HEAD TRAUMA

EMERGENCY MEDICINE

UNIVERSITY OF MANITOBA, CANADA

CHKV Medical Mission 2011

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Objectives

- Current definition and scoring of TBI & CHI
- To scan or not to scan MHI patients?
- Identify key strategies to optimize care of the TBI/CHI patient in the ED
- Describe the concept of neuro-protective agents

Epidemiology

- ED visits: 1.1 million/yr
- ~50,000 deaths/yr
- Penetrating increasing
- Blunt decreasing
- Highest incidence rate:
  - <5 years old
  - >85 years old

Classification of Head Injury

- Severe: GCS ≤ 8 (~10%)
- Moderate: GCS 9-13 (~10%)
  - "Talk and deteriorate"
- Minor: GCS 14-15 (75-80%)
  - Period of confusion, disorientation
  - Amnesia
  - Signs of neurologic / neuropsychological dysfunction
  - LOC < 30min

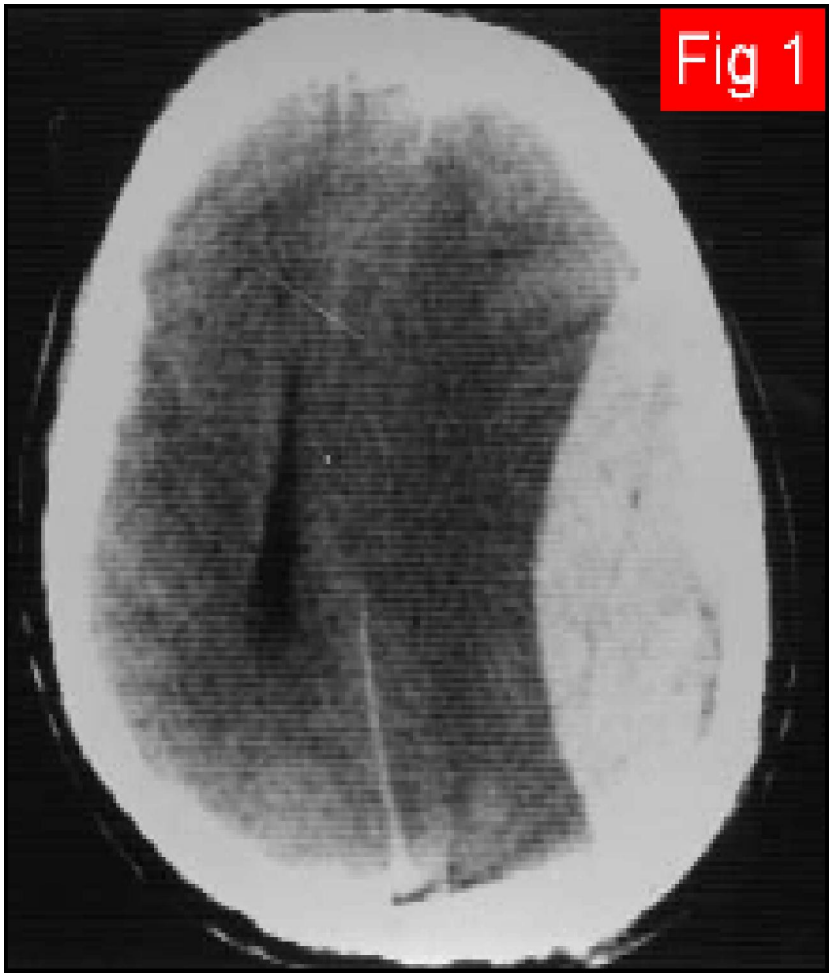
Glasgow Coma Scale

Teasdale, Lancet 1974

- Published in 1974
- Designed to provide a classification for serial neuro exams in ICU patients, comatose for >6 hours
- Standardize the assessment
- Developed prior to CT
- Not good for a single assessment

Treatment of Severe Head Injuries

- ABCs
- Airway: Neuroprotective RSI
  - Lidocaine (1.5mg/kg) IV
  - Fentanyl (3ug/kg) IV
  - Etomidate (0.3mg/kg) IV
  - Sux (1-2mg/kg) IV



Pathophysiology of Brain Injury

- **Primary Insult:**
  - Direct tissue damage at the time of impact
  - Treatment goal: injury prevention
- **Secondary Insult:**
  - Tissue injury occurring after the initial injury due to multiple causes
  - Treatment goal: prevent these types of insults with appropriate treatment

Causes of Secondary Injury

Systemic:

- Hypotension
- Hypoxia
- Anemia
- Altered glucose
- Hyperthermia
- Hyper/hypo-capnia

Intracranial:

- IC hypertension
- Direct compression
- Cerebral edema
- Vasospasm
- Hydrocephalus
- Infection
- Seizures

What is the Evidence?

- Decades of basic & clinical studies on neurotrauma & stroke research
- Scarce data showing measurable or consistent benefit for specific therapies
- Many promising therapies have been tested in clinical setting with disappointing results
- Overall: no consensus for recommendation of one single specific treatment as a standard
  - Intubate, oxygenate, ventilate, sedate
  - Hyperventilation ± Mannitol if herniation

Hypotension & Hypoxia with Head Injury

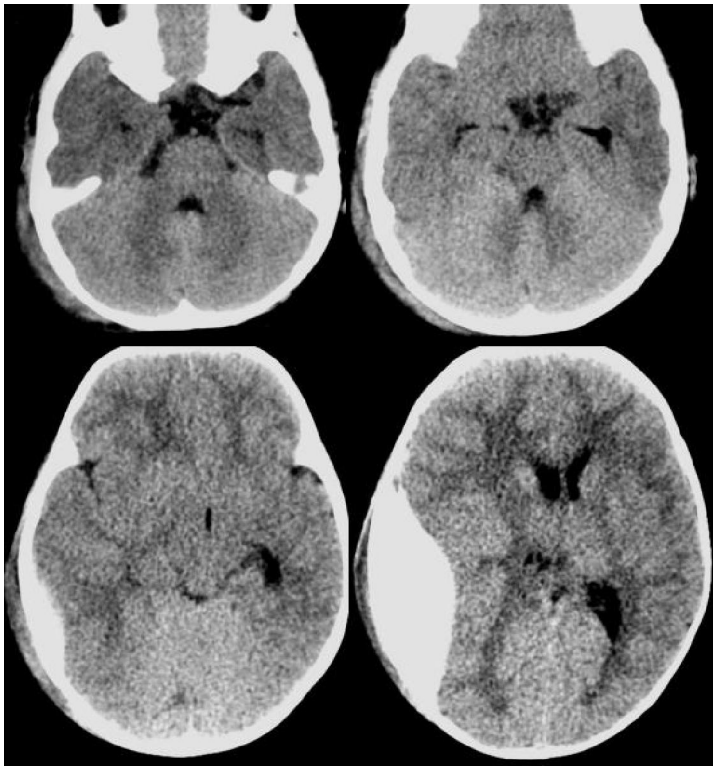
- Perfusion (oxygenation) to watershed areas decreased with low BP & hypoxia
- Hypotension
  - Perfusion of ischemic tissue passively dependent on arterial pressure
  - Goal:
    - Volume resuscitation and expansion (NS better than LR) for SBP >90mmHg
    - Vasopressors
- Hypoxia
  - Kills neurons
  - Hyperoxia also shown to ↑ oxidative brain injury in animal models
  - Goal:
    - Treat hypoxia aggressively
    - 100% oxygen appropriate for resuscitation then FiO2 titrated down after ROSC
    - Avoid anemia (HCT <30%) as it reduces oxygen-carrying capacity
      - Associated with increased mortality

Glycemic Control

- Hyperglycemia has detrimental effects on:
  - CBF
  - Metabolism
  - Edema formation
  - Neurologic outcome
- Goal:
  - Normalglycemia with insulin
  - Avoid glucose administration (unless documented hypoglycemia)

Cushing's Reflex

- ICP puts pressure on brainstem
- Triad of:
  - Hypertension
  - Bradycardia
  - Respiratory irregularity



Uncal Herniation

Hyperventilation in TBI

- Theory: ↓ ICP via constriction of cerebral vasculature and reduced brain volume
- Change: 2-4% ↓ in cerebral blood flow with every 1mmHg change in pCO2
  - Goal pCO2 30-35 mmHg
  - Onset in 30 sec, peaks at 8 min
- *Most likely harmful if prolonged, aggressive, or used prophylactically*
  - Severe vasoconstriction with pCO2 <25mmHg is harmful (Marion, Crit Care Med, 2002)

Initial Hyperventilation: Recommendations

- Cochrane Database: data insufficient to suggest benefit or harm
- Brain Trauma Foundation:
  1. Prophylactic hyperventilation is to be avoided
  2. Hyperventilate for brief periods when there is acute neuro deterioration
  3. Hyperventilate for ↑ ICP that is refractory to sedation, paralysis, CSF drainage, & osmotic diuresis
  4. No hyperventilation during initial 24 hours

Osmotic Diuresis: Mannitol

- ↓ *ICP* & ↑ MAP
- Mechanism of action:
  1. Immediate effect as a plasma expander: ↑ cerebral blood flow & cerebral oxygen delivery
  2. Delayed effect (30 min – 6 hr): osmotic agent
- No placebo controlled trials
- Adverse effects:
  - Hypotension if volume depleted
  - May stimulate bleeding
  - Renal failure
  - Concentrated in brain tissue with prolonged infusion

Hypertonic Saline (HS)

- As prophylaxis or treatment of increased ICP - inconclusive
- Hypertonic saline (up to 7.5% NaCl):
  - Hypothesis: cerebral swelling may be prevented by altering the osmolar load
  - Keep serum Na < 155mmol/L
  - Also good for fluid resuscitation: Sub-analysis of RCTs suggest that patients who are hypotensive with TBI and given HS have improved outcome
    - Wade, J Trauma 1997 (2x as likely to survive in HS group)
    - Vassar, J Trauma 1993

Sedation, Positioning & Paralysis

- Comatose brain responds to external stimuli by increasing cerebral metabolism
- Protection from stimuli may prevent imbalance between oxygen supply and demand
- Goal:
  - Restrict activities that cause ↑ ICP
  - Titrate sedative or anaesthetics
  - Elevate head of bed 30°
    - Not proven to be beneficial
  - Paralysis as needed to control ICP

Corticosteroids

- Steroids shown to be beneficial in patients with cerebral edema and brain tumors
- Trials in patients with TBI have not shown benefit
- Recommendations:
  - Cochrane Database: no benefit shown in 19 trials
  - CRASH Trial (Roberts, Lancet 2004):
    - Increased risk of death with steroids – not recommended
  - Brain Trauma Foundation:
    - Not recommended in TBI

Hypothermia & TBI

- No evidenced-based support for improved mortality or morbidity with prophylactic hypothermia in moderate or severe TBI
- Meta-analysis by Brain Trauma Foundation
  - Hypothermia >48 hrs was associated with ↓ mortality
    - Limited results due to small sample size

Coagulopathy & TBI

Coagulopathy may be prior to or a result of the TBI

1) Patient on Warfarin

2) TBI activates the clotting system

- Close monitoring of coagulation parameters
  - Coagulopathy at time of ED arrival is bad
  - 50% vs 17% mortality (Wafaisade, Neurocrit Care 2010)
- More severe the TBI, the higher the risk of DIC (may occur rapidly)
- Some authors recommend FFP in those with a GSC <6 (May, Am Surg 1997) or <8 (Talving, J Trauma 2009)

Warfarin and Head Trauma

- ↑ risk of ICH in patients with minor head trauma
- ↑ risk of worse outcomes once TBI occurs
- Aggressive ED treatment warranted
- Early CT scanning
- Treatment of coagulopathy if bleed on CT
- Careful discharge instructions if negative CT scan

Holmes, "Beyond GCS," ACEP 2011

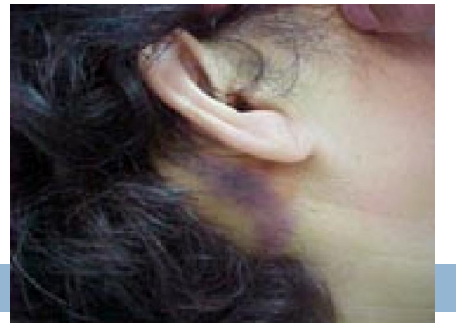
Post-traumatic Seizures

- Early post-traumatic seizures (<7 days of injury):
  - Occurs in 4-25% of those with TBI
- Late post-traumatic seizures (>7 days of injury):
  - Occurs in 9-42% of those with TBI
- Risk factors for post-traumatic seizures:
  - Seizure at time of injury or ED presentation
  - GCS<10 (severe HI)
  - Cortical contusion
  - Subdural/epidural/intracerebral hematoma
  - Depressed skull fracture
  - Penetrating injury
  - Prior seizure history

Anticonvulsants: Recommendations

- Evidence:
  - Carbamazepine vs placebo: Glotzner, Neurochiurgia Stuttg, 1983
  - Dilantin vs. placebo: Temkin, NEJM, 1990
  - Both studies showed reduction in early seizures but no difference in late seizures
- Recommendations:
  - Cochrane: 10 RCTs
    - NNT to prevent 1 seizure = 10
    - No reduction in mortality
    - No evidence that late seizures are reduced
  - Brain Trauma Foundation
    1. Dilantin and CMZ prevent early post-traumatic seizures and are recommended
    2. Anticonvulsants not recommended for preventing late seizures

Antibiotic Prophylaxis?



- Abx prophylaxis for patients w/ CSF leak?
- Most CSF leaks resolve spontaneously in 1 week
  - Meta-analysis: Abx generally not offered prophylactically in 1st week of CSF rhinorrhea from basilar skull # (Clin Infect Dis 1998)
  - World J Surg 2001: pts. w/ post-traumatic CSF leakage had 2x the incidence of meningitis w/o prophylaxis
- Abx prophylaxis indicated in penetrating head injury, open skull #s, and complicated scalp lacerations

Moderate HI

- Management principles same as for severe HI

Minor HI: To Scan or Not to Scan?

Cost of a CT Scan ? (CAD)

Indications for CTs in MHI Patients

New Orleans Criteria

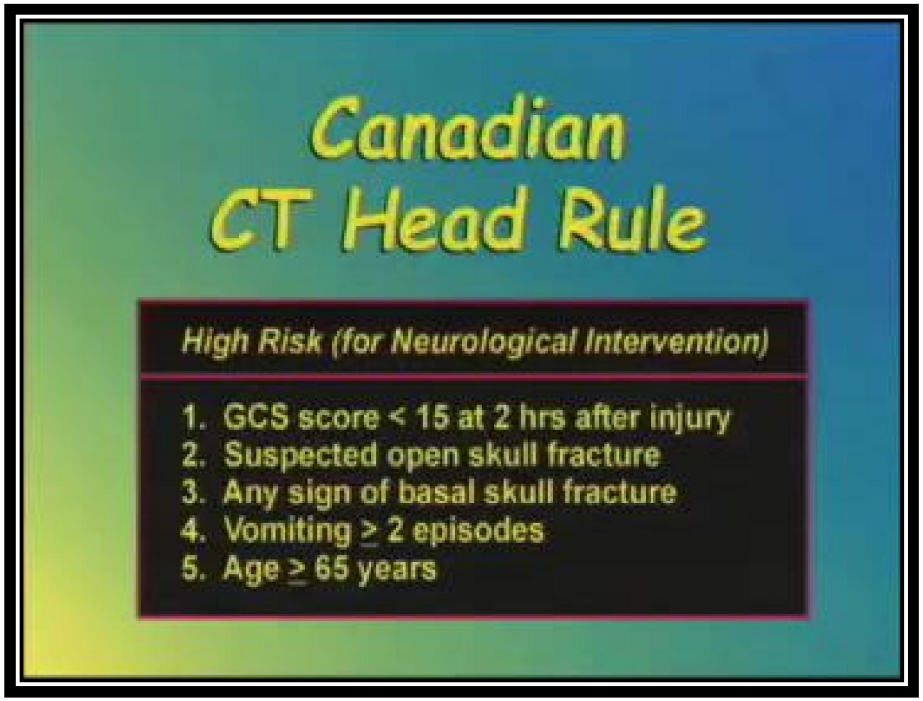
- Haydel et al. (NEJM 2000)
  - 7 criteria: H/A, vomiting, age>60, drug/etoh intoxication, short-term memory deficit, trauma above the clavicles, post-traumatic seizure

Canadian CT Head Rule

Stiell et al. (JAMA 2005)

- High risk criteria (for neurological intervention)
- Medium risk criteria (for brain injury on CT)

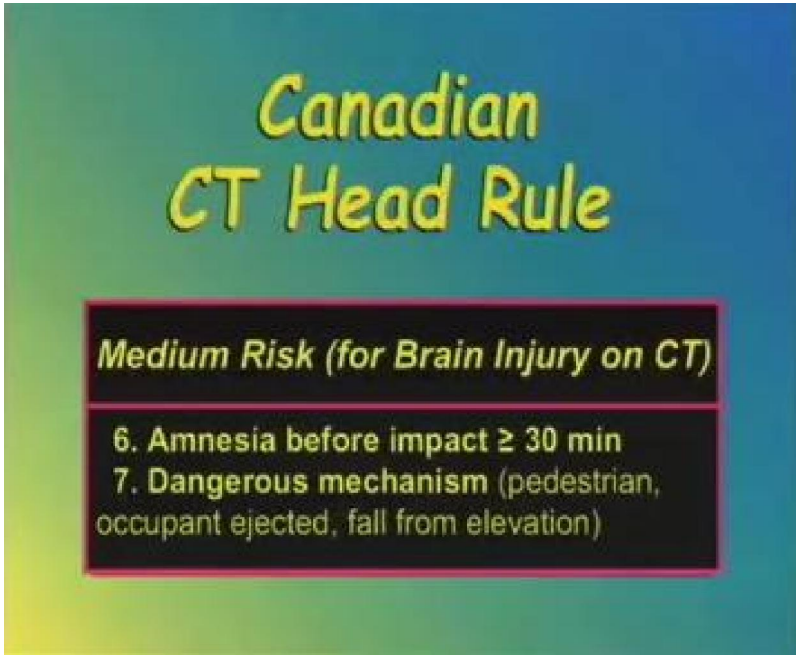
Canadian CT Head Rule



100% Sensitive

70% Specific

32% would need CT



98% Sensitive

50% Specific

54% would need CT

External Validation of CCHR & NOC in MHI

Smits et al. JAMA 2005

- Both NOC & CCHR are highly SN (100% for both) for neurosurgical intervention
- However, CCHR has lower SN than NOC (83% vs 99%) for neurocranial traumatic or clinically important CT findings
- The CCHR was more specific (40% vs 3%) and efficient
- Widespread implementation of CCHR would dramatically ↓ use of CT & result in cost effectiveness

Concussion (complicated minor TBI)

- Most common type of head injury
- Caused by acceleration-deceleration or rotational injury to a freely mobile head
- Concussive signs & symptoms:
  - LOC, traumatic amnesia, headache, nausea, blurry vision, vertigo, sleep disturbance, emotional lability, and difficulty concentrating
  - May last weeks to months
- Treatment: depends on severity but centers on avoiding further contact during at risk periods

Questions?