

Monitoring of rehabilitative nursing practices in relation to function ability for patient with spinal cord injury

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Abstract: This review aims to create a framework that shows how the nursing practices offered during rehabilitation of patients with Spinal Cord Injuries relate to their functional ability. Data source: articles from six databases including Google Scholar, PubMed, Medline, CINAHL and EMBASE (from 2011). Study selection: This review was done on theoretical and qualitative studies that study knowledge about functional ability of the patients and different nursing practices. Analysis and synthesis of the studies was later done through content analysis. Results: 2904 records were available in the initial search. In this review, the PRISMA explain the process of inclusion of 45 studies that met inclusion criteria bases on their study title and the abstract. Findings: Nurses add value to the rehabilitation process by helping and encouraging the patient to transfer the skills learned in therapy sessions to their daily routine Another finding is that rehabilitation nursing practices have a significant relationship with the patients function ability. Conclusion: Findings create nurses awareness and health care providers on the needs of patients with SCI and offers direction for further research.

Keywords: functional ability, Spinal cord injuries (SCI), Spinal cord, FIM, , Nursing rehabilitation, functional ability.

1. INTRODUCTION

In this review , the researcher reviewed all literature to find relevant researches that can help the researcher to make this research. The purpose in searching the literature is to find out what is known about the research problem [1]. To obtain sources of data, the researcher depends mainly up on articles from Journals that available in the web sites such as Magazines, Journals, articles and other dissertations in the same area of the present study and help to achieve the aim of this study.

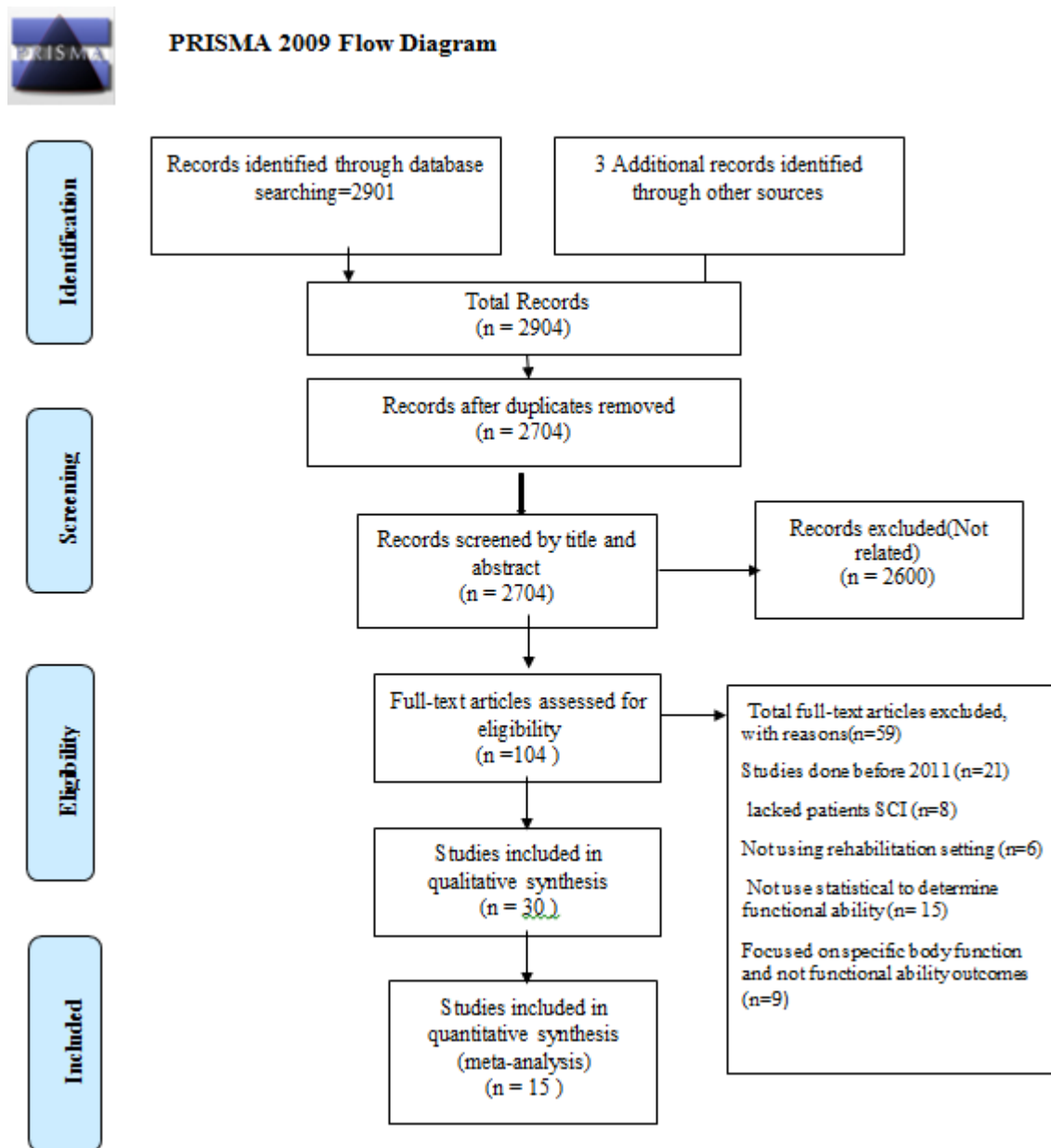
To find relevant studies, Literature exploration was carried out using different electronic data bases including the Pub Med, Cumulative Index Nursing and Allied Health Literature (CINAHL), Medical Literature On Line (Medline), The Exerpta Medical Data base (EMBASE) and Google Scholar. The search for this subject was conducted by entering a key words that captures the key concepts in the articles [1]

2. SEARCH STRATEGY

The electronic searches were performed in the following electronic databases to be used for this review included of the Medicine –PubMed, Database of Medical Literature Analysis and Retrieval System Online –Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL®). CINAHL® were chosen as it provided access to —virtually all English-language nursing and allied health journals[1].

The search terms were drawn both from the research question as well as the conceptual framework. The keywords used, in various combinations, to search the database included: spinal cord injury, rehabilitation, functional ability, nursing practices. The years of search in data base was specified to 2011-2019 to identify the updated literature depending on inclusion and exclusion criteria. Titles, abstracts, and texts were all reviewed in order to assess the fit of the article with the stated inclusion criteria.

The review used Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines in identifying the literature used in this review. The guidelines helped in ensuring that there is the appropriateness of the content in the reviewed research. The PRISMA flow diagram shown in figure 1 below explain the process of inclusion of 45 studies that met inclusion criteria bases on their study title and the abstract. Reasons for exclusion are well presented in the diagram.



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed.1000097

For more information, visit www.prisma-statement.org.

In the initial search, 2904 studies were identified, as shown in figure 1 above. After carrying out the initial search, 200 reviews were removed since they were duplicated. The remaining 2704 studies were screened by the investigator, then 2600 studies were removed because of not related to the research study and just 104 studies met inclusion criteria at the screening phase, which were then reviewed in full. In the preliminary review, 59 studies were excluded because they failed to meet inclusion criteria for the following reasons; studies done before 2011 (21), lacked patients SCI (n=8), studies that were not done using rehabilitation setting (n=6), studies that did not use statistical modeling approach to determine predictors of functional ability such as regression (n= 15), generally focused on specific body function and not functional ability outcomes (n=9).

Finally, thematic framework to guide the narrative account of existing literature and to collating, summarizing and reporting the results.

2.1 Spinal cord injury

Spinal cord injury is the injury of the spinal cord from the foramen magnum to the cauda equina which occurs as a result of compulsion, incision or contusion. As a result of the injury, the functions performed by the spinal cord are interrupted at the distal level of the injury [2]. The spinal cord is the main organ that is responsible for coordinating communication between the brain and the rest of the body parts [3].

The spinal cord is a cylindrical well-organized structure. It begins at the foramen magnum as a continuation of the medulla oblongata at the base of the skull. It is located within the vertebral or spinal canal. In men, it extends up to 45 cm and in women up to 43 cm. The spinal cord divides into 31 segments: cervical 8, thoracic 12, lumbar 5, sacral 5, and coccygeal 1. These segments consist of 31 pairs of spinal nerves with their respective spinal root ganglia. Spinal nerves contain motor, sensory, and autonomic fibers. These nerves exit through the intervertebral foramen [4].

The vertebral column consists of seven cervical, twelve thoracic, and five lumbar segments. In adults, the cord terminates at the level of L1-L2. Thus the cord spans within 20 bony vertebrae. The spinal cord consists of both white matter and gray matter. The amount of white matter becomes sparse towards the end, and the gray matter converges to form the conus medullaris. The cord is anchored at the caudal end to the coccyx by filum terminal which is an extension of the pia mater. The spinal nerves L2 to C1 make up the cauda equina present within the subarachnoid space called the lumbar cistern [14].

Functions of the spinal cord include sensory which constitute the following: pain, temperature, touch, and proprioception. Different sense organs in the peripheral structures initiate these sensory modalities, but the processing of them is usually carried out by a network of neurons in the spinal cord that are common to several of these different modalities of sensation [14]. Another function includes motor functions in which the structures of the spinal cord are able to produce stereotyped responses to external stimuli. These responses were referred to as reflexes and carefully defined and observed. The simplest of these reflexes is the monosynaptic stretch reflex, elicited by activation of the IA afferent fibers that originate from the muscle spindle, and when activated produces contraction of the synonymous muscle [16].

In addition to the monosynaptic stretch reflex the circuitry of the spinal cord can generate patterned responses that involve movement of several joints. The best explored reflex of this type is the flexor, or withdrawal reflex in response to various sensory stimuli, and in particular in response to pain. During this reflex the extremity is withdrawn from the site of the stimulus. The flexor reflex is a complex movement which involves a highly organized sequence of activation and inhibition of motoneurons to particular muscles [16].

Mechanisms of SCI include two mechanisms, the primary mechanical damage, in which the most common mechanism of human SCI is the injury caused by compression, flexion, hyperextensions or flexion-rotation mechanisms. In this mechanism, can damage the small intramedullary vessels causing hemorrhage in the central grey matter and perhaps vasospasm. The compression which results from the hematomas in the spinal canal, the functional loss may be complete but the effects of the primary injury depend on the severity and the site [4].

While bleeding in spinal cord trauma starts in early period, the interruption of blood flow occurs in a later period. Interruption of blood flow leads to hypoxia and ischemia local infarction. This, particularly, causes damage to the gray matter whose metabolic requirement is more. Neurons located in the damaged area are interrupted physically and myelin thickness is reduced. Also, edema and macrophages in the damaged area are other factors leading to deterioration of nerve transmission [17].

Secondary mechanical damage is a damage which is started by primary injury and in which many pathophysiological mechanisms are defined when it develops in the hours and days after injury. The main pathological process underlying all of these mechanisms is lack of energy due to impaired perfusion at the cellular level and ischemia. It has been reported that ischemia begins immediately after traumatic SCI and if not treated, it deteriorates in the first 3 hours and continues for at least 24 hours. After SCI, there are many changes including hemorrhage, edema, demyelination, the formation of cavities with axonal and neuronal necrosis and a series of pathological changes which ended with infarction [17].

2.2 Classifications of SCI

Generally, SCI can be classified as either complete or incomplete. Functional classification of SCI has been developed to establish reproducible scoring systems by which the severity of SCI could be measured, compared, and correlated with the clinical outcomes (Furlan et al., 2013). Neurological assessments in complete SCI show no spared motor or sensory function below the level of injury [19].

A complete injury means full loss of motor and sensory functions at the distal level of injury [4]. While, Incomplete injury defines partial preserving of sensory and motor functions below the neurological level and in the lower sacral segments. With this lesion, deep anal sensation and/or anal mucocutaneous superficial sense is expected to be preserved. The status of the lesion could be unclear until the end of the spinal shock period. Although the signs indicating the end of this period are disputed, an increase in reflex activity is known to be a positive indicator [4].

In the past decades, several scoring systems have been employed for clinical classification of neurological deficits following SCI. The first classification system, —Frankel Grade, was developed by Frankel and colleagues in 1969. They assessed the severity and prognosis of SCI using numerical sensory and motor scales (Alizadeh et al., 2019). This was a 5-grade system in which Grade A was the most severe SCI with complete loss of sensory and motor function below the level of injury. Grade B represented complete motor loss with preserved sensory function and sacral sparing. Patients in Grade C represented motor complete. Motor function is preserved below the neurological level. Grade D represented motor incomplete. Grade E represented normal sensory and motor function [18].

The American Spinal Injury Association (ASIA) standard for neurological and functional classification is the recommended preferred tool. The ASIA impairment scale describes a person's functional impairment as a result of a SCI. This scale indicates how much sensation a person feels after light touch and a pin prick at multiple points on the body and tests key motions on both sides of the body. It is important as a means of standardizing the initial and follow-up examinations, and also has a role in predicting the prognosis. The tool consists of two components, the sensitive and the motor. The sensitive component comprises the testing of a key point in each of the 28 dermatomes (from C2 to S4-5) on the right and left sides. Light touch and pinprick sensation are also tested [21].

Each modality is separately scored on a three point scale, ranging from 0 (absent) to 2 (normal or intact). The motor examination encompasses testing of key muscle functions corresponding to ten paired myotomes (C5-T1 and L2-S1). Voluntary external anal sphincter contraction should also be tested. The strength should be graded according to the Medical Research Council grading system, from 0 to 5 [23]. With that, the neurological level of injury is determined as the most caudal segment of the cord with intact sensation and antigravity muscle function strength (Figure 2).

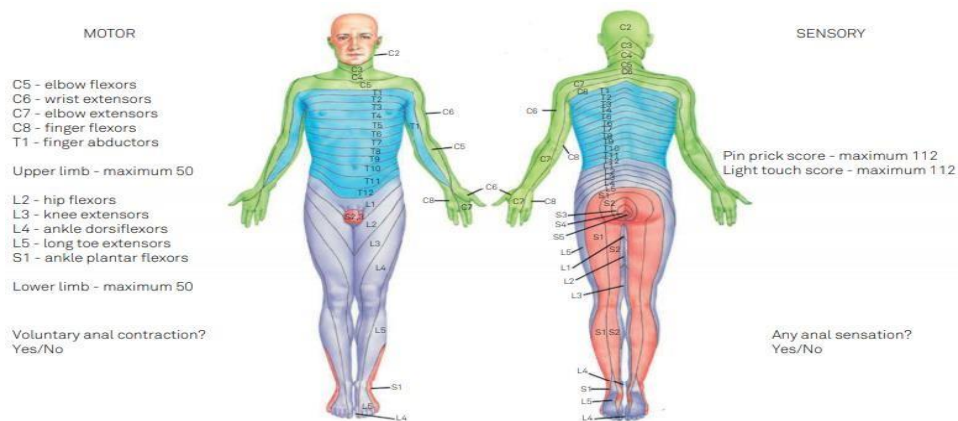


Figure 2: American Spinal Injury Association (ASIA) Standard Neurological classification of spinal cord injury. Steps of required motor and sensory examinations.

The ASIA Impairment Scale should be determined, as follows; impairment scale include A = complete. No sensory or motor functions in sacral segments S4-S5. B = sensory incomplete. Sensory but not motor function is preserved below the neurological level of injury including S4-S5 and no motor function is preserved more than three levels below the motor level on each side of the body. while C = motor complete. Motor function is preserved below the neurological level, and more than half the muscles below the neurological level of injury have a muscle grade less than 3. On the other hand, D = motor incomplete. Motor function is preserved below the neurological level, and at least half the muscles below the neurological level of injury have a muscle grade > 3, and E = Normal. Sensation and motor functions are normal in all segments tested [22]. As previously mentioned, the ASIA Impairment Scale score has a prognostic value. Eighty-five percent of ASIA A patients will not regain function. Of the 15% who will improve, only 3% will have useful motor function. More than half (54%) ASIA B patients, and the vast majority (86%) of ASIA C-D patients will regain function [23].

In clinical management of SCI, neurological outcomes are generally determined at 72 h after injury using American Spinal Injury Association (ASIA) scoring system. This time-point has shown to provide a more precise assessment of neurological impairments after SCI. One important predictor of functional recovery is to determine whether the injury was incomplete or complete. As time passes, SCI patients experience some spontaneous recovery of motor and sensory functions. Most of the functional recovery occurs during the first 3 months and in most cases reaches a plateau by 9 months after injury (Furlan et al., 2013). However, additional recovery may occur up to 12–18 months post-injury. Long term outcomes of SCI are closely related to the level of the injury, [20].

Motor outcomes include autonomic dysreflexia which is an abrupt, uncontrolled sympathetic response, elicited by stimuli below the level of injury. Other outcomes include upper motor neuron syndrome (reflex bladder) that involves loss of cortical inhibition of sacral reflex arcs due to disturbance of descending spinal tracts, leading to detrusor hyperactivity often in combination with detrusor sphincter dyssynergia (Burns et al., 2013). Lower motor neuron syndrome is due to injury to the sacral (S2-S4) part of the autonomic nervous system resulting in a diminished motor stimulation of the bladder and reduced or absent contractility of the detrusor and subsequently an enlarged bladder (Consortium for Spinal Cord Medicine, 2006).

Sensory outcomes include sensory hypersensitivity (brush- or cold-evoked pain, dysesthesia or pinprick hyperalgesia) in dermatomes corresponding to lesion level than SCI patients without pain [24].

Also, motor-sensory loss can be affects the autonomic neurologic function of the body, resulting in multiple impairments such as loss of bowel, bladder and sexual functions. Patient with SCI also limitations of daily life activity such as mobility (e.g. changing body position, transferring, walking), self-care activities (e.g. bathing, dressing, toileting, eating and cleaning [6].

Cognitive outcomes include long-term cognitive impairments in humans after SCI. Standardized neuropsychological tests have identified performance impairments in span memory, executive functioning, memory function, concentration ability, attention, processing speed, and learning. Sixty percent of spinal cord injured patients suffer not only from cognitive impairment but also from depression and anxiety conditions which result in a general decrease in quality of life. A prospective longitudinal neuropsychological study has shown that cognitive impairment in spinal cord injured patients was associated with elevated depressive mood, anxiety and fatigue only when patients returned to society, where there is less support and substantial challenges [26].

Regarding prognosis, the severity of the injury is the principal prognostic factor for the prediction of ambulation outcomes after SCI. In clinical practice, the distinction between –complete and –incomplete SCI is commonly made to express the injury's severity. However, van Middendorp et al. (2011) recently demonstrated that this distinction results in a suboptimal prediction for ambulation outcomes after SCI [27]. A more nuanced method for the prediction of ambulation outcomes can be achieved with use of the ASIA neurological standard scale. With use of the AIS grades, more accurate predictions can be made than with distinction between a –complete and an –incomplete injury [27].

2.3 Management of patient with SCI

A patient has a SCI there is three phases of management, acute phase, the need to ensure immediate survival and stabilization, SCI can be life-threatening and can undermine the possibility of future function and independence. Second

phases post-acute medical care and rehabilitation, to ensure that functioning is maximized and that the individual can be as independent. Last phases is maintenance of health care, so that the patient can avoid or survive the complications of SCI, such as urinary tract infections, pressure ulcers and cardiovascular, respiratory complication. To management of the potential complications of SCI required across the three phases of care [25].

The concept of 'time is spine' is a key tenet in the acute management of SCI and should guide interventions. Treatment begins in the field and a streamlined approach to management in the acute phase is essential for efficient delivery of care and improved outcomes [11].

Airway and respiratory complications are the main cause of morbidity and mortality in the phases acute phase of the SCI, with incidence ranging from 36% to 83%. Reduced vital capacity, retention of secretions, and autonomic dysfunction all play a role. Up to two thirds of patients will have complications such as atelectasis, pneumonia, or respiratory failure that require mechanical ventilation [30].

The injury level and the ASIA classification are the two most important predictors for the need of intubation. Virtually 100% of lesions above C5 require intubation (the phrenic nerve originates from C3-C5), which should be performed electively rather than as an emergency. It is important to avoid hyperextension, rotation, and other movements of the neck during intubation. When possible, awake, fiberoptic intubation is preferred. In-line stabilization without traction is an alternative when a fiber optic laryngoscope or bronchoscope is unavailable [30].

Hypotension after SCI is frequent. It may be due to hypovolemia in a context of polytrauma, or due to the direct cervical or thoracic spinal trauma itself, leading to neurogenic shock. Neurogenic shock results from the interruption of sympathetic tone due to disruption in supraspinal control, and an intact parasympathetic influence via the vagus nerve, leading to an imbalance in the autonomic control. There is, therefore, loss of peripheral vascular tone and bradycardia [19].

Although the deleterious consequences of hypotension in SCI have not been assessed in a controlled prospective way, there is convincing evidence that hypotension contributes to secondary injury after acute SCI, reducing spinal cord flow and perfusion. Based on this, the current recommendation is to strictly avoid hypotension, and maintain mean arterial pressure (MAP) at 85-90mmHg for seven days after injury (level III evidence). In order to achieve that goal, the mainstay of treatment is intravenous fluid therapy (mainly with crystalloids) to maintain a euvolemic or slightly hypervolemic status, in association with vasopressors [11].

It is important to have invasive blood pressure monitoring with an arterial line. The main predictors of poor cardiovascular function requiring resuscitation and support are high cervical and complete lesions. Cardiovascular instability may be transient and episodic, but can also be recurrent in the first 7–10 days after injury. The best vasoactive amine is still a matter of debate. The last guideline does not address this controversy. A systematic review tried to answer several questions regarding the use of vasopressors in acute SCI. However, it was inconclusive in determining which vasopressor is better, what the optimal therapy duration is and what the MAP level is below which one should initiate vasopressor support [23].

Regarding pharmacological (Intravenous methylprednisolone), methylprednisolone is a synthetic corticosteroid that upregulates anti-inflammatory factors and decreases oxidative stress, enhancing endogenous cell survival in animal models of SCI. It reduces edema, prevents intracellular potassium depletion and inhibits lipid peroxidation. Since the 1980s, clinical trials have been trying to demonstrate its benefits in humans. No difference in motor or sensitive neurological recovery was observed between groups, and wound infections were more prevalent in the high-dose group. The National Spinal Cord Injury Study II, published in 1990, compared MP 30mg/kg intravenously followed by 5.4 mg/kg/h over 23 hours to naloxone and placebo [19].

At one year, there was no significant difference in neurological function among the groups. A sub analysis found that the subset of patients who received the corticosteroid within eight hours had a modest improvement in motor recovery. Wound infections were more frequent among patients who receive Methylprednisolone. The National Spinal Cord Injury Study III, published in 1997, compared three treatment groups: MP for 48 hours, the same drug administered for 24 hours and tirilazad mesylate [a potent lipid peroxidation inhibitor] [23].

Neuroprotective agents aiming to reduce secondary insults are potential key therapies in SCI. Multiple approaches have been studied, and many others are currently under investigation. Gangliosides are glycolipid molecules present in neuronal membranes. Laboratory studies have shown that they can enhance axonal regeneration, besides having a variety of neuroprotective effects, such as prevention of apoptosis and anti-excitotoxicity activity. GM-1 (Sygen) was suggested as a therapeutic option until the 2002 guideline [23].

Nimodipine is an L-type calcium channel blocker thought to prevent calcium-dependent apoptotic enzymes and block presynaptic release of glutamate. In comparison with placebo, however, no difference in neurological status at one year was noted. Tirilazad mesylate, a drug that attenuates peroxidation of neuronal membranes, was analyzed together with MP in the National Spinal Cord Injury Study III trial, with no difference between groups. There are no placebo-controlled studies [23].

Neuroregeneration A wide number of strategies are being developed worldwide to help recovery in SCI patients. There are numerous targets and therapeutic opportunities using endogenous and exogenous repair mechanisms. The aim is to surpass barriers to recovery such as the loss of structural framework, cystic cavitation, scarring and inhibitory molecular signaling. Cell-based therapies are promising modalities of regeneration [11].

2.4 Nursing rehabilitative practices

World Health Organization (WHO) has defined rehabilitation as –a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions, in interaction with their environment. Rehabilitation interventions optimize well-being by addressing impairments, limitations, and restrictions in many areas (areas as disparate as mobility, vision, and cognition), as well as by considering personal and environmental factors [4].

The purpose of this rehabilitation period should focus on stability and strength education for sitting and transportation. Functional goals must prepare the patient for movements such sitting up in bed or a wheelchair, dressing and transfers. Initially, the goal is for successful bed movements. Range of motion (ROM) and stretching exercises are used for functional activities. Exercises for sitting, balance and strengthening of the upper extremities should be done at the beginning. Patients who can tolerate sitting can begin to push up, with static and dynamic balance training to transfer to the wheelchair [34].

Rehabilitation period begins with admission to hospital until discharge of the patient's neurological state and is a 6-12 weeks bed period. The aim of rehabilitation in this period is to prevent complications that may occur long term. Passive exercises should be done intensively to resolve contractures, muscle atrophy and pain during the acute period of hospitalization in patients with complete injury. Positioning of the joints is important in order to protect the articular structure and maintain the optimal muscle tonus. Sand bags and pillows can be useful in positioning. If the pillows and sandbags are not able to provide positioning, it can be achieved with plaster splints or more rigid orthotics. Ankle foot orthosis, knee-ankle foot orthosis or static ankle foot orthosis, etc. are mainly used for this purpose [4].

Recent studies have shown that early mobilization plays an important role in prevention of pulmonary function decline and in the development of muscle strength. Breathing exercises should be carried out and taught and its importance should be explained to complete or incomplete paraplegic and tetraplegic patients during the acute phase in order to protect lung capacity. During this period, the number of exercises should be kept at the maximum level depending on the patient's tolerance [35].

Orthostatic hypotension is likely to be found in patients with a long period of lying in bed. Syncope can be seen in these patients while sitting and being lifted up due to low blood pressure. A tilt table may be useful for patients with this condition, starting from 45 degrees for 30 min a day. The degree is increased according to the patient's complaints or state. Standing upright stimulates the blood pressure reflexly to a sufficient and persistent limit. The patients adapt to sit and stand and are prepared to transfer and balance. When the patient comes to the upright position with a tilt table, the patient should be in a sitting position on the edge of the bed 3-4 times a day and balance exercises should be done to maintain this position. Independent sitting on the edge of the bed is very important for wheelchair use, enabling wheelchair transfer [4].

Range of motion (ROM) exercises prevent contractures and maintain functional capacity. These exercises should be done in a flaccid period at least once a day and at least 2-3 times a day in the presence of spasticity. Damage level, awareness and cooperation with the state determine the places that must be protected by passive EHA. Shoulder ROM exercises are important to prevent pain in all levels of damage. Passive ROM exercises should be done for both upper extremities in C1-C4 level tetraplegia. In injuries of C5 and C6 levels, ROM exercises should be done to prevent the development of contractures, especially contractures of elbow flexion and supination [37].

Stretching should be done to protect the tenodesis effect in patients without active wrist extension and fingers that are not fully stretched. Muscles are flaccid during the spinal shock period. Exercises can be done more easily with flaccid muscles. Flaccidity is replaced with spasticity after the period of spinal shock. Despite the positive effects of spasticity, it has negative effects on mobility, daily living activities and transferring. The severity and type of the other complications of SCI affects spasticity and the precipitating factors should be eliminated for the treatment of spasticity. Isometric, active or active-assisted truncal exercises should be done in the patient's bed if partial movements are present, depending on the injury level [35].

The most important point is strengthening of the upper extremities to the maximal level in the acute period of rehabilitation in patients with complete paraplegia. At the end of the acute phase, strong upper extremities are needed for the independent transfer from bed. For this purpose, active and resistance exercises to strengthen the muscles of the upper extremity should be initiated at the earliest possible period. Weight and resistance exercises can be applied with dumbbells in bed depending on the patient's muscle strength. Electrical stimulation may be a useful alternative if extreme fatigue occurs while strengthening the muscles. Shoulder exercises performed with elastic bandages were found to be effective to reduce shoulder pain [35].

Corsets are used for fixation and supporting the spine while moving on to a sitting position after the end of the bed interval. Hyperextension corsets or plaster plastic body jackets are used in treatment of thoracic and upper lumbar region fractures. A knight-type corset would be more appropriate to support the fractures at the lower of L2 vertebrae. Knight-Taylor type corsets restrict flexion and extension of the trunk but have no restriction on rotation. Plaster or plastic body jacket corsets should be used to restrict movements in all directions [4].

Wheelchairs, walkers and crutches are used for out of bed transferring of patients. The wheelchair is the most important tool for SCI patients to be mobile and participate in social life. Ideally, wheelchairs must allow for optimal mobility, protect skin integrity and maintain the normal anatomical posture. A battery assisted wheelchair is appropriate for injuries at the upper segments, whereas a manual wheelchair is preferred at lower levels. Wheelchair dimensions such as the height, pelvic width, seat length, backrest, seat and arm support should be specifically prescribed for each patient [36].

The most important goal in rehabilitation to realization of the independent mobilization for both complete and incomplete paraplegic patients during the chronic period. Ambulation can be social, domestic and aimed at exercise. The patient must be able to walk 50 meters unaided or with assistive devices for social ambulation. Those who ambulate domestically can walk independently or with partial assistance and need a little help or can be independent at home. Factors such as injury level, age, weight, general health status, motivation and spasticity affect the ambulation potential. Generally, patients with an injury of T10 and above can be ambulated for exercise. Patients with T11-L2 injuries can ambulate in the home (domestic) and the patients of more distal injuries can ambulate socially [4].

Walkers, crutches and orthoses are important to provide chronic stage ambulation. Patients with pelvic control can walk with an orthosis or crutches outside the parallel bars. If the muscle strength of quadriceps femoris is normal, patients can walk with elbow crutches and orthosis without needing a wheelchair. In patients with complete injury of C8-T12, ambulation can be achieved by a parawalker (hip guidance orthosis), both in the house and outside [36].

Walking devices used in spinal cord injury are becoming more and more lightweight and easy to move. However, the devices with advanced technological features are also more expensive. Oxygen consumption, energy expenditure and walking speed can vary significantly depending on the shape, type and weight of material of devices used by the patients. One of them is the RGO (Reciprocating Gait orthosis). For effective use, patient's excess weight reduction and increased aerobic capacity must be maintained and muscle mass must be increased. RGO has been further developed and is more complicated and more expensive than ARGO. ARGO also leads to an excessive waste of energy like RGO [36].

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Hybrid walking devices were created by adding Functional Electrical Stimulation to orthosis. Walking is becoming better within the hybrid devices. Robotic training is a new approach and is developing day by day. A case report showed that upper extremity function has been improved by robotic assistance over four weeks. After training, manual muscle test scores of wrist extensor, finger flexor and finger abductor are significantly increased. Another study demonstrated that the robotic-assisted gait training using the locomat system improved the functional outcome of subacute SCI patients [38].

The most important expectations in the chronic phase or phase to return home are ensuring the maximum independence related to the level of the patient's injury, integration of the patient to society and teaching the importance of the family's role. In addition, house modifications are important for patients with SCI in order to have independent activities of daily living. Door width should be 81.5 cm for manual wheelchair access and 86.5 cm for battery assisted wheelchairs. The height of electric switches should be 91.5 cm.

In order to prevent pressure ulcers, the patient's position nurse should be changed every 2-3 hours. Pressure ulcers occur most frequently on the sacrum, ischium, trochanter and superior aspect of the heel. Flexion contractures of the hip may develop due to continuous lying on the side and sitting in the wheelchair. Flexor muscle tension can be reduced with a prone position at regular intervals and ROM exercises in all directions. The ankle ROM exercises are useful to prevent contractures of the foot as well as the proper positioning of the foot while sitting in a wheelchair. Patients should be asked to change position and actively participate. In addition, attention should be paid to keeping the skin clean and preventing the formation of decubitus ulcers [4].

One of the important features of this period is restoring the patient's psychological and emotional state again because of the high incidence of depression in patients (the incidence is about 1/3 in the first six months). Depression is not a natural process experienced after SCI but is a complication that needs to be treated. Suicide is the most common cause of death after SCI among patients under the age of 55. Frequency of posttraumatic stress disorder is 17% and usually occurs in the first 5 years. Consultation with a psychiatrist is needed if there is psychotic behavior and depression. Occupational therapy and finding the patient's role in society are most important factors in restoring the psychological state. Social and psychological problems in the absence of daily activities have been reported. Suicide attempts have been reported due to a lack of daily activity, depression, alcohol dependence and emotional distress. Occupational therapy allows SCI patients to be more social, to use their own functions for creative jobs and to deal with psychological problems like depression [4].

Occupational rehabilitation is an important part of the rehabilitation process. In developed countries, occupational therapy is carried out by the occupational therapist in the rehabilitation team. Occupational therapists assess the patient's limitations and plan the occupational activities. Occupational rehabilitation is planned and implemented depending on the social and cultural characteristics of individuals, level of education, personality traits, interests, values, attitudes and behaviors before and after the injury. Pictures, music, crafts, ceramic work and a variety of activities (for example, sports) and entertainment are implemented and planned to focus on the purpose in the occupational treatment [4].

Wolters Kluwer Health (2018) investigated the practical skills that seem to make the most significant impact on the patient's quality of life. The study involved 195 patients with TSCI admitted in specialized trauma centre from 2010-2016. Most had suffered injuries in motor vehicle accidents, and about 65% had tetraplegia (upper and lower limbs paralysis), and 35% had paraplegic (more moderate limbs paralysis). Spinal Cord Independence Measure (SCIM) was measured in a standard Questionnaires in the assessment of their independence level in 19 functional abilities associated with Activities of Daily Living (ADL) such as bathing, eating, dressing and toileting.

There exists limited research on rehabilitative nursing practices on patients with spinal cord injuries. However, some reviewed studies acknowledge that rehabilitation pathways for SCI are increasingly becoming complex while admission times are, on the other hand, becoming shorter and extensive. Hence, there is an increasing need for knowledge and experience sharing to develop professional nursing skills that will improve rehabilitative nursing care and make a valuable and positive contribution to teamwork across professions.

A spinal cord injury is a disease required appropriate nursing practices to provide optimal care for these patients who are unable to do activities of daily life, nurses should be aware of the valuable contribution to make the acute care and rehabilitation for patients and their successful reintegration back into community setting. The contribution of nurses to long-term quality of life cannot be overestimated, particularly in the area of continence management. Communication and collaboration is crucial for successful acute care and rehabilitation of the patient with SCI [3].

Nurses add value to the rehabilitation process by helping and encouraging the patient to transfer the skills learned in therapy sessions to their daily routine, in addition to the unique nursing contributions around continence and skin management. Equally important is the feedback that nursing staff members provide to the multidisciplinary team regarding the patient's ability to carry over these skills during evening and night hours. Nurses have interactions with family members that are of great value to other team members, allowing all members to adjust their treatment goals and strategies as necessary [2].

Nurses working in SCI care need experience and knowledge around a range of rehabilitative interventions which will include bladder, bowel, and skin management; management of spasticity and autonomic dysreflexia sexuality and fertility; and psychosocial issues and patient education for self-care and management [2].

Patients in these situations are often emotionally traumatized and vulnerable; aggression and challenging behavior is not uncommon. Ways of supporting nurses may include team debriefs and clinical supervision [3]. The continuing contact between the nurse and patient allows the nurse to provide emotional and psychological support to individuals at their most vulnerable moments. The nurse's role is important in supporting the patient by explaining what is happening, in terminology that is easy to understand. Obtaining informed consent from the patient prior to any intervention is essential in gaining the confidence of the patient. Nurses assess the readiness of the patient for learning, including cognitive ability, particularly in the presence of concomitant Traumatic brain injury [3].

Verbal communication should be reinforced with supplementary materials such as leaflets, diagrams, or online resources, as appropriate to the individual's needs. Particularly in individuals with high level SCI, when offering reassurance by touch, the nurse must remember to touch a part of the body that has sensation for example, the shoulder or upper arm. Facilitating the patients' communication with the nurse is important. The patients' ability to summon assistance may be impaired after SCI [3].

A suitable and appropriate method of calling for assistance when required is essential for each patient dependent on their level of altered function. The patients' communication may be inhibited by the inability to use gesture in their usual way; they may be unable to use their hands/ arms when they are talking [3].

In contrast to the theme about the level of nursing practices, the findings in reviewed studies had another theme on level of injury and the relationship that exists between the rehabilitative nursing practices and the level of damage. Understanding the patient's level of injury and the functional ability at every level enables the nurses to offer better care to the patients. Rehabilitation should be initiated since the first hospitalization and should meet each individuals particular needs, use an interdisciplinary approach, hence preventing initial complications and reducing the total cost of care. Delays in initiating those actions may have a negative effect on the individuals' functional independence and extend rehabilitation time [7].

Dvorak, et. al, (2015) suggest that there are benefits related to early intervention such as reduced rates of injury. Findings related to Length of Stay (LOS) complications are recorded in different articles where intervention is done beyond a week after injury. Hence, there is a great need to have strategic and fact-based planning of the rehabilitative nursing interventions given to the patients to not only improve cost-efficiently but also maintain the system and patient outcomes.

2.5 Functional abilities for patients with SCI

The Consortium for Spinal Cord Medicine(1999) have provided clinical guidelines towards functional outcomes after SCI, functional ability is usually measured using different outcome measures like Functional Independence Measure (FIM). Spinal Cord Independence measure (SCOM), Modified Bartel Index (MBI) and Quadriplegia Index Function (QIF). These measures are objective tools which do in consideration the patient's needs. Also, they measure activity without including participation measures like employment and community integration. But, the International Classification of Function (ICF) definition of rehabilitation as one that entails all measures required in acquiring maximum physical and psychological well-being and that the patients and their opinion play significant role in determination of outcomes. The FIM is considered the most effective tool of quantifying effective improvements during the rehabilitation program[18].

In the present study, the Functional Independence Measure (FIM) is the most widely used amongst people with SCI to measure functional ability during rehabilitation. The SCI Model Systems adopted the FIM as a functional measure after evaluation in a collaborative study by Whiteneck in 1998. The FIM was developed to resolve the long-standing problem of lack of uniform measurement and data on disability and rehabilitation outcomes by Granger in 1998[41].

The FIM is an 18-item ordinal scale. It has two major domains [Motor Items and cognitive items]. Motor items include 1) self-care (Eating, Grooming, Bathing, Dressing upper body, Dressing lower body, and Toileting), 2) Sphincter Control [Bladder management, and Bowel management), 3) Mobility [Bed, chair, wheelchair transfer, Toilet transfer, Tub, shower transfer, Walking/wheelchair locomotion, and Stairs]. Cognition Items include 1) Communication [Comprehension, and Expression], 2) Psychosocial Adjustment [Social interaction), and 3) Cognitive Function [Problem solving, and Memory] [42].

Scores on the individual items range from 1 to 7: a FIM item score of 7 is categorized as "complete independence"; a score of 1 is "total assist" (performs less than 25% of task). Scores falling below 6 require another person for supervision or assistance. Evaluation of the metric properties of the FIM have been reported extensively. Precision (the ability of the instrument to detect meaningful change in level of function during rehabilitation) is high [42].

There are significant research efforts that have been put to describe effective rehabilitation processes that are linked to positive patient outcomes. In most researches, the function ability outcome of the patients is measured in terms of Functional Independence Measure (FIM) and use FIM efficiency to delineate rehabilitation efficiently. The FIM is extensively used in measuring outcome for assessing function ability, primarily physical and cognitive disability. Generally, it consists of five cognitive and 13 motor items with reputable reliability, validity and sensitivity to medications — Motor FIM aids in dressing, grooming, feeding, and toileting and mobility items. Cognitive FIM assesses problem-solving, communication, social interaction and memory. There exists limited research on rehabilitative nursing practices on patients with spinal cord injuries. that this study intends to fill.

The research was carried out to explore how rehabilitation therapy relates to functional outcome, care costs, bed utilization in incidences of traumatic spinal cord injury (tSCI). In this research, a retrospective review of 262 persons that were admitted with tSCI in an inpatient rehabilitation facility (from 2005-2012) was done. Outcome measures and treatment variables included the Length of Stay (LOS) in the rehabilitation, days and hours of rehabilitation, the intensity of therapy and FIM. Generalized additive models and polynomial regression models were used to explore the link between therapy duration and motor FIM change. The patients were categorized by injuries. In the findings, change in Motor FIM was positively linked to the total number of therapy hours ($\beta = 0.40$, $p < 0.0001$) for a specific point in time that was adjusted based on gender, age, complications, injury and rehabilitation onset [42].

Modification in FIM suggested that the quality of the patient's day to day life improved with intervention, even though there was no full recovery. On the other hand, compared the effects of two rehabilitation programs on hand function in patients with incomplete cervical SCI. In the findings, the FIM score assessment indicated that there was an improvement in patients although it did not attain significant values ($P > 0.05$), [9].

2.6 Conclusion

This review provide an overview of spinal cord injury which is the injury of the spinal cord from the foramen magnum to the cauda equina which occurs as a result of compulsion, incision or contusion. As a result of the injury, the functions performed by the spinal cord are interrupted at the distal level of the injury. Pathophysiology was clarified, neurological outcomes of spinal cord injury also have been illustrated. The ASIA standard for neurological and functional classification is the recommended preferred tool, Previous studies related to the effect of rehabilitative nursing practices on the progress of spinal cord injury are very few .

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