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Acute Rehabilitation of Persons with Traumatic Brain Injury (TBI)

Jill Seale, PT, PhD, NCS
Physicaltherapy.com
August 31, 2016

Objectives

1) Describe the pathophysiology and at least two most common mechanisms of TBI.
2) Describe the common clinical presentations across the TBI spectrum from concussion/mild to severe TBI.
3) Examine the current medical management of acute TBI, and impact of medical management on rehabilitation intervention.
4) Identify at least three evidence based rehabilitation interventions for the most common impairments and activity/participation limitations in the acute phase of TBI.
5) Differentiate the levels of care and appropriate referral across the continuum of care for persons with acute TBI.
TBI... what is it?

- “caused by a bump, blow, or jolt to the head or a penetrating head injury that disrupts the normal function of the brain”
- Severity ranges from mild to severe
- Most TBIs that occur each year are mild, commonly called concussions.
  

TBI Statistics

- 2.5 million sustain a TBI each year in US
- 52,000 die; 275,000 hospitalized, almost 1.4 million treated and released
- At risk for TBI
  - Males 1.5 times greater
  - 0-4 yr/old and 15-19 yr/old

- Long Term
  - 5.3 million Americans with long term disability
  - Direct/indirect costs estimated at $60 million in US in 2000
    - CDC 2010
TBI by Age

- Children 0-4, adolescents 15-19, and adults aged ≥ 65 are most likely to have TBI
- Adults ≥ 75 have highest rates of TBI related hospitalizations and death

TBI by Gender and External Cause

- At every age, TBI rates higher in males
- Males 0-4 have highest rates of TBI ER visits, hospitalizations, and deaths
Mechanisms of Injury

- Direct Impact
- Severe acceleration/deceleration
- Blast injury
- Penetrating object

Primary v Secondary Damage

- Primary
  - Contusions
  - Hematomas
  - Diffuse axonal injuries
  - Penetrating injuries
  - Blast injuries
- Secondary
  - Increased intracranial pressure (ICP)
  - Hypoxia or ischemia
  - Seizures
  - Intracranial hemorrhage (ICH)
  - Electrolyte and acid-base imbalance

*Neurological Rehabilitation, 2013*
The Effects of TBI

- Neuromuscular/somatosensory
- Autonomic dysfunction
- Cognitive
- Psychological
- Behavioral
- Communication
- Visual/Perceptual
- Dysphagia
- Vision/Vestibular
- Cardiovascular

Neuromuscular/Somatosensory

- Paralysis/paresis
- Altered muscle tone and/or abnormal reflexes
- Poor coordination/ataxia
- Cranial nerve dysfunction
- Impaired balance
- Poor selective motor control
- Bowel and bladder dysfunction
- Dysphagia
- Loss of sensory function or hypersensitivity
Autonomic Dysfunction

- Temperature elevations/Excessive sweating
- Hypertension
- Tachycardia/Tachypnea
- Pupillary dilation
- Extensor posturing
- Paroxysmal Autonomic Instability with Dystonia (PAID) and Paroxysmal Sympathetic Hyperactivity
- Management of symptoms pharmacologically
  — Meyer KS. Surg Neurol Int. 2014

Neuropsych

- Memory impairment
  — PTA
  — Short term memory
- Emotional changes
  — Behavior ranging from obtundity to hyperactivity
- Communication
  — Aphasia
  — Dysarthria
- Cognitive impairment
  — Attention/concentration deficits
  — Executive function loss
  — Loss of reasoning and/or abstract thinking
  — Poor problem solving
Posttraumatic Amnesia

- Cranial nerve impairment that affects vision
- Visual field changes
- Visuospatial abnormalities
- Vestibular: peripheral or central
- Vestibulo-ocular: dizziness, vertigo, blurred/unstable vision, nausea, difficulty with busy environments
- Agnosia
- Apraxia
Cardiovascular

- Severe deconditioning
- VO2 Peak significantly decreased in all neuro dx
- NO RESERVE
- Most with neuro dx don’t have the VO2 peak to meet demands for daily living of older adult
- Growth hormone insufficiency

ORIGINAL ARTICLE

Aerobic Capacity After Traumatic Brain Injury: Comparison With a Nondisabled Cohort

Kurt A. Meeberg, PhD, PT, Danielle Ayala, MPT, Tracery Baker, MPT, Justin Heard, MPT, Brent Mosel, MD

Objectives: To compare aerobic capacity of people recovering from traumatic brain injury (TBI) with a study sample of nondisabled sedentary adults. The subjects could walk, sit, sit (14 mph), follow a simple irrigation, and comply with testing using the gas collection apparatus.

Participants: Convenience sample of 13 people with TBI and 13 age and sex matched individuals from a state rehabilitation setting. The study used a 30% age and sex matched sample.

Methods: Aerobic capacity was measured by peak oxygen consumption (VO2peak) and ventilatory equivalent for oxygen (VE/VCO2). VO2peak was determined by exercise testing to a self-limited endpoint or until the patient could no longer walk. VO2peak was calculated using the following equation: VO2peak = [O2 uptake during exercise test] / [time to reach peak O2 uptake]. VE/VCO2 was measured using the V-slope method.

Results: Subjects recovering from TBI had significantly lower peak responses for heart rate, VO2, VE, and VO2peak than the control group. There were no detectable differences in VO2peak or endurance capacity.

Conclusion: Patients with TBI were significantly more deconditioned than a comparable group of sedentary people. Participation in cardiopulmonary fitness training is important for TBI patients to be encouraged to prevent secondary disability.

For more information, please visit the ContinEd website.
More issues

• For most with neuro dx, VO2 requirements increase secondary to gross motor insufficiencies
• Low level of fitness associated with increased mortality
• Decrease in available motor units →
  decrease in metabolically active tissue →
  decrease in oxidative potential

Classifications of TBI

• Most commonly determined by Glasgow Coma Scale (GCS)
  – 3 Domains: eye response, verbal response, motor response
• Mild: 13-15
• Moderate: 9-12
• Severe: 3-8
  – Adapted from: Advanced Trauma Life Support: Course for Physicians, American College of Surgeons, 1993
<table>
<thead>
<tr>
<th>Level</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Response</td>
</tr>
<tr>
<td>2</td>
<td>Generalized Response</td>
</tr>
<tr>
<td>3</td>
<td>Localized Response</td>
</tr>
<tr>
<td>4</td>
<td>Confused and Agitated</td>
</tr>
<tr>
<td>5</td>
<td>Confused-Inappropriate/ Non-agitated</td>
</tr>
<tr>
<td>6</td>
<td>Confused-Appropriate</td>
</tr>
<tr>
<td>7</td>
<td>Automatic-Appropriate</td>
</tr>
<tr>
<td>8</td>
<td>Purposeful – Appropriate, initiates and carries out with stand by assistance</td>
</tr>
<tr>
<td>9</td>
<td>Purposeful- Appropriate, initiates, requests assistance when needed</td>
</tr>
<tr>
<td>10</td>
<td>Purposeful – Appropriate, Modified Independent</td>
</tr>
</tbody>
</table>

**Examination of Level of Consciousness**

- **Coma Recovery Scale Revised (CRS-R)**
  - Score Range from 0-23
  - 6 subscales:
    - Auditory
    - Visual
    - Motor
    - Oromotor/verbal function
    - Communication
    - Arousal
  - Lower scores = reflex activity
  - Higher scores = cognitively mediated activity
    - Giacino J et al, 2004
### Measurement

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td>13-15</td>
<td>9-12</td>
<td>3-8</td>
</tr>
<tr>
<td>Loss of Consciousness</td>
<td>&lt; 30 min</td>
<td>30 min – 24 hours</td>
<td>&gt; 24 hours</td>
</tr>
<tr>
<td>Posttraumatic Amnesia</td>
<td>0-1 day</td>
<td>&gt;1 to ≤ 7 days</td>
<td>&gt; 7 days</td>
</tr>
</tbody>
</table>

*Neurological Rehabilitation, 2013*

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**Mild TBI or Concussion**

- Injury to head from blunt trauma or acceleration/deceleration forces
- Results in 1 or more of the following:
  - Confusion, disorientation, or impaired consciousness
  - Dysfunction of memory around time of injury
  - LOC < 30 minutes
  - Onset of observed signs or symptoms of neurological or neuropsychological dysfunction
  - CDC
Mild TBI or Concussion

<table>
<thead>
<tr>
<th>Thinking/Remembering</th>
<th>Physical</th>
<th>Emotional/Mood</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty thinking clearly</td>
<td>Headache</td>
<td>Irritability</td>
<td>Sleeping more than usual</td>
</tr>
<tr>
<td>Fuzzy or blurry vision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>Nausea or vomiting (early on)</td>
<td>Sadness</td>
<td>Sleep less than usual</td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>Sensitivity to noise or light</td>
<td>More emotional</td>
<td>Trouble falling asleep</td>
</tr>
<tr>
<td>Balance problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty remembering new information</td>
<td>Feeling tired, having no energy</td>
<td>Nervousness or anxiety</td>
<td></td>
</tr>
</tbody>
</table>

CDC

Trends and Patterns

- **Impact of Income**
- **Mortality and outcomes improving?**
  - Overall mortality rate in severe TBI not decreasing
  - Increased risk of death increased up to sevenfold
  - Increased risk for Alzheimer’s disease
- **TBI Model System Data at 5 yrs post injury**
  - 21.7% dead
  - 32.3% need assistance
  - 29.1% dissatisfied with life
  - 55% unemployed
  - 57.8% with moderate to severe disability
  - 38.8% declined from earlier status to 5 yr outcome
    - Corrigan JD et al, 2014
Acute Management of TBI

Common Medical Complications

- Seizures (46%)
- Spasticity (57%)
- UTIs (47%)
- Hydrocephalus (with/without shunt) (38%)
Restrictions and Precautions

• Craniotomy/Bone flap
• Head of bed restrictions
• Mechanical ventilation/tracheostomy
• Weightbearing precautions
• Seizure precautions

Intracranial Pressure

• Edema, abnormal fluid dynamics or hematomas can result in increase ICP
• Normal ICP is 4-15 mmHg
• Severe increase in ICP can result in brain herniation
• Increased ICP associated with increased mortality and poorer outcomes
Unstable ICP Management

- Ventriculostomy open to drain
- Hyperventilation - decreases PCO₂ = vascular constriction = decreased space taken up in cranium = decreased pressure (ICP)
- Osmotherapy with Diuretics/Mannitol - decreases edema only in areas with intact cells and vasculature = decreased edematous pressure = decreased ICP

Drug Induced Paralysis

- Done in cases with increasing ICP
- Pentobarbitol: strong barbiturate; acts on smooth and skeletal mm; need careful monitoring of cardio resp status
- Pavulon: blocks impulse at NMJ; affects skeletal mm only
Drug Interventions after TBI

Common BI Medications

- Anti-convulsants
- Neuro-stimulants
- Anti-spasmodics
- Anti-depressants/anti-anxiety
- Psychoactive or neuroleptic medications
Neuro-stimulants

- Ritalin (Methylphenidate)
- Symmetrel (Amantadine)
- Other dopamine-enhancing agents
- Antidepressants
- Provigil (Modafinil)
- Ambien (Zolpidem)
- Revia (Naltrexone)
Antipsychotics or Neuroleptics

- Haldol
- Thorazine
- Zyprexa
  - Weight gain, diabetes, postural hypotension, sleepiness, hyperlipidemia, and dizziness
- Risperdal
  - Postural hypotension, insomnia, dizziness, weight gain
- Seroquel
  - Sleepiness, dizziness, postural hypotension

Acute PT Treatment

- Prevention of anticipated problems
- Patient/family education
- ONGOING Evaluation
- Early mobilization
- Appropriate environment
- Systems based approach
Start with Mental Status

• Increasing arousal and awareness

• Memory: orientation, implementation of memory strategies

• Cognition, speech, language: increased time for processing, cognitive rest, consistent approach to speech/language; graded cognitive exercise

Neuromuscular Interventions

• Increasing upright tolerance
  – Tilt table therapy
    • Krewer C, Luther M, Koenig E, Muller F, 2015

• Activities to maintain flexibility
• Management of altered tone
• Emphasize automatic tasks/movements
• Normalizing sensory input
Cardiovascular/Respiratory

- Increasing upright tolerance
  - Managing orthostatic hypotension
- Endurance training
- DVT prevention
- Positioning to optimize pulmonary function
- Activities to improve respiratory function

Integumentary System

- Thorough and ongoing examination
- Positioning to prevent pressure
- Pressure relieving beds and w/c systems
- Bowel and bladder management
- Protection against agitation/restlessness
- Family education
Exercise and TBI

Benefits above Improved Fitness

• Impact on cognition
• Impact on mood/behavior
• Impact on recovery
Exercise and Depressive Symptoms

• Increased prevalence of depression in persons with neurological disorders
• Exercise improves depression
  – Needed to be exercise that met PAGs
  – Moderate to vigorous intensity
  – 3-5 days per week

Exercise Maintenance after TBI

• Decreased score on BDI
  – Maintained improvement over time
• Increased physical activity
  – 48% with increased activity level at 6 months post
• Exercise greater than 90 minutes per week resulted in lower BDI and higher perceived QOL and mental health
• 52% of subjects were exercising greater than 90 minutes per week at 6 months
Cognition and Aerobic Exercise

• > 50% of TBI survivors still experiencing cognitive problems several years post TBI
• Vigorous training: 3 times/wk x 30 minutes on treadmill x 12 wks
  — supervised
• Improved cognitive function with aerobic training in TBI
  — Processing speed, executive function, overall cognition
• Aerobic exercises associated with physical adaptations and positive cortical functions like angiogenesis and neurogenesis

Physical exercise and cognitive recovery in acquired brain injury: a review of the literature.

Devinue JL, Zafonte RD.
Department of Physical Medicine & Rehabilitation, Spaulding Rehabilitation hospital, Harvard Medical School, Boston, MA, USA.

Abstract

OBJECTIVE: Physical exercise has been shown to play an ever-broadening role in the maintenance of overall health and has been implicated in the preservation of cognitive function in both healthy elderly and demented populations. Animal and human studies of acquired brain injury (ABI) from trauma or vascular causes also suggest a possible role for physical exercise in enhancing cognitive recovery. DATA SOURCES: A review of the literature was conducted to explore the current understanding of how physical exercise impacts the molecular, functional, and neuromanometric status of both intact and brain-injured animals and humans. STUDY SELECTION: Searches of the MEDLINE, CINHAL, and PsychInfo databases yielded an extensive collection of animal studies of physical exercise in ABI. Animal studies strengthen the physical exercise to the upregulation of multiple growth factor pathways in brain-injured animals, resulting in both hippocampal neurogenesis and functional improvements in memory. DATA EXTRACTION: A search of the same databases for publications involving physical exercise in human subjects with ABI yielded 24 prospective and retrospective studies. DATA SYNTHESIS: None of these evaluated cognitive outcomes in persons with ABI who were involved in physical exercise. Three studies cited a positive association between exercise and improvements in cognitive function, whereas one observed no effect. Human exercise interventions varied greatly in duration, intensity, and level of subject supervision, and neurocognitive changes were inconsistent. CONCLUSIONS: There is strong evidence in animal ABI models that physical exercise facilitates neurocognitive recovery. Physical exercise interventions are safe in the subacute and rehabilitative phases of recovery for humans with ABI. In light of strong evidence of positive effects in animal studies, more controlled, prospective human interventions are warranted to better explore the neurocognitive effects of physical exercise on persons with ABI.
Concussion and Exercise

- Rest versus exercise debate
- Neurometabolic cascade following mild TBI results in neurologic energy deficit
- Period of vulnerability to additional injury
- Led to extreme of absolute rest until all symptoms have resolved
- But is that the best strategy??
Concussion Treatment and Recovery

• Physical Rest
  – Metabolic dysfunction post concussion
  – Risk of second injury
  – Unrestricted activity may worsen symptoms/delay recovery
  – But is complete rest best?
  – Unrestricted exercise in immediate acute phase may increase risk of subsequent injury and/or delay recovery
  – Some level of exercise may be beneficial once beyond acute injury stage

Concussion Treatment and Recovery

• Cognitive Rest
  – increased cognitive activities post concussion increase symptom recovery time and prolong recovery
  – Reduction in brain stimulating activity
  – “prolonged cognitive rest and reduction of school events have the potential to exacerbate symptoms or cause negative mental health issues”
  – Key is during acute phase; symptoms are guide
Concussion Treatment and Recovery

• Vestibular and Oculomotor Impairment
  – Occurs in approx 60% of athletes
  – Vestibular: peripheral or central
  – Vestibular issues: benign paroxysmal positional vertigo (BPPV), vestibulo-ocular reflex (VOR) impairment, visual motion sensitivity, balance dysfunction, cervicogenic dizziness, and exercise-induced dizziness.
  – Vestibulo-ocular: dizziness, vertigo, blurred/unstable vision, nausea, difficulty with busy environments
  – Vision Therapy
  – Pharmacological interventions
• May predict prolonged recovery

TBI Continuum of Care

• Acute Care
  – ICU
  – Neuro unit
• Inpatient Rehabilitation
• Post Acute Brain Injury Rehabilitation
  – Residential
  – Day program
• Outpatient Therapy
• SNF
• Long term care
Any Questions

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