WHAT EVERY PT SHOULD KNOW ABOUT MANAGING COGNITIVE & NEUROBEHAVIORAL DEFICITS IN ACQUIRED AND TRAUMATIC BRAIN INJURY

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COURSE OVERVIEW

1. Understand the anatomy of the brain and articulate the functional significance of its inter-connectivity within the cortical and subcortical structures.

2. Select and interpret standardized cognitive and functional tests and measures used in both inpatient and outpatient rehabilitation settings for patients with brain injury.

3. Describe the factors that contribute to prognosis and outcomes following moderate to severe brain injury based on the most recent evidence.

4. Integrate cognitive strategies and/or challenges during mobility interventions to promote return to highest level of function.

5. Discuss how to incorporate principles of the brain-behavior relationship in the examination and intervention of individuals with cognitive deficits such as impaired awareness, attention, memory and executive function.
OVERVIEW OF BRAIN INJURY

**Objectives:** By the end of this unit, you will be able to:
- Describe the incidence, prevalence and epidemiology of brain injury
- Identify basic brain structures and functions
- Describe the brain-behavior relationship
CLINICAL PICTURE BY HEMISPHERE

- **Right Side Brain Injury:**
  - Loss of the Big picture
  - Visual-spatial deficits
  - Left neglect
  - Impaired visual memory
  - Impulsivity

- **Left Side Brain Injury**
  - Difficulty with details
  - Difficulty with speech/language
  - Impaired verbal memory
  - Impaired sequencing & logic & processing
  - Impaired initiation
CLINICAL PICTURE BY LOBE

**Frontal Lobe**
- Initiation
- Problem-solving
- Judgment
- Inhibition of behavior
- Planning/Anticipation
- Self-monitoring
- Motor planning
- Personality/Emotions
- Awareness of abilities/Limits
- Organization
- Attention/Concentration
- Mental flexibility
- Speaking

**Temporal Lobe**
- Memory
- Hearing
- Understanding language
- Organization & sequencing

**Cerebellum**
- Balance
- Coordination
- Skilled motor activity

**Brain Stem**
- Breathing
- Heart rate
- Arousal/Consciousness
- Sleep/Wake functions
- Attention/Concentration

**Parietal Lobe**
- Sense of touch
- Differentiation of size, color, shape
- Spatial perception
- Visual perception

**Occipital Lobe**
- Vision
SUBCORTICAL STRUCTURES

- Brain stem
- Thalamus & Hypothalamus
- Limbic System
- Amygdala & Hippocampus
- Basal ganglia
WHY IS THE PREFRONTAL CORTEX SO IMPORTANT?
DEFINITIONS OF BRAIN INJURY

- **Acquired Brain Injury:**
  - Occurs after birth but is not hereditary, congenital or degenerative in nature.
  - Commonly results in a change in neuronal activity, which affects the physical integrity, the metabolic activity, or the functional ability of the cell.

- **Traumatic Brain Injury:**
  - Not of a degenerative or congenital nature
  - Caused by an external physical force,
  - Results in an impairment of cognitive ability and/or physical functioning.
  - May be either temporary or permanent.

Source: www.biaa.org
WHAT ARE SOME CAUSES OF BRAIN INJURY?

Traumatic Brain Injury

Acquired Brain Injury
MECHANISMS OF INJURY

- Closed head Injury
  - Direct
    - Acceleration (moving object hits head)
    - Deceleration (moving head strikes object)
    - Rotation
  - Indirect
    - Extreme flexion/extension of the neck
    - Fall on buttocks
- Penetrating Head Injury
  - Bullet or sharp weapon
Incidence Rate: (onset)

- BI is the leading cause of mortality among Americans under 45 and over 75 years of age – TBI is responsible for the majority of these deaths
- 63,936 outpatient/ER visits/year due to TBI reported in Indiana 2003-2005
- In the 23 seconds it takes to read these statistics, one person in the US sustains a TBI

Faul et al. TBI in the US CDC 2014
Comparison of Annual Incidence in the U.S.

- **TBI**: 1.5 million
- **Breast Cancer**: 176,300
- **HIV/AIDS**: (smaller slice)
- **SCI**: (even smaller slice)
- **MS**: (smallest slice)

Source: Brain Injury Association of America
EPIDEMIOLOGY

~ 73% to 27%

Males 14-24

Infants 0-4

> 65
EPIDEMIOLOGY

1.6-3.8 million sport-related TBI's in US/Yr

Firearms are leading cause of death related to TBI: 9/10 die.

Leading cause for all groups
Highest for age 0-4 yrs & > 75 yrs

Greatest # hospitalizations
Greatest age 15-19 yrs

http://www.cdc.gov/ncipc/tbi/Causes.htm
PRIMARY DAMAGE

Skull Fracture

Contusion

Diffuse Axonal Injury

Laceration
PRIMARY DAMAGE

- **Diffuse Axonal Injury (DAI)**
  - Shearing stress at time of impact causes severance of delicate axons within the brain
  - Normal transmission of nerve cells is disrupted. “Disconnection syndrome”
  - Affects a larger area of the brain
  - Centripetal theory
  - **DAI is the single most important indicator of outcome for TBI**
DAI CLINICAL PRESENTATION

Confusion

Fatigue

Increased

Thinking speed
Attention
Concentration
Cognition

Decreased
SECONDARY DAMAGE

- Hemorrhage
  - Subarachnoid
  - Intracerebral
  - Punctate

SAH

ICH

Punctate
SECONDARY DAMAGE

- Hematoma
- Subdural
- Epidural
- Vasospasm
- Edema
- Hypoxic/Ischemic Damage
- Hydrocephalus
### PRIMARY & SECONDARY DAMAGE OF TBI

<table>
<thead>
<tr>
<th>Focal Effects</th>
<th>Diffuse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral Contusion</td>
<td>Diffuse Axonal Injury</td>
</tr>
<tr>
<td>(primary)</td>
<td>(primary)</td>
</tr>
<tr>
<td>Intracranial Hematoma</td>
<td>Hypoxic Injury</td>
</tr>
<tr>
<td>(secondary)</td>
<td>(secondary)</td>
</tr>
<tr>
<td>Intracerebral Hemorrhage</td>
<td>Edema</td>
</tr>
<tr>
<td>(secondary)</td>
<td>(secondary)</td>
</tr>
</tbody>
</table>
NON-TRAUMATIC BRAIN INJURY EXAMPLES

- Stroke
- Infectious disease (encephalitis, meningitis)
- Tumors (surgery, radiation, chemo)
- Toxic exposure (substance misuse)
- Metabolic disorders (insulin shock, diabetic coma)
- Lack of oxygen to the brain (near drowning, airway obstruction, cardiopulmonary arrest, carbon monoxide poisoning,)
## Acquired Brain Injury

<table>
<thead>
<tr>
<th>Focal Effects</th>
<th>Diffuse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>Infectious disease</td>
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<tr>
<td>Tumor</td>
<td>Toxic exposure</td>
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<tr>
<td></td>
<td>Metabolic disorder</td>
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<tr>
<td></td>
<td>Hypoxia/Ischemia</td>
</tr>
</tbody>
</table>
ABI: CAUSES OF STROKE

“Stroke in evolution”

Sudden onset
HYPOXIC-ISCHEMIC BRAIN INJURY

- **Definition:**
  - Hypoxic: decreased delivery of oxygen to the brain (near drowning, near hanging, sedative intoxication); produce transient, less severe or permanent brain damage than those produced by combination of hypoxia and ischemia.
  - Ischemic examples- diminished blood supply via compression of arterial flow (near hanging/strangulation) or during hypotensive events or hemorrhagic shock.
  - Hypoxic-Ischemic examples- cardiac arrest; the brain loses oxygen, glucose and other nutrients required for brain metabolism.
  - The effects are “global” versus local as in non-hemorrhagic strokes.
# Consequences of Hypoxic-Ischemic Brain Injury

<table>
<thead>
<tr>
<th>Seizure</th>
<th>Movement Disorder</th>
<th>Sensorimotor Disorder</th>
<th>Cognitive Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Partial - complex</td>
<td>• Parkinsonism</td>
<td>• Quadriplegia</td>
<td>• DOC</td>
</tr>
<tr>
<td>• Myoclonic</td>
<td>• Dystonia</td>
<td>• Paraplegia</td>
<td>• Attention</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Spasticity</td>
<td>• Memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ocular apraxia</td>
<td>• EF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ataxia</td>
<td>• Language</td>
</tr>
</tbody>
</table>

- DOC: Dura Coma
SUMMARY: BRAIN COMPLEXITY

- Most brain areas perform multiple tasks
  - Some areas “take the lead” in certain function
- Most injuries involve more than one brain area.
- Brain functions as a unified whole
  - Injury to one part can reduce how the whole system works
  - The interconnectivity can cause a wide variety of difficulties
- Injury in one area doesn’t necessarily lead to one specific problem
- The same injury in two different people can cause very different deficits
Objectives: By the end of this unit, you will be able to:

- Describe factors that impact short term and long term outcomes after brain injury
- Analyze and select appropriate outcome measures for individuals with brain injury
PROGNOSTICATION: SHORT TERM SURVIVAL

- Severity
- Location
- Type (DAI, SDH...)
- Control of secondary complications

ICF Disability and Health: ICF. Geneva, Switzerland: WHO; 2001
## BRAIN INJURY SEVERITY DEFINITIONS

<table>
<thead>
<tr>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC &lt; 30 min</td>
<td>LOC 30 min-24hrs</td>
<td>LOC &gt; 24 hrs</td>
</tr>
<tr>
<td>GCS 13-15</td>
<td>GCS 9-12</td>
<td>GCS 3-8</td>
</tr>
<tr>
<td>PTA &lt; 24 hrs</td>
<td>PTA 1-7 days</td>
<td>PTA &gt; 7 days</td>
</tr>
</tbody>
</table>

- Skull Fracture
- Bleeding/Bruising

- Temporary or permanent altered mental state
- Some LT deficits in > 1 area of life
- Multiple LT deficits in > 1 area of life
EFFECTS OF THE INJURY SEVERITY ON OUTCOMES

- Post Traumatic Amnesia (PTA) is a strong predictor of functional outcome. If < 4 weeks, the likelihood of Severe Disability on the GOS was less than 15%. PTA extending to >/=8 weeks resulted in the probability of “Good” recovery on the GOS less than 10%. (Ponsford 2001)

- Duration of coma > 2 weeks were left with moderate to severe disability at 1yr post-injury. If coma <1 week individuals were left with moderate disability to good recovery. If PTA > 12 weeks, resulted in moderate to severe disability versus coma <4 wks resulted in moderate disability to good recovery. (Katz et al 1992)
PROGNOSTICATION: LONG TERM RECOVERY DETERMINANTS

- Who’s brain was this in?
- Age
- Substance abuse
- Previous injury
- Level of education
- Relationships

- Family support
- Rehabilitation
- Socioeconomic status

**The contextual ICF Factors**

Source: Ponsford et al 2011
Pre-injury patterns of **family function** are associated with the ways in which the family adapts after the injury. (Ponsford 2011)

Higher **premorbid IQ** associated w/ better processing speed, memory & EF at 2 & 12 months post, postulating greater “cognitive reserve”

**Pre-injury education/employment** influence short and long term outcomes on work, cognition, social function, community integration. (Ponsford 2011)

**Socioeconomic variables** had stronger impact on outcome 10yrs post than severity, age and pre-injury education. (Hoofien et al 2002)

Pre-injury **psychiatric disorder** is major risk factor for post injury psych disorder

“Emotion-focused” **coping style** (versus problem based) is associated with poorer outcome
MEASURING FUNCTIONAL OUTCOMES

- Return to productive activity
- Place of residence (residential)
- Level of independence (ADL, IADL)
- Community integration - What does this really mean?
- Participation
EFFECTS OF AGE ON OUTCOMES

- Older age had generally poorer outcomes compared to younger individuals (Marquez de la Plata et al 2009)
- Those > 60 years required greater number of resources to obtain favorable outcome compared to individuals < 40 years old with similar severities of injury. (Pennings et al 1993)
- Older age group requires longer LOS to address slower rates of functional gain (Chan et al 2013a)
- Both admit and d/c FIM scores from IRF are poorer among older adults (Chan et al 2013b)
- Older age at time of injury associated with poorer performance on cognitive domains (Senathi-Raja et al 2010)

Source: http://www.abiebr.com Module 2
So, now that we have an idea of “what” to measure and what outcomes to look for, what next?
CHOOSING TESTS & MEASURES

Patient Related Factors

Test Related Factors

Resource Related Factors
SOURCES OF OUTCOME MEASURES

- TBI EDGE Recommendations at: www.neuropt.org
- Model Systems Knowledge Translation Center (TBI) at: www.msktc.org
- Center for Outcome Measures in Brain Injury at: http://tbims.org/combi/
- Rehab Institute of Chicago database at: www.rehabmeasures.org
- Stroke Engine at: www.strokeengine.ca
4 point recommendation system based on **psychometrics & clinical utility**
- 4 = Excellent psychometrics in target population and clinical utility (<20min)
- 3 = Good psychometrics in target population and clinical utility (> 20 min)
- 2 = Good or excellent psychometrics in at least one population;
- 1 = Poor psychometrics and clinical utility

Recommended **practice settings** indicated (4 point system)
- Highly recommended versus do not recommend in this setting

**ICF category** of measure indicated
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>I  Complete Independence</td>
<td>Independent ambulation on level and unlevel surfaces without an assistive device</td>
</tr>
<tr>
<td>II  Mild dependence</td>
<td>Modified independent, on level surfaces only and requires supervision for unlevel surfaces</td>
</tr>
<tr>
<td>III Moderate dependence</td>
<td>Requires intermittent or continuous manual assistance of one person on level and unlevel surfaces</td>
</tr>
<tr>
<td>IV  Severe dependence</td>
<td>Unable to ambulate or requires more than one person to assist with ambulation</td>
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</tbody>
</table>
ICF MODEL OF ENABLEMENT/DISABLEMENT

Health Condition (disorder or disease)

Body Structure & Functions (Impairments)

Activity (Functional Limitations)

Participation (Disability)

Personal Factors

Environmental Factors

Source: www.who.int/classifications/icf/site/beginners/bg.pdf
RECOMMENDED MEASURES
ACUTE CARE

- Agitated Behavior Scale
- Coma Recovery Scale-Revised
- Moss Attention Rating Scale
- Rancho Levels of Cognitive Functioning
- For moderate to severely dependent ambulation- FIM-FAM
- For mildly dependent ambulation- gait speed, BESS, HiMAT, CBM scale
<table>
<thead>
<tr>
<th>Body Structure/Function Measures</th>
<th>Inpatient Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait speed</td>
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<tr>
<td>Coma Recovery Scale-Revised</td>
<td></td>
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<tr>
<td>Moss Attention Rating Scale</td>
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<tr>
<td>Modified Ashworth Scale</td>
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<tr>
<td>Rancho Levels of Cognitive Function</td>
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<tr>
<td>Agitated Behavioral Scale</td>
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<tr>
<td>Cognitive Log; Orientation Log</td>
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<tr>
<td>Barthel Index</td>
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<tr>
<td>Disorders of Consciousness</td>
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ACTIVITY/PARTICIPATION MEASURES INPATIENT REHABILITATION

- Berg Balance Scale
- Community Balance & Mobility Scale
- FIM-FAM
- Disability Rating Scale
- QOL-BI
BODY STRUCTURE/FUNCTION MEASURES
OUTPATIENT REHAB

- Apathy Evaluation Scale
- Global Fatigue Index
- Gait Speed
- Modified Ashworth Scale
- Dizziness Handicap Inventory
ACTIVITY/PARTICIPATION MEASURES
OUTPATIENT REHAB

- Berg Balance Scale
- FAM
- High Level Mobility Assessment
- Balance Error Scoring Scale
- Action Research Arm Test
- Community Integration Questionnaire
- Sydney Psychosocial Reintegration Scale
- QOL-BI
- Patient Health Questionnaire
- Disability Rating Scale
SUMMARY

- What injury specific factors might impact outcomes: severity, type, location
- What pre-existing factors- who’s brain (education, previous injury/health), substance abuse, relationships, support
- Access to rehabilitation and resources after injury
- What outcomes are we interested in measuring?
  - Short-term versus long-term
  - ICF category
- How will we measure?
Objectives: By the end of this unit, students will be able to:

- Distinguish between Rancho Los Amigos Levels of Cognitive Functioning
- Identify goals and early interventions according to patient’s level of functioning
- Select & interpret appropriate outcome measures according to stage of recovery
- Identify potential secondary complications commonly encountered in individuals with brain injury
- Design an evidence-based treatment plan for individuals with brain injury in the inpatient rehabilitation setting
RANCHO LOS AMIGOS LEVELS OF COGNITIVE FUNCTIONING

- Describes typical patterns of recovery
- Provides the team with a common language.
- Individuals progress through these stages are their own rate depending on the severity, location and time since injury.
- Individuals may fluctuate between levels or progress through levels quickly.
- Components of cognition include: attention, awareness, memory, problem solving, organizing, planning, judgement and reasoning
RECOVERY OF MEMORY

Continuous memory (pre-injury storage)

Injury

Coma-MCS
RLA: I-3

Post-traumatic Confusion (PTC)
RLA 4-6

Restoration of Memory
RLA 7-10

Retro-grade amnesia

Adapted from Hufford B. BI Module  RHI
RLA LEVELS  I-III

- I. No response- deep sleep, coma
- II. Generalized response- reacts inconsistently and non-purposefully to stimuli in nonspecific manner.
- III. Localized response- reacts specifically but inconsistently to stimuli. Responses are related to the type of stimulus presented. May follow simple, inconsistent commands, delayed manner, such as eye closing, squeeze hand.
DISORDERS OF CONSCIOUSNESS

GOALS FOR ACUTE MANAGEMENT RLA 1-3 (MCS)

- Optimize medical status
- Facilitate recovery of consciousness and function
- Decrease or prevent secondary complications
- Educate family/caregivers to provide/direct care
- Facilitate an appropriate discharge plan

Source: TIRR MCS Program
OUTCOME MEASURES: MCS

- Coma Recovery Scale-Revised
  - 23 items;
  - 6 sub-scales- auditory, visual, motor, oromotor, communication, arousal
  - Purpose; assist with differential diagnosis, prognosis and treatment planning
  - **Distinguish between VS, MCS and Emergence**
  - Higher score indicates emergence from coma

http://www.rehabmeasures.org/Lists/RehabMeasures/PrintView.aspx?ID=998
RANCHO LEVEL 4 DEFINED

- Confused & Agitated
  - May physically or verbally overreact to what they see, hear or feel
  - May be highly focused on basic needs i.e. eating, relieving pain, rest, going home or going to the bathroom
  - Difficulty following directions,
  - Unable to pay attention or concentrate
  - May be frightened and not understand what they feel or what is happening around them
  - Requires help for simple routine activities
THERAPY GOALS FOR RANCHO LEVEL 4

- Decrease intensity, frequency and duration of agitation
- Decrease confusion
- Increase attention to environmental stimuli
- Improve interaction with the environment to a more appropriate level
- Improve physical ability and provide an outlet for excess energy
RANCHO LEVEL 5 DEFINED

- Confused, Inappropriate Non-Agitated
  - Alert, not agitated but may wander randomly or with vague intention of going home
  - May be come agitated in response to external stimulation and/or lack of environmental structure
  - Not oriented to person, place or time
  - Frequent brief periods of non-purposeful sustained attention
  - Severely impaired memory with confusion present; unable to learn new information
  - Absent goal directed, problem solving and self-monitoring behavior
  - Able to respond to simple commands with structure and cues
RANCHO LEVEL 6 DEFINED

- Confused & Appropriate
  - Will recall main points but forget or confuse the details
  - Will follow a schedule with some assistance but confused with changes in routine
  - Able to pay attention for ~ 30 minutes
  - Difficulty concentrating when it’s noisy or in complex environments
  - Will do/say things too fast or without thinking first
  - More aware of physical problems but not thinking problems
  - Tend to associate their problems with being in the hospital but will be fine once home
1. Minimize agitation caused by the external environment
2. Minimize confusion stemming from the environment
3. Improve memory and recall
4. Increase attention to specific tasks
5. Improve orientation & participation in functional activities
6. Improve/maximize functional mobility
EDGE RECOMMENDATIONS FOR INPATIENT REHAB

**Body Structure/Function**
- Gait speed
- Coma Recovery Scale-Revised
- Moss Attention Rating Scale
- Modified Ashworth Scale
- Rancho Levels of Cognitive Function
- Agitated Behavioral Scale
- Cognitive Log
- Orientation Log
- Barthel Index
- Disorders of Consciousness

**Activity-based/Participation**
- Berg Balance Scale
- Community Balance & Mobility Scale
- FIM-FAM
- Disability Rating Scale
- QOL-BI
OUTCOME MEASURES: INPATIENT REHABILITATION

- If unit accepts RLA-3/4:
  - Agitated Behavior Scale
  - Coma Recovery Scale-Revised
  - O-Log and C-Log
  - Disorders of Consciousness
- Generally at lower functional level with significant cognitive impairment

- RLA 5-6
  - FIM-FAM
  - Gait speed
  - Berg, CBM, DGI, FGA
  - DRS
  - QOL-BI
- Selection of these tests depend on ambulatory and cognitive function.
- Great variety in inpatient rehab setting
EVIDENCE BASED INTERVENTION STRATEGIES

1. Structure the environment to optimize success and promote participation
2. Utilize compensatory strategies for memory
3. Implement consistency: with treating team, schedule, setting, commands and expectations
4. Emphasis on mobilizing patient
5. Neurobehavioral management
6. Initiate functional/meaningful therapeutic exercise
GUIDELINES FOR INTERVENTIONS

- Treat what you see with the following understanding:
- Patients in RLA 4-6 are still in post-traumatic confusion
- Meaningful cognitive evaluation doesn’t begin until after this stage
- We must provide an environment to maximize their interactions, participation and physical engagement
- We must not be a barrier to their improvement
WAIT? AREN’T THESE PHYSICAL INTERVENTIONS?
SECONDARY IMPAIRMENTS & COMPLICATIONS

- What effect does cognition have on these issues?
  - Joint contracture
  - Heterotopic Ossification
  - Skin breakdown
  - Infection
  - DVT
  - VP- shunt failure
  - Seizures
Our patients can’t follow directions, have poor attention and memory, are unaware, can be impulsive, agitated and have great difficulty learning.

But……….. We have PT goals to meet. We have to show we worked on something “billable” like walking and transferring right?
Objectives: By the end of this unit, you will be able to:

- Describe how an injury to the brain can result in various behaviors and challenges
- Identify appropriate outcome measures for assessment of cognitive recovery
- Identify components of cognition and their impact on physical recovery
- Describe neuro-behavioral changes and implement the A-B-C strategy
- Develop functional goals for discharge from inpatient rehabilitation
- Design and evidence based treatment plan for individuals with brain injury
GENERAL DEFINITIONS

- **Cognitive Impairments**: decreased ability to process internal and external information
  - Important to incorporate cognitive, behavioral and physical aspects into each treatment session for patients with TBI
  - Retraining cognitive skills should be introduced in the early stages of recovery
  - PTs should:
    - Be familiar with cognitive examinations
    - Work on interdisciplinary teams
    - Incorporate cognitive strategies into each PT treatment session
COMPONENTS OF COGNITION

**Input**
- Sensory Information

**Attention**
- Focused
- Sustained
- Selective
- Alternating
- Divided

**Memory**
- Auditory
- Visual-spatial
- LTM
- STM
- Working

**Executive Function**
- Problem solving
- Planning
- Organizing

**Processing Speed**

**AWARENESS**
DECREASED ALERTNESS & AROUSAL

- Associated with Rancho Levels I, II, III (not the same as low initiation)
  - **Persistent vegetative state:** no meaningful motor or cognitive function and a complete absence of awareness of self or the environment (dx 3-months-1-year post TBI)
  - **Minimally conscious state:** severely altered consciousness with minimal, but definite evidence of self or environmental awareness
IMPAIRED ALERTNESS & DECREASED AROUSAL
**INTERVENTIONS: DECREASED ALERTNESS & AROUSAL**

- Treat during times of increased alertness, several times per day, balanced with rest periods.
- Repeat stimuli and commands frequently, but do not over-stimulate.
- Give the patient time to respond.
- Use one-to-two sensory channels at a time.
- Find which sensory channel is most effective and use it to stimulate the patient.
- Use meaningful/non-detailed explanations and commands.
- Use the family as a resource for pre-injury interests to use as stimulators for the patient.
Attention underlies and supports all other cognitive abilities
BASIC TYPES OF ATTENTION

Focused Attention
- Look

Sustained Attention
- Ability to maintain attention over a period of time during continuous, repetitive activity
- Recognize

http://www.dianecarbonell.com/
www.travelzoo.com
www.optimus5.com
INTERMEDIATE TYPES OF ATTENTION

Selective Attention

Alternating Attention

- Shifting one’s focus between tasks that demand different behavioral/cognitive skills
DIVIDED ATTENTION

Ability to respond to 2 or more events or stimuli simultaneously
DECREASED ATTENTION
INTERVENTION TIPS FOR DECREASED ATTENTION

- Make the intervention meaningful to grab or stimulate attention
- Increase complexity of task, duration of treatment, and/or environmental distracters as attention improves but begin with simple one-step commands
- Be sure to have the patients attention before giving a command, ask the patient to repeat your command
- May need frequent redirection to task & a variety of stimuli to maintain attention
- Give positive reinforcement and praise immediately after a task
- Provide measurable goals/limits for the patient to reach.
- Instruct patient to recognize when safety is compromised by distractions and mental slowness/develop plan to avoid distractions
TYPES OF MEMORY

- Comprised of attention, encoding, storage and retrieval
- Encoding is the ability to assign meaningfulness to sensory information
- Storage is the transfer of information from STM to LTM
- Retrieval is the search for or activation of existing LTM and problems here are often related to faulty organization of information at time of encoding.

Types of LTM include:

- Declarative (explicit) memory - intentional and conscious recall of facts
- Procedural (implicit) memory - Involved in learning a motor skill, does not rely on conscious recall.
Continuous memory (pre-injury storage) → Injury → Coma-MCA (RLA: I-3) → Restoration of memory

Time

Retro-grade amnesia

Post-traumatic Confusion (PTC) RLA 4-6
ACRM Recommendations for intervention:

- **Mild-Moderate TBI**
  - Internal Memory Strategies (“Memory Strategy Training” – recovery/compensation)
    - Associations (visual or auditory), mnemonics, stories

- **Moderate-Severe TBI**
  - External Memory Strategies (Compensatory)
    - Orientation notebook, memory notebook, electronic devices
WHAT ARE INTERNAL MEMORY STRATEGIES?

Visual representation

Word association & story telling

CRANIAL NERVES MNEMONIC

<table>
<thead>
<tr>
<th>S = Sensory</th>
<th>M = Motor</th>
<th>B = Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olfactory</td>
<td>On</td>
<td>S Some</td>
</tr>
<tr>
<td>Optic</td>
<td>Old</td>
<td>S Say</td>
</tr>
<tr>
<td>Oculomotor</td>
<td>Olympus</td>
<td>M Marry</td>
</tr>
<tr>
<td>Trochlear</td>
<td>Towering</td>
<td>M Money</td>
</tr>
<tr>
<td>Trigeminal</td>
<td>Tops</td>
<td>B But</td>
</tr>
<tr>
<td>Abducens</td>
<td>A</td>
<td>M My</td>
</tr>
<tr>
<td>Facial</td>
<td>Finn</td>
<td>B Brother</td>
</tr>
<tr>
<td>Vestibulocochlear</td>
<td>And</td>
<td>S Says</td>
</tr>
<tr>
<td>Glossopharyngeal</td>
<td>German</td>
<td>B Bad</td>
</tr>
<tr>
<td>Vagus</td>
<td>Viewed</td>
<td>B Business</td>
</tr>
<tr>
<td>Spinal accessories</td>
<td>Some</td>
<td>M Marry</td>
</tr>
<tr>
<td>Hypoglossal</td>
<td>Hops</td>
<td>M Money</td>
</tr>
</tbody>
</table>
WHAT ARE EXTERNAL MEMORY STRATEGIES?
Decision tree for treatment planning

Is Patient Aware of Deficits?

Yes

Can Patient Use an External Strategy?

Yes

What is patient’s level of impairment?

Mild/Mod

Use Internalized Strategies, as Able

Severe

Use both, as needed

No

Use Techniques to Increase Awareness

Use Task Specific Approach: Errorless Learning, Spaced Retrieval, Chaining

Use both, as needed

Use External Strategies only: Provide Cueing and Assistance

Continue to Use External Strategy with Assistance, if Needed

No

Source: ACRM Cognitive Rehabilitation
INTERVENTION TIPS FOR IMPAIRED MEMORY

- All staff/family must be trained and consistent with chosen strategy
- Repetition for *procedural learning*
- Strategies work best if patient has some level of self-awareness of memory impairments
- Cueing strategies should be meaningful to patient (their need for device)
- Must have easy access to device/notebook at all times
- Pair new learning with old, familiar/meaningful concepts
- Structured environment
- If necessary, give frequent orientation, spread cues throughout session
WHAT IS EXECUTIVE FUNCTIONING?

- Integrative cognitive processes for goal-directed and purposeful behavior in all daily functions.
- Problems with executive functioning include:
  - Awareness/lack of goal
  - Anticipation of problems/consequences (problem solving)
  - Planning and organizing solutions
  - Initiating/executing solutions
  - Monitoring and adapting behavior
EXECUTIVE FUNCTION: AWARENESS

- Awareness is the highest, most advanced executive function.
- Awareness impacts every level of cognition.
- Awareness helps us monitor how we are doing at all levels.
- It’s not the same as being in “denial”
DECREASED AWARENESS
Choosing/applying appropriate compensation for impaired executive function requires some level of awareness.

How might self-awareness (internal) impact therapy interventions?

How might situational awareness (external) impact therapy interventions?
Therapists can help a patient to recognize deficits by pointing out discrepancies between their perception and reality.

First: attempt to build trust with a therapeutic alliance

Select meaningful tasks/environments

Provide clear feedback

Use habit formation, repetition, procedural learning techniques

Education and support (patient/family/group)

Predict-perform techniques
### THE PROCESS OF FORMAL PROBLEM SOLVING

| Awareness          | • Recognize existence of problem  
|                    | • Set goal  
|                    | • “What is the task they want to accomplish?” |
| Anticipate/Plan    | • Define problem.  
|                    | • Creation of structured plan to lead to desired outcome.  
|                    | • Learn steps of solution |
| Execute/Self Monitor | • Execute task/solution  
|                      | • Self-monitor limitation (cognitive and behavioral)  
|                      | • “Aiming towards goal?” |
| Self-Evaluate      | • Use of feedback (therapist/peer/self) for modification of plan  
|                    | • Self-correct errors  
|                    | • Modify goal |
EXECUTIVE FUNCTIONING IS NECESSARY IN ORDER TO ADAPT TO NOVEL SITUATIONS, REACT TO UNEXPECTED EVENTS, AND/OR CORRECT MISTAKES.

- BI-ISIG of ACRM recommends:
  - Self-monitoring/regulation strategies (metacognitive techniques)
  - Formal problem solving strategies
INTERVENTIONS FOR EXECUTIVE FUNCTIONING

Problem Solving

Goal

Plan

Do

Review

GOAL:
What do I want to accomplish? What is the goal?

PLAN:
How am I going to accomplish the goal? List all the steps.

DO:
Execute the plan.

REVIEW:
How did I do? What worked? What didn’t?

Source: ACRM Cognitive Rehabilitation
WHAT ARE EVIDENCE BASED INTERVENTIONS FOR IMPAIRED EXECUTIVE FUNCTION?

- Predict-Perform: Addresses awareness through error estimation
- Have the patient label steps to a task to make them more meaningful before doing it.
- Awareness/Judgment: Use “why” and “what if” questions during performance of a task.
- What are some examples of using these techniques within a PT session?
BEHAVIORAL AND EMOTIONAL IMPAIRMENTS

Emotional Impairments
- Stem from damage to areas of the brain responsible for inhibiting the limbic system
- Result in loss of emotional self-regulation

Behavioral Impairments
- Irritability/agitation
- Impulsivity
- Disinhibited
- Decreased motivation/apathy
- Decreased initiation
- Hypervерbose
- Cognitive inflexibility
UNDERSTANDING BEHAVIOR

Neurologic Influences

Environmental Influences
UNDERSTANDING BEHAVIOR

Increased likelihood of behavior
- Rewards
- Escape & Avoidance

Decreased likelihood of behavior
- Punishment
- Extinction
WE DON’T HAVE TO FEEL LIKE THIS WHEN FACED WITH PROBLEM BEHAVIOR
MANAGEMENT OF AGITATION: PREVENTION—NECESSARY ELEMENTS

- Realistic Mindset
- Know your Patient
- Creating Positive Associations
- Decrease Stimulation
- Increase Predictability
- Increase Endurance

Adapted from Hufford B. Brain Injury Modules: RHI 2007
1) REALISTIC MINDSET

- Always assume it’s the BI and/or confusion talking.
- Agitation is not a “choice”, it’s a temporary situation that will get better.
- We must modify the patients external environment to manage the behavior.
- We must anticipate and address the patients “internal” environmental distractors.
2) KNOW YOUR PATIENT: MONITOR WARNING SIGNS

- Increased talking, motor restlessness, darting eye movement, confabulations, etc., that signal a blowup is coming
- Will be different for every person
WHAT IS THE BEHAVIOR Communicating?

Antecedents

Behavior

Consequences
**BEHAVIORAL CHARTING**

<table>
<thead>
<tr>
<th>Setting (date, time, who else was around, activity patient in the middle of, etc.)</th>
<th>Antecedent</th>
<th>Behavior (what did the patient actually do?)</th>
<th>Consequence</th>
<th>What happened after behavior occurred?</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
3) POSITIVE ASSOCIATIONS

- A confused patient can’t remember your name but can learn to associate you with calm feelings and trust.
- Focus on positive behaviors & praise the effort not the results.
- Pick your battles…don’t argue
- or reason
- Don’t…..use humor or sarcasm
- Don’t…… slip into “parent mode”
4) DECREASE STIMULATION

Irritant
proof the
environment

KEEPCALM
AND
moVE
sLOwly
5) INCREASE PREDICTABILITY

- Have a consistent schedule & staff
- Give patient access to schedule/post
- Review orientation information daily & educate family on how to do this via “errorless learning” techniques
POOR EMOTIONAL CONTROL/DIS-INHIBITION

- **Intervention tips:**
  - give the patient control over their environment
  - avoid closed ended questions ("yes"/"no")
  - keep stress to a minimum
  - keep things simple and understandable
  - during mood episodes remain calm, non reactive
  - do not make the patient feel remorseful for what they have done (i.e. sexually inappropriate behavior)
  - understand pre-trauma personalities
Objectives: By the end of this unit, you will be able to:

- Discuss the 8 dimensions of community ambulation
- Differentiate “basic” levels of cognition from “higher” levels of cognition
- Relate how these levels of cognition apply to gait assessment and intervention
- Develop interventions at the appropriate level of gait or cognitive challenge
Until recently, normal gait was considered an “automated” motor task requiring minimal higher-level cognition.
Now we view the interaction between cognition and gait as a “manifestation in part by an individual’s awareness of destination, the ability to appropriately control the limb movements that produce gait, and the ability to navigate within an often complex environment”
8 dimensions of *community mobility*
- Distance & *time*
- Ambient conditions
- *Terrain* characteristics
- External physical *loads*
- Attention demands
- *Postural transitions*
- Traffic level
- Velocity = greatest predictor of community ambulation

Shumway-Cook 2002
HIERARCHY OF COGNITION: DEFINITIONS

Basic Level
- Arousal
- Generalized attention
- Focused/Selective attention
- Working memory

Higher Level
- Divided and/or alternating attention
- Sustained attention
- Executive Functions:
  - Initiation, planning, organizing, sequencing, problem solving, self-monitoring, safety awareness, decision making
COGNITIVE DEMANDS DURING GAIT

The ability to process an environment in motion minimally requires:

- Selective attention to focus on environmental stimuli
- Gaze stabilization when moving head & body
- Ability to use peripheral vision (Gentile)

Ability to integrate & interpret sensory stimulation from multiple senses & combine them into perceptual constructs

- Differentiate accurate from inaccurate stimuli
- Weigh sensory information appropriately

(Shumway-Cook)
Awareness of one’s own impairments and physical limitations allows the potential use of safe and effective strategies to address or compensate for those deficits during functional mobility.

Cognitive load & Cognitive reserve
- Teaching a patient how to weight shift, utilize a certain gait pattern, correct a gait deviation
CLINICAL PROGRESSION: TBI EXAMPLE

- Rancho Levels 4-6
  - They’re only equipped with that “Basic” level of cognitive ability.
  - They are in a state of Post-Traumatic Confusion (PTC)
SO.......WHAT TO DO?

- You still have to introduce functional activities to these patients
  - Implicit Learning versus Explicit Learning
    - **Procedural** - develops slowly through repetition.
      - **Does NOT require awareness, attention or other higher cognitive processes**
The ability to problem solve in novel & unpredictable situations is needed for adaptability of a task.

Consider the TBI Rancho Levels 7-10
- Meaningful assessment begins after RLA 6 with the beginning of the restoration of memory and resolution of PTC
- Significant deficits in Executive Function persist

Greater cognitive skills needed in an “open” environment
INTERVENTIONS
Executive Function Strategies

- Set goals & make a plan WITH the patient
- External structure/supports i.e. written plan, calendar for HEP or treatment for that day.
- **Encourage self-monitoring of performance-**
  - predict-perform
- Encourage problem solving (as appropriate) with task variability
Greater demands placed on executive functions if the gait task is more challenging (obstacle course) and/or if the normal gait pattern is already altered (as in patient populations)

Correlations not causations have been made between EF and selected parameters of gait (speed & variability)
HIGHER LEVEL MOBILITY

Open Environment
- High sensory processing & monitoring
- Movement diversification
- Movement generation
- Prediction
- External pacing

Dual-Task Mobility
- Attention at all levels is required in order to process both tasks
- Working memory
- Problem solving
- Sufficient skill in one task so that it requires only minimal attention
LET'S DEFINE DUAL TASK FIRST

- “The concurrent performance of two tasks that can be performed independently and have distinct and separate goals.”
- Each task performance can be measured independently as a single task.

Mclsaac et al 2016
CHOOSING A DUAL-TASK INTERVENTION

- Consider the task characteristics- Novelty or familiarity
  - Pairing an overlearned task with a novel task
  - Skilled performance implies “automaticity”
“Patients may derive their own priority for attention” (Shumway-Cook)

Unconscious “posture first” strategy used to avoid hazards & prevent falls. (Bloem et al 2001)

There may also be improper “prioritization” within our patient populations (Bloem et al 2001)

- Parkinson disease- use “posture second”
- Stroke
- Older adults
INTERVENTION EXAMPLES

- Path finding
- Making mental calculations during gait
- Following a written HEP or your treatment in the clinic
  - Judging time, following directions, sequencing and organizing equipment, space and the task.
- Obstacle course negotiation and navigating unpredictable environments
- Incorporating self-monitoring via clarifying an objective with a gait activity i.e. < 2 LOB and having the patient judge their own performance.
- Incorporate patient in setting overall goal i.e. running and “plan the steps” to get back to that.
GENTILE’S TAXONOMY OF TASKS

- **Body Orientation**
  - Stability/Stationary-
    - Object manipulation
    - No object manipulation
  - Transport/Moving-
    - Object manipulation
    - No object manipulation
GENTILE’S TAXONOMY OF TASKS

- Environment
  - Closed-
  - Variable-
  - Continuous Motion-
  - Open-
EXAMPLES WITHIN TAXONOMY

- Standing and holding a balance condition
- Standing and rolling a ball under one foot
- Walking in an empty hallway
- Walking an empty hallway using a quad cane
- Standing on grass or a ramp
- Standing and picking up objects from varied locations.
- Walking on different surfaces (grass, gravel)
- Walking on different surfaces carrying grocery bags.
PT SPECIFIC CLINICAL TESTS

- Stops Walking When Talking Test
  - Conversation is initiated, observe response
- TUG manual
  - Carry a cup of water or tray with cups; time difference
- TUG cognitive
  - Subtract by 3 from 100, time difference
- Walking While Talking Test
  - Recite alphabet or alternate letters, name certain animals, observe time difference & gait variability
- Walking & Remember Test
  - Forward digit span, walk time or recall & gait variability

(McCullough et al)
MORE DUAL-TASK INTERVENTIONS

- Using Gentile’s Taxonomy with focus on the Body Transport and Object Manipulation
  - Then vary the environment from
    - Closed-Variable-Continuous-Open
- Think-Pair-Share:
  - Acute care
  - Inpatient rehab setting
  - Outpatient setting
  - Community setting
MOSS ATTENTION RATING SCALE

- 22 items (rated on 5-point scale
  - 1 = definitely false, 5 = definitely true
- Encompass three major factors
  - Restlessness or Distractibility
  - Initiation
  - Sustained/Consistent Attention
- Reliable and valid for measure of behavioral complexities of attention
- Could also be used to characterize patient responses during PT activities when task complexity is increased.

(McCulloch et al)
PARTING THOUGHTS

- Encourage active engagement during gait tasks
- Make tasks meaningful to not only motivate but link to memory for those with impairments.
- May need to “support” their lack of executive function through strategies for memory, by providing structure and increasing repetition to maximize procedural or implicit learning.
- Progress challenges in order to achieve adaptability needed for resumption of community level gait
- DOCUMENT these supports, strategies and compensations