Spinal Cord Injury Education

An Overview for Patients, Families, and Caregivers
Spinal Cord Anatomy

- A major component of the Central Nervous System (CNS)
- It is 15 to 16 inches long, and weighs 1 to 2 ounces
- It extends from the brain stem downwards, and tapers into segments at the end called caudaequina, or “horses tail”
Spinal Cord Segments

Spinal Column with Vertebrae

- Cervical Vertebrae (7) - C₁ - C₇
- Thoracic Vertebrae (12) - T₁ - T₁₂
- Lumbar Vertebrae (5) - L₁ - L₅
- Sacrum (5 - fused)
- Coccyx (4 - fused)
Vertebral Column

- This is a photograph of the spine from the cervical (neck) area,
- To the thoracic (chest) area,
- To the lumbar (lower back) area.
- The changes in shape of the vertebra allow for different functions in those areas.
Central Nervous System

- Brain
- Spinal Cord
- Peripheral Nerves
The Function of the Spinal Cord at Various Levels

Cervical Nerves control breathing, sensation, and movement in the shoulders, arms, and fingers

- Nerves C1 through C3 control breathing
- C4 controls breathing and some shoulder function
- C5 through C8 controls the arms, wrist, and fingers
Levels of Function

• Thoracic Nerves provide function to the arms, hands, and trunk

• **T1** Full hand grasp and release

• **T2-T12** Accessory muscles for breathing, coughing, and trunk support. Also temperature regulation
Levels of Function

Lumbar Nerves control the upper and lower legs. If an injury is below L3, walking is possible.
Levels of Function

• Sacral nerves control bowel, bladder, and sexual function

• Because of the location on the cord of these segments, nearly all patients’ have bowel, bladder, and sexual function concerns after SCI
Bone notch at the base of the neck is C7.

The spinal cord ends approximately between L1 & L2.

Sacral cord segmants (S1-S5 "Cauda Equina") are level with T12-L1 Vertebrae.

The sacral vertebrae are fused to make up the sacrum.

The coccygeal vertebrae are fused to make the coccyx or "tail bone".

C1 Cervical spinal nerve roots C1 - C7 correspond with upper aspects of vertebral bodies.

C8 Sensation of C7 nerve is for the middle finger.

T1 C8 and lower spinal nerve roots leave below the corresponding vertebral body.

T4 Sensation of T4 spinal nerve is approximately level with the nipple line.

T6 Sensation of T6 spinal nerve root is approximately level with the bottom of the sternum.

T10 Sensation of T10 spinal nerve root is approximately level with the abdomen.

T12 Sensation of T12 spinal nerve root is approximately level with the pubic bone.

The sensations of lumbar nerves are over the legs.

L5
S1
S3
S5 Sensation of S3,S4 & S5 nerves is the Perineal (genital) area.
Spinal Cord Injury

• An injury or disease could result in damage to only the vertebral column

• Or, damage could be only to the spinal cord

• Most commonly, there is damage to both the vertebral column and the spinal cord
Classification of SCI

• Complete Injuries
  – Defined as an injury where there is no sensation at the lowest sacral nerve segment
  – A complete SCI injury exists when there is no VOLUNATARY movement or sensation below the level of injury

• Incomplete Injuries
  – Defined as an injury where there is sensation at the lowest sacral nerve segment
  – An incomplete SCI injury exists when there is at least some voluntary movement or sensation below the level of injury
Classification of SCI

- **Upper Motor Neuron Injury**
  - The connection between the brain and body below the injury is disrupted

- **Lower Motor Neuron Injury**
  - The Lower Motor Neurons (spinal nerves below injury) are spared
  - Reflexive muscle activity is present (spasms)
American Spinal Injury Association Classification

The American Spinal Injury Association (ASIA) Classification of spinal cord injury, also called the ASIA Impairment Scale. Here is the definition:
A = Complete: No motor or sensory function is preserved in the sacral segments S4-S5.
B = Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
C = Incomplete: Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
D = Incomplete: Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.
E = Normal: motor and sensory function are normal.
SCI Syndromes

- **Central Cord Syndrome**
  - Injury with greater impairment in the upper vs. the lower extremities

- **Brown-Sequard**
  - Injury to only one half of the cord, resulting in paraplegia

![Figures illustrating Central Cord Syndrome and Brown-Sequard Syndrome](Images)
Other Types of SCI

- Cauda Eqina Injury
  - Injury below the end of the spinal cord

- Cervical Stenosis
  - Caused by narrowing of the vertebral column, which compresses the cord
Spinal Cord Injury

- In SCI, function is impaired below the level of actual injury.
- For example, a C5 cord injury may result in impairment of arm, trunk, and leg function.
- A L2 cord injury may result in impairment of leg function.
Types of Injury

- Trauma is the main cause of a SCI. The vertebrae are fractured and the cord is injured as a result of car accidents, sports injuries, or falls.
- The most common areas of injury are at levels C5-7 and T12- L1.
- Thoracic level injuries are the least common.
Types of Fractures

- Compression Fracture
Types of Fractures

Flexion/Compression Fracture

Flexion/Distraction Fracture
Fracture / Dislocation

Figure 7. Dislocation

Figure 8. Fracture-Dislocation
Burst Fracture

Figure 5. Burst Fracture
Spinal Cord Damage

- SCI injury occurs when there is damage or cell death to the tracts that carry signals to and from the brain.
- The main way that cell death occurs is by ischemia, or loss of blood supply to the cells.
- Blood supplies oxygen and nutrients to the cord. Lack of blood supply assures that cell death will occur.
- Swelling occurs after any trauma to the body. Swelling creates further pressure and ischemia, resulting in more cell death.
- Once swelling recedes, damaged nerve tissue is replaced with scar tissue. Messages cannot be transmitted through scar tissue.
Transitions: from Acute Care to Rehabilitation

- As soon as SCI patients are medically stable, the rehabilitation process should begin

- During rehab, patients will continue to recuperate as well as begin therapy to address specific conditions
Inpatient Rehab Expected Outcomes

• The overall goals of inpatient rehab for SCI include but are not limited to:
  – Management of the acute care issues
  – Maximizing physical independence through intensive daily therapy
  – Preventing secondary complications of injury
  – Preparation of the patient and family regarding all aspects of SCI
  – Providing resources to be used after discharge
Early Management of SCI

• Airway Management
  – Artificial airways
  – Intubation
  – Ventilators

• Spinal Stabilization
  – Removes pressure from the cord
  – Fusion
  – Traction provides stability
  – Braces and Halos
Things to Address During Rehab

- Strengthening
- Bowel and Bladder Function
- Skin Care
- Nutrition and Swallowing
- Prevention of blood clots
- Pain
- Use of braces
How SCI Affects Other Body Systems

• Primarily, sensory and motor functions are affected

• The respiratory system can be affected
  – If nerves that control the diaphragm are affected, a tracheostomy or ventilator may be required
  – If coughing is weak or absent, there is a risk of pneumonia
  – Respiratory complications are a leading cause of death in patients with SCI
Cardiovascular System

• The **Cardiovascular System** can be affected

• **Othostatic Hypotension**
  - is a drop in blood pressure that occurs when the body changes from lying or sitting, to upright
  - can cause dizziness, sweating, or fainting
Cardiovascular System cont

- **Blood Clotting**
  - Blood can pool and clot in the legs and feet, forming clots attached to veins
  - Clots can form Deep Vein Thrombosis (DVT)
  - Clots can break away from the vein and travel to the heart or lungs
Cardiovascular System cont

- Temperature Regulation can be affected, especially if injury is above T6
Gastrointestinal System

- **Dysphagia** (difficulty or inability to swallow) is common due to nerve damage, tracheostomy placement, and cervical immobilization.
- **Oral hygiene** may be affected due to difficulty with self-care.
- **Gastric ulcers** are more likely to occur.
- There is an increased risk of **constipation and bowel obstruction**.
Genitourinary System

- **Neurogenic Bladder** occurs when someone is unable to empty the bladder. The bladder becomes distended
  - Bladder distension leads to pressure that may force urine back into the kidney
  - The constant pressure on the kidney could lead to kidney failure
  - There is a high risk of bladder infection due to the inability to void, and the use of catheters
Skin

- **Pressure Sores** (or decubitus ulcers) can form on the skin because of immobility and sensory loss
  - Unrelieved pressure on the skin decreases blood flow to skin cells, causing cells to die
  - Dead skin cells form a wound
  - Friction or shearing, poor nutrition, and incontinence can also cause decubitus ulcers
Areas with little fat and muscle over bony prominences are common sites of bed sores.
Pain and Muscle Spasms

• Pain and muscle spasms can be problematic for patients with SCI. Types of pain include:
  – Musculoskeletal
  – Neuropathic
  – Visceral
  – Central
Spasticity

- Involuntary muscle activity, resistance to passive motion, or spasms

- Spasms can affect mobility, positioning, and comfort

- Spasms can also lead to skin breakdown (ulcers)
Musculoskeletal

• Several conditions affect the muscles, bones, and joints. These conditions can cause pain and lengthen recovery. Most of these conditions are preventable:
  – Contractures
  – Fractures
  – Heterotopic Ossification
  – Osteoporosis
Sexuality and Fertility

- The basic fundamentals of sexuality can be completely altered by SCI
- Healthcare professionals can discuss sexuality with patients as part of rehabilitation
- There are many additional resources available
Adjustment to Disability

• Inpatient rehabilitation is a stepping stone in the process of adjusting to life with SCI
• Successful adjustment is achieved when disability is no longer the dominant function in the life of the person with SCI
Inpatient Rehab Expected Outcomes

• The overall goals of inpatient rehab for SCI include but are not limited to:
  – Management of the acute care issues
  – Maximizing physical independence through intensive daily therapy
  – Preventing secondary complications of injury
  – Preparation of the patient and family regarding all aspects of SCI
  – Providing resources to be used after discharge
Overview of Remaining Classes

• Daily classes will cover a variety of topics related to SCI, including:
  – Exercise
  – Diet and Nutrition
  – Leisure
  – Wheelchairs
  – Medical Concerns
  – And others
We Welcome Your Questions!

- Education is vital to your successful rehabilitation
- Please let us if there is something you don’t understand
- We will work with you to assure your understanding of your individual needs
- Every question is a good question