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Disorders of Consciousness After Traumatic Brain Injury

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June 6, 2018

Objectives and Background
Objectives

As a result of this course, participants will be able to:

- Define the four main diagnostic classifications for patients who are experiencing a disorder of consciousness.
- Identify at least three prognostic indicators in severe traumatic brain injury.
- Identify two components of level of consciousness.
- Describe at least five components of examination and evaluation that are relevant to patients with disorders of consciousness.
- Identify at least 5 special examination and treatment considerations for patients with disorders of consciousness.

Background

- Approximately 1.7 million people sustain a traumatic brain injury (TBI) in the US each year.
- A disorder of consciousness may be a result of a severe acquired brain injury, including TBI.
  - Other common mechanisms of injury:
    - hypoxic/anoxic injury
    - cerebral vascular accident

CDC 2010
Classification of Initial Severity of ABI

Severity of Acquired Brain Injury (ABI)

- Glasgow Coma Scale is the standard of care for determining level of consciousness in first response and critical care/acute settings

  - 3 domains:
    - Eye response
    - Verbal response
    - Motor response

Eken et al. 2009
## Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Eye Opening Response</th>
<th>Verbal Response</th>
<th>Motor Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 = Spontaneous</td>
<td>5 = Oriented</td>
<td>6 = Obeys commands</td>
</tr>
<tr>
<td>3 = To verbal stimuli</td>
<td>4 = Confused</td>
<td>5 = Localizes pain</td>
</tr>
<tr>
<td>2 = To pain</td>
<td>3 = Inappropriate words</td>
<td>4 = Withdraws from pain</td>
</tr>
<tr>
<td>1 = None</td>
<td>2 = Incoherent</td>
<td>3 = Flexion to pain or decorticate</td>
</tr>
<tr>
<td></td>
<td>1 = None</td>
<td>2 = Extension to pain or decerebrate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = None</td>
</tr>
</tbody>
</table>

## Severity of Acquired Brain Injury (ABI)

- Initial classification of severity of ABI using GCS:
  - Mild: 13-15
  - Moderate: 9-12
  - Severe: 3-8
Severity of Acquired Brain Injury

<table>
<thead>
<tr>
<th>Level</th>
<th>Glasgow Coma Scale score (GCS)</th>
<th>Duration of Posttraumatic Amnesia (PTA)</th>
<th>Duration of Loss of Consciousness (LOC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>13-15</td>
<td>&lt;1 day</td>
<td>0-30 min</td>
</tr>
<tr>
<td>Moderate</td>
<td>9-12</td>
<td>&gt;1 to &lt;7 days</td>
<td>&gt;30 min to &lt;24 hours</td>
</tr>
<tr>
<td>Severe</td>
<td>3-8</td>
<td>&gt;7 days</td>
<td>&gt;24 hours</td>
</tr>
</tbody>
</table>

Seale 2013

Rancho Los Amigos Levels of Cognitive Functioning

<table>
<thead>
<tr>
<th>Level</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No Response</td>
</tr>
<tr>
<td>II</td>
<td>Generalized Response</td>
</tr>
<tr>
<td>III</td>
<td>Localized Response</td>
</tr>
<tr>
<td>IV</td>
<td>Confused, Agitated</td>
</tr>
<tr>
<td>V</td>
<td>Confused, Inappropriate, Nonagitated</td>
</tr>
<tr>
<td>VI</td>
<td>Confused, Appropriate</td>
</tr>
<tr>
<td>VII</td>
<td>Automatic, Appropriate</td>
</tr>
<tr>
<td>VIII</td>
<td>Purposeful, Appropriate</td>
</tr>
</tbody>
</table>
Amnesia

- Retrograde: Loss of memory of events before the traumatic event

- Anterograde: Unable to form new memories of events after the traumatic event

Umphred 2007
Amnesia

- Period of time after injury where person is unable to form new memories
  - Patient may be confused and disoriented (to person, place, time, and situation).
  - May consist of some retrograde as well as anterograde amnesia

Umphred 2007, Seale 2013
Posttraumatic Amnesia

Recall….

- According to the Glasgow Coma Scale, a severe brain injury is considered a score of:
  - 3-8
Recall….

- What is posttraumatic amnesia?
  - Consists of some retrograde (loss of memory of events preceding injury) and anterograde (loss of memory of events following injury) amnesia

Prognostic Indicators in Severe TBI
Prognostic Indicators in Severe TBI

- Pre injury characteristics:
  - History of brain injury
  - Level of education
  - Age

- Injury characteristics
  - Size and location of lesion

- Early post injury indicators
  - Early GCS scores
  - Length of posttraumatic amnesia
  - Time to rehabilitation

Umphred 2007, Eastvold et al. 2013
Recall….

- What are 3 prognostic indicators after severe TBI?
  - Pre injury characteristics: Age, level of education, history of brain injury
  - Injury characteristics: size and location of lesion
  - Early post injury indicators: early GCS scores, length of post traumatic amnesia, time to rehabilitation

Defining Consciousness
Consciousness

- Content of consciousness
  - Cortical and subcortical functions

Consciousness

- Level of consciousness
  - Arousal: Level of alertness (wakefulness)
    - Subcortical: Brainstem, midbrain, thalamus
  - Awareness: Of self and environment
    - Cortical to subcortical connections

Seale 2013, Blumenfeld 2010
Recall….

- What are 2 components of consciousness?
  - **Content** of consciousness
  - **Level** of consciousness

- What are 2 components of **level** of consciousness?
  - **Arousal**: level of alertness (wakefulness)
  - **Awareness**: Of self and environment

**Diagnostic Classification of Disorders of Consciousness**
Diagnostic Classification of Disorders of Consciousness

- 4 Classifications:
  1. Coma
  2. Vegetative State
  3. Minimally Conscious State
  4. Emergence from Minimally Conscious State

Fig. 1. Behavioral observation assesses two dimensions of consciousness: arousal and awareness. In brain death and coma, both dimensions are absent. In the vegetative state, arousal level is relatively preserved in the absence of signs of awareness. In the minimally conscious state, both dimensions are present although behavioral signs of awareness often fluctuate. In the locked-in syndrome, both dimensions are fully preserved despite complete loss of speech and motor functions.

Giacino et al. 2009
Diagnostic Classification

- **Coma:**
  - Unarousable state
  - No sign of awareness of self or environment


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Diagnostic Classification

- **Vegetative state (VS):**
  - No evidence of sustained, reproducible, purposeful or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli
  - No evidence of language comprehension or expression
  - Intermittent wakefulness manifested by the presence of sleep/wake cycles (periodic eye opening)

Diagnostic Classification

- Minimally conscious state (MCS):
  - Simple command following
  - Gestural or verbal yes/no responses (regardless of accuracy)
  - Intelligible verbalization

Giacino et al. 2002, Seel et al. 2010

Diagnostic Classification

- Minimally Conscious State (MCS):
  - Movements or affective behaviors that occur in contingent relation to relevant environmental stimuli and are not caused by reflexive activity. Examples:
    - Episodes of **crying, smiling, or laughter** in response to the linguistic or visual content of emotional but not neutral topics or stimuli
    - **Vocalizations** or **gestures** that occur in direct response to the linguistic content of comments or questions
    - **Reaching** for objects that demonstrates a clear relationship between object location and direction of reach
    - **Touching or holding objects** in a manner that is appropriate for the size and shape of the object
    - **Visual pursuit or sustained fixation** that occurs in direct response to moving or stationary stimuli

Giacino et al. 2002, Seel et al. 2010
Diagnostic Classification

- Emergence from MCS (MCS+):
  - Reliable demonstration of:
    - Interactive communication
    - or
    - Functional object use

Giacino et al. 2002, Seel et al. 2010

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Fig. 1. Behavioral observation assesses two dimensions of consciousness: arousal and awareness. In brain death and coma, both dimensions are absent. In the vegetative state, arousal level is relatively preserved in the absence of signs of awareness. In the minimally conscious state, both dimensions are present although behavioral signs of awareness often fluctuate. In the locked-in syndrome, both dimensions are fully preserved despite complete loss of speech and motor functions.

Giacino et al. 2009
Recall….  

- What are the 2 main components of level of consciousness?
  
  1. Arousal  
     - Sleep/wake cycles  
  
  2. Awareness  
     - Of self and/or environment  

Recall….  

- What are the 4 main diagnostic classifications for people who are experiencing a DOC?
  
  1. Coma  
  
  2. Vegetative state  
  
  3. Minimally conscious state  
  
  4. Emergence from minimally conscious state
Recall….

- What differentiates vegetative state from coma?
  - Evidence of intact sleep/wake cycles
    - Person’s eyes remain open for periods of time throughout the day, and mostly remain closed at night

Examination and Evaluation of Patients with Disorders of Consciousness
Examination/Evaluation

- History:
  - Mechanism of injury, time since injury, earliest GCS score
  - Prior level of functioning (including employment and level of education)
  - Pre-morbid/co-morbid health conditions
  - Personal and environmental factors that may affect treatment and discharge planning

Seale 2013, Umphred 2007

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Examination/Evaluation

- Review physician and nursing notes
- Secondary injuries
- Surgical interventions
- Pharmacologic interventions
- Results of lab testing and imaging
- Restrictions/precautions
  - Bone flap
  - Head of bed
  - Weight bearing
  - Tracheostomy

Seale 2013, Umphred 2007
Examination/Evaluation

- Systems review

- Physical examination:
  - Muscle tone
  - Range of motion
  - Active movement

- Baseline status – level of consciousness

Seale 2013, Umphred 2007

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Examination/Evaluation

- Most common medical complications during inpatient rehabilitation (n=68, DOC>28 days):
  - Active seizures (46%)
  - Spasticity (57%)
  - Urinary tract infections (47%)
  - Hydrocephalus with and without shunt (38%)

Ganesh et al 2013
Case Study: Examination/Evaluation

- Practice setting: Neuro Intensive Care Unit
- Lisa is a 22-year old who was involved in an auto-pedestrian accident 7 days prior to initial PT evaluation.
- Her initial GCS in the field was 5.
- She was intubated during transport to the ED for airway protection.
- She was found to have a large right side subdural hematoma (SDH) and diffuse subarachnoid hemorrhage.
- She underwent a decompressive right frontoparietal craniectomy, evacuation of the SDH, and placement of an external ventricular drain (EVD) on the day of the accident.
- She had a tracheostomy 1 day prior to initial PT evaluation and continues to require mechanical ventilation, though vent settings are on continuous bipap.
- She was fully withdrawn from sedation yesterday. She is currently taking prophylactic anti-convulsant medications.

1. How would you classify the severity level of Lisa’s TBI?

2. What additional information would you want to know?
   - From chart review
   - From other staff
3. Where would you start with your initial evaluation of Lisa?

4. What components of examination/evaluation would you perform?
   - How would you determine her level of consciousness?
   - What components of exam would give you information about her prognosis?
   - What components of exam would allow you to set appropriate goals?

**Outcome Measures for Use With Patients With Disorders of Consciousness**
Purpose of Outcome Measurement for Patients with DOC

- Accurate diagnostic classification into VS, MCS, or MCS+
- Outcome prediction
- Discharge planning

Seel et al. 2010

Purpose of Outcome Measurement for Patients with DOC

- Interdisciplinary treatment planning
- Monitoring patient progress and treatment effectiveness
- Consistent communication among healthcare professionals
Outcome Measures

Glasgow Coma Scale (GCS):

- See previous slides
- Cannot determine verbal response on patients who are orally intubated
- Does not detect vegetative state versus minimally conscious state

Seale 2013, Eken et al. 2009

Outcome Measures

Full Outline of UnResponsiveness Score (FOUR):

- Developed as an alternative to the GCS for emergency and critical care settings.
- Can be used with patients who are intubated
- Includes some, but not all, diagnostic criteria for MCS
- Eye response, motor response, respiration, brainstem reflexes
- Scored from 0 to 16
- 10 min to administer
Outcome Measures

Coma/Near Coma Scale (CNC):
- Designed to measure small clinical changes in patients with severe brain injury
- Visual, auditory, command following, threat response, olfactory, tactile, pain, vocalization
- 0.00-0.89 no coma; 0.90-2.00 near coma; 2.01-2.89 moderate coma; 3.50-4.00 extreme coma
- 10 min to administer

Disorders of Consciousness Scale (DOCS):
- Designed to measure small changes in neurobehavioral functioning during coma recovery
- May be used to differentiate between VS and MCS, but not for differentiating between MCS and MCS+
- Auditory, visual, tactile, sensory, swallowing, olfactory
- Scored from 0 to 100
- 45 min to administer
Outcome Measures

Sensory Modality Assessment Technique (SMART):

- Consists of formal and informal (reports from family members and staff) assessment
- Auditory, vision, tactile, olfactory, gustatory, wakefulness, motor, communication
- Each scale scored from 1 to 5
- 60+ min to administer


Outcome Measures

Wessex Head Injury Matrix (WHIM):

- Designed to detect small changes in people who are experiencing VS and MCS
- Visual, tactile, olfactory, arousal/attention, auditory, expressive, communication
- Scored from 0 to 110
- 45 min to administer
Outcome Measures

Coma Recovery Scale-Revised (CRSR)

- Scores range from 0 to 23
- 6 subscales:
  - Auditory function
  - Visual function
  - Motor function
  - Oromotor/verbal function
  - Communication
  - Arousal

- Lower scores on subscales represent reflexive activity
- Higher scores on subscales represent cognitively mediated activity

Kalmar K et al. 2005, Giacino J et al. 2004

Outcome Measures

Coma Recovery Scale-Revised (CRSR)

- The only outcome measure that includes all of the Aspen Workgroup diagnostic criteria for VS, MCS, and MCS+
- 25 min to administer
- Validated in inpatient rehabilitation setting

Seel et al. 2010, Kalmar et al. 2005, Giacino et al. 2004
Recall….

- What are a few purposes of outcome measurement in patients with DOC?
  - Accurate diagnostic classification
    - VS, MCS, MCS+
  - Discharge planning
  - Interdisciplinary communication and treatment planning
  - Monitoring patient progress and treatment effectiveness

Treatment Interventions
Treatment Interventions

- Increasing arousal
  - Provide various types of sensory and/or noxious stimulation
  - Promote normal sleep/wake cycles

- Increasing awareness
  - Aim to improve frequency and consistency of responses to internal and external stimuli
  - Provide sensory input and give patient opportunity to respond
  - Educate family members on appropriate ways to provide sensory input outside of therapy sessions
Treatment Interventions

- Tolerance to upright positioning
- Weight bearing activity
- Prevention of secondary impairments:
  - Range of motion limitations: passive stretching program, positioning schedule/devices
  - Heterotopic ossification: range of motion program
  - Integumentary: prevention of pressure ulcers with positioning program
  - Cardiovascular: upright positioning, use of compression hose, initiate of physical activity if appropriate

Treatment Interventions

- Autonomic storming:
  - Monitor vital signs
  - Observe patient
  - Respond accordingly
  - Communicate with nursing and medical staff
Case Study: Treatment Interventions

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- She was fully withdrawn from sedation yesterday. She is currently taking prophylactic anti-convulsant medications.

Case Study: Treatment Interventions

- Lisa is still in the neuro ICU, and you are seeing her for a 30-minute treatment session 1 day after her initial evaluation.
- Initial evaluation findings:
  - Lisa required tactile or noxious stimulation to open her eyes on multiple occasions during the IE, while seated at EOB, but did maintain her eyes open >50% of the time.
  - Lisa did not verbalize or demonstrate any other signs of attempts to communicate.
  - She required total assistance to sit at edge of bed, and to maintain sitting balance at edge of bed.
  - She demonstrated occasional non-purposeful movements of her left upper and lower extremities, no active movements of right upper and lower extremities observed.
  - She did not follow any commands.
Case Study: Treatment Interventions

- Where would you start with your treatment interventions if you were seeing Lisa in an ICU or acute care setting?
  - Lisa appears to be in a vegetative state, possibly progressing toward minimally conscious state

- The basics:
  - Check vital signs & make sure physiologic status is stable, don helmet, prepare lines/monitors, prepare family for what is about to happen

- Next:
  - Determine position to start with:
    - Upright position helps to facilitate arousal (reticular activating system in brainstem)
  - Determine what you will work on:
    - Break it down by systems (similar to CRSR)
      - Visual, auditory, tactile, motor

Case Study: Treatment Interventions

- 2 weeks after her initial injury, Lisa has transferred to an inpatient rehab facility.

- Re-evaluation findings:
  - Lisa is now keeping her eyes open more consistently, with fewer auditory/tactile cues needed (about 3 cues needed during 30 minutes)
  - Lisa is still not verbalizing, though does vocalize sometimes (moaning during position changes)
  - She is demonstrating non-purposeful movement of all 4 extremities, though she moves her LUE and LLE more frequently than her RUE and RLE
  - She continues to require total assistance for all functional mobility tasks, though occasionally when she is assisted from her bed to a wheelchair (squat pivot transfer) she is observed to reach for the armrest of the wheelchair
  - She is demonstrating visual pursuit from her right side to midline, with use of a mirror
Case Study: Treatment Interventions

- What signs of minimally conscious state is Lisa demonstrating?
  - Vocalization, reaching, visual pursuit

- How would your treatment interventions change based on the information you now have about Lisa’s current level of functioning and the practice setting?
  - Longer duration, greater frequency of treatment sessions
  - More options available for positioning, treatment environment
  - Progression from facilitation of reflexive responses to facilitation of volitional/purposeful responses
  - Decrease frequency of cues necessary for arousal

Special Examination and Treatment Considerations for Patients with DOC

- Effect of medications

- Patient positioning
  - Supine in bed vs. sitting at edge of bed

- Presence of distractors
  - Noisy rooms or hallways, people entering/leaving room during test administration
  - Number of people in room
  - Amount of sensory input given to patient
Special Examination and Treatment Considerations for Patients with DOC

- Processing time
  - Allow plenty of extra time to observe a response

- Lighting

- Presence/absence of close friends/family

- Time of day

Recall….

- What are a few special considerations with regard to examination and treatment sessions for patients with DOC?
  
  - If possible, try to reflect back on previous treatment sessions, what went well, what could have gone better, etc…
Pharmacologic Interventions for Patients with Disorders of Consciousness

Pharmacologic Treatment

- Intra cranial pressure control (acute)
  - Hypertonic solutions: sodium chloride, mannitol

- Sedation (acute)
  - Benzodiazepines: lorazepam
  - Propofol

Samuel 2013
Pharmacologic Treatment

- Seizure prophylaxis (acute through chronic)
  - Anticonvulsants: phenytoin, levetiracetam, valproic acid, lorazepam

- DVT prophylaxis (acute through subacute)
  - Anticoagulents: heparin, enoxaparin, warfarin, rivaroxaban

- Decrease agitation (acute through chronic)
  - Antipsychotics: risperidone, quetiapine, ziprasidone, propanolol, valproic acid

- Decrease pain (acute through chronic)
  - Neuropathic: gabapentin, pregabalin, duloxetine
  - Nociceptive: acetaminophen, ibuprofen, hydrocodone/acetaminophen
Pharmacologic Treatment

- Increase arousal and awareness (subacute through chronic)
  - Stimulants: methylphenidate, modafinil, armodafinil, amphetamine
  - Arousal and initiation: amantadine, bromocriptine

- Decrease spasticity (subacute through chronic)
  - Baclofen, dantrolene, phenol, botulinum toxins

Pharmacologic Treatment

- Heterotopic ossification (subacute through chronic)
  - Anti inflammatory: indomethacin
  - Biphosphonate for 3 months

- Promote sleep (subacute through chronic)
  - Trazodone, zolpidem, melatonin
Questions?

- Presenter contact info:

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References


- Seale J. Altered states of consciousness. Presented at: University of Texas Medical Branch at Galveston; May 2013; Galveston, TX.


References

- Samuel S. Pharmacology review for physical therapy residency program. Presented at: TIRR-Memorial Hermann Neurologic Physical Therapy Residency; July 2013; Houston, TX.