

TABLE 60.2 Level of Spinal Cord Injury and Rehabilitation Potential

Movement Remaining	Rehabilitation Potential	Movement Remaining	Rehabilitation Potential
Tetraplegia			
C1-3			
<ul style="list-style-type: none"> • Often fatal • Movement in neck and above, loss of innervation to diaphragm, absence of independent respiratory function 	<ul style="list-style-type: none"> • Able to drive electric wheelchair equipped with portable ventilator by using chin control or mouth stick, headrest to stabilize head • Computer use with mouth stick, head wand, or noise control • Attendant care 24 hr/day, able to instruct others 	<ul style="list-style-type: none"> • All triceps to elbow extension, finger extensors and flexors • Good grasp with some decreased strength • ↓ Respiratory reserve 	<ul style="list-style-type: none"> • Able to transfer self to wheelchair • Roll over and sit up in bed • Push self on most surfaces • Perform most self-care • Independent use of wheelchair • Able to drive car with powered hand controls (in some patients) • Attendant care 0–6 hr/day
C4			
<ul style="list-style-type: none"> • Sensation and movement in neck and above • May be able to breathe without ventilator 	<ul style="list-style-type: none"> • Same as C1-3 	Paraplegia	
C5			
<ul style="list-style-type: none"> • Full neck, partial shoulder, back, biceps • Gross elbow, inability to roll over or use hands • ↓ Respiratory reserve 	<ul style="list-style-type: none"> • Able to drive electric wheelchair with mobile hand supports • Indoor mobility in manual wheelchair • Able to feed self with setup and adaptive equipment • Attendant care 10 hr/day 	T1-6	
C6			
<ul style="list-style-type: none"> • Shoulder and upper back abduction and rotation at shoulder • Full biceps to elbow flexion, wrist extension, weak grasp of thumb • ↓ Respiratory reserve 	<ul style="list-style-type: none"> • Able to help with transfer and perform some self-care • Feed self with hand devices • Push wheelchair on smooth, flat surface • Drive adapted van from wheelchair • Independent computer use with adaptive equipment • Attendant care 6 hr/day 	<ul style="list-style-type: none"> • Full innervation of upper extremities • Back, essential intrinsic muscles of hand • Full strength and dexterity of grasp • ↓ Trunk stability, decreased respiratory reserve 	<ul style="list-style-type: none"> • Full independence in self-care and in wheelchair • Able to drive car with hand controls (in most patients) • Independent standing in standing frame
T6-12			
		<ul style="list-style-type: none"> • Full, stable thoracic muscles and upper back • Functional intercostal muscles, resulting in 1 respiratory reserve 	<ul style="list-style-type: none"> • Full independent use of wheelchair • Able to stand erect with full leg brace, ambulate on crutches with swing (although gait difficult) • Unable to climb stairs
L1-2			
		<ul style="list-style-type: none"> • Varying control of legs and pelvis • Instability of lower back 	<ul style="list-style-type: none"> • Good sitting balance • Full use of wheelchair • Ambulation with long leg braces
L3-4			
		<ul style="list-style-type: none"> • Quadriceps and hip flexors • Absence of hamstring function, flail ankles 	<ul style="list-style-type: none"> • Completely independent ambulation with short leg braces and canes • Unable to stand for long periods

the thorax, abdomen, and/or pelvis. It may be dull, tender, or cramping.

Neuropathic pain in SCI occurs from damage to the spinal cord or nerve roots. The pain can be at or below the level of injury. Patients often describe the pain as hot, burning, tingling, pins and needles, cold, and/or shooting. They may be extremely sensitive to stimuli. Even light touch can cause significant pain. (Pain is discussed in Chapter 8.)

Diagnostic Studies

CT scan is the preferred imaging study to diagnose the location and degree of injury and the degree of spinal canal compromise. Cervical x-rays are done when CT scan is not readily available. However, it is hard to see C7 and T1 on a cervical x-ray, decreasing the ability to fully evaluate a cervical spine injury.

MRI is used to assess soft tissue injury, neurologic changes, unexplained neurologic deficits, or worsening neurologic condition. MRI results guide clinical decisions about surgery.² Perform a comprehensive neurologic examination with assessment of the head, chest, and abdomen for other injuries or trauma. Patients with cervical injuries who have altered mental status may need a CT angiogram to rule out vertebral artery damage. Table 37.9 presents the diagnostic studies used to determine the site or location and extent of a VTE.

Interprofessional Care

Prehospital. Goals immediately after injury include maintaining a patent *airway*, adequate ventilation/*breathing*, and adequate *circulating* blood volume (ABCs) and preventing extension of spinal cord damage (secondary injury). Table 60.3 outlines emergency management of the patient with SCI. Spinal motion should be restricted with a combination of a rigid cervical collar and a supportive backboard with straps. Patients should be kept supine and may be logrolled for transfers. Uncooperative patients may need chemical sedation or physical restraints to protect them from further injury.¹³ Reverse Trendelenburg position may be used if necessary. Spinal immobilization in patients with penetrating trauma should be tried as long as it does not affect resuscitation efforts.¹³

Intubation to secure the airway is done as soon as possible for patients with respiratory distress. Using end-tidal CO₂ monitoring can help determine the need for rapid sequence intubation (RSI). Patients with stable airways in the field may need intubation at the medical facility. Systemic and neurogenic shock are treated with IV fluids and vasopressors to maintain systolic BP (SBP) greater than 90 mm Hg. After cervical injury, all body systems must be maintained until the full extent of the damage can be evaluated. After stabilization at the injury scene, the person should be transferred to the nearest medical facility.

+ TABLE 60.3 Emergency Management
Spinal Cord Injury

Etiology	Assessment Findings	Interventions
<p>Blunt Trauma</p> <ul style="list-style-type: none"> • Compression, flexion, extension, or rotation injuries to spinal column • Diving • Falls • Motor vehicle crash • Pedestrian accidents • Sports injuries <p>Penetrating Trauma</p> <ul style="list-style-type: none"> • Gunshot wounds • Stab wounds • Stretched, torn, crushed, or lacerated spinal cord 	<ul style="list-style-type: none"> • Respiratory distress/difficulty breathing • Neurogenic shock: hypotension, bradycardia, cool or warm dry skin • Spinal shock • Muscle weakness, paralysis, or flaccidity • Changes in sensation: temperature, light touch, deep pressure, proprioception • Numbness, paresthesia • Pain, tenderness, deformities, or muscle spasms adjacent to vertebral column • Cuts; bruises; open wounds on head, face, neck, or back • Bowel and bladder incontinence • Urinary retention • Priapism • Decreased rectal sphincter tone 	<p>Initial</p> <ul style="list-style-type: none"> • Ensure patent airway and adequate breathing. • Maintain SaO₂ >90%: <ul style="list-style-type: none"> • Apply O₂ via nasal cannula, nonrebreather mask, or endotracheal tube. • Maintain SBP >90 mm Hg. • Establish IV access with 2 large-bore catheters to infuse normal saline or lactated Ringer's solution. • Immobilize and stabilize cervical spine. • Assess for other injuries. • Control external bleeding. • Obtain appropriate imaging. <p>Ongoing Monitoring</p> <ul style="list-style-type: none"> • Monitor vital signs, level of consciousness, motor and sensory function, O₂ saturation, cardiac rhythm, urine output. • Anticipate need for intubation if in respiratory distress or gag reflex absent. • Maintain normal temperature.

The preferred facility is one that specializes in acute SCI care. A thorough assessment determines the degree of deficit and the level and degree of injury.

Acute Care. Interprofessional care during the acute phase for a patient with a cervical injury is described in Table 60.4. Compared to cervical injury, patients with SCI of the thoracic and lumbar vertebrae need less intense support. At this level of injury, respiratory compromise is not as severe, and bradycardia is usually not a problem. Other problems are treated symptomatically.

Obtain a history, with emphasis on how the incident occurred. Assess the extent of injury perceived by the patient or by the emergency response system (ERS) personnel right after the event. Initial assessment occurs in the emergency department (ED). It includes managing the person's ABCs and vital signs to ensure a secure airway and maintain oxygenation saturation (SaO₂) greater than 92% and mean arterial pressure (MAP) greater than 85 mm Hg. Avoid SBP less than 90 mm Hg. Appropriate medical interventions and diagnostics are implemented to ensure the patient is hemodynamically stable.

Perform a complete neurologic assessment using the ASIA tool (Fig. 60.5). Muscle groups are tested with and against gravity, alone and against resistance, on both sides of the body. Record strength, symmetry, and spontaneous movement. Complete a sensory examination, including touch and pain, as tested by pinprick. Start at the toes and work upward toward the head. Assess rectal tone and note the presence of *priapism*. Voluntary anal contractions indicate incomplete SCI. If time and conditions permit, assess position sense and vibration.

Mechanisms of injury that cause spinal cord trauma, especially involving the cervical cord, may result in brain injury and/or vertebral artery injury. Assess for a history of unconsciousness, signs of concussion, and increased intracranial pressure (see Chapter 56). Carefully assess for musculoskeletal injuries and trauma to internal organs. Because the patient may have altered or no muscle, bone, or visceral sensations below the level of injury, the only clue to internal trauma with hemorrhage may be a rapidly decreasing BP and increasing pulse. Check urine for hematuria, which indicates internal injuries.

Move the patient in alignment as a unit (*logroll*) during transfers and when repositioning to prevent further injury. Monitor respiratory, cardiac, urinary, and GI functions. The patient may go directly to surgery after the initial evaluation or to the intensive care unit (ICU) for monitoring and management.

Nonoperative Stabilization. Nonoperative treatments involve stabilization of the injured spinal segment and decompression, either through traction or realignment. Stabilization eliminates damaging motion at the injury site. It is meant to prevent secondary spinal cord damage caused by narrowing of the spinal canal, or continued contusion or compression of the spinal cord at the level of the injury. Early realignment of an unstable fracture-dislocation injury by closed reduction through craniocervical traction is effective and safe.

Surgical Therapy. Surgical treatment after acute SCI is used to manage instability and decompress the spinal cord. It may reduce secondary injury and improve the patient's outcome. Early surgery (within 24 hours after the injury) is recommended for persons with central cord syndrome and for adults with an acute SCI at any level.² The type of surgery depends on the severity and level of the injury, mechanism of injury, and location and degree of compression.

Surgery to stabilize the spine can be done from the back of the spine (*posterior approach*) or from the front of the spine (*anterior approach*). In some cases, both approaches may be needed. Fixation involves attaching metal screws, plates, or other devices to the bones of the spine to help keep them aligned. This procedure is usually done when 2 or more vertebrae are injured. Small pieces of bone may be attached to the injured bones to help them fuse into 1 solid piece. The bone used is obtained from the patient's spinal bone harvested during surgery, from another bone in the patient's body, or from donor bone. (Specific surgical and nursing interventions for these techniques are discussed in Chapter 63 on pp. 1488–1489.)

Drug Therapy. Current evidence for the use of methylprednisolone is mixed. Guidelines for managing spinal cord injuries issued by both the American Association of Neurological Surgeons and Congress of Neurological Surgeons do not recommend its use for treating acute SCI.¹⁴ The FDS no longer approves

its use either. However, recommendations in the AOSpine 2017 Guidelines suggest a 24-hour infusion of high-dose methylprednisolone within 8 hours of acute SCI.² So, some HCPs may consider this option.

VTE prophylaxis with low-molecular-weight heparin (LMWH) (e.g., enoxaparin [Lovenox]) or fixed, low-dose heparin should start within 72 hours after injury, unless contraindicated. Contraindications include internal or external bleeding and recent surgery. For those with abnormal kidney function, heparin is best as LMWH is mainly excreted via the kidneys.

Vasopressor agents (e.g., phenylephrine, norepinephrine) are used in the acute phase of injury as adjuvants to treatment. They maintain the MAP to improve perfusion to the spinal cord. Use of vasopressors has significant risk for complications. These include ventricular tachycardia, troponin elevation, metabolic acidosis, and atrial fibrillation. Dopamine has more complications than phenylephrine in SCI. Considerations for vasopressor selection include level of injury, patient age, and comorbidities (e.g., heart problems).

TABLE 60.4 Interprofessional Care
Cervical Cord Injury

Diagnostic Assessment

- History and physical examination, including complete neurologic examination
- ABGs
- Electrolytes, serum glucose, coagulation profile, hemoglobin and hematocrit
- Urinalysis
- CT scan, MRI, EMG (measure evoked potentials)
- Anteroposterior, lateral, and odontoid spinal x-rays
- Serial bedside pulmonary function tests (PFTs)

Management

Acute Care

- Immobilization and stabilization of vertebral column
- ABCs (airway, breathing, circulation)
- O₂ by high-humidity mask (PaO₂ >60 mm Hg)
- Intubation (if indicated by ABGs and PFTs)
- Maintain heart rate (e.g., atropine) and BP (e.g., dopamine) (SBP >90 mm Hg, MAP >85)
- Administer IV fluids
- Insert NG tube and attach to suction.
- Assessment and management of nutrition
- Maintain normal body temperature
- Indwelling urinary catheter
- Pain management
- VTE prophylaxis
- Pressure injury prevention
- Stress ulcer prophylaxis
- Bowel and bladder care and training
- Mobilization once spine stabilized
- Physical, occupational, speech therapy and physiatrist consults

Rehabilitation and Home Care

- Physical therapy (ROM, mobility, strength, equipment)
- Occupational therapy (splints, ADLs training)
- Speech therapy (swallow and cognition)
- Pain management
- Spasticity management
- Bowel and bladder training
- Autonomic dysreflexia prevention
- Pressure injury prevention
- Recreational therapy
- Patient and caregiver teaching

❖ NURSING MANAGEMENT: SPINAL CORD INJURY

◆ Nursing Assessment

Subjective and objective data you should obtain from a patient with recent SCI are outlined in Table 60.5.

TABLE 60.5 Nursing Assessment
Spinal Cord Injury

Subjective Data

Important Health Information

Past health history: Motor vehicle crash, sports injury, industrial incident, gunshot or stabbing injury, falls

Functional Health Patterns

Health perception–health management: Use of alcohol or recreational drugs, Risk-taking behaviors

Activity–exercise: Loss of strength, movement, and sensation below level of injury, Dyspnea, inability to breathe adequately (“air hunger”)

Cognitive–perceptual: Tenderness, pain at or above level of injury, Numbness, tingling, burning, twitching of extremities

Coping–stress tolerance: Fear, denial, anger, depression

Objective Data

General

Poikilothermia (unable to regulate body heat)

Integumentary

Warm, dry skin below level of injury (neurogenic shock)

Respiratory

Injury at C1–3: Apnea, inability to cough

Injury at C4: Poor cough, diaphragmatic breathing, hypoventilation

Injury at C5–T6: ↓ Respiratory reserve

Cardiovascular

Injury above T6: Bradycardia, hypotension, postural hypotension, absence of vasomotor tone

Gastrointestinal

↓ Or absent bowel sounds (paralytic ileus in injuries above T5), abdominal distention, constipation, fecal incontinence, fecal impaction

Urinary

Retention (for injuries at T1–L2), flaccid bladder (acute stages), spasticity with reflex bladder emptying (later stages)

Reproductive

Priapism, altered sexual function

Neurologic

Complete: Areflexic, flaccid paralysis and anesthesia below level of injury resulting in tetraplegia (injuries above C8) or paraplegia (injuries below C8), hyperactive deep tendon reflexes and bilaterally positive Babinski test (after resolution of spinal shock)

Incomplete: Mixed loss of voluntary motor activity and sensation

Musculoskeletal

Muscle atony (in flaccid state), contractures (in spastic state)

Pain

Neuropathic, musculoskeletal, and/or visceral

Possible Diagnostic Findings

Location of level and type of bony involvement on spinal x-ray, Injury, edema, compression on CT scan and MRI; positive finding on myelogram

◆ Nursing Diagnoses

Nursing diagnoses for the patient with SCI depend on the severity of the injury and level of dysfunction. Nursing diagnoses for a patient with SCI may include:

- Impaired breathing
- Impaired nutritional status
- Ineffective tissue perfusion
- Impaired tissue integrity
- Impaired urinary system function
- Constipation
- Difficulty coping

Additional information on nursing diagnoses and interventions for the patient with complete cervical SCI is provided in eNursing Care Plan 60.1 (available on the website in this chapter).

◆ Planning

Overall goals are that the patient with an SCI will (1) maintain an optimal level of neurologic functioning; (2) have minimal complications of immobility; (3) learn new skills, gain knowledge, and acquire new behaviors to be able to care for or direct others to do so; and (4) return home at an optimal level of functioning.

◆ Nursing Implementation

Health Promotion. Nursing interventions for the patient with SCI include identifying high-risk persons and providing teaching. Support measures to combat distracted and impaired driving. Teach people to use child safety seats and helmets for motorcyclists and bicyclists. Promote programs for occupational safety (e.g., STEADI) aimed at preventing accidental death and injury. Emphasize the importance of health promotion and injury prevention behaviors after SCI. Health-promoting behaviors can have significant impact on the general health and quality of life of the person with SCI. Nursing interventions include providing education and counseling; (2) referring to programs such as cessation classes, recreation programs, and alcoholism programs; and (3) performing routine physical examinations for non-neurologic problems. Promotion and screening programs must be accessible to and accommodate people with disabilities. Nurses should advocate for wheelchair-accessible rooms, adjustable-height examination tables, and scheduling that allows extra time if needed.

Acute Care. High cervical cord injury caused by SCI is the most complex SCI. It is the focus of this chapter. Interventions for this type of injury can be modified for less severe injuries.

Immobilization. To restrict spinal motion, maintain the patient in a neutral position. For cervical injuries, closed skeletal traction is used for early realignment (retraction). Crutchfield (Fig. 60.6) or Gardner-Wells (halo ring) can provide this type of traction. A rope attached to the center of the device over a pulley to weights at the end. Traction must be maintained at all times. Placement of the skull pins is a disadvantage of tongs. When placement occurs, hold the patient's head in a neutral position. Immobilize the head while the HCP repositions the patient.

! SAFETY ALERT Cervical Spine Injuries

- Always keep the patient's body in correct alignment.
- Turn the patient as a unit (e.g., logrolling) to prevent the spine.

