Cognitive Rehabilitation with Current Research and Transition of Care

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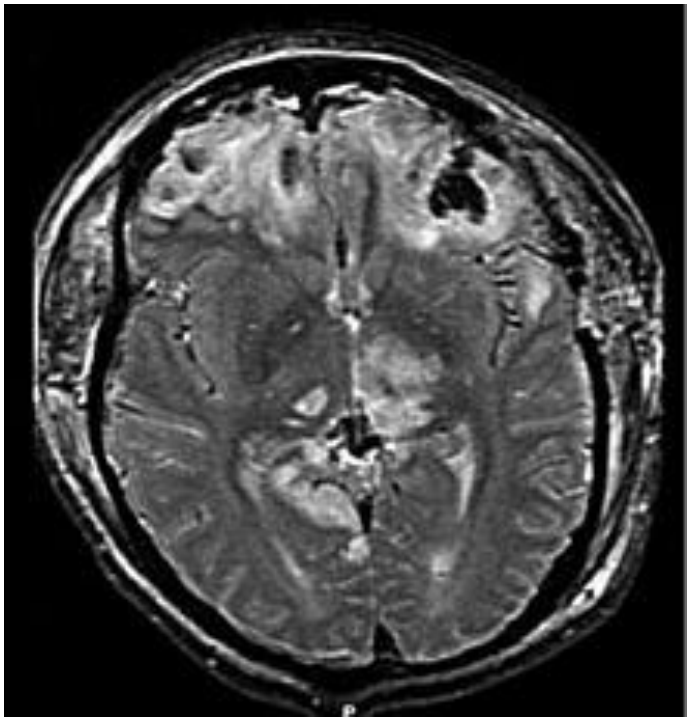
Objectives

- Describe differences in cognitive impacts of TBI by age at time of injury
- Describe current topics and research in cognitive rehabilitation for patients with brain injury
- Describe current efforts in transition of care for patients with brain injury

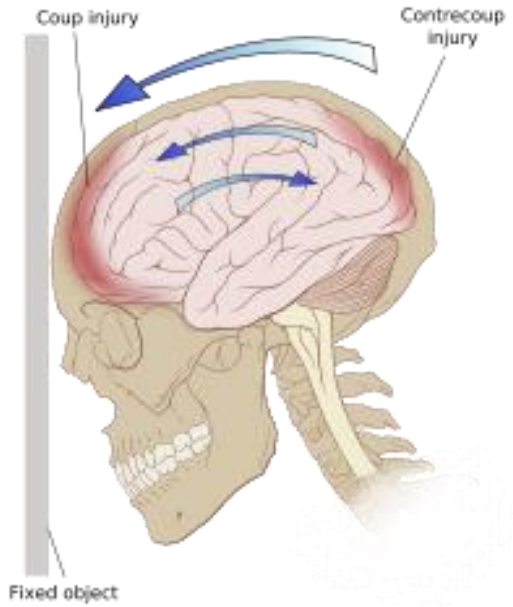
Pediatric Brain Injury

- **Traumatic Brain Injury: 1.5 million/year**
- **Mild traumatic brain injury: 80%**
- **Severe childhood traumatic brain injury: 15,000 per year**



Pediatric Brain Injury

- **Traumatic Brain Injury is the leading cause of death and disability for children aged 1 day- 25 years in the U.S. (CDC Report, 2007)**
- **There are more than 2,600,000 children in the U.S. who have survived moderate-severe TBI (National Trauma Registry)**



Brain Injury in the Young Child

- **We Know…**
  - **Primary Injury**
  - **Secondary Injury**

- **But what is the impact of these in the young child?**
  - **Plasticity**
  - **Brain injury during development**

Brain Injury - A Complicated Process

- **Primary injury and secondary injury**

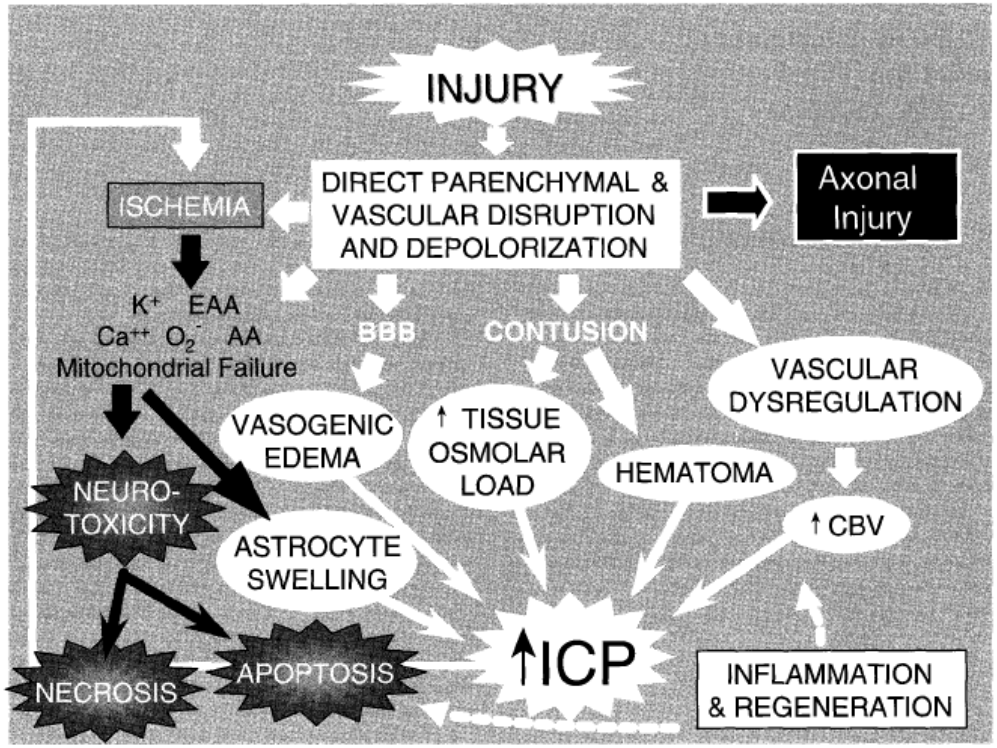
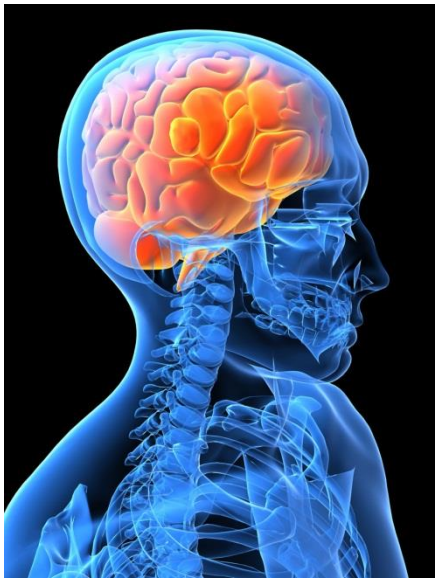


FIGURE 8-1

Categories of mechanisms proposed to be involved in the evolution of secondary damage after severe TBI in infants and children. Three major categories for these secondary mechanisms include (i) ischemia, excitotoxicity, energy failure, and cell death cascades; (ii) cerebral swelling; and (iii) axonal injury. A fourth category, inflammation and regeneration, contributes to each of these cascades. K^+ = potassium; EAA = excitatory amino acids; Ca^{++} = calcium; O_2^- = superoxide; AA = arachidonic acid; BBB = blood brain barrier; ICP = intracranial pressure; CBV = cerebral blood volume

Primary Injury

- **Primary Injury – What happens and where**
  - **Extra-axial – on the brain**
    - **Bleeding on the surface of the brain**
      - **Subdural hematoma, subarachnoid hemorrhage, epidural hematoma**
  - **Intra-cerebral – within the brain**
    - **Contusion (with or without hematoma)**
    - **Intra-ventricular hemorrhage**
    - **Stroke/Hypoxic-ischemic injury**
    - **Shear/Diffuse Axonal injury**
    - **Infection**
    - **Tumor/mass**

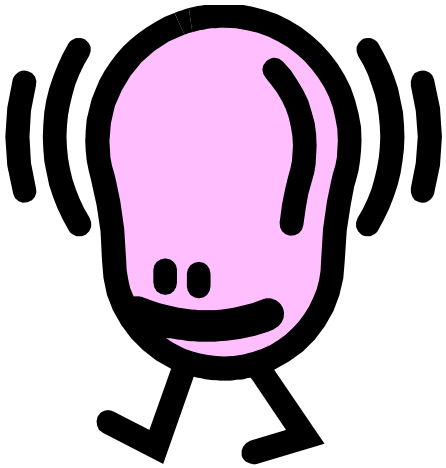


Secondary Injury

- Secondary Injury –
  - Cytotoxic Edema
  - Neuro-toxicity
  - Vascular dysregulation
    - Vasogenic edema
  - Increased intra-cranial pressure
    - Neurosurgical intervention
  - Cell death

Where in the Brain?

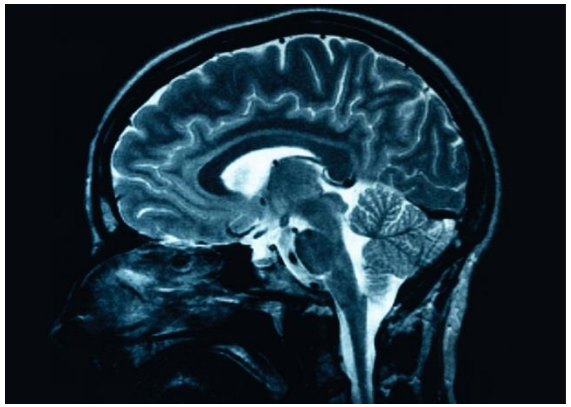
- **Different parts of the brain have different functions:**
  - **Frontal – Executive function, motor planning and control, language**
  - **Parietal – Sensation, language**
  - **Temporal – Mood, memory, language, hearing, learning**
  - **Occipital - vision**
  - **Cerebellum - coordination**



- **Areas of brain do not function in isolation, especially in young children**

Plasticity vs. Early Brain Development

- **Plasticity**
  - **The ability of the brain to change how it performs a function after brain injury**
    - **Areas surrounding the injury**
    - **Other areas of the brain**
- **Brain Development**
  - **Brain developing its basic structure**
  - **Different structures of the brain show developmental changes at different times through childhood**
  - **Connections between brain structures develop at different ages**



Pediatric Brain Injury

Brain Injury at a young age directly alters brain development

Impacts on Health, Function and Family

- **Brain injury impacts:**
  - **Medical health of the child**
  - **Development of the child**
    - **Gross and fine motor skills**
    - **Cognition and communication skills**
    - **Social, behavioral and emotional development**
  - **Social and emotional function of the biological/foster family**
- **Injury in young childhood**
  - **More likely to have cognitive and social difficulties long term**

Pediatric TBI – Common Pattern of Recovery

- Physical and sensory deficits
- Memory and attention capacity
- Information processing, subtleties of language
- Coping with stress
- IQ changes
- Solving new and unique problems

Pediatric TBI – Common Pattern of Recovery

- Cognitive, personal-emotional, and social abilities emerge developmentally
- Abilities developed at one stage of life form the foundation for more complex abilities
- Capacities in process of development, and those not yet developed, are most vulnerable to brain injury
- The earlier the injury, the more pervasive the impact on thinking, emotion regulation and behavior

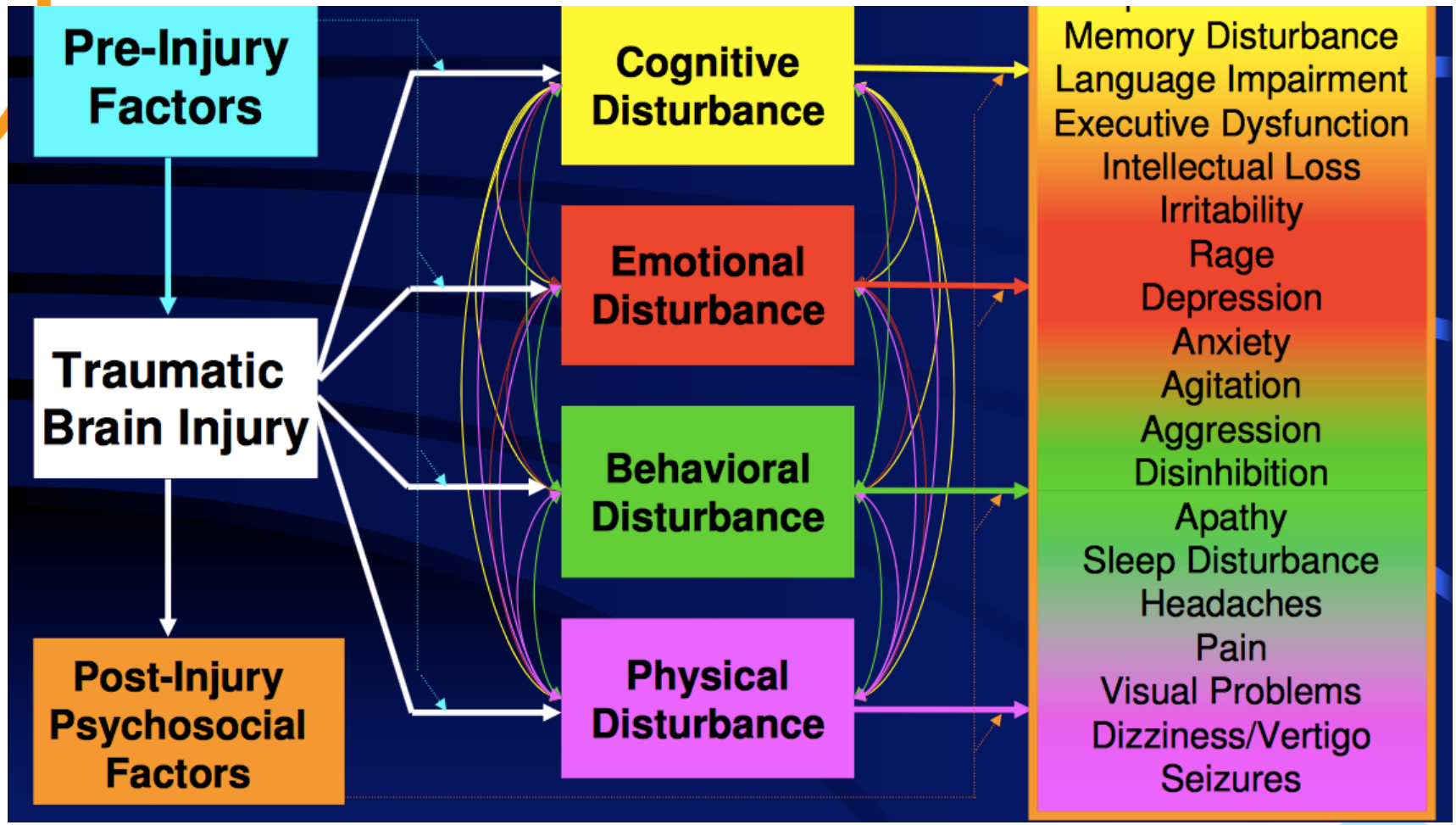
Typical Development

- Development of language
  - 0-3: receptive language
  - 3-6 expressive language
  - 6-12 reading decoding
  - 12-16 reading comprehension
  - 16-19 written language

Typical Development

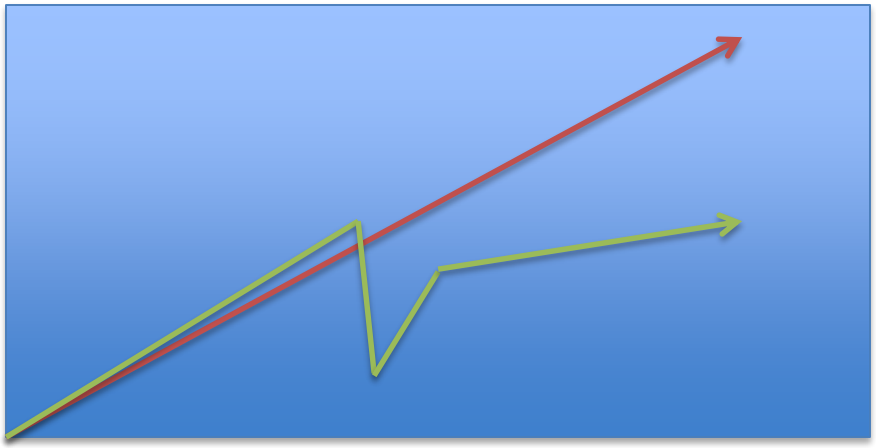
- **Executive control processes**
  - **0-3: self regulation, impulse control**
  - **3-6 emotional regulation, mental flexibility**
  - **6-12 initiation, working memory**
  - **12-16 planning, organization, monitoring**
  - **16-19 problem solving, judgment**

Pediatric TBI – Common Pattern of Recovery



Pediatric TBI – Common Pattern of Recovery

- **Development with TBI**
  - **Prior to injury, often on par with same age peers**
  - **Initial often significant decline with injury**
  - **Early often significant recovery**
  - **Post-acute recovery is often progressive, but not at the same rate as peers**



Rehabilitation – Outcomes

- Varying levels of motoric and cognitive deficits
- Independent in ambulation and self-care: 73%
- 90% Persistent neuropsychological abnormalities and behavioral problems

Cognitive Rehabilitation

Cognitive Rehabilitation

What is Cognitive Rehabilitation Therapy?

- Cognitive Rehabilitation Therapy (CRT) is the process of relearning cognitive skills that have been lost or altered as a result of damage to brain cells/chemistry.
- If skills cannot be relearned, then new ones have to be taught to enable the person to compensate for their lost cognitive functions.

Cognitive Rehabilitation

What is Cognitive Rehabilitation Therapy?

- The Brain Injury Interdisciplinary Special Interest Group (BI-ISIG) of the American Congress of Rehabilitation Medicine defines cognitive rehabilitation therapy to be:
- A systematic, functionally-oriented service of therapeutic cognitive activities, based on an assessment and understanding of the person's brain-behavior deficits.
- Services are directed to achieve functional changes by (1) reinforcing, strengthening, or reestablishing previously learned patterns of behavior, or (2) establishing new patterns of cognitive activity or compensatory mechanisms for impaired neurological systems (Harley, et al., 1992, p.63).

Cognitive Rehabilitation

The process of CRT comprises 4 components

- **Awareness**: Education about cognitive weaknesses and strengths. The focus here is on developing awareness of the problem.

- **Process Training**. This refers to the development of skills through direct retraining or practicing the underlying cognitive skills. The focus here is on resolving the problem.

- **Strategy Training**. This involves the use of environmental, internal and external strategies. The focus here is on compensating rather than resolving the problem.

- **Functional Activities Training**. This involves the application of the other three components in everyday life. The focus here is on real life improvements.

Cognitive Rehabilitation - Pediatric

Individualized for each child

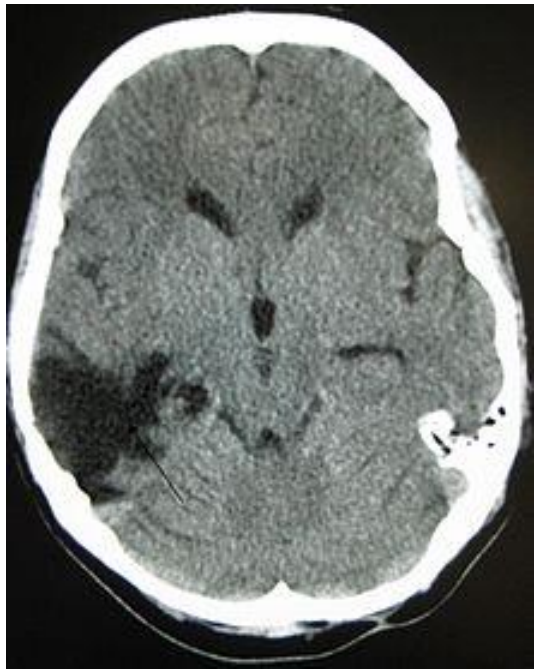
- What cognitive, social, emotional and behavioral skills did this child have pre-injury/are age appropriate
- By age
  - Before Elementary
  - Early Elementary
  - Late Elementary
  - Middle School
  - High School
  - Post-secondary school age
- By time of day
  - Before School
  - During school
  - After school
  - Evenings/weekends

Neurotransmitters

TBI - Neurotransmitters

- Background for treatment of PSH, agitation, stimulation

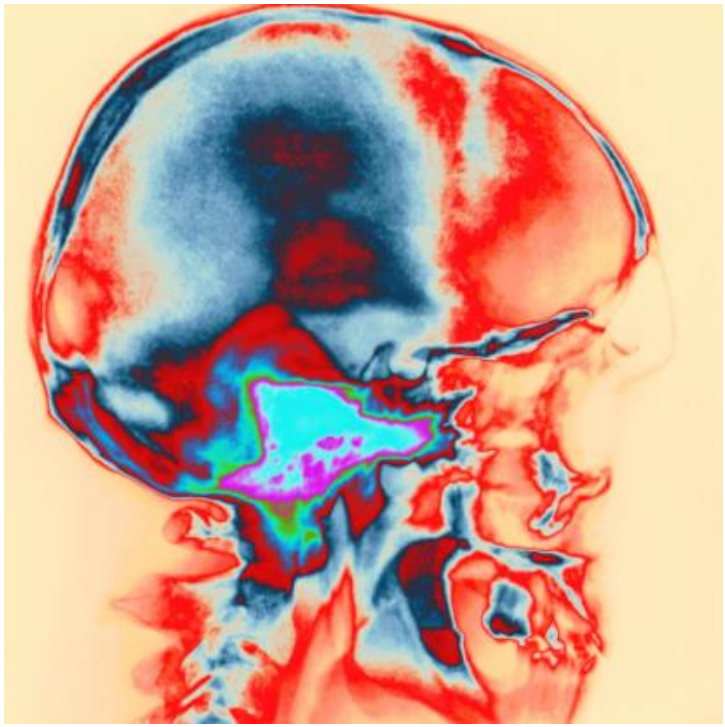
- Glutamate
  - excitatory neurotransmitter
- Serotonin
  - mood, appetite, sleep, pain modulation, motor control, movements
- Catecholamines:
  - Dopamine: Motor initiation, working memory, emotion, arousal, cognition appetite, aggression
  - Norepinephrine: mood, attention, energy, movement, blood pressure
- Cholinergic – Acetylcholine:
  - arousal, motor coordination, attention, memory, learning
- GABA:
  - Inhibitory Neurotransmitter. (A and B)



Neurostimulation

Rehabilitation - Neurostimulation

- **Dopamine agonists**
  - **commonly used to improve arousal**
- **Include:**
  - **carbidopa-levodopa**
  - **amantadine**
  - **bromocriptine**
  - **pramipexole**
  - **methylphenidate**
  - **Amphetamine**



Rehabilitation - Neurostimulation

- **Amantadine**
  - acts pre-synaptically
  - enhances dopamine release and decrease dopamine reuptake.
  - improve arousal
  - improve speed of information processing
  - reduce perseverative mistakes
  - may improve motivation

Rehabilitation - Neurostimulation

- **Bromocriptine:**
  - **Few small studies show improvement in progression from vegetative to minimally conscious**
  - **In stroke related aphasia some evidence that it aids with recovery**
  - **Also some role in improved speech function**

Rehabilitation - Neurostimulation

- **Provigil:**
  - **reductions in gamma-aminobutyric acid (GABA) release in the cerebral cortex, medial preoptic area, and posterior hypothalamus**
  - **Arousal and attention**

Rehabilitation - Neurostimulation

- **Methylphenidate**
  - **increases release and blocks reuptake of dopamine and norepinephrine.**
  - **prefrontal cortical modulation of attention and working memory**
  - **improvements in processing speed**
  - **Mixed reports on attention**
  - **Not significantly supportive of memory improvements**

Rehabilitation - Neurostimulation

- **Cholinesterase Inhibitors**
  - **Donezepil, Rivastigmine**
  - **Effects attention and memory**

Individual Interventions

Attention Training

Class II evidence for Attention focused rehabilitation

- involves training on tasks targeting selective, sustained, and divided attention
- shown to be effective with adults and children with TBI

Evidence regarding rehabilitation of complex attention (eg, working memory) is inconclusive

Memory Training

- Class III evidence for memory training
- Individuals with severe brain injuries showed less improvement than individuals with mild or moderate injuries
- Class I evidence found memory training could increase the use of compensatory strategies that may support improvement in day-to-day functioning

Executive Function

Level I evidence for The Metacognitive Strategy Instruction (MSI)

- Focus on problem-solving, organization and metacognitive strategies
- Strategy is breaking complex tasks into steps, identifying potential solutions, while learning individual performance

Computer Based Training

Delivery of rehabilitation services via computer-based modalities

- No conclusive evidence supporting it use
- Needs further research

Cognitive Prosthetics – PDA's

Support memory and participation in ADL's, work, school participation in instrumental activities of daily living and work-related activities.

- Limited evidence, but increasing use and interest

Virtual Reality

Three-dimensional immersive viewing/listening device

- Early in development for training for ADL's, other life skills.
- Significant promise

Hyperbaric Oxygen Therapy (HBOT)

Administering 100% oxygen at higher-than-normal pressure encourages absorption

Class II evidence in a broad group of patients with brain injury:

- oral and motor speed
- Attention
- verbal fluency
- recall of prose passages

Small study in Severe TBI without significant effect

Cost Estimated cost is $100 to $250 (US) per session.

Quantitative EEG

Use of EEG to direct biofeedback to increase or decrease responses of specified brain areas.

No significant studies

Cost Published prices range from $350 to $1500 (US) per session.

Pediatric Cognitive Rehabilitation

Cognitive Rehabilitation - Pediatric

Laatsch, et. Al, 2007

An Evidence-based Review of Cognitive and Behavioral Rehabilitation Treatment Studies in Children With Acquired Brain Injury

Domain	Practice guideline	Reference
Attention and memory	Service providers of children and adolescents with acquired brain injury (ABI) should consider providing attention remediation to assist recovery	Bulter and Copeland[18] van't Hooft et al[19]
Comprehensive	Providers of comprehensive rehabilitation serving children and adolescents with ABI should consider the involving family members as active treatment providers in the rehabilitation treatment plan.	Braga et al[13]
	Practice option	
Comprehensive treatment	Parents or guardians of children who are seen in an emergency department would most likely benefit from an information booklet concerning the effects and symptoms of traumatic brain injury	Ponsford et al[14] Ponsford et al[20]

Chevignard, et. al

- Model for Pediatric Cognitive Rehabilitation
- Comprehensive inpatient and outpatient program for the care of children with ABI. St Maurice Hospital, near Paris
- Emphasis:
  - Inpatient and community based care
  - Multidisciplinary
  - Care from the acute phase through adulthood
  - Child and family centered care
  - Emphasis on re-integration into school and community

Chevignard, et. al - Inpatient

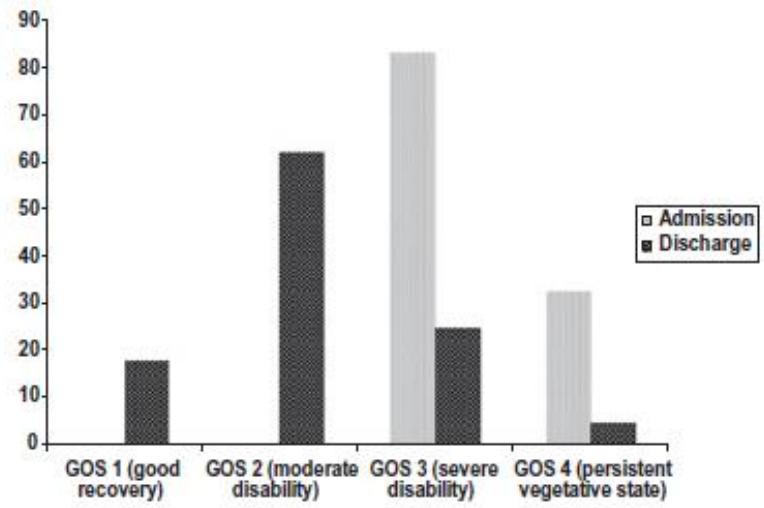
- Inpatient team included:
  - Physiatry, PT, OT, SLP, School, Psychiatry, Psychology, Social Work
- Age 7.3 years
- 50% TBI
- Length of Stay 95 days
- 8.5 therapy sessions per week
- Importance of integrating school, psychology and patient family education
- Well established rehabilitation and school program at discharge
- 80% discharging home with regular or specialized education

Chevignard, et. al – Assessment, Academic and Vocational Guidance Unit, Outpatient Unit

- Child and adolescent programs focusing on school and vocation
- Services included:
  - Physiatry, Psychiatry, neuropsychology, psychosocial and family interviews, community/school meeting, home visits
- Age 11.1 (children), 18.6 (adolescent)
- Follow up to age 25
- 90% TBI
- Goal to provide education and outreach support

Chevignard, et. al - Outcomes

- Glasgow Outcome Scale, improved dramatically:
  - admission (3.3; SD = 0.45)
  - discharge (2.15; SD = 0.74).
- Most of the children were discharged home with an adequate personalized plan for ongoing rehabilitation and school adaptations.
- The outreach program addressed challenging issues arising in late adolescence-early adulthood.



Transitions of Care

Rehabilitation – Transition of Care

- Transitions of Care are a significant challenge
- On the Adult side
  - Lack of resources, especially multi-disciplinary resources
  - Relative lack of expertise in the adult manifestations of childhood injuries
  - Lack of adult providers accepting Medicaid

Rehabilitation – Transition of Care

- Transitions of Care are a significant challenge
- On the Pediatric side
  - Relative limitation of resources
  - Desire to focus resources on pediatric brain injury
  - Lack of medical expertise in adult medicine

Rehabilitation – Transition of Care

- **Development of transition care clinics**
  - **dual trained general physicians (internal medicine and pediatrics)**
  - **Subspecialty care providers may be a mix of adult and pediatric providers**
  - **Resources and support for multi-disciplinary clinics**


QUESTIONS?