การทดสอบระยะการเอื้อมมือเพื่อระบุการหกล้ม ความสามารถในการเคลื่อนย้ายตัว และความสามารถในการทำกิจกรรมในผู้ป่วยบาดเจ็บไขสันหลัง

THE FUNCTIONAL REACH TEST FOR IDENTIFYING FALLERS, AMBULATION, AND FUNCTIONAL ABILITY IN PATIENTS WITH SPINAL CORD INJURY

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THE FUNCTIONAL REACH TEST FOR IDENTIFYING FALLERS, AMBULATION, AND FUNCTIONAL ABILITY IN PATIENTS WITH SPINAL CORD INJURY

WITTAYA DUANGNGA

A Thesis Submitted in partial Fulfillment of Requirements

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BY

WITTAYA DUANGNGA

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Title	THE FUNCTIONAL REACH TEST FOR IDENTIFYING FALLERS, AMBULATION, AND FUNCTIONAL ABILITY IN PATIENTS WITH SPINAL CORD INJURY
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The objectives of this study are to explore whether or not the functional reach test (FRT) in a sitting position could discriminate between people with a history of falls, ambulatory or non-ambulatory status and to investigate the correlation between FRT and the functional ability assessed by the Spinal Cord Independence Measure Version III Thai version (th-SCIM III). The study included sixty-five participants with spinal cord injuries (SCI). The FRT was used to assess all of the participants. Furthermore, they were interviewed about their history of falls, ambulatory status, and th-SCIM III by using a questionnaire. The receiver-operating characteristic (ROC) was used to calculate the FRT cut-off score and the Pearson correlation coefficient was used to evaluate the correlation between the FRT and th-SCIM III. These findings showed that the FRT cut-off score of participants with SCI did not accurately discriminate between people with SCI who had history of falls (area under the curve; AUC = 0.51) but could accurately discriminate the ambulatory status using the FRT cut-off score at 10.17 cm. (AUC = 0.78) with a high level of sensitivity (78.90%) and specificity (78.30%) for identifying SCI patients with who ambulation with aid devices. Moreover, the study showed a weak correlation between the FRT and th-SCIM III. (r = 0.325) In conclusion, this study suggested that the FRT score cannot be used to discriminate between people with a history of falls among participants with SCI. However, the study suggested that the FRT score can be used to discriminate between the ambulatory status of participants with SCI. This information was useful in planning the rehabilitation programs to reduce the risk of falls. Moreover, these results can help the rehabilitation teams to select the most appropriate ambulatory mode and devices for patients with SCI.

Keyword : Functional reach test, History of falls, Ambulation, Spinal cord injury

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Finally, I would like to express my sincere gratitude and appreciation to my dear parents, who gave me a chance to study and provide strongly support to me.

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INTRODUCTION

1. Background

Spinal cord injury (SCI) is referred to any damage to the spinal cord which caused by traumatic and non-traumatic injuries. The incidence of SCI varies around the world and most of them are adolescents who just reach adulthood. (1, 2) The severity of the symptoms depends on the level of damage and the stage of the injury. (2) Most patients have moderate to severe injuries that limit their abilities and increase the risk of medical complications and falls. (3) The consequences of SCI lead to loss or impaired sensory, motor and autonomic functions that affect their daily activities, balance and ambulation. (4, 5) The impaired motor and sensory functions result in abnormal muscle tone, reduced muscle strength, and loss or reduced sensation that leading to impaired ability to perform daily activities as well as having a high risk of falls. (6) Most patients with SCI tend to ambulate by wheelchair in their community. (7) Thus, wheelchair skills are necessary to train in the rehabilitation programs. According to Gao et al. (2015), forward and backward weight shifting is a necessary skill for initiating wheelchair activities in daily living. (8) Patients who can perform functional activities in a wheelchair must have at least good sitting balance control. (9, 10) Those with better dynamic sitting balance control will be able to achieve higher ambulatory status such as walking with assistive devices or independent walking.

Balance performance is necessary to be evaluated in patients with SCI. The balance control involves the patients to maintain, achieve, or restore a state of stability during any activity. Appropriate balance control to avoid falls depends on the integration of various sensory inputs, and the interaction of the body with the changing environment. (11) The assessment of sitting balance is useful to plan and monitor treatment strategies for discharge planning that is high importance in clinical settings. (12) The Functional Reach Test (FRT) is the balance test that is administered in sitting position. This test assessed the ability to reach forward as far as possible without losing balance and often used to assess balance control that is related to performing daily activities in a wheelchair of patients with SCI. (13) Srisim et al. (2015) reported that standing FRT testing can predict the incidence of multiple falls in patient with incomplete SCI (iSCI). (14) Moreover, the previous study founded that the incidence of falls related to injury in patients with SCI, especially while performed wheelchair activity. (15) Srisim et al. (2015) reported that standing FRT distance between the non-faller and the multiple faller patients with iSCI was significantly different. (14) They reported that the standing FRT could be used to discriminate between patients with iSCI who had a single fall and who had multiple falls. They suggested that the cut-off score was 20 cm, leading to multiple falls in ambulatory patients with iSCI. (14) However, this study did not show the standing FRT cut-off score that can distinguish between patients with SCI who had and did not have experienced falls.

Fall in SCI is defined as an unintentional change in position resulting in coming to rest on the ground or other lower level. (16) Krause et al. (2004) reported that 19% of patients with SCI experienced subsequent injuries from a variety of causes including falls each year. (17) Brotherton et al. (2007) illustrated that 75% of ambulatory patients with SCI sustained at least 1 fall a year. (6) In Thailand, the incidence of falls (during 6 months after discharge) in patients with SCI who were wheelchair ambulatory was 36% and increased to 54% in independent ambulatory patients with SCI. (3, 16, 18) Phonthee and the colleges (2013) reported that independent ambulatory subjects with SCI who had a history of falls during 6 months showed significant higher abilities than the non-faller. They suggested that the subjects who had a retrospectively falls had increased exposure to fall opportunity. (19) Wannapakhe et al. (2014) prospectively evaluated changes in functional ability relating to fall in patients with SCI. The study reviewed that subjects who fell during 6 months after discharge had statistically improvement in all functional ability. (18) They suggested that fall was positively correlated with increased long-term gains in functional ambulatory skills. The results from this study suggested that falls in patients with SCI were related to their functional abilities. (18)

After SCI, ambulation ability and functional ability recovery are the aims of rehabilitation. (20) The ambulation status and functional ability depends on the level of injury, severity of the injury, motor recovery, and balance performance. (20-25) Van Hedel and colleges (2009) suggested that more than 80% of patients with SCI recovered their ability to walk after rehabilitation. (26) However, the quality and degree of their ambulation is likely to be limited to perform without assistive devices. (22) Therefore, the patients with SCI are commonly to use assistive devices such as canes, crutches, and walkers. The assistive device is useful to reduce lower-limb loading that help to decrease the compensation of lower extremities muscle weakness. Moreover, the device is advantage to somatosensory feedback and increase the body base of support (27) that improve balance control in independent ambulatory. (22) At present, the patients with SCI have a shorter length of stay in a hospital because the hospital tends to discharge the patients faster. Therefore, the patients may not achieve optimal ability at the time of discharge and expose to a high risk of falls after discharge. (28) Thus, the test that easy to use and can predict the ambulatory status in patients with SCI is necessary. According to Saensook et al. (2013), they evaluated the three functional assessment tools (10-meter walk test; 10MWT, the five times sit-to-stand; FTSST, and the timed up and go test; TUGT) for discriminative ambulation status. The results showed iSCI participants who were ambulation without assistive devices had a greater functional ability than those who needed assistive devices. (22) The previous finding was able to discriminate only iSCI participants but it cannot be applied to participants that unable to walk or standing independently. Thus, the FRT may be used to discriminate ambulation status.

The patients with SCI performed their activities in wheelchairs. More than 60% of patients with SCI rated trunk and arm function as priorities to improve functional independence and daily activities. (12) An unsupported short sitting position is limited their balance control to perform daily activities. (8) However, the previous study showed that the assessment of sitting balance control has focused on the maximum displacement of the center of pressure (29) that related with transfer. The sitting assessment includes the diagonal movements when performs transfer activities. Patients with SCI usually lean trunk forward to life their buttocks off the initial surface and quickly pivot the buttocks to the target surface using a twist motion. (8) Thus, the functional activities do not end in a single direction, but ended with a sequence of movement. The interesting point from the review was the sitting assessment is correlated with functional abilities in patients with SCI. A systematic review suggested that The Spinal Cord Independence Measure (SCIM) was appropriate for measuring functional ability regain in individuals with SCI. (30) SCIM is a functional abilities tool that was developed specifically for patients with SCI to evaluate activities necessary for the patients. (31, 32) There are three versions of the SCIM that include the first, the second, and the third version. (32) The SCIM III consists of three areas of functions, including self-care (20 scores), respiratory and sphincter management (40 scores), and mobility (40 scores). (33) The SCIM III has been translated into Thai language (th-SCIM III) and validated to measure overall activities relating to patients with SCI. (34) Finally, the SCIM III is modified to assess wheelchair skill and it adds a new item of transferring from the ground to wheelchair. Thus, the SCIM III might be related to sitting assessment. However, there was no evidence to support this hypothesis.

2. Objective of the Study

1. To determine whether the functional reach test can be used for identifying the participants with spinal cord injury who had and did not have a history of falls.

2. To determine whether the functional reach test can be used for identifying the participants who were ambulated with a wheelchair and walking with assistive devices.

3. To evaluate the correlation between the FRT and functional ability as measured by the Spinal Cord Independence Measure III Thai version (th-SCIM III) of patients with SCI who had and did not have a history of falls.

3. Research Hypothesis

The cut-off score of reaching distance as measured by functional reach test will be able to identify patients with SCI who had and did not have a history of falls. Moreover, the FRT can identify the patients who were ambulated with a wheelchair and walking with assistive devices. Finally, the FRT had a moderate or high correlation with the functional ability of patients with SCI who had and did not have a history of falls.

4. Benefit of the Study

The results of this study will expand the benefit of FRT to identify a history of falls, ambulation, and functional ability of patients with spinal cord injury. This information can be applied in the fall prevention, rehabilitation program, or home adaptation to improve the performance and quality of life in patients with SCI after discharge.

5. Definition of Terms

Functional Reach Test (FRT) is the dynamic sitting balance assessment tool which is measured in the forward direction.

Modified FRT (mFRT) is the sitting balance test that measured in eight directions including forward, backward, medial to right or left lateral and four-diagonal directions.

Motor complete SCI (cSCI) is the participant who was diagnosed by the American Spinal Injury Association Impairment Scale (AIS) A and B.

Motor incomplete SCI (iSCI) is the participant who was diagnosed with AIS C and D.

6. Conceptual Framework

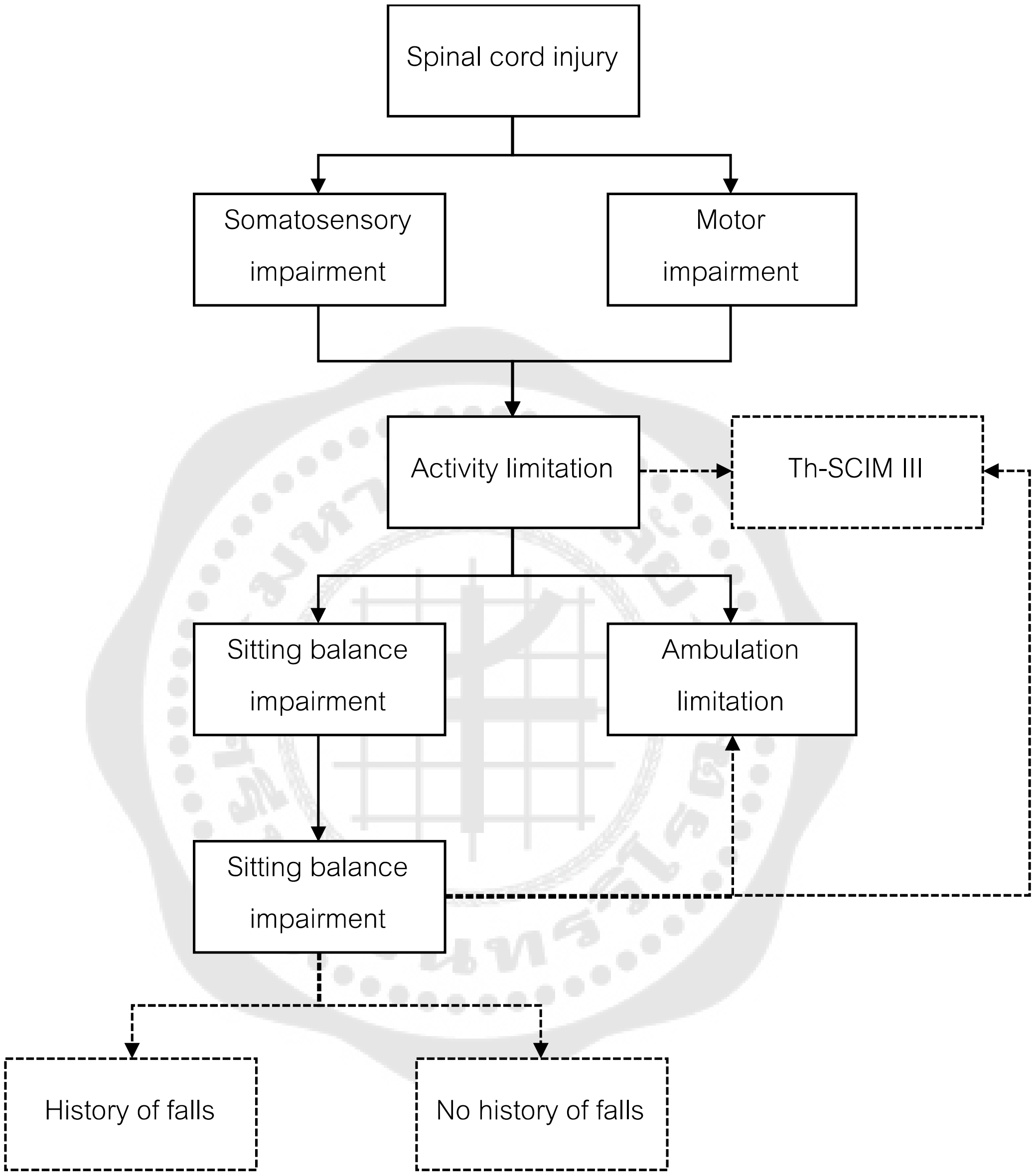

Figure 1 Conceptual framework

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature relating to the study. Details of this chapter include neuroanatomy of the spinal cord, Spinal cord injury (SCI), postural control, functional ability, ambulation status, falls in SCI, balance measurement tools and functional ability measurement. Details of each topic are as follows;

1. Neuroanatomy of spinal cord

The spinal cord is a part of the central nervous system (CNS) located within the spinal canal of the spinal columns. Three membranes cover the cord which include dura mater, arachnoid mater, and pia mater. (35, 36) There are thirty-one pairs of the spinal nerve root that divided into five segments. Each segment has an anterior/ ventral root and posterior/ dorsal roots. Eight spinal nerves locate at the cervical segment which control nerve signal of the head, neck, hand, arm, and diaphragm muscles. Twelve spinal nerves locate at the thoracic segment which control chest, respiration and abdominal muscles. Five spinal nerves locate at the lumbar segment that controlled lower limb muscles. Five spinal nerves locate at the sacral segment which control bowel and bladder functions. Finally, the coccygeal segment has a function to control sexual function. (5, 35-37) The spinal nerves include sensory and motor fibers.

The sensory fibers are divided into two major groups that include the general somatic afferent (GSA) and the Interoceptive general visceral afferent (GVA). The GSA contains the cutaneous receptors and proprioception receptors. It locates within muscles, tendons, and joints. The GSA divides into Exteroceptive GSA and Proprioceptive GSA. The Exteroceptive GSA is derived from two sensory units that affect muscles or tissue injuries. (5) Moreover, Exteroceptive GSA stimuli sensation from the skin that includes chemical, temperature, and mechanical stimulus. The sensation signals through the A-δ and C-fiber with myelinated and unmyelinated fibers. The discriminative touch or vibration sensation unit conducts the nerve signals through the A-β with myelinated fiber. (5) The Proprioceptive GSA is the proprioception sense. The information which receives from the sensory receptors of the muscles, tendons, and joints is sensitive to stretch or pressure, through the Ia, Ib, and A-β fiber. (5) The GVA is a sensation of the internal organs. The sense organs are located in the chest, abdomen and pelvic region. Sensitive to pain stimulants through the splanchnic nerve enters the sympathetic chain and connects to the white communicating ramus before entering the spinal cord. (5, 36)

The motor fibers are divided into two groups that included control of skeletal muscle and autonomic nerves system. They are controlled of smooth muscle, cardiac muscle, and endocrine system. Somatic fiber is the control of striate or skeletal muscle function through the signal from the CNS. The neuron enters in the anterior of gray matter, through the anterior root and conjugate the posterior root. This is a part of the formation of the spinal cord with myelin and the end of the connective tissue to the skeletal muscles. This location calls the neuromuscular junction (NMJ). (5) The autonomic nervous system is divided into sympathetic and parasympathetic. Sympathetic fibers are located in the thoracic segment to the second lumbar segment. The most sympathetic nerve cells regulate smooth muscle. Sympathetic function controls the vasoconstriction that increases total peripheral resistance to all arteries and increases blood pressure. While, parasympathetic fibers originate from the sacral region. (5, 36) The signal of the spinal cord includes;

1.1 Spinal tracts

The spinal cord consists of two portions which are white and gray matters. The white matter is covered around the gray matter. Gray matter consists of nerve cell bodies with unmyelinated axon, motor, sensory, and interconnection neuron. (35) The spinal tract is divided upon the nature of nerve transmission. (36) The details are as follows;

1.1.1 The descending tracts

1) Pyramidal tract (Corticospinal tract) includes 1/3 nerve fibers of the premotor cortex (Brodmann 6) and 1/3 nerve fibers of the parietal lobe (Brodmann 3, 1, 2). The descending fibers pass the corona radiate and posterior limb of the internal capsule. Then this fiber passes the middle 3/5 of crus cerebi in the midbrain.

The corticospinal tract controls upper and lower extremities which the medial part of fiber controls upper extremities and lateral part of fiber controls lower extremities. (4, 38)

2) Rubospinal tract is developed by a part of the red nucleus and descends crossing to contralateral. The tract exerts excitatory on flexor muscle tone and inhibits extensor muscle tone. (5)

3) Reticulospinal tract is originated from the medullary reticular formation and descends to the ipsilateral of the spinal cord. The tract integrates motor signals to coordinate automatic movements of locomotion and posture. (5)

4) Vestibulospinal tract is a part of the vestibular system to maintain head-neck and eyes coordination, upright position, and balance. The vestibulospinal tract is responsible for control the upright position and stabilization of the head. If the body is a small movement, the sensory neuron sends nerve signals to CNS. Vestibulospinal tract instructs motor nerve signals to specific muscles to counteract these movements and return the body to a stable state. (36)

5) Tectospinal tract originated from the neurons in the deeper layer of the superior colliculus of the midbrain. This tract is the ventromedially and dilated periaqueductal gray. After that, it crosses within the dorsal tegmental decussation and descends into the medial part of the ventral funiculus of the cord, which ventral to the medial longitudinal fasciculus (MLF). The tectospinal fibers are combined with MLF at medulla levels and located near the anterior median fissure. (4, 5) The tectospinal tract controls reflex and postural movements of the head that respond to visual and auditory stimuli. (4, 5)

1.1.2 The ascending tracts

1) Dorsal column carries the fine touch, proprioceptive and vibratory senses. The sensory signals in dorsal root ganglia and the first-order neuron consist of signals from the gracile fasciculus (lower limbs) and cuneate fasciculus (upper limbs), which transmitted to second-order neurons and crossing within medulla oblongata. The second-order neurons synapse with the third-order neurons arise in thalamus continue to the primary sensory cortex (postcentral gyrus). (4, 38)

2) Lateral spinothalamic tract submits a sensory signal to the primary sensory cortex for interpreting pain and temperature sensibilities. Transmitting nociceptive and thermal signals input to the dorsal root ganglion, which entry to second-order neuron in the dorsal gray horn and crossed to the other side within 1-2 segment. Later on, transmitted to a third-order neuron at the thalamus and follow to the primary sensory cortex. (4, 38)

3) Anterior spinothalamic tract is transmitting a crude touch and pressure signals to the primary sensory cortex for interprets crude tactile and pressure modalities. The process is similar to the lateral spinothalamic tract. (4, 38)

4) Spinocerebellar tract is an ascending pathway to transmit proprioceptive signals associated with fine coordination of limb movement. (38)

2. Spinal cord injury

Spinal cord injury (SCI) is occurred from a direct and indirect force which mostly causes by accidental injuries, falls, bodily injury, and neurological diseases. The previous study showed that there were 100 patients with spinal cord injury accounted with road accidents for 62% of all spinal injuries. (1) Moreover, Choochart et al, (2015) investigated the quality of life of SCI patients in north-eastern Thailand. They found that 77.4% of the subjects were caused by road accidents. The severity of the symptoms depends on the level of damage and neuro recovery. (2) The incidence of SCI vary around the world and most of them are the adolescence and reaching adulthood. (1, 2)

After SCI within 48 hours, the patients will absent balbocavernosus reflex (the anal contraction) and the anal wink (the skin of the anal contraction). They imply to complete cord lesion but the reflex appeared represents incomplete cord lesion. (4) Period from 6 to 9 months after injury was found the higher level of neurological recovery. After 1 year post injury, the neurological recovery rate was founded but had slow recovery. (39) Moreover, SCI also affected the sensorimotor and autonomic functions. According to sensorimotor and autonomic dysfunction, it induces the patient's impaired or loss of functional ability especially, balance and mobility. After that, the patients are at high risk of complications and fall. (6, 40)

2.1 Classification of Spinal Cord Injury

2.1.1 Classified by Neurological level

1) Quadriplegia or tetraplegia presents the paralysis of both arms and legs which has an injury at the cervical level. Most of them can recovery motor function in the lower extremities less than upper extremities. (39)

2) Paraplegia shows the paralysis just only in the lower extremity. The neurological level is below T2. They can use upper extremity by themselves. Therefore they can perform independent wheelchair transfer and ADL. (39)

2.1.2 American Spinal Cord Injury Association Classification (ASIA)

ASIA consists of 2 parts that include sensory and motor assessment. There are 5 grades which consist of grade A (complete cord) to grade E (normal). (39) The details of each grade are as follows in table 1.

1) Sensory assessment includes light touch and pinprick that assess bilaterally at 28 dermatomes from C2 to S4-5. (39)

2) The motor assessment evaluates manual muscle testing of 10 key muscles (5 uppers and 5 lower extremities). Each key muscle represents myotome of C5-T1 to L2-S1. (38) There are 5 grades to define muscle test. The range scale from 0 (total paralysis) to 5 (normal). (39)

Table 1: The ASIA classification

GRADE	DEFINITION
A	Complete: loss of motor and sensory function is preserved in the sacral segments S4-5
B	Incomplete: sensory impaired but motor function not presents includes the sacral segments S4-5

Source: Burns AS, Marino RJ, Flanders AE, Flett H. Clinical diagnosis and prognosis following spinal cord injury. In: Handbook of Clinical Neurology

Table 1: (Continued)

GRADE	DEFINITION
C	Incomplete: motor function is presented; muscle below neurological level less half of key muscle have a muscle ≤ grade 3
D	Incomplete: motor function is presented; muscle below neurological level least half of key muscle have a muscle ≥ grade 3
E	Normal: sensory and motor function are normal

Source: Burns AS, Marino RJ, Flanders AE, Flett H. Clinical diagnosis and prognosis following spinal cord injury. In: Handbook of Clinical Neurology

3. Postural control system

In generally, Postural control systems are achieving goals depend on the integration of the Central Nervous System (CNS). (41) Postural control occurs in response to ground reaction force (GRF) act on the body moving the center of mass. (42) within the base of support. (27, 41, 43, 44) Postural control adaptation is emerging a complex interaction of balance system consists of 3 major systems. Firstly, the sensory function system consists of 3 major sensory systems which are contributed to posture control (visual system, vestibular system, and somatosensory system). (41, 45)

The visual system is controlled by the visual field and stimulates head movement that related to the environment. (43, 45) The vestibular system is directly controlled head position to detect linear acceleration and deceleration of head position within reference line of gravity and follow by stimulating hip ankle strategy for keeping the body upright position. (41, 43) The somatosensory system is the multi-sensory inputs such as cutaneous, pressure sensation and proprioception sense. (41, 44) The signal inputs is investigates for selecting posture body schema movement to maintain posture balance. (43) Secondly, motor function system is contributed by the sensory signal inputs to CNS and select a set of posture body schema control respond to the environment for the muscular system, such as the control of the hip ankle strategy and direct control of the head and neck muscle for control head position for keeping normal alignment and control the body position within base of support. (27, 43) Finally, the CNS integrations are investigates of the sensory inputs from the various systems involved the body balance. For example, the patients who lose balance, the somatosensory inputs are primarily transmitted to the central nervous system. If somatosensory impaired, the vision system is prioritized to transmit information to the central nervous system to deliver the body's balance. (41) Limits of stability (LOS) refer to the maximum distance that a human can reach within the base of support without loss of balance. (10)

Center of mass is the middle point of the length of stay that minimal sway in the mediolateral, lateromedial, anteroposterior, and posteroanterior directions while walking or standing. The LOS in sitting position is larger than standing position because of sitting position has wild base of support. (41) After SCI, the patients will lose or impair the spinal cord function of both descending and ascending spinal tracts. The motor fibers degenerate below the lesion and sensory fibers degenerate above the lesion. (5, 36) The postural control measurements assess the position of the center of pressure. (41, 46) The center of mass refers to symmetry and asymmetry posture in each patient with various pathology that effect on balance control. (41) Lemay JF et al., (2014) measured maximum excursion in multidirectional standing limits of stability between individuals with incomplete SCI (iSCI) and able-body. (46) The result showed that the dynamic postural control of incomplete SCI subjects differentiated from able-body. Moreover, the iSCI subjects showed that widely movement of the center of mass than able-body subjects. This performance reflected among individuals with incomplete SCI lack of precision when reaching. (46)

Moreover, the previous study evaluated the relevant balance that assessed the center of mass parameters. The study found that the center of mass parameters were valid with clinical scale test (Berg balance scale; BBS, Tinetti scale, and Walking index for Spinal cord injury; WSIC). (47) According to Cindy et al. (2013) studied sitting balance in patients with SCI and able-body individuals. The subjects seated in a different direction. The study found that multidirectional seated postural stability in individuals with SCI reduced more than subjects with able-body individuals. (10)

4. Functional ability

Functional ability recovery had various factors for archived functional independently. According to Hasting et al. (2015) they reported that the factor was influenced functional ability in patient with SCI after discharge. The balance performance had a majority in functional recovery and help them to archive functional tasks independently. (18, 21, 48) Other than that, such as level of injury, the severity of the injury, and motor recovery had another factor that should be considered for the ability to change activities. (18, 21, 48) Among SCI, balance control was important. The SCI need rehabilitation for new movement or strategy for control balance. (21) The balance impairment in SCI was difference that depend on the severity and level of injury. (21) Most of individuals with cSCI perform ADL in a wheelchair and a few individuals were a functional ambulatory with assistive devices. (21) While iSCI, they were an opportunity to functional ambulation with or without assistive devices to perform ADL. The highest goal that could be achieved and balanced performance as in table 2. Previously, Wannapakhe et al. (2014) they studied the functional ability change after discharge among individuals with SCI. The previous finding showed after discharge the functional ability was improving that measured by TUGT, 10MWT, BBS, and 6MWT at 6 months after discharge. (18) After 1 year, they founded that functional ability between cSCI and iSCI was a difference. (34) The study used th-SCIM III discriminated functional ability, the finding showed iSCI greater functional ability in all items including self-care, respiratory and sphincter management, mobility in room-toilet, and mobility indoor-outdoor. In addition, functional ability levels were one of the factors that induced the patient exposure to fall. (18, 19) Which a cause of complications such as fear of falling, decreased social participation and including medical complications such as bruising, bones fractured, may lead to unconsciousness. (3, 18)

Table 2 Functional ability level and Ambulation ability level.

Level of injury	Physical ability	Sitting balance	Functional ability	Ambulation ability
Cervical level 1 - 3 complete SCI	Unable to control the neck body and diaphragm.	Unable to sit with unsupported. Individuals still absent the protective and righting reaction	Impaired or non-function of the diaphragm, ventilators had needed and need a caregiver for help in all ADL.	Dependent a manual wheelchair and/or electrical wheelchair were adaptive.
Cervical level 4 complete SCI	Able to control some movement of the neck, shoulder elevation, and diaphragm.	Unable to sit with unsupported. Individuals still absent the protective and righting reaction	Individuals in this level regain partial control of the diaphragm. Must be need breathing exercise and need a caregiver for help in all ADL.	Dependent a manual wheelchair and/or electrical wheelchair were adaptive.

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001.

Table 2 (Continued)

Level of injury	Physical ability	Sitting balance	Functional ability	Ambulation ability
Cervical level 5 complete SCI	Able to control the movement of the neck, shoulder elevation, some control shoulder joint movement, and elbow	Able to control some sitting balance. The righting reaction had very limited.	Individuals are able to perform some ADL independently such as feeding, brush teeth with an adaptive device.	A manual wheelchair had limited.
Cervical level 6 complete SCI	Like a C5 level but able to control wrist extension.	Able to be sitting balance with elbow locking support had needed, the righting reaction had slightly decreased.	Feeding, dressing and cleaning the upper part of the body had performed independently. Pressure relieves during sitting	Manual wheelchair indoors and outdoors (short distance) had archived.

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001

Table 2 (Continued)

Level of injury	Physical ability	Sitting balance	Functional ability	Ambulation ability
Cervical level 7 complete SCI	Like a C6 level but able to control elbow flexion.flexion	Some individuals can be sitting unsupported. (static sitting balance)	ADL independent with a need or didn't need an adaptive device	Manual wheelchair indoors and outdoors had archived.
Cervical level 8 – thoracic level 1 complete SCI	Like a C7 level but able to control grasp and fine motor movement.	Independently sitting in long sitting. Some individuals had an adequate righting reaction in high sitting with unsupported	ADL independent and limited some wheelchair activities.	Manual wheelchair indoors and outdoors had archived.
Thoracic level 2 - 6 complete SCI	Able to control upper limb movements and some upper trunk muscle depend on the level of injury.	Limited dynamic sitting. Some individuals able to maintain dynamic sitting balance without loss of balance	ADL independent. Some individuals can transfer floor to wheelchair or wheelchair to floor	Manual wheelchair indoors and outdoors had achieved. Some individuals can stand and walk for exercise with the appropriate orthotics and assistive devices.

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001

Table 2 (Continued)

Level of injury	Physical ability	Sitting balance	Functional ability	Ambulation ability
Thoracic level 7 - 12 complete SCI	Able to control upper limb movements and some upper trunk muscle depend on the level of injury.	Limited dynamic sitting. Some individuals able to maintain dynamic sitting balance without loss of balance	ADL independent. Some individuals are able to transfer the floor to a wheelchair or wheelchair to the floor.	Manual wheelchair indoors and outdoors had achieved. Some individuals able to functional ambulation with the appropriate orthotics and assistive devices.
Lumbar level 1 - 2 complete SCI	Able to control the upper body, trunk movement, and some movement of lower extremity depend on the level of injury.	Independent sitting balance	ADL independent. Some individuals are able to perform fully wheelchair activities.	Some individuals able to functional ambulation outdoors with the appropriate orthotics and assistive devices.

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001

Table 2 (Continued)

Level of injury	Physical ability	Sitting balance	Functional ability	Ambulation ability
Lumbar level 3 - 5 and sacral level 1 complete SCI	Able to control the upper body, trunk movement, and some movement of lower extremity depend on the level of injury.	Independent sitting balance	ADL independent. Some individuals are able to perform fully wheelchair activities	Some individuals able to functional ambulation outdoors with the appropriate orthotics and assistive devices.
Sacral level 2 - 5 complete SCI	Able to control lower extremity but impaired of the excretory system and reproductive system	Independent sitting balance	ADL independent. Able to perform all functional closely normal.	Functional ambulation with or without assistive devices.

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001

5. Ambulation status

Ambulation status in the current study defines as an ambulation aid device included wheelchair, cane, crutches, and walker. Generally, individuals with neurological conditions must use assistive devices to maintain balance and achieved ambulation tasks. (49) Among ambulatory SCI should be ambulation with assistive devices. (3, 18, 34) The most cSCI often ambulation with wheelchair and iSCI often ambulation with walking aid devices and appropriate orthotics. (table 3) (3, 21, 34) Which each type of walking aids has different benefits and disadvantages.

5.1 Wheelchair

A wheelchair is majority of mobility devices that consists of the four-wheel and seats for improving mobility among people with mobility deficits especially patients with spinal cord injury. (50, 51)

The components of a wheelchair are consisting of large two wheels and small two wheels. A seat pad attached between the large two wheels. There are backrest, brakes system, armrests, footrests, and push handles. (Figure 2)

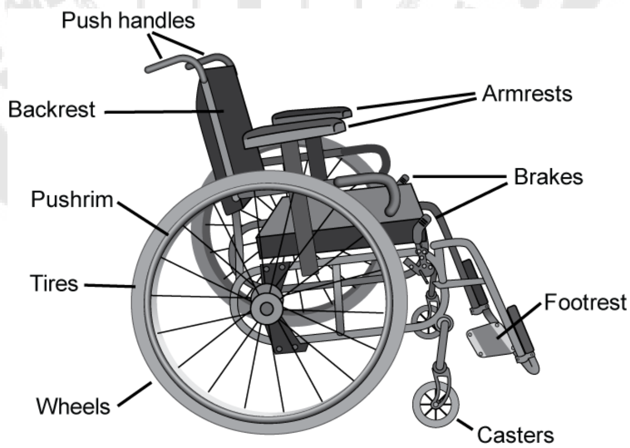

Figure 2 Feature of wheelchair

Source: Boninger M. The manual wheelchair: What the SCI consumer needs to know. 2011 01/01.

5.1.1 The benefits of a wheelchair

1) Providing health and quality of life: an appropriate wheelchair that reduce common complication such as pressure ulcer, shoulder pain, and improve respiratory function. (51)

2) Improved mobility: a wheelchair that improve mobility its help them to transfer and perform activities daily living life independently. (51)

3) Improved self-confidence: the suitable wheelchair that improved functional performance and help them pound to do everything by themselves. (51)

5.2 Canes

A Canes are a simple ambulation aid device for improving balance during walking. A Cane is appropriate for individuals who have fair to moderate level of walking deficits. (25, 49, 52) Most patients use a cane held on the unaffected leg. (52, 53) Canes designs for supporting body weight and transfer lower limb load to the upper body. (49) During a cane load, the sensory feedback from the walking surface is increasing balance and postural stability. (52) (Figure 3)

Figure 3 Cane

5.3 Crutches

There are four common types of crutches (axillary crutches, triceps crutches, forearm crutches, and platform crutches). (53) A crutches was designs to supported body weight, wide base of support than a cane. The gait pattern was selected depends on motor function performance. (52) Individuals with SCI often used crutches for ambulation with four-point gait, swing-through gait, swing-to gait. (52, 54) Crutches ambulation faster gait than walker. (52) (Figure 4)

Figure 4 Crutches

5.4 Walker

A walker often used for improving mobility, providing bilateral support in an individual with balance impairment and limited physical activity. (49, 52) A walker appropriate with who those had poor balance control and needs maximum stability. (49, 52) Walker can reduced load into lower extremity. (52) (Figure 5)

Figure 5 Walker

Although, most of cSCI was ambulation with a wheelchair. But still experiencing the incidence of falls. (3, 21, 34) Fall event performed during wheelchair activity. (3, 21, 34) In individuals with iSCI, fall incidents occur during walking. (3, 21, 34) Muscle weakness, loss of balance, and environment hazard was a typical factor of fall in both of cSCI and iSCI. (3, 21, 34) According to Lee et al. (1995) study, the effect of body position was one factor that maintains wheelchair stability. (55) The previous study showed reaching forward had a majority effect on wheelchair stability. (55) Suwannarat et al. (2015) reported that walking aids had beneficial to the elderly who have a loss of balance. Walking aid devices can help the elderly do various activities by themselves without loss of balance. (25) Thus, choosing the appropriate ambulatory devices was reducing the risk of falling in patients who lose balance. (25, 49) The appropriate ambulation devices an individual with SCI had a difference.

Table 3 The appropriate ambulation devices and orthotics for each level of injury

Motor level	Significant of innervated musculature	The suggestion of assistive devices	The suggestion of orthotic devices
Cervical level 8 and higher	In the case of cSCI the motor function is inadequate for ambulation.	Wheelchair	None
Thoracic level 1-9	Motor function of the upper extremity is fully function but trunk muscle also a weakness.	Crutches Walker	KAFO HKAFO
Thoracic level 10-12	The partial weakness of trunk muscle.	Crutches Walker	KAFO HKAFO
Lumbar level 1	Trunk muscle is fully function but minimal innervate of psoas major muscle.	Crutches Walker	KAFO HKAFO

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001.

Table 3 (Continued)

Motor level	Significant of innervated musculature	The suggestion of assistive devices	The suggestion of orthotic devices
Lumbar level 2	Partial innervate of psoas major, iliacus, sartorius, and pectineus muscle and knee flexor muscle.	Crutches Walker	KAFO AFO
Lumbar level 3	Fully function of iliacus, and pectineus muscle, partial innervate of the sartorius and gracilis muscle.	Crutches Walker	KAFO AFO
Lumbar level 4	Fully function of the sartorius, and gracilis muscle. Partial innervate of tibialis anterior muscle.	Crutches Cane	AFO
Lumbar level 5	Partial to nearly full function of tibialis anterior muscle.	Cane	AFO or none

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001.

Table 3 (Continued)

Motor level	Significant of innervated musculature	The suggestion of assistive devices	The suggestion of orthotic devices
Sacrum level 1	Partial innervate of gastrocnemius and soleus muscle	None	AFO if dorsiflexor muscle is inadequate.
Sacrum level 2	Full function of lower extremity muscle	None	None

Source: Somers MF. Spinal Cord Injury: Functional Rehabilitation. 2 ed. Prentic Hall, Upper Saddle River, New Jersey 07458: Julie Alexander; 2001.

6. Falls in spinal cord injury

Falls defines as that an unintentionally, unexpected event of person loses balance. Resulting in subsidence or rest on the ground or lower than a support surface. (3) After SCI, patients were a loss or impaired sensorimotor function that affected postural balance and motor function. These impairments are key factors to induce falls among individual SCI. (44, 56) Previous prospectively study showed the incidence of fall in wheelchair users. The study showed that 64% of participants had an experience of falls and 34% of fallers had an injury. (15)

6.1 The factors were associated with falls

6.1.1 Motor function impairment

A damaged of the corticospinal tract involved a motor pathway that limited motor neuron signal leading to impairment of muscle. The different types of muscle impairment, such as muscle weakness, muscle atrophy, a muscle tone change, and motor reflex, depend on a level of injury and area damage inner side of the spinal cord. (38) In the previous study found walking ability related with lower extremities strengthen, especially, lower extremities key muscle (ASIA assessment) (57) and strengthen of knee extensor, knee flexor modulate correlation with Five Times Sit To Stand because the tools are universal tools for evaluating lower extremities strengthen. (58) So, motor function recovery in incomplete SCI is important for walking ability and reduces the risk of falls.

6.1.2 Balance impairment

SCI damages sensory and motor pathways. The sensory pathways are the spinothalamic tract which represents vibration, touch, proprioception, pain, and temperature. The motor pathway is the corticospinal tract which represents muscle activity. The damaged sensory and motor pathways induce patients to lose or impaired sensory and muscle functions. (38)

6.1.3 Environment hazard

Environment hazard is the major extrinsic factor in the risk of falls in the elderly. (59) Amatachaya et al. (2015) suggested that the subjects who were success obstacle crossing tests could hypothesize that they did a great walking in a different environment. (60) The sensory-motor function was important for adaptation in walking with the various environment. (61) The study reviewed that 43% of faller subjects fell in their houses, and 38% fell outside their houses. (61)

6.2 Activity during fall

Wannapakhe et al. (2015) studied the incidence of falls in patients with SCI. The researchers divided the participants into 2 groups that included wheelchair users and independent walking with or without gait aids. The result showed that 92% of wheelchair users had experience of fall during performing activity in a wheelchair, 3% had fallen during the transfer from wheelchair to bed or bed to a wheelchair, and 5% had fallen during performing an activity on a chair or bed. Furthermore, the study showed that 100% of independent walking with or without gait aids had an experience of fall while walking. (3) Phonthee et al. (2013) reported that the patients with iSCI who used assistive devices had a high risk of falls. Moreover, the data showed that the patients with iSCI who were FIM-L6 and L7 classification had a high number of falls.

6.3 Consequences after falling in patients with Spinal Cord Injury

The previous study showed that 76% of incomplete SCI had experience of falls while walking and 64% of wheelchair users. (15, 61) The consequences after the fall include physical and psychological consequences. The physical consequences had a variety seriously such as a bruise, muscle sprain or fracture that limit mobility and reduce social participation. Brotherton et al. (2007) reported that 76% of faller subjects with SCI had a mild consequence after fall, included muscle pain or strain and ligament sprain. However, some peoples have severe consequences. The evidence showed that 18% of faller subjects had fractured and 3% of subjects were loss of conscious (6). Moreover, consequences after fall could induce a faller to need medical attention, a decrease of functional abilities, decrease social participation, and increase psychological consequences like fear of falls. (3) Therefore, a falls prevention program in SCI is importance for reduces complications, mortality rate, and re-hospitalization rate of the patients. (3)

7. Balance measurement tools

7.1 Berg Balance scale (BBS)

Basically, the BBS is not only evaluated static or dynamic balance but, included measuring functional tasks ability. It includes the 14 items of static and dynamic balance which has a range of score between 0 to 4 points and the most score is 56 points. Therefore, several authors were offered the BBS as a gold standard for functional balance measurements. (62) The previous study showed that the BBS was of high reliability and validity in patients with neurological conditions. (63) For patients independent walking with iSCI showed high inter-rater reliabilities (0.83-0.98) (14, 56) and high correlations (≥ 0.60) with walking speed, Spinal Cord Injury Functional Ambulation Inventory (SCI-FAI), Timed up and go (TUG), Walking Index for Spinal Cord Injury (WISCI), Spinal Cord Independence Measure (SCIM) mobility section, Falls Efficacy Scale–International Version, motor scores, and weak correlation with Modified Functional Reach. (24, 56, 64) In contrast Forrest et al. (2012) found that the improvement of walking performance had weak correlations with the BBS (24) and consistent with Wirz et al. (2010). Moreover, Srisim et al. (2015) reported that the BBS had weak correlations with falls and unable to discriminate the multiple fallers. (14, 56)

7.2 Timed up and go test (TUG)

TUG is one of the functional balance assessment. (62) The test is used to measure balance during ambulation in patients with neurological conditions that mostly use in patients with iSCI. According to Lemay and Nadeau (2010) they evaluated the concurrent validity between BBS and TUGT. The finding showed that the normative data of individuals with paraplegia was19.7 second and tetraplegia was 14.6 second. (64) The TUGT had an excellent of intra-rater (0.979) and inter-rater (0.973) reliability (65). Moreover, van Hedel et al. (2005) found that TUGT was validated with walking performance. (65) The convergent validity data showed that TUGT had an excellent validity with the WISCI II (r = 0.76). (65) Moreover, Saensook et al. (2013) reported that individuals with SCI who ambulated with non-assistive devices had a greater TUG than patients with SCI who used assistive devices. (22) However, the literature showed that the TUGT able to measure balance performance and walking ability only in the independent ambulatory SCI but, limited to measure in wheelchair users.

7.3 Functional reach test (FRT)

The functional reach test was developed in 1990 to represent the movement of COP in the forward-backward direction within the base of support among dwelling populations. (66) The FRT is administered in standing position with the starting position in the natural standing, raising both arms at the shoulder level (90 degrees) (66) and extending the elbow. The assessment begins when the subjects reach forward as far as they can with safety. The total distance of trunk movement is measured at the acromion process from start to endpoints. (66, 67) The reliability of FRT in patients with spinal cord injury (68) demonstrated excellent reliability (ICC2,3= 1.00). (14) The limitation of FRT is that it cannot be used in persons who cannot stand independently.

Recently, the FRT was modified to assess in sitting position. The sitting position is assessed the movement of the center of pressure within the base of support in eight directions of patients with completed SCI. A starting position is sitting position with 90 degrees of hips, knees and ankle joints while flexing their shoulder at 90 degrees. (69) The participants were then asked to reaching forward in various directions as much as comfortable without losing balance. The ulnar styloid process was used as the anatomical landmark for reaching distance measurement. (69)

The present study defines the FRT in sitting position that measured in the forward direction.

8. Functional ability measurement tools

Functional ambulation defied as the walking ability with or without assistive devices, safety and sufficient carry out mobility associated with performing activities of daily living. (68)

8.1 Functional Independent Measure (FIM)

FIM is developed for the assessment level of disability of patients. (70) There are 18 items which include self-care, sphincter control, transfer, locomotion, communication, and social cognition. (70) The rating scores range from 0 to 7 for each item(70). The validity data of the FIM motor score and Barthel Index (BI) showed excellent validity (r = 0.92) in individuals with stroke. (71) Among SCI, the inter-rater reliability demonstrated excellent for complete and incomplete quadriplegia. (72) According to Ditunno et al. (2007), they founded excellent correlation between FIM and WISCI (r = 0.73 – 0.77), FIM and BBS (r = 0.72 - 0.77), locomotor FIM (LFIM) and WISCI (r = 0.88 – 0.92), LFIM and BBS (r = 0.86 – 0.89) in participants with iSCI. (42) Although FIM is able to assess mobility and functional balance, it still finds the ceiling effect of the cognitive ceiling effect (80 - 90%). (73) Thus, individuals with SCI did not have a problem with communication and social cognition. May FIM inappropriate for measure functional ability.

8.2 Barthel Index (BI)

The BI is designed to assess the basic activity daily of living (ADL) among patients with a neurological condition and musculoskeletal condition. (74) The test includes 10 categories that cover an area of ADL, bowel, bladder, grooming, toilet use, feeding, transfer, mobility, dressing, stairs, and bathing. (74) The BI is useful for assessing the disability in an individual with stroke. The previous study showed that the reliability of BI was excellent (0.83 - 0.91). (71, 75) The concurrent validity data was 0.92 and 0.94 compared with the FIM motor scale. (71) Uyttenboogaart et al. (2005) founded high sensitivity and specificity of the cut-off score in each level of disability based on the modified Rankin Scale (mRS). (76) Among SCI individuals, Kucukdeveci et al. (2000) presented inter-rater reliability was 0.77 and modified BI was a high correlation with ASIA motor assessment (r = 0.76) at discharge. (77) The limitation of BI was unable to detect a small change of functional ability. Moreover, the BI was unable to reflect the improvement of BI score in patients with SCI because the BI had a large scale to detect functional ability change. (30, 76, 78)

8.3 Quadriplegia Index of Function (QIF)

QIF developed to solve the limitation of BI, Gresham et al. (1986) designs the QIF that includes 10 items to measure ADL in individuals with SCI. (78) The rating score of each item has more detail than BI (table 4). The reliability of QIF was adequate-excellent inter-rater reliability (0.55 – 0.95). (78) Yavus et al. (1998) presented QIF excellent correlation with ASIA motor assessment (r = 0.91). (79) The responsiveness of QIF had moderate sensitivity (46%) for functional recovery after rehabilitation. (78) Nevertheless, Anderson et al. (2008) reported QIF had a ceiling effect in participants with a greater ability of hand function. (80)

Table 4: QIF items and component activities

Category		Component activities
I.	Transfer	1. Bed-Chair 2. Chair-Bed 3. Chair-Toilet/Commode 4. Toilet/Commode-Chair 5. Chair-Vehicle 6. Vehicle-Chair 7. Chair-Shower/Tub 8. Shower/Tub-Chair
II.	Grooming	1. Brushing teeth/managing dentures 2. Brushing/ Combing hair 3. Shaving (men) 4. Managing tampon (women)
III.	Bathing	1. Wash/ Dry upper body 2. Wash/ Dry lower body 3. Wash/ Dry feet 5. Wash/ Dry hair

Source: Gresham GE, Labi MLC, Dittmar SS, Hicks JT, Joyce SZ, Phillips Stehlik MA. The quadriplegia index of function (QIF): sensitivity and reliability demonstrated in a study of thirty quadriplegic patients. Spinal Cord. 1986; 24(1): 38-44

Table 4: (Continued)

	Category		Component activities
IV.	Feeding	1.	Drink from cup/ glass
		2.	Use spoon/ fork
		3.	Cut food (meat)
		4.	Pour liquids out
		5.	Open carton/ jar
		6.	Apply spreads to bread
		7.	Prepare simple meals
		8.	Apply adaptive equipment
V.	Dressing	1.	Upper indoor clothes on/ off
		2.	Lower indoor clothes on/ off
		3.	Upper outdoor clothes (heavy) on/ off
		4.	Socks on/ off
		5.	Shoes on/ off
		6.	Fasteners
VI.	Wheelchair activity	1.	Turn corners
		2.	Reverse direction
		3.	Lock wheelchair brakes
		4.	Propel wheelchair on rough/ uneven surface
		5.	Propel wheelchair on an incline
		6.	Move and position in a chair
		7.	Maintain sitting balance

Source: Gresham GE, Labi MLC, Dittmar SS, Hicks JT, Joyce SZ, Phillips Stehlik MA. The quadriplegia index of function (QIF): sensitivity and reliability demonstrated in a study of thirty quadriplegic patients. Spinal Cord. 1986; 24(1): 38-44

Table 4: (Continued)

	Category	Component activities
VII.	Bed activities	1. Supine-prone 2. Supine -long sitting 3. Supine-side 4. Side-side 5. Maintain long sitting balance
VIII.	Bladder program	Separate sets of score criteria for: A. Voluntary voiding 1. Toilet 2. commode B. Intermittent catheterization program C. Autonomic bladder program D. Indwelling catheter E. Ileal diversion F. Crede
IX.	Bowel program	Separate sets of score criteria for: A. Voluntary voiding 1. Toilet 2. Commode B. Suppository 1. Toilet 2. Commode/ Bed/ Chux pad C. Digital disimpaction 1. Toilet disimpaction 2. Commode/ bed disimpaction D. Digital or mechanical stimulation 1. Toilet 2. Commode/ Bed

Source: Gresham GE, Labi MLC, Dittmar SS, Hicks JT, Joyce SZ, Phillips Stehlik MA. The quadriplegia index of function (QIF): sensitivity and reliability demonstrated in a study of thirty quadriplegic patients. Spinal Cord. 1986; 24(1): 38-44.

Table 4: (Continued)

	Category		Component activities
X.	Understanding personal care	1.	Skincare
		2.	Diet/ Nutrition
		3.	Medication
		4.	Equipment
		5.	Range of motion
		6.	Autonomic dysreflexia
		7.	Upper respiratory infection
		8.	Urinary tract infection
		9.	Deep vein thrombosis
		10.	Obtaining human services

Source: Gresham GE, Labi MLC, Dittmar SS, Hicks JT, Joyce SZ, Phillips Stehlik MA. The quadriplegia index of function (QIF): sensitivity and reliability demonstrated in a study of thirty quadriplegic patients. Spinal Cord. 1986; 24(1): 38-44.

8.4 Spinal Cord Independence Measure (SCIM)

The SCIM was a disability measurement that evaluates the abilities to perform a task activity daily of living. (81) The original SCIM developed by Catz et al. a major tasks included self-care, respiratory and sphincter management, and mobility divided into subscale consists of 16 items. (81) The score was 0-100 of range scale each task-related based on an individual ability performing ADL. In 2001 the second version (SCIM II) was published, represents improves the sensitivity, reliability, and validity of spinal cord injury populations. (81-83)

Psychometric properties of Spinal Cord Independence Measure Version III (SCIM III) A systematic review suggests that the SCIM III respected a suitable psychometric properties performance and comprehensive functional abilities assessment outcome. (32, 82) The Rasch reliability index showed the intra-class correlation coefficient (ICC) was 0.91, and the ICC of The SCIM III was 0.94 to 0.97. (68,

83) The ICC of each domain was 0.941 for the self-care domain, 0.844 for respiratory and sphincter management domain, 0.945 for Mobility indoor domain and 0.956 for Mobility outdoor domain. (84) The internal consistency was 0.77-0.78. (84) The validity of SCIM III consisted of the correlation between SCIM III and FIM (r = 0.79). (83) Wannapakhe et al. (2016) translated SCIM III into the Thai version (th-SCIM III). Th-SCIM III had excellent inter-rater reliability (ICC > 0.90), good internal consistency (Cronbach'salpha ≥ 0.88), and able to discriminate people with a complete and incomplete injury. (34)

CHAPTER 3
METHODOLOGY

This chapter explained materials and methods of the study. It included study design and setting, population and sample size, procedure and instruments, data analysis, and statistical analysis. Details of each topic were as follows;

1. Study design and Setting

This study was a crosss-sectional study which investigated the reaching distance by the Functional Reach Test (FRT), history of fall and ambulation by the questionnaire, and functional ability by the Spinal Cord Independence Measure Thai version (Th-SCIM III). The study was conducted in patients with SCI who were admitted to a rehabilitation ward of the Thai Red Cross Society, Samut Prakan, The Pattaya Redemptorist Technological College for People with Disabilities, Chonburi, Nonthaburi, Center for Independent Living, Nonthaburi, Pathum thani Center for Independent Living and the Industrial Rehabilitation Centre, Pathum thani, Thailand.

2. Population and Sample size

This study recruited patients with SCI using below inclusion criteria;

1. Patients aged at least 18 years with complete and incomplete spinal cord injury.
2. Patients with SCI at sub-acute or chronic stage of injury.
3. Able to sit independently at least 2 minutes.
4. Patients adequate muscle force to maintain shoulder flexion at 90 degrees with the elbow fully extension.

Participants were excluded from the study as follows;

1. Spinal cord injury from a progressive disease.
2. Medical conditions or disorders that might affect the study such as.
3. Pressure sore at the bottom.

4. Bone fracture such as shoulder fracture that limited shoulder flexion, and hip fracture limited hip flexion at 90 degrees during sitting.

5. Musculoskeletal pain of upper limb and back (VAS ≥ 5/10).

6. Unstable cardiopulmonary condition which was diagnosed by a physician such as postural hypotension.

7. Contracture or marked hypertonicity of upper limbs that limited the patients to lift their arm. Hypertonicity was indicated by Modified Ashworth Scale (MAS) of more than 3 scores (Considerable increase in muscle tone, passive movement difficult). (85)

All subjects read and signed an informed consent document approved by the Ethics Committee for Human Research prior to participate in the study (Appendix A). This study investigated the reaching forward distance using the FRT to differentiate patients who had and did not have a history of fall. The Convenience sampling technique was used in this study. Sample size was calculated with the formula. (86)

$$n = \frac{Z^2_{\alpha/2} P(1-P)}{e^2}$$

The power of analysis was set at 80%, alpha value of 0.05, Sensitivity of tool according to previous study of 73%. (14) This was led to a total of 76 participants with SCI to participate in this study.

3. Procedure and Instrument

The data was collected within one day. Participants was assessed by two physical therapists who had experience in the field of SCI rehabilitation. Health screening, history of falls and ambulation, and functional ability was gathered by one physical therapist (A1) whereas FRT was measured by another physical therapist (A2). During assessment, the assessor prevented accidence or falls by closely stand beside the participants who wore the safety belt. Moreover, the assessor was trained to assess the FRT and functional ability tool before starting the collected data and evaluated their intra-rater reliability. The procedure to collect the data was carried out in the following order.

3.1 Health Screening

Baseline characteristics of the participants was assessed by the questionnaire. The questionnaire included the questions regarding age, gender, post injury time, stage of injury, level of injury, the severity of injury, cause of injury, medical conditions, level of pain, and MAS score (Appendix B)

3.2 History of falls and ambulation status

The history of falls and ambulation status of subjects with SCI was assessed by the questionnaire. The questions of falls history were modified from the literature about falls in patients with SCI that included incidences, time, places, and consequences of falls. (3, 18) The falls history in the past year was collected by interview. The question of ambulation status included wheelchair ambulation, walking with assistive devices and independent walking. This questionnaire was assessed for its content validity by the expert. (Appendix C)

3.3 Functional Reach Test (FRT)

The FRT was administered to assess sitting balance in term of limit of stability (10) of subjects using unilateral reach forward. (67) Subjects started from sitting unsupported with 90 degrees of hips and knees joints while feet supported on the floor (69) The non-dominant hand placed on the umbilicus in order to minimize arm support (Figure 6A). Then, subjects used a dominant arm to flex their shoulder at 90 degrees with the elbow fully extended and reached forward as far as possible without losing their balance. (69) The buttock touched the chair and the body did not twist and hold at the furthest point for 3 seconds (Figure 6B). The ulnar styloid process was used as the anatomical landmark for reaching distance measurement (69) The difference in reaching distance between the starting position and the maximum distance excursion was recorded. (8) The average reaching distance of 3 trials was calculated. (87) (Appendix D)

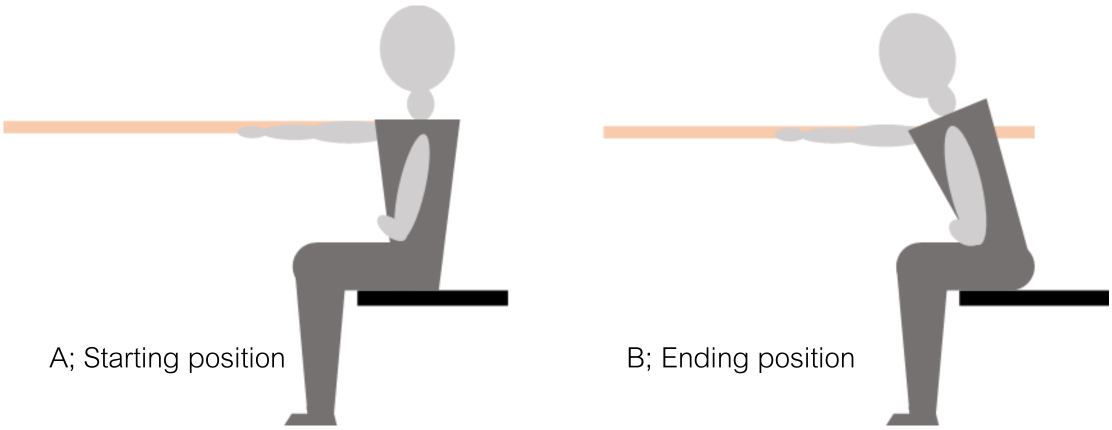

Figure 6 Sitting FRT

3.4 Functional ability

The functional ability in this study was assessed using the Spinal Cord Independence Measure III Thai version (th-SCIM III). (34) The th-SCIM III included areas of particular functional importance for patients with SCI. The scores were weighted according to their clinical relevance with respect to the overall activity of patients with SCI including self-care (20 scores), respiratory and sphincter management (40 scores), mobility (40 scores). (34) All items were evaluated by direct observation, except some items such as bathing, dressing, and bowel and bladder management which were asked from the patients or caregivers.

4. Data analysis

4.1 Fall discrimination.

The cut-off score of FRT for identifying faller SCI was calculated in all participants with SCI and subgroup analyzed in participants with cSCI and iSCI. The cut-off score was used to identify participants into faller and non-faller.

4.2 Ambulation status discrimination

The cut-off score of FRT for identifying ambulation status SCI was calculated in all participants with SCI and subgroup analyzed in participants with cSCI and iSCI. The ambulation status was divided into ambulation with wheelchair and ambulation with walking aid devices.

4.3 Correlation

The correlation between FRT and functional ability were calculated in total score of th-SCIM III, and calculated separately in each domain including self-care, respiratory and sphincter management, and mobility indoor-outdoor

5. Statistical analysis

Descriptive Statistics Analysis was used to explain the participant's demographic data, SCI characteristic and incidences of fall. Chi-Square test and Mann-Whitney U test was used to calculate the characteristic difference between groups. The receiver-operating characteristic (ROC) was performed to calculate the value of reaching forward distances between subjects with SCI who had or did not have a history of falls and the ambulation (wheelchair and walking with or without assistive devices). The cut-off point would provide the best balance between sensitivity and specificity for each test. (88) The accuracy of FRT for discriminating participants who had and did not have history of falls was measured by area under the curve (AUC). Level of an AUC was defined as 0.9 and over to indicate high accuracy, 0.7 to 0.9 indicates moderate accuracy, 0.5 to 0.7 indicates low accuracy, and 0.5 and less indicates a finding worthless (88) The Pearson correlation coefficient was used to evaluate the correlation between the th-SCIM III (total scores and each domains) of subjects with SCI and FRT. Level of correlation was defined as r, where less than 0.25 was no correlation, from 0.25 to 0.50 was low correlation, from 0.50 to 0.75 was moderate correlation, and more than 0.75 was high correlation. (88) Level of significant difference was set at less than 0.05

CHAPTER 4

FINDING

The purpose of this study was to determine whether the functional reach test can be used to identify the patients with spinal cord injury who had and did not have a history of falls and ambulation status. Moreover, the study was to examine the correlation between FRT and functional ability. The research results were as follows.

1. Baseline demographic data

Sixty-five patients with SCI participated in the study (table 5). They were divided into two groups that 43 participants were cSCI and 22 participants were iSCI. All participants had age range between 18-67 years old. Most of them had a paraplegic SCI at a chronic stage of injury (post injury time ≥ 12 months), and ambulated by wheelchair with significant difference between group of cSCI and iSCI and The FRT was significant difference between group of cSCI and iSCI ($p < 0.001$, table 5).

Table 5: Baseline demographic data of participants

Charecteritics		cSCI	iSCI	*p*-value
Gender[1]	Male	36	18	0.014
	Female	7	4	0.366
Age (year)[2]		25(18-59)	29(18-67)	0.291
Post injury time (month)[2]		58(4-350)	51(4-192)	0.360
Level of lesion[1]	Quadriplegia	2(4.65)	6(27.30)	0.157
	Paraplegia	41(95.35)	16(72.70)	0.001*
Ambulation status[1]	Wheelchair	35(81.40)	10(45.50)	< 0.001*
	Walking aid	8(18.60)	12(54.50)	0.251
Functional reach test (cm.)[2]		7.00(2.67-45.67)	16.50(3.67-46.33)	< 0.001*

NOTE: [1]The data were presented the number of participants (%) and analyzed using the Chi-Square test. [2]The data were presented using the median (min-max) and analyzed using the Mann-Whitney U test. *Indicated significant difference between group cSCI and iSCI $p < 0.05$.

2. The cut-off score for identifying faller and non-faller

The area under the curve was 0.51. From Figure 7, it can be seen that FRT score cannot discriminate the participants who had and did not have a history of falls. The median distance of the SCI who had non-falls was 8.33 cm. and who had fallen was 7.83 cm. The difference distance was not shown a significant difference (table 6, p = 0.891).

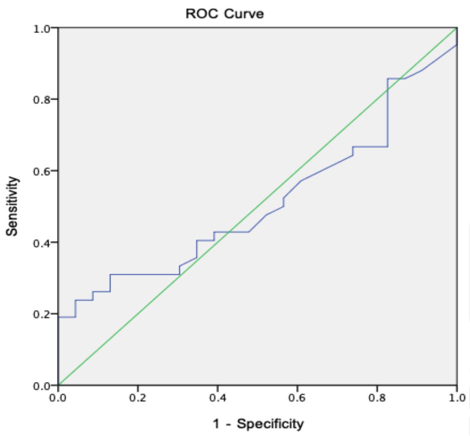

Figure 7: The ROC curve of the participants who had and did not have a history of falls.

2.1 Subgroup analysis; the cut-off score for identifying faller and non-faller in participants with motor complete SCI.

Forty-three participants with cSCI were included in this subgroup analysis. The area under the curve was 0.40. Figure 8 showed that the FRT score cannot discriminate the participants who had and did not have a history of falls. The median distance of the SCI who had non-falls was 7.67 cm. and who had fallen was 6.67 cm. The difference distance was not shown a significant difference (table 6, p = 0.270).

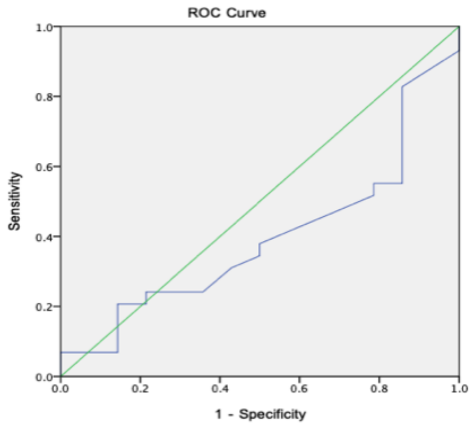

Figure 8: The ROC curve of the cSCI participants who had and did not have a history of falls.

2.2 Subgroup analysis; the cut-off score for identifying faller and non-faller in participants with motor incomplete SCI.

Twenty-two participants with iSCI were included in this analysis. The cut-off score of 16.50 cm. was the best cut-off score that provided the best balance between sensitivity (76.90%) and specificity (89.00%) for FRT test. From the raw data, we founded this cut-off score would miss diagnosing risk for 3 out of the 13 participants who have fallen, and we would incorrectly target 1 out of the 9 non-fallers. The area under the curve was 0.81. Thus, the FRT were moderately accurate for discriminating who had falls and did not have falls (table 7). Moreover, the result founded that the median reaching distance of participants who had non-falls was 12.67 cm. and who had fallen was 22.33 cm. with statistically significant difference (table 6, p = 0.015).

Table 6: Comparison of FRT between group non-faller and faller

Participants	Non-faller	Faller	*p*-value
SCI	8.33(3.33-22.67)	7.83(2.67-46.33)	0.891
cSCI	7.67(3.33-22.00)	6.67(2.67-45.67)	0.270
iSCI	12.67(3.67-22.67)	22.33(5.00-46.33)	0.015*

NOTE: All values are show as median (min-max) in cm, *significant difference $p < 0.05$

Table 7: FRT to discriminative faller of iSCI

Participant	Cut-off (cm.)	Sensitivity	Specificity	AUC	95% CI	
					Lower	*Upper*
iSCI	> 16.50	76.90%	89.00%	0.81	0.63	0.99

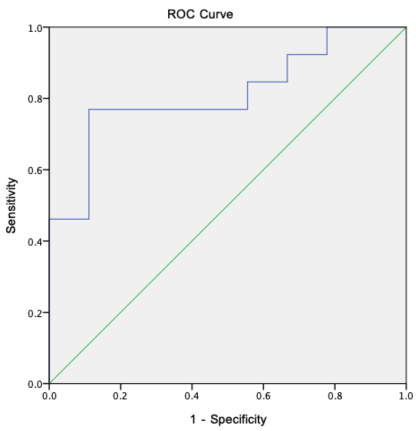

Figure 9: The ROC curve of the iSCI participants who had and did not have a history of falls.

2.3 The history of falls in participants with SCI

Twenty-nine participants with cSCI (67.40%) had history of falls (range 1 to 20 times/participant). Most falls occurred in within the house while they performed wheelchair activity and transfer (table 8). After falls, 14 participants (48.30%) had consequences of falls including physical, psychological and functional consequences (table 8).

Thirteen participants with iSCI (59.10%) had history of falls (range 1 to 20 times/participant). Most falls occurred in within the house while they were walking (table 8). After falls, 7 participants (53.80%) had consequences of falls including physical, psychological and functional consequences (table 8).

Table 8: Falls data of the participants

Falls data	Number of falls	
	Complete SCI [29 participants (67.40%)]	Incomplete SCI [13 participants (59.10%)]
Location of falls		
Within the house	43.75	53.34
Around the house	18.75	13.33
Community	31.25	33.33
Workplace	6.25	0
Activities during falls		
Perform activities in a wheelchair	32.35	14.29
While ambulate with wheelchair	32.35	28.57
Transfer between wheelchair and other	32.53	14.29
While walking	2.95	42.85

NOTE: The data were presented the percentage of participants.

Table 8: (continued)

Falls data	Number of falls	
	Complete SCI [29 participants (67.40%)]	Incomplete SCI [13 participants (59.10%)]
Consequences of falls	14 participants (48.30%)	7 participants (53.80%)
Physical consequences		
No	50.00	46.20
Bruise	12.50	23.00
Muscle pain or tear	12.50	7.70
Skin abrasion	25.00	7.70
Fracture	0	7.70
Unconsciousness	0	7.70
Psychological consequences		
No	13.80	76.92
Fear of fall	86.20	23.08
Functional consequences		
No	99.00	84.60
Reduce social participation	1.00	15.40

NOTE: The data were presented the percentage of participants.

3. The cut-off score for identifying ambulation status

Sixty-fifth participants with SCI were included in this study. The cut-off score of 10.17 cm. was the best point for discriminating ambulation status. This cut-off distance provided the best sensitivity (78.90%) and specificity (78.30%) (Figure 10, table 9, $p < 0.001$). From the raw data, we founded this cut-off score would miss diagnosing risk for 5 out of the 20 participants who were ambulated with walking aid devices and we would incorrectly target 10 out of the 45 participants with wheelchair bound. The area under the curve was 0.78 (table 9). Moreover, the result founded that the median reaching distance of participants who had ambulated with wheelchair was 7.00 cm. and walking aids devices was 16.55 cm. with statistically significant difference (table 10, $p < 0.001$).

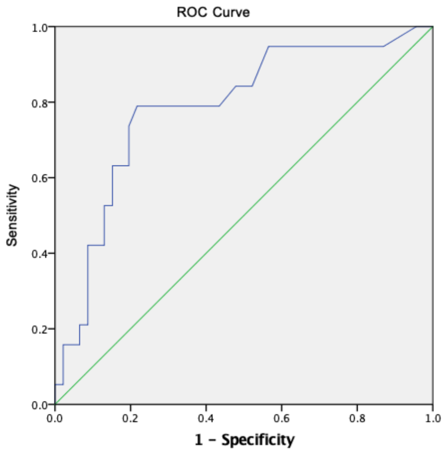

Figure 10: The ROC curve of the participants who had ambulation with wheelchair and walking aid devices.

3.1 Subgroup analysis; the cut-off score for identifying ambulation status in participants with motor complete SCI.

Forty-three participants with cSCI were included in the study. The cut-off score of 6.50 cm. was the best point that provided the best sensitivity (85.70%) and specificity (44.40%) for discriminating ambulation status in participants with cSCI. From the raw data, we founded this cut-off score would miss diagnosing risk for 2 out of the 8 participants who were ambulated with walking aid devices and we would incorrectly target 19 out of the 35 wheelchair bound. The area under the curve was 0.68 (table 9). The median distance of the cSCI who were ambulated with wheelchair was 6.83 cm. and walking aid devices was 10.33 cm. The difference distance was not shown a significant difference (table 10, p = 0.142).

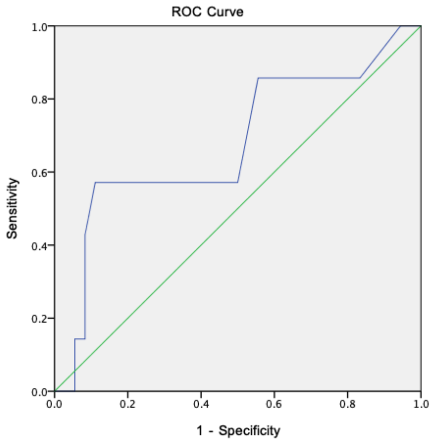

Figure 11: The ROC curve of the cSCI participants who had ambulation with wheelchair and walking aid devices.

3.2 Subgroup analysis; the cut-off score for identifying ambulation status in participants with motor incomplete SCI

Twenty-two participants with iSCI were included in the study. The cut-off score of 14.50 cm. was the best point that provided the best sensitivity (75.00%) and specificity (60.00%) for discriminating ambulation status in participants with iSCI. From the raw data, we founded this cut-off score would miss diagnosing risk for 3 out of the 12 participants who were ambulated with walking aid devices and we would incorrectly target 4 out of the 10 wheelchair bound. The area under the curve was 0.74 (table 9). The median distance of the iSCI who were ambulated with wheelchair was 12.50 cm. and walking aid devices was 22.33 cm. Table 10 was not shown the statistically significant difference of participants with iSCI (table 10, p = 0.056).

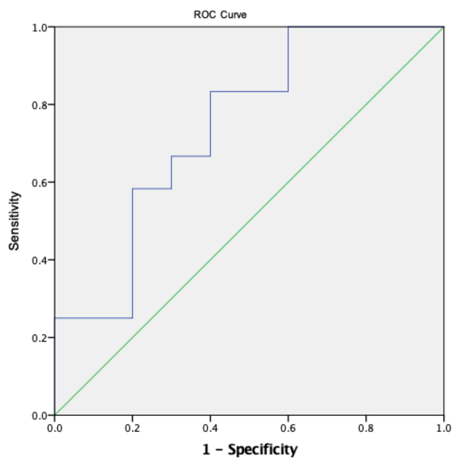

Figure 12: The ROC curve of the iSCI participants who had ambulation with wheelchair and walking aid devices.

Table 9: FRT for dicriminative ambulation status who was ambulation with walking aid devices

Participants	Cut-off (cm.)	Sensitivity	Specificity	AUC	95% CI	
					Lower	*Upper*
SCI	> 10.17	78.90%	78.30%	0.78	0.66	0.91
cSCI	> 6.50	85.70%	44.40%	0.68	0.44	0.92
iSCI	> 14.50	75.00%	60.00%	0.74	0.53	0.96

Table 10: Comparison of FRT between group ambulation status

Participants	Wheelchair	Walking aids	p-value
SCI	7.00(2.67-45.67)	16.55(3.33-46.33)	< 0.001*
cSCI	6.83(2.67-45.67)	10.33(3.33-22.00)	0.142
iSCI	12.50(3.67-30.00)	22.33(7.33-46.33)	0.056

NOTE: All values are show as median (min-max) in cm, *significant difference $p < 0.05$

4. The correlation between FRT and Functional ability

The correlation between FRT and functional ability showed the weak correlation in all domains and total score of th-SCIM III (range from 0.325 to 0.042, table 11) In addition, the statistically significant difference was shown in respiratory and spinchter domain, mobility domain, and total score. (Table 11)

Table 11: Pearson Correlation between FRT and th-SCIM III

Variables	SCIM_Self	SCIM_Res	SCIM_mobility	SCIM_total
FRT	0.042	0.341	0.330	0.325
p-value	0.742	0.005*	0.007*	0.008*

NOTE: SCIM_Self = SCIM sub-score Self-care; SCIM_Res = SCIM sub-score Respiratory and Spinchter management; SCIM_mobility= SCIM sub-score Mobility; SCIM_total= total score of SCIM; *Correlation was significant $p < 0.05$

CHAPTER 5
DISCUSSION AND CONCLUSION

The current study evaluated whether the functional reach test can be used to identifying the participants with spinal cord injury who had and did not have a history of falls and identifying the participants who were ambulated with a wheelchair and walked with assistive devices. In addidion, the study evaluated the correlation between the FRT and functional ability as measured by the Spinal Cord Independence Measure III Thai version (th-SCIM III) of patients with SCI who had and did not have a history of falls. The results demenstrated that the FRT could not be used to discriminate patients with spinal cord injury who had and did not have a history of falls. However, when considering only in the iSCI, the FRT demonstrated moderate accuracy with the reaching distance more than 16.5 cm. and high sensitivity and specificity in identifying participants with iSCI who had history of fall. In contrast, the FRT score can be used to identify ambulation status in participants with SCI with the reaching distance of more than 10.17 cm. as those who can walk. Finally, the correlation between FRT and functional ability showed weak correlation in all sub-score and total score of th-SCIM III.

The original FRT was developed to measure standing balance that represents the ability to control limit of stability (LOS) within the base of support. (10, 27, 69) Previous study showed that the standing FRT represented high reliability, sensitivity, specificity and able to predict the risk of falls in the elderly. (89, 90) Moreover, the individuals with Parkinson's disease who had a history of falls showed a high reliability of FRT (ICC = 0.93) and had a responsiveness to indicate risk of fall with high sensitivity (86%) and moderate specificity (52%) (91, 92). In ambulatory iSCI, the FRT was the best tool to predict multiple falls. Srisim et al. (2015) showed the cut-off score in patients with iSCI who was able to reach more than 20 cm. indicated multiple falls (high sensitivity (73%) and moderate specificity (55%)). (14) However, there had limitations in patients with SCI who were unable to stand independently, so the study that assessed in the sitting position was recommended. (69, 93) The sitting FRT in individuals with stroke showed excellent test-retest reliability (ICC = 0.94). (94) In patients with SCI showed and excellent reliability (ICC = 0.94). (69) Field-Fote and Ray 2010 and Gao et al. 2015 founded that the sitting reach distance was able to reflect the balance in patients with SCI. (8, 95)

The FRT cannot identify faller in the cSCI group. This may due to the fact that the FRT requires core trunk muscles to complete the test. In general, balance control was a complex sensory system that included somatosensory system, visual system, and vestibular system. (45) The nerves signal ascent to the higher brain integrate and decent to the motor system. (21) The pathology of SCI occurred loss of somatosensory and motor function which both system function affected the core stabilizer muscles function for maintaining postural upright without loss of balance. (21, 24) According to the present result, most of the participants in cSCI group was paraplegia have a various level. It was resulting from weak of core trunk muscles for maintaining body balance. Moreover, fear of fall might be the reason for the number of falling because who had fear of fall may be increased fall avoidance. Jorgensen et al. (2017) reported that fear of fall was a risk factor for fall which was similar to Phonthee et al. study (2013). (19, 96) Thus, the level of injury and fear of falls were the reason that supported the FRT cannot discriminate faller in this group.

The score of FRT to identify faller iSCI was more than 16.50 cm. The present result indicated that those higher balance control had fall opportunity more than lower balance control ability. The previous result showed the FRT in standing position reflected balance ability and the distance more than 20 cm. was high ability for discriminating multiple fall and single fall. (14) The participants with high functional abilities were at high exposure to fall than the lower performance. The possible reasons to support the current result were that most of participants who had a history of falls were adult male with middle age. (96) Thus, the adulthood needs to perform daily activity independently. However, they had limited ability to perform activities so they had a high exposure to fall. Furthermore, the incidence of fall in the current study appeared during walking and wheelchair activities which is similar to

Jorgensen et al. study (2017). They founded the falls occurred during walking that reflected the patients attempt to perform activitied by themselves. (96)

The finding of discriminative ability of ambulation status, the current study investigated all severity of SCI and specific subgroup of cSCI and iSCI. The finding showed all SCI participants with reaching score at 10.17 cm. and over, was in the walking aids group. For subgroup analysis, participants with cSCI with FRT score at 6.50 cm. and over, and iSCI with FRT score at 14.50 cm. However, these cut-off scores had a high percentage of mistake which was consistent with Seansook et al. (2014) who studied the discriminative ability of three-functional assessment tools that discriminate between individuals with SCI who were able to ambulation with assistive devices and non-assistive device. (22) The finding showed individuals with SCI greater functional ability that they were ambulation with assistive devices. (22) Previously, Lam et al. (2008) studied the systematic review of psychometric properties data of functional ambulation outcome of SCI. They included seven assessment tools that separated into two types. (68) The study included timed measures of ambulation (10-meter walk test, 6-minute walk test, timed up and go) and categorical measures of ambulation (Spinal Cord Injury-Functional Ambulation Index; SCI-FAI, Functional Independence Measure; FIM, Spinal Cord Independence Measure; SCIM, and the Walking Index for Spinal Cord Injury; WISCI). (68) The results showed seven tools can be measures functional ambulation change, whereas timed measures of ambulation suitable for only walking populations. (68) They suggested that categorical measures of ambulation might be more responsiveness for all a wheelchair ambulation and walking devices. (68) According to Morgati et al. (2005) investigated criteria validity of WISCI, the finding founded participants with motor complete SCI and non-ambulation participants were lower level of WISCI (97) which consistant with our results. The current results showed the reaching distance of wheelchair bound less than walking aids bound.

Previously, the FRT was correlated with functional ability assessment in stroke patients. According to Katz-Leurer et al. 2009 they evaluated the reliability and validity of modified FRT (mFRT) with Balance master, FIM, and Stroke Activity Scale (SAS).

The finding represented mFRT correlated with balance assessment and motor-function assessment in low to moderate level of correlation. (94) In participants with SCI, Sprigle et al. 2006 they developed a simple tool for assess postural stability. The finding showed sitting forward reach test low correlation with ADL task score. (87) This was consistant with Gao et al. 2015 they developed a reliability and validity of measurement tools for assess the dynamic sitting balance of wheelchair users with SCI. (8) The results demonstrated that FRT in sitting position low correlation with functional ability which measured by SCIM III. (8) Which is consistant with Abou et al. (2019) reported that FRT not correlated with function in sitting test but lateral reach test correlated with function in sitting test. (12) The previous results were consistent with the current finding, the functional ability was low correlation with the FRT. The SCIM III was measured the functional ability that included 3 domain (self-care, respiration and sphincter management and mobility domains. This test consisted the activities during perform ADLs that might be required multidirectional movement, was only forward reach test may be inadequate. (8, 32)

1. Implication of the study

The finding of this study provide information to classify the risk of fall and ambulation status in patients with SCI. The cut-off FRT for identifying risk of fall is useful to create the rehabilitation program to reduce risk of fall when patients get the suggested distance. Moreover, the cut-off FRT for identifying ambulation status can help the rehabilitation teams to decide the program that appropriate with their ambulatory and choose the aid devices for patients with SCI.

2. Limitation of the study

There are some limitations in this study. Firstly, the data of falls was restrospectively collected via interview. However, the researcher attempted to reduce bias and errors by confirmed the place and consequences of fall data. Secondly, findings of the study did not directly suggest strategies to reduce falls in individuals with SCI. Further study that explored and takes these factors into account may help to improve effectiveness of interventions, particularly when faced with their own environments, is still needed. Thirdly, the characteristic of the participants had various thus, further study which control the lesion, severity, and post injury time of the participants may show the clearly cut-off FRT in all SCI. Finally, the th-SCIM III did not show the correlation with FRT. A further study, the researchers suggest that will separate a level of lesion for analysis and using other functional abilities assessment tools for minimize floor effect of th-SCIM III may fulfill indicate strongly the finding.

3. Conclusion

The FRT is a simple tools for assess balance performance in SCI and other populations. This study demonstrated that the FRT cannot be used for identifying faller in participants with SCI. However, the FRT score can be used to classify the walking status of the participants with SCI at the cut-off score of 10.17 cm. Finally, the FRT was weakly correlated with the functional status.

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APPENDIX

APPENDIX A Ethic Approved

เอกสารรับรองโครงการวิจัย

โดยคณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์

คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ

เอกสารรับรองเลขที่	PTPT 2018-004
ชื่อโครงการ :	**การทดสอบระยะการเอื้อมมือเพื่อระบุการหกล้ม ความสามารถในการเคลื่อนย้ายตัวและความสามารถในการทำกิจกรรมในผู้ป่วยบาดเจ็บไขสันหลัง (The functional reach test for identifying fallers ambolation, and functional ability in patients with spinal cord injury)**
ชื่อหัวหน้าโครงการ :	**นายวิทยา ดวงงา**
หน่วยงานที่สังกัด :	**สาขากายภาพบำบัด**
เอกสารที่รับรอง :	1. แบบเสนอโครงการวิจัย 2. เอกสารชี้แจงผู้เข้าร่วมการวิจัย 3. หนังสือยินยอมตนให้ทำการวิจัย 4. แบบการเก็บรวบรวมข้อมูล/โปรแกรมหรือกิจกรรม
วันที่รับรอง :	**24 สิงหาคม 2561**
วันที่หมดอายุ :	**24 สิงหาคม 2562**

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับคำประกาศเฮลซิงกิ จากคณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์ คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ **ออกให้ ณ วันที่...31...สิงหาคม 2561**

ลงนาม..

(อาจารย์ ดร.ชัชฎา ชินกุลประเสริฐ)

ประธานคณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์

ลงนาม..

(รองศาสตราจารย์ ดร.รัมภา บุญสินสุข)

คณบดีคณะกายภาพบำบัด

APPENDIX B **แบบสอบถามเพื่อคัดกรองอาสาสมัคร** (Health Screening)

เลขที่........

คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ

แบบสัมภาษณ์ข้อมูลทั่วไปของอาสาสมัคร

<u>คำชี้แจงในแบบสัมภาษณ์</u>

เรื่อง การทดสอบระยะการเอื้อมมือเพื่อระบุการหกล้ม ความสามารถทางกาย และความสามารถในการเดินในผู้ป่วยบาดเจ็บไขสันหลัง

Functional reach test for identifying fallers, functional ability, and gait performance in patients with spinal cord injury

วัตถุประสงค์

1. เพื่อระบุผู้ป่วยบาดเจ็บไขสันหลังที่มีประวัติการหกล้ม โดยใช้การทดสอบระยะการเอื้อมมือ

2. เพื่อระบุความสามารถในการเคลื่อนย้ายตัว โดยใช้การทดสอบระยะการเอื้อมมือ

3. เพื่อหาความสัมพันธ์ระหว่างการทดสอบระยะการเอื้อมมือและความสามารถในการทำกิจกรรม โดยใช้แบบประเมิน the Spinal Cord Independence Measure III Thai version (th-SCIM III)

<u>คำอธิบาย</u>: โปรดกรอกข้อมูลตามความเป็นจริงในช่องว่างและใส่เครื่องหมาย✓ ในช่องว่าง ☐ ที่ตรงกับตัวท่านมากที่สุด

ส่วนที่ 1 ข้อมูลทั่วไป

1. ชื่อ.................................... นามสกุล... อายุ...................... ปี
2. เพศ: ☐ เพศชาย ☐ เพศหญิง
3. น้ำหนัก.................. กิโลกรัม ส่วนสูง .... cm.
4. ที่อยู่ปัจจุบัน..
5. เบอร์โทรที่ติดต่อได้...
6. ระดับการศึกษา: ☐ ไม่ได้รับการศึกษา
   ☐ ได้รับการศึกษา โปรดเลือกระดับการศึกษาสูงสุดของท่าน
   - ☐ ประถมศึกษา ระบุ...
   - ☐ มัธยมศึกษาตอนต้น
   - ☐ มัธยมศึกษาตอนปลาย/ ปวช.
   - ☐ อนุปริญญา/ ปวส.
   - ☐ ปริญญาตรี
   - ☐ ปริญญาโทหรือสูงกว่า ระบุ..
7. อาชีพ:

☐ ข้าราชการ/รัฐวิสาหกิจ ☐ พนักงานเอกชน

☐ ค้าขาย ☐ รับจ้าง/ ลูกจ้าง

☐ ธุรกิจส่วนตัว ☐ อื่น ๆ ระบุ......................................

ส่วนที่ 2 ข้อมูลสุขภาพ

1. ระยะเวลาของการบาดเจ็บไขสันหลัง (Post injury time)

   .... ปี .... เดือน

2. ระดับของการบาดเจ็บไขสันหลัง (Level of injury)...
3. AIS class ....
4. สาเหตุของการบาดเจ็บไขสันหลัง (cause of injury : traumatic, non-traumatic)

   ....

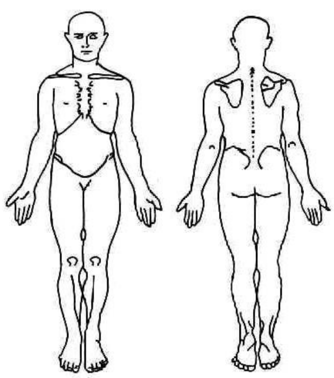
5. ปัจจุบันท่านมีแผลกดทับหรือไม่?

   ☐ ไม่มี ☐ มี ระบุตำแหน่ง...

6. ปัจจุบันท่านมีอาการปวดกล้ามเนื้อหรือไม่?

   ☐ ไม่มี

   ☐ มี VAS.........../10 ระบุตำแหน่ง



0 1 2 3 4 5 6 7 8 9 10

ไม่ปวด ปวดเล็กน้อย ปวดปานกลาง ปวดมาก ปวดมากที่สุด

7. ปัจจุบันท่านสามารถนั่งได้อย่างอิสระด้วยตนเองหรือไม่?

☐ ไม่สามารถช่วยเหลือตนเองได้

☐ สามารถช่วยเหลือตนเองได้<u>เล็กน้อย</u> ต้องการความช่วยเหลือ 75%

☐ สามารถช่วยเหลือตนเองได้<u>ปานกลาง</u> ต้องการความช่วยเหลือ 50%

☐ สามารถช่วยเหลือตนเองได้ <u>ไม่ต้องการผู้ช่วยเหลือ</u>

APPENDIX C **แบบสอบถามประวัติการหกล้มและการเคลื่อนย้ายตัว** (History of falls and Ambulation)

เลขที่.......

<u>คำอธิบาย</u>: โปรดกรอกข้อมูลตามความเป็นจริงในช่องว่างและใส่เครื่องหมาย✓ ในช่องว่าง ☐ ที่ตรงกับตัวท่านมากที่สุด

ส่วนที่ 1 ข้อมูลทั่วไป

1. ชื่อ... นามสกุล.. อายุ............... ปี
2. เพศ: ☐ เพศชาย ☐ เพศหญิง
3. เบอร์โทรที่ติดต่อได้..

ส่วนที่ 2 ประวัติการหกล้มและการเคลื่อนย้ายตัว

1. ท่านสามารถเคลื่อนย้ายตัวได้ด้วยตนเองหรือไม่
   ☐ ไม่ได้ (ข้ามไปตอบข้อ 3)
   ☐ ได้ (ตอบข้อต่อไป)
2. ท่านเคลื่อนย้ายตัวด้วยอุปกรณ์ช่วยหรือไม่
   ☐ Wheelchair
   ☐ Cane
   ☐ Crutches
   ☐ Walker
   ☐ เดินเองโดยไม่ใช้อุปกรณ์ช่วย
   ☐ อื่น ๆ ระบุ...

3. 1 ปีที่ผ่านมา ท่านเคยพลัดตก หรือ หกล้ม หรือไม่ (ถ้าตอบ ***"เคย"*** ให้ตอบคำถามข้อต่อไป)

☐ ไม่เคย

☐ เคย 1 ครั้ง

☐ เคยมากกว่า 1 ครั้ง ระบุ............... ครั้ง

4. ท่านพลัดตก หกล้ม บริเวณใด?

☐ ภายในบ้าน /ที่พักอาศัย

☐ บริเวณรอบบ้าน /บริเวณรอบที่พักอาศัย

☐ ในที่ชุมชน เช่น ตลาด ห้างสรรพสินค้า บนทางเท้า เป็นต้น

☐ บริเวณที่ทำงาน

5. ท่านพลัดตก หกล้ม ขณะทำกิจกรรมอะไร?

☐ ขณะทำกิจกรรมบนรถเข็น

☐ ขณะใช้รถเข็น

☐ ขณะการเคลื่อนย้ายตัวจากเตียงไปรถเข็น/เก้าอี้ หรือจากรถเข็น/เก้าอี้ไปเตียง

☐ ขณะการเดิน

☐ อื่น ๆ ระบุ..

6. หลังจากท่านพลัดตก หกล้มแล้ว ท่านมีผลกระทบเกิดขึ้นหรือไม่? (ถ้าตอบ ***"ไม่มี"*** ไม่ต้องตอบคำถามข้อต่อไป) สามารถตอบได้มากกว่า 1 ข้อ

☐ ไม่มี

☐ มีผลกระทบต่อร่างกาย (ข้ามไปข้อ 7)

☐ มีผลกระทบต่อจิตใจ (ข้ามไปข้อ 8)

☐ มีปลกระทบต่อการทำกิจกรรม (ข้ามไปข้อ 9)

☐ อื่น ๆ ระบุ...

7. ผลกระทบต่อร่างกาย

☐ เกิดแผลพกช้ำ ตามร่างกาย ระบุตำแหน่ง...

☐ เกิดอาการปวดกล้ามเนื้อ หรือเอ็นกล้ามเนื้อฉีกขาด ระบุตำแหน่ง................

☐ รอยถลอก

☐ กระดูกหัก

☐ หมดสติ ไม่รู้สึกตัว

☐ อื่น ๆ ระบุ...

8. ผลกระทบต่อจิตใจ

☐ กลัวการหกล้ม

☐ อื่น ๆ ระบุ...

9. ผลกระทบต่อการทำกิจกรรม

☐ ทำให้ท่านมีส่วนร่วมกับกิจกรรมในชุมชนได้น้อยลง

☐ ต้องใช้เวลาอยู่บนเตียงนอนมากขึ้น

☐ ทำให้ท่านมีความสามารถในการดูแล/ช่วยเหลือตนเองลดลง

☐ ทำให้ท่านทำงานได้น้อยลง

☐ ทำให้ท่านมีปฏิสัมพันธ์กับผู้อื่นได้น้อยลง

☐ อื่น ๆ ระบุ...

APPENDIX D **แบบบันทึกการตรวจประเมิน** Functional reach test

เลขที่.......

ชื่อ...วันที่......................................

ครั้งที่ 1 (cm.)	**ครั้งที่** 2 (cm.)	**ครั้งที่** 3 (cm.)	**ค่าเฉลี่ย** (cm.)

APPENDIX E **แบบประเมิน** The Spinal Cord Independence Measure III Thai version (th-SCIM III)

שירותי בריאות
כללית

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(ผู้ได้รับอนุญาตการแปล อ.ดร.จิราภรณ์ วรรณปะเข สาขากายภาพบำบัด คณะสหเวชศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ e-mail: j_wannapakhe@hotmail.com
รศ.ดร.สุกัลยา อมตฉายา สายวิชากายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยขอนแก่น e-mail: samata@kku.ac.th)

ชื่อผู้ป่วย:..............................รหัสประจำตัวผู้ป่วย..........................ชื่อผู้ประเมิน:..............................

(ใส่คะแนนสำหรับแต่ละหน้าที่ไว้ในช่องสี่เหลี่ยมใต้วันที่ แบบฟอร์มนี้ใช้สำหรับการประเมินได้ถึง 6 ครั้ง)

SCIM-SPINAL CORD INDEPENDENCE MEASURE **ฉบับที่ 3 วันที่ 14 กันยายน 2545**

การดูแลตัวเอง (Self-Care) **วันที่** \ \ \ \ \ \ \

1. การรับประทานอาหาร (การตัดอาหาร การเปิดภาชนะบรรจุ การเทอาหาร การนำอาหารเข้าปาก การถือแก้วที่บรรจุของเหลว) □□□□□□

0. รับอาหารทางสายยาง เจาะหน้าท้อง หรือต้องการความช่วยเหลือในการรับประทานอาหารทั้งหมด
1. ต้องการความช่วยเหลือบางส่วนในการรับประทานอาหาร และ/หรือการดื่มน้ำ หรือการใส่อุปกรณ์ช่วย
2. รับประทานอาหารได้เอง ต้องการอุปกรณ์ช่วยหรือความช่วยเหลือเพียงการตัดอาหาร และ/หรือการเท และ/หรือการเปิดภาชนะ
3. รับประทานอาหารหรือดื่มน้ำได้เอง ไม่ต้องการความช่วยเหลือหรืออุปกรณ์ช่วย

2. การอาบน้ำ (การถูสบู่ การล้างตัว การเช็ดตัวและศีรษะ การเปิดก๊อกน้ำ) **ก – ร่างกายส่วนบน; ข – ร่างกายส่วนล่าง**

ก. 0. ต้องการความช่วยเหลือทั้งหมด □□□□□□
1. ต้องการความช่วยเหลือบางส่วน
2. อาบน้ำได้เองโดยใช้อุปกรณ์ช่วยหรือในบริเวณที่จัดทำขึ้นเฉพาะ (ที่ไม่ใช้สำหรับคนสุขภาพดี เช่น มีราวเกาะยึด เก้าอี้) (adss*)
3. อาบน้ำได้เอง ไม่ต้องใช้ adss

ข. 0. ต้องการความช่วยเหลือทั้งหมด □□□□□□
1. ต้องการความช่วยเหลือบางส่วน
2. อาบน้ำได้เองโดยใช้ adss
3. อาบน้ำได้เอง ไม่ต้องใช้ adss

3. การใส่เสื้อผ้า (เสื้อผ้า รองเท้า อุปกรณ์เสริมที่ใช้ถาวร: การแต่งตัว การใส่ การถอด) **ก – ร่างกายส่วนบน; ข – ร่างกายส่วนล่าง**

ก. 0. ต้องการความช่วยเหลือทั้งหมด □□□□□□
1. ต้องการความช่วยเหลือบางส่วนสำหรับการสวมใส่เสื้อผ้าที่ไม่มีกระดุม ซิป หรือเชือกผูก (cwobzl**)
2. สวมใส่เสื้อผ้าแบบ cwobzl ได้เอง ต้องการ adss
3. สวมใส่เสื้อผ้าแบบ cwobzl ได้เอง ไม่ต้องการ adss ต้องการความช่วยเหลือหรือ adss เพียงสำหรับ bzl
4. สวมใส่เสื้อผ้าทุกแบบได้เอง ไม่ต้องการ adss

ข. 0. ต้องการความช่วยเหลือทั้งหมด □□□□□□
1. ต้องการความช่วยเหลือบางส่วนสำหรับการสวมใส่เสื้อผ้าที่ไม่มีกระดุม ซิป หรือเชือกผูก (cwobzl**)
2. สวมใส่เสื้อผ้าแบบ cwobzl ได้เอง ต้องการ adss
3. สวมใส่เสื้อผ้าแบบ cwobzl ได้เอง ไม่ต้องการ adss ต้องการความช่วยเหลือหรือ adss เพียงสำหรับ bzl
4. สวมใส่เสื้อผ้าทุกแบบได้เอง ไม่ต้องการ adss

4. การแต่งตัว (การล้างมือและหน้า แปรงฟัน หวีผม โกนหนวด แต่งหน้า) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการความช่วยเหลือบางส่วน
2. แต่งตัวได้เองโดยใช้อุปกรณ์ช่วย
3. แต่งตัวได้เองโดยไม่ใช้อุปกรณ์ช่วย

คะแนนรวมย่อย (0-20) □□□□□□

หมายเหตุ *adss = อุปกรณ์ช่วยหรือในบริเวณที่จัดทำขึ้นเฉพาะ (adaptive devices or specific setting)
**cwobzl = เสื้อผ้าที่ไม่มีกระดุม ซิบ หรือเชือกผูก (clothes without buttons, zipps or laces)

การจัดการด้านการหายใจและระบบขับถ่าย (Respiratory and Sphincter Management) **วันที่** \ \ \ \ \ \ \

5. การหายใจ □□□□□□

0. ต้องใส่ท่อผ่านหลอดลม (tracheal tube: TT) และต้องใช้เครื่องช่วยหายใจแบบถาวรหรือเป็นระยะ (intermittent assisted ventilator: IAV)
2. หายใจได้เองร่วมกับ TT; ต้องการออกซิเจน ความช่วยเหลือในการไอหรือการจัดการ TT อย่างมาก
4. หายใจได้เองร่วมกับ TT; ต้องการออกซิเจน ความช่วยเหลือในการไอหรือการจัดการ TT เล็กน้อย
6. หายใจได้เองโดยไม่ใช้ TT; ต้องการออกซิเจน ความช่วยเหลืออย่างมากในการไอ หน้ากาก (เช่น peep) หรือ IAV (bipap)
8. หายใจได้เองโดยไม่ใช้ TT; ต้องการความช่วยเหลือเพียงเล็กน้อย หรือการกระตุ้นการไอ
10. หายใจได้เองโดยไม่ต้องการความช่วยเหลือหรืออุปกรณ์ช่วย

6. การจัดการหูรูด-กระเพาะปัสสาวะ □□□□□□

0. ต้องคาสายสวนปัสสาวะ
3. ปัสสาวะคงค้างในกระเพาะปัสสาวะ (residual urine volume: RUV) > 100 ซีซี; ไม่ต้องสวนปัสสาวะเป็นประจำ หรือต้องช่วยสวนปัสสาวะแบบเป็นระยะ
6. RUV < 100 ซีซี หรือสวนปัสสาวะแบบเป็นระยะด้วยตนเอง; ต้องการความช่วยเหลือในการใช้อุปกรณ์ระบายปัสสาวะ
9. สวนปัสสาวะแบบเป็นระยะด้วยตนเอง ใช้อุปกรณ์ระบายปัสสาวะภายนอกได้เอง
11. สวนปัสสาวะแบบเป็นระยะด้วยตนเอง กลั้นปัสสาวะระหว่างการสวนแต่ละครั้งได้ ไม่ต้องใช้อุปกรณ์ระบายปัสสาวะภายนอก
13. RUV < 100 ซีซี ต้องการเพียงอุปกรณ์ระบายปัสสาวะภายนอก โดยไม่ต้องการความช่วยเหลือในการระบายปัสสาวะ
15. RUV < 100 ซีซี สามารถกลั้นปัสสาวะได้ โดยไม่ต้องใช้อุปกรณ์ระบายปัสสาวะภายนอก

7. การจัดการหูรูด-การขับถ่ายอุจจาระ □□□□□□

0. ถ่ายอุจจาระไม่เป็นเวลาหรือนานๆ ครั้ง (น้อยกว่า 1 ครั้งใน 3 วัน)
5. ถ่ายอุจจาระเป็นเวลา แต่ต้องการความช่วยเหลือ (เช่น การใส่ยาเหน็บทวาร) มีการราดน้อย (น้อยกว่า 2 ครั้ง/เดือน)
8. ถ่ายอุจจาระเป็นปกติ ไม่ต้องการความช่วยเหลือ มีการราดน้อย (น้อยกว่า 2 ครั้ง/เดือน)
10. ถ่ายอุจจาระเป็นปกติ ไม่ต้องการความช่วยเหลือ ไม่มีการราด

8. การใช้ห้องน้ำ (การทำความสะอาด การจัดเสื้อผ้าก่อนและหลัง การใช้กระดาษชำระ) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการความช่วยเหลือบางส่วน ไม่สามารถทำความสะอาดได้เอง
2. ต้องการความช่วยเหลือบางส่วน สามารถทำความสะอาดได้เอง
4. สามารถใช้ห้องน้ำได้เอง แต่ต้องใช้อุปกรณ์ช่วยหรือบริเวณที่ทำไว้เฉพาะ (เช่น ราว)
5. สามารถใช้ห้องน้ำได้เอง ไม่ต้องใช้อุปกรณ์ช่วยหรือบริเวณที่ทำไว้เฉพาะ

คะแนนรวมย่อย (0-40) □□□□□□

ความสามารถในการเคลื่อนไหว (ในห้อง และห้องน้ำ) [Mobility (room and toilet)]

9. การเคลื่อนไหวบนเตียงและการป้องกันแผลกดทับ (การพลิกลำตัวส่วนบน การพลิกลำตัวส่วนล่าง การลุกนั่งบนเตียง การยกตัวในรถเข็นนั่ง โดยใช้หรือไม่ใช้อุปกรณ์ช่วย ที่ไม่ใช่อุปกรณ์ช่วยไฟฟ้า) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
2. สามารถทำได้ 1 กิจกรรมโดยไม่ต้องการความช่วยเหลือ
4. สามารถทำได้ 2 หรือ 3 กิจกรรมโดยไม่ต้องการความช่วยเหลือ
6. สามารถเคลื่อนไหวบนเตียงและการเคลื่อนไหวเพื่อลดแรงกดทับได้เองทั้งหมด

10. การเคลื่อนย้ายตัวระหว่างเตียงและรถเข็น (การล็อครถเข็นนั่ง การยกที่วางเท้า การถอดและปรับที่วางแขน การเคลื่อนย้ายตัว การยกเท้า) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการความช่วยเหลือบางส่วน และ/หรือการดูแล และ/หรืออุปกรณ์ช่วย (เช่น แผ่นเลื่อนตัว)
2. ทำได้เอง (หรือไม่ต้องใช้รถเข็นนั่ง)

วันที่ \ \ \ \ \ \ \

11. การเคลื่อนย้ายตัวระหว่างรถเข็น ห้องน้ำ อ่างอาบน้ำ □□□□□□

(หากใช้รถเข็นแบบมีที่ขับถ่าย ให้ดูการเคลื่อนย้ายตัวไป-กลับ หากใช้รถเข็นนั่งแบบปกติ ให้ดูการล็อครถเข็นนั่ง การเปิดที่วางเท้า การถอดและปรับที่วางแขน การเคลื่อนย้ายตัว และการยกเท้า)

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการความช่วยเหลือบางส่วน และ/หรือการดูแล หรืออุปกรณ์ช่วย (เช่น ราวจับ)
2. ทำได้เอง (หรือไม่ต้องใช้รถเข็นนั่ง)

การเคลื่อนไหว (ภายในและภายนอกบ้าน บนพื้นที่ระดับเดียวกัน) [Mobility (indoors and outdoors on even surface)]

12. การเคลื่อนไหวภายในบ้าน □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการใช้รถเข็นไฟฟ้าหรือความช่วยเหลือบางส่วนในการใช้รถเข็นนั่งแบบธรรมดา
2. เคลื่อนไหวได้เองโดยใช้รถเข็นนั่งแบบธรรมดา
3. ต้องการการดูแลขณะเดิน (โดยใช้หรือไม่ใช้อุปกรณ์ช่วย)
4. เดินได้โดยโครงเหล็กช่วยเดินหรือไม้ค้ำยัน (เดินแบบเหวี่ยงตัว)
5. เดินได้โดยใช้ไม้ค้ำยันหรือไม้เท้า 2 อัน (เดินแบบก้าวขาสลับ)
6. เดินได้โดยใช้ไม้เท้า 1 อัน
7. ต้องการกายอุปกรณ์เสริมสำหรับขาเท่านั้น
8. เดินได้โดยไม่ต้องใช้อุปกรณ์ช่วย

13. การเคลื่อนไหวระยะทางขนาดกลาง (10-100 เมตร) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการใช้รถเข็นไฟฟ้าหรือความช่วยเหลือบางส่วนในการใช้รถเข็นนั่งแบบธรรมดา
2. เคลื่อนไหวได้เองโดยใช้รถเข็นนั่งแบบธรรมดา
3. ต้องการการดูแลขณะเดิน (โดยใช้หรือไม่ใช้อุปกรณ์ช่วย)
4. เดินได้โดยโครงเหล็กช่วยเดินหรือไม้ค้ำยัน (เดินแบบเหวี่ยงตัว)
5. เดินได้โดยใช้ไม้ค้ำยันหรือไม้เท้า 2 อัน (เดินแบบก้าวขาสลับ)
6. เดินได้โดยใช้ไม้เท้า 1 อัน
7. ต้องการกายอุปกรณ์เสริมสำหรับขาเท่านั้น
8. เดินได้โดยไม่ต้องใช้อุปกรณ์ช่วย

14. การเคลื่อนไหวนอกบ้าน (มากกว่า 100 เมตร) □□□□□□

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการใช้รถเข็นไฟฟ้าหรือความช่วยเหลือบางส่วนในการใช้รถเข็นนั่งแบบธรรมดา
2. เคลื่อนไหวได้เองโดยใช้รถเข็นนั่งแบบธรรมดา
3. ต้องการการดูแลขณะเดิน (โดยใช้หรือไม่ใช้อุปกรณ์ช่วย)
4. เดินได้โดยโครงเหล็กช่วยเดินหรือไม้ค้ำยัน (เดินแบบเหวี่ยงตัว)
5. เดินได้โดยใช้ไม้ค้ำยันหรือไม้เท้า 2 อัน (เดินแบบก้าวขาสลับ)
6. เดินได้โดยใช้ไม้เท้า 1 อัน
7. ต้องการกายอุปกรณ์เสริมสำหรับขาเท่านั้น
8. เดินได้โดยไม่ต้องใช้อุปกรณ์ช่วย

15. การใช้บันได □□□□□□

0. ไม่สามารถขึ้นหรือลงบันไดได้
1. ขึ้นและลงบันไดได้อย่างน้อย 3 ขั้น โดยใช้ความช่วยเหลือหรือการดูแลจากผู้อื่น
2. ขึ้นและลงบันไดได้อย่างน้อย 3 ขั้น โดยการเกาะราวบันได และ/หรือการใช้ไม้ค้ำยันหรือไม้เท้า
3. ขึ้นและลงบันไดได้อย่างน้อย 3 ขั้น โดยไม่ต้องการความช่วยเหลือหรือการดูแล

วันที่ \ \ \ \ \ \ \

16. การเคลื่อนย้ายตัวระหว่างรถเข็นนั่งและรถยนต์ □□□□□□

(การนำรถเข็นเข้าใกล้รถยนต์ การล็อครถเข็น การถอดที่วางแขนและที่วางเท้า การเคลื่อนย้ายตัวไปและออกจากรถยนต์ การนำรถเข็นนั่งเข้าเก็บและนำออกจากรถยนต์)

0. ต้องการความช่วยเหลือทั้งหมด
1. ต้องการความช่วยเหลือหรือการดูแลบางส่วน หรือต้องใช้อุปกรณ์ช่วย
2. เคลื่อนย้ายตัวได้เองโดยไม่ต้องใช้อุปกรณ์ช่วย (หรือไม่ต้องใช้รถเข็นนั่ง)

17. การเคลื่อนย้ายตัวระหว่างพื้นและรถเข็นนั่ง □□□□□□

0. ต้องการความช่วยเหลือ
1. เคลื่อนย้ายตัวได้เองโดยใช้หรือไม่ใช้อุปกรณ์ช่วย (หรือไม่ต้องใช้รถเข็นนั่ง)

คะแนนรวมย่อย (0-40) □□□□□□

คะแนน SCIM รวม (0-100) □□□□□□

VITA

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