Neurotrauma Guidelines

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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

1. Intubation (RSI + lidocaine 100 mg)
2. ABG / ETCO₂; keep PaCO₂ 35-40, PaO₂ > 60
3. HOB >30 degrees or reverse Trendelenburg if spines not cleared
4. Maintain MAP > 70 mmHg until ICP available
5. CT Head (? Surgical lesion, consider FFP early)

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(1) Neurosurgical consultation
(2) TICU admission / OR
(3) Establish access / monitoring (CVP/PAC, arterial line, ICP monitor)
(4) Pain control (fentanyl) and sedation (propofol, midazolam)
(5) Phenytoin/fos-phenytoin for 7 day course (following 1 gm IV load)

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Continue monitoring & current therapy

ICP

- > 20 mmHg OR
  - CT with increased shift/edema

- <20 mmHg

ICP > 20

- NO
  - 3% hypertonic saline bolus
    (Repeat if Cl- <120, Na+ <160)

- YES
  - Mannitol 0.25-1.0 g/kg IV
  - ICP >20 and CPP <60, then Repeat CT Head
    Notify attending/fellow
  - Consider pentobarbital coma
    Increase propofol/fentanyl
    Contact neurosurgery re: decompressive craniectomy
    Check intra-abdominal pressure***

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Euvolemic: PCWP 10-15
CVP 5-10
EDVI 95-120

CPP < 60

- Euvolemic, but CPP < 60
  - Norepinephrine infusion

- HR < 120
  - Phenylephrine infusion

- HR ≥120
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 (pCO2 < 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
STEROIDS 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
• 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.
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

Neurotrauma Guidelines

2/20/2014
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)

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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

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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

Neurotrauma Guidelines
Spine Injury Guidelines

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

**Ant. column**
- Ant Longit Lig
- Ant annulus
- Ant 2/3 vert body

**Middle column**
- Post 1/3 of vert body
- Post annulus
- Post Longit Lig

**Post. column**
- Posterior elements
  - pedicles, facets
  - lamina
  - spinous process
- Posterior ligaments
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

2/20/2014
Neurotrauma Guidelines
Vertebral Artery Injuries
*(Guidelines Cervical Spine Injury)*

**Anatomy:** transverse foramina C2-7

**Workup:** angiography

**Pathology:** occlusion, dissection, pseudoaneurysm

**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
1/29/02 Application of Gardner-Wells Tongs

Sectional View of Head

Press of Gardner-Wells rings placed into skull

25 pounds of traction

Exhibit 106907_03K

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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
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)

• Ventilataton
Perfusion

MAP = 85

Fluids

Pressors
STER OIDS SCI (Guidelines Cervical Spine Injury)

Solumedrol protocol
OUT!

2/20/2014
Neurotrauma Guidelines
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