



Neurotrauma Guidelines

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Neurosurgery

LACUSC



Guidelines

- **Definitions**
 - Types
- **Methodology**
 - Authorities
 - Classification
- **Applications**
 - Legal
 - Quality
 - Research
- **Currency**



Guideline Protocol Orders Policy Practice

- Definitions
- Authors
- Methodology
- Implications
- Applications
- Legal



Evidence-Based Recommendations

Grades of Evidence

Class I - Good quality randomized controlled trial (RCT)

Class II - Moderate quality RCT, good quality cohort, or good quality case-control

Class III - Poor quality RCT; moderate or poor quality cohort; moderate or poor case-control; or case series, databases, or registries

Levels of Recommendation

Levels of recommendation are Level I, II, and III, derived from Class I, II, and III evidence, respectively.

Level I - Recommendations are based on the strongest evidence for effectiveness, and represent principles of patient management that reflect a high degree of clinical certainty.

Level II - Recommendations reflect a moderate degree of clinical certainty.

Level III - Recommendations for which the degree of clinical certainty is not established.



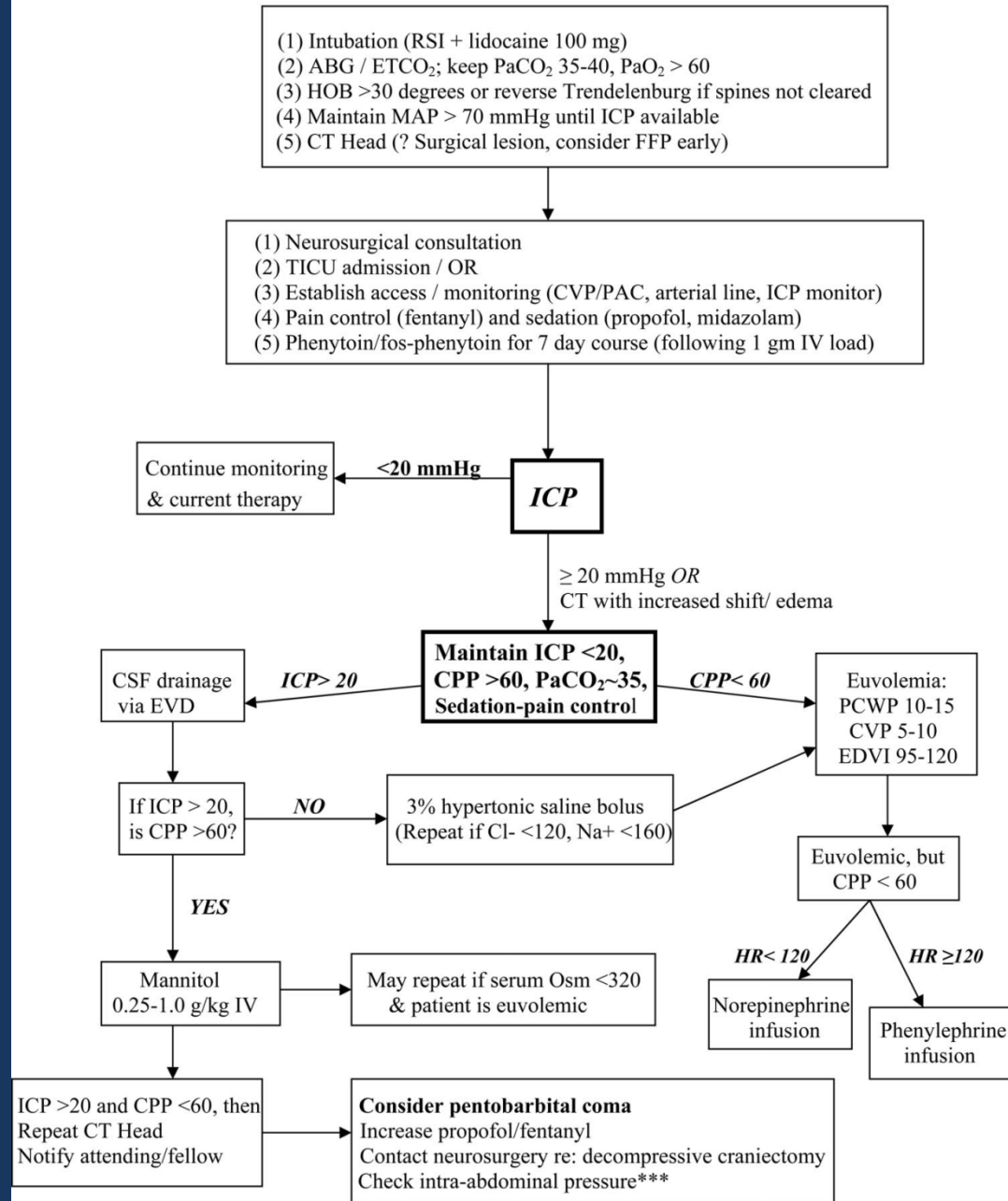
Criteria for Evidence Classification

- **Class I**
 - Good quality randomized controlled trial (RCT)
- **Class II**
 - Moderate quality RTC
 - Good quality cohort or case-control
- **Level III**
 - Poor quality RTC
 - Moderate of poor quality cohort or case-control
 - Case series, database, registry

Levels of Recommendation

- **Level I**
 - Based on the strongest evidence for effectiveness. Represent principles of patient management that reflect a high degree of clinical certainty
- **Level II**
 - Reflect a moderate degree of clinical certainty
- **Level III**
 - Clinical certainty not established

Traumatic Brain Injury (TBI) Pathway, GCS<9



***Consider decompressive laparotomy if intra-abdominal pressure ≥ 25



Orders

- **Admit**
- **Diagnosis**
- **Condition**
- **Vitals**
- **Allergies**
- **Activities**
- **Nursing**
- **Medications**
- **Fluids**
- **Catheters**
- **Monitoring**
- **Ventilator**



Authority

- **Peer Review Literature**
 - **Randomized Controlled Trial**



Inclusion Exclusion

- Age (children vs adults)
- Socioeconomics (uninsured vs insured)
- Race (black vs white)
- Sex (women vs men)

Judgment v Reflex

- “Cookbook” Medicine
- Limited Class 1

TBI and SCI

Traumatic Brain Injury

- **National Guidelines Clearinghouse**
 - NBTF
 - American College Surgeons (ATLS)
 - American College Radiology
 - Neurology



NBTF TBI Guidelines

- Imaging
- Monitoring
- Resuscitation, Optimization, Protection
- Hyperventilation
- Sedation & Pharmacologic coma
- VTE prophylaxis
- Hemostasis
- Seizure prophylaxis
- Hyperosmolar therapy
- Hypothermia
- Steroids
- Infection prophylaxis
- Nutrition
- Decompressive craniectomy
- PEG & Trach
- Therapy & Rehab
- Concussion follow up
- Brain death



BLOOD PRESSURE & OXYGEN (TBI NBTF)

- NO LEVEL I Recommendation
- Blood pressure should be monitored. Arterial hypotension (SBP < 90 mmHg) should be avoided (*Level II*)
- Oxygenation should be monitored and hypoxia (paO₂ < 60 mmHg, O₂ sat < 90%) avoided (*Level III*)



HYPEROSMOLAR THERAPY (TBI NBTF)

- **NO LEVEL I Recommendation**
- **Mannitol is effective for control of raised ICP at .25 gm/kg to 1 g/kg body weight. Arterial hypotension (SBP < 90 mmHg) should be avoided. (*Level II*)**
- **Restrict mannitol use prior to ICP monitoring to patients with signs of transtentorial herniation or progressive neurological deterioration not attributable to extracranial causes. (BTF Level III)**



PROPHYLACTIC HYPOTHERMIA (TBI NBTF)

- NO LEVEL I Recommendation
- NO LEVEL II Recommendation
- Lower mortality risk when target temperature maintained more than 48 hours (*Level III*)
- Higher Glasgow Outcome Score (GOS) compared to controls (*Level III*)



INFECTION PROPHYLAXIS (TBI NBTF)

NO LEVEL I Recommendation

Periprocedural antibiotics for intubation (*Level II*)

Early tracheostomy to reduce mechanical ventilation days (*Level II*)

Routine catheter exchange or prophylactic antibiotics for ventricular catheter not recommended to reduce infection (*Level III*)

Early extubation if by qualified (*Level III*)



VTE PROPHYLAXIS (TBI NBTF)

- NO LEVEL I Recommendation
- NO LEVEL II Recommendation
- Graduated compression stockings or intermittent pneumatic compression (IPC) recommended. Continue until patient ambulatory (*Level III*)
- Low molecular weight heparin (LMWH) or low dose unfractionated heparin should be used in combination with mechanical prophylaxis for DVT (risk of expansion contusion) (*Level III*)
- Insufficient evidence to support recommendations for: agent, dose, timing... (*Level III*)



HYPERVENTILATION (TBI NBTF)

- **Prophylactic hyperventilation ($p\text{CO}_2 < 25$ mmHg) not recommended (BTF Level II)**
- **-Hyperventilation recommended as temporizing measure reduction elevated ICP**
- **-Hyperventilation should be avoided first 24 hours when CBF critically low**
- **-If hyperventilation used, jugular venous O₂ sat or brain tissue oxygen should be monitored (BTF Level III)**



ICP MONITORING INDICATIONS (TBI NBTF)

- Intracranial pressure
- Arterial pressure, O2 sat
- Capnography
- Brain Oxygen



ICP MONITORING TECHNOLOGY (TBI NBTF)

- **ICP**

- **Salvageable, GCS 3-8 after resuscitation, abnormal CT scan (BTF Level II)**
- **NORMAL CT but two or more of: age > 40 yrs, motor posturing, SBP < 90 mmHg (BTF Level III)**

Treat ICP > 20 mmHg

Cerebral Perfusion Thresholds

- fluids and pressors aggressively maintaining CPP > 70 mmHg risk ARDS and should be avoided (BTF Level II)
- avoid CPP < 50 mmHg
- patients with intact autoregulation tolerate higher CPP values



CEREBRAL PERFUSION PRESSURE THRESHOLDS (TBI NBTF)

- NO LEVEL I Recommendation
- Aggressive measures to keep CPP > 70 mmHg with fluids and pressors can cause ARDS and should be avoided (*Level III*)
- Cerebral perfusion pressure (CPP) < 50 mmHg should be avoided
- The CPP target is between 50-70 mmHg. Patients with intact autoregulation tolerate a higher CPP.
- Ancillary monitoring of blood flow, oxygen, or metabolism facilitate CPP management



BRAIN OXYGEN MONITORING AND THRESHOLDS (TBI NBTF)

- Tissue oxygenation (BTF Level III)
- jugular venous saturation (<50%) (BTF Level III)
- brain tissue oxygen tension (<15 mmHg) (BTF Level III)



HYPOTHERMIA TBI (TBI NBTF)

- Pooled data indicates prophylactic hypothermia does not decrease mortality compared with normothermic controls. Preliminary data suggests greater decrease in mortality if hypothermic more than 48hrs**
- Prophylactic hypothermia significantly high GOS compared to normothermic**



SEDATION AND COMA (TBI NBTF)

- **NO LEVEL I Recommendation**
- **Prophylactic barbiturate coma NOT recommended (*Level II*)**
- **High-dose barbiturates recommended to control elevated ICP refractory to standard medical and surgical treatment. Hemodynamic stability essential before and during therapy (BTF Level II)**
- **Propofol recommended for ICP control but not improved mortality at 6 months. Can cause significant morbidity. (BFT Level II)**



SEIZURE PROPHYLAXIS (TBI NBTF)

NO LEVEL I Recommendation.

Anticonvulsants are indicated to decrease the incidence of PTS (within 7 days of injury) *(Level II)*

Prophylactic phenytoin or valproate not recommended for preventing late PTS *(Level II)*



NUTRITION (TBI NBTF)

- **NO LEVEL I Recommendation**
- **Full caloric replacement by day 7 post-injury**



STERIODS TBI (TBI NBTF)

- **NOT recommended for improving outcome or reducing ICP. In moderate to severe TBI high-dose methylprednisolone increased mortality and is contraindicated.**



CONCUSSION (TBI NBTF)

- Discharge from DEM
- Follow up



DECOMPRESSIVE CRANIECTOMY (TBI)

- Aggressive resuscitation, decompressive craniectomy may be increasing number of non-functioning survivors
- Evacuation
 - Hematoma
 - Brain tissue
- Decompression
 - Craniectomy (remove bone, open dura)



PEG & TRACH (TBI)

- Early tracheostomy
- Early nutrition



CLOTTING FACTORS AND PLATELETS TBI (LACUSC)

- Clotting factors and platelets



IMAGING Traumatic Brain Injury (ACR)

- **Imaging**

- **Indications for initial head CT**

- Minor or mild closed injury (GCS <14) without risk factor low yield**

- Minor or mild, focal neuro deficit and/or risk factors**

- Moderate or severe**

- Children under 2**

- (ACR Appropriateness criteria)**



BRAIN DEATH DECLARATION (LACUSC)



CATASTROPHIC BRAIN INJURY (OPO)

- **Hypothermia:**
 - Warming blanket core body temperature of 36.0 and 37.5 C.
- **Hypotension:**
 - Start Dopamine infusion and titrate to maintain SBP between 85 and 110mmHg
 - (maximum dose 20mcg/kg/min)
- **For CVP less than 6, may give fluid challenge of ½ NS. May repeat if necessary.**
 - If pt remains hypotensive, initiate Levophed.
- **Respiratory Function:**
 - CPT every 4 hours and prn, Turn patient side to side every 2 hours
 - ABG every 24 hours and prn; treat any abnormalities, Tidal Volume at 8-10cc/kg, +5 Peep on vent settings, FiO2 at lowest setting to maintain pO2>100, Chest X-ray every 24 hours
- **Diabetes Insipidus:**
 - If urine output greater than 500cc/hr and Sodium greater than 160, administer DDAVP 1 mcg IV Q 12 hr; hold if U/O less than 100 ml/hr
- **Laboratory:**
 - CBC and Complete Metabolic Profile every 24 hours, Replace low electrolyte levels of K, P, Mg, Ca
- **Maintenance:**
 - IVF: D5W with 20mEq KCL at 100cc/hr.
 - Urine output replacement: 1/2 NS to match urine output cc:cc



Research NBTF Severe TBI BLOOD PRESSURE & OXYGENATION

- 1. Level of hypotension and hypoxia that results in worse outcome**
- 2. Treatment thresholds**
- 3. Optimal resuscitation thresholds**
- 4. Impact of resuscitation/treatment on outcome**
- 5. Specification of target values**

Research NBTF Severe TBI HYPEROSMOLAR THERAPY

- 1. RCT Mannitol vs Hypertonic Saline**
- 2. Optimal administration and concentration hypertonic saline**
- 3. Mannitol single high dose needs validation: a) multicenter trial, and b) entire severe TBI population**
- 4. Prolonged hypertonic therapy efficacy (outcome)**



Research NBTF Severe TBI HYPOTHERMIA

1. Adequate, well-described randomization; no allocation concealment
2. Rule out confounding treatment effects
3. Blind outcome assessors
4. Management of missing outcome data

Research NBTF Severe TBI INFECTION PROPHYLAXIS

- 1. Prophylactic antibiotics for intracranial pressure and drainage devices**
- 2. Antibiotic-impregnated catheters**



Research NBTF Severe TBI CPP THRESHOLDS

1. CPP relationship to
 - A. Ischemia
 - B. Autoregulation
2. RTC to assess optimal CPP based on monitored ischemia/autoregulation



Thank You!

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Neurotrauma

LAC USC



Spine Injury Guidelines

- Assessment
- Immobilization
- Imaging
- Surgery
- Ventilation
- Perfusion
- VTE prophylaxis
- Urination
- GI
- Monitoring
- Hypothermia
- Nutrition
- Steroids
- Therapy & Rehab



Spine Injury Guidelines

- Assessment
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Sources Spinal Injury Guidelines

- ATLS
- Guidelines Cervical Spine Injury

- **Assessment**

Primary and secondary survey as long as patient's spine protected

Differentiate hypotension due to hypovolemia from neurogenic shock (ATLS)

ASIA Score *(Guidelines Cervical Spine Injury)*

Patient Name _____

Examiner Name _____ Date/Time of Exam _____



STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



MOTOR

KEY MUSCLES
(scoring on reverse side)

	R	L	
C5	<input type="checkbox"/>	<input type="checkbox"/>	Elbow flexors
C6	<input type="checkbox"/>	<input type="checkbox"/>	Wrist extensors
C7	<input type="checkbox"/>	<input type="checkbox"/>	Elbow extensors
C8	<input type="checkbox"/>	<input type="checkbox"/>	Finger flexors (distal phalanx of middle finger)
T1	<input type="checkbox"/>	<input type="checkbox"/>	Finger abductors (little finger)
UPPER LIMB TOTAL (MAXIMUM) <input type="checkbox"/> + <input type="checkbox"/> = <input type="checkbox"/> (25) (25) (50)			

Comments:

L2	<input type="checkbox"/>	<input type="checkbox"/>	Hip flexors
L3	<input type="checkbox"/>	<input type="checkbox"/>	Knee extensors
L4	<input type="checkbox"/>	<input type="checkbox"/>	Ankle dorsiflexors
L5	<input type="checkbox"/>	<input type="checkbox"/>	Long toe extensors
S1	<input type="checkbox"/>	<input type="checkbox"/>	Ankle plantar flexors

Voluntary anal contraction (Yes/No) ☐

LOWER LIMB TOTAL (MAXIMUM) ☐ + ☐ = ☐ (25) (25) (50)

LIGHT TOUCH PIN PRICK

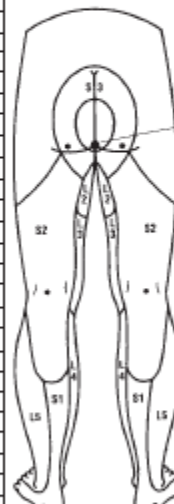
	R	L	R	L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-S5				

TOTALS { ☐ + ☐ = ☐ (MAXIMUM) (55) (55) (55) (55) }

SENSORY

KEY SENSORY POINTS

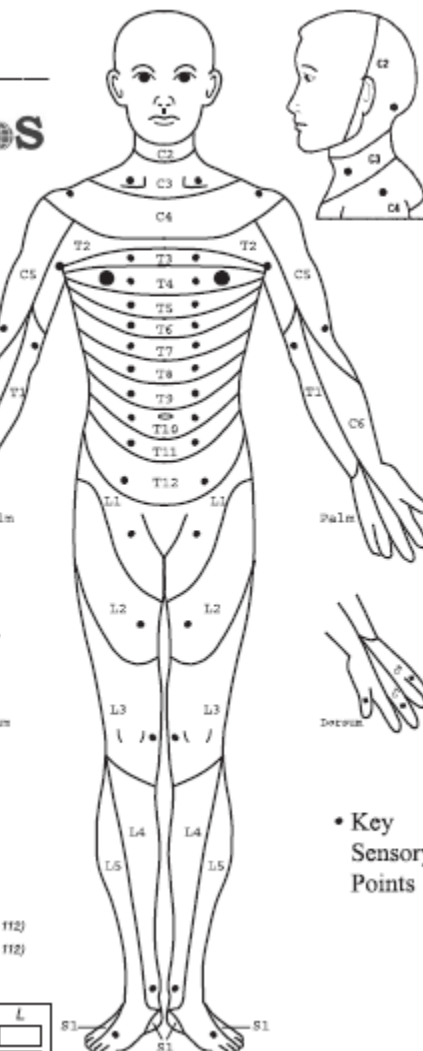
0 = absent
1 = impaired
2 = normal
NT = not testable



Any anal sensation (Yes/No) ☐

PIN PRICK SCORE (max: 112) ☐

LIGHT TOUCH SCORE (max: 112) ☐



• Key Sensory Points

NEUROLOGICAL LEVEL
The most caudal segment with normal function

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

COMPLETE OR INCOMPLETE?
Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE ☐

ZONE OF PARTIAL PRESERVATION
Caudal extent of partially preserved segments

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

Spine Injury

• Assessment

SPINAL CORD = ASIA

A- Complete

No motor or sensory function in the lowest sacral segment (S4-S5)

B- Incomplete

Sensory function below neurologic level and in S4-S5, no motor function below neurologic level

C- Incomplete

D- Incomplete

Motor function is preserved below neurologic level and at least half of the key muscle groups below neurologic level have a muscle grade >3

E- Normal

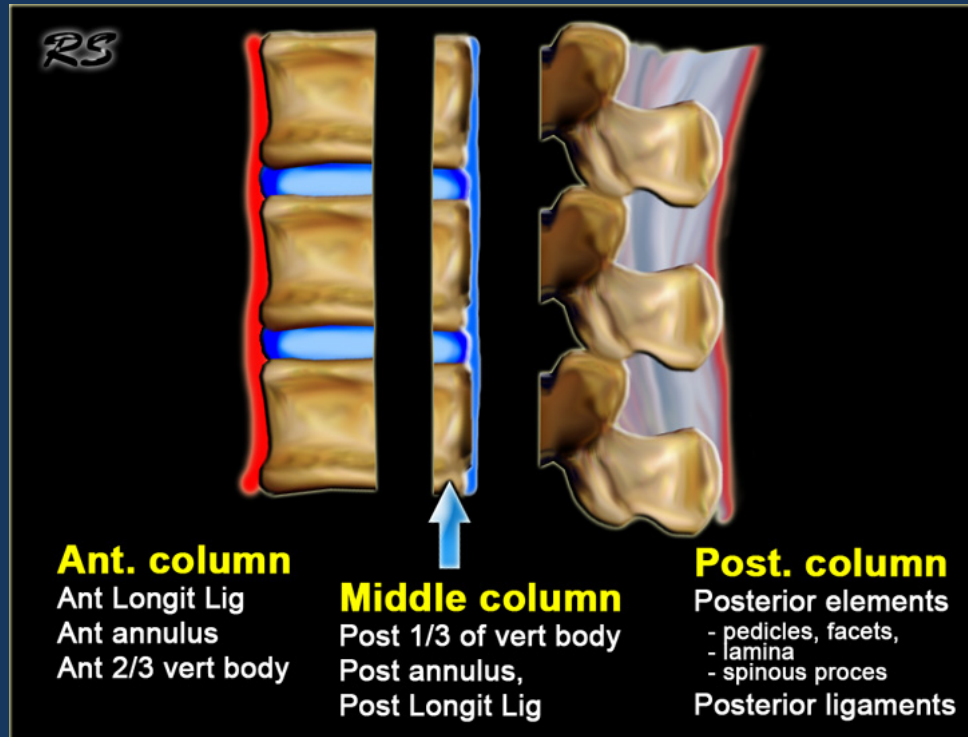
Sensory and motor function is normal

Spine Injury

• Assessment

SPINAL COLUMN

Three-Column Model





Radiographic Assessment C-Spine ***(Guidelines Cervical SCI)***

- Awake Asymptomatic**
- Awake Symptomatic**
- Obtunded Unevaluable**



Spine Injury

- **Imaging**

- Spinal column stability
- Cord pathology, compression

- * Nexus Criteria**

- * Clearance of the spine: cooperative vs uncooperative patient**



Radiographic Assessment C-Spine

(Guidelines Cervical Spine Injury)

Awake Symptomatic Patient

CT



Radiographic Assessment C-Spine (*Guidelines Cervical Spine Injury*)

Awake Asymptomatic

No imaging, Discontinue collar



Radiographic Assessment C-Spine (*Guidelines Cervical Spine Injury*)

Obtunded Unevaluable:

CT



Vertebral Artery Injuries

(Guidelines Cervical Spine Injury)

Anatomy: transverse foramina C2-7

Workup: angiography

Pathology: occlusion, dissection,
pseuoaneurysm

Management: anti-coagulation vs no
treatment



Radiographic Assessment (*Guidelines Cervical Spine Injury*)

Spinal Cord Injury Without Radiographic Abnormality (SCIWORA)

Imaging

- MRI region suspected injury

- Radiographic screen entire spinal column

- Flexion-extension (even with negative MRI)

- NO spinal angiography or myelography

Treatment

- External immobilization up to 12 weeks

- Early discontinuation external immobilization

- Avoid high risk activities 6 months



Management SCI (ATLS)

- From: ATLS Manual

Examination for level of injury

Motor

Sensory

Treatment principles

- 1 semi-rigid collar, backboard (get patient off board within 2 hours)
log roll
- 2 fluid resuscitation
CVP monitoring
- 3 urinary catheter (during primary surgery - 1. monitor urine output, 2. prevent bladder distention)
- 4 gastric catheter (prevent aspiration)



Pharmacologic Therapy (*Guidelines Cervical Spine Injury*)

NO! Solumedrol (methylprednisolone)

high-dose 24-hour infusion protocol

**Steroids may be used at lower doses for
incomplete injuries and/or before surgery where
further mechanical injury a risk**



Initial closed reduction cervical spine fracture dislocations

(Guidelines Cervical Spine Injury)

- Early closed reduction
- Early closed reduction NOT if additional rostral injury
- Pre-reduction MRI in unevaluable patients

Tongs SCI (*Guidelines Cervical Spine Injury*)





PEDIATRIC SCI (*Guidelines Cervical Spine Injury*)

- Thoracic elevation / occipital recess 8 years of age or less
- Closed reduction and halo for C2 synchondrosis in < 7 years
- Reduction or traction for acute AARF that does not reduce spontaneously. Reduction with halter or tong/halo traction for patients with AARF > 4 weeks duration
- Internal fixation and fusion for recurrent and/or irreducible AARF
- Surgery: isolated ligamentous injuries , unstable or irreducible fractures, or dislocations with associated deformity
- Surgery: cervical spine injuries that fail non-operative management



DEEP VENOUS THROMBOSIS

Guidelines SCI (*Guidelines Cervical*

Spine Injury)

- Prophylactic treatment of venous thromboembolism (VTE) in patients with severe motor deficits
- Low molecular weight heparins, rotating beds, or a combination of modalities
- Low dose heparin in combination with pneumatic compression stockings or electrical stimulation



Nutritional Support Guidelines SCI (*Guidelines Cervical Spine Injury*)

- Indirect calorimetry to determine needs
- Feed as soon as feasible



VENTILATION (*Guidelines Cervical Spine Injury*)

- Ventilaton



GU Guidelines Spine Injury (*Guidelines Cervical Spine Injury*)

- GU



PERFUSION Spine Injury (*Guidelines Cervical Spine Injury*)

Perfusion

MAP = 85

Fluids

Pressors



STEROIDS SCI (*Guidelines Cervical Spine Injury*)

Solumedrol protocol OUT!



SURGERY SCI (*Guidelines Cervical Spine Injury*)

- **Surgery**

Halo vest Guideline





Research

- **Outcomes**
 - Does compliance with Guideline improve outcome?
 - Quality improvement
- **Improvement**
 - What are Guideline weaknesses?
 - Evidence base