Comprehensive Roadmap to Managing Patients with Disorders of Consciousness

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**Relevant Financial Relationship(s)**

- **TIRR Innovations Grant**
  - Use of the Body Weight Support Treadmill in the Minimally Conscious Patient: Effects on Arousal, the Cardiopulmonary System, and Response to Multi-Sensory Stimulation
    - Principle Investigators: Kelly Betts, PT, DPT and Patrice Perrin, PT, DPT

- **TIRR Memorial Hermann Employees**
  - Kelly Betts, PT, DPT, NCS
  - Patrice Perrin, PT, DPT

**Relevant non-financial relationship(s)**

- No relevant non-financial relationships to disclose
Objectives

- Understand the distinction between the different levels of consciousness (coma, vegetative, and minimally conscious)
- Understand how to set their patients up for success when attempting to respond to multi-sensory stimulation
- Understand how to use the Coma Recovery Scale-Revised (CRS-R)
- Have an understanding of the treatment program for persons with disorders of consciousness
- Therapy goals for this patient population
- Review the literature regarding those with disorders of consciousness
  - Discuss current ongoing research
The Road Map
Is the patient conscious?
What is consciousness?

- A state of awareness of self and environment that requires alertness and arousal.
Neuroanatomy

(B) Cortex
Thalamus
Midbrain
Pons
Pontomesencephalic reticular formation
What are the different states of consciousness?
Across the Spectrum of Consciousness

Emerged
- Ability to functionally communicate or use objects

Minimally Conscious State
- Minimal, but behavioral evidence is present that indicates awareness of self and/or environment

Vegetative State
- Wakeful unconsciousness
- Return of sleep/wake cycle
- No evidence for awareness of self or environment

Coma
- Complete loss of arousal
- No sleep/wake cycle
Arousal vs. Awareness

- **AROUSAL:**
  - **Level** of Consciousness

- **AWARENESS:**
  - **Content** of Consciousness
Consciousness

CONSCIOUSNESS = AROUSAL + AWARENESS
Coma

- No eye opening
- Absence of sleep/wake cycle
- Unable to follow instructions
- No speech or other forms of communication
- No purposeful movement (no evidence of discrete localizing responses)
- Behavior limited to reflexive activity – (*failure of both reticular activating system and integrated cortical activity*)
Vegetative State

• Return of sleep-wake cycle with periodic eye opening and eye closing
• May moan or make other sounds especially when tight muscles are stretched
• May cry or smile or make other facial expression without apparent cause
• May briefly move eyes toward persons or objects
• May react to loud sounds with startle response
• Unable to follow instructions
• No speech or other forms of communication
• No evidence of sustained, reproducible, purposeful or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli – no purposeful movement
Minimally Conscious State

- Sometimes follows simple instructions
- May communicate yes or no by talking or gestures
- May speak some understandable words or phrases
- May respond to people, things, or other events by:
  - Crying, laughing, or smiling
  - Making sounds or gesturing
  - Reaching for objects
  - Trying to hold or use an object
  - Keeping eyes focused on people or things for a sustained period of time
- People in MCS do these things inconsistently, which makes it difficult to distinguish between VS and MCS.
Emergence from MCS

- Can communicate
- Can follow instructions consistently
- Can demonstrate functional use of an object
- Almost always people emerging from MCS will experience confusion
Comparison of Coma, Vegetative State (VS), Minimally Conscious State (MCS) and Emerged from Minimally Conscious State

<table>
<thead>
<tr>
<th></th>
<th>Coma</th>
<th>VS</th>
<th>MCS</th>
<th>Emerged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Opening</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sleep/wake</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Visual Tracking</td>
<td>No</td>
<td>No</td>
<td>Often</td>
<td>Yes</td>
</tr>
<tr>
<td>Object recognition</td>
<td>No</td>
<td>No</td>
<td>Inconsistent</td>
<td>Functional</td>
</tr>
<tr>
<td>Follows commands</td>
<td>No</td>
<td>No</td>
<td>Inconsistent</td>
<td>Consistent</td>
</tr>
<tr>
<td>Communication</td>
<td>No</td>
<td>No</td>
<td>Inconsistent</td>
<td>Functional</td>
</tr>
<tr>
<td>Contingent emotion</td>
<td>No</td>
<td>No</td>
<td>Inconsistent</td>
<td>Varies</td>
</tr>
</tbody>
</table>
Affective Responding

- Often forgotten during assessment but also very powerful.

- Frequently reported by family.

- Environmentally contingent affective responses are a sign of conscious awareness:
  - May require an IQBA to assess.
  - Standardized neurobehavioral assessments do not quantify this area.
Trajectory

- DEATH
  - UNCONSCIOUSNESS
    - COMA
  - CONSCIOUSNESS
    - MINIMALLY CONSCIOUS STATE
    - CONSCIOUS

- LIFE
  - VEGETATIVE STATE
Confusional State

- Disorientation
- Severe impairment in attention, memory, and other cognitive abilities
- Fluctuation in level of responsiveness
- Restlessness
- Nighttime sleep disturbance
- Excessive drowsiness/sleeping during the day
- Delusions or hallucinations
- In TBI = PTA (post traumatic amnesia)
“Estimates of misdiagnosis among disorders of consciousness range from 15% to 43%” (Giacino, Katz, and Schiff 2007).
How does arousal play a part in determining consciousness?
Let’s Clarify…

- **Awake**: Eyes open
- **Arousal**: “Regulated by physiological functioning only”; a state of readiness to respond to internal and external stimuli
- **Awareness**: “Allows one to receive and process all the information communicated by the five senses and thus relate to oneself and the outside world.”
- If you demonstrate arousal, you’re not necessarily aware.
- If you are aware, you demonstrate arousal.
How do we assess for consciousness?
Consciousness

• Conscious behavior is often **subtle** and **inconsistent** in the aftermath of a severe brain injury.

• It must be **systematically differentiated** from reflexive or random behaviors.
Behavioral Assessment

• Behavioral observation constitutes the major tool for detecting signs of consciousness.

• Distinction between **arousal** vs. **consciousness**:
  
  – Arousal is necessary, but insufficient, for consciousness.
  
  – The repertoire of behaviors available for assessment of conscious awareness may be dramatically diminished.
Purpose of Assessment

Goal:
- to provide accurate diagnosis
- develop appropriate treatment plan
- give accurate prognosis

Assessment includes:
- bedside neurological assessment
- Standardized rating scales
Assessment: Chart Review

- Diagnosis
- Etiology
- Age
- Date of Onset
- Initial GCS
- CT/MRI Results
- Vision/Hearing
- Bedside/MBS
- Trach/Vent
- Past Medical History
- Complications
- Precautions
- Transfer Records
- Physical status
- Social History
- Previous therapy notes
Formal Assessment

• Formal assessment measures provide a structured approach to:
  – Monitoring and documenting recovery
  – Monitoring efficacy of different interventions (pharmacologic)
  – Communication among team members
  – Research
  – Identifying patients sensory, physical, and cognitive strengths and weaknesses
Formal Assessment

- Commonly used rating scales:
  - Disability Rating Scale (DRS)
  - Glasgow Coma Scale: initial rating scale
  - Rancho Los Amigos Levels of Cognitive Functioning: used especially for TBI

- Not sensitive to small changes in VS and MCS
Scales with acceptable standardized administration and scoring procedures:

<table>
<thead>
<tr>
<th>Scales</th>
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<tbody>
<tr>
<td>Coma Recovery Scale-Revised (CRS-R)</td>
<td></td>
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<tr>
<td>Sensory Stimulation Assessment Measure (SSAM)</td>
<td></td>
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<tr>
<td>Wessex Head Injury Matrix (WHIM)</td>
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<tr>
<td>Western Neuro Sensory Stimulation Profile (WNSSP)</td>
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<tr>
<td>Sensory Modality Assessment Technique (SMART)</td>
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<tr>
<td>Disorders of Consciousness Scale (DOCS)</td>
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<tr>
<td>Coma/Near-Coma Scale (CNC)</td>
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- Minor reservations
- Moderate reservations
- Major reservations
Assessment: CRS-R
Coma Recovery Scale – Revised

- The **CRS-R** was developed in 1991 and revised in 2004.
- The CRS-R assists with:
  - Differential diagnosis.
  - Prognostic assessment.
  - Treatment planning.
- Contains **23 items** that comprise **6 subscales**.
- Standardized scoring is based on the presence or absence of operationally defined behavioral responses to specific sensory stimuli.
CRS-R

• Purposes
  – Determine diagnosis (coma vs. vegetative state vs. minimally conscious state) based on existing criteria
  – Establish prognosis and project disposition needs
  – Facilitate planning of treatment
  – Determine level of arousal
  – Facilitate selection of appropriate commands
  – Help differentiate volitional from random/coincidental movement
  – Monitor progress over time
  – Alert to subclinical changes in responsiveness
  – Monitor changes in response to intervention
Additional Goals

• Aid in evaluation of effectiveness of interventions
• Generate recommendations for treatment targets
• Assist with treatment and disposition planning
• Generate research hypotheses
• Facilitate participation in multi-center clinical trials
Why this scale?

- Selection of the Coma Recovery Scale-Revised (CRS-R) as measure of choice
  - Acceptable standardization of administration and scoring
  - Excellent content validity and only scale to address all Aspen Neurobehavioral Conference Work Group criteria for MCS (2002)
  - Substantial evidence of internal consistency and good inter-rater reliability
Who is Appropriate?

• Patients who range from **Rancho Level II to V**:
  
• **Level II: Generalized Response:**
  – Begin to respond to stimuli but slow, inconsistent, or delayed.
  – Responses tend to be similar irrespective of stimulation.

• **Level III: Localized Response:**
  – Increased movements and reacts more specifically to stimuli (e.g., turns toward sound, withdraws from pain).
  – May begin to respond inconsistently to commands and yes/no questions.

• **Level IV: Confused and Agitated**
• **Level V: Confused and Inappropriate**
What to do?

- Tell patient and family what you are about to do
  - Don’t assume the patient is not aware
- Baseline observation
- Arousal Protocol: if needed
Baseline Observation

- **Purpose:**
  - Determine level of arousal.
  - Facilitate selection of appropriate commands.
  - Help differentiate volitional from random/coincidental movements.

- **Observe for one minute** and record observations:
  - Resting posture of extremities, eye opening status, presence/absence of spontaneous visual fixation or tracking, type/frequency of spontaneous movement.
  - If no eye opening, perform the **arousal protocol**.
Arousal Protocol

- Perform when there is sustained eye closure or the patient stops following commands for one minute.
  - Deep pressure stimulation presented unilaterally to face, neck, shoulder, arm, hand, chest, back, leg, foot, and toes.
  - Muscle should be firm grasped between thumb and forefingers and rolled back and forth (3 to 4 times)
  - Repeat on contralateral side
- If patient becomes aroused keep going until you finish both sides of the body.
- Be aware of medical devices or other precautions
Arousal Protocol

• Insert video
Auditory Function Scale

Start at highest level of function – the highest score

4: **Consistent Movement to Command**
   - highest level
   - have to perform command 4 times
   - have to respond to sections a or b and c
   - same as object recognition (5) on the visual functional scale
   - Pick a purposeful object and identify an appropriate limb (the one that moves the most)

3: **Reproducible Movement to Command**
   - have to perform command 3 times
   - *This is the lowest level that indicates consciousness*

2: **Localization to Sound**
   - e.g. Call name and clap but needs to last for 5 seconds
   - Can use family members for a more familiar voice

1: **Auditory Startle**
   - Directly above and behind the patients head and out of view

0: **None**
Visual Function Scale
Visual Function Scale

5: Object Recognition
   – Same consistent movement to command on auditory scale (sec 2a and 2b)

4: Object Location – Reaching
   – Any attempt to move towards the object is seen as a positive response since this is a test of vision and not motor function – does not have to make contact with the object

3: Visual Pursuit
   – Use a mirror

2: Fixation
   – Use brightly colored or illuminated object, or something meaningful (i.e. picture of family)
     – *This is the lowest level that indicates consciousness*

1: Visual Startle
   – Be careful not to touch the patient

0: None
Motor Function Scale

SCALE IS FROM 6 TO 0
6: Functional Object Use
   - Pick meaningful common object
   - *this indicates emergence from minimally conscious state*

5: Automatic Motor Response
   - read carefully
   - If they wave inappropriately (when you tell them NOT to), they actually get points for that b/c it’s suppose to be an *automatic* motor response

4: Object Manipulation
   - when rolling the ball do NOT touch the palmar surface of the hand (this will stimulate a grasp reflex)
   - Must be grasped *and* held
Motor Function Scale (cont.)

3: Localization to Noxious Stimulation
   - The non-stimulated limb must make contact with the stimulated body part on 2 of 4 trials
     - *This is the lowest level that indicates consciousness*

2: Flexion Withdrawal
   - *Isolated* flexion withdrawal to pull away

1: Abnormal Posturing
   - Stereotyped flexion OR extension of extremities immediately after the stimulus

0: None/Flaccid
Oromotor / Verbal Function Scale

3: Intelligible Verbalization
   - Must consist of consonant-vowel-consonant
   - “Ma” is not accepted “Mom” is accepted
   - Two different words must be documented
     • Can happen at any time during test
     - this is indication of MCS

2: Vocalization/Oral Movement
   - Can be any vocalization
   - Can NOT be swallowing or yawning

1: Oral Reflexive Movement
   - Examples: chewing, yawning, clamping of jaw after tongue blade is presented

0: None
Communication Scale

- The communication scale consists of an assessment protocol with 6 visual or aurally based orientation questions that are situational.
- The assessment protocol is not administered if there is no evidence of reproducible command following or spontaneous communication.
- Examiner may use the visual or auditory set of the situational orientation questions.

2: Functional: Accurate
- Accurate responses to all 6 of the questions
- *this is indication of emergence from MCS*

1: Non-Functional: Intentional
- Any communicative response (head nods/thumbs up) on 2 out of 6 trials irrespective of accuracy
- *This level indicates consciousness*

0: None
3: **Attention**
   - Over the length of the exam there are no more than 3 occasions in which the patients fails to respond to a verbal prompt.

2: **Eye Opening w/o Stimulation**
   - No arousal protocol or tactile stimulation needed

1: **Eye Opening with Stimulation**
   - Used the arousal protocol

0: **Unarousable**
   - No eye opening

- Document the number of times required to arouse the patient
Common Errors in Standardization of Administration

• When to D/C within the session
  – If the arousal protocol is administered 3 times within a subscale then discontinue the subscale
  – If 3 consecutive subscales are discharged for this reason then discontinue the CRS-R

• When D/C prematurely = no score (different than a zero score)

• Emphasizing length of time to respond
  – Only have 10secs…but can test the limits and document in comments section

• Tactile cues

• Depth of the arousal protocol
  – Not meant to be comfortable
Common Errors in Standardization of Administration

- Stick to the script – give direct commands
- Flexion withdrawal vs. abnormal posturing
- Score what happens in the exam, not what you know about the patient or what they did earlier in the day.
- Location of examiner – vision vs. auditory
  - Stand in a neutral position; stay in same position
- What are you measuring – think about the construct
- Observers/family
- Time of administration can be quick – avoid test the limits if time does not allow
Set the Patient up for Success!!
Keys to success

• Environment
  – Low stimulation (consistency)
  – Minimal interruptions

• Biomechanical Advantage
  – Positioning, positioning, positioning

• Comfort
  – Is the position of the patient…
    • Painful? Increasing spasticity? Increasing HR?

• Arousal
  – Full schedule….end of day
  – Time of day (sleep wake cycle)
  – Position of patient (supine in bed vs sitting edge of mat)
  – Neurostimulants…Are you in the optimal window?
Remember to…

• Communicate with the primary therapist about optimal position and behavior they may have observed

• Advise the primary therapist on areas where behavior is not consistent to help guide treatment and develop consistency
Documentation

• Very important to include:
  – Time of day (change time to reflect real time)
  – Position (include details) - supine, sitting, standing
  – The amount of times that you needed to perform the arousal protocol
  – Document the details:
    • Specify examiner actions (objects, commands used, etc.)
    • Specify patient responses and observations (even if didn't meet criteria – 1 of 4 trials)
    • Report environment tested in (e.g., room, time, who is in the room, etc.)
    • Report interventions utilized – (medication trials, etc.)
  – Refer to previous documentation prior to assessment to ensure consistency of stimuli COMMANDS, etc.
Guidelines for Scoring

**Lower-reflexive**  **Higher-cognitively based**

- Stick to the scoring criteria
- Score only elicited responses
- If the response is ambiguous, do not credit
- Do not score if the response takes more than 10 seconds
What behaviors indicate the presence of consciousness?
The Score

- Document the total score but also document and be able to report the **subscale scores** because this is more telling of the person’s state of consciousness.

- If the patient demonstrates one of the following they have some level of *consciousness*:
  - Communication: 1
  - Visual: 2
  - Motor, auditory, oromotor: 3

- Can remember by $C_1-V_2-MAO_3$
Indicators of Emergence

- Functional Object use (motor scale)
- Functional accurate communication
How do we develop a communication system?
Command Following Protocol:

- Observation: any movement; volitional vs. non-volitional
- Review any imaging done
  - If large L hemisphere lesion: consider need to use gestures with commands
- Assess auditory function: do they have a startle?
- Identify the command: use above to set pt up for success
- 3 Commands:
  - “Do it”
  - “Hold still”
  - Don’t say anything
• **Other considerations:**
  – Define what movement will “count”
  – Use of 2\textsuperscript{nd} tester if bias is possible
  – May need to stretch prior to testing if spasticity is an issue

• **Measure:**
  – Response rate
  – Accuracy
  – Measure separately because they tell you different things
    • Low response rate is “better” than low accuracy because you can always ask them again if you don’t get a response the first time.

• **Response Window**
  – Vision – typically 5 seconds
  – Commands – cue every 10sec x3; thus a total of 30 seconds window to respond
Vision Protocol:

- Visual functioning is one of many areas used to assess a patient’s level of consciousness.

- Clinical questions regarding the status of the visual system may arise.

- Vision is a critical channel for acquiring information, especially in the DOC population because exploring and manipulating the environment can be limited.
Vision Protocol Methods:

• Similar to Command Following Protocol, set-up and assessment are individualized to the particular patient.

• Stimuli:
  – Glossy, color, meaningful photo.
  – Plain white card the same size as the photo.

• Procedure:
  – Patient shown unilateral stimulus or bilateral stimuli.
  – **Yes Response:** first lateralized eye movement after presentation.
  – **No Response:** No eye movement within 5 seconds.
## Data Pattern for VP

<table>
<thead>
<tr>
<th>Stimulus (left/right)</th>
<th>Looks Left</th>
<th>Looks Right</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Photo/_____</td>
<td>9</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>2. _____/Photo</td>
<td>1</td>
<td>28</td>
<td>3</td>
</tr>
<tr>
<td>3. Card/_____</td>
<td>12</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>4. _____/Card</td>
<td>1</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>5. Photo/Card</td>
<td>1</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>6. Card/Photo</td>
<td>4</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28</td>
<td>89</td>
<td>75</td>
</tr>
</tbody>
</table>
Adaptive technology

- Switches
- Eye gaze systems
- Tablets with apps
- Communication board
How do we measure pain?
Pain Assessment

- Biofeedback (i.e. vitals)
- NCS-R (Chatelle et al)

Table I. The nociception coma scale-revised.

<table>
<thead>
<tr>
<th>Motor responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – Localization to painful stimulation</td>
</tr>
<tr>
<td>2 – Flexion withdrawal</td>
</tr>
<tr>
<td>1 – Abnormal posturing</td>
</tr>
<tr>
<td>0 – None/flaccid</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Verbal responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – Verbalization (intelligible)</td>
</tr>
<tr>
<td>2 – Vocalization</td>
</tr>
<tr>
<td>1 – Groaning</td>
</tr>
<tr>
<td>0 – None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facial responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – Cry</td>
</tr>
<tr>
<td>2 – Grimace</td>
</tr>
<tr>
<td>1 – Oral reflexive movement/startle response</td>
</tr>
<tr>
<td>0 – None</td>
</tr>
</tbody>
</table>
What are the hindrances to revealing consciousness?
Common Hindrances

- Medications
- Neuromuscular Impairments
- Medical
- Arousal
- Differential diagnoses
Medications

• **Neurostimulants**
  – Ritalin, adderall, provigil, nuvigil

• **Anti-spasmodics (systemic)**
  – Baclofen, dantrium, flexeril, tizanidine

• **Anti-spasmodics (non-systemic, local)**
  – Botox (botulinum toxin A) and intrathecal baclofen

• **Dopaminergics (dopamine is linked to arousal)**
  – Bromocryptine, amantadine, sinemet, requip
Medications

- **Anti-Convulsants**
  - Dilantin, klonopin, valium, depakote, keppra, topamax, gabapentin

- **Memory/Cognition (Cholinesterase Inhibitors)**
  - Aricept, Cognex, Namenda

- **Pain Management**
  - Non-Steroidal Anti-Inflammatory Drugs (NSAID's), non-narcotics, narcotics

- **Hypnotic/Sleep Agents**
  - Ambien, lunesta, Sonata, Trazodone, etc

- Several other medications can be included as needed (ie, stool softeners, beta-blockers, antibiotics)
Amantadine

- Retrospective study of 74 patients with severe TBI (GCS <8)
- 41 patients received 200mg BID from 3\textsuperscript{rd} day post injury vs 33 controls
- Baseline GCS scores were similar
- Amantadine group had a mean GCS of 10 and the control group had a mean GCS of 6
- Amantadine group had a mortality rate of 6% and the control group had a rate of 51 % (Cossu, 2014)
Bromocriptine

- Retrospective study of five patients in a VS tried to assess the administration in the acute setting (< 40 days post) combined with multidisciplinary therapy.

- Patients showed improvement in cognitive and physical function with 1st 4 weeks of treatment (dose 1.25mg BID with titration up to 2.5mg) (Cossu, 2014).
Zolpidem (Ambien)

- Shown to improve consciousness in those in VS and MCS
- In Whyte et al 2014, 5% of the participates demonstrate improvement including:
  - increased movement
  - social interaction
  - command following
  - attempts at communication
  - functional object use
- Though percentage is small, for those that did respond the change was significant
- Further research is needed to determine the mechanism of action to better define ‘clinical predictors’ to identify who are ‘responders’ and thus will benefit from its use.
Neuromuscular Impairments
Spasticity Management

- **Conservative management**
  - Casting
  - Splinting
  - w/c and bed positioning
  - Stretching
  - Inhibitive techniques

- **Medical management**
  - When the above techniques aren’t enough or are no longer working
  - Oral medications
  - Injections/Neurolytics
  - Intrathecal Baclofen (ITB) pump
Positioning: In Bed

- Consider what we call “foam art”
- Props: foam, casts/bivalves, splints
- Consider position: sidelying is considered the most neutral position for spasticity
- When creating positioning devices, consider how they can be used in more than one position
  - They need to roll every 2 hrs
- Consider user friendliness
  - Can nursing and/or family implement your program?
Positioning: In Bed (cont)

- **Specific examples:**
  - Adductor wedges
  - Foam blocks to inhibit extensors spasms of LEs.
  - Pillows between arms and trunk
    - If too strong consider foam here as well
  - Bivalves vs. PRAFOs vs. custom orthotics
    - When to consider ordering custom orthotics
  - UE bivalves and splints

- Thibaut et al found that soft hand splints improved spasticity of finger flexors and increased hand opening in patients with DOC
  - Noted that splinting compared to manual stretching could be for a more prolonged period of time and did not require direct supervision.
Bed Positioning
Bed Positioning
Positioning: In W/C

- Attempt to achieve neutral midline alignment but also consider what is functional for the pt
  - May not be 100% ideal but what is a good compromise to allow them to be functional and prevent skin breakdown/contracture/compensation.

- Props: lap tray, angle adjustable foot plates, foam build ups, inserts for trunk or pelvis, straps
W/C Positioning
Short term vs. long term

• Short term:
  – Foam, straps, bi-valves

• Long term
  – Custom orthotics, custom wheelchair
    • NOTE: Is their positioning going to change with spasticity management?
    • The patient may not be appropriate for a custom orthotic if they are receiving Botox or an ITB pump
Oral Medications For Spasticity

• Mostly commonly used: baclofen
  – Generally not used in BI population due to sedating effects and slowing recovery

• Others:
  – Dantrolene
    • Less sedating
  – Sinemet
    • Used more for rigidity
  – Tizandine
    • May cause hypotension
  – Benzodiazepines
    • Ex: diazepam
Neurolytics & Terminology

- **Chemo-denervation** - “umbrella” term for Botox, phenol, neurolytic injections

- **Botox (Botulinum toxin A)**
  - blocks neurotransmitter by inhibiting acetylcholine release

- **Phenol- temporary nerve block**
  - Used in larger muscle groups such as in the lower extremity

- **Lidocaine**
  - Temporary nerve block; last approximately 1 day
  - Often used to determine appropriateness for phenol or Botox
Intrathecal Baclofen (ITB) Pump

- Most aggressive/invasive management technique of spasticity
- Typically used for severe global spasticity
- Pt will undergo trial prior to pump placement to determine if they are a candidate
  - Just determines “yes/no” does the pt respond; NOT what they would look like with the pump
- Consider funding
  - For pump placement as well as follow-up
  - Example: Medicaid
ITB use in DOC

• Shown to not only improve spasticity but also responsiveness in those in a MCS

• Currently, there is no clear pathophysiological reason for improvement in cognition but studies have proposed:
  – Decrease in amount of baclofen needed (compared to oral) decreases the side effects of drowsiness and cognitive slowing
  – Decreases the overflow of dysfunctional sensory stimuli to the injured brain allowing for it to better process external information.
  – Acts on the cortico-thalamo-cortical connection in the brain via CSF circulation

Margetis et al; Pistoia et al; and Al-Khodairy, Nicolo & Vuadens.
Theories for Improvement following ITB placement

- **Movement Recovery**: spasticity that was blocking limb movement is decreased and therefore pt better able to respond to motor commands

- **Reduction of Proprioceptive Information**: decreasing proprioceptive “overload” that might interfere with the maintenance of attention

- **Orexin Pathway**: ITB acts as a GABA-B agonist in the hypothalamus and brainstem to promote wakefullness

- **Thalamic Reticular Nucleus (TRN)**: an area that facilitates attention and has GABA-B receptors; thus, it is hypothesized that ITB can contribute to the recovery of damaged TRN function.
Surgical Interventions

• Tendon lengthenings
  – Hip, knee, ankle, wrist, fingers, elbow, etc.
• Orothopedic manipulations
• Removal of HO
Other Medical Management Options

- Dorsal column stimulation
- Transcranial magnetic stimulation
- Deep brain stimulation
- Hyperbaric oxygen therapy
- Cell transplantation

(Cossu 2014)
Hypotonic/Severe weakness

- Surface EMG
- Diagnostic EMG
Barriers with Arousal

- Therapeutic Interventions
  - Arousal protocol
  - Vestibular stimulation
  - Salience
  - Music

- Positions: supine vs. sitting unsupported vs. developmental positions vs. standing vs. walking
Differential Diagnoses

Other conditions that can impede performance:

- Apraxia
- Abulia
- Global Aphasia
- Locked-In Syndrome
- Spasticity
- Visual Impairments
- Akinetic Mutism
- Catatonia
- Hydrocephalus
- Seizures
- Hearing deficits
- Attention
- Arousal deficits
Assessment: Pitfalls and Considerations

- Confusing purposeful intent with reflex
- Inadequate evaluation: too short sampling time, inadequate arousal, poor stimulus choice
- Sensory deficits
- Decreased initiation: too high demands
- Don’t underestimate
- Desire/will to respond
- Observer/patient rapport
- Family observation: over/under considerations of family

Giacino, Katz (2002)
Overcoming Pitfalls

- Adequate stimulation to ensure arousal level
- Address factors adversely affecting arousal (sedating medications)
- Don’t give commands that occur frequently on reflexive basis
- Do Give commands that are within patient’s functional ability
- Attempt to elicit a variety of behaviors using a range of stimuli
- Distraction free environment
- Re-assess using systematic observation and reliable measurement strategies
- Observe family members, caregivers, and professional staff and consider their interactions during assessment
- For children under age 3, consider language and motor development
What are other therapeutic goals and interventions?
PT/OT Goals

- Assess level of consciousness
- Positioning in wheelchair and bed
- Spasticity Management
- Standing Programs
- Equipment trials
- Establishing a home program
- Initiate intensive mobility program
- Family/Caregiver Training
- Manage medical issues with medical team
OT/PT Goal Examples

• **Positioning Goals:**
  – Pt will tolerate bed positioning to inhibit abnormal tone, maintain alignment, and prevent skin breakdown
  – Pt will tolerate wheelchair positioning to inhibit abnormal tone, maintain alignment, and prevent skin breakdown

• **Neuromuscular Goals:**
  – Pt will have increased ROM in ankle via serial casting to improve alignment in preparation for weight bearing with functional tasks.
  – Patient participates in activities to facilitate increased postural and motor control throughout UEs/LEs/trunk/head in preparation for participation in functional mobility and ADLs
  – Pt will participate in a standing program for…
OT/PT Goal Examples

• Discharge Planning Goals:
  – Patient/family will be trained in all aspects of patient's care,
  – Patient/family has necessary equipment and supplies and/or generated prescriptions prior to time of discharge.
  – Patient will have written and/or verbal home program prior to discharge.
PT/OT Treatment Options

- Pain assessment and management
- Spasticity assessment and management
- Head/trunk control
- Identifying movement for command protocols
- Surface EMG
- Vestibular assessment and treatment
- Positioning programs: bed and w/c
- Splinting and Casting for ROM and/or positioning
- Standing program
- Trying various positions/activities to promote increased arousal and consciousness
  - Prone, tall kneeling, quadruped, standing, walking
- Responses to multisensory stimulation
- Co-treats with MT and TR to improve responsiveness
- Equipment trials
- Caregiver/Family training
- Establishing an extensive home programs and modifying
Therapeutic Interventions

- Vision Protocol/Command Protocol
- Body weight supported treadmill training (BWSTT)/Lokomat
- Vector
- Bed and wheelchair positioning
  - Inhibitory or supportive
- Trach weaning/decannulation
- Swallowing
- Vocalizations
- Responses to multisensory stimulation
- Electrical Stimulation (FES bike/NMES)
Proprioceptive Feedback

Developmental positions
- Weight bearing
- Quadruped
- Tall kneeling
- Prone
- Standing

(Co-treats are important)
Electrical Stimulation

• Various uses:
  – To prevent atrophy in an acute care setting
    • Hirose et al:
      – 30-40mA; 30 min daily; BLEs (flexors and extensors)
      – Acute care setting; starting 7 days after admission
      – Performed weekly for 6 weeks
      – Result: effective in preventing disuse atrophy in pt’s with DOC
  – To improve arousal
    • Right Median Nerve stimulation:
      – Shown to cause earlier arousal from coma
      – Inconsistently shown to improve functional and cognitive outcomes
      – Cossu 2014

• FES
  – Decreases spasticity
  – Prevent muscle atrophy
  – Provides sensory input
• Elliott L, Coleman M, Shiel A, et al. demonstrated Improvement in behavioral responses in those in vegetative and minimally conscious states.

• Study states that patient experienced increased arousal at 85 degrees on a tilt table vs. supine in bed
  – Benefits for co-treating with SLP

• Tilt table also shown to decrease the occurrence of orthostatic hypotension in the DOC population (Giovanni et al)
Ambulation

• Progression from standing
• Automatic motor activity, thus may see:
  – Increased arousal
  – Increased muscle activation
  – Improved responsiveness to stimuli
• No literature present on use of ambulation in those with DOC, though it seems a natural progression from a standing program
• Con: difficult and labor intensive; maintaining safety while optimizing movement patterns
Body Weight Supported Treadmill Training (BWSTT)

- **Benefits:**
  - Increased *repetition* of a *task-specific* activity (motor planning principles)
  - Earlier opportunities for weight bearing
  - Improve strength
  - Reduce spasticity
  - Decreased burden on therapist; allowing for focus to be on facilitating various components of gait
    - Improve safety when working with those with significant functional impairment

- Allows for improve safety and mechanics when ambulating with the DOC population
• VERY limited evidence when studied in the TBI population with inconsistent reports in it’s efficacy
• Lapitskaya, Nielsen, Fuglsang-Frederiksen (2011)
  – No changes in EEG following robotic gait training in pts with severe TBI
  – Might be an indicator of the severity of the brain injury/dysfunction
• In case studies with TBI, it has shown:
  – Improve cardiorespiratory capacity
  – Improve efficiency of gait
  – Increase gait speed
  – Decrease use of assistive devices
• Supported in the literature in the those with SCI and CVA (Tefertiller et al 2011)
Research has demonstrated that it is not superior to standard gait/overground training – However, it is shown to be an effective treatment modality

This suggests it should be used in a progression:
– Transitioning from BWS/robotic gait training to traditional overground training as is safe and effective
– Use those clinical reasoning skills: to optimize gait mechanics, weight bearing, repetitions
– Progress from a more restrictive environment to a less restrictive environment when appropriate
BWSTT

- Insert video
Equipment

- Things to consider ordering:
  - Hospital Bed and Mattress (Group 1 and 2)
  - Tilt in space w/c and cushion
  - Hoyer lift with slings
  - Ramps
  - Tilt in space shower chair
  - Inflatable tub
  - Orthotics (solid vs articulated)
  - Standers
Why is rehab important in DOC?
Rehab Implications

• Multiple studies show that DOC is NOT a static condition and thus require ongoing monitoring, assessment, and care.
  • Caterina et al
  • Williams, Sattin, Vingerhoets, and Leonardi

• Nehra et al found that trauma patients who discharged to an IRF had:
  – Increased functional independence scores
  – Increased likelihood of discharging home
  – Decreased 1-year mortality
Who should be involved?
The Interdisciplinary Team

- Doctor(s)
- Nurse/PCA
- Pharmacist
- Social worker
- Case manager
- PT
- OT
- Speech
- Neuropsychology
- Dietitian
- Respiratory therapist
- Therapeutic recreation specialist
- Music therapist
- Chaplain
- Patient/Family/Caregiver
Disorders of Consciousness (DOC) Program

• 2 week evaluation period – the focus will be:
  – Determine level of consciousness
  – Rule out secondary medical causes of decreased level of consciousness
  – Trial meds for stimulation
  – Determine future recommendations

• Initial rounds: extended to 30 min to discuss goals of admission, determine best ways to assess consciousness
• While LOS will initially start at 2 week, this could be extended if primary team deemed it necessary/appropriate

• Exit criteria from program: when a patient is appropriate to transition to the standard BI program
  – Same criteria that clinically indicates exit from the MCS (functional object use and/or communication)
Paired Assessment Team

• Leverage skills of cognitive/physical function emphasis amongst team members

• Provide two observers to monitor for responses

• Obtain input from primary team to facilitate selection of appropriate commands, etc.

• Twice weekly administration – (PT/SLP) and (OT/NP)
  – Or as needed based on availability of staff and other therapy goals
What role does the family play?
Role of family

- Understand family
  - Do they want to know? How much? What’s their level of education regarding BI? In what terms will they best understand.
- Be sensitive to family needs
- Understand families level of education regarding BI
- Provide education when family is emotionally ready; don’t force
- Provide basic BI information: educate family in a general sense and then move to more specific ramifications of injury on the patient as rapport is built
- Be honest based on quantitative assessment
Family Involvement with Testing

- Family members, or others with recognizable voices, may assist to elicit a response from the patient, but they must understand that the test is objective.

- Typical Questions Received from Family:
  - Why are you doing this test?
  - Answer: We are using this tool to help us find the best way to communicate with your family member.
  - What does the score mean?
  - Answer: The score may vary and depends on many different factors, but it usually highlights which communication method is the strongest.

- Try to encourage the family not to get caught up on the number.
Caregiver Training

• Importance
  – Almost all caregivers of a study stressed the importance of being informed about their relatives’ health condition, being able to take care of them, being involved in decisions that affect their relatives and easily communicating with operators of the treating team (Leonardi, 2012)
Caregiver Considerations

- Interventions should be aimed at minimizing caregiver burden and developing individualized disability management programs.

- Therapists working with this patient population should consider the needs of the individual patient in the context of their family/care environment and recognize ease of care-giver burden as a meaningful outcome. (Wheatley-Smith, 2013)
Caregiver perceptions of Physical Therapy in DOC

- Physical therapy is viewed as a vital part of good care.
  - Clear communication is critical if it is reduced or withdrawn
- The purpose of PT can be misinterpreted by family members
  - Give clear expectations; what it can and cannot achieve
- Some families can find some interventions difficult to watch
  - Explain what interventions may be expected
- PT’s and families can attribute different meanings to physical therapy
  - Identify how families view PT and modify explanations to improve understanding.

Latchem, Kitzinger, and Kitzinger
Caregiver Burden

Researchers also found that vegetative patients’ spouses used different ways of coping: some were helped with spiritual support, some abandoned their social lives and disconnected from their friends; some stopped reading books and watching television. All of the spouses reported that they preferred not to deal with the possibility of death. (Hamama-Raz, 2013)
Caregiver Burden

• Study of wives with husbands in a vegetative state
  – Initially, the meaning of love and loyalty to the husband intensified and increased the energy to care for him, the sense of obligation to the husband and the family, and acceptance of the situation.
  – Then, as the husband’s vegetative state continued, the wives described an escalation of negative feelings toward the situation, such as sadness, pain, a sense of loneliness and loss of togetherness, reduced hope for change, and a sense of mourning. (Hamama-Raz, 2013)
• As care-giving is a long-term commitment process, support to the caregiver should be guaranteed throughout the duration of the relative’s disease

• Early involvement of caregivers in a comprehensive process of care should be guaranteed by healthcare supporting programs (Giovannetti, 2012)
Caregiver support

• Franscesco et al found that psychological support/counseling for caregivers decreased anxiety and stress levels as well as improved QOL measures.
  – Independent of diagnosis (VS and MCS)

• Chiara Zucchella et al found that use of telemonitoring/communication:
  – Improved caregivers’ QOL
  – Decreased caregiver anxiety and depression
  – Increased caregiver degree of satisfaction regarding interventions
  – Decreased cost per day for a patient
What happens next?
Discharge Planning

• Skilled Nursing Facility vs. Home Health vs. Outpatient

• Appropriate time to discharge
  – Medically stable
  – Can move on to next level of care

• Often met with resistance (see as giving up)
  – Setting clear expectations from the beginning
  – Giving family clear expectations from OP
  – Giving family goals to work on at home that if pt meets/progressed then they can set-up a time to be re-evaluated again for either IP or OP

• Working with Social Worker and Case Manager to help with realistic length of stay goals
What if the patient never shows signs of consciousness?
Discussion

How do you feel about withdrawal of care with this patient population?
Discussion

• Life and death
  – Is MCS better than Vegetative?
• Withdrawal of care
  – Kitzinger and Kitzinger performed interviews with 51 individuals with a relative who is/was in a vegetative or MCS
    • Families generally arrived at the conclusion that the person would rather be dead (after exhausting all the possibilities)
    • Despite this, many families are not willing to consider withdrawal of artificial nutrition and hydration (ANH)
Questions


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TIRR Memorial Hermann and the Memorial Hermann Rehabilitation Network

TIRR Memorial Hermann Entities

Memorial Hermann Rehabilitation Network Entities