The Role of Physiatry in the Medical Management of Brain Injury

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Disclosure

I have nothing to disclose at this time.
TBI Incidence & Prevalence Center for Disease Control

- 1.7 million Americans suffer TBI each year (now 3.5 million)
  - Figure based on death, hospitalizations and ED visits*
  - Addition of pmd office
  - 80% treated and released

- 52,000 deaths: 1/3 of all injury related deaths

- 275,000 hospital admissions each year

- 80,000 - 90,000 develop disability each year

- 5.3 million survivors in America

- 1,365,000 ED visits

- Concussion – estimated at 1.4 to 3.8 million occurrences per year
**TBI Mechanism of Injury**

- Injuries related to falls are the leading cause of TBI

- In United States
  - 35.2% of TBI due to falls
  - 17.3% of TBI due to MVA
  - 16.5% of TBI due to external cause of “being struck”, including sports-related injuries
  - 21% unknown
  - 10% assault
TBI Mechanism of Injury

- **Age Group**
  - Children 0-4
    - Falls leading cause at 50% of TBI
  - Adults > 75
    - Falls leading cause at 60% of TBI

- **Gender**
  - Incidence – 1.4 times higher in males than females

- **Death**
  - Male: 37,000 deaths per year
  - Females: 13,000 deaths per year
Age

- Two peaks 15 - 24 years and greater 75
- Falls major source ages 0 to 4 and over 75 years of age
- Over 75 years highest mortality
- 15 - 24 second highest mortality
Mortality

- 52,000 deaths per year
- 30% of all injury related deaths
- Firearms leading cause of death in TBI

Nearly one third of all injury deaths involve TBI.
Estimated Financial Cost

- In the year 2000 the total cost of all injury in the USA was $406 billion
- $80 billion in direct cost
- $326 billion in lost productivity
- $283 billion male
- $164 billion for between ages 25 - 44 years
- $76.5 billion is the cost for TBI in 2010
- $51 billion in lost productivity
- $9 billion in lifetime medical costs
Overview

- “Primary Care” physician for Brain Injury – Focus on regaining function and preparing for the future

- Knowledge across Specialties
  - Neurology
  - Neurosurgery
  - Orthopedics
  - Endocrinology
  - Cardiology
  - etc
Coordination of Care

- Patient Care
- Therapy
- Nursing
- Family issues
- Social work/Case management
- Medical Issues
TBI as a Chronic Condition

- Misconception that TBI is an “event”

- World Health Organization
  - Chronic Condition – A disease having one or more of the following characteristics:
    - It is permanent
    - Caused by non-reversible pathological alterations
    - Requires special training of the patient for rehabilitation
    - May require a long period of observation, supervision or care

Masel and DeWitt Journal of Neurotrauma 2010
TBI as a Chronic Condition

+ Lifelong Needs
  + Medical issues are ongoing
  + Prevention of secondary complications/co-morbidities
  + Psychosocial support/vocational support
  + Services for community re-integration

+ Function continues to be impaired long after injury

+ Patients are adjusting to their “new normal”

+ New paradigm for treatment

Malec et al J Head Trauma Rehabil 2013
TBI as Chronic Condition - Mortality

- Increases long term mortality and decreases life expectancy
  - Moderate/Severe – twice as likely to die 1 year post injury, 7 year reduction in life expectancy
  - Mild – small but statistically significant reduction in long term survival

- Medical issues linked to increased mortality
  - Seizures
  - Septicemia
  - Pneumonia
  - Circulatory Disorders
  - Suicide
  - Digestive system
Timeline for Medical Issues

**Acute**
- Seizures
- Hydrocephalus
- Agitation
- Spasticity
- Dysautonomia
- Orthopedic issues
- Electrolyte abnormalities
- Arousal
- Sleep
- Etc.

**Chronic**
- Hydrocephalus
- Spasticity
- Cognition
- Behavioral issues
- Psychiatric issues
- Endocrine issues
- Sleep
- Seizures
- Etc.
Post-traumatic Seizure/Epilepsy

**Post-traumatic Seizure**
- An initial or recurrent seizure episode not attributable to another obvious cause after penetrating or non-penetrating TBI

**Post-traumatic Epilepsy**
- A seizure disorder characterized by recurrent late seizure episodes not attributable to another obvious cause in patients following TBI

Brain Injury SIG Arch PM&R 1998
Incidence of Post-traumatic Seizures

- In mild TBI incidence is slightly greater than the general population.
- Rate with penetrating injury is 35% to 65%.
- Rate of early seizures is 5% in NPTBI but higher in young children at 10%.
- Continuous EEG may suggest a rate of 22% (convulsive and nonconvulsive).
Immediate Seizures

- A seizure due to TBI occurring within the first 24 hours of injury
- Makes up 50 – 80 % of EPTS
- Most frequent in children with severe TBI
- EPTS can be seen in children with mild TBI
- If an adult seizes after mild TBI suspect intracerebral hemorrhage
- In 4000 adult with mild TBI and EPTS over 50% had bleeding
Post-traumatic Seizure

Early Post-Traumatic Seizures
+ A seizure due to TBI occurring within the first week of injury
+ EPTS is 10% in young children
+ Immediate seizures make up 50 – 80% of EPTS
+ EPTS is very common in children with severe TBI

Late Post-Traumatic Seizures
+ A seizure due to TBI occurring after the first week of injury
+ LPTS is less common in children

Brain Injury SIG Arch PM&R 1998
Natural History

- ½ to 2/3rd of patients who will develop PTS will experience a seizure in 1st year
- 75 to 80% by year 2
- After 5 years mild TBI return to normal population risk while moderate/severe still have increased risk
- Increased risk for 15 years after cerebral parenchymal injury
- 95% of people with TBI that are seizure free after 3 years will remain so
Posttraumatic Epilepsy

- TBI causes 20% of symptomatic epilepsy observed in the general population and 5% of all epilepsy
- Leading cause of epilepsy in young adults
- Overall observed in 4-7% of patients with closed head injuries
- Unusual with mild TBI
- 30%-50% of patients with penetrating head injury

Consequences of Post Traumatic Seizures

- Reduces employment
- Also increased seizure frequency was associated with increased health care costs and lower quality of life
  
  Van Hout et al Epilepsia 1997

- Linked to higher mortality
Post Traumatic Hydrocephalus

- Normal pressure hydrocephalus (NPH)- most common type in TBI

- Symptoms:
  - dementia, ataxia, incontinence.
  - prolonged coma
  - Arrest or digression in progress

- Atypical presentations include seizures, emotional problems, increased spasticity

- Must be differentiated from hydrocephalus ex vacuo
Post Traumatic Hydrocephalus

- Different authors report different incidences of PTH.
- Phuenpathom et al reported 1.6% acute TBI. *J Med Assoc Thai* 1999.
- Mazzini et al reported a 45% rate with severe TBI. *Arch Phy Medicine* 2003.
- 5% of patients severe TBI patients will develop hydrocephalus requiring shunt placement.
- PTH may occur as early as 2 weeks or as late as 2 years.

Bontke CF, J Head Trauma Rehabil, 1993.
Cardiac

- EKG can be changed secondary to CNS insult
- Reports give a range of 20 – 80 % after TBI
- All changes do not reflect cardiac pathology

- Sinus bradycardia
- Supraventricular tachycardia
- ST segment changes
- Flipped T waves
- Tall P waves
- Prolonged QRS and QT
- Heart block
Mechanism of EKG Changes

- Not truly known
- There is a rise in catecholamines noted in the plasma secondary to TBI
- 50% of TBI deaths were noted to have subendocardial hemorrhagic necrosis at nerve endings
- Heart rate variability is increased in TBI patients
- Autonomic dysregulation of heart noted
- Miner reported that the incidence of cardiomyopathy was increased in TBI patients
- Should screen on admission
Neuroendocrine Dysfunction

- Result of Injury to Hypothalamus or Pituitary
  - 15% of people are diagnosed more than 5 years after injury
  - Estimated that 40% of moderate to severely injured people have some dysfunction
  - Deficiency may lead to impaired rehabilitation, chronic problems and decreased quality of life

- Abnormalities
  - Salt and water regulation
  - Thyroid function
  - Body Temperature
  - Cortisol levels
  - Glucose metabolism
  - Testosterone
  - Growth Hormone
Endocrine Complications

- Cerebral Salt Wasting
  - Hyponatremia, dehydration, body losses salt and water
  - Treatment: Salt tabs, NS

- SIADH - most common
  - Hyponatremia
  - Treatment: water restriction, hypertonic saline

- DI - associated with hypotension
  - Hypernatremia
  - DDAVP
Normal Anterior Pituitary Hormonal Function Essential for Maximizing Rehabilitation

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<th>FSH</th>
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<td>Testosterone</td>
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- **Memory**
- **Mood**
- **Metabolism**
- **Energy**
- **Neuromuscular**
- **Mood**
- **Electrolytes**
- **Energy**
- **Stress**
- **Energy**
- **Mood**
- **Libido**
- **Reproduction**
- **Muscle mass**
- **Muscle mass**
- **Energy**
- **Exercise capacity**
Spasticity Management

- Found on 25 % of patients admitted to inpatient rehabilitation unit (data from TBI Model Systems)
- **Tone** - Resistance to stretch or movement
- **Spasticity** - *Velocity dependent* increase in resistance to stretch
- **Rigidity** - *Non-velocity dependent* increase in tone.
Spasticity Management

- Treatment goals should be somewhat functional
  - Preventing loss of ROM and contracture
  - Positioning
  - Causing pain
  - ADLs
  - Mobility
  - Balance
Spasticity Management

- First line treatment focuses on decreasing noxious stimuli (infection, skin irritation, edema, DVT, distended viscus)
- First line treatment is appropriate positioning and controlled ROM.
- Second line treatment is splinting, inhibitive casting, and modalities.
Spasticity Management
Generalized Versus Localized

**Generalized:**
- TBI/CVA - Dantrolene Sodium
  - Less cognitive and sedative effects
  - Monitor LFTs
- Tizanidine
  - May be best oral agent for TBI spasticity but
  - Sedation, dry mouth, orthostatic hypotension and there is a question of impaired recovery
- ITB – Intrathecal Baclofen

**Localized Spasticity:**
- Phenol / Alcohol Injection
- Botulinum Toxin Injection
Arousal / Attention / Neglect

Limit sedating medications

- Benzodiazepines
- Antipsychotics – typical and atypical
- Antiepileptics - Dilantin
- Antihistamines – diphenhydramine, famotidine
- Antidopaminergics – metoclopramide (reglan)
- Antichololnergics - scopolamine
Arousal

- Environmental
  - Limit stimulation at night – ICU, light, noise, etc.
  - Therapy – more of a routine
- Sensory Stimulation
  - Unimodal - Single Sense, music therapy
  - Multimodal - Multisensory input
  - Median Nerve Stimulator – postulated to stimulate the reticular center and cortical areas, increased blood flow and dopamine
  - No significant evidence
Arousal / Attention / Neglect

Pharmacology
- Catecholamine neurotransmitters – dopamine and norepinephrine
  - Methylphenidate, amphetamine, bromocriptine, amantadine, sinemet, venlafaxine, buproprione
- Histaminergic
  - Modafinil (Provigil), armodafinil (Nuvigil)
- Cholinergic
  - Donepezil, galantamine
- Others
  - Naltrexone
  - Zolpidem (Ambien)
Agitation

- An excess of one or more behaviors that occurs during an altered state of consciousness (Bogner & Corrigan, 1995)
- 33-50% prevalence after TBI
- Behaviors may include:
  + Aggression
  + Disinhibition
  + Lability
  + Low arousal/hyperarousal
  + Post traumatic amnesia
  + Confusional state
Agitation

Manifests as
- Restlessness
- Irritability/Outbursts of anger
- Sensory hyperstimulation
- Distractibility/poor sustained attention
- Compulsive behaviors
- Behavioral disinhibition
- Egocentricity
Agitation

**Possible underlying causes**
- Pain – patients often post surgery, multi-trauma
- Hypoxia
- Impaired Sleep
- Environmental stimuli – helmets, braces, gym, roommate
- Anxiety
- Medications - stimulants

**Non-pharmacologic treatment**
- Control Environment
- Reorientation
- Behavior modifications
Agitation

Pharmacology

- Dopamine/Norepinephrine – blockade
  - Atypical antipsychotics – quetiapine, risperidone, olanzapine, ziprasidone, aripiprazole

- GABA enhancement
  - Valporic Acid, Carbamazepine, gabapentin

- Serotonin
  - SSRI’s – Citalopram, Sertraline, Fluoxetine

- B-blockers
  - Propranolol – most well supported by evidence
Agitation

Pharmacology

- Stimulants – calming effect, paradoxical
- Acetylcholine
  - Donepizil, rivastigmine
- Others
  - Clonidine – may also help with attention due to action on alpha receptors
  - Memantidine
  - Dextromethorphan - IEED
Sleep Disturbance

+ **Epidemiology**
  + Rates range depending on timeframe
    + Hospitalized – 81.2%
    + Recent TBI – 36%
    + Discharged pts – 72.7%

+ **Etiology**
  + Medical – OSA, pain, etc
  + Environmental - ICU
  + Hormonal – decreased melatonin, impaired circadian rhythms
Sleep Disturbance

- Non-pharmacologic treatment
  - Environment – quiet, minimal interruptions
  - Sleep hygiene – out of the bed during the day, scheduled activity and rest
  - Treat underlying medical issues – bipap, etc

- Neurotransmitters
  - GABA – promotes induction of sleep
  - Serotonin – regulation of stages of sleep
  - Histamine – blockade promotes non-REM sleep
Sleep Disturbance

Pharmacologic treatment

- Pain control – tylenol, tramadol, fentanyl patch
- Melatonin – ramelteon (Rozerem)
- Serotonin
  - Trazadone - promotes stage 3 and 4 sleep
  - Mirtazapine – Also may increase appetite
- Histamine
  - Quetiapine – has more histamine blockade than other atypical anti-psychotics
- GABA
  - Neurontin, Depakote
Driving

Driving – Identified as the most important concern above any other functional limitation

- Other populations (SCI, Elderly, CVA)
  - Independently associated with depression
  - Reduced social interaction and support
  - Reduction in community participation
  - Increased risk of injury as a pedestrian

- 40-60% of people port TBI return to driving
  - Concern about increased accident rate
  - If patients pass formal multidisciplinary assessment - rate is same as general population

Liddle et al Disability and Rehabilitation, 2011
TBI is a complex medical process

Medical complications span across specialties and range from acute to chronic and can significantly influence function and outcome.

Patient care and function is influenced by multiple disciplines, therapy, nursing, social work, psychology, etc

Physiatrist is responsible for coordinating input from all disciplines and incorporating medical care to maximize outcome

TBI should be thought of as a chronic disease state and not something that can be cured.
Questions?