The ABCs of Hypoxic-Ischemic Brain Injury

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Acknowledgement: Patrick Hennessy, PT, DPT, NCS
Learning Objectives

• Introduce the mechanisms and pathophysiology associated with hypoxic–ischemic brain injury (HI-BI)

• Identify common movement disorders associated with HI-BI and rehab management

• Describe common cognitive impairments associated with HI-BI and treatment strategies

• Discuss the role of the interdisciplinary team in working with individuals with HI-BI
Meet “Sarah”

- 23 y/o female with history of asthma and drug abuse who was found down in respiratory distress. EMS arrived to find the patient in pulseless electrical activity (PEA) for unknown length of time.
- Hospital course: acute care initiated hypothermia protocol and then transferred to another acute care provider with a diagnosis of “Anoxic Brain Injury”
  - Remained on ventilator for unknown period of time
  - Acute onset seizures
  - “Poor” mental state
- Additional complications: dysautonomia, fevers, rash, leukocytosis, sepsis and agitation
“Sarah”

- Transferred to inpatient rehab where additional complications noted:
  - B shoulder adhesive capsulitis
  - B ulnar neuropathy

- Arrived to OP services....
  - Meds: Dextroamphetamine, Baclofen, Vimpat, Keppra, Oxycodone, Albuterol
  - Social: living with mother and her significant other in 2 story home with 1 step to enter
  - Education: Nearly college graduate- the event occurred on day of her last final for college
  - Mobility: uses a wheelchair for all mobility except occasional short walks to bathroom with mother’s significant other
  - Cognition: delayed processing speed, low-average memory
“Anoxic Brain Injury”.....

• Misnomer??

• Anoxic brain injury

• Hypoxic brain injury
What is a Hypoxic-Ischemic Brain Injury?

• Diagnostic term encompassing constellation of pathophysiological and molecular injuries to the brain induced by hypoxia, ischemia, cytotoxicity, or a combination of these (Busl and Greer 2010)

• Common causes:
  – Cardiopulmonary arrest
  – Respiratory arrest
  – Drug overdose
  – Carbon monoxide poisoning
  – Drowning/strangulation
Mechanism of Injury

- Cardiorespiratory
- Pure anoxic or hypoxic
- Carbon Monoxide
- Post Hypoxic Encephalopathy
Cerebral Vulnerability with HI-BI

- Superior brainstem – reticular formation
- Cerebellum
- White matter and subcortical structures supplied by distal branches of deep and superficial penetrating vessels
- Cerebral white matter at “watershed areas”
- Hippocampus
- Cortical layers 3, 4, 5, and 6
Physiologic consequences:

- Decreased ATP production
- Energy failure
- Calcium-induced neuronal death
- Excitotoxicity
- Ischemic reperfusion injury (vascular injury)
- Oxidative injury
- Necrosis
- Apoptosis
Necrosis & Apoptosis

- Necrosis: occurs due to edema and rupture of the cell sending the intracellular contents into the extracellular space, resulting influx of inflammatory cells and vascular disruption.
- Apoptosis: programmed cell death with associated cell shrinkage, DNA fragmentation, cellular changes and appearance of apoptotic bodies, secondary inflammation and fibrosis.
Common Impairments Associated with HI-BI

- Visual-perceptual
- Bradykinesia
- Ataxia
- Dystonias and abnormal posturing
- Myoclonus
- Cognitive deficits
“Sarah” Evaluation

- Decreased memory, slow processing of auditory information, oriented x3
- Intermittent myoclonic jerks at trunk and upper extremities (UE’s) > lower extremities (LE’s)
- Mod A with rolling, max A supine > sit, Min A sit to stand and sit pivot
- Mod A to walk 20’ with PT providing with shift – no trunk or pelvic rotation, no arm swing, advances with large lateral shift and body rigid, no isolation of hip flexion, strikes forefoot B
- Dependent in manual wheelchair
- Dependent standing balance without any protective reactions
- L ankle PF -10 degrees with knee extended
- Decreased speed of movement throughout body but slower right upper extremity > left upper extremity; patient able to selectively isolate movement in the lower extremities with more difficulty right lower extremity than left lower extremity and only able to isolate in supine or supported sitting position
“Sarah” Evaluation

- Min to mod cues for problem solving
- Vision: wears glasses, difficulty with pursuits in superior and inferior visual fields, slow saccades, reports seeing colored spots when stressed or fatigued
- Shoulder AROM less than 70 degrees B, unable to extend wrist, unable to make fist
- Self care: Dependent upper body and lower body dressing, max A grooming & hygiene, max A feeding
- Barthel = 10/20
COMMON MOTOR IMPAIRMENTS
Bradykinesia

- "Slow" motion
- Reduced movement speed and amplitude
- Slowness in initiation and execution of movement

Clinical Implication

- Slowed initiation and execution of movement
- Delayed postural reactions
- Delayed and possibly ineffective balance reactions
Therapy Interventions for Bradykinesia

• * No literature in the HI-BI population
  – Searched Parkinson’s disease literature

• Strength training
• High intensity exercise
• Motor imagery and physical practice (Tamir et al 2007)
• Rhythmical auditory cuing (Lim 2005, 2010)
• Cuing to increase amplitude of movement (Farley 2005, Janssens 2014)
• Cognitive strategies
Dystonia

• "Secondary dystonia"
• Involuntary, sustained, patterned or repetitive muscle contractions
• Twisting, repetitive movements or abnormal postures (Albanase 2007)
• + cocontraction
• May be initiated or suppressed by movement
• May involve triggers
Therapy Interventions for Dystonia

- Biofeedback
- Seating and positioning
- Contracture management
- Managing secondary pain (Zetterberg 2008)
- “Postural Orientation” (Zetterberg 2008)
- Agonist motor control and endurance (Shumway-Cook 2001)
- Environmental modifications
- Stress management
- Self management strategies
Management of Dystonia

Pharmacologic

- GABAergic agents (Benzodiazepines)
- Anticholinergics
- Dopaminergic
- Chemodenervation

- Emerging evidence for deep brain stimulation (Alterman 2007)
- Thalamotomy or pallidotomy have also been used
Chronic Post Hypoxic Myoclonus

- Sudden, brief, lightening-like muscle jerk arising from abnormality in the nervous system
- Triggered by voluntary muscle activation or inhibition
- Post hypoxic myoclonus AKA Lance Adams syndrome
- Diverse clinical presentation
- Positive vs negative myoclonic jerks
- Possible triggers
  - Intention to move
  - Voluntary movement
  - Sensory stimuli
  - Emotional state

Gupta 2016
Post Hypoxic Myoclonus - Treatment

- Properly assessing change in impairments
- Functional training (Polesin 2006)
- Postural stability
- Handling techniques
- Seating and positioning
- Adaptive equipment
- Environment modifications
- **Self-management**
  - Cognitive prep strategies
  - Relaxation
  - Augmented movement/posturing
Post Hypoxic Myoclonus – Pharmacologic Treatment

• Sodium valproate
• Clonazepam
• Levetiracetam
• Piracetam
• Benzodiazepines
• Phenobarbital
“Sarah” Treatment

- Received PT, OT, SLP initially
  - PT/OT/SLP made referral to neuropsychologist due to anxiety issues contributing to increase in dystonia, cocontraction, myoclonus and generalized fear of falling

- PT
  - Deep breathing and relaxation techniques
  - Stretching for home exercise program (HEP)
  - Full body strength program w/ attention to agonist muscles
  - Joint mobilization (ankles, hips, shoulders, thoracic spine)
  - PNF and diagonal pattern work
  - Tall and half kneel activities
  - Treadmill training w/ intervals
  - Elliptical
  - Standing balance
  - Progression to walking while carrying items, jumping tasks, and running
“Sarah” Treatment

- Range of motion (A/P) – shoulder, elbow, hands
- Splinting/bracing – serial casting
- Strengthening – upper extremity and grip
- Functional transfer training
- Dressing/grooming tasks – buttons, zippers etc.
- Memory prosthetics
Common Cognitive Impairments Associated with HI-BI
Neuropsychological Effects

- Impaired memory
- Visual-spatial deficits
- Executive function
- Generalized cognitive decline
Memory Impairments

• Declarative (semantic, episodic, autobiographical)

• Implicit (sensorimotor, emotional)
  • Formal neuropsychological assessment recommended to determine extent of deficits
Visual Impairments

• Field cuts
• Blindness
• Visual scanning
• Visual attention
• Environmental interaction
Executive Functioning

- Initiation
- Judgment
- Insight
- Self awareness
- Planning & organizing
Psychiatric Changes

- Psychological and behavioral changes following ABI often include euphoria, irritability, hostility, depression and anxiety (Li, 2000)
  » Mania post-ABI has been reported

- Alternatively, some individuals may be unconcerned or show little emotional response to their cognitive impairments or exhibit emotional lability including anger, agitation and depression (Armengol, 2000)
Prevalence

Caine and Watson (2000) identified 67 cases of which:

- 36 (54%) had amnesia
- 31 (46.2%) had impaired executive function or personality change
- 21 (31.3%) visuospatial deficits
- 6 (9%) had language impairments
“Sarah” Evaluation

• Neuropsychological evaluation results
  – Intellectual skills largely unaffected
  – Impaired Processing Speed
  – Memory Low Average
    • However, anxiety regarding her memory would at times cause her to exhibit Impaired memory skills.
“Sarah’s” Treatment

• Cognitive deficits will impact therapeutic intervention

• You must consider cognition when structuring plan of care

• Treatment may require varied or combined approaches:
  – Environmental modification
  – Remediation
  – Compensation
Interdisciplinary Team
Transdisciplinary Team Management

• Given multiple systems involved in HI-BI comprehensive team approach can improve outcomes and efficiency
  – Identification of impairments and treatment strategies carried over between services
  – Carryover of transfer and functional progressions between therapies
“Sarah” Outcome

- Seen over period of 8 months with some gaps in care
- At discharge from PT:
  - Walking >1000’ with close supervision and no assistive devices
  - Standing >35 min without upper extremity assistance
  - Independent bed mobility and transfers
  - Up/down FF stairs step over step with 1 rail and supervision
  - Community ambulator- had wheelchair for distance but she refused it
- Barthel= 16.5
Thank you!!