**Traumatic Brain Injury (Minimally Conscious State)**

**Introduction:**

In the U.S there are nearly 1.7 million people who suffer from a traumatic brain injury (TBI) each year1 and 5.3 million are living with TBI-related disability2. The top three causes of TBI are motor vehicle accidents, gunshot wounds, and falls.2 Blasts are the leading cause of TBI in active duty military personnel in war zones.2 Types of severe TBI include closed injury and open injury and the related symptoms correlate with the extent of the damage.2 There are a wide range of short-term and long-term outcomes that can result from TBI including those related to cognitive function, motor function, sensation, and emotion. Some of the most important influences on outcome in persons’ with TBI are prevention, early management, and treatment.2

An estimated 56-170: 1 million people sustain prolonged loss of consciousness per year in the U.S.3 People who acquire a severe TBI may transition from being in a coma or a vegetative state, and then progress into a minimally conscious state (MCS). A MCS has been described as a “severely altered consciousness in which the person demonstrates minimal but definite behavioral evidence of self or environmental awareness.”3 Criteria developed to characterize the diagnosis of the transition into a MCS include: comprehension of simple commands, manipulation of objects, gestural or verbal yes/no response, intelligible verbalizations, and stereotyped movements (non-reflexive).4 On the Rancho Los Amigos coma scale this is categorized as Level III- Localized Response.5 Research has proposed that the emergence of functional communication and functional object use are characteristic of the progression out of a MCS.3 Furthermore, studies have sought to enhance the reliability of emergence from a MCS by proposing that functional communication is defined as accurate yes/no responses to six out of six questions.3

In addition, there are primary injuries and secondary injuries associated with TBI. Primary injury includes the initial focal destruction of brain tissue sustained at impact (i.e. coup/contrecoup lesions), which then result in secondary injuries, which are responses to the initial injury (i.e. hematoma).2 An example of a secondary injury is diffuse axonal injury (DAI), which results from changes on a subcellular level that can alter axon function and nerve signaling, as well as predict morbidity and mortality.2 Other secondary injuries include hypoxic-ischemic injury, caused by lack of oxygenated blood flow to the brain tissue, and increased intracranial pressure (ICP), caused from hematomas.10 Hematomas are classified based on their location (epidural, subdural, intracerebral) and increased ICP causes this herniation of the brain, which can also lead to cell death.10 Research of pharmacology interventions and other rehabilitation interventions to reduce the effects of secondary injury has been conducted for many years, and will be discussed further below.

**APTA Guide Patterns:**

The *APTA Guide to Physical Therapist Practice* provides practice patterns related to individuals with TBI are6:

* 5C: Impaired motor function and sensory integrity associated with nonprogressive disorders of the central nervous system—congenital origins or acquired in infancy or childhood
* 5D: Impaired motor function and sensory integrity associated with nonprogressive disorders of the central nervous system—acquired in adolescence or adulthood
* 5I: Impaired arousal, range of motion, and motor control associated with coma, near coma, or vegetative state

**Pathology/Pathophysiology of Systems Affected:**

TBI can affect a number of systems within the body. The damage depends on the mechanism of injury to the head, the location and type of the injury, and any associated secondary injuries. More specifically, for those in a prolonged MCS, body systems can be greatly affected.

1. *Pulmonary*: Individuals who sustain a TBI may or may not need help breathing with mechanical ventilation. If lung function is working properly, those within a MCS may be at risk for the development of pulmonary complications and decreased function. Proper drainage, clearance, and respiration must be carefully monitored to prevent infections such as pneumonia.10
2. *Cardiovascular & Circulatory*: Those in a MCS are limited in their mobility and can be bed ridden for long periods of time. Positioning and limb movement can affect decreased circulation, which results in decreased stroke volume and cardiac output. These individuals are at risk for deep vein thrombosis, and hypotension.10
3. *Integumentary*: Prolonged bed rest can cause increased pressure on bony prominences and skin breakdown without proper positioning and mobility. The development of decubiti in individuals is more likely for those with longer durations in a MCS.10
4. *Neuromuscular*: Hypertonicity is common in a severe TBI. Those in a MCS can develop decorticate or decerebrate rigidity depending on the area of the lesion. Alterations in sensation including light touch, pain, deep pressure, temperature, proprioception and kinesthesia may be present. Ambulation, balance, and motor control impairments such as hemiparesis, monoparesis, teraparesis, and/or abnormal reflexes may also be present.10
5. *Musculoskeletal*: Increased periods of immobilization, abnormal muscle tone, and localized tissue trauma can increase the risk of heterotopic ossification (HO) development. HO occurs in 10-20% of adult patients after TBI, and is characterized by bone formation in periarticular tissues, causing pain and restricted joint motion.11
6. *Cognitive/Behavioral/Communication*: Presence of inconsistent cognitive-mediated behavior, memory loss (post-traumatic amnesia), attention deficits, and orientation deficits may be present. Aphasia, dysarthria, dysphagia, decreased drive, disinhibited or impulsive, altered emotional responseslack of awareness, and self-centeredness can develop throughout the emergence of a MCS.10
7. *Digestive & Urinary*: Immobility and altered consciousness can affect feeding, digestion, and elimination for those in a MCS. Feeding through tubes, and elimination through catheters are common. Digestion is slowed from immobility and can cause constipation, which can be managed with medication.12

**Impairments:**

Impairments that result from TBI vary on the reason the TBI occurred, the severity, and other secondary injuries. A person who is categorized as being within a MCS may present with the following impairments related to:6

* Motor function (motor control and motor learning)
* Muscle performance
* Aerobic capacity/endurance
* Impaired gait
* Balance and functional mobility
* Sensory integrity
* Abnormal muscle tone
* Arousal, attention, and cognition
* Circulation (arterial, venous, lymphatic)
* Cranial and peripheral nerve integrity
* Integumentary integrity
* Joint integrity and mobility
* Joint contracture
* Reflex integrity
* Posture
* Pain
* Self-care

**Activity/Participation Limitations:**

The majority of patients admitted with severe TBI in a MCS emerge within 7 weeks, while those in a vegetative state (VS) can take up to 16 weeks.8 The duration of MCS is a strong predictor of duration of post-traumatic amnesia, which can cause confusion and activity/participation delays. At 1-year post-TBI, nearly 50% of patients who emerged from MCS are independent at home, return to work/school, or are near pre-injury levels.8 Additional challenges include secondary complications during post-TBI hospital stay and rehabilitation. Many patients with prolonged hospital stays frequently acquire contractures, pressure sores, respiratory complications, urinary tract infections, and malnutrition.9 Taking action within acute care and inpatient rehabilitation units is important in the prevention of developing secondary functional complications.

Participation involves the domains of household and domestic chores, shopping, social outings, employment, and relationships.7 Some of the biggest challenges affecting participation post-TBI are the mechanism, severity and location of the primary injury, secondary injury, and its resulting activity limitations (temporary vs permanent), which can restrict some or all of the above domains.

**Environmental/Individual Factors:**

Environmental and individual factors involve quality of life (QoL) in persons who are in a MCS. QoL is directly related to participation rates and includes physical and psychological health, independence, relationships, and how all of these domains interact with the person’s environment.7 QoL is hard to determine in the acute stages of TBI especially with those in a MCS. Depending on the duration of a MCS along with activity and participation gains, QoL should be continually assessed throughout recovery. Additional factors that may affect the individual and their environment as a direct result of impairments and activity/ participation limitations are occupation, social integration, required assistance, depression/anxiety, and secondary complications or comorbidities.13

**Interventions:**

The first and most important aspect of TBI intervention is a multidisciplinary approach. This includes the involvement of the patient and family, physician, speech-language pathologist, occupational therapist, physical therapist, recreational therapist, nursing, case manager, social worker, and neuropsychologist.10 After the identification of a MCS in an individual who has sustained a TBI, the next step is to address the associated impairments to improve outcomes.

The use of neuroimaging studies such as CT, MRI, x-ray, and lab values can help track recovery or secondary complications. Maintaining the patient’s vital signs and monitoring the ICP are critical in keeping the patient stable.10 An example of a secondary complication that may require surgical intervention is the formation of HO. Testing for increased serum alkaline phosphatase can help with the early identification and prevent large mass bone formation and forceful manipulation under anesthesia.11

Physical therapy intervention for a MCS after TBI include passive range of motion (PROM). This will help to improve joint mobility and integrity as well as reduce the risk of secondary impairments such as contracture and hypertonicity. Proper positioning in the bed, chair, or wheelchair is important for preventing skin breakdown, maintaining hygiene, and promoting proper circulation and respiration. The use of multipodus boots, help foot and ankle positioning, splinting and serial casting, tilt in space wheel chairs help patient upright posture, and cushions, headrest, chest straps, foot plates, and tray tables can also be adjusted.10

Additionally, physical therapy can help to improve arousal through sensory stimulation techniques.10,11 Support for this approach includes the effects of sensory deprivation on neurological recovery, effects of enriched environments on behavior and nervous system structure and function, nervous system plasticity, and effects of environmental input during sensitive periods of neurodevelopment.10 A graded presentation of visual, auditory, olfactory, vestibular, and tactile stimulation should all be included in this intervention.11 Those in a MCS may be unaware to respond motorically but are intact cognitively, thus the physical therapist should also converse with the patient to assess orientation and awareness during treatment.11

An Advanced Care Protocol (ACP) has been shown to improve the rates of clinical progression from baseline to discharge in those recovering from a consciousness disorder (VS or MCS-TBI).14 The combination of medications, median nerve stimulation, neutraceruticals, and traditional therapies (PT, OT, SLP) were administered over the course of 12-weeks, with MCS patients showing a 100% clinical improvement at time of discharge. As previously stated, the duration of MCS is an important indicator in the improvement of activity limitations, participation, and quality of life after a TBI.

There are a variety of medications that can be used to manage recovery for those in a MCS after TBI. These may include analgesics for pain relief and management, anti-anxiety agents, anti-coagulants, anti-convulsants, anti-depressants, anti-psychotics, muscle relaxants, sedative-hypotonic agents, and stimulatnts.15

Dopamine is a general stimulatory neurotransmitter that is important in the maintenance of the circadian rhythms. Thus, many dopaminergic agonists have been used to treat VS and MCS. Because many medications are taken orally, this can present problems with those in these states, therefore, apomorphine has been considered. Apomorphine is administered subcutaneously and is rapidly absorbed. Little research supports its use, however there has been reported success with its administration in a MCS. In addition to apomorphine treatment, 2 hours of inpatient sensory stimulation and 1 hour of general mobilization was given. This particular patient demonstrated rapid awakening within the first 24 hours of treatment (104 days after TBI). Within 4 days the patient was naming objects, 13 days he was lifting his legs, 6 months he was walking with a RW, and 2 years later he was playing polo.12

Depending on the outcomes present at discharge from an inpatient rehabilitation setting, it is important to return to the interdisciplinary approach for the decision of continued care. This can include outpatient therapy, home health services, subacute rehabilitation and skilled nursing facilities, community re-entry programs, and independent living programs.15

Patient and/or family education is vital for those who will be considered a caregiver for these individuals in recovery. Addressing conflicts, worries, stresses, time, (etc) is key along with the designated therapy concerns. Proper positioning, ROM exercises, sensory stimulation and emergency contact information needs to be demonstrated and provided.10

Overall, a variety of intervention techniques may be used to manage the recovery and outcomes of people post-TBI in a MCS. Incorporation of various interventions highly depends on the progression through conscious levels. Those who remain in a MCS will need interventions tailored towards preventative and maintenance measures. Those who progress out of a MCS will focus on higher mobility and cognition interventions.s

**References:**

1. CDC website. Injury Prevention & Control: Traumatic Brain Injury. Centers for Disease Control and Prevention. Updated March 18, 2013. Accessed from: <http://www.cdc.gov/TraumaticBrainInjury/index.html>.
2. Greve MW, Zink BJ. Pathophysiology of traumatic brain injury. *Mount Sinai Journal of Medicine*. 2009; 76: 97-104.
3. Giacino JT, Ashwal S, Childs N, et al. The minimally conscious state: definition and diagnostic criteria. *Neurology*. 2002; 58: 349-53.
4. Taylor CM, et al. Sequence of recovery during the course of emergence from the minimally conscious state. *Arch Phys Med Rehabil*. 2007; 88: 521-525.
5. Rancho Los Amigos National Rehabilitation Center. Family Guide to the Rancho Levels of Cognitive Functioning. Accessed February 27, 2013. Retrieved from: <http://www.rancho.org/research/bi_cognition.pdf>.
6. APTA Interactive Guide to Physical Therapist Practice. American Physical Therapy Association. 2003. doi: 10.2522/ptguide.978-1-931369-64-0.
7. Williams G, Willmott C. Higher levels of mobility are associated with greater societal participation and better quality of life. *Brain Injury*. 2012; 26(9): 1065-1071.
8. Katz DI, Polyak M, Coughlan D, Nicols M, Roche A. Natural history of recovery from brain injury after prolonged disorders of consciousness: outcome of patients admitted to inpatient rehabilitation with 1-4 year follow-up. *Progress in Brain Research*. 2009; 177: 73-88.
9. Denes Z. Consequence of secondary complications during the rehabilitation of patients with severe brain injury. *Orv Hetil*. 2009; 150(4): 165-9.
10. O’Sullivan S. and Schmitz T. Ch. 22-Traumatic Brain Injury. *Physical Rehabilitation*. 5th ed. 2007. F.A. Davis Company. Philadelphia, PA. p895-922.
11. McCulloch K, Crea D. Current concepts in the management of patients with traumatic brain injury. Topics in Physical Therapy: Neurology. Lesson 10: p1-29.
12. Fridman EA, et al. Fast awakening from minimally conscious state with apomorphine. *Brain Injury*. 2009; 23(2): 172-177.
13. Whiteneck G, Brooks CA, Mellick D, Harrison-Felix C, Terrill MS, Noble K. Population-based estimates of outcomes after hospitalization for traumatic brain injury in Colorado. *Arch Phys Med Rehabil*. 2004; 85(4 suppl 2): S73-81.
14. DeFina PA, Fellus J, Thompson JW, Eller M, Moser RS, Frisna PG, et al. Improving outcomes of severe disorders of consciousness. *Restor Neurol Neurosci*. 2010; 28(6): 769-80.
15. BIAA website. Treatment: medications. Brain Injury Association of America. Updated 2013. Retrieved from: <http://biausa.fyrian.com/brain-injury-treatment.htm>.