



WEBINAR SERIES

Hypoxic-Ischemic Brain Injury: Movement Disorders and Clinical Implications

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Disclosures

- Carolyn Tassini, PT, DPT, CBIS, NCS – Nothing to disclose
- Additional credit for this presentation goes to Kimberly Miczak, PT, NCS

Following this session:

- Participants will appreciate mechanisms underlying motor, cognitive and visual impairments following hypoxic-ischemic brain injury.
- Participants will utilize current evidence from movement disorder literature in developing treatment plan for individuals following hypoxic-ischemic brain injury.
- Participants will recognize the importance of transdisciplinary team in maximizing treatment and outcomes for individuals recovering from hypoxic-ischemic brain injury.

Introduction

- What is a hypoxic or anoxic brain injury?
 - → Hypoxic-Ischemic brain injury
- Common Causes
 - Cardiorespiratory arrest
 - Respiratory failure
 - Drug overdose
 - Carbon monoxide poisoning
 - Drowning/strangulation
- Primary vs secondary injury

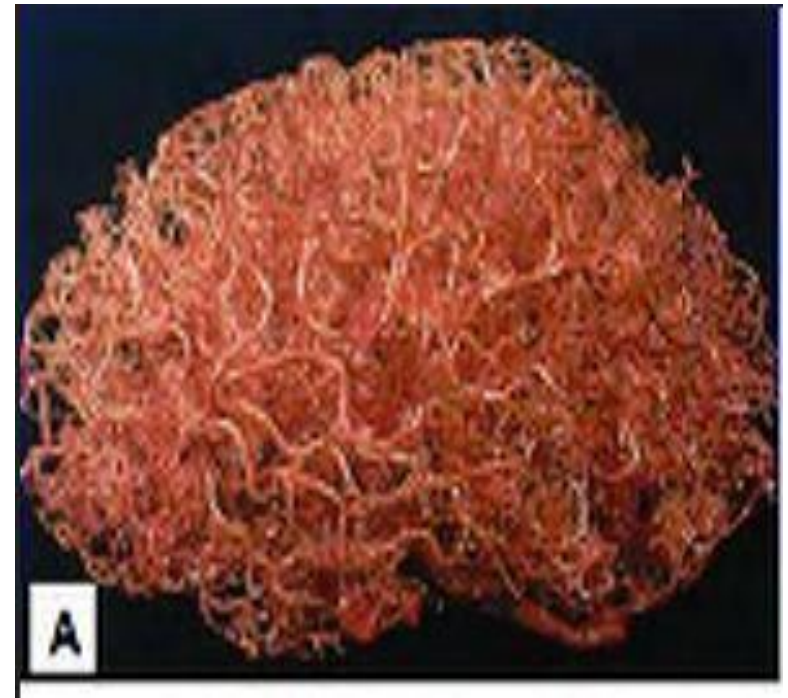


Image from: neurolove.tumblr.com

Background Info

- No national data available on the prevalence of HI-BI
- Peak frequency in males aged 60-years (r/t cardiac) and females in their late 20's r/t suicide and parasuicide/self-harm attempts (Fitzgerald 2010)
- Can range from mild to severe
- HI-BI vs TBI rehab course:
 - slower progress
 - poorer outcome
 - more likely to DC to residential facility vs home (Fitzgerald 2010)

Mechanism of Injury

- Cardiorespiratory- hypoxia with ischemia
 - Reperfusion injury
- Pure anoxic or hypoxic
- Carbon monoxide
- **Delayed Post-Anoxic Encephalopathy

Cerebral Vulnerability with HI-BI

- Hippocampus – CA1 pyramidal neurons
- Superior brainstem – reticular formation
- Cerebellum – Purkinje cells
- Cerebral white matter at “watershed areas”
- White matter and subcortical structures supplied by distal branches of deep and superficial penetrating vessels
- Striatum
- Pyramidal neurons in cortical layers 3, 4, 5, and 6

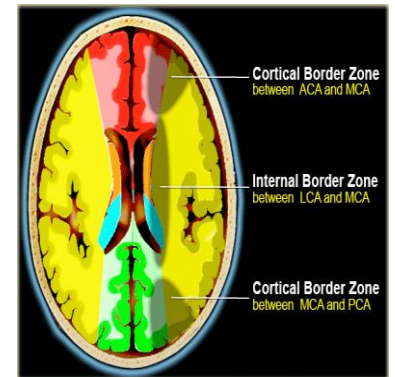


Image from: radiologyassistant.nl

Common Impairments Associated with HI-BI

- Cognitive impairments: memory, concentration, attention, executive dysfunction
 - ▶ Visual impairments: cortical blindness, partial visual loss, visual inattention, visuospatial impairments
 - ▶ Motor/sensory impairments: quadriparesis w/ cranial nerve impairment, quadriparesis, mono/para/hemiparesis, cranial nerve, myoclonus, seizures
 - ▶ Speech/swallowing impairments: dysphagia, dyspraxia, dysarthria, dyslexia, dysgraphia

Addressing today:

- Myoclonus
 - Dystonias and abnormal posturing
- Post Hypoxic Parkinsonism

Movement/Motor Disorders

- Myoclonus
- Dystonia
- Parkinsonism

Post Hypoxic Myoclonus (PHM)

- Characterized by rapid, jerking muscle contractions, arrhythmic and irregular in amplitude
- Pathophysiology unknown
 - Thought to be related to abnormal neurochemicals (in particular Serotonin)
 - May be of cortical, subcortical, brainstem or spinal cord etiology (Levy 2016)
- 2 Types
 - Acute Post Hypoxic Myoclonus (PHM)
 - Chronic PHM*

Chronic PHM

- AKA Lance-Adams syndrome
 - LAS or chronic PHM = myoclonus associated w/ dysarthria, apraxia, seizures or cognitive deficits
- More favorable prognosis than acute PHM
- Typically quiet during sleep, mild at rest and worse w/ startle or action especially intention
- Can be contractions (positive) or muscle tone lapses (negative), brief, involuntary, shock-like
(Gupta 2016)
- Impairs function – self care, mobility, transfers etc.
- Often associated w/ signs of incoordination

Chronic PHM

- Diverse clinical presentation
- Possible triggers include:
 - Intention to move
 - Voluntary contractions
 - Sensory stimuli
 - Emotional state



VIDEOS with permission from:

Ramdhani, Ritesh A., Steven J. Frucht, and Brian H. Kopell. "Improvement of Post-hypoxic Myoclonus with Bilateral Pallidal Deep Brain Stimulation: A Case Report and Review of the Literature." *Tremor and Other Hyperkinetic Movements* 7 (2017).

Chronic PHM

Pharmacologic Treatment

Trial and error often applied

Typically a combination of:

- Sodium valproate
- Clonazepam (Klonopin)
- L-5-HTP (L-5 hydroxytryptophan)
- Levetriacetam (Keppra)

PT Interventions for PHM

- *PT treatment is adjunct to pharmaceutical*
- Assessing change in impairments
- Functional training (Polesin 2006)
- Postural stability
- Slow the movement
- Handling techniques
- Seating and positioning
- Adaptive equipment
- Environment modifications

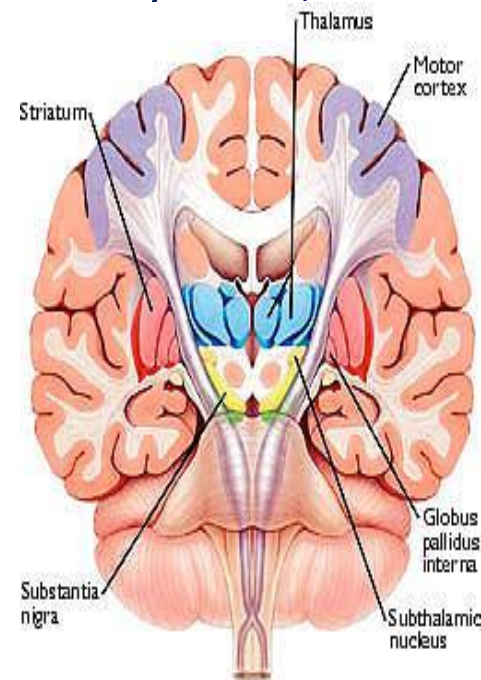
PT Interventions for PHM



- Self-management
 - Cognitive strategies
 - Relaxation
 - Augmented movement/posturing
- Biofeedback to address:
 - Postural awareness
 - Alter motor recruitment
 - Facilitate motor recruitment
 - Tone/reflex inhibition
- Reduce Anxiety

Dystonia

- Characterized by: involuntary, abnormal muscle contractions that result in sustained abnormal postures, twisting, or both, and repetitive movements of body parts
 - Dystonia following HI-BI is a “Secondary Dystonia”
 - Classified by location: focal, multi-focal, segmental, hemi-dystonia, and generalized dystonia
- Caused by disruption of the basal ganglia
 - Globus pallidus
 - Putamen (Hawker 1990)
 - Cortico-striatal-thalamo-cortical loop
 - Dopamine changes
 - Decreased reciprocal inhibition
 - Impaired cortical activity during motor planning (Gilio 2003)



Treatment for Dystonia

Pharmacologic Treatment

- Benzodiazepines
- Anticholinergics
- Chemodenervation
- Baclofen

Surgical Treatment

- Inconclusive but emerging evidence for DBS

PT Interventions for Dystonia

- Seating and positioning
- Environmental modifications
- Adaptive equipment
(Jahansahi 1991, Krack 1998)
- Contracture management
- Stretching of agonist
- Managing secondary pain
(Zetterberg 2008)
- Antagonist strengthening
(Zetterberg 2008, Hakkinen 2004)
- Motor control and endurance
- Postural Orientation
(Zetterberg 2008)
- “Slow down exercises”
(Yoshie 2015)
- Self management strategies

Post-Anoxic Parkinsonism

- Due to damage of Globus Pallidus
- Most common delayed onset movement disorder after HI-BI
- Presents as:
 - Akinetic-rigidity, +/- tremor
 - Bradykinesia, Retropulsion
 - Gait pattern: festinating or shuffling, freezing
- Does not respond well to dopaminergic agents

Mangaraj, 2014
Schramm, 2004
Cho, 2002



Post-anoxic Parkinsonism

- Treatment:
 - Largely depends on level of cognition
 - “Typical” PD strategies
 - Auditory or visual cues
 - External inputs to drive movement– Treadmill, guided assistive device
 - Wider turns, counting when freezing occurs
 - Postural re-ed “Backwards disequilibrium”

Avanzino , 2016

Radder, 2017

Scheets et al, 2015



Integrated Case Example

Meet Mr. X

- 50 y/o man s/p cardiac arrest in 2012
 - 7-8 months “unresponsive” per family
- 8-9 month acute rehab stay then DC to SNF
 - Family reports “he mostly stayed in bed”
- DC to home w/ his wife approx. 1.5 years prior to presenting to OP therapy
 - Per family had course of PT at home but no services in the past year
 - Pt transitioned from his wife’s care to family care approx. 1 year ago when he became too much for her to care for at home

Mr. X

- PMHx
 - Unremarkable
 - Old right shoulder injury from HS football
- Current Medical
 - Seizures
- Course of care from this injury
 - Pt noted decline over the past year:
 - Per pt. he was able to do short walks at home w/ his wife but hasn't been able to walk for "a long time"
 - Previously able to dress and feed himself
 - Myoclonus has increased over the past year

Mr. X

- Medications

- Keppra
- Klonopin
- Xanax
- Valium
- Lipitor

Mr. X

- Social

- Prior worked FT in maintenance at apartment complex
- Married but separated, estranged daughter
- Living with family and hired CNA – 24 hour care
- Multi story home w/ stairs to enter. Bedroom and bathroom on 2nd floor.
- DME includes commode, urinal and standard WC w/ sling back and seat
- Unable to transfer to shower due to bathroom setup
- Current activity pattern: out of bed in AM, spending day in chair (WC or recliner) all on 2nd floor. Meals brought to him.
- Dependent for dressing and feeding, requires assist w/ all transfers, unable to walk

Task Analysis- Sit pivot transfer

- Deviations that vary from “normal”
 - Static sitting: (positive) myoclonus present
 - Sitting posture
 - Post pelvic tilt, “slouched” posture, UEs not engaged, poor foot contact with floor
- Decreased ability to attain **initial condition** for task
 - Neutral pelvis, neutral spine, arms to supportive position
 - Difficulty sustaining unsupported posture due to myoclonus
- **Execution** unsuccessful due to myoclonic intrusions



Generation of Hypotheses

1. Myoclonus interferes with ability to perform at optimal level
 - Doesn't allow for isolated movement, which may or may not be intact
 - Limited ability to determine motor planning and motor execution
 - Potential of bradykinesia
2. Co-contractions (dystonia) lead to stiffness and rigidity of movement
 - Would like to evaluate cognition, vision, emotional status
 - Executive dysfunction: externally/internally distracted, hypervigilant/responsive to environment
 - Vision: intact
 - Emotional status: signs of depression, frustrated with situation

Prioritization of Treatment

- Patient's goal “to be able to walk”
- Barriers to goal attainment:
 - Myoclonus
 - Selective motor control/dystonia/incoordination
 - Cardiovascular fitness
 - ROM
- Prioritized interventions to address myoclonus management
- Secondly
 - Selective motor control/coordination
 - Functional motor planning

Treatment Approach Utilized: Myoclonus

- Education
- Self-management techniques
 - Deep breathing and relaxation
- Postural re-education and training
 - Supported training
 - Unsupported
 - Anticipatory vs reactive postural control activities
- Body weight support training
- Functional training
 - Closed chain work
- Caregiver training
- Referral: Occupational therapy, neuropsychology

Education



- Critical to inform patient that myoclonus is not unusual following his injury
- Educate role and likely outcomes with PT
 - Adjunct to medications
 - Expect long term deficits
- Educate treatment plan and factors impacting myoclonus
 - Anxiety
 - Mood
 - Triggers

Awareness & Engagement

- Patient engagement!
 - May increase activity in several cortical regions
 - Improve neuroplasticity
- Skills to improve engagement
 - Build rapport and trust
 - Use motivational interviewing
 - Client education process
 - Empowerment strategies

Danzl 2012



Self-Management Techniques: Relaxation & Deep Breathing

- Duckett & Kramer ⁽¹⁹⁹⁴⁾ reported on case using biofeedback and relaxation techniques to manage myoclonus
 - Relaxation techniques listening to tape 3x/day
 - Relaxation techniques utilized prior to transfers and standing
 - EMG on temporalis for biofeedback
- Khoury et al ⁽²⁰¹³⁾ found mindfulness-based therapy (MBT) to be effective for treating psychological disorders including anxiety and depression
- Deep breathing techniques work by inhibiting the sympathetic nervous system and can be useful to decrease anxiety and stress



Treatment Concepts

- Slow the movement
 - Cuing the patient to perform actions in “slow motion” improved control and decreased myoclonus (Polesin & Stern 2006)
- Clinician awareness of touch and environment
 - Reflex myoclonus can be triggered by either or both of these stimuli
 - Firm touch and intentional contact
 - Manage environmental sounds
 - Manage environmental distractions

Postural Re-Ed & Body Awareness

- Postural and equilibrium control are required for balance (Massion & Woollacott 1996)
- Balance system requires adequate sensory input, efficient CNS processing, and strong effector system of muscles and joints (Horak 1989)
- Feedback vs feedforward loops

Functional Interventions

- Functional training combined with slow movement training improved transfer and gait status (Polesin 2006)
- BWS training – allow for practice of task specific training
 - Allow for reciprocal gait pattern
 - Provides safe environment
 - Increased duration practice
 - Increased number of repetition

Treatment Approach Utilized: Dystonia

- Deep breathing, relaxation, mindfulness training
- Standing – weight bearing and stretching program
- PNF – to encourage new and multi-plane movement patterns
- Functional positions – quadruped > tall kneel > half kneel
- Coordination training – variable speeds and positions
- Family and patient education/training



Dystonia

- **Scarce** literature for PT intervention, nothing for generalized dystonia
 - PT targets secondary deficits r/t dystonia
- Biofeedback: limited evidence that biofeedback alone is effective treatment for cervical dystonia (CD) *BUT* can be beneficial combined with relaxation and exercise (De Pauw 2014)
- Combination of exercises and relaxation equally effective as biofeedback training in reducing tone of SCM, improve ROM and head position (Jahanshahi 1991)
- Self-relaxation techniques and “slow down” exercises in focal hand dystonia (van Vugt 2014)

Dystonia

- Quieroz 2012 examined rehab protocol of kinesiotherapy, motor learning exercises and FES and Botox compared to treatment of Botox® alone for pts with CD
 - Ex/btx® group improved on severity, pain and disability subscales of TWSTRS vs improvement on severity subscale only for botox
 - Ex/btx® group improved on all 3 domains (physical functioning, role-physical, bodily pain) of SF-36 vs only role-physical and bodily pain with btx alone
 - Ex/btx® group improved mental health on SF-36 (vitality, social functioning and mental health) with no significant diff in the btx alone group
- Kinesio Taping improved pain and sensory discrimination in individuals with focal hand dystonia compared to sham taping (Pelosin 2015)
- “Sensory tricks” to alleviate spasms

Weight bearing & Stretching

- Standing- weight bearing & stretching
 - Long-term stretching may be recommended for clients at risk or with contractures of neurologic origin
 - Katalinic et al. (2011, 2010) and Harvey (2017) found that regular stretches do not produce clinically important changes in pain, joint mobility, spasticity or activity limitation
 - Stretching not ruled in or out for individuals with ABI
 - **Not followed for stretching >6 months or combined with other intervention i.e. motor training or botox

Multi-plane movements

- PNF – based on maximal stimulation of proprioceptive and external (touch, verbal, visual) receptors aiming at activation of impaired structures of the nervous system
 - Principles: slow approximation, timing for emphasis, bilateral reciprocal patterns
 - Mostly closed chain
- Mirek et al ⁽²⁰¹⁵⁾ found improvement in static and dynamic balance w/ PNF rx in individuals with HD (BBS, FRT, Pastor test)

Functional positions

- Quadruped, tall and ½ kneel
 - Allow for targeted stability
- Core stability training - necessary for stability of spinal column, resist perturbations, and provide stable base for balance (Wilson 2005)

Coordination/Timing

- Bilateral movements improve inter-limb coordination and coupling of muscles to improve motor performance in hemiparesis (Stewart 2006, Cauraugh 2005)
- Post-stroke hemiparesis shows atrophy of type II muscle fibers (Patten 2004)
- Rehabilitation requires training of both resistance exercises and skill (motor control exercises)
- Patten (2013) compared functional task specific training (FTP) to hybrid (FTP and power training) and found greater improvement in function and 6-mos retention w/ hybrid compared to FTP

Treatment approach utilized: Parkinsonism

- Postural control
 - Sitting with progression to standing balance
 - Static to dynamic tasks
 - anticipatory to reactionary postural control
- Treadmill
 - External cuing for gait speed, repetition, endurance
- Selective motor control
 - Functional postures
 - Management of degrees of freedom
- Task specific training

Task Specific Training

- Assessment of performance to allow for collaborative problem solving of therapist and client
- Systems model of motor control, which considers
 - Person
 - Environment
 - Task

Take Home Messages

- HI-BI is a diffuse injury w/ diverse clinical presentation
- Incidence of HI-BI may be increasing due to improved emergency medicine abilities
- May be seen as secondary complication to another injury i.e. primary TBI, cardiac arrest, etc.
- Onset of movement disorders may be acute, subacute or chronic
- Unfortunately there lack of literature in this specific population- must use complimentary literature
 - Not fully generalizable to persons with HI-BI
- Multi-sensory component to many of the movement disorders with HI-BI
- Transdisciplinary approach is beneficial to maximize outcomes

Thank You? Questions?



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