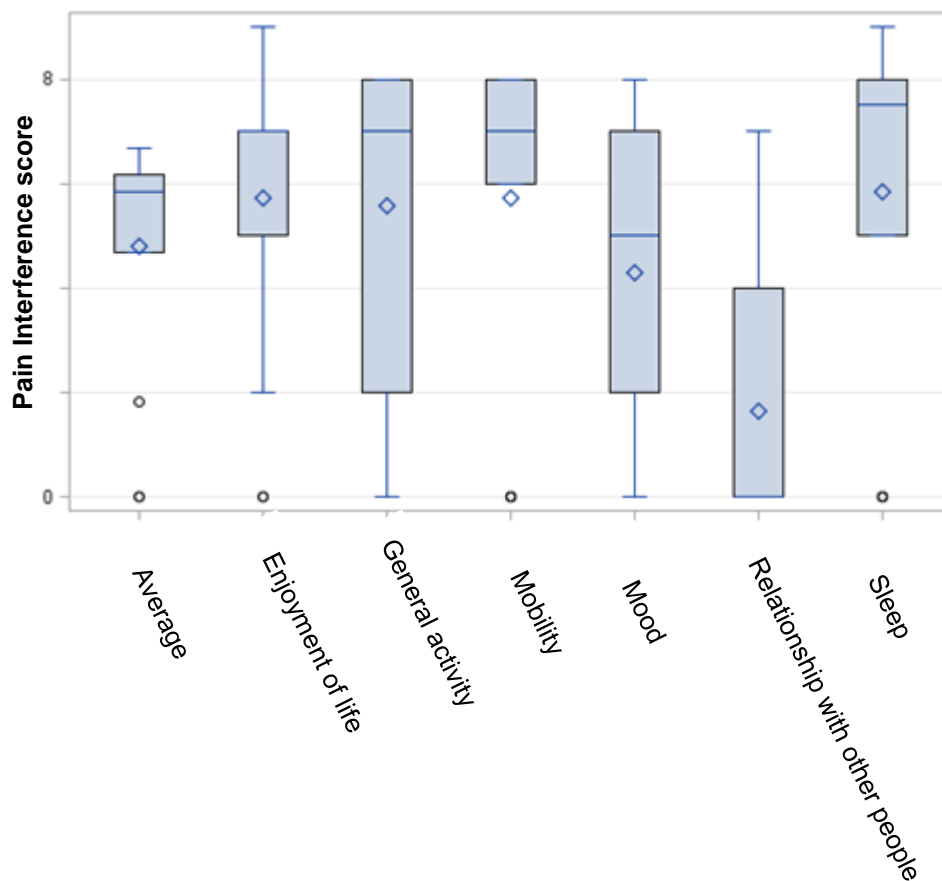


Figure 3.11.: Box and whisker plots of pain interference scores for individual items and the average score across all six items on an 11-likert scale

3.7.7. NEUROPATHIC PAIN

At this assessment participants experienced moderate pain (4-6 on 11-point NRS). With regards to sharp, hot, dull and sensitive pain, participants

were experiencing moderate pain (4-6 on 11-point NRS). No participant reported itchy or cold pain during this assessment.

The results regarding the temporal nature of pain reported by the participants were as follows, 65% described having a single type of pain all the time, whereas 21% described having a single type of pain only sometimes, other times, pain free. Two participants reported experiencing no pain in the last 7 days.

The overall unpleasantness of pain, deep and surface pain was reported by Mean (SD) in this cohort 6.5(2.82), 5.7 (2.58), 3.4(1.8), respectively.

The results may suggest moderate neuropathic pain.

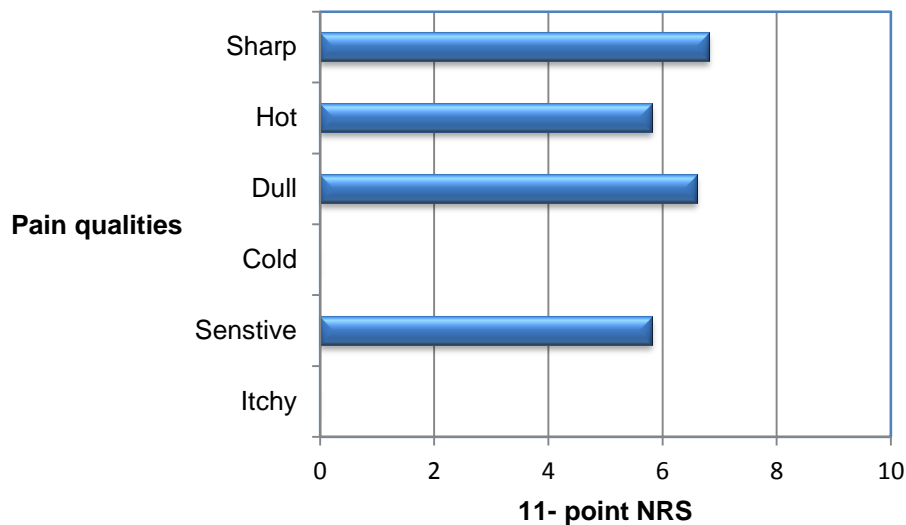


Figure 3.12.: Pain intensity on an 11-point NRS to measure six pain qualities on the NPS

3.7.8. Pain catastrophizing

The PCS (Total) was reported to be below the cut off score (≥ 30); however, two of the PCS subscores were within the cut off scores respectively, for magnification and helplessness has portrayed in figure 3.13.

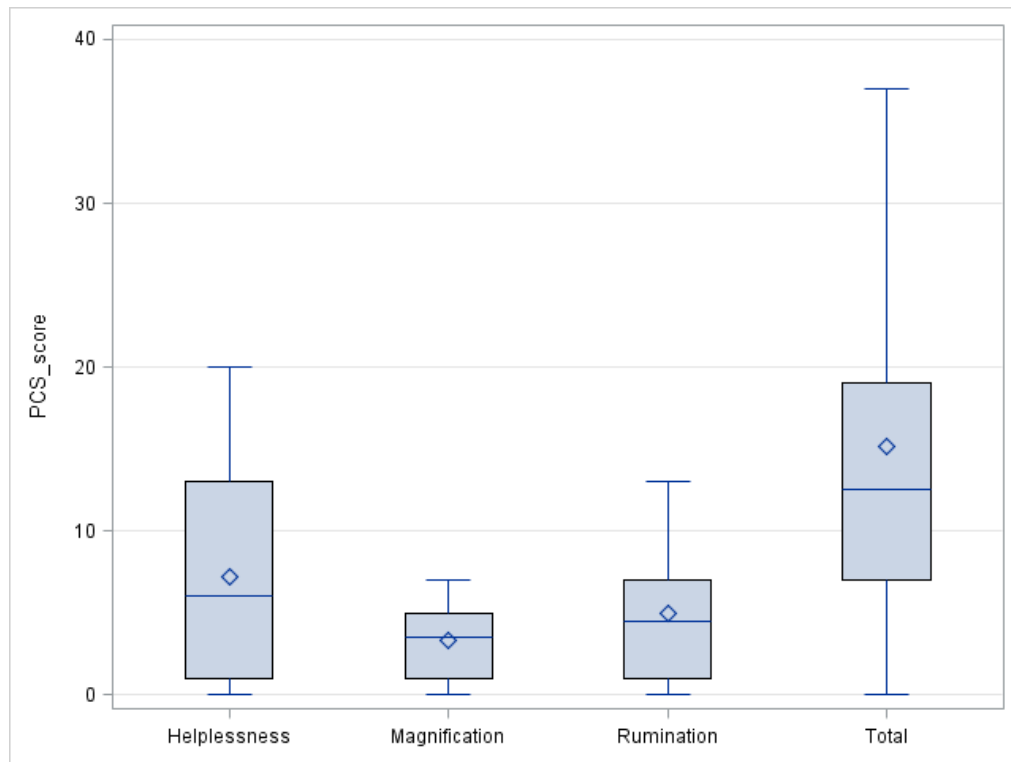


Figure 3.13.: Box and whisker plots of pain catastrophizing subscales and total score during assessment 2.

3.8. SLEEP

3.8.1. Sleep disturbances

The PIRS (Total) were reported to have a median and range of 46(39-66). Overall in this cohort the PIRS (Total), in keeping with the fact that their sleep subscale reflected low sleep disruption, their distress from sleep disturbances was also low. The subscales for PIRS are represented in

figure 3.14. The PIRS subscale scores were low in comparison to the PIRS scale. The scores obtained for the distress parameter were particularly low suggesting that insomnia had no effect on distress. The sleep parameters subscale (Table 3.7) suggests that this cohort were mild insomniacs and the quality of life scores obtained were also moderate in this group was 13.5 (11 - 18), suggesting that sleep did not affect quality of life scores in this cohort.

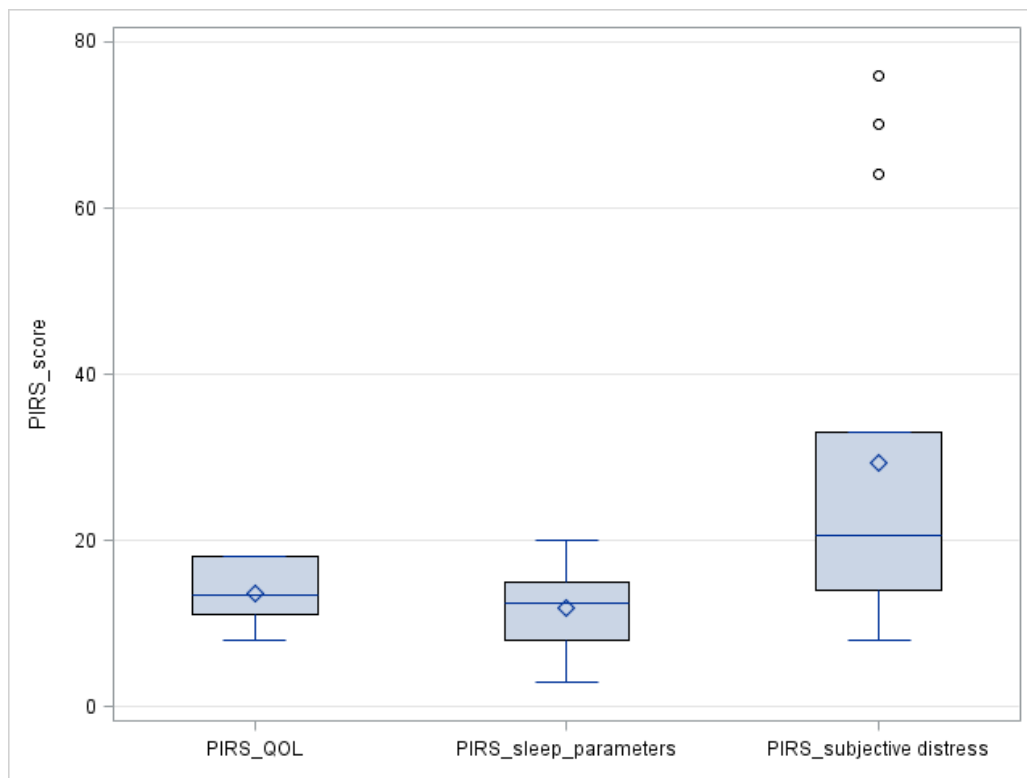


Figure 3.14.: Box and whisker plots of descriptive information of sleep according to PIRS subscales.

Table 3.7.: Descriptive analysis of the sleep parameter subscale questions from the PIRS questionnaire

| PIRS SLEEP PARAMETER QUESTIONS | EXIT (%) |
|--|------------|
| 47. From the time you tried to go to sleep, how long did it take to fall asleep on the worst night | |
| 0 less than ½ hr | 1 (7.14) |
| 1 between ½ to 1 hr | 2 (14.23) |
| 2 between 1 to 3 hrs | 10 (71.43) |
| 3. more than 3 hrs or I didn't sleep | 1 (7.14) |
| 48. From the time you tried to go to sleep, how long did it take to fall asleep on the most nights? | |
| 0 less than ½ hr | 4 (28.57) |
| 1 between ½ to 1 hr | 8 (57.14) |
| 2 between 1 to 3 hrs | 2 (14.23) |
| 3. more than 3 hrs or I didn't sleep | |
| 49. If you woke up during the night, how long did it take to fall back to sleep on the worst night? | |
| 0 less than ½ hr | 2 (14.23) |
| 1 between ½ to 1 hr | 3 (21.43) |
| 2 between 1 to 3 hrs | 6 (42.88) |
| 3. more than 3 hrs or I didn't sleep | 3 (21.42) |
| 50. If you woke up during the night, how long did it take to fall back to sleep on most nights? | |
| 0 less than ½ hr | 6 (42.88) |
| 1 between ½ to 1 hr | 6 (42.88) |
| 2 between 1 to 3 hrs | 2 (14.23) |
| 3. more than 3 hrs or I didn't sleep | |
| 51. Not counting times when you were awake in bed, how many hours of actual sleep did you get during the worst night? | |
| 0 more than 7 hrs | |
| 1 between 4 to 7 hrs | 4 (28.57) |

| | |
|--|-----------|
| 2. between 2 to 4 hrs | 8 (57.14) |
| 3. Less than 2hrs or I didn't sleep | 2 (14.23) |
| 52. Not counting times when you were awake in bed, how many hours of actual sleep did you get during most nights? | |
| 0 more than 7 hrs | 4 (28.57) |
| 1 between 4 to 7 hrs | 8 (57.14) |
| 2. between 2 to 4 hrs | 1 (7.14) |
| 3. Less than 2hrs or I didn't sleep | 1 (7.14) |
| 53. On how many nights did it take longer than 30 minutes to fall to sleep? | |
| 0. None or 1 night | 2 (14.23) |
| 1 on 2 or 3 nights | 7 (50) |
| 2 on 4 or 5 nights | 2 (14.23) |
| 3. on 6 or all nights | 3 (21.42) |
| 54. On how many nights did you wake up and have trouble falling back to sleep? | |
| 0. None or 1 night | 3 (21.42) |
| 1 on 2 or 3 nights | 7 (50) |
| 2 on 4 or 5 nights | 1 (7.14) |
| 3. on 6 or all nights | 3 (21.42) |
| 55. On how many mornings did you wake up not fully rested? | |
| 0. None or 1 mornings | 6 (42.88) |
| 1 on 2 or 3mornings | 5 (35.71) |
| 2 on 4 or 5 mornings | 2 (14.23) |
| 3. on 6 or all mornings | 1 (7.14) |
| 56. On how many days did you have trouble coping because of poor sleep? | |
| 0 none or 1 day | 7 (50) |
| 1 On 2 or 3 days | 6 (42.88) |
| 2 on 4 or 5 days | 1 (7.14) |
| 3 on 6 or all days | |

Most of the participants during assessment 2 were regarded as mild insomniacs. With regards to falling asleep on the worst night, 71.43% of the participants took between 1-3 hours to fall asleep and ½ to 1hr (57.14%) to fall asleep in most nights.

With reference to falling back to sleep on the worst and most nights, participants took 1-3 hours (42.88%) and 0-1 hour (85.76%) to fall back to sleep, respectively.

The amount of actual sleep participants got on the worst and most nights were good to moderate sleep, with 57.14% reporting 2 to 4 hours of actual sleep and 57.14% of the participants reporting 4-7 hours of sleep, respectively.

It was also reported that 50% of the participants took longer than 30 minutes to fall asleep on 2 to 3 nights. Furthermore, 50% of the participants reported having trouble falling back to sleep on 2 to 3 nights. However, the participants reported to be rested when awoken in the mornings which is contradictory to the questionnaire.

3.8.2. RLS

During assessment 1 three participants reported moderate RLS this is in contrast to assessment 2, where one participant reported mild RLS and similar to assessment 1, one participant reported severe RLS.

3.9. MOOD

Ten (71%) participants reported depressive symptoms. The rest of the participants scored below the threshold for depression (n=4).

3.10. Change in measures of pain, sleep, RLS, depression and quality of life between admission and discharge

The results are tabulated below (table 3.9). The results show that there was no significant change in the median score on any of the scales between the admission and exit assessments.

Table 3.8.: Wilcoxon signed-rank sum test to test for change in measures between assessment 1 and assessment 2

| Variable | P-value for Wilcoxon Signed Rank Sum Test |
|--------------------------|---|
| Pain Intensity | 0.7 |
| Pain interference | 0.29 |
| Quality of life | 0.19 |
| PCS | 0.087 |
| PCS Rumination | 0.084 |
| PCS Magnification | 0.14 |
| PCS Helplessness | 0.14 |
| PIRS Total | 0.77 |
| PIRS subjective distress | 0.82 |
| PIRS sleep parameters | 0.87 |
| PIRS QOL | 0.72 |
| CESD Total | 0.57 |
| RLS Score | 0.25 |

3.11. Associations between pain intensity, pain interference, sleep, psychological measures.

With regards to the correlations of the scales in assessment 2 they were identical as shown in the first assessment.

3.12. Qualitative analysis

This section deals with the answers that were recorded to these two questions:

- 1) Do you foresee any problems coping with your injury outside the rehabilitation hospital?
- 2) How will you manage with pain and sleep disturbances outside the rehabilitation unit?

Problems coping with injury outside hospital

The participant's concerns dealing with their injuries outside the rehabilitation hospital are tabulated below (Table 3.10).

Table 3.9.: Participants concerns regarding SCI after discharge

| ISSUE | N (%) |
|-------------------------------|--------------|
| Concerns about injury at home | 14 (100) |
| Activities of daily life | 13 (93) |
| Re-integration into family | 11 (79) |
| Work issues | 13 (93) |

Concerns about injury at home

In this theme, patients were concerned about injuries occurring at home, specifically falling and the lack of support dealing with these events.

“Hmmm, yes I am concerned about being alone at home, in the hospital we have nurses that assist us in the event we fall, and I am concerned that if left alone who will pick me up in the event that I fall, I do not know how to pick myself up.”

Activities of daily living

In this theme patients were concerned about depending on others in dealing with day to day activities.

“I was a person that was self-reliant, I was able to perform my daily activities, (sigh) I know that I am now a different person and will not be able to do what is needed of me, and I just do not like to be dependent on others to carry out my daily tasks.”

Re-integration with family

In this theme, patients were concerned about social interaction with their family they were also concerned, how family members will react to them after obtaining a SCI.

“My greatest concern is reintegrating with my family, I have three small kids, two boys and a girl that need me, I will not be able to play with them like before, I am afraid that I will get frustrated and take it out on my kids

and wife, I do not know how I will deal with their reactions when I cannot be the same man I was before.”

Work issues

In this theme, patients were concerned, how they are going to provide for their families, for some it was the fear of going back to work where the injury took place and for others in the study there are no ramps to accommodate them using a wheel chair.

“I am the bread winner in my family; now I don’t know if I can support them, my injury happened at work, I do not know whether I will be able to cope there after what happened; also my workplace does not accommodate for disable people.”

Management of pain and sleep outside the rehabilitation unit

In this theme, patients had a range of possible solutions to their pain and sleep difficulties after leaving the rehabilitation hospital including exercise, medication and traditional healers.

“Having such an injury is difficult. I will be exercising I noticed this helped somewhat with the pain and with sleep in the rehab centre, and I will also take medication to help me sleep well and help with pain.”

“ When I was injured I knew my life will never be the same again, I guess I will medicate myself to relieve me from pain and sleep problems, these

issues can be frustrating and I don't want to be a nuisance to my family complaining all of the time about my pain and sleep issues.

"I might go to a traditional healer, which can give me something to help with my situation."

CHAPTER 4
DISCUSSION AND CONCLUSION

4.1. SUMMARY OF FINDINGS

The majority of the participants were Black, male. The main cause of traumatic SCI reported in our study was motor vehicle accidents. The commonest sites of injury in this cohort were legs and neck/shoulder areas. The verbal descriptors that were commonly chosen were, “sharp, shooting and tight,” these are also common descriptors for neuropathic pain. Below level neuropathic pain, followed by musculoskeletal pain was the common types of pain reported in this cohort. Pain interference was greatest in sleep and on average pain intensity was moderate (4-6 on 11-point NRS). There were strong correlations and positive relationship between pain scales. PIRS sleep correlated with all pain scales. In this cohort, environmental factors in the rehabilitation unit affected sleep. A high incidence of RLS was reported in this study (24%). Depression reported by the participants was common in both assessments.

4.2. DISCUSSION AND CONCLUSION

Demographic Characteristics

The patient demographic characteristics of this cohort were generally consistent with international trends reported in SCI literature (Siddall *et al.*, 1999; New *et al.*, 1997).

Participants were Black. This race profile is also a reflection of the South African population in general, where Blacks make up 79.3% of the population.

The current study consisted mainly of males (ratio of 4:1). The gender distribution was similar to international research on SCI in terms of male dominance (Norton, 2010, Rathore, 2010).

Injury Characteristics

Motor vehicle accidents were the highest cause of SCI in this cohort. The predominance of motor vehicle accidents as a cause of SCI was also reported in a previous study in South Africa (Mothabeng, 2006). In contrast, two previous South African studies reported that the cause of injury in their study was greatest due to violence (Hart and Williams, 1994; Velmahos *et al.*, 1995). This finding could be due to the political climate of South Africa in the 1990's when these studies were conducted. In the current study, violence in the form of gunshots was the third cause of injury in this cohort. This is comparable to international studies, where the common global causes of traumatic SCI are motor vehicle accidents, followed with violence (Siddall *et al.*, 1999; NSCISC; 2012; Rathore, 2010).

The injuries sustained by the majority of the participants in the present study were incomplete injuries and resulted mainly in paraplegia. Contradictory results have been reported from other developing countries where patients presented mainly with complete injuries (Maharaj, 1996; Singh *et al.*, 2003; Rathore *et al.*, 2008). In the developed world, patients present mainly with incomplete injuries (Rathore, 2010, NSCISC, 2012). Our study was found to be in agreement with the developed world this

could be due to the good infrastructure that is found in South Africa in comparison to the rest of the developing world that resulted in complete injuries

Pain sites and Pain classification

SCI pain was present from 12 weeks after injury, which is similar to previous reports (Stromer *et al.*, 1997; Siddall *et al.*, 1999; Ravenscroft *et al.*, 2000). This data would emphasize the importance to assess SCI pain and its characteristics as early as possible to provide proper pain management during the acute phase.

In the present study, on average, the participants reported two sites of pain. Similarly, other studies reported equal findings were ≥ 3 locations of pain were experienced by their participants (Felix *et al.*, 2007; New *et al.*, 1997). The present study identified the legs and the neck/shoulder areas as the most common location of pain, which is similar to reports in the literature (Cruz-Almeida *et al.*, 2005, Widerstrom-Noga *et al.*, 2001). Pain common in the legs region may be due to the level of injury in this cohort. Pain in the neck/shoulder (upper extremities) area for paraplegics maybe explained due to pressure releases and the overuse of the shoulder during wheelchair propulsion and activities of daily living, weight bearing activities such as transfers. Pain in this area is also common in quadriplegics, which may be the result of spasticity, weakness and subluxation, reducing normal function.

The most common descriptive words chosen from participants in this cohort were; “sharp,” “tight,” “shooting” and “hot”, which were also the most prevalent descriptors previously described in persons with SCI as well as patients experiencing neuropathic pain (Turner and Cardenas, 1999; Siddall and Middleton, 2006). In previous literature “burning” was the common word chosen to indicate neuropathic pain and “aching” was the common word selected to indicate musculoskeletal pain. The participants in the present study choose the word ‘hot’, which is in the same group as burning. This could be due to the interpretation of the words in the McGill Questionnaire by a South African cohort. According to pain type and classification, this study provided interesting information with regards to pain type. The most common type of pain reported in our study was below-level neuropathic pain, followed by musculoskeletal pain. Similar to previous studies (Sjolund, 2002; Siddall *et al.*, 1999; Siddall and Middleton, 2006) the most common words selected to describe neuropathic pain were, “burning, aching, tingling, shooting, stabbing, electric, and sharp (Sjolund, 2002; Siddall *et al.*, 1999; Siddall and Middleton, 2006).

At level neuropathic pain was reported by Nashold *et al.*(1991) to be the most common of the neuropathic pain types (41%) with an early onset, however, this did not concur to the current study where below-level neuropathic pain was reported to be the most common neuropathic pain type in both assessment 1 and 2.

Neuropathic pain was the most common pain category recorded during inpatient rehabilitation in our cohort as well as in other studies (Stromer *et al.*, 1997; Ravenscroft *et al.*, 2000). This is of great concern since this type of pain is refractory to most treatments and is very difficult to treat. With the early onset of SCI pain, pain is a major concern for most acute SCI patients during their inpatient rehabilitation. This could be a challenge to the patient and the managing treating team that will have to use various strategies to try and reduce the pain experience to an appropriate level for most of these patients by discharge.

Pain intensity

In the present study the participants reported experiencing moderate pain, which is similar to international studies (Ataoglu *et al.*, 2013; Siddall *et al.*, 1999). These results could be attributed to the time of the interview; the interviews were all done at 3pm, after the participants have performed all activities in the rehabilitation unit for the day.

The last activity performed by the participants in the present study was exercise. A study by Ginis *et al.* (2005) investigated SCI participants who underwent a regular exercise program and compared them to SCI participants who did not. It was established in their study that those who underwent a regular exercise program reported a significant improvement in pain scores, which in turn accounted for improved depression scores.

Unfortunately, in the present study no data was collected regarding this. Further studies are therefore warranted to observe whether exercise programmes will play an important role in improving pain scores in a South African sample.

Furthermore, strong and consistent associations were found between average pain intensity and interference in different basic activities of daily living assessed by the modified BPI interference scale. This suggests that as pain becomes severe it can have a substantial negative impact on even very basic activities such as sleep, mood and mobility as in this study, which further hampers recovery of these patients thereby decreasing their quality of life.

Pain interference

Results yielded in this study have shown that patients experiencing pain have interference with day to day activities. This study reported participants experiencing pain have greatest interference with sleep, enjoyment of life, mobility and general activity at both assessment 1 and 2, which concurs to other studies in the literature (Roehrs and Roth, 2005; Biering-Sørensen and Biering-Sørensen, 2001). Pain interference is a great challenge to individuals with SCI; it greatly hampers their day to day activities that are necessary for them to perform. Evidence from previous studies (Roehrs and Roth, 2005; Biering-Sørensen and Biering-Sørensen, 2001; Turner and Cardenas, 1999; Rose *et al.*, 1998 and Davidoff *et al.*,

1987) have shown that pain is a serious, complex secondary problem in individuals with SCI, and there is a great need for early and better diagnosis and treatment since many respondents reported that pain significantly interferes with their work, home, social and recreational activities.

Sleep and RLS:

The Pittsburgh Insomnia Rating Scale was used to determine insomnia in this cohort. The PIRS (total) and the subscale scores for subjective distress sleep parameters and quality of life were too low and indicated mild insomnia in assessment 1 and assessment 2 in this cohort.

The PIRS scale failed to detect insomnia in this cohort. The contradictory results between the relationship of pain and sleep in a spinal cord injury population may be explained by the use of this inappropriate scale. A more appropriate scale might have been used such as Pittsburgh Sleep Quality Index (PSQI) which is a more sensitive and validated scale used to determine the effects of sleep. According to the data reported by the participants, most of them took more than 30 minutes to fall asleep. Already in the PSQI, this would earn them 3 points out of 21. The majority of the participants wake up at night and seem to really have difficulties falling asleep. Again, that would earn them 3 more points in the PSQI, so 6 in total. Then most of them reported on average sleeping between 4-7 hours, which could earn them 1-3 points. According to the actual number

in the PSQI, a total of 9/21 is reported to be a significant for sleep disruption. The PIRS Scale seems to be designed to be less sensitive to sleep as seen by the results obtained in this study. Furthermore, we as the investigators should not have used this scale since a validation study was not found since the scale was first presented in 2002. This thereby provides a limitation in the study.

Participants reported sleep disturbances due to environmental factors. Furthermore, participants were on hypnotics and other medication that could account for them experiencing fewer problems with their sleep.

In our study sleep disturbances were also reported due to RLS. The current study reported a high incidence of this condition (24%) with participants experiencing moderate to severe RLS.

Depression

The majority of participants in both assessments reported depression, concurring with other studies which, reported depression to be a major issue in SCI patients (DeVivo, 1991; Kennedy *et al.*, 1999). It is imperative to examine the psychosocial variables that predict pain and sleep deprivation in this population. Further studies in this area are warranted where objective measures can be used to study depression in SCI.

Correlations between pain, sleep and mood

Our results showed that the total scales and subscales for both PCS and PIRS to be significantly correlated, this concur to other studies (Lundh and

Broman, 2000, Segerstrom *et al.*, 2000). This may suggest that catastrophizing affects sleep quality in SCI respondents in this cohort. Additionally, this is in agreement with the literature that found catastrophizing to affect sleep in other pain populations (Harvey, 2000; Lundh and Broman, 2000; Nicassio *et al.*, 1985). The current study also showed that as pain intensity increased it caused an increase in Pain interference this is similar to reports of other studies (Cruz *et al.*, 2005; Widerstrom-Noga *et al.*, 2001). Furthermore, the current study also showed an increase in pain intensity had a positive, moderate relationship with PIRS sleep outcome measures this concurs with a study by Widerstrom-Noga *et al.* (2001). PIRS sleep and pain interference showed a positive, moderate relationship which concurs with studies in the SCI literature (Widerstrom-Noga *et al.*, 2001, Felix *et al.*, 2007). This study established that there exists a relationship between pain and sleep and that pain catastrophizing affects sleep.

Change between assessment 1 and assessment 2

No significant changes were noted between the pain, sleep and mood in this study between the two assessments, this finding could be attributed to the time frame between the assessments which was short in this cohort. Cairns *et al.* (1996) also reported no change in pain from admission to discharge, which is in agreement to the current study.

Qualitative assessment

This is one of the few studies in the SCI literature to report on the perspectives of individuals with regards to their thoughts and fears about coping with their injury at home and how they would feel about managing their pain and sleep outside the rehabilitation unit. Four themes were raised by the participants regarding their fears of coping with the injury outside the rehabilitation unit. Their viewpoints are in agreement with other studies that SCI individuals are concerned about re-integration to their households, families, caring for themselves with no assistance from nurses that helped them when they were inpatients in the hospital, and return to the working environment (Garret, 2012).

The use of medication to manage the respondent's pain, sleep and depression is of concern since most of these medications are addictive and can cause further harm to SCI individuals.

4.3. LIMITATIONS OF STUDY

The greatest challenge in this study was the assessment process with this cohort of acute SCI respondents, the respondents were still dealing with acceptance of their injury and were still very emotional during the assessments resulting in rescheduling of interviews.

English was not the first language for most of the participants, which required the explanation of words, statements found in most of assessment tools used in the study.

Furthermore, the small sample size restricted the use of multivariate statistics.

4.4. GENERAL CONCLUSIONS

Pain, sleep, mood and quality of life, are common and significant problems for most acute spinal cord injured patients. Although it may not be the primary reasons for admission to a rehabilitation hospital, the impact of these secondary conditions in SCI is substantial. Firstly, SC individuals describe their pain as moderate or severe. Secondly, pain and sleep deprivation is significantly associated with increased levels of psychological distress, and individuals with pain are less likely to rate their health as excellent or good. Thirdly, although patients with SCI face major obstacles, such as loss of mobility, the secondary complications of pain, sleep, mood and quality of life can be detrimental to their daily functioning. Increased understanding and improved management of SCI pain, sleep and mood will produce substantial reduction in distress and will enhance the quality of life for many people with SCI. This study sought to describe the pain, sleep, mood and quality of life during acute SCI, identify the risk factors associated with pain and sleep disturbances in patients with SCI and to compare pain, sleep, mood, and quality of life during assessment 1 and assessment 2 within a South African cohort.

4.5. FUTURE STUDIES

Presently there is no database in South Africa for SCI; future studies should focus in establishing a database for SCI as disability increases in our country, having our own database will help us to develop better programmes and management for people with disability in our country. Additionally, further studies should report on the comparisons of SCI pain and sleep in other Rehabilitation hospitals in South Africa to gain an overview of this devastating injury and the effects of secondary complications that pain and sleep has on SCI individuals. Also, a follow up study is warranted to evaluate change in pain and sleep from acute to chronic stages in order to develop more dynamic, efficient programmes in assisting persons with SCI in South Africa. To create quality of life scales that is valid for South African non- English populations and to use other measures.

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APPENDIX A
CONSENT FORM AND INFORMATION DATA SHEET

APPENDIX B
ASSESSMENT TOOLS
PAIN, SLEEP AND DEPRESSION

APPENDIX C
ETHICS