SPINAL CORD INJURIES

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OBJECTIVES

By the end of class the student will know:

- Etiology of spinal cord injuries
- Pathophysiology of spinal cord injuries
- Clinical manifestations
- Therapeutic management
- Prioritization of acute intervention
- Complications

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CENTRAL NERVOUS SYSTEM

CENTRAL NERVOUS SYSTEM	PERIPHERAL NERVOUS SYSTEM
BRAIN	Cranial nerves arising from the brain 1. Somatic fiber connecting to the skin and skeletal muscles 2. Autonomic fiber connecting to visceral organs
SPINAL CORD	Spinal nerves arising from the spinal cord 1. Somatic fibers connecting the skin and skeletal muscles 2. Autonomic fibers connecting to visceral organs

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CENTRAL NERVOUS SYSTEM

- Asending tracts
  - Carry certain sensory information from receptors in the skin, muscle, joints, viscera, and blood vessels to higher levels of the CNS
- Descending tracts
  - Carry impulses that are responsible for voluntary muscle movement.
  - Upper Motor Neurons (UMN)
  - Lower Motor Neurons (LMN)

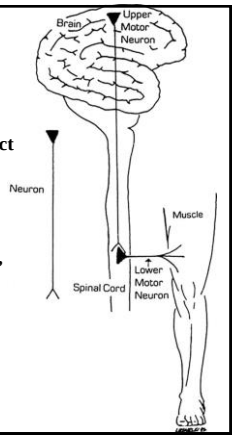
(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Upper Motor Neurons (UMN)

- **Begin in the cerebral cortex and project downward**

Lower Motor Neurons (LMN)

- **Influence skeletal muscles of the arms, trunk, and legs and are located in the anterior horn**



(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

STATISTICS & ETIOLOGY

Spinal Cord Injury (SCI)

- Greatest at risk
  - Young men ages 16-30
    - Causes-various types of trauma and damage
- Average age of SCI patient is 40 years old
  - 12,000 SCI/year
  - 260,000 Americans living with SCI
- Older adults
  - Increasing in numbers

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

PATHOPHYSIOLOGY
Initial injury

- Initial Injury
  - Cord compression
  - Interruption of blood supply
  - Traction
  - Penetrating trauma
    - GSW
    - Stab wounds
  - Primary injury
  - Secondary injury

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

INITIAL INJURY

- Primary
  - initial disruption of axons
- Secondary
  - ongoing damage progressive damage after initial injury.
    - Ischemia
    - Hypoxia
    - Microhemorrhage
    - Edema
- **The extent of injury is a direct result of the primary and secondary damages**
- **Complete cord damage d/t autodestruction of the cord**
- **The extent of the injury and prognosis is most accurately after 72 hours post injury**

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

SPINAL SHOCK

- Spinal Shock
  - A temporary neurologic syndrome
    - Occurs at the time of injury
    - All cord function below the level of the lesion ceases including all motor and sensory function
      - Decreased reflexes
      - Loss of sensation
      - flaccid paralysis below the level of the injury
    - Lasts days to months

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

NEUROGENIC SHOCK

- Neurogeneic shock
  - Due to the loss of vasomotor tone caused by the injury
    - Hypotension and bradycardia with warm extremities
    - Loss of sympathetic nervous system innervation
    - Associated with cervical or high thoracic injuries T6 or higher

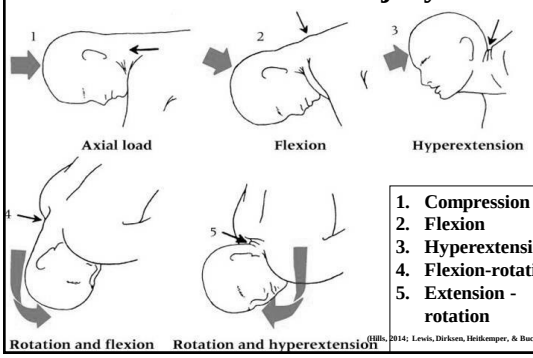
(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Classification of Injury

- Mechanism of injury
- Level of injury
- Degree of injury
  - Complete
  - Incomplete

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLASSIFICATION OF INJURY
Mechanisms of Injury



1. Compression
2. Flexion
3. Hyperextension
4. Flexion-rotation
5. Extension - rotation

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Mechanism of Injury

Compression

Injuries

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Mechanism of Injury
Flexion

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Mechanism of Injury
Hyperextension

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Mechanism of Injury

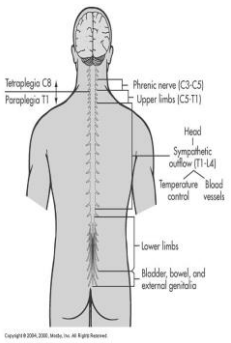
- **Flexion Rotation**
  - **The most unstable of all cervical spine injuries**
- **Extension Rotation**
  - **Disruption of the intervetebral disk**

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLASSIFICATION OF INJURY

Level of Injury

- Level of injury
  - Skeletal
    - Cervical
    - Thoracic
    - Lumbar
      - Cervical and lumbar are the mos common spinal cord injuries
  - Neurologic



(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

TETRAPLEGIA

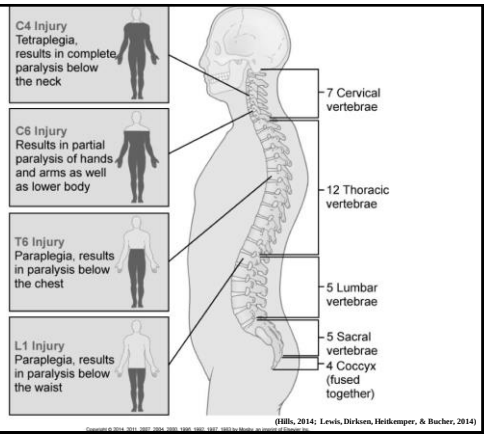
Level of Injury	Remaining Movement
C1-C3 Often fatal, vagus nerve domination of heart, respiratory, blood vessels, and all organs below injury	Movement in neck and above, loss of innervation to diaphragm, absence of independent respiratory function
C4 Vagus nerve domination of heart, respirations, and all vessels and organs below injury	Sensation and movement in neck and above may be able to breathe without a ventilator
C5 Vagus nerve domination of heart, respirations and all vessels and organs below injury	Full neck, partial shoulder, back, biceps; gross elbow, inability to roll over or use hands decreased respiratory reserve
C6 Vagus nerve domination of heart, respirations, and all vessels and organs below injury	Shoulder and upper back abduction and rotation at shoulder, full biceps to elbow flexion, wrist extension, weak grasp of thumb, decreased respiratory reserve
C7-C8 Vagus nerve domination of heart respirations and all vessels and organs below injury	All triceps to elbow extension, finger extensors and flexors, good grasp with some decreased strength, decreased respiratory reserve

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

PARAPLEGIA

Level of Injury	Remaining Movement
T1-T6 Sympathetic innervation to heart, vagus nerve domination of all vessels and organs below level of the injury.	Full use of upper extremities, back, intrinsic muscles of the hand full dexterity of grasp with some decreased strength, decreased respiratory reserve
T6-T12 Vagus nerve domination only of leg vessels, GI and GU organs	Full stable thoracic muscles and upper back functional intercostals resulting in increased respiratory reserve
L1-L2 Vagus nerve domination of leg vessels	Varying control of legs and pelvis, instability of lower back
L3-L4 Partial vagus nerve domination of leg vessels, GI and GU organs	Quadriceps and hip flexors, absence of hamstring function, flail ankles

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)



(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

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CLASSIFICATION OF INJURY

Degree of Injury

- Complete Cord Injury
- Incomplete Cord Injury
  - Six syndromes

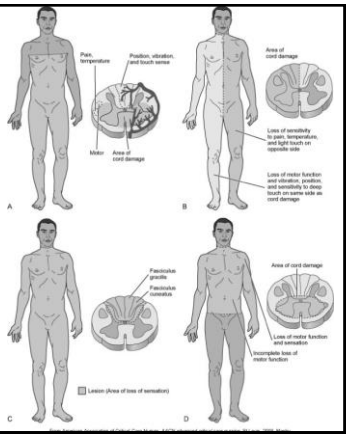
(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

Incomplete Lesions
6 Syndromes

- Central cord
- Anterior cord
- Brown-Sequard
- Posterior cord
- Cauda equina
- Conus medullaris

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

INCOMPLETE CORD SYNDROMES

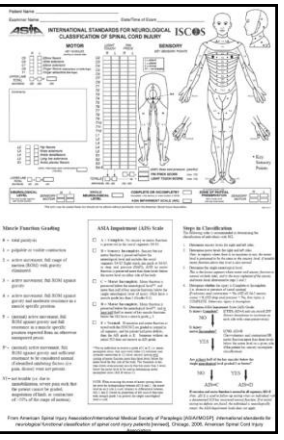


(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

ASIA Impairment Scale

American Spinal Injury Association (ASIA) Impairment Scale

- ☐ **A** = **Complete:** No motor or sensory function is preserved in the sacral segments S4-5.
- ☐ **B** = **Incomplete:** Sensory but not motor function is preserved below the neurologic level and includes the sacral segments S4-5.
- ☐ **C** = **Incomplete:** Motor function is preserved below the neurologic level, and more than half of key muscles below the neurologic level have a muscle grade less than 3.
- ☐ **D** = **Incomplete:** Motor function is preserved below the neurologic level, and at least half of key muscles below the neurologic level have a muscle grade of 3 or more.
- ☐ **E** = **Normal:** Motor and sensory function are normal.



(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

- Direct result of trauma causing:
  - Cord compression
  - Ischemia
  - Edema
  - Possible cord transection
- Immediate Post Injury concerns
  - Airway management
  - Adequate blood volume
  - Prevention of further cord damage

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

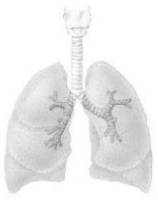
- Respiratory
- Cardiovascular
- Urinary
- Gastrointestinal
- Integumentary
- Thermoregulation
- Metabolic
- Peripheral vascular problems

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

Respiratory

- Above C4
  - Total loss of respiratory function. Vent dependent
- Below C4
  - Diaphragmatic breathing leads respiratory insufficiency
- Nursing Considerations
  - Respiratory Dysfunction
  - Nursing assessment



(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS
CARDIOVASCULAR SYSTEM

- Injury above T6 ↓ influence of the sympathetic nervous system
  - Bradycardia
  - Peripheral vasodilation=hypotension
  - Relative hypovolemia

Nursing Interventions

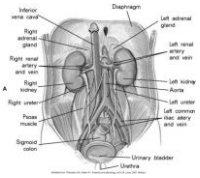
- Cardiac monitoring
- if HR < 40bpm
  - Atropine ↑ heart rate
- Peripheral vasodilation
  - IV fluids or vasopressor drugs to increase BP
- DVT prophylaxis assessment q shift → PE
- Older adult
  - CV disease
  - Max. heart rate lower

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS
URINARY SYSTEM

Acute Phase

- Urinary retention
- Bladder is atonic and over distended
- Need indwelling catheter



Postacute phase

- Bladder becomes hyperirritable
- Loss of inhibition from the brain
- Reflex emptying of the bladder

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

NURSING IMPLEMENTATION
URINARY SYSTEM

- Bladder Management
  - Immediately post injury-must assess
  - Bladder over distention
    - Renal failure
    - Rupture
  - Catheterization program
    - Indwelling vs. intermittent
      - Fluid restriction
      - UOP monitored
      - Intermittent Vs. Indwelling
  - UTIs
  - Age related changes

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

GASTROINTESTINAL SYSTEM

- Above T5 → hypomotility
  - Paralytic ileus
  - Gastric distention
    - Nasogastric tube
    - Metoclopramide (Reglan)
  - Stress ulcers
  - intra=-abdominal bleeding

Neurogenic bowel

- T12 or below
  - Bowel initially areflexic with decreased sphincter tone
- Return of reflexes
  - Sphincter tone is enhanced
  - Reflex emptying of the bowel occurs
- Regular bowel program needed
  - Coordinate with gastrocolic reflex

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

NURSING IMPLEMENTATION

GASTROINTESTINAL SYSTEM

- Paralytic ileus
- Fluid and Nutritional Maintenance
- Bowel management

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

INTEGUMENTARY SYSTEM

- High risk for skin breakdown
- Thermoregulation –poikilothermism
  - Interruption of SNS
  - ↓Ability to sweat or shiver
  - More common with high cervical injury

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CLINICAL MANIFESTATIONS

METABOLIC NEEDS

- NGT suctioning = alkalosis
- Decreased tissue perfusion = acidosis
- Electrolyte imbalances
- High nutritional needs
  - High protein
  - High

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

DIAGNOSTIC STUDIES

- CT
- X-ray
- MRI
- Comprehensive neurologic exam
- Angiography (C-spine)

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE

- Immediate goals
  - Patent airway
  - Adequate ventilation
  - Adequate circulating blood volume
  - Prevent extension of cord damage
- Frequent accurate monitoring of patient

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE
EMERGENCY MANAGEMENT

- Initial care C-Spine
  - Ensure patent airway
  - Stabilize cervical spine
  - Administer oxygen
  - Establish IV access
  - Assess for other injuries
  - Control external bleeding
  - Obtain imaging
  - Prepare for stabilization with tongs and traction
  - Ongoing monitoring

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE
EMERGENCY MANAGEMENT

- Initial care Thoracic and lumbar
  - Support less intense
  - Less respiratory compromise
  - Bradycardia usually not a problem
  - Problem treated symptomatically

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE

- Once stabilized
  - Obtain history of incident
  - Thorough assessment
    - Muscle groups
    - Sensory exam
    - Associated brain injury
    - Other injuries
  - Logroll
  - Continuous monitoring

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE

- **Non-operative**
  - To stabilize and decompress injured spinal segment
  - Traction or realignment
  - Eliminate damaging motion.
  - Prevent secondary damage.

Surgical

- Early surgery indicated if
  - Evidence of cord compression
  - Progressive neurologic deficit
  - Compound fracture
  - Bony fragments
  - Penetrating wounds
- Laminectomy

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE

DRUG THERAPY

VASOPRESSORS

- Vasopressor agents
  - Maintain mean arterial pressure > 90 mm Hg
    - Dopamine
    - Dobutamine
    - Levophed
    - Neo-Synephrine
- Altered drug metabolism → ↑ risk for interactions

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

COLLABORATIVE CARE

DRUG THERAPY

- Treatment of specific autonomic dysfunctions
  - Gi hypoactivity
  - Bradycardia
  - Autonomic dysreflexia
- Analgesics
- Antidepressents
- Anticoagulants
- Antispasmotics
  - Baclofen
  - Flexeril
  - Valium
  - Norflex
- H2 blockers
  - Ranitidine
- PPI
  - Pantoprazole
  - Omeprazole
  - lansoprazole

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

NURSING ASSESSMENT

- Assessment
  - Subjective data
  - Objective data
- Nursing Diagnosis
  - Ineffective breathing pattern
  - Impaired skin integrity
  - Impaired urinary elimination
  - Constipation
  - Risk for autonomic dysreflexia

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

PLANNING

- Overall Goals
  - Optimal level of neurologic functioning
  - Minimal to no complications of immobility
  - Learn skills, gain knowledge, and acquire behaviors to care for self.
  - Return to home and community.

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

NURSING IMPLEMENTATION

- Health Promotion
  - Identify
    - High-risk populations
  - Provide
    - Education
    - Counseling
    - Referral to programs
  - Support legislation on seat belt use, helmets for motorcyclists/bicyclists, and child safety seats.

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

IMMOBILIZATION

- Immobilization
- Traction
- Special beds
- Halo fixation
- Intubation
- Aggressive CPT
- Pain management

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

CARDIOVASCULAR INSTABILITY

ONGOING ASSESSMENT

- Risk for bradycardia and cardiac arrest
- Chronic low blood pressure with postural hypotension
- ↑ Risk for DVT
- Frequent assessment
- Anticholinergic drug/pacemaker
- Vasopressor agent
- Sequential compression devices and/or gradient stockings
- Range-of-motion exercises
- Prophylactic heparin

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

FLUID AND NUTRITITIONAL MAINTENANCE

ONGOING ASSESSMENT

- Initial paralytic ileus and nasogastric tube
- Monitor fluid and electrolytes.
- Gradually introduce oral food and fluids.
  - High-protein, high-calorie diet
- Inadequate nutritional intake
  - Assess for cause
  - Contract with patient
  - Pleasant eating environment
  - Calorie count
  - Dietary supplements
  - Dietary fiber

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

GU / GI

ONGOING ASSESSMENT

BLADDER MANAGEMENT

- Indwelling urinary catheter initially
  - Strict aseptic technique
  - ↑Fluid intake
- Intermittent catheterization program
  - Every 3-4 hours
  - Monitor for s/s of urinary tract infections

BOWEL MANAGEMENT

- Bowel program started during acute care
  - Daily rectal stimulant
  - Digital stimulation or manual evacuation
  - Upright position when able

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

ONGOING ASSESSMENT

Temperature control

- No vasoconstriction, piloerection, or heat loss through perspiration below level of injury
- Temperature control external
- Monitor environment and body temperature.
- Do not overload or unduly expose patient.

Stress ulcers

- ↑Risk secondary to severe trauma and physiologic stress
- Monitor stool, gastric contents, and hematocrit.
- Prophylactic medications

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

ONGOING ASSESSMENT

SENSORY DEPRIVATION

- Secondary to absent sensations
  - Stimulate patient above level of injury.
  - Conversation, music, strong aromas, and interesting flavors
  - Prism glasses to read and watch TV
  - Prevent patient from withdrawing.

REFLEXES

- Return may complicate rehab.
  - Hyperactive
  - Exaggerated responses
  - Penile erections
  - Spasms
- Patient teaching
- Antispasmodic drugs

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

RESPIRATORY DYSFUNCTION

ONGOING ASSESSMENT

- May increased during first 48 hours
- May need intubation and mechanical ventilation
- ↑ Risk for pneumonia and atelectasis

- Regular assessment
- Aggressive chest physiotherapy
- Adequate oxygenation
- Proper pain management
- Assisted coughing
- Tracheal suctioning
- Incentive spirometry

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

AUTONOMIC DYSREFLEXIA

- Massive uncompensated cardiovascular reaction mediated by sympathetic nervous system
  - SNS responds to stimulation of sensory receptors – parasympathetic nervous system unable to counteract these responses.
  - Hypertension and bradycardia

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

AUTONOMIC DYSREFLEXIA

- Risk factors
  - Most common precipitating factor is distended bladder or rectum.

- Clinical manifestations
  - Hypertension
  - Throbbing headache
  - Marked diaphoresis above level of injury
  - Bradycardia
  - Piloerection
  - Flushing of skin above level of injury
  - Blurred vision or spots in visual field
  - Nasal congestion
  - Anxiety
  - Nausea

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

AUTONOMIC DYSREFLEXIA

- Nursing interventions
  - Elevate head, notify HCP
  - Assess for and remove cause
    - immediate catheterization
    - remove stool impaction if cause
    - remove constrictive clothing and tight shoes
  - Patient and family teaching

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

GRIEF AND DEPRESSION

- Regression normal process can occur at different stages of recovery
- Allow time for patient to mourn
- Fluctuations in emotions is to be expected
- Promote independance

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

GERONTOLOGICAL CONSIDERATIONS

- SCI patients are living longer d/t improved medical advances
- Chronic illnesses
- Rehabilitation

(Hills, 2014; Lewis, Dirksen, Heitkemper, & Bucher, 2014)

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QUESTIONS

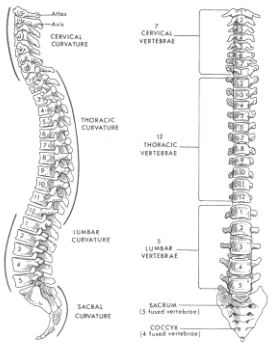

FIG. 1. Frontal *(right)* and left lateral *(left)* views of the human spine.