ICU Management After Spinal Cord Injury

Scn - Epidemiology

- Spine trauma
  - 200,000 non-paralyzing fractures per year
- SCI
  - 11,000 paralyzing injuries per year
  - 225,000 - 296,000 in US with a disability r/t SCI
Etiology of Injury

http://www.spinalcordcenter.org/statistics/stay.html

- Mean Age 38
  - > 60 years 11.5%
- Sex
  - Males 77.8%
- Ethnic groups
  - Caucasian 76.8%
  - Blacks 14.2%
  - Hispanic 6%
- Time of occurrence
  - Summer predominance

- **Cost**
  - 9.7 billion/year
  - 1.2 billion – annual cost of treatment of pressure sores
- **Age/Mechanism of injury**
  - < 65 MVC
  - > 65 Falls
- **High risk groups**
  - Males
    - “Weekend warriors”
    - High powered toys
  - Elderly
  - Falls

---

**Types of SCI**

- **Complete Injury** (45%)
  - Complete motor and sensory loss
- **Incomplete Injury** (55%)
  - Sensory/motor sparing
    - Brown Sequard
    - Central Cord
    - Caudal Equina
- **Level**
  - Cervical spine involved in 55% of traumatic SCI
  - Thoracic level most common in acute non-traumatic SCI
- **Recovery**
  - 10-15% with complete injury have some degree of functional recovery
  - 54-86% with incomplete have some degree of functional recovery

http://www.spinalcordcenter.org/statistics/stay.html
Mechanism of Injury

- Hyperflexion
- Hyperextension
- Rotation
- Axial Load

Pathophysiology of SCI

- Primary injury
  - Initial insult

- Secondary injury
  - Vascular impairment
  - Inflammatory changes
  - Cellular dysfunction
SCI: Pathophysiology

- Early NECROTIC cellular death at focus of traumatic injury
- Extension of cellular injury continues long after trauma as a result of APOPTOSIS

Acute Manifestations of Spinal Injury

- Motor
  - Flaccid paralysis:
    - Duration – 1 to 4 weeks
    - Absence of neurologic function (motor, sensory, autonomic, reflexes) below the lesion
    - Periphery is atonic, and the peripheral blood vessels are dilated
  - Loss of deep tendon reflexes (DTRs)
Cardiac
- Bradycardia
  - Only efferent component of baroreflex pathway that remains intact is the vagus nerve
  - Loss of sympathetic input
- Hypotension
  - Greater risk - Cervical and high Thoracic spine

Pulmonary
- Alveolar hypoventilation
- Hypoxemia
- Decreased ability to protect airway increases risk of aspiration
- Normal – Diaphragm:
  Intercostal = 70:30
  - Cervical spine injury
    - The intercostal muscles are often loss
    - Vital Capacity is decreased by approximately 40%
The most important treatment consideration is to maintain adequate oxygenation and perfusion of the injured spinal cord.

Also be aware of:
- Bladder and bowel incontinence
- Compensatory enhancement of renin-angiotensin-aldosterone system for BP maintenance
- Hypothermia
- Anemia
- Dehydration
- Electrolyte imbalances
- Hyperkalemia
Assessment of Injuries

- **Associated Injuries** *Leading cause of death in SCI*
  - TBI  25-50%
    - Severe TBI with coma  14%
  - Internal thoracic trauma  16%
    - Thoracic injuries common with dislocation
    - Pulmonary contusions/hemorrhage
  - Pelvic, trunk fractures  17%
    - Ileus common
  - Long Bone fractures  10%
  - Facial Trauma  5%

---

Mortality by Age Group

http://www.spinalcordcenter.org/statistics/stay.html

Critical Care

- ABC’s
  - Respiratory
  - Cardiovascular
- Spinal stabilization
- General management
  - Nutrition
  - DVT
  - Bowel/bladder
  - Skin care
- Rehabilitation
Acute Care

- Level III
- Management of patients with an acute cervical spinal cord injury in an intensive care unit or similar monitored setting is recommended.

Goals of Critical Care

- Basic ABC's
  - Protect and maintain airway
    - Maintain oxygenation
  - Maintenance of mean arterial pressure (MAP) > 85; Systolic blood pressure (SBP) > 90
- Treatment of associated injuries
- Ongoing Assessment
- Limit ICU stay - Prevent early complications

Respiratory - Intubation
- Basic ABC’s
- Evaluate need
- Use technique with minimum amount of cervical spine movement
  - Oral = Fiber optic
  - Nasal = Blind Intubation
  - Cricothyroidotomy = Emergency airway
- C1-4
  - Require intubation/ventilatory support
    - Phrenic nerve (diaphragm) involvement
    - Long term respiratory support
    - Early trach and conversion to portable ventilator
- C5-7
  - May require temporary respiratory support
    - Diaphragm preserved or weakened
    - Decreased inspiratory & expiratory force
    - Decreased TV & force residual
    - Possible need for Trach

Clinical Pearls.....
- Direct relationship between the level of cord injury and degree of respiratory function
  - With C1 or C2 lesions vital capacity is only 5-10% of normal and cough is absent
  - C3 through C6 lesions vital capacity is 20% of normal and cough is weak and ineffective
T2 through T4 lesions vital capacity is 30-50% of normal and cough is weak

T11 injuries and below - respiratory dysfunction is minimal. Vital capacity is essentially normal, and cough is strong

Ventilator management

- Assist control/volume control
  - TV 5-10 ml/kg
  - O2 – less is better
  - Peep – 5 physiological
  - Assist control (AC)
- Early tracheostomy
  - Decreases ICU length of stay
  - Patient comfort
Respiratory complications

- Associated Injuries
  - Rib fractures, pulmonary contusions
- Pneumonia
  - Aspiration
  - Nosocomial
- Adult respiratory distress syndrome (ARDS)

Weaning of respiratory support

- Ventilator
  - On/off method
    - Evaluates function of respiratory & defines tolerance
    - Allow for conditioning of respiratory muscles
- Supplemental treatments
  - Hand held nebulizers/IPPB
  - EMG or Fluoroscopy of diaphragm (+/-)
    - Evaluate for paralysis of diaphragm
Trach decannulation

- Ability to decannulate is directly related to function
- Process
  - Downsize trach
  - Deflate balloon as tolerated
  - Once tolerates un-cuffed trach, plug as tolerated
  - DC trach if tolerates plugged trach X 24 hours
Communication in vent dependent quads

- Ventilator assisted communication
  - Trach de-cuffed at all times
  - High volume

Acute Blood Pressure Management in SCI

- **Level III:**
  - * Use of cardiac, hemodynamic, and respiratory monitoring devices to detect cardiovascular dysfunction and respiratory insufficiency in patients following acute spinal cord injury is recommended.
* Correction of hypotension in spinal cord injury (systolic blood pressure < 90 mm Hg) when possible and as soon as possible is recommended.

* Maintenance of mean arterial blood pressure between 85 and 90 mm Hg for the first 7 days following an acute spinal cord injury is recommended.

“Shock”

- Hemorrhagic shock
  - Can be masked by neurogenic shock
- Hypotension & tachycardia
- Treatment
  - Treat source of hemorrhage
  - Fluid replacement/pressors

_Hemorrhage is #1 cause of hypotension in acute SCI_
Neurogenic Shock (Injury above T6)
- Loss of sympathetic input/vaso-vagal response
  - Hypotension
    - Decreased cardiac preload & after load
    - Decreased vasomotor tone
    - Increased venous pooling
  - Bradycardia
    - Vasovagal
    - Loss of sympathetic response
- Treatment
  - Fluids, Pressers
  - Resolves in 10-14 days
  - High level quads may require use of abdominal binder/compressive stockings/pacer

Know the Difference

<table>
<thead>
<tr>
<th>SPINAL SHOCK</th>
<th>NEUROGENIC SHOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute &amp; transient</td>
<td>Involves hemodynamic instability</td>
</tr>
<tr>
<td>Occurs immediately after injury, last hours to months</td>
<td>Occurs in minutes, hours after injury. Immediate release of catecholamines; can take 24 hours to return to normal levels</td>
</tr>
<tr>
<td>Due to of descending impulses form higher centers</td>
<td>Injury above T6 – disruption of sympathetic pathways</td>
</tr>
<tr>
<td>Flaccid areflexic paralysis with loss of sensation (all modalities)</td>
<td>Unopposed vagal tone with peripheral dilatation; results in bradycardia with reduction of cardiac output, hypotension &amp; hypothermia</td>
</tr>
<tr>
<td>Present in 50% of spinal cord injuries</td>
<td></td>
</tr>
</tbody>
</table>
Clinical pearls…….

- If possible, avoid reverse Trendelenburg – this can cause > 60% reduction in BP
- Maintain spinal perfusion pressure, although there is no clinically useful method of measuring it – requires vasopressors for BP augmentation, and careful fluid loading to prevent pulmonary edema and CHF
  - Hypotension leads to hypo-perfusion thus increases secondary injury
- Think Neurogenic shock
  - Acute SCI above T6
  - Hypotension & bradycardia
- Think of hemorrhage if
  - Hypotension & Tachycardia
  - Hypotension and/or shock with acute SCI at or below T6
  - Hypotension with a spinal fracture alone without any neurologic deficit/SCI
Autonomic Dysreflexia

- Medical emergency
- Injury above T6 after resolution of spinal shock
- Imbalance of sympathetic reflex discharges with massive arterial vasoconstriction
- Inhibitory response is unable to pass below the level SCI

Symptoms
- HA – vasodilatation above level of injury
- Hypertension – arterial vasoconstriction
- Compensatory bradycardia with flushing, diaphoresis (above the level of injury)
- Piloerection, nasal congestion, burred vision

Treatment
- Elevate the head of the bed - promotes venous pooling
- Removal of “stressor”
  - Empty bladder/bowel, treat infection……
- Antihypertensive – immediate release
Acute management of Traumatic SCI

- Level III
- * Intensive care unit management of patients with acute traumatic central cord syndrome (ATCCS), particularly patients with severe neurological deficits, is recommended.
- * Medical management, including cardiac, hemodynamic, and respiratory monitoring, and maintenance of mean arterial blood pressure at 85 to 90 mm Hg for the first week after injury to improve spinal cord perfusion is recommended.

- * Early reduction of fracture-dislocation injuries is recommended.
- * Surgical decompression of the compressed spinal cord, particularly if the compression is focal and anterior, is recommended.
Traction

- **Level III**
- * Early closed reduction of cervical spinal fracture/dislocation injuries with craniocervical traction for the restoration of anatomic alignment of the cervical spine in awake patients is recommended

---

Traction

- **Rationale**
  - Realignment of vertebra
  - Reduction of fracture
- **Devices**
  - Gardner Wells Tongs
  - Halo Ring
- **Weights**
  - Added in 5-10 lb increments
  - AP films after every increase
- **Failure to reduce = Surgery**
Traction……why

Serial x-rays - traction
Surgical Stabilization

- Level III
- * Surgical decompression of the compressed spinal cord, particularly if the compression is focal and anterior, is recommended
Surgery

- Reduction of subluxation
- Decompression
- Arthrodesis
  - Boney Fusion
  - Long term fusion
- Instrumentation
  - Immediate fusion

DVT Prophylaxis

Level I

* Prophylactic treatment of venous thromboembolism (VTE) in patients with severe motor deficits due to spinal cord injury is recommended.
* The use of low molecular weight heparins, rotating beds, or a combination of modalities is recommended as a prophylactic treatment strategy.
* Low dose heparin in combination with pneumatic compression stockings or electrical stimulation is recommended as a prophylactic treatment strategy.
**Level II**

* Low dose heparin therapy alone is not recommended as a prophylactic treatment strategy.
* Oral anticoagulation alone is not recommended as a prophylactic treatment strategy.
* Early administration of VTE prophylaxis (within 72 hours) is recommended.
* A 3-month duration of prophylactic treatment for deep vein thrombosis (DVT) and pulmonary embolism (PE) is recommended.

**Level III**

* Vena cava filters are not recommended as a routine prophylactic measure, but are recommended for select patients who fail anticoagulation or who are not candidates for anticoagulation and/or mechanical devices.
* Duplex Doppler ultrasound, impedance plethysmography, venous occlusion plethysmography, venography, and the clinical examination are recommended for use as diagnostic tests for DVT in the spinal cord injured population.
Nutrition

- **Level II**
  - * Indirect calorimetry as the best means to determine the caloric needs of spinal cord injury patients is recommended.

- **Level III**
  - * Nutritional support of spinal cord injury (SCI) patients is recommended as soon as feasible. It appears that early enteral nutrition (initiated within 72 hours) is safe, but has not been shown to affect neurological outcome, the length of stay, or the incidence of complications in patients with acute SCI.

---

Bowel/Bladder function

**Lower Motor Neuron Injury** – Loss of reflexive function of bowel/bladder

**Upper Motor Neuron Injury** – Reflexive bowel/bladder
- **Bowel**
  - Starts day 1
  - Upper motor neuron - Reflex intact
    - Reflex emptying/medications
  - Lower Motor Neuron – Loss of reflex
    - Digital stimulation/medications

- **Bladder**
  - Foley
  - Upper Motor Neuron – Reflex intact
    - intermittent straight catheterization vs. reflex emptying
  - Lower motor neuron – Loss of reflex
    - Foley versus intermittent straight catheterization

**Skin care**

- **Risk of Breakdown**
  - Heels, Elbows, Sacral, Occiput (cervical collar)

- **Management**
  - Early removal of spine board in ER
  - Turning schedule
Methylprednisolone

- Is not be used for the treatment of acute SCI within the first 24 to 48 hours. The standard was revised because of the lack of medical evidence supporting the benefits of these drugs in the clinical setting. In fact, the report includes strong evidence that high-dose steroids are associated with harmful adverse effects.

Rehabilitation

Begins at time of injury
Goal – rapid transition to rehab
Ethics

- Ventilator Dependent Quads
  - Request for removal from Ventilator
  - Timing
    - Related to Age
    - Related to level of Injury
    - Related to MD
    - Full course of Rehab recommended before decision is made
Case 1

- 26 year old male involved in motor vehicle crash - T boned, rollover multiple times @ 60 mph; unrestrained in backseat
- No movement at scene
- Spontaneous respirations – protecting airway

CT Spine

![CT Spine Image]

C4
C5
MRI

Additional Injuries:
Right vertebral artery occlusion
ICU management

- **Neuro** –
  - No Methyprednisone given
  - Surgery day 0

- **CV - MAP goal > 85**
  - Dopamine drip X 5 days
  - Fluids
  - Brief period on Levophed
C2-6 fusion
Intraoperative films

- Resp:
  - Intubated for surgery; unable to wean off vent support
  - Trach & PEG HD #7
  - SCI weaning POD #1
LLL infiltrate and increased atelectasis
Sputum on HD 6 positive for MRSA
- Transferred to SCI ward HD # 12
- Transfer to rehab HD # 30
  - Anticipated LOS 3-4 weeks
- SCI wean continued
  - Trach removed HD # 36
- HD # 42 - Passed swallow study
  - General diet/thin liquid diet

Case 2
- 36 year old male fell into 4-5 feet of water while attempting a back-flip on a rope swing. Landed on his head
- After fall unable to move with loss of sensation below nipple line & in all 4 extremities
- Solumedrol bolus at OSH
- **Level of injury –**
  - C5 transverse process fracture
  - C4 facet fracture

- **Level of function**
  - C4 - Elbow flexion - R 2/5; L 1/5

- **Neuro**
  - 22 hour solu-medrol protocol initiated
  - Surgical fixation – anterior/posterior Day 1 post injury

- **CV**
  - Episode of asystole post operatively
  - Limited sympathetic innervation/Vasovagal response
Pulmonary
- Intubated for OR
- Post op - Desaturation with increase O2 needs
  - CXR revealed increased bibasilar consolidation
- Unable to wean vent
- Trach – 11 days post injury
- Bronched X2 secondary to increase secretions
- Culture staphylococcus pneumonia; treated with appropriate ABX
- Transferred to ward on portable vent HD #12
- Continued on SCI wean
- To rehab day 18 days post injury

Thank you.
Questions????