

**Functional Activities Related to Neurological Levels of the
Client with a Spinal Cord Injury**

**Part 1: Mat Mobility, Transitional Movements and Sitting Balance
Part 2: Transfers, W/C Mobility and Gait/Ambulation**

Overview and Purpose:

This project is funded by the Physiotherapy Practice Champion Award through Vancouver Coastal Health. The goal of this project is to create online and in-print resource manuals, for both therapists and individuals with spinal cord injuries that outline the functional activities related to various neurological levels of spinal cord injury.

Resource information on this topic can be found in SCI specific therapy textbooks, online and as resource material from spinal cord rehab centers. The purpose of this project was to amalgamate the resources in existence as well as bring in more current information, to create a SCI specific resource for Vancouver Coastal Health Authority. This resource manual aims to be progressive and evolve through time as new and more current information becomes available. Also, in the future, this project aims to include current technology such as weblinks, video and pictures to enhance and highlight the information provided.

The goals of this resource manual are to:

- 1) Outline the functional potential of individuals with various neurological levels of spinal cord injury for mat mobility, transitional movements and sitting balance
- 2) Build capacity of clinical skills between the Physiotherapists throughout Vancouver Coastal Health and the Province of British Columbia
- 3) Transfer knowledge of skills between the Physiotherapists throughout Vancouver Coastal Health and the Province of British Columbia
- 4) Promote a seamless transition for individuals with spinal cord injuries throughout the continuum of care of Vancouver Coastal Health and the Province of British Columbia
- 5) Enhance skill development and efficiency of mastery of skills of each individual through the continuum of care of Vancouver Coastal Health and the Province of British Columbia

***Prepared by: Jean Cremin, PT, MSc PT
Physiotherapist
Spinal Cord Injury Program
GF Strong Rehabilitation Centre
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Key Muscles for AIS Classification of Neurological Level of Injury

Motor Level	Key Muscles
C1-C4	Sensory level and diaphragm
C5	Biceps, brachialis, brachioradialis
C6	Extensor carpi radialis longus and brevis
C7	Triceps
C8	Flexor digitorum profundus
T1	Interossei
T2-L1	Intercostals, abdominals
L2	Iliopsoas
L3	Quadriceps
L4	Tibialis anterior
L5	Extensor hallucis longus
S1	Gastrocnemius, soleus
S2-S5	Sphincter

Key Determinants of Functional Ability

- Neurological Level
- Available joint ROM
- Muscle length
- Joint integrity
- Flexibility
- Strength
- Conditioning
- CV endurance
- Cognition, memory, perception
- Proprioception
- Body type: size, weight
- Age
- Spasticity
- Resting tone
- Motivation
- Body awareness
- Problem solving abilities
- Environment
- Rehabilitation services available
- Therapist's assessment of individual's skill level

C3 (and above) Complete Spinal Cord Injury

Innervation of the Major Muscles and Muscle Groups:

Full Innervation		Partial Innervation	
Cranial Nerves	CNI - CNXII	Trapezius	CN XI, C2-4
		Neck flexors	C1-3
		Neck extensors	C1-3
		Sternocleidomastoid	C1-3
		Levator Scapulae	C3, C4
		Diaphragm	C3-5

Functional Significance

Individuals with C3 or higher complete tetraplegia retain motor control over their cranial nerves. Complete SCI. Voluntary control over facial, pharyngeal and laryngeal musculature is maintained. Innervation of the diaphragm is at the cervical levels C3, C4, C5; therefore individuals with this level of injury have an impaired or non-functional diaphragm. Therefore, these individuals require assistance to breathe. Most commonly, a ventilator is used, however, more recently, phrenic nerve stimulators and diaphragmatic pacers may also be optional for some of individuals. Individuals with this level of injury drive a power wheelchair using adaptive technology and a sip and puff mechanism.

Mat Mobility:

Individuals with this level of injury are unable to perform mat mobility independently. They may assist by initiating movement with their head and neck, but they will be dependent to roll and to position themselves on the mat or in bed.

Transitional Movements:

Individuals with this level of injury are unable to perform transitional movements and are dependent for supine ⇔ sit as well as transfers. They may assist by maintaining alignment through their head and neck during transfers and transitional movements.

Sitting Balance:

Individuals with this level of injury are unable to sit unsupported. Protective and righting reactions are absent. Therefore, supervision and spotting are necessary for an individual with this level of spinal cord injury and it is unsafe for them to be left unattended in the sitting position as he/she is unable to prevent self from falling and is unable to get back up after a fall.

Transfers:

Verbally directing the transfer: individual has the potential to be independent

W/C ⇔ Bed/Therapy Mat: Dependent

Techniques:

- Mechanical lift transfer: 1 – 2 person assist
- Pivot transfer: 1 – 2 person assist
- Sliding board transfer: 1 – 2 person assist
- Towel/strap transfer method: 1- 2 person assist
- Dependent lift transfer (“quad lift”): 2 – 3 person assist

W/C ⇔ Floor: Dependent

Techniques:

- Mechanical lift transfer: 1 – 2 person assist * recommended for client/caregiver safety
- Dependent lift transfer (“quad lift”): 2 – 4 person assist depending on heaviness of the transfer

* Precautions: when transferring a individual with this high a level of injury, one needs to be very careful of the placement of the individual’s vent tubing, lines/tubes, as well as trache site and the changes in individuals BP with positional/postural changes.

W/C Mobility and Skills

An individual with a C3 and above complete spinal cord injury will require an adapted power wheelchair for all mobility needs. This individual will be able to use the power wheelchair to get around, as well as tilt/recline as needed for pressure relief and comfort. A manual wheelchair may be warranted as a back-up wheelchair in the event that this individual’s power wheelchair breaks down. This person will be completely dependent in a manual wheelchair and will require assistance with wheelchair mobility and tilt/pressure relief.

Power Wheelchair:

Power wheelchair with adaptive set up for driving/tilting:

- Sip and Puff
- Head/Chin activation

Potential Physical Therapy Goals for the Individual with C3 (and above) SCI

1. Inspiratory muscle training
2. Maximize independent breathing time
3. Direction of care: mobility, transfers, positioning
4. Direction of a ROM program
5. Direction of assisted cough, bronchial hygiene treatments, bagging and suctioning

C4 Complete Spinal Cord Injury

Innervation of the Major Muscles and Muscle Groups:

Full Innervation		Partial Innervation	
Cranial Nerves	CNI - CNXII	Diaphragm	C3, 4, 5
Trapezius	CN XI, C2-4	Levator Scapulae	C3, 4, 5
Neck flexors	C1-3	Levator Scapulae	C3, 4, 5
Neck extensors	C1-3	Rhomboids	C4-5
Sternocleidomastoid	C1-3	Supraspinatus	C4, 5, 6

Functional Significance

Individuals with C4 complete tetraplegia retain partial motor control over their diaphragm, and therefore in most cases, do not require a ventilator to breathe. Individuals with this level of injury retain full function of their trapezius musculature, as well as their neck flexors and extensors. They are also capable of scapular adduction and elevation from full trapezius function and partial levator scapulae and rhomboids function. Individuals with this level of injury drive a power wheelchair using adaptive technology and a sip and puff mechanism.

Mat Mobility

Individuals with this level of injury are unable to perform mat mobility independently. They may assist by initiating movement with their head and neck, but they will be dependent to roll and to position themselves on the mat or in bed.

Transitional Movements

Individuals with this level of injury are unable to perform transitional movements and are dependent for supine ↔ sit as well as transfers. They may assist by maintaining alignment through their head and neck during transfers and transitional movements.

Sitting Balance

Individuals with this level of injury are unable to sit unsupported. Protective and righting reactions are absent. Therefore, supervision and spotting are necessary for an individual with this level of spinal cord injury and it is unsafe for them to be left unattended in the sitting position as he/she is unable to prevent self from falling and is unable to get back up after a fall.

Transfers:

Verbally directing the transfer: individual has the potential to be independent

W/C ⇔ Bed/Therapy Mat: Dependent

Techniques:

- Mechanical lift transfer: 1 – 2 person assist
- Pivot transfer: 1 – 2 person assist
- Sliding board transfer: 1 – 2 person assist
- Towel/strap transfer method: 1- 2 person assist
- Dependent lift transfer (“quad lift”): 2 – 3 person assist

W/C ⇔ Floor: Dependent

Techniques:

- Mechanical lift transfer: 1 – 2 person assist * recommended for client/caregiver safety
- Dependent lift transfer (“quad lift”): 2 – 4 person assist depending on heaviness of the transfer

W/C Mobility and Skills

An individual with a C4 complete spinal cord injury will require an adapted power wheelchair for all mobility needs. This individual will be able to use the power wheelchair to get around, as well as tilt/recline as needed for pressure relief and comfort. A manual wheelchair may be warranted as a back-up wheelchair in the event that this individual’s power wheelchair breaks down. This person will be completely dependent in a manual wheelchair and will require assistance with wheelchair mobility and tilt/pressure relief.

Power Wheelchair:

Power wheelchair with adaptive set up for driving/tilting:

- Sip and Puff
- Head/Chin activation

Potential Physical Therapy Goals for the Individual with C4 SCI

1. Inspiratory muscle training
2. Direction of assisted cough, bronchial hygiene treatments
3. Direction of care: mobility, transfers, positioning
4. Direction of a ROM program

C5 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups:

Full Innervation		Partial Innervation	
All previously listed		Rotator Cuff:	
Diaphragm	C3, 4, 5	Supraspinatus	C5, 6
Levator Scapulae	C3, 4, 5	Infraspinatus	C5, 6
Rhomboids	C4-5	Teres Minor	C5, 6
		Subscapularis	C5, 6
		Deltoids:	
		Anterior Deltoid	C5, 6
		Middle Deltoid	C5, 6
		Posterior Deltoid	C5, 6
		Biceps	C5, 6
		Teres Major	C5, 6, 7
		Supinator	C5, 6, 7
		Pec Major: Clavicular Head	C5, 6, 7
		ECRL	C6, 7
		ECRB	C 6, 7, 8
		Serratus Ant	C5, 6, 7

Functional Significance

Individuals with C5 complete tetraplegia have the potential for more function than individuals with higher C spine neurological injuries. The preservation of partial elbow flexors and deltoids allows for some function when assisting with transfers, manual wheelchair propulsion, some ADLs as well as some mat and bed mobility skills. If these partially innervated muscles are strong – then the individual will be able to perform and assist with some functional activities. If these partially innervated muscles remain weak – then the individual will function much like an individual with a higher C spine neurological injury.

Other functionally significant activities:

- Potential for joystick driving a power wheelchair

- Potential to propel a manual wheelchair on smooth even indoor surfaces * set up is very important
- Potential for self-feeding with equipment: i.e.: a gravity eliminated sling set up (OB Arm)
- Potential to perform some ADL's with adapted equipment
- Improved head and neck control
- Improved balance with head on body righting reactions
- Shoulder girdle remains poorly stabilized
- Weak shoulder abduction, flexion and extension
- Strong unopposed elbow flexion and supination * see below
- Weak to absent wrist extension
- Minimal pectoral activity
- Potential to hook arm behind push handle and lean forward
- Potential to push up from a high surface when arms stabilized

** Unopposed elbow flexion has the potential to become problematic with elbow flexor over activity:

1. Increased resting muscle tone in elbow flexors
2. Shortened sarcomeres in elbow flexors
3. Increased concentric activity in elbow flexors
4. Decreased eccentric activity in elbow flexors
5. No antagonist muscle activity in elbow extensors
6. Decreased flexibility in elbow flexors leading to potential of contractures
7. Spasticity

Mat Mobility

Individuals with this level of injury are able to perform some and assist with most mat mobility:

- Potential to roll with physical assistance and/or the use of assistive devices: bed ladder, loops etc
- Supine side lying: has the potential to perform independently +/- assistive devices or requires assistance +/- the use of assistive devices
- Side lying Supine: has the potential to perform independently +/- assistance or assistive devices
- Supine ↔ Prone: requires assistance
- Scooting on mat: requires assistance but can often assist by depressing shoulders
- Seat lifts: requires assistance

Transitional Movements

Individuals with this level of injury can assist with transitional movements, but in most cases require physical assistance and/or assistive devices

- Supine Long sit: physical assistance required and/or use of assistive devices: bed ladder/loops etc. Can also work on pull to sit activities utilizing the intact biceps and deltoids.
- Long sit Supine: physical assistance often required, if individual has enough shoulder ROM and stability, he/she can often lower self down with supervision

Sitting Balance

*The individual with a C5 complete tetraplegia has the potential to achieve some sitting balance, however this person's righting reactions are very limited, and they lack any protective reactions to prevent themselves from falling. In addition, this individual is not able to recover, or get themselves back up after a fall independently. Therefore, supervision and spotting are necessary for an individual with this level of spinal cord injury and it is unsafe for them to be left unattended.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat

- Propped forwards: Once positioned in long sitting, he/she can maintain long sitting position if the individual is propped forward with upper extremities resting forwards on lower extremities. In this position, the individual does not have any protective reactions and has very limited righting reactions; therefore, supervision or spotting is necessary.

- Propped backwards/elbow locking: Once assisted into a propped back/elbow locked position with shoulders externally rotated and extended; the individual can maintain this position with minimal assistance/supervision at the elbows. There is no motor control in the triceps; therefore, this individual does not have active extension. If the individual loses the extension/external rotation of the shoulder, the elbow will bend and the individual will fall. The individual has limited righting and protective reactions in this position, therefore, supervision or spotting is necessary.

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)

- Propped forwards: Once positioned leaning forward on lap, he/she can maintain this position with supervision. This position can be frightening for some people as the fear of falling forward is strong, and the individual feels quite helpless in this position. Often the individual learns to prop forward on a mat/table in front through their forearms where they can maintain this position with supervision and it is more safe and functional in that they can have their head up and interact with their environment.

- Propped backwards/elbow locking: Once assisted into a propped back/elbow locked position with shoulders externally rotated and extended; the individual can maintain this position with minimal assistance/supervision at the elbows. The individual has limited righting and no protective reactions in this position, therefore, supervision/spotting is necessary. Also, due to the high sitting position and the forward momentum if the individual was to fall forward, they need to be spotted from in front to prevent falling forward onto the ground.

Transfers:

Verbally directing the transfer: individual has the potential to be independent

W/C ⇔ Bed/Therapy Mat: Dependent

Techniques:

- Mechanical lift transfer: 1 – 2 person assist
- Pivot transfer: 1 – 2 person assist
- Sliding board transfer: 1 – 2 person assist

- Towel/strap transfer method: 1- 2 person assist
- Dependent lift transfer (“quad lift”): 2 – 3 person assist

W/C ⇔ Bed/Therapy Mat: Assisted

Technique:

- Sliding Board Transfer:

W/C ⇔ bed/mat

Individual likely will need assistance to get to the front of the cushion and to place sliding board appropriately. Individual can lean forward and position head in opposite direction of the transfer. Individual will likely need assistance adjusting the placement of his/her hands, and will require assistance with sliding his/her bottom along the board to the mat/bed or into the wheelchair. Individual will require assistance to push trunk upright into high sitting and with leg management onto the bed/mat or footplate of wheelchair. A firm surface makes it easier to transfer to and from as well as angling the transfer in a somewhat level or downward direction.

W/C ⇔ Floor: Dependent

- Mechanical lift transfer: 1 – 2 person assist * recommended for client/caregiver safety
- Dependent lift transfer (“quad lift”): 2 – 4 person assist depending on heaviness of the transfer

W/C Mobility and Skills

An individual with a C5 complete spinal cord injury may have the potential to be both a power wheelchair and manual wheelchair user. This individual will require an adapted power wheelchair for his/her mobility needs. This individual will be able to use the power wheelchair to get around, as well as tilt/recline as needed for pressure relief and comfort. A manual wheelchair may be beneficial for indoor use on smooth, even surfaces as well as for exercise. This individual will require assistance with pressure relief as well as with outdoor wheelchair mobility and on uneven terrain and slopes.

Manual wheelchair

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Plastic coated rims**
- **Surgical tubing wrapped around push rims**
- **Peg rim projections**
- **High pressure tires**
- **Increased dump in wheelchair**
- **Centre of gravity and wheeling axel as far forward as possible**
- **Anti-tippers**
- **? chest strap**
- **? seat belt**
- **Push to lock brakes set up at appropriate angle for client**
- **Push handles for hooking**

W/C Skills:

Manual W/C:

Independent:

- **Sitting balance in wheelchair**
- **Putting brakes on and off**
- **Hooking with push handles**
- **Weight shifts**
- **Propulsion: forward/backward with peg rims projections or plastic coated rims**
- **Turning 360**
- **Popping into wheelie position**
- **Pop up to 1" curb (door step)**
- **Indoor/smooth surface manual wheeling**

Assistance Required:

- **Positioning in wheelchair**
- **Ascending/descending a ramp**
- **Ascending/descending > 1" curbs**
- **Outdoor manual wheeling on uneven terrain**

Power W/C:

Independent:

- **Driving power w/c indoors and outdoors with hand drive**
- **Pressure shifts/tilts**

Assistance Required:

- **Positioning in wheelchair**

Potential Physical Therapy Goals for the Individual with C5 SCI

1. Inspiratory muscle training
2. Direction of assisted cough, bronchial hygiene treatments
3. Direction of care: mobility, transfers, positioning
4. Direction of a ROM/stretching/positioning program
5. Direction of an exercise program

Goals:

Direct care for transfers and ADLs

Assist with transfers by leaning forwards, shifting weight for sliding board placement, and assisting to push up after leaning forward

Work on sitting balance in high and long sitting

Pull up to sit

Manual wheelchair use indoors

Joystick power wheelchair driving

ADLs – self feeding, grooming etc with adaptive equipment

C6 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups:

Full Innervation		Partial Innervation	
All previously listed		Pec Major: Clavicular Head	C5, 6, 7
Rotator Cuff:		Pec Major: Sternal Head	C6, 7, 8, T1
Supraspinatus	C5, 6	Teres Major	C5, 6, 7
Infraspinatus	C5, 6	Supinator	C5, 6, 7
Teres Minor	C5, 6	ECRL	C6, 7
Subscapularis	C5, 6	ECRB	C 6, 7, 8
Deltoids:		Serratus Ant	C5, 6, 7
Anterior Deltoid	C5, 6	Pronator Teres	C6, 7, 8
Middle Deltoid	C5, 6	FCR	C6, 7, 8
Posterior Deltoid	C5, 6	Latissimus Dorsi	C5, 6, 7
Biceps	C5, 6	EPL	C6, 7, 8, T1

Functional Significance

Individuals with C6 complete tetraplegia have neurologically intact biceps, deltoids, brachialis and brachioradialis as well as significant innervation to the clavicular portion of pec major – which together allow for this individual to have a greater functional potential. The serratus anterior has adequate innervation to stabilize the scapula on the trunk, which in turn improves the individual's ability to lift his/her body for transfers and pressure relief, as well as move the arm away from the body with a stable scapula. Most significantly, the preservation of radial wrist extensors allows the individual to have a potential grasp and functional hand using tenodesis grip.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on smooth even surfaces as well as slightly uneven terrain (grass, sidewalks), small grade inclines, and 2 “ curbs. Depending on strength of individual, skill level and motivation – some individuals are able to ascend/descend 4” curbs, larger slopes, and challenging uneven terrain independently.
- ADLs: self feeding, dressing, self catheterization, etc
- Improved head and neck control
- Improved balance with head on body righting reactions
- Improved shoulder strength in flexion, abduction, extension, internal and external rotation
- Improved scapular control
- Strong elbow flexion
- Strong wrist extension tenodesis grip
- Strong clavicular head of pecs
- Weak pronation and wrist flexion
- Tenodesis grip
- Potential to hook arm behind push handle and lean forward
- Potential to push up from a high surface when arms stabilized

Mat Mobility

Individuals with this level of injury are able to perform much of their mat mobility skills independently, or may need some assistance:

- Potential to roll independently +/- the use of assistive devices (ie: bed ladder, loops etc), and/or with physical assistance
- Supine side lying: has the potential to perform independently +/- assistive devices or physical assistance
- Side lying supine: has the potential to perform independently
- Supine ↔ Prone: has the potential to perform independently
- Scooting on mat: has the potential to scoot independently by shifting head and twisting upper trunk through stable shoulders and fixed arms
- Seat lifts: potential to perform independently but often requires assistance

Transitional Movements

Individuals with this level of injury can perform many transitional movements independently with assistive devices

- Supine Long sit: has the potential to perform independently +/- assistive devices: bed ladder/loops etc.
- Long sit Supine: has the potential to perform independently
- Getting legs up onto mat: has the potential to be independent with the use of assistive devices: leg loops/straps

Sitting Balance

*The individual with a C6 complete tetraplegia has the potential to achieve sitting balance, however this person’s righting reactions and protective reactions remain slightly decreased, and therefore supervision is recommended, especially in the early stages. Once the individual masters elbow locking and throwbacks, the individual’s sitting balance and safety increases

significantly. At this level of injury, the person's deltoids and external rotators are fully innervated, and the potential for the individual to lose the elbow lock position (shoulder extension + external rotation) decreases significantly and therefore he/she is capable of maintaining this position. As the individual learns to successfully get him/herself up from supine/side lying into long sitting, then the individual has potential to be left unsupervised. This is at the discretion of the supervising therapist.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat

- Propped forwards: has the potential to be independent
- Propped backwards/elbow locking: has the potential to be independent. Once the individual has mastered locking his/her elbows and practices getting into and out of this position, then they can progress to independence.

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)

- Propped forwards: has the potential to be independent, as long as individual can push up from forward leaning position independently and achieve sitting balance with elbows locked behind

- Propped backwards/elbow locking: has the potential to be independent. Supervision is recommended in the early stages as this position can be precarious if the person loses his/her balance and the momentum forward can knock the client forward onto the ground

Transfers:

Verbally directing the transfer: client has the potential to be independent

W/C ⇔ Bed: Assisted

Techniques:

- Mechanical lift transfer: 1 – 2 person assist
- Pivot transfer: 1 – 2 person assist
- Sliding board transfer: 1 – 2 person assist
- Towel/strap transfer method: 1- 2 person assist
- Dependent lift transfer (“quad lift”): 2 – 3 person assist

W/C ⇔ Bed: Assisted/Modified Independence

Sliding Board Transfer:

W/C → bed/mat

Client pushes bottom forward to the front of the cushion through extended arms placed on wheels and using shoulder depressors to shift bottom forward. Once bottom is forward of wheel in wheelchair and angled towards transfer side, client can place the sliding board under upper thigh by leaning head and trunk away from transfer side. Often loops or holes on the sliding board can help the individual manipulate the board into place. Client then again leans forward and in opposite direction of the transfer. Client may need assistance adjusting the placement of his/her hands. Client positions the hand on the wheelchair next to the thigh, the other hand stabilizes the board, far enough away for the buttocks to be able to slide across the board.

Although the buttocks do not need to be lifted, the person does need to de-weight them and this is achieved by a forward lean and the head-hips relationship technique. The client then slides

his/her bottom along the board to the mat/bed or into the wheelchair. Client will then position arms in a wide tripod position and will perform a “push up” to push the trunk upright into high sitting by using the pectoral muscles and externally rotating and extending through the shoulders as well as supinating through the forearms into a elbow-locked position. A firm surface makes it easier to transfer to and from as well as angling the transfer in a somewhat level or downward direction.

W/C ⇔ Floor: Dependent

- Mechanical lift transfer: 1 – 2 person assist * recommended for client/caregiver safety
- Dependent lift transfer (“quad lift”): 2 – 4 person assist depending on heaviness of the transfer

W/C Mobility and Skills

An individual with a C6 complete spinal cord injury may have the potential to be both a power wheelchair and manual wheelchair user. This individual will require an adapted power wheelchair for his/her mobility needs outdoors, on uneven or hilly terrain, and for longer distances. This individual will be able to use the power wheelchair to get around, as well as tilt/recline as needed for pressure relief and comfort. A manual wheelchair is often beneficial for indoor use on smooth, even surfaces as well as for exercise. As this individual builds his/her manual wheelchair skills and endurance, this person can be quite an effective manual wheelchair user in indoor and outdoor terrain. This individual has the potential to be independent with pressure relief in the manual wheelchair.

Manual Wheelchair:

Manual wheelchair – may be appropriate for certain individuals depending on needs of client

Will require a lightweight rigid manual wheelchair with custom modifications:

- Plastic coated rims
- Surgical tubing wrapped around push rims
- Peg rim projections
- High pressure tires
- Increased dump in wheelchair
- Centre of gravity and wheeling axel as far forward as possible
- Anti-tippers
- ? chest strap
- ? seat belt
- Push to lock brakes set up at appropriate angle for client
- Push handles for hooking

W/C Skills:

Manual W/C:

Independent:

- Sitting balance in wheelchair

- **Putting brakes on and off**
- **Hooking with push handles**
- **Weight shifts**
- **Propulsion: forward/backward with peg rims projections or plastic coated rims**
- **Turning 360**
- **Popping into wheelie position**
- **Pop up to 1" curb (door step)**
- **Indoor/smooth surface manual wheeling**

Assistance Required:

- **Positioning in wheelchair**
- **Ascending/descending a ramp**
- **Ascending/descending > 1" curbs**
- **Outdoor manual wheeling on uneven terrain**

Power W/C:

Independent:

- **Driving power w/c indoors and outdoors with hand drive**
- **Pressure shifts/tilts**

Assistance Required:

- **Positioning in wheelchair**

Potential Physical Therapy Goals for the Individual with C6 SCI

1. Independent sliding board transfer
2. Leg management up onto mat
3. Lateral scooting on mat
4. Seat lifts
5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs

C7 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups:

Full Innervation		Partial Innervation	
All previously listed		ECRB	C 6, 7, 8
Pec Major: Clavicular Head	C5, 6, 7	Pronator Teres	C6, 7, 8
Teres Major	C5, 6, 7	FCR	C6, 7, 8
Supinator	C5, 6, 7	Pec Major: Sternal Head	C6, 7, 8, T1
Serratus Ant	C5, 6, 7	EPL	C6, 7, 8, T1
Latissimus Dorsi	C5, 6, 7	Triceps	C6, 7, 8, T1
ECRL	C6, 7	*FDP	C7, 8, T1
		*FDS	C7, 8, T1
		*Lumbricales	C6, 7, 8, T1

Functional Significance

Individuals with C7 complete tetraplegia have partially intact triceps muscles which allow them to actively extend their elbows without muscle substitution. The presence of this muscle group has a significant impact on increasing the person's functional ability. There is also significant innervation of the lats and both the sternal and clavicular pecs, allowing for more refined arm movement.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on slightly uneven terrain, curbs, steeper ramps, and 4" curbs are possible
- ADLs: self feeding, dressing, self catheterization, etc
- Strong shoulders in flexion, abduction, extension, internal and external rotation, abduction and adduction allowing the person to maneuver their body more easily
- Stable scapula
- Strong elbow flexion and extension
- Strong wrist extension tenodesis grip
- Potential weak finger flexors and extensors and thumb extensors
- Pronation and increased wrist stability
- Tenodesis grip
- Potential to push up from a low surface when arms stabilized

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ↔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform many transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent, may use assistive devices: leg loops/straps

Sitting Balance

The individual with a C7 complete tetraplegia has the potential to achieve independent sitting balance. This person has adequate righting and protective reactions to maintain an upright balance and also demonstrates the ability to transition to long sitting from supine

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat

- Propped forwards: independent
- Propped backwards: independent
- Unsupported sitting/hands free: independent, once individual demonstrates adequate protective reactions

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)

- Propped forwards: independent
- Propped backwards: independent

- Unsupported sitting/hands free: independent, once individual demonstrates adequate protective reactions

Transfers:

Verbally directing the transfer: client has the potential to be independent

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer
- Sliding board transfer
- Mechanical lift transfer (self slinging)

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

W/C Mobility and Skills

An individual with a C7 complete spinal cord injury has the potential to primarily/solely be a manual wheelchair user. A manual wheelchair is often beneficial for both indoor and outdoor use. As this individual builds his/her manual wheelchair skills and endurance, this person can be quite an effective manual wheelchair user in indoor and outdoor terrain. This individual has the potential to be independent with pressure relief in the manual wheelchair.

Manual Wheelchair:

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Plastic coated rims**
- **Surgical tubing wrapped around push rims**
- **Peg rim projections**
- **High pressure tires**
- **Increased dump in wheelchair**
- **Centre of gravity and wheeling axel as far forward as possible**
- **Anti-tippers**
- **? chest strap**
- **? seat belt**
- **Push to lock brakes set up at appropriate angle for client**
- **Push handles for hooking**

W/C Skills:

Manual W/C:

Independent:

- **Propulsion: forward/backward with peg rims projections or plastic coated rims**
- **Turning 360**
- **Popping into wheelie position**

- **Pop up to 2-6" curb**
- **Uneven terrain/ramps/inclines**

Potential Physical Therapy Goals for the Individual with C7 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat
3. Lateral scooting on mat
4. Seat lifts
5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs

C8 & T1 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups:

Full Innervation	
All previously listed	
Pec Major: Sternal Head	C6, 7, 8, T1
EPL	C6, 7, 8, T1
Triceps	C6, 7, 8, T1
*FDP	C7, 8, T1
*FDS	C7, 8, T1
*Lumbricales	C6, 7, 8, T1

Functional Significance

Individuals with C8 and T1 complete tetraplegia have mostly neurologically intact upper extremities and function much like an individual with paraplegia. These individuals have functional hands with an adequate grasp and fine motor control in their digits to manipulate most objects.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on slightly uneven terrain, curbs, steeper ramps, and 4" curbs are possible
- ADLs: self feeding, dressing, self catheterization, etc
- Strong shoulders in flexion, abduction, extension, internal and external rotation, abduction and adduction allowing the person to maneuver their body more easily
- Stable scapula
- Strong elbow flexion and extension
- Strong wrist extension
- Stronger fingers flexors and extensors
- Functional grasp
- Improved fine motor control

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ↔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform many transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent, may use assistive devices: leg loops/straps

Sitting Balance

*The individual with a C8 and T1 complete tetraplegia has the potential to achieve independent sitting balance. This person has adequate righting and protective reactions to maintain an upright balance and also demonstrates the ability to transition to long sitting from supine

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat

- Propped forwards: independent
- Propped backwards: independent
- Unsupported sitting/hands free: independent, once individual demonstrates adequate protective reactions

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)

- Propped forwards: independent
- Propped backwards: independent

- Unsupported sitting/hands free: independent, once individual demonstrates adequate protective reactions

Transfers:

Verbally directing the transfer: client has the potential to be independent

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer
- Sliding board transfer
- Mechanical lift transfer (self slinging)

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

W/C Mobility and Skills

An individual with a C8-T1 complete spinal cord injury has the potential to primarily/solely be a manual wheelchair user. A manual wheelchair is often beneficial for both indoor and outdoor use. As this individual builds his/her manual wheelchair skills and endurance, this person can be quite an effective manual wheelchair user in indoor and outdoor terrain. This individual has the potential to be independent with pressure relief in the manual wheelchair.

Manual Wheelchair:

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Regular hand rims**
- **Appropriate dump in w/c for balance and ease of transfers**
- **Centre of gravity and wheeling axel as far forward as possible**
- **? Anti-tippers**
- **? seat belt**
- **Scissor or push to lock brakes set up at appropriate angle for client**

W/C Skills:

Manual W/C:

Independent:

- **Propulsion: forward/backward with peg rims projections or plastic coated rims**
- **Turning 360**
- **Popping into wheelie position**
- **Pop up to 2-6" curb (door step)**
- **Uneven terrain/ramps/inclines**

Potential Physical Therapy Goals for the Individual with C8 – T1 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat
3. Lateral scooting on mat

4. Seat lifts
5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs

T2 – T6 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups:

Full Innervation	Partial Innervation	
All previously listed U/E musculature	Intercostals Erector spinae	T1-T12 T spine

Functional Significance

Individuals with T2-T6 complete paraplegia have neurologically intact upper extremities, making it possible to perform more advanced activities, and function in less accessible environments. The functional potentials of people with different levels of paraplegia are not as distinct as those with varying levels of quadriplegia (Lazar et al. 1989). With lower level injuries, it becomes possible to be independence with self-care, mat and bed mobility, as well as more challenging manual wheelchair skills. As the neurological level descends, the trunk musculature increases allowing more functional activities at lower neurological levels such as:

uneven transfers between floor ⇔ wheelchair as well as the potential for standing and walking with appropriate assistive devices and orthoses.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on uneven terrain, negotiating 4-8” curbs, steep ramps, hills, gravel, sand, ascend/descend stairs becomes possible
- ADLs: self feeding, dressing, self catheterization, etc
- Uneven transfers i.e.: floor ⇔ w/c transfers
- Functional ambulation with appropriate orthoses and devices
-

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ⇔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform all transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent
- Prone ⇔ 4 point kneel: potential to be independent
- 4 point kneel ⇔ high kneel: potential to be independent to get into position but will likely require an assistive device to pull up to high kneel and maintain high kneel position i.e.: table or supportive surface in front
- Sit ⇔ stand: has the potential to be independent in parallel bars with KAFO's
- *Ambulation: usually for exercise purposes only on smooth, even indoor surfaces within parallel bars or with a walker

Sitting Balance

*The individual with a T2-T6 complete paraplegia has independent sitting balance and displays adequate righting and protective reactions to maintain balance.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat
Independent with unsupported/hands free sitting

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)
Independent with unsupported/hands free sitting

Transfers:

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer
- Sliding board transfer

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

W/C Mobility and Skills

An individual with a T2-6 complete spinal cord injury is primarily a manual wheelchair, and often does not require a power wheelchair for mobility – unless there are health-related benefits that warrant a power wheelchair. This individual has the potential to be independent with all manual wheelchair mobility and skills, indoors, outdoors, uneven terrain, curbs, curb cutouts as well as steep inclines/declines and ramps. This individual is independent for pressure relief.

Manual Wheelchair:

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Regular hand rims**
- **Appropriate dump in w/c for balance and ease of transfers**
- **Centre of gravity and wheeling axel as far forward as possible**
- **? Anti-tippers**
- **? seat belt**
- **Scissor or push to lock brakes set up at appropriate angle for client**

Potential Physical Therapy Goals for the Individual with T2 - T6 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat
3. Lateral scooting on mat
4. Seat lifts
5. ? Brace walking with KAFOs or ARGO
6. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs

T7 – T12 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups

Full Innervation	Partial Innervation	
U/E musculature	Intercostals	T1-T12
	Erector spinae	T spine
	Abdominals (rectus, obliques, TA)	T7-T12

Functional Significance

Individuals with T7-T12 complete paraplegia have neurologically intact upper extremities and partially intact trunk musculature, making it possible to perform more advanced activities, and become more independent and functional with standing and walking with appropriate assistive devices and orthoses.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on uneven terrain, negotiating 4-8" curbs, steep ramps, hills, gravel, sand, ascend/descend stairs becomes possible
- ADLs: self feeding, dressing, self catheterization, etc
- Uneven transfers i.e.: floor ⇔ w/c transfers
- Functional ambulation with appropriate orthoses and devices

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ⇔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform all transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent
- Prone ⇔ 4 point kneel: potential to be independent
- 4 point kneel ⇔ high kneel: potential to be independent to get into position but will likely require an assistive device to pull up to high kneel and maintain high kneel position i.e.: table or supportive surface in front
- Sit ⇔ stand: has the potential to be independent in with KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc.
- *Ambulation: potential to be a functional indoor ambulator with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc
- *Ambulation: potential to be a functional outdoor ambulator on even slightly uneven terrain, inclines/declines, stairs, curbs with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc

Sitting Balance

*The individual with a T7-T12 complete paraplegia has independent sitting balance and displays adequate righting and protective reactions to maintain balance.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat
Independent with unsupported/hands free sitting

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)
Independent with unsupported/hands free sitting

Transfers:

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer: independent
- Sliding board transfer: independent

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

W/C Mobility and Skills

An individual with a T7-12 complete spinal cord injury is primarily a manual wheelchair user, and often does not require a power wheelchair for mobility – unless there are health-related benefits that warrant a power wheelchair. This individual has the potential to be independent with all manual wheelchair mobility and skills, indoors, outdoors, uneven terrain, curbs, curb cutouts as well as steep inclines/declines and ramps. This individual is independent for pressure relief.

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Regular hand rims**
- **Appropriate dump in w/c for balance and ease of transfers**
- **Centre of gravity and wheeling axel as far forward as possible**
- **? Anti-tippers**
- **? seat belt**
- **Scissor or push to lock brakes set up at appropriate angle for client**

Potential Physical Therapy Goals for the Individual with T7 – T12 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat
3. Lateral scooting on mat
4. Seat lifts
5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs
6. Indoor ambulation with KAFO's and appropriate assistive device (walker, forearm crutches)
7. Potential for outdoor ambulation with KAFO's and appropriate assistive device (walker, forearm crutches)

L1 – L2 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups

Full Innervation	Partial Innervation
U/E musculature Abdominals (Rectus, Obliques, TA) Back extensors Intercostals	Iliopsoas Quadratus lumborum

Functional Significance

Individuals with L1-L2 complete paraplegia have neurologically intact upper extremities and trunk musculature, making it possible to perform more advanced activities, and become more

independent and functional with standing and walking with appropriate assistive devices and orthoses. They retain partial innervation of the iliopsoas hip flexor muscle, and it may be enough to assist with some hip flexion during the swing phase of gait to allow for a swing through gait pattern or a 4 point gait pattern with bilateral KAFO's and assistive device: walker or forearm crutches.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on uneven terrain, negotiating 4-8" curbs, steep ramps, hills, gravel, sand, ascend/descend stairs becomes possible
- ADLs: self feeding, dressing, self catheterization, etc
- Uneven transfers i.e.: floor ↔ w/c transfers
- Functional indoor and outdoor ambulation with appropriate orthoses and devices

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ↔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform all transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent
- Prone ↔ 4 point kneel: potential to be independent
- 4 point kneel ↔ high kneel: potential to be independent to get into position but will likely require an assistive device to pull up to high kneel and maintain high kneel position i.e.: table or supportive surface in front
- Sit ↔ stand: has the potential to be independent in with KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc.
- *Ambulation: potential to be a functional indoor ambulator with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc
- *Ambulation: potential to be a functional outdoor ambulator on even slightly uneven terrain, inclines/declines, stairs, curbs with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc

Sitting Balance

*The individual with a L1-L2 complete paraplegia has independent sitting balance and displays adequate righting and protective reactions to maintain balance.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat
Independent with unsupported/hands free sitting

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)
Independent with unsupported/hands free sitting

Transfers:

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer: independent
- Stand step around transfer with appropriate orthoses and gait aids

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

Floor ⇔ Stand: independent to transition from sitting on floor => half kneel => stand using supportive surface to push off

*With KAFO's on: rolls over to prone, has crutches placed beside with tips facing forward, presses up onto the hands and "walks the hands towards the feet while bringing the crutches with, balances on one hand and reaches for one crutch, gains balance on that crutch and reaches of other crutch and then walks crutches towards feet until eventually individual is standing erect.

W/C Mobility and Skills

An individual with a L1-L2 complete spinal cord injury is primarily a manual wheelchair user, and often does not require a power wheelchair for mobility – unless there are health-related benefits that warrant a power wheelchair. This individual has the potential to be independent with all manual wheelchair mobility and skills, indoors, outdoors, uneven terrain, curbs, curb cutouts as well as steep inclines/declines and ramps. This individual is independent for pressure relief.

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Regular hand rims**
- **Appropriate dump in w/c for balance and ease of transfers**
- **Centre of gravity and wheeling axel as far forward as possible**
- **? Anti-tippers**
- **? seat belt**
- **Scissor or push to lock brakes set up at appropriate angle for client**

Potential Physical Therapy Goals for the Individual with L1 – L2 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat
3. Lateral scooting on mat
4. Seat lifts

5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs
6. Indoor ambulation with KAFO's and appropriate assistive device (walker, forearm crutches)
7. Potential for outdoor ambulation with KAFO's and appropriate assistive device (walker, forearm crutches)

L3 – L5 Complete Spinal Cord Injury

Innervation of Major Muscles and Muscle Groups

Full Innervation	Partial Innervation	
U/E musculature	Quadriceps	L2, L3, L4
Abdominals (Rectus, Obliques, TA)	Adductors	L3, L4
Back extensors	External Rotators	L3-S1
Intercostals		

Iliopsoas Quadratus lumborum	
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Functional Significance

Individuals with L3-L5 complete paraplegia have neurologically intact upper extremities and trunk musculature, hip flexors and partially intact quadriceps making it possible to perform ambulatory activities with less assistive devices. The tibialis anterior and posterior, extensor hallucis longus, and peronei receive innervation from L4, however the gastrocnemius and soleus receive sacral innervation. Lacking the plantar flexor innervation, individuals at this level have decreased static standing balance. AFOs therefore may be required during ambulation and standing activities.

Other functionally significant activities:

- Manual wheelchair propulsion indoors and outdoors on uneven terrain, negotiating 4-8" curbs, steep ramps, hills, gravel, sand, ascend/descend stairs becomes possible
- ADLs: self feeding, dressing, self catheterization, etc
- Uneven transfers i.e.: floor ⇔ w/c transfers
- Functional ambulation with appropriate orthoses and devices

Mat Mobility

Individuals with this level of injury have the potential to perform all mat mobility independently.

- Rolling: independent
- Supine side lying: independent
- Side lying Supine: independent
- Supine ⇔ Prone: independent
- Scooting on mat: independent
- Seat lifts: independent
- Managing legs on mat: independent

Transitional Movements

Individuals with this level of injury can perform all transitional movements independently +/- assistive devices

- Supine Long sit: independent
- Long sit Supine: independent
- Managing legs on/off mat: independent
- Prone ⇔ 4 point kneel: potential to be independent
- 4 point kneel ⇔ high kneel: potential to be independent to get into position but will likely require an assistive device to pull up to high kneel and maintain high kneel position i.e.: table or supportive surface in front
- Sit ⇔ stand: has the potential to be independent in with KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc.
- *Ambulation: potential to be a functional indoor ambulator with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc

- *Ambulation: potential to be a functional outdoor ambulator on even slightly uneven terrain, inclines/declines, stairs, curbs with bilateral KAFO's and appropriate assistive device i.e.: walker, forearm crutches etc

Sitting Balance

*The individual with a L3-L5 complete paraplegia has independent sitting balance and displays adequate righting and protective reactions to maintain balance.

Long Sitting/Frog Sitting: Legs in neutral rotation or slight external rotation on mat
Independent with unsupported/hands free sitting

High Sitting: Legs dangled over edge of mat (hips at ~ 90 degrees)
Independent with unsupported/hands free sitting

Transfers:

W/C ⇔ Bed: Independent

Techniques:

- Pivot transfer: independent
- Stand step around transfer with appropriate orthoses and gait aids

W/C ⇔ Floor: has the potential to be independent, may require minimal assistance initially with technique and lift

Floor ⇔ Stand: independent to transition from sitting on floor => half kneel => stand using supportive surface to push off

W/C Mobility and Skills

An individual with a L3-5 complete spinal cord injury is primarily a manual wheelchair user, and often does not require a power wheelchair for mobility – unless there are health-related benefits that warrant a power wheelchair. This individual has the potential to be independent with all manual wheelchair mobility and skills, indoors, outdoors, uneven terrain, curbs, curb cutouts as well as steep inclines/declines and ramps. This individual is independent for pressure relief.

Will require a lightweight rigid manual wheelchair with custom modifications:

- **Regular hand rims**
- **Appropriate dump in w/c for balance and ease of transfers**
- **Centre of gravity and wheeling axel as far forward as possible**
- **? Anti-tippers**
- **? seat belt**
- **Scissor or push to lock brakes set up at appropriate angle for client**

Potential Physical Therapy Goals for the Individual with L3 – L5 SCI

1. Independent sliding board transfer, even and uneven heights
2. Leg management up onto mat

3. Lateral scooting on mat
4. Seat lifts
5. Manual wheelchair propulsion indoors and outdoors, even, uneven terrain, slopes, curbs
6. Indoor ambulation with KAFO's and appropriate assistive device (walker, forearm crutches)
7. Potential for outdoor ambulation with KAFO's or AFO's and appropriate assistive device (walker, forearm crutches, Nordic walking poles, canes, ?no gait aid)

TRANSFERS

DEPENDENT TRANSERS

General Principles for Effective Dependent Transfers

Communication:

- It is very important that the client communicate how the transfer works best for him/her, if there is any pain that the caregivers should know about and techniques that work best for this individual's set up and body size
- It is very important that the caregivers and client communicate about how they are going to perform the transfer
- It is important to decide on a signal of when the transfer takes place ie: "on 3, 1...2...3..." or "on transfer, 1...2...3..... transfer" etc

Wheelchair Positioning:

- Wheelchair at a 20-30 degree angle to the transfer surface
- Casters in a forward position (can be locked) to give more front/back stability
- Brakes on
- Armrest off on transfer side
- Shift buttocks forward in the wheelchair to avoid landing or scraping skin against the wheel (padding may be used over wheel if necessary)

Components of a Transfer:

The Forward Shift

- When the client is dependent for the transfer, Person #1 (the person in front) is responsible for the weight shift forward, often leaning the client forward onto their hip, in the opposite direction of the transfers
- Person # 1 perform the weight shift forward portion

The Lateral Shift

- When the client is dependent for the transfer, Person #2 (the person in back) is responsible for the lateral shift portion of the transfer
- The head and trunk lean away from the transfer direction and Person #2 shift the clients buttocks (with hands under the ischium) in the direction of the transfer

The Descent:

- Both Person # 1 and 2 are responsible for controlling the descent and buttock placement into the wheelchair.
- The client can be slid along a sliding board in multiple scoots towards the cushion, or can be pivoted in 1 or 2 pivots onto the cushion – this will be decided by the caregivers and the set up of the transfer

***When there is only 1 person performing this transfer, they take the position of Person #1 in front of the client and by resting the client's head/shoulder on their opposite leg, Person #1 leans over clients, and using the pants to create a hammock, shifts the client over onto the cushion, or slides the client along a sliding board.

Mechanical Lift

- Use of the mechanical lift is recommended for client/caregiver safety for a heavy individual or an individual who is unable to assist with the transfer
- A client can learn how to self-sling using the mechanical lift, thus increasing his/her independence

- 1 or 2 person assistance is often required with this transfer

1-2 Person Pivot/Sliding Board Transfer (front/back approach)

- This technique is ideal for transferring heavier individuals
- Ideal for even and/or uneven transfers
- A strap can be used if easier or clothing can be used if it can be hammocked – you do not want to pull on clothing to transfer the client, but rather create tension in the clothing to hammock it across the client’s sit bones
- Person # 1 (taller person) is positioned in front of client or if only person assisting with transfer
- Person # 2 (shorter person) is positioned behind client
- Person # 1 supports clients knees between their own while bringing client’s buttocks forward in the wheelchair to allow transfer to occur in front of the rear wheel of wheelchair
- If strap is being used, then Person # 1 places strap under client’s legs with the lower edge positioned at mid thigh (if strap is positioned too low the mechanical advantage is lost, if it is too high, it may slip behind the client)
- If a sliding board is being used, Person # 1 places sliding board under client’s upper thigh and buttocks on the side of the transfer angled onto the transferring surface in front of the wheel
- The client is leaned forward over Person #1’s hip that is opposite the direction of the transfer
- Clients arms may be crossed in lap
- Person #2 places hands under client’s Ischia or gets a firm grip to hammock clothing
- Person #1 grasps ends of the strap tightly as close to the client’s hips as possible
- Persons #1 and 2 together lift and pivot or slide client along a sliding board on a pre-arranged signal

2 person Dependent Lift (side/side approach) “Quad Lift”

- This technique is ideal from wheelchair ⇔ wheelchair or for uneven transfers
- Person #1 and #2 stand on either side of the client
- Person #1 and #2 hold client under the closes knee with one hand
- Client is leaned forward
- Person #1 and #2 grasp the client’s clothes at the buttocks and draw it out to the side to create a hammock
- Person #1 and #2 lift together on a pre-arranged signal

2 Person Dependent Lift (front/back approach) “Fireman Lift”

- This technique is not appropriate for client’s with weak shoulder depressors or significant shoulder pain
- This technique can be used for a floor ⇔ wheelchair transfer, uneven transfers or wheelchair ⇔ wheelchair transfers
- Person #1 (taller person) stands behind the client holding onto his forearms which are folded across the client’s chest
- Client is encouraged to depress shoulder girdle during the lift
- Person #2 holds the client under the thighs with one hand and the other hand under the lower legs
- Person #1 and 2 lift together on a pre-arranged signal

*****IMPORTANT NOTE***** Although an individual may be dependent in transfers, it is essential for them to know the principles involved and be clear on the technique that works for them. This will empower them to direct others and be in control of their care.

ASSISTED/INDEPENDENT TRANSFERS

General Principles for Effective Transfers

Wheelchair Positioning:

- Wheelchair at a 20-30 degree angle to the transfer surface
- Casters in a forward position (can be locked) to give more front/back stability
- Brakes on
- Armrest off on transfer side
- Shift buttocks forward in the wheelchair to avoid landing or scraping skin against the wheel (padding may be used over wheel if necessary)

Components of a Transfer:

The Lift

- Should be practiced in long sitting (also useful for bed mobility) as well as high sitting
- For a straight lift, hands should be positioned close to the thighs and slightly anterior to the hips – this may be altered to suit body build, strength, ROM, etc
- Elbows need to be locked and shoulder depressors have to be effective (if triceps are not functional to maintain elbow extension, deltoids may be used with the shoulders in external rotation, elbows/wrists extended and forearms supinated)
- Leaning forward assists in lifting buttocks higher and blocks may be used while training to improve technique and strength
- More trunk flexion = higher lift but also increases balance demands

The Twist

- The hand in the direction of the transfer is positioned further away from the body while the other hand is close to the hip
- The head-hip relationship is used to achieve an effective twist
- This is achieved by a strong head and trunk rotation away from the direction of the movement
- The shoulders act as a fulcrum in a lever system and therefore the buttocks are moved in the transfer direction
- Note: more than one rotational movement of the head/shoulders in the opposite direction may be performed to optimize momentum
- A good lift and twist enables the person to transfer sideways and should be practiced in both directions

The Descent:

- Practice of a controlled descent is necessary to prevent skin damage
- It requires good body awareness and reasonable shoulder strength

TRANSFERS

Legs Down Transfer

- Requires good scapular depression, good high sitting balance, ≥ 90 degree hip flexion

Wheelchair → Bed

- Wheelchair set up, buttocks moved forward to clear wheel, sliding board positioned if required

- If sliding board is used, it is positioned under mid-thigh and directed towards the centre of the wheelchair in front of the wheel
- Feet positioned on footrests or floor (depends on leg length and height of transfer surface)
- Elbows locked
- If the individual is unable to maintain extended elbows then a prone push position can be used (trunk flexed forward and pushing with bent elbows and can place head on a supportive surface to stabilize forward leaning trunk)
- Trunk is flexed forward as much as possible
- Head and shoulders turn sharply in the direction opposite to transfer while simultaneously pushing or lifting with arms
- Individual scoots self over onto the bed and gains balance in high sitting

Raising legs onto bed (1 leg at a time)

- Position buttocks on a 45 degree angle on the bed so that inner most thigh is positioned more on the bed
- Propping onto the elbow in the same direction as the transfer, furthest away from the wheelchair, client uses other hand/arm/wrist to hook under knee/lower leg/ankle and pulls leg up using biceps and wrist extensors (a strap or leg loop may also be used)
- Once first leg is positioned on bed, client regains sitting balance and moves leg into abduction and props down on same elbow in order to pull up second leg hooking under lower leg/ankle (a strap or leg loop may also be used)
- Once both legs are up on mat, client can regain long sitting position in order to seat lift and reposition his/her bottom to be more centered in bed
- To lie back in bed, client can either lower self through side lying or rolling, or spread elbows out and lower self down onto the pillow

Raising legs onto bed (2 legs at a time)

- This technique is often used with individuals with C6 SCI or higher or for clients who are unable for whatever reason to bring one leg up at a time
- A strap is used around both thighs, keeping legs together for the transfer as well as allowing the client to hook arms to bring legs up
- Once the client has managed to get him/herself onto the bed, both arms are hooked under the strap and a rocking momentum is created to rock back on a diagonal and to bring the legs up with the individual
- There is a point when the client is hooking arms under the strap where they are very vulnerable to falling forward
- Much practice is required and this technique can often lead to unpredictable lower extremity placement.
- Once the client has the lower extremities placed onto the bed, he/she then needs to get up into long sitting position to remove the strap around the lower extremities and reposition legs prior to lying back down. A strap that has two loops on either side can be beneficial as the client is able to pull with one hand to get the strap out from under his/her legs without having to get back up into long sitting

Bed → Wheelchair

- Once client is in long sitting, he/she can lean forward and position legs over edge of bed either onto footrests or ground

- If sliding board is used, it is positioned under mid-thigh and directed towards the centre of the wheelchair in front of the wheel
- The individual lifts or slides across, turning head and shoulders down and away from the direction of the transfer

Legs Up Transfer

- Requires > 90 degree hip flexion, may not be appropriate for someone with strong extensor tone, may be appropriate for someone with strong flexor tone
- Wheelchair positioned, buttocks moved forward and sliding board placed
- Legs lifted onto bed using opposite arm to lift each leg up onto the transfer surface
- Elbows locked
- If the individual is unable to maintain extended elbows then a prone push position can be used (trunk flexed forward and pushing with bent elbows and can place head on a supportive surface to stabilize forward leaning trunk)
- Trunk is flexed forward as much as possible
- Head and shoulders turn sharply in the direction opposite to transfer while simultaneously pushing or lifting with arms
- Individual scoots self over onto the bed and gains balance in high sitting
- To transfer off the bed, legs remain extended on the bed until the end of the transfer

Car Transfers:

- The lift and pivot transfer used for wheelchair ⇔ bed transfers, is used in this transfer
- Body build, strength and spasticity are factors with this transfer
- Foot placement varies for each individual, and depends on the transfer distance and transfer height, as well as the length of the individual's legs. The feet can either remain on the footplates, or be lifted into the car, or one foot can remain on the footplate and the other lifted into the car
- A sliding board may be used if necessary
- The bottom is slid forward of the wheel and angled on a 45 degree with the transfer side more forward in the wheelchair
- Sliding board is placed in front of the wheel, under the upper mid thigh of the client
- The trunk is flexed well forward and the head and shoulder turn sharply away from the direction of the transfer while simultaneously pushing and pivoting bottom into the car seat
- Returning to the wheelchair from the car is the reverse, but most often the feet are left inside the vehicle

Wheelchair ⇔ Floor Transfers

Side Approach

Wheelchair → Floor

- Scoot forward to the edge of the wheelchair and removes armrest in direction of the transfer
- Person positions legs at a 30-40 degree angle
- Floor hand can be positioned by walking hand down legs or placed directly on the floor while hanging onto the wheelchair's push handles with the other hand
- Floor hand should be reached and placed as far away from the wheelchair as possible, as the person will need to leave room for their bottom to go
- Person slides buttocks off seat by twisting head/trunk slightly towards the opposite direction of the transfer
- Once buttocks have moved from the seat, gravity provides the downward force

- The person's task is now to control the motion by resisting the upward/chair ward twist of head and trunk and maintaining the head/trunk leaning in the opposite direction of the transfer

Floor → Wheelchair

- Sit at approx 90 degrees to the wheelchair seat with buttocks in front of the seat
- Flex knee closest to the wheelchair, other leg is slightly bent angled at approximately 45 degrees
- Hand closest to the chair is placed on furthest front arm of the frame with palm down and elbow facing upwards
- The other hand is on the floor slightly anterior to the hip
- To lift the buttocks in the seat, the person swings his head/trunk down and away forcefully and pushes downward with the arms
- To provide extra lift, the person should protract the scapula of the floor arm at the end of the transfer
- Once bottom is positioned on the wheelchair seat (often this is at the very edge of the upholstery), the floor hand is then walked up the legs and the person can push their bottom deeper into the seat pushing off the frame angle.

Front Approach:

Floor → Wheelchair:

- Person assumes upright kneeling position facing the wheelchair
- Using a forceful downward push on the armrests, (cannot pull up on the chair), the person tucks their head and protracts scapulae to help raise their buttocks high above the level of the seat
- The person releases one hand and then using head-hips relationship, twists the trunk around in to a sitting position

Back Approach:

Floor → Wheelchair

- Start with sitting with back to chair and knees bent
- Place both hands on the front of the seat with fingers facing forward (this position requires a great deal of flexibility in shoulder internal rotation and extension)
- Lift strongly, extending head and neck until buttocks reach seat level
- Once the wheelchair seat has been cleared, the head-hip relationship is used to lift the buttocks higher
- Depression of the shoulder, protraction of the scapulae and contraction of the abdominals (if present) are used to pull the pelvis back into the seat

***** IMPORTANT NOTE *****

- The wheelchair cushion may be removed to decrease the height needed to lift
- The cushion can be placed onto the ground so that the client can decrease the height differential from ground to wheelchair
- An interim surface can be used to bridge the distance and decrease the height differential
- A step may be used to push off of instead of the floor giving the arms more clearance

Definitions

Mat Mobility:

- 1) Supine \Leftrightarrow Side lying
- 2) Side lying \Leftrightarrow Prone
- 3) Supine \Leftrightarrow Prone

- 4) Prone ⇔ Supine
- 5) Scooting on mat
- 6) Bringing legs up onto mat

Transitional Movements:

- 1) Supine ⇔ Long sit/High sit
- 2) Prone ⇔ 4 point ⇔ high kneel
- 3) Sit ⇔ stand

Balance:

- 1) Long sitting
- 2) High sitting

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Harvey, L. (200*) _____