

RULE 17 EXHIBIT 10

**Traumatic Brain Injury
Medical Treatment Guidelines**

Revised: September 29, 2005

Effective: January 1, 2006

Adopted: January 8, 1998

Effective: March 15, 1998

Revised: March 1, 2005

Effective: May 1, 2005

Presented by:

State of Colorado

**Department of Labor and Employment
DIVISION OF WORKERS' COMPENSATION**



ERRATA FOR RULE 17, EXHIBIT 10-TRAUMATIC BRAIN INJURY MEDICAL TREATMENT GUIDELINES

Please note the following errors in the Traumatic Brain Injury Medical Treatment Guidelines. These errata will be recommended changes during the next applicable rules hearing.

1. Section E. 6. Electrodiagnostic Studies

After 'a. EMG and Nerve Conduction Studies,' there should be a subsection entitled, '**b. Electroneuronography (EnoG):**' that states

'b. Electroneuronography (EnoG): is a well-established and generally accepted test that measures facial nerve function. This test measures the action potential of different branches of the facial nerve. It is used in individuals with TBI resulting in a facial paralysis and is key in determining the need for surgical intervention. This test is most useful within the first three weeks of facial nerve dysfunction. If the action potentials on the affected side are 90-100% less than those on the normal side, it suggests significant injury to the nerve and calls for surgical exploration. Individuals with TBI whose nerve is less than 90% decreased in function have a reasonably good outcome with observation alone.'

2. Section E. 9. c. iv. Audiometry and Otology, Vestibular Function Tests, Electrocochleography (ECoG):

The text for *Electrocochleography* was incorrectly replaced by the text for *Electroneuronography*. The correct description of *Electrocochleography* is as follows:

'iv. Electrocochleography (ECoG): is a well-established and generally accepted procedure that tests endolymphatic fluid pressures indirectly. It is helpful in diagnosing cases of post-traumatic endolymphatic hydrops and also post-traumatic perilymphatic fistula.

The inner ear has two fluid chambers – the perilymphatic and the endolymphatic. After TBI, it is not uncommon for patients to develop an increase in the endolymphatic fluid pressure; this condition is called hydrops. When the endolymphatic pressures are abnormally high, the inner ear membranes distend, and the ear malfunctions. Symptoms include hearing loss, dizziness that is sporadic, tinnitus, aural fullness and sensitivity to sound.

Another condition that often occurs after TBI is perilymphatic fistula. The trauma itself can cause a rupture of inner ear membranes and a subsequent leak of the perilymph. This can cause symptoms of hearing loss and dizziness, especially with any pressure changes (e.g. Valsava, airplanes, diving)

The ECoG is another test that uses evoked potentials. The patient listens to a series of clicks. Monitors, including one sitting on the tympanic membrane, measure three potentials: the cochlear microphonic, the summing potential (SP), and the action potential (AP). The ratio of the summing potential to the action potential (SP/AP) increases in the presence of hydrops or perilymphatic fistula. The test is more specific than it is sensitive. A normal result does not necessarily rule out pathology. An abnormal result usually is evidence that pathology exists.'

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DEPARTMENT OF LABOR AND EMPLOYMENT

Division of Workers' Compensation CCR 1101-3

RULE 17 EXHIBIT 10

TRAUMATIC BRAIN INJURY MEDICAL TREATMENT GUIDELINES

A. INTRODUCTION

This document has been prepared by the Colorado Department of Labor and Employment, Division of Workers' Compensation (Division) and should be interpreted within the context of guidelines for physicians/providers treating individuals qualifying under Colorado Workers' Compensation Act as injured workers with traumatic brain injury (TBI).

Although the primary purposes of this document for practitioners are advisory and educational, these guidelines are enforceable under the Workers' Compensation Rules of Procedure, 7 CCR 1101-3. The Division recognizes that acceptable medical practice may include deviations from these guidelines, as individual cases dictate. Therefore, these guidelines are not relevant as evidence of a provider's legal standard of professional care.

To properly utilize this document, the reader should not skip or overlook any sections.

B. GENERAL GUIDELINE PRINCIPLES

The principles summarized in this section are key to the intended implementation of these guidelines and are critical to the reader's application of the guidelines in this document.

1. **APPLICATION OF GUIDELINES** The Division provides procedures to implement medical treatment guidelines and to foster communication to resolve disputes among the provider, payer and patient through the Workers' Compensation Rules of Procedure. In lieu of more costly litigation, parties may wish to seek administrative dispute resolution services through the Division or the office of administrative courts.
2. **EDUCATION** of the individual and/or family/support system, as well as the employer, insurer, policy makers and the community should be the primary emphasis in the treatment of TBI and disability. Currently, practitioners often think of education last, after medications, manual therapy and surgery. Practitioners must develop and implement an effective strategy and skills to educate individuals with TBI, employers, insurance systems, policy makers and the community as a whole. An education-based paradigm should always start with inexpensive communication providing reassuring information to the individual with TBI. More in-depth education currently exists within a treatment regime employing functional restorative and innovative programs of prevention and rehabilitation. No treatment plan is complete without addressing issues of individual and/or family/support system education as a means of facilitating self-management of symptoms and prevention.
3. **TREATMENT PARAMETER DURATION** Time frames for specific interventions commence once treatments have been initiated, not on the date of injury. Obviously, duration will be impacted by individual's compliance, as well as availability of services. Clinical judgment may substantiate the need to accelerate or decelerate the time frames discussed in this document.
4. **ACTIVE INTERVENTIONS** emphasizing personal responsibility, such as therapeutic exercise and/or functional treatment, are generally emphasized over passive modalities, especially as treatment progresses. Generally, passive and palliative interventions are viewed as a means to facilitate progress in an active rehabilitation program with concomitant attainment of objective functional gains.
5. **ACTIVE THERAPEUTIC EXERCISE PROGRAM** goals should incorporate strength, endurance, flexibility, coordination, and education. This includes functional application in vocational or community settings.
6. **POSITIVE PATIENT RESPONSE** results are defined primarily as functional gains which may be objectively measured. Objective functional gains include, but are not limited to, positional tolerances, range-of-motion, strength, and endurance, activities of daily living, cognition, psychological behavior, and efficiency/velocity measures which may be quantified. Subjective reports of pain and function should be considered and given relative weight when the pain has anatomic and physiologic correlation. Anatomic correlation must be based upon objective findings.
7. **RE-EVALUATE TREATMENT EVERY 3 TO 4 WEEKS** If a given treatment or modality is not producing positive results within three to four weeks, the treatment should be either

modified or discontinued. Reconsideration of diagnosis should also occur in the event of poor response to a seemingly rational intervention.

8. **SURGICAL INTERVENTIONS** should be contemplated within the context of expected functional outcome and not purely for the purpose of pain relief. The concept of "cure" with respect to surgical treatment by itself is generally a misnomer. All operative interventions must be based upon positive correlation of clinical findings, clinical course and diagnostic tests. A comprehensive assimilation of these factors must lead to a specific diagnosis with positive identification of pathologic condition(s).
9. **RETURN TO WORK** following TBI involves a skillful match between the individual's abilities (physical, cognitive, emotional, and behavioral) and the work requirements.

The practitioner must write detailed restrictions when returning an individual with TBI to limited duty. The provider must consider cognitive and behavioral workplace demands in the preparation of a return to work plan. The individual with TBI should never be released to "sedentary or light duty" without specific physical or cognitive limitations. The practitioner must understand all of the physical, cognitive, and behavioral demands of the individual's job position before returning him/her to full duty and should request clarification of job duties. Clarification should be obtained from the employer or if necessary, including an occupational health nurse, occupational therapist, speech therapist, vocational rehabilitation specialist, industrial hygienist, or other appropriately trained professional.

10. **DELAYED RECOVERY** All individuals with moderate/severe TBI will require an integrated system of care. For individuals with mild TBI (MTBI), strongly consider a neuropsychological evaluation, if not previously provided, as well as initiating interdisciplinary rehabilitation treatment and vocational goal setting, for those who are failing to make expected progress 6 to 12 weeks after an injury. In individuals with MTBI, neurological recovery is generally achieved at one year post-injury, but functional improvements may be made beyond one year. Neurological recovery following moderate/severe brain injury is greatest in the first 12 months post-injury, but may occur for up to two years post-injury, with further functional improvements beyond two years. The Division recognizes that 3 to 10% of all industrially injured individuals will not recover within the timelines outlined in this document despite optimal care. Such individuals may require treatment beyond the limits discussed within this document, but such treatment will require clear documentation by the authorized treating practitioner focusing on objective functional gains afforded by further treatment.

11. **GUIDELINE RECOMMENDATIONS AND INCLUSION OF MEDICAL EVIDENCE**

Guideline recommendations are based on available evidence and/or consensus recommendations. When possible, guideline recommendations will note the level of evidence supporting the treatment recommendation. When interpreting medical evidence statements in the guideline, the following apply:

Consensus means the opinion of experienced professionals based on general medical principles. Consensus recommendations are designated in the guideline as "generally well-accepted," "generally accepted," "acceptable," or "well-established."

“Some” means the recommendation considered at least one adequate scientific study, which reported that a treatment was effective.

“Good” means the recommendation considered the availability of multiple adequate scientific studies or at least one relevant high-quality scientific study, which reported that a treatment was effective.

“Strong” means the recommendation considered the availability of multiple relevant and high quality scientific studies, which arrived at similar conclusions about the effectiveness of a treatment.

All recommendations in this guideline are considered to represent reasonable care in appropriately selected cases, regardless of the level of evidence attached to it. Those procedures considered inappropriate, unreasonable, or unnecessary, are designated in the guideline as “not recommended.”

The remainder of this document should be interpreted within the parameters of these guideline principles that may lead to more optimal medical and functional outcomes for injured workers.

C. INTRODUCTION TO TBI AND PHILOSOPHY OF CARE

1. **DEFINITIONS AND DIAGNOSIS OF TBI** Before a diagnosis of TBI is made, the physician must assess the level of trauma to which the individual was exposed using available objective evidence. A diagnosis of TBI should be determined by the criteria listed below. Severity of initial impairment following brain injury is subdivided into two major categories, Mild (MTBI) and moderate/severe TBI. These definitions apply to the initial severity of impairment, and do not necessarily define or describe the degree of subsequent impairment or disability. Further, they do not necessarily define or describe the need for the subsequent type, intensity, or frequency of treatment.
 - a. **Mild TBI (MTBI):** is defined as a traumatically induced physiological disruption of brain function, as manifested by at least one of the following:
 - i. Any period of loss of consciousness up to 30 minutes
 - ii. Any dysfunction of memory for events immediately before or after the accident
 - iii. Any alteration in mental state at the time of the accident, e.g., transient confusion, disorientation, impaired consciousness
 - iv. Focal neurological deficit(s) that may or may not be transient; but where the severity of the injury does not exceed the following:
 - A) Loss of consciousness of approximately 30 minutes
 - B) At 30 minutes, an initial Glasgow Coma Scale (GCS) of 13-15, and
 - C) Post-traumatic amnesia (PTA) not greater than 24 hours
 - D) The individual with TBI should have no evidence of traumatically induced intracranial lesion on neuroimaging studies and have had other possible causes of alterations in mental status ruled out
 - b. **Moderate/severe TBI:** is defined as a traumatically induced physiological disruption of brain function, at least one of the following:
 - i. Loss of consciousness of greater than 30 minutes
 - ii. PTA greater than 24 hours
 - iii. Evidence of traumatically induced intracranial lesion on neuroimaging studies
2. **INTERVENTION** Early identification and early intervention by providers with specialty training and experience is critical in diagnosis, treatment and management of individuals with traumatic brain injury. Brain injury treatment may also require immediate

interdisciplinary evaluation and treatment. The treatment and ultimate functional outcome of individuals with TBI depends upon a complex, interacting set of pre-injury, injury, and post-injury factors. Treatment programs should be specialized, based upon a comprehensive data set, both functional, goal and outcome-oriented, and should be delivered in the least restrictive setting(s) possible. Treatment settings may include hospitals, outpatient settings, residential settings, home, and community settings. Treatment should be well managed and time-limited, based upon progress.

The provision of the on-site case managers familiar with brain injury rehabilitation treatment protocols is well-accepted and recommended for all moderate/severe TBI cases, and for select mild traumatic brain injury (MTBI) cases, based upon complexity and need.

3. **EDUCATION** Outcome following TBI is often dependent on the health, education, and resources of the individual's family. Therefore, education of the individual and/or family/support system, insurer, case manager and employer should be a primary emphasis in the treatment and management of individuals with TBI. Providers should develop and implement effective strategies and forums to include family members with the interdisciplinary treatment team. Education for individuals and/or their family/support system should include, but is not limited to: communication of basic information about the brain and the effects of brain injury on behavior, cognition, physical function, appropriate family interventions, and possible long-term outcomes. Insurance carriers, case managers, and treatment providers are highly encouraged to provide education and support services to families in order to maximize treatment outcomes and the durability of those outcomes. Further in-depth education may be required to maximize the individual's potential for functional living. Treatment plans should include individual and group education as a means of facilitating self-awareness, self-management and prevention of secondary disability.
4. **RETURN-TO-WORK** This involves a skillful match between the individual's physical, cognitive, emotional, behavioral abilities, and the physical, cognitive, emotional, and behavioral requirements of the work. Successful return-to-work activities should usually include vocational evaluation, job analysis, supervisor and coworker education, on-the-job-trials, monitored and skillful increased titration of job duties and demands, job coaching, and follow-up maintenance support services.
5. **DISABILITY** The World Health Organization (WHO) conceives of disability as the interaction among health conditions and environmental factors, such as social and legal structures, personal factors, including age, education and coping styles.

A model of disablement known as the Nagi scheme defines:

- Active pathology/diseases as the interruption of/or interference with normal process, and efforts of the organism to regain normal state
- Impairment as anatomical, physiological, mental, emotional abnormalities, or loss of structure or function
- Functional limitation as the restriction of the ability to perform a physical or cognitive action, task or activity at the level of the whole person

- Disability as the limitation in performance of socially defined roles and tasks within a socio-cultural physical environment

For the purposes of these guidelines, we are adopting the Nagi scheme of disablement.

Because of the nature of TBI and the nature of learning and memory, functional skills often cannot be generalized across working environments. Therefore, the evaluation, treatment, and assessment of disability must not only consider the injured worker, but also include evaluations of the individual's "real world" environment, conducted by qualified practitioners.

6. **COURSE OF RECOVERY** In individuals with MTBI, neurological recovery is generally achieved at one year post-injury, but functional improvements may be made beyond one year. Neurological recovery following moderate/severe brain injury is greatest in the first 12 months post-injury, but may occur for up to two years post-injury, with further functional improvements beyond two years.

Due to the uncertain evolving nature of disability secondary to TBI, individuals with TBI may either improve or deteriorate over time. In most cases of moderate/severe brain injury, and in some unusual circumstances of MTBI, impairment will be life-long, and will require a life-long maintenance plan of services. Complications may warrant periods of active treatment in addition to the maintenance plan.

In at least 40% of cases, TBI is accompanied by other substantial trauma (e.g. internal, orthopedic injuries), which may involve dysfunction in other bodily systems. Users of these TBI Guidelines are encouraged to use appropriate guidelines for other disorders and dysfunction as the need arises.

7. **GUARDIANSHIP AND CONSERVATORSHIP** Individuals with TBI may clinically be determined to be unable to make competent and informed decisions concerning their medical care, housing, and/or finances. Health care providers, insurance carriers, and case managers should become familiar with Colorado laws regarding guardianship, conservatorship, medical power of attorney, advanced directives, living wills, etc., and provide family members with appropriate education and/or resources concerning these issues when clinically indicated.
8. **SYSTEMS OF CARE** Integrated systems of care have been established in Colorado with the goal of assisting individuals with TBI in progressing along a continuum of care toward achieving optimal clinical outcomes as efficiently and as cost-effectively as possible (**Figure 1**). Long-term outcome and "value" are recognized as superior to short-term price-driven management. (**Please go to next page**).

TBI Model System of Continuum of Care

Figure 1: Continuum of Care (adapted from the Rocky Mountain Regional Brain Injury System)

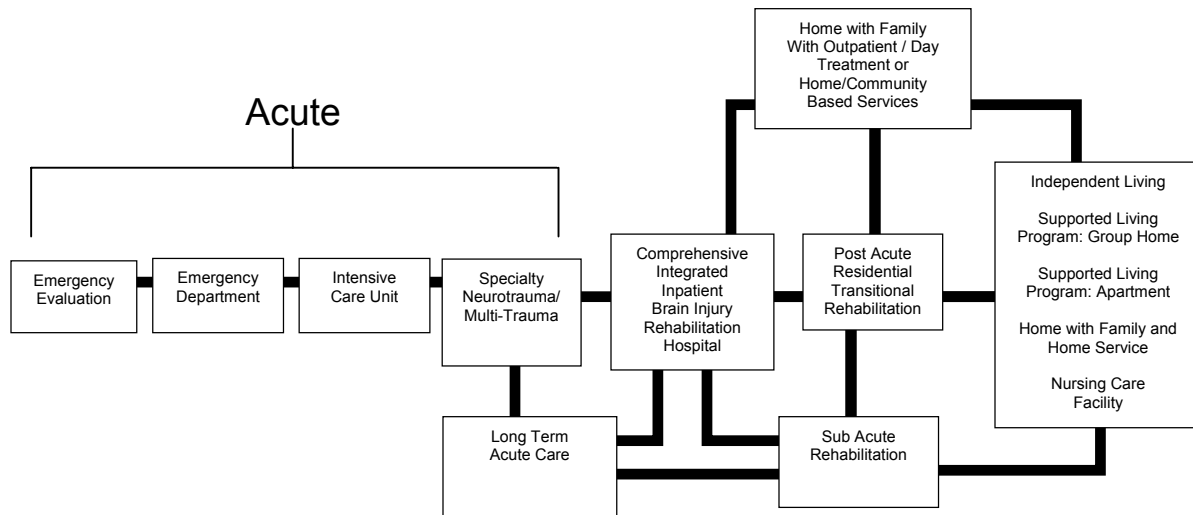


Figure 1 shows a schematic depicting an organized continuum of care for individuals with moderate/severe traumatic brain injury. The system is not a locked-step progression, but an array of TBI programs and services based on individual needs.

Individuals with brain injury respond to different programs and services based on their condition and needs. Individual treatment plans should be based upon the nature of the neurological and medical injuries and each person's specific goals.

The type, amount, frequency and duration of medical, rehabilitation, and long-term services are determined by the degree of functional improvement within specific time frames as well as the individual's potential to achieve additional, measurable functional improvements with continued provision of services. Decisions concerning treatment within the continuum of care should be made by specialists in traumatic brain injury in conjunction with the individual with TBI, family and/or support system. The following paragraphs describe care programs commonly used by individuals with moderate/severe brain injuries. Individuals with MTBI usually do not require most of inpatient and residential services described by the level of care reflected in this continuum.

- a. **Acute Care:** Established Emergency Medical Services (EMS) triage guidelines and organized pre-hospital trauma systems improve the delivery of trauma care and should be utilized. Trauma systems with identified regionally-designated

neuro-trauma centers (preferable Level I or Level II Trauma Centers) should be utilized for the acute care of individuals with traumatic brain injury. Neurotrauma centers should have a multidisciplinary trauma team, an in-house trauma surgeon, promptly available neurosurgeon, a continuously staffed Operating Room, Neuroscience nurses, Neuro-Intensive Care Unit, lab, and a CT immediately available at all times. Other team members should include orthopedists, radiologists, and anesthesiologists. Insurance carriers should develop programs to respond quickly to individuals with TBI and their families once moderate/severe TBI is identified. In these instances, insurance carriers are encouraged to deploy on-site case management to assist treatment providers, individuals and/or family support system. The American Association of Neurological Surgeons (AANS) published TBI acute care guidelines in 1995, which the Division supports.

- b. **Acute Rehabilitation:** Following medical stability, individuals with moderate/severe brain injury should be transferred from acute hospital care to a comprehensive integrated inpatient brain injury rehabilitation program (Refer to section G.1. Comprehensive Integrated Inpatient Rehabilitation). Acute brain injury rehabilitation hospitals should have a designated specialty program, with designated beds for brain-injured individuals, designated staff, treatment areas, therapy programs, equipment, and a sufficient number of individuals with TBI to constitute a peer and family milieu. Acute rehabilitation hospitals should be accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), and have components consistent with the Commission on Accreditation of Rehabilitation Facilities (CARF). CARF eligibility implies that programs meet specific care standards of design and efficacy.
- c. **Long-Term Acute Care (LTAC) Programs:** Some individuals will be unable to participate in a full inpatient program immediately following Acute Care and may need long-term acute care for a period of time prior to entering a comprehensive program. LTAC is a recognized designation (by the Centers for Medicare and Medicaid Services) for acute care hospitals whose average length of stay is at least 25 days. LTAC hospitals provide specialized care services, including skilled nursing care to manage medical conditions, so that individuals with catastrophic or acute illnesses/injuries may progress toward entry into comprehensive brain injury inpatient rehabilitation. LTAC programs should be accredited by the JCAHO. LTAC rehabilitation is generally accepted, but should not be used in lieu of categorical inpatient rehabilitation.
- d. **Subacute Rehabilitation Programs:** These programs are located on separate and specially licensed units of hospitals or nursing homes. Individuals appropriate for subacute care typically are medically stable, require skilled nursing care, and have either completed comprehensive inpatient rehabilitation, or are judged to not be able to benefit from inpatient rehabilitation. Subacute rehabilitation is generally accepted, but should not be used in lieu of categorical inpatient rehabilitation for individuals who may benefit from a comprehensive inpatient rehabilitation program. Subacute rehabilitation programs should be accredited by the JCAHO.
- e. **Post-Acute Rehabilitation:** This describes programs following inpatient rehabilitation including outpatient or day treatment rehabilitation, residential transitional rehabilitation, or home-based programs. The most appropriate post-

acute rehabilitation program is dependent on the individual's needs following inpatient rehabilitation, as well as proximity and availability of services, family dynamics, and projected long-term outcomes. Individuals with significant deficits or who require behavioral treatment or supervision for safety may require brain injury residential transitional rehabilitation. (Refer to section G 1.c-Residential Rehabilitation and e. Behavioral Programs). Other individuals may be able to use a combination of home and community-based rehabilitation and outpatient or day treatment rehabilitation. (Refer to sections G.1.d. Home and Community-based Rehabilitation and b. Outpatient Rehabilitation).

- f. **Long-Term Care:** The range of long-term outcomes following TBI is diverse from virtually complete independence and function to severe and permanent disability. Therefore, the range of needed services is complex and individualized. Some individuals with moderate/severe brain injury will require significant care and supervision, either at home by family or attendant care, or in a nursing care facility, or long-term supported living program. (Refer to sections G.1.g Supported Living Programs or Long-Term Care Residential Services). Individuals may also benefit from periodic re-evaluations, based on condition and needs (Refer to section I, Maintenance Management). Long-term care programs should be accredited by the JCAHO and have components consistent with certification by CARF. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

- 9. **INTERDISCIPLINARY TREATMENT TEAM** (may also be called multidisciplinary or transdisciplinary treatment) is an alliance of professionals from different medical or therapeutic disciplines (as described below) that provides a coordinated treatment program. The disciplines, which make up the team, will be determined by the particular treatment needs of the individual with TBI. The team establishes treatment priorities and goals and provides treatment. Team members contribute their respective skills, competencies, insight, and perspectives to the rehabilitation process. This includes education, communication, and alignment of expectations for the purpose of optimizing treatment outcomes. It is highly recommended that the individual with TBI, along with his or her family/support system, insurance carrier, and case manager, participate in team planning.

The most common disciplines involved in the medical and rehabilitation treatment of TBI include, but are not limited to:

- a. **Behavioral Psychologist:** A psychologist with special training, credentials, and licensing, who specializes in the area of behavior analysis and treatment.
- b. **Case Manager:** Case management is a collaborative process that assesses, plans, implements, coordinates, monitors, and evaluates the options and services required to meet an individual's health needs, using communication and available resources to promote quality, cost-effective outcomes. TBI case management operates with an underlying premise that when individuals reach their optimum level of wellness and functional capability, everyone benefits: the individuals being served, their support systems, the health care delivery system, and the insurance carriers.

The primary functions of TBI case management are:

- To maximize individual and family understanding, compliance, and treatment outcomes through education and support
 - To advocate for patient wellness and autonomy through advocacy, communication, and identification of service resources
 - To optimize patient access to appropriate health care services
 - To integrate and coordinate service delivery by multiple providers and to prevent fragmentation of services
 - To predict and avoid potential complications
- c. **Chiropractor:** A credentialed and licensed doctor of chiropractic, who assesses, treats, and manages musculoskeletal injuries and conditions utilizing joint manipulation and various therapies and modalities.
- d. **Clinical Psychologist:** A licensed psychologist with special training, credentials, and licensing, who specializes in the assessment and treatment of personality and personality disorders, education and adjustment counseling, psychotherapy, and management of behavior.
- e. **Neurologist:** A physician with special training and credentials in the area of the nervous system, who has successfully completed an approved residency in neurology.
- f. **Neuro-ophthalmologist:** An ophthalmologist or neurologist who has completed an approved residency in ophthalmology or neurology as well as a fellowship in neuro-ophthalmology, and who specializes in the treatment of visual disorders related to the nervous system.
- g. **Neuropsychologist:** A licensed psychologist with special training in and knowledge of brain-behavior relationships including causality of neurobehavioral changes and treatment and management of neurobehavioral disorders.
- h. **Neuroscience Nurse:** A registered nurse who has certification in the treatment of individual and/or family/support system responses to nervous system function and dysfunction across the healthcare continuum.
- i. **Neurosurgeon (Neurological Surgeon):** A physician who has special training and credentialing in the surgery of nervous system disorders and who has successfully completed an approved residency in neurosurgical medicine.
- j. **Nurse:** An LPN or RN with specialty training, credentialing, and licensing, who specializes in the collection and assessment of health data, and health teaching and provision of treatment supportive and restorative to life and well-being.
- k. **Occupational Therapist (OT):** A therapist who specializes in the assessment and treatment of physical, perceptual, behavioral and cognitive skills needed to perform self-care, home maintenance, and community skills.

- l. **Optometrist:** A specialist with training, credentials, and licensing, who examines, assesses, diagnoses, and treats abnormal conditions of the eye and its appendages. Optometrists cannot treat posterior uveitis, interpret x-rays, or perform invasive laser surgery. Pharmaceutical treatment is limited by statute.
 - m. **Ophthalmologist:** A physician with special training, credentials, and licensing in the field of vision, visual disorders and disorders of the visual systems, as well as, diagnosis related to systematic conditions, and who has successfully completed an approved residency in ophthalmology.
 - n. **Physical Therapist (PT):** A licensed therapist with expertise in managing movement dysfunction, which specializes in the assessment and treatment of individuals with impairment deficits and functional limitations in the areas of strength, muscle tone, motor control, posture, coordination, endurance, general functional mobility, and works to improve functional independence.
 - o. **Physiatrist:** A physician with special training, credentials, and licensing, in the field of physical medicine and rehabilitation, and who has successfully completed an approved residency in physiatry.
 - p. **Psychiatrist:** A physician with special training, credentials, and licensing, who specializes in the field of mental health and mental disorders, and who has successfully completed an approved residency in psychiatry.
 - q. **Rehabilitation Counselor:** A bachelor's or master's prepared counselor, who specializes in assisting individuals in the process of independent living, productive activity and employment. This includes assistance with financial resources, housing, community resources, social skills, vocational evaluation and treatment, and patient and/or family/support system counseling.
 - r. **Social Worker:** A bachelor's or master's prepared licensed social worker who specializes in patient and family relationships, as well as housing, financial resources, and society reintegration.
 - s. **Speech-Language Pathologist:** A certified master's or PhD level therapist who specializes in the assessment and treatment of individuals in the areas of communication (speech, language, voice, reading, writing, calculating), cognition, education and swallowing.
 - t. **Therapeutic Recreation Specialist (Recreational Therapist):** A bachelor's or master's prepared therapist who specializes in the assessment and treatment of individuals in the areas of planning and management of leisure activities, time management, mental health through recreation, and community access.
10. **PREVENTION** of injuries such as TBI is an essential component of any medical treatment guideline or injury management program. The following definitions of the various types and levels of prevention are necessary to prevent the deterioration from a healthy state to pathology and to successfully intervene at the levels of disablement described in the disability section.

- a. **Primary Prevention:** is the prevention of disease in a susceptible, or potentially susceptible, population through specific measures such as general health promotion efforts. All health providers should remind individuals and supervisors of the primary measures for preventing recurring traumatic brain injuries.

Always use appropriate protective equipment on jobs that require protection. Examples include the following:

- Protective helmets, complying with American National Standards Institute (ANSI), on jobs requiring protection from falling objects or electrical hazards
- Safety goggles or glasses on jobs that require protection from flying objects or debris
- Protective helmets and headwear when involved in contact, collision, and other sports such as biking, horseback riding, skating, skiing and snowboarding
- Avoid walking on wet, slippery floors on the worksite
- Ensuring that scaffolding is in good working order
- Using ladders according to OSHA recommendations – for example, making sure that ladders over 20 feet tall have cages
- The use and provision of airbags/safety belts, etc. in motor vehicles
- Avoid alcohol use during recreation activities such as boating, hunting, skiing, snowboarding, etc.

- b. **Secondary Prevention:** includes efforts to decrease duration of illness, severity of disease, and sequelae through early diagnosis and prompt intervention.

Mild traumatic brain injury is one of the most common neurologic disorders. Health care providers may play a key role in improving outcomes following MTBI. Early diagnosis of individuals with mild and moderate/severe brain injury is critical in helping to avoid secondary symptoms and problems in living. The length of post-traumatic amnesia requires careful consideration since individuals with more than twenty-four hours of post-traumatic amnesia have moderate injuries, necessitating further diagnostic attention and follow-up planning. Individuals with co-morbid depression and substance abuse are also at greater risk for poor outcome and represent an opportunity to reduce the effects of brain injury. Such individuals should receive appropriate referrals for the co-morbid conditions. For mild traumatic brain injury, providing education about symptoms, their management and their probable positive outcome is indicated. Using the available diagnostic information as the basis for providing education and providing written instructions on the discharge sheet regarding timing for return to regular activities, and high-risk activities, may help to improve outcomes and prevent further injury. Written materials that provide appropriate education for individuals with TBI and/or family/support system about brain injury care and

prevention are available in English and Spanish from the Centers for Disease Control and Prevention.

In the case of young adult employees with mild brain injury, providing information to the individual and/or family/support system about second impact syndrome and the need for follow-up before return to activities with a risk for repeat brain injury is indicated.

Workers who have suffered a recent brain injury should be especially cautious about returning to work on activities that may lead to a second brain injury as second injuries occurring prior to a full recovery from initial mild brain injuries may have more serious consequences. Providers should practice secondary prevention by setting appropriate restrictions for these workers and workers who are suffering from impairment, such as dizziness, that could lead to falls in some work environments (Refer to Return to Work, section G. 21).

- c. **Tertiary Prevention:** is the effort to decrease the degree of disability and promote rehabilitation and restoration of function in individuals with chronic and irreversible diseases and to prevent disease and disability.

The remainder of this guideline addresses tertiary prevention of disability for workers with traumatic brain injury.

D. INITIAL DIAGNOSTIC PROCEDURES

The purpose of these procedures is to establish the type and severity of TBI as a diagnosis, and to establish initial treatment goals. If the individual with TBI regains normal consciousness in the field or emergency department, and has normal neurological findings on examination and neuroradiological studies when appropriate, he/she may be discharged home with close supervision for the initial twenty-four hours. If the individual does not regain normal consciousness, or has focal neurological findings, or persistent cognitive impairment, further neurological evaluation, treatment, management and follow-up is indicated. This may include acute hospitalization or outpatient interdisciplinary team treatment, depending on the severity of the TBI.

1. **HISTORY OF INJURY** In order to establish a diagnosis of TBI and to establish treatment plans and goals, it is a generally accepted and widely used practice for a qualified practitioner to obtain a thorough history of the injury. Recommended data obtained in the history-taking should generally include:
 - a. **Identification Data:** should include name, address, age, gender, and marital status.
 - b. **Precipitating Event:** Information regarding the circumstances of the brain injury should include where and when the injury occurred, how the injury occurred, what the individual was doing at the time of the injury, and what happened. If the injury occurred as a result of a motor vehicle crash, information should be obtained as to the speed of the vehicle, use of restraints or helmet, degree of damage to the vehicle, etc. If the injury occurred as a result of a fall, information should be obtained regarding the type of fall, distance of the fall, type of surface, etc. The goal is to provide a review of the biomechanical forces involved in the event. If possible, collaborative information from witnesses should be obtained to seek details of the event and the injured person's behavioral and cognitive responses immediately following the injury. All of this history should be used when establishing the presence of a brain injury caused by a work-related event.
 - c. **Neurological History:** should include review of chief complaints, presenting problems and symptoms. Generally accepted data should include information about alteration of consciousness, or length of unconsciousness, degree and length of retrograde and post-traumatic amnesia, or confusional state, as well as cognitive and behavioral impairments, with collateral sources of information when possible. Information should be collected regarding various time intervals for the following:
 - i. **Current Neurological Status:** report of current neurological condition, symptoms, complaints, functional problems, etc.
 - ii. **Initial Neurological Status:** report of neurological condition at the time of the injury, symptoms, complaints, functional problems, etc. The Glasgow Coma Scale (GCS) when performed in the emergency department may aid in predicting the level of traumatic brain injury. Individuals with mild traumatic brain injuries may have a normal score on the GCS. Serial GCS scores may be helpful when intoxication may be a factor. When

evaluating alteration in mental state at the time of the injury, it is also important to consider the individual's emotional reaction to the distressing event. Whether the feeling of "being dazed" could be a manifestation of emotional numbing, or to other emotional reaction to the event should be considered. It is possible to have dazing due to both mild and traumatic brain injury and emotional reactions to the event (for example, numbing and/or detachment). The diagnosis of acute stress disorder should be considered in evaluating individuals with possible mild traumatic brain injury.

iii. **Evolution of Neurological Status:** Report of change in neurological condition between the time of the injury and the present, including symptoms, complaints, and functional problems. The individual's report of when he/she was able to return to independent activity is relevant to understanding severity of injury.

d. **Review of Medical Records:** In addition to the individual's self-report, practitioners should attempt to obtain and review any external sources of data, including police reports, ambulance reports, emergency department records, eyewitness reports, etc. The practitioner should utilize this information to establish the probable degree of trauma involved in the incident and the consistency between these reports and current symptoms.

e. **Past Medical/Health History:** Taking a history is a generally accepted practice and should include a history of past illnesses, injuries, previous brain injuries or other disabilities, epilepsy, pain, previous surgeries of any kind, mental health and medication history, or other medical/health data. A report from family members or other persons knowledgeable about the individual with TBI relevant to pre-injury as compared to post-injury function should be obtained.

f. **Family History:** should include neurological and medical history of illness, disability within the family that is relevant to the individual's condition.

g. **Social History:**

i. **Living situation:** should include marital history, family members, household makeup, significant others, etc.

ii. **Occupational History:** should include name of current company, job title, primary job duties, length of employment, prior places and dates of employment, and educational history

ii. **Avocations:** should include common non-occupational activities, such as the leisure activities of sports, hobbies, and personal interests

iv. **Substance Use History:** should be obtained (particularly if there is data to suggest substance abuse was involved in the injury) as well as information related to the amount and duration of alcohol and drug use, licit and illicit

v. **Mood:** should be assessed at the initial visit and periodically at follow-up visits. Depression and anxiety are common conditions following TBI, and symptoms may be subtle or unapparent unless actively looked for. Individuals may not always present with complaints of sadness or anxiety, but instead may endorse other symptoms that are commonly seen in clinical depression or anxiety. Many individuals also tend to focus on somatic complaints that do not always correlate with objective findings. Therefore, it is crucial to question the individual and their family or friends about significant changes in appetite, sleep disturbances, decreased interest in pleasurable activities, loss of energy, diminished ability to think or concentrate, irritability, and suicidal ideation as well as feeling empty, worthless, and excessive guilt. Clinical depression and anxiety require active treatment that may include psychopharmacology and/or psychotherapy. Due to the complexity and multi-factorial etiology of such disorders, a referral to a psychologist or psychiatrist may be needed in order to obtain an accurate diagnosis.

h. **Review of Systems:** is a generally accepted practice and should include a complete review of body systems and functions.

2. **PHYSICAL EXAMINATION** is a well-accepted practice and should be performed by a qualified practitioner.

3. **NEUROLOGICAL EXAMINATION** should be performed by a qualified practitioner, and should include a mental status examination. The mental status examination involves both informal and formal observations. It includes observations about the individual's presentation, personal hygiene, ability to provide a history, and ability to follow directions. A formal (structured) cognitive examination should be performed to the extent indicated by the situation. It includes an assessment of the individual's alertness, orientation, attention, concentration, memory, affect, mood, thought process and content, language, ability to perform simple calculations, and higher order assessments of reasoning, judgment, and insight.

4. **INITIAL NEUROPSYCHOLOGICAL ASSESSMENT** is the evaluation of cognitive processes and behavior, using psychological testing to assess central nervous system function and to diagnose specific behavioral or cognitive deficits or disorders. They are generally accepted and widely used as a valuable component of the diagnosis and management of individuals with brain injury. Neuropsychological assessments include sensitive tests that are used to detect subtle cognitive changes, severity of injury, and improvement over time. Neuropsychological assessment may make a contribution to the differential diagnosis of neurobehavioral disorders, and the cumulative effect of multiple brain injuries.

Neuropsychological assessments may also be utilized as a basis for formulating rehabilitation strategies, and may provide information related to prognosis and outcome. Neuropsychological assessments may be utilized to formulate how the individual's underlying brain injury impacts behavior and the ability to function effectively in daily life.

Neuropsychological assessment utilizes standardized testing procedures. Test reliability and validity are important considerations. Examiners should be aware that abnormal cognitive function could occur in the setting of chronic pain, mental disorders, or malingering. Multiple sources of data (self-report information, medical history,

psychosocial history, family report, etc.) are integrated with test performance factors to draw inferences about brain-behavior relationships. The individual's cultural background, race, and developmental history including primary language should be considered. When practical, educational records including history of learning disability should be obtained and reviewed.

- a. **Initial Neuropsychological Assessment – MTBI:** The referral for focused neuropsychological testing during the first month post-MTBI is advantageous in that it facilitates the documentation of attentional, memory, and other cognitive deficits as well as cognitive strengths and preserved cognitive capabilities. This provides a baseline for following the injury and permits the adequate documentation of the severity of the injury and improvements over time.

Neuropsychological consultation is indicated in the acute setting for:

- Determining emergence from post-traumatic amnesia
- Documenting a baseline post-injury and the time course of improvements in attentional functioning, memory and executive functions in order to contribute to treatment planning
- Providing relevant information regarding the individual's current functioning in the domains of speed of information processing, memory, and executive functions. Testing with a MTBI battery that permits serial testing focusing on attentional/concentration skills, memory, speed of processing, executive functions and emotional status may be indicated

Individuals with MTBI in the following circumstances should be considered for testing:

- Injuries at the upper end of the mild continuum [duration of coma greater than 10 minutes, duration of Post-Traumatic Amnesia (PTA) greater than four to six hours]
- Other risk factors, such as very demanding or stressful vocations, or being employed in the current job for a short period of time
- Age above 40 years
- Injury complicated by the presence of intracranial lesions
- History of prior head injury
- Associated orthopedic or soft tissue injuries
- MTBI is not improving

During the first three months post mild brain injury, assessment with a full neuropsychological test battery may be relevant when issues include return to highly demanding and/or safety-sensitive positions or when there are complex questions related to differential diagnosis (brain injury versus other diagnosis).

There should be a clear rationale for undertaking testing on any occasion, and the influence of practice effects should be considered.

b. Initial Neuropsychological Assessment – Moderate/severe Traumatic Brain Injury:

- i. In the acute setting neuropsychological consultation and assessment in moderate/severe brain injury is indicated for:
 - A) Determining emergence from post-traumatic amnesia
 - B) Documenting the early course of improvements in attentional functioning, memory, visual-perceptual abilities, and language and executive functions. This information may be utilized in:
 - Treatment planning and team consultation
 - Family education/support
 - Education and/or psychotherapy
- ii. During the subacute phase cognitive/physical stamina is reduced, availability for testing may be limited due to medical priorities, and other rehabilitation commitments.

Selective neuropsychological testing may be indicated to:

- Identify cognitive strengths and weaknesses
- Provide intervention such as psychotherapy
- Educate individual and family about TBI
- Assess or recommend behavioral management interventions

During this time period test selection will be dependent upon the individual's neurobehavioral status and other aspects of their medical condition.

Neuropsychological testing is often undertaken to identify treatment goals and to monitor progress over time. During this phase descriptive psycho-educational testing is commonly performed in rehabilitation by Speech-Language Pathologists and Occupational Therapists.

Administration of a full neuropsychological test battery is not indicated in moderate/severe cases until the individual with TBI has clearly emerged from post-traumatic amnesia. In most cases, administration of a full battery of neuropsychological tests should not be undertaken until attentional functioning has improved to the point where such extensive testing may be meaningfully undertaken and will be contributory to long-term treatment planning and rehabilitation.

- c. **Post-Acute Testing:** Once the individual's behavior has improved in attentional disturbance, fatigue, pain from other injuries, and neurobehavioral disinhibition to the point where valid test data may be obtained, testing with a full neuropsychological test battery may be productive.

5. **IMAGING PROCEDURES**

- a. **Skull X-Rays:** are well-established diagnostic tools used to detect a fracture of the skull base or cranial vault. CT scanning is preferred if fractures are suspected because the CT scan may identify clinically significant fracture as well as potentially co-existent contusion or hemorrhage. Skull x-rays are generally accepted if CT scans are not available.
- b. **Computed Axial Tomography (CT):** is a well-established brain imaging x-ray study comprising of a mathematical reconstruction of the tissue densities of the brain, skull, and surrounding tissues. CT scans require the use of computer-based scanning equipment. For acute brain trauma, iodine contrast enhancement is not necessary. CT scans are noninvasive and should reveal the presence of blood, skull fracture, and/or structural changes in the brain. CT scans provide limited information about intrinsic cerebral damage involving deep brain structures.

CT scans are widely accepted for acute diagnostic purposes, and for planning acute treatment. They are the screening image of choice in acute brain injury and are used to assess the need for neurosurgical intervention. CT scans are recommended for abnormal mental status, focal neurologic deficits, or acute seizure and should also be considered in the following situations:

- Signs of basilar skull fracture
 - Physical evidence of trauma above the clavicles
 - Acute traumatic seizure
 - Age greater than 60
 - An interval of disturbed consciousness
 - Pre-or post-event amnesia
 - Drug or alcohol intoxication
 - Any recent history of TBI, including MTBI
- c. **Magnetic Resonance Imaging (MRI):** is a well-established brain imaging study in which the individual is positioned in a magnetic field and a radio-frequency pulse is applied. Hydrogen proton energy emission is translated into visualized structures. Normal tissues give off one signal, while abnormal structures give off a different signal. Due to its high contrast resolution, MRI scans are superior to CT scans for the detection of some intracranial pathology, except for bone injuries such as fractures. MRI may reveal an increased amount of pathology as

compared with CT. Specific MRI sequences and techniques are very sensitive for detecting traumatic cerebral injury; they may include, but are not limited to, diffusion-tensor, gradient echo, and Fluid Attenuated Inversion Recovery (FLAIR). Some of these techniques are not available on an emergency basis. MRI scans are useful to assess transient or permanent changes, to determine the etiology of subsequent clinical problems, and to plan treatment. MRI is more sensitive than CT for detecting traumatic cerebral injury. Initially, MRI scans are clinically useful in the following situations to:

- Determine neurological deficits not explained by CT
- Evaluate prolonged interval of disturbed consciousness
- Define evidence of acute changes super-imposed on previous trauma or disease

6. **VASCULAR IMAGING TESTS** reveal arterial or venous abnormalities in the chest, neck, head, or extremities (e.g., thrombosis, dissection, spasm, emboli, or tearing). These studies are generally used if more standard CT/MRI fails to demonstrate suspected vascular abnormalities. They may be useful in moderate/severe TBI as an adjunct to aforementioned studies (Refer to Sections D 5.a. Skull X-Rays, b. Computed Axial Tomography (CT) and c. Magnetic Resonance Imaging), but only rarely in MTBI. Procedures that are generally accepted include:

- Arteriography:** is generally accepted, when the above-noted traumatic vascular abnormalities are suspected but unproven with the techniques discussed so far, or when further investigation of the vascular lesion is necessary. This is particularly true with arteriovenous fistulous change.
- Venography:** is generally accepted, if increased venous flow and pressure are suspected and still undemonstrated. This is done either by the jugular or orbital systems.
- Noninvasive Vascular Assessment (NIVA):** is the least invasive and may demonstrate direction of blood flow and general patency of the carotid and vertebral arterial systems in the neck, but not in the head.
- Magnetic Resonance Angiography(Magnetic Resonance Arteriography(MRA) /Magnetic Resonance Venography(MVA)):** is indicated when vessel changes are suspected but not demonstrated by other simpler tests. Internal obstruction of an artery (e.g., thrombosis, spasm, dissection, emboli from a concomitant chest, or neck injury) may be demonstrated. Arterial compression due to an external pressure (e.g., bony fracture or mass affect from a large intra-axial hemorrhage or cerebral edema) may be demonstrated. Dissection or arteriovenous fistula formation may be seen, but as with other vascular abnormalities may need conventional contrast arteriography/venography to confirm or refute the MRA or MRV findings. The source for intra or extra-axial bleeding may be seen. Intracerebral dural venous sinus thrombosis, as well as poor venous return may be demonstrated by MRA or MRV.

7. **LUMBAR PUNCTURE** is a well-established diagnostic procedure for examination cerebrospinal fluid (CSF) in neurological disease and injury. The procedure should be performed by qualified and trained physicians under sterile conditions. Lumbar puncture is contraindicated in acute trauma to the spinal column, certain infections, increased intracranial pressure due to space occupying lesions, and in some coagulation disorders or defects. Additionally, it should be avoided if there are cutaneous infections in the region of the puncture site.

In individuals with suspected or known increased intra-cranial pressure, lumbar puncture should be preceded by fundoscopic examination and by a CT scan or MRI. If no radiographic evidence of extra-axial hemorrhage, mass effect, or impending brain herniation is found then lumbar puncture may proceed. If CT or MRI shows intracerebral, intra-ventricular, or subarachnoid blood, lumbar puncture should be withheld until neurological consultation is obtained.

E. FOLLOW-UP DIAGNOSTIC PROCEDURES

1. IMAGING

a. Structural Imaging:

- i. Computed Axial Tomography (CT): may be used to follow identified pathology or screen for late pathology. Subsequently, CT scans are generally accepted when there is suspected intracranial blood, extra-axial blood, hydrocephalus, altered mental states, or a change in clinical condition, including development of new neurological symptoms or post-traumatic seizure (within the first days following trauma). MRI scans are generally recommended as opposed to CT once the initial acute stage has passed.
- ii. Magnetic Resonance Imaging (MRI): is the image of choice to detect late the subacute structural changes in the brain which underlie abnormal functioning and is a well-accepted technique for follow-up imaging. Complications of TBI that may be explained by MRI include, but are not limited to: post-traumatic epilepsy, post-traumatic movement disorder, post-traumatic cranial neuropathy, post-traumatic infection, or failure to recover within the expected time frame. Specific MRI sequences and techniques as previously mentioned may have more anatomic sensitivity, and be of clinical utility (Refer to D.5.c.-Magnetic Resonance Imaging (MRI)).

b. Dynamic Imaging: In contrast to anatomical imaging procedures, the following procedures are designated to detect physiologic activity of the brain, including cerebral blood flow and cerebral metabolism.

- i. Single Photon Emission Computed Tomography (SPECT): is not generally accepted as a diagnostic test for TBI of any severity and is considered investigational for diagnostic purposes. It is a functional image of the brain created by a flow tracer or a receptor binding substance tagged with a radionuclide and injected intravenously into the individual. Radiotracer is assumed to accumulate in different areas of the brain proportionately to the rate of delivery of nutrients to that volume of brain tissue. Using a gamma camera and the techniques of CT, a 3-D image of the distribution of a radionuclide in the brain is obtained. SPECT may identify areas of decreased perfusion and provide a qualitative estimate of regional cerebral blood flow (CBF), which correlates with metabolism in many neurologic disorders. There is a variable correlation of SPECT with other measures such as neuropsychological test findings.

Although it should not be used to diagnose MTBI, there is some evidence that SPECT may provide useful information in some cases in which the prognosis is in question. SPECT may be useful when expected recovery from MTBI is not occurring within several months from the time of injury. A normal SPECT scan in this setting indicates a likelihood of resolution of symptoms within twelve months. However, due to its lack of specificity, an abnormal SPECT scan does not mean that symptoms will persist. Symptoms may resolve even when areas of abnormal perfusion continue to be seen on the SPECT scan.

For severe brain injury, SPECT may be useful for individuals with prolonged low levels of responsiveness (i.e. persistent vegetative state) in cases of anoxia, or when additional data is needed.

In all severities of TBI, it is recommended that medical necessity and clinical usefulness for this study be justified.

- ii. Positron Emission Testing (PET): is a functional brain imaging procedure. A tracer molecule tagged with a positron-emitting radioisotope is injected into the body. Biodistribution of the tracer is imaged, producing information about local cerebral glucose utilization and cerebral perfusion. This procedure requires on-site access to a cyclotron.

PET can reveal areas of decreased metabolism in the brain. In individuals with moderate/severe TBI, PET findings are closely correlated with the site and the extent of cerebral dysfunction derived from neurological and neurobehavioral examinations. Little information is available about its use and results in MTBI. In all severities of TBI, it is recommended that medical necessity and clinical usefulness for this diagnostic study be justified. It is not generally accepted as a diagnostic study and should not be used solely to diagnose the presence of TBI.

2. ADVANCED MRI TECHNIQUES

- a. Magnetic Resonance (MR) Spectroscopy: is a noninvasive test that applies a burst of radio-frequency energy to tissue inside an applied magnetic field. The resulting excitation and relaxation of nuclei generates a signal which carries information about the chemical environment of those nuclei. MR spectroscopy may detect changes in levels of n-acetyl-aspartate, an intermediate in neurotransmitter synthesis which is present in large amounts in normal functioning neurons but is decreased in damaged brain tissue. Its spectral signal may correlate with neuronal integrity and function and may show loss of function in tissue which appears normal on conventional CT or MRI studies. MR spectroscopy may increase the sensitivity of MR imaging for traumatic lesions. This sensitivity may allow for increased correlation to more specific neuro-cognitive deficits, guide treatment planning and be useful information in determining long-term outcome. MR spectroscopy remains predominantly a research tool at this time should not be used solely to diagnose the presence of TBI. It may be considered with adequate documentation of its medical necessity in selected cases when the information will assist in clarifying the pathology to direct a therapeutic approach to the individual with TBI.
- b. Functional MRI (fMRI): uses MRI to detect physiologic responses of brain tissue to various tasks. Blood oxygenation level dependent (BOLD) contrast, the most popular fMRI technique, derives an image from differences in the magnetic properties and therefore differences in MR decay parameters, of oxygenated and deoxygenated hemoglobin. A typical fMRI study compares images under two or more behavioral conditions, which may involve motor, cognitive, or visual tasks. fMRI studies have shown functional reorganization as a general response to brain injury. Alterations in patterns of cerebral activity seen on fMRI may correlate with cognitive deficits in individuals with TBI, but the specificity of the test is not sufficient to make fMRI a diagnostic tool. It is currently a research tool and not recommended for clinical use.

3. **NEUROPSYCHOLOGICAL ASSESSMENT** past the acute period is appropriate in the following situations when:

- input is needed to plan treatment to maximize long-term cognitive and overall functional outcomes
- it is considered useful to define how strengths may be utilized in cognitive rehabilitative therapy to compensate for weakness
- there is a question of the individual's ability to perform work-related duties and there are safety issues (i.e., possible harm to self or others), or when the person's vocation necessitates more extensive testing prior to vocational re-entry or return to school/training
- assistance is needed with differential diagnosis including the diagnosis of traumatic brain injury past the acute period
- it is deemed necessary to evaluate and/or monitor effectiveness of treatment approaches (i.e., cognitive rehabilitation therapy) in specific individuals
- the individual with TBI fails to show improvement and cognitive abilities and emotional functioning or personality variables are suspected to be interfering with treatment progress
- subjective complaints are disproportionate to the clinical history or objective findings as observed by provider(s)
- the degree of disability is disproportionate to the clinical history and objective findings as observed by provider(s)

The following information may aid in delineating when a full neuropsychological battery is necessary versus more limited testing:

a. **Mild Traumatic Brain Injury:** Between one and six months post-injury, serial testing with specialized mild brain injury batteries that emphasize speed of processing, memory, and executive functions will usually be appropriate for treatment planning and monitoring progress. However, the administration of a full neuropsychological test battery may become necessary in this time period when:

- there is no medical history of traumatic brain injury, and there is the question of whether a brain injury occurred
- it is necessary to address issues on the initial indicators list

b. **Moderate/severe TBI:** The administration of a full neuropsychological test battery after the acute period is appropriate in a number of situations when:

- developmental issues are interacting with a history of traumatic brain injury (e.g. determining if age related memory changes are diminishing)

functioning in a person with a history of moderate/severe traumatic brain injury)

- late complications develop that affect memory and thinking (seizures, depression)
- there are questions of competency
- it is necessary to address any of the issues on the initial indications tests

4. **PERSONALITY/PSYCHOLOGICAL/PSYCHOSOCIAL EVALUATIONS** are generally accepted and well established diagnostic procedures with selective use in the TBI population, but have more widespread use in the sub-acute and chronic populations. Diagnostic testing procedures may be useful for individuals with symptoms of depression, delayed recovery, chronic pain, recurrent painful conditions, and disability problems. An individual with a PhD, PsyD, or psychiatric MD/DO credentials may perform evaluations. An explanation of the elements that may be included in a psychosocial assessment are found in the Chronic Pain Guidelines, section E.2.

A psychosocial assessment may be necessary if symptoms do not correlate with a diagnosis of TBI. Complaints of cognitive dysfunction may also be associated with a variety of conditions that do not involve neurological disease, brain injury, or concussion. This includes conditions such as depression, anxiety, chronic pain, somatoform disorders, and factitious orders. At times, a set of symptoms may not coincide with expected objective findings for a diagnosis of TBI. To identify non-neurological contributions to cognitive or other functional complaints, a psychological evaluation focusing on mental disorder diagnoses is appropriate when:

- delayed recovery is present
- there is a question of whether a brain injury has occurred
- neuropsychological testing yields a pattern of test results that do not make logical sense in view of clinical history
- when neurologically improbable symptoms are present

5. **ELECTROENCEPHALOGRAPHY**

- a. **Electroencephalography (EEG)**: is a well-established diagnostic procedure that monitors brain wave activity using scalp electrodes and provocative maneuvers such as hyperventilation and photic strobe. Information generated includes alterations in brain wave activity such as frequency changes (nonspecific) or morphologic (seizures). EEG is not generally indicated in the immediate period of emergency response, evaluation, and treatment. Following initial assessment and stabilization, the individual's course should be monitored. If during this period there is failure to improve, or the medical condition deteriorates, an EEG may be indicated to assist in the diagnostic evaluation. Potential diagnoses include seizures, focal encephalopathy due to persistent effects of hemorrhage, or diffuse encephalopathy due to the injury, or other complicating factors such as hydrocephalus or medications.

b. **Quantified Electroencephalography (QEEG) (Computerized EEG):** is a modification of standard EEG using computerized analysis of statistical relationships between power, frequency, timing, and distribution of scalp recorded brain electrical activity. These statistically generated values are then compared to those recorded from selected control and specific populations, generally using multiple regression analysis of multiple measurements and calculated parameters. A statistically derived probability statement regarding the likelihood of the individual studied belonging to the patient pathological population in comparison to the control non-pathological population is then generated.

i. **Indications for Use:** Recent studies suggest that in the future QEEG may become a useful tool in the retrospective diagnosis of TBI and its severity, but this application remains investigational. In moderate/severe TBI the results of QEEG are almost always redundant when traditional electroencephalographic, neurologic and radiologic evaluations have been obtained. QEEG is not recommended for diagnosing MTBI or moderate/severe TBI.

ii. **Practice Requirements of QEEG:** QEEG is based upon sophisticated technical and statistical methodologies. Therefore, adherence to some type of technical standards such as outlined by the American Medical EEG Association is necessary. The physician QEEG practitioner should possess EEG board certification from a national certifying organization, documented additional training relevant to QEEG, and “hands on” additional training with one or more qualified QEEG practitioner(s).

6. **ELECTRODIAGNOSTIC STUDIES** are limited to EMG, nerve conduction studies and multisensory evoked potentials including visual evoked potentials (VEP), somatosensory evoked potentials (SSEP), and brain stem auditory evoked responses (BSAER).

a. **EMG and Nerve Conduction Studies:** are generally accepted, well-established diagnostic procedures. These studies may be useful for individuals with brain injury and EMG associated suspected peripheral nervous system involvement. They are often used to differentiate peripheral versus central spinal cord or brain deficits. These electrodiagnostic studies are possibly complementary to other imaging procedures such as CT, MRI, and/or myelography. These studies provide useful correlative neuropathophysiologic information that is unattainable from standard radiologic studies.

b. **Dynamic Electromyographies:** are electrodiagnostic studies utilized to distinguish the voluntary capacity of a muscle from a spastic reaction. This aids the clinician in better planning specific rehabilitative treatment. This study is helpful in the differential diagnosis and diagnostic work-up of disordered muscle tone. This is a generally accepted procedure.

c. **Evoked Potential Responses (EP):** are generally accepted, well-established diagnostic procedures. EPs are stimulus based central nervous system electrophysiologic responses to stimulus, either externally generated via one or more sensory modalities, or internally generated via the processing of information. Multisensory EP studies are limited to visual evoked potentials, brain stem evoked potentials, somatosensory evoked potentials and cognitive

evoked potentials. In moderate/severe TBI, including the “minimal responsive or vegetative state,” there is some utility in the use of these studies for differential diagnosis, prognosis and to determine an individual’s more specific level of neurologic functioning.

- i. Brain Stem Auditory Evoked Response (BSAER): is a generally accepted diagnostic procedure useful in assessing damage to the brain stem, midbrain and other neural structures that govern hearing and/or balance. It may be more useful than the SSEP in MTBI. A normal test does not rule out structural damage, and the test may be abnormal in middle ear and non-traumatic disease affecting the auditory pathway. Waves one and three but particularly five, are most useful in assessing injury. While amplitude and the presence of wave are important, the latency and interwave latency is equally as important. This test is often sensitive and nonspecific.
- ii. Electroretinogram (ERG): This generally accepted diagnostic procedure for occult retinal trauma accompanying brain injury. Most traumatic retinal pathology may be detected by direct examination.
- iii. Cognitive Event-related Potential: is an acceptable diagnostic procedure for moderate/severe brain injury. Event-related potential provides no information in MTBI that cannot be obtained through other diagnostic procedures and is not recommended.
- iv. Somatosensory Evoked Potential (SSEP): is a generally accepted diagnostic procedure for moderate/severe brain injury. SSEP provides no information on MTBI that cannot be obtained through other diagnostic means. SSEP is not recommended in MTBI.
- v. Visual Evoked Potential (VEP): This is a generally accepted diagnostic procedure. Pattern reversal monocular VEP recording may detect pathology in the anterior-posterior visual pathway from the retina to the occipital cortex. It may be indicated in the event of compromised acuity or visual field defect. The VEP may occasionally be normal in cases of severe structural damage if there is enough preserved central visual field.

7. **LABORATORY TESTING** is a generally accepted, well-established procedure. In MTBI, they are rarely indicated at the time of initial evaluation unless there is suspicion of systemic illness, infection, neoplasia, or underlying disease. In moderate/severe brain injury, extensive lab testing will be necessary to monitor electrolyte status, organ functions, and other physiologic processes, depending on the medications used and the severity of the injury. Any individual with TBI on medication will require laboratory testing to monitor effects on organ function.

8. **DIAGNOSTIC NERVE BLOCKS** are generally accepted procedures involving percutaneous needle injection techniques to a specific nerve. These diagnostic blocks are typically performed with quick-acting, short duration local anesthetics such as lidocaine or bupivacaine. Temporary diagnostic nerve blocks evaluate limb range-of-

motion (ROM), dystonia or spasticity and assist in planning subsequent more specific therapy.

9. **AUDIOMETRY AND OTOTOLOGY** Neurotologic evaluation is a widely used and generally accepted practice in cases of hearing loss, dizziness, balance problems, facial nerve injury and cerebrospinal fluid leak. These symptoms may each occur in an individual with TBI of all severities.

- a. **Audiometry:** is a generally accepted and well-established procedure that measures hearing. An audiologist or skilled trained technician administers the test using of an audiometer. The machine presents individual frequencies to the individual (typically ranging from 125-8000 Hz) at different levels of loudness (in dBHL). The individual is asked to respond to the sound that he may barely perceive (threshold). Normal thresholds are from 0-25dBHL. The results are displayed in normal graphic form or on audiogram. The audiologist or physician may determine the presence and type (conductive, sensorineural, or mixed) of hearing loss based on the audiogram.

Baseline audiometry following brain injury is indicated when the individual with TBI presents with hearing loss, dizziness, tinnitus, or facial nerve dysfunction.

Audiograms may be obtained in serial fashion to monitor inner ear function in response to time and treatment.

- b. **Tympanometry:** is a generally accepted and well-established procedure that measures middle ear air pressures. It is used to help identify the presence of tympanic membrane perforations, ossicular abnormalities, and middle ear fluid.

- c. **Vestibular Function Tests:**

- i. **Electro- or video-nystagmography (ENG/VNG):** is a generally accepted and well-established procedure that measures inner ear balance function. The test measures eye movement in response to inner ear balance stimulation making use of the vestibulo-ocular reflex. There are several components to the ENG/VNG. They include oculomotor testing, positional testing and caloric testing. This series of tests may identify peripheral and central abnormalities, abnormalities in oculomotor function, and unilateral and bilateral vestibular dysfunction. The ENG/VNG may also in some cases identify the affected ear. This test is often used in individuals with TBI complaining of dizziness or dysequilibrium and may help diagnose conditions such as labyrinthine concussion, vestibular hypofunction, and central vertigo. It is often used in conjunction with other tests such as the audiogram and clinical history to help arrive at a diagnosis.

- ii. **Rotary Chair Testing:** is a generally accepted and well-established test that may identify the presence of a vestibular lesion. It may help identify peripheral lesions, but unlike the ENG/VNG it cannot identify the site of the lesion. The rotary chair test often is used to identify whether or not an injured vestibular system has compensated.

- ii. Dynamic Posturography: is a functional test of balance that allows a separate evaluation of the sensory organization and motor coordination components of balance. The purpose of this procedure is to identify the integral components of a functional balance deficit that may help in treatment planning. This technique also may be useful in monitoring neurologic recovery in individuals with TBI and balance deficits. These functional methods of evaluation are considered generally accepted practices in the evaluation of persistent vestibular and balance deficits that may require specific treatment and remediation strategies.
- iv. Electrocochleography (ECoG): is a well-established and generally accepted test that measures facial nerve function. This test measures the action potential of different branches of the facial nerve. It is used in individuals with TBI resulting in a facial paralysis and is key in determining the need for surgical intervention. This test is most useful within the first three weeks of facial nerve dysfunction. If the action potentials on the affected side are 90-100% less than those on the normal side, it suggests significant injury to the nerve and calls for surgical exploration. Individuals with TBI whose nerve is less than 90% decreased in function have a reasonably good outcome when compared with observation alone.
- v. Other clinical referrals: The treating physician may often refer individuals with TBI who have balance problems to other clinicians to assist in their assessment. This may include but is not restricted to, physical therapy, occupational therapy, chiropractic therapy, neuro-optometry and neuroophthalmology. There should be a coordinated approach between these disciplines and the physician specialist in the individual's treatment.
- vi. Vestibular evoked myogenic potentials (VEMP): is an investigational technology that uses a vestibulocolic reflex to evaluate the function of the otolithic system of the inner ear. The otolithic organ is a part of the balance system not addressed in the previous tests.

In VEMP testing, myogenic potentials are recorded from the individual's actively flexed sternocleidomastoid muscle. A sound stimulus is introduced that should cause a drop in the myogenic potential. If this drop does not occur, it suggests dysfunction of the saccular otolith, or the vestibular branch of the eighth cranial nerve. This is currently a research tool and is not recommended for routine clinical use.

10. **VISION EVALUATION** is a well-established series and combination of examination techniques and diagnostic tests. The visual evaluation measures a wide range of visual processes that involve the functional status of the eyes, the visual pathways of the brain, and the systemic health conditions that affect the eyes and visual pathways. It generates information regarding the presence or absence of refractive error, vision loss, oculomotor dysfunction, binocular vision disorder, ocular injury, and pathology. Visual evaluation may be necessary to evaluate central and peripheral nervous system disorders including central visual acuity loss, visual field loss, nystagmus, ocular motility impairment, cranial nerve palsy, ophthalmoplegia, pupillary reflex disorders, and visual perceptual disorders.

Visual evaluation is indicated when signs or symptoms consistent with a visual problem are reported by the individual, or observed by others. Significant signs and symptoms not directly and solely attributable to other causes (e.g., cognitive, vestibular, medication, psychological) indicate the need for vision evaluation as soon as is reasonably possible post-injury. Mild signs and symptoms may be monitored for several weeks to allow for resolution or improvement.

Signs and symptoms of visual dysfunction may include, but are not limited to, the following: blurred vision, focusing problems, double vision, eye turn (strabismus), eye closure, or eye cover to improve function, headache or eye strain with use of eyes, impaired depth perception, poor tracking (e.g., loses place when reading), words appear to move when reading, impaired peripheral vision, head tilt, dizziness with use of eyes, visual distortions (e.g., objects, floor, walls appear bowed, slanted or tipped), reduced visual attention or concentration for visual tasks. To establish the diagnosis of visual disorders, it is a generally accepted practice for a qualified practitioner to obtain a thorough vision evaluation. A vision examination may be intermediate, extended, or comprehensive, depending on the nature of the deficits. The vision examination includes, but is not limited to the following: case history, visual acuity, refraction, color vision testing, pupillary examination, visual field by confrontation, tangent screen or Amsler grid testing, ocular motility examination, binocularity examination, accommodation testing, intraocular pressure testing, and anterior and posterior segment examinations.

Diagnostic tests include, but are not limited to, visual field testing, ultrasonography, fluorescein angiography, anterior segment and fundus photography, electrodiagnostic studies, low vision evaluation, and visual perceptual testing.

- a. **Visual Field Testing:** is a well-established technique to evaluate central and peripheral vision. It is indicated when a field defect is suspected by the practitioner. Visual field testing beyond the basic examination should be performed using a procedure and tool that is well-established and standardized. Examples include automated perimetry and Goldmann perimetry.
- b. **Ultrasonography:** is a well-established diagnostic test that is indicated for evaluation of ocular or orbital pathology. It is indicated for ocular lesions that are suspected but poorly visualized due to opaque ocular media or for further evaluation of ocular or orbital pathology.
- c. **Fluorescein Angiography:** is a well-established diagnostic test to evaluate the retinal and choroidal circulation. It is indicated when lesions of one or both of these circulations are suspected.
- d. **Visual Perceptual Testing:** consists of functional assessments to evaluate an individual's recognition and interpretation of visual sensory information. Visual perceptual testing is indicated for determination of the level of visual perceptual impairment and/or confirmation of suspected impairment. Perceptual areas assessed include visual memory, judgment of visual spatial relationships, visual discrimination, visual motor integration, visual figure-ground discrimination, and visual attention. Numerous tests are used for the evaluation of visual perception. Some of these tests are well-established. It is suggested that only tests with established norms in the TBI population be used. Visual perception testing should not be construed to include the full battery of neuropsychological

assessment that must be performed by a neuropsychologist. In complex presentations, the full battery may be required. Visual perception testing alone cannot be used to make a diagnosis of TBI. Interpretation should occur in the context of assessment of other cognitive functions, including attention, memory, language and executive function.

- e. **Low Vision Evaluation:** is well-established and indicated in the presence of subnormal bilateral visual acuity or visual field. The goal is to provide low vision aids for distance or near vision that improves visual functioning.
- f. **Electrodiagnostic Studies:** are well-established and indicated in the presence of reduced visual acuity or visual fields, ocular pathology, or suspected optic nerve or visual pathway deficit (Refer to section E.6. Electrodiagnostic Studies for further description.)

11. **SWALLOWING EVALUATION** Swallowing impairment or dysphagia may be due to neurologic, structural or cognitive deficits and may result from head trauma. Dysphagia may result in pneumonia, inadequate nutrition, dehydration, weight loss, failure to thrive, and death.

a. **Clinical Assessment:**

- i. **Clinical Bedside Assessment:** This generally accepted clinical examination of oral-pharyngeal swallow function consists of pertinent medical history, examination of function of lip, tongue, soft palate, oral sensitivity, function of pharynx and larynx, observation of dry swallow(s) and, if appropriate, with various food/liquid consistencies, ability to follow directions and discipline his/her own behaviors. If pharyngeal dysfunction or aspiration is suspected, an instrumental assessment may be indicated.
- ii. **Modified Evans Blue-Dye Test (MEBDT):** is a variation of the clinical bedside assessment used to detect the presence or absence of aspiration in an individual with tracheostomy. This procedure uses blue dye (FC&C Blue No. 1), or methylene blue placed on the tongue, or into liquids or food items. Aspiration is assumed if tracheal suctioning reveals blue-tinged secretions. Recent research has shown questionable reliability with this procedure with an overall 50% false-negative rate when compared with modified barium swallow studies. The MEBDT has not been found reliable in identifying individuals who aspirated trace amounts (less than 10% of the bolus). In the critical care setting, blue dye is not a recommended diagnostic test due to potential toxicity from systemic absorption. Recognizing the limitations and risks of MEBDT, it is a common and practical means of screening individuals to determine readiness for cuff deflation or further swallowing evaluation.

- b. **Instrumental Evaluation:** of swallow function are generally accepted diagnostic tests. They are conducted by a Speech-Language Pathologist and physician in collaboration (Radiologist, ENT or other physician familiar with the procedure as appropriate) or by the Speech-Language Pathologist under the supervision of a physician.

Modified Barium Swallow Studies (MBS): or videofluoroscopic study is well-established and the most common instrumental procedure used to study swallow function. The individual's swallowing function involving the oral cavity, pharynx and upper esophagus is visualized while swallowing various quantities and textures of food and/or liquid with barium contrast material.

The MBS is useful in visualizing, identifying, and documenting the presence of risk of penetration and/or aspiration and the swallowing disorder responsible for it, clearance of material through the mouth and pharynx, the timing and appropriate percentage of penetration/aspiration, effectiveness of treatment techniques and strategies to improve swallow safety and efficiency. Recommendations are made concerning safety of oral feeding, the need to consider an alternative nutritional method, diet texture modifications, therapy techniques, compensatory postures and strategies. Repeated studies may be needed to determine change in swallow function over time.

- c. **Further Instrumental Evaluation**: are generally accepted, but not as frequently used and require documentation of clinical necessity:
- i. Manofluorographic Swallowing Evaluation (MSE): is a videofluoroscopic swallowing study with the addition of oropharyngeal pressure assessment. Solid state pressure transducer sensors are typically placed in the esophagus, upper esophageal sphincter (UES), hypopharynx and tongue base. Manometry provides quantitative information at rest and during swallowing on pharyngeal, UES, and esophageal pressures, completeness of UES relaxation and coordination of timing between pharyngeal contraction and UES relaxation.
 - ii. Fiberoptic Endoscopic Evaluation of Swallowing (FEES): is used to evaluate the pharyngeal phase of the swallow with a flexible endoscope that is placed transnasally into the hypopharynx. It may be completed at bedside and may be useful in those who may not tolerate the radiographic procedure, or when such procedures are not readily available. FEES permits direct visualization of anatomy as well as vocal fold motor activity and morphology. It allows an assessment of briskness of swallow initiation, timing of bolus flow, and swallow initiation, adequacy of bolus driving/clearing forces, adequacy of velar and laryngeal valving forces, penetration or aspiration and presence of hypopharyngeal reflux.
 - iii. Fiberoptic Endoscopic Evaluation of Swallowing with Sensory Testing (FEEST): is a modification of the FEES procedure, which adds quantification of the sensory threshold in the larynx. The sensory evaluation involves the delivery of pulses of air at sequential pressures to elicit the laryngeal adductor reflex, thus establishing a sensory threshold. Sensory testing is a quantifiable indicator of those persons at risk for aspiration. It provides better understanding of laryngeal sensory deficits, which may be useful in dietary and behavioral management of individuals with dysphagia.

12. **RETURN-TO-WORK** assessment following TBI involves a skillful match between the individual's abilities (physical, cognitive, emotional, and behavioral) and work

requirements. Evaluations used to define these abilities such as the Functional Capacity Evaluation (FCE) and the Worksite Analysis should be objective and appropriately timed. The professional performing the FCE and worksite analysis should be specifically trained and familiar with the unique presentation of the individual who has suffered a TBI. The ability to tolerate these evaluations and follow commands may be limited due to TBI and should not be construed as non-cooperative or malingering behavior. Two evaluations that may be used are:

- a. **Functional Capacity Evaluation (FCE)**: may be indicated to identify residual physical limitations. FCE is a comprehensive assessment of the various aspects of physical function as they relate to the individual's ability to perform functional activities necessary for return to work. When cognitive, emotional and/or behavioral sequelae are also present, a comprehensive FCE may provide indications of return to work readiness.

Components of the physical portion of the FCE may include, but are not limited to: musculoskeletal screen, cardiovascular profile/aerobic capacity, coordination, lift/carrying analysis, job specific activity tolerance, maximum voluntary effort, pain assessment, non-material and material handling activities, balance/dizziness, climbing, physical fatigue, endurance, and visual skills.

Components of the cognitive portion of the FCE may include, but are not limited to: memory, executive skill function, attention and concentration, communication, speed of information processing, multi-tasking, new learning, and cognitive fatigue and endurance.

Components of the emotional portion of the FCE may include, but are not limited to: temperament, ability to manage stress, adaptation to change, toleration of feedback, and anger control.

Components of the behavioral portion of the FCE may include, but are not limited to: appropriate social and behavioral interactions. This may present as inability to complete or cooperate with the tests, mood changes, inconsistent or erratic behavior.

FCE's include tools that are an extension of the basic physical examination and may be useful for the determination of impairments, functional/cognitive restrictions, determination of progress, and planning and monitoring of the rehabilitation program. Whenever possible, FCEs should be supplemented with information from neuropsychology, speech/language pathology, occupational therapy, and physical therapy to determine physical, cognitive and psychological abilities to safely and productively function in a work setting. FCEs are typically conducted in 4 to 6 hours, but for individuals who have suffered a traumatic brain injury, additional time may be required, or it may be necessary to conduct the evaluation in two or three separate sessions to allow for the potential variability of cognitive and physical fatigue. Total time for an FCE would rarely exceed 8 to 10 hours.

- ❖ Frequency: An FCE may be used to determine baseline status and readiness for return to work. Additional evaluations may be performed to

monitor and assess programs and aid in determining the endpoint for treatment

- b. **Worksite/Job Site Analysis:** is a generally accepted, established procedure used to determine and document the individual's ability to safely meet essential work demands of a potential job, or return to a pre-existing defined job. This analysis should also identify if job modifications, job coaching or work restrictions are necessary. It involves an on-site systematic task and work process analysis to define safety, ergonomic, cognitive, emotional, human and environmental factors for a specific job. The evaluator should be a qualified practitioner experienced in the principles of biomechanical, environmental and cognitive rehabilitation. Modifications in the workplace, if applicable, should also be recommended as they relate to performing essential job demands. Job descriptions provided by the employer are helpful but should not be used as a substitute for direct observation.

- ❖ Frequency: One time, with additional visits as needed for follow-up per worksite/jobsite.

F. ACUTE THERAPEUTIC PROCEDURES – NONOPERATIVE

1. RESUSCITATION

- a. The first priority in TBI is complete and rapid physiologic resuscitation.
- b. Special consideration for isolated communities without neurosurgical support:
 - i. Trauma surgeons and emergency physicians may perform the initial resuscitation and neurologic treatment in the deteriorating individual
 - ii. Once stable, transport to a designated neuro-trauma center for further evaluation and management should occur expeditiously
- c. Sedation and neuromuscular blockade are appropriate if needed for transport. Short-acting agents are preferred to allow for serial exams
- d. Hypotension and hypoxia must be avoided to optimize outcome
- e. Avoid unnecessary or prophylactic hyperventilation ($Paco_2$ less than 26), in the first 24-hours after injury

2. INTRACRANIAL PRESSURE (ICP) AND CEREBRAL PERFUSION PRESSURE (CPP)

Individuals with brain injury should not be treated for intracranial hypertension (ICH), without clear evidence of brain injury such as a neurologically focal exam, or evidence of herniation syndrome, Glasgow Coma Score (GCS) of less than 9 without systemic explanation (hypotension, hypoxia, significant intoxication), or CT evidence of intracranial pathology with significant mass lesion or swelling.

- a. ICP Monitoring is indicated in individuals with low GCS (less than 9) and/or CT changes, or when the individual cannot have continual neurologic evaluation (e.g., use of anesthesia), and it should also be considered in situations of posturing or multi-trauma.
- b. Aggressive treatment should be initiated with clinical evidence of ICH, to include transient mild hyperventilation, euvolemia and mannitol (if not hypovolemic), until ICP monitoring may be initiated to measure ICP.
- c. Sedation, neuromuscular blockade, and CSF drainage (if ventriculostomy is in place) are appropriate if needed to control ICH.
- d. Interpretation and treatment of ICP should be corroborated by frequent clinical examination and CPP data. In general, it is desirable to:
 - i. Maintain ICP less than 20-25mm Hg
 - ii. Maintain mean arterial pressure (MAP) above 90
 - iii. Maintain CPP (MAP at head level minus ICP) at, or above 70mm Hg

- e. Intracranial pressure monitoring devices have therapeutic potential but consideration should be given to possible risks related to accuracy and reliability.
 - i. Ventricular catheter to manometer: potential for CSF drainage. Catheters may become occluded or obstructed by coapted/slit ventricles and then may be unreliable or inaccurate. Ventricular catheters have a higher risk of intracerebral hemorrhage and infection as compared to parenchymal monitors.
 - ii. Ventricular catheter to external strain gauge: potential for CSF drainage. A dampened waveform warns of unreliability. Catheters may become obstructed, need a fixed reference, and are useless when obstructed.
 - iii. Ventricular catheter with internal strain or pressure sensor: potential for CSF drainage.
 - iv. Other devices for ICP monitoring (fiber optic and internal strain gauge parenchymal monitors) do not allow CSF drainage and may demonstrate drift over time, but are very useful for initial ICP assessment and for short periods of time. They have lower complication rates and may still be used in the setting of slit ventricle when a ventriculostomy cannot be used.

- f. Cerebral oxygen saturation monitoring is an emerging technology that may be used, usually in conjunction with ICP monitoring, to assess the effects of treatment interventions on oxygen delivery to the injured brain, and to optimize the management of brain swelling and intracranial pressure in the setting of severe brain injury.

- g. Hyperventilation: Options for use in treating ICP elevations:
 - i. Controlled hyperventilation may be necessary for brief periods in acute neurologic deterioration not attributable to systemic pathology (i.e., hypotension)
 - ii. Avoid prophylactic hyperventilation (if P_{aCO_2} is less than 30 mm) in the absence of ICP monitoring or with normal ICP and within the first 24 hours after severe brain injury to reduce the risk of secondary ischemia
 - iii. Jugular venous oxygen saturation (SjO_2), determination of arterial venous oxygen difference ($P_aO_2 - P_vO_2$), and cerebral flow studies are useful to identify ischemia related to hyperventilation or hypoperfusion
 - A) useful especially for lower CPPs, or if arterial partial pressure of carbon dioxide (P_{aCO_2}) is less than 30 mm
 - B) may require special technologies such as intracranial Doppler, jugular venous oxygen saturation catheters, other emerging technologies

- C) jugular venous oxygen saturation determination is not necessary if other methods are adequate
 - iv. Avoid chronic hyperventilation to Paco₂ less than 26
 - h. Options for use of mannitol in treating ICP elevations:
 - i. Use prior to ICP monitoring only if neurologic deterioration is not attributable to systemic pathology (i.e., hypotension) and/or if there are signs of transtentorial herniation
 - ii. Euvolemia must be established and maintained
 - iii. Keep serum osmolarity (OSM) less than 320, especially in acute renal failure (ARF)
 - iv. Bolus (rather than drip) mannitol is more effective treatment for elevated ICP
 - i. Glucocorticoids (steroids) are not useful or generally accepted to improve outcome or decrease ICP, and in some instances may be harmful. There is good evidence that they do not decrease mortality, and there is some evidence that they may even increase the mortality rate in trauma individuals with brain injuries.
 - j. Barbiturates may be used to treat elevated ICP as a last resort.

3. **NUTRITION**

- a. Nutritional support should be aggressively initiated as soon as practicable.
- b. Preferable route is jejunal by gastrojejunostomy.
- c. Early aggressive establishment of positive nitrogen balance is probably beneficial. Appropriate caloric input should be established by the seventh day.
- d. Nutritionist or dietitian consultation may be indicated.

4. **ANTICONVULSANTS**

- a. Anticonvulsant treatment may be used to prevent early posttraumatic seizures in the high-risk individual, and are usually administered for one week in those with intracranial hemorrhage.
- b. Prevention of early seizures has no statistically significant impact on long-term outcome or the development of late seizures or chronic epilepsy.
- c. Prevention of early seizures is reasonable to reduce seizure-associated complications during acute management.

- 5. **HYPOTHERMIA** is an evolving technology for controlling ICP. It has possible utility in hypoxic or ischemic encephalopathy, however, its use in TBI is currently investigational.

It may benefit individuals with a critically elevated ICP unresponsive to traditional therapies.

Of course, hyperthermia must be treated aggressively to avoid exacerbation of increased ICP.

G. THERAPEUTIC PROCEDURES - NONOPERATIVE

Due to the complex nature of the brain, individuals with traumatic brain injury require coordinated interdisciplinary treatment. Usually the impairment and functional limitations are appropriately treated by more than one therapeutic discipline. Treatment should emphasize functional, outcome-oriented and community reintegration goals. Treatment often involves longer treatment sessions, with variable frequencies. The location of treatment sessions may begin in a clinical setting, but eventually may be more effective in the home, workplace or community, based upon functional goals. TBI may result in lifetime deficits and a long-term disability management model is appropriate. Frequency and duration of specific, non-acute treatments should be included in every treatment plan and should be re-evaluated about every four weeks (Refer to section B. General Guideline Principles). Experienced practitioners should not necessarily use all of the therapies and modalities listed in the guidelines. Periodic modification or consultation may be necessary throughout an individual's lifetime following TBI. Therapy for specific impairments and functional limitations may be re-initiated for goal specific, time limited treatment as new goals are identified and developed. Treatment should be based upon medical and impairment diagnosis, cognitive ability, clinical evaluations, anticipated functional gains, progress, etc.

1. **INTERDISCIPLINARY REHABILITATION PROGRAMS** must be directed and/or overseen by a physician board certified in psychiatry or another specialty, such as neurology, with additional training in brain injury rehabilitation. All programs should have access to a team of interdisciplinary professionals, medical consultants, physical therapists, occupational therapists, speech-language pathologists, neuropsychologists, psychologists, rehabilitation nurses, social workers, rehabilitation counselors, dieticians, therapeutic recreation specialists and others. The individual's use of these resources will be dependent on each person's specific treatment plan. All phases of treatment should involve the individual's family/support system.

a. **Comprehensive Integrated Inpatient Rehabilitation:** is a generally accepted and widely used practice. Preferably, inpatient brain injury rehabilitation programs should have designated staff for TBI, designated TBI patient rooms, designated TBI treatment facilities and programs and serve at least 25 to 30 TBI individuals per year. Inpatient programs should be accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and have components consistent with the Commission on the Accreditation of Rehabilitation Facilities (CARF). CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

The length of initial rehabilitation depends on the severity of deficits, complication and the medical progress. Continued lengths of stay should be based upon documented functional progress, and may typically range from 30 to 90 days for moderate/severe injury. The individual should be re-evaluated every 30 days. On-site insurance case managers are encouraged to be a part of the treatment team, attend team conferences and assist the individual, his/her family/support system members and facility discharge planners in short and long-term management and goal setting.

b. **Outpatient Rehabilitation Services:** are generally accepted and widely used. These therapeutic interventions may be delivered in a hospital, free-standing outpatient facilities, or community-based, post-acute facilities with focused goals

for home and community functioning. In MTBI, community-based services may be the primary type of appropriate intervention. Frequency may vary from daily to less than one day per week and from four to six hours per day. Immediately following inpatient rehabilitation, outpatient rehabilitation is usually intensive, followed by a systematic and gradual reduction in therapy as appropriate. Typically, outpatient treatments include one or more of the following disciplines: physical therapy, occupational therapy, speech/language pathology, mental health counseling, neuropsychology, therapeutic recreation, family counseling, vocational rehabilitation and chiropractic treatment. Outpatient rehabilitation should be functionally oriented, goal specific, time-limited and case managed. Outpatient rehabilitation programs should be accredited by JCAHO and have components consistent with certification by CARF. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

- ❖ Frequency: 1 to 7 hours per day, 1 to 5 days per week
- ❖ Optimum Duration: For moderate/severe TBI, up to 24 months, or beyond with monthly re-evaluations

- c. **Residential Rehabilitation:** also called residential or transitional living, is clinically appropriate and generally accepted for individuals who have completed initial inpatient rehabilitation. This treatment is indicated for individuals who continue to have significant deficits, who are deemed unsafe to be discharged home, who require continued behavioral treatment, or who are deemed to be more effectively treated in a residential setting. Residential rehabilitation typically includes treatment and management by an interdisciplinary treatment team, with an emphasis on safety, independent living skills and functional community re-integration. Residential rehabilitation is also appropriate for those whose condition has changed, such as in caregiver death, disability, or unavailability, as well as for those who may not have had access to appropriate or adequate inpatient or sub-acute rehabilitation treatment, or in those which cognitive, communicative, physical or behavioral status has deteriorated.

The length of residential rehabilitation treatment depends upon the severity of deficits, complications, progress and available discharge options. Residential rehabilitation is a generally adopted and widely used practice, ranging typically from 30 to 120 days, depending upon the individual's condition and discharge needs, with re-evaluations every 30 days.

Residential programs should be accredited by JCAHO and have components consistent with CARF certification. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

- d. **Home and Community-Based Rehabilitation:** encompasses services provided in an individual's home and/or community settings and may be delivered as a separate service or in conjunction with outpatient therapy in a treatment facility. These post-acute services are generally accepted and widely used for individuals with TBI who have completed inpatient, residential rehabilitation, or those who have not required inpatient or residential services.

Home and community-based services are designed to maximize the transition and generalization of skills and behaviors in those with moderate/severe injuries from facility settings to application and assimilation in the community. In MTBI, community-based services may be the primary type and most appropriate intervention.

One or more therapeutic disciplines are appropriate to deliver home and community-based services including qualified/credentialed clinicians from physical therapy, occupational therapy, speech-language pathology, medicine, neuropsychology, clinical psychology and counseling, therapeutic recreation, nursing, vocational rehabilitation, and chiropractic treatment. Case management should continue during home and community-based treatment. Programs should preferably be accredited by JCAHO and have components consistent with CARF certification. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

- ❖ Frequency: 1 to 7 hours per day, 1 to 3 times per week
- ❖ Optimum duration: For moderate/severe TBI, up to 24 months or beyond with monthly re-evaluations

- e. **Behavioral Programs:** are specialized in TBI inpatient or residential rehabilitation programs designed for individuals with brain injury who have persistent and significant maladaptive behaviors. While all brain injury rehabilitation programs treat behavior, behavioral programs are usually required for individuals who are unsafe, or who have suicidal, homicidal, or violent behavior and individuals who cannot be treated in less restrictive environments. Behavioral programs may be physically located in secured hospital units, or community-based residential programs.

Behavioral programs generally use an interdisciplinary approach that may include behavior modification, medications, socialization skills training, substance abuse treatment, family therapy and physical management programs, as well as traditional interdisciplinary treatment. Length of stay may greatly vary depending on etiology and severity of the behavioral disorders and may typically range from one to six months or longer. Upon discharge from behavioral programs, disposition is either back to inpatient acute rehabilitation, inpatient programs, supported living programs or home and community-based programs. Use of psychiatric hospitals that are not experienced in brain injury rehabilitation is not recommended. Behavioral programs are also appropriate for severe behavioral problems due to other concomitant diagnoses, such as alcohol or substance abuse. Categorical adolescent inpatient hospital and residential programs may be appropriate for adolescent behavioral disorders due to TBI. Programs should be accredited by JCAHO.

- f. **Nursing Care Facilities:** generally provide care in specialty-licensed units of nursing homes. Extended nursing facility care is generally accepted and widely used. Individuals appropriate for extended care are not able to be cared for in a private home, supported living program, group home or community setting. Individuals appropriate for this type of care do not generally require skilled nursing care, but require ongoing care that is supervised by RNs. Rehabilitation therapies may be necessary to supplement nursing care. Rehabilitation

programs are established by appropriately licensed or certified therapists but may be delivered by paraprofessionals. The goal of care is to maintain and improve function if possible, this usually occurs at a slower rate over an extended period of time. Accreditation by JCAHO is recommended.

g. Supported Living Programs (SLP) or Long-Term Care Residential Services:

include licensed personal care boarding homes (group homes), supported apartment living programs, or supported inpatient programs designed for long-term living at the completion of the rehabilitation continuum. SLPs are designed for those who, due to their brain injury, are not able to safely and independently care of themselves in the community and for whom home placement is unavailable or inappropriate. Such programs are appropriate for individuals who are at risk for medical, physical and psychological complications, but who do not require a secured setting. Housing, food, supervision, activity programs, sheltered employment, transportation and case management are typical components of supported living programs. These programs are becoming more available and are generally accepted services for individuals with chronic brain injury who are moderately to severely disabled, and who require care, supervision and support services. Long-term residential services should be accredited by JCAHO and preferably have components consistent with CARF certification. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

2. PATIENT/FAMILY/SUPPORT SYSTEM EDUCATION for individuals with TBI and/or their family/support system is appropriate, generally accepted, and widely used in brain injury rehabilitation and is recommended by the Centers for Disease Control (CDC).

a. MTBI:

- ❖ Frequency: One-hour sessions weekly
- ❖ Optimum duration: 2 to 3 months
- ❖ Additional sessions may be required as justified

b. Moderate/severe Brain Injury: Formal conferences involving the individual with TBI, family/support individuals and case managers, including insurance case manager, should be held regularly during the inpatient and outpatient phases of rehabilitation and periodically during the home and community-based phases of community re-integration. Education may include, but may not be limited to, brain-behavior relationships, health maintenance, family interventions, emotional adjustments and family roles changes. Families and brain-injured individuals may require education and support as part of the long-term maintenance plan. Education for the individual and family/support system is typically provided by social workers, rehabilitation counselors, family counselors, licensed mental health professionals and/or nurses.

- ❖ Frequency and Duration: May require daily one-hour sessions for the first month
 - Up to twice weekly for 2 to 3 months
 - Up to twice monthly for 6 months

-Monthly for an additional 6 months

❖ Additional sessions may be required as justified

3. **NEUROMEDICAL CONDITIONS – MODERATE/SEVERE BRAIN INJURY REQUIRING TREATMENT**

There are a number of associated neuromedical problems unique to moderate/severe TBI. These conditions often require specialized evaluation and therapeutic interventions by physicians, nurses and relevant interdisciplinary team disciplines. The resultant problems may be classified as follows:

- a. **Neurological Complications**: Ongoing evaluation to detect the delayed development of space occupying intraparenchymal lesions, pneumocephalus, extra-axial lesions such as subdural and epidural hematomas, and hygromas, are often necessary. If an individual's neurological status worsens or plateaus, neuroimaging studies may be warranted.
- b. **Post-Traumatic Seizures/Post-Traumatic Epilepsy (PTE)**: Major risk factors for the development of PTE include penetrating head wounds hematoma, depressed skull fracture and early seizures. The issue of seizure prophylaxis remains controversial in high-risk individuals. The role of routine seizure prophylaxis utilizing antiepileptic drugs (AEDs) is recommended for seven to ten days post brain trauma. Thereafter, there is no consensus regarding the role of prophylaxis and this is generally not recommended, but at times occurs on an individual basis. The management of late post-traumatic seizures conforms to the treatment of 'epilepsy.' This includes principles of mono-therapy, compliance, considerations of cognition, behavioral, and psychosocial functioning.
- c. **Spasticity and Hyperreflexia**: are defined as velocity dependent hyperactivity of stretch reflexes secondary to the upper motor neuron syndrome. It is characterized by exaggerated deep tendon reflexes, increased muscle tone that results in a range of abnormal reflexes and motor patterns. The Modified Ashworth Scale is a clinical tool for measuring resistance to passive limb movement. If spasticity is interfering with the individual's general functioning (which may include range of motion (ROM) limitations, limitations in care and/or activities of daily living and mobility), then treatment is often warranted. Individuals with TBI may demonstrate changes in muscle activation based on emotional factors, positional changes, and functional demands. Treatment approaches involve the disciplines of rehabilitation nursing, physical therapy and occupational therapy. Therapeutic intervention should be concentrated on active control, force production and functional muscle use rather than just tone or spasticity reduction. Specific treatments may include, but are not limited to:
 - i. **Postural Control**: Trunk control is essential for the body to remain upright and to adjust and control movements against gravity. Postural tone and stability is evaluated by assessing the basic movement components of the upper and lower body, the coordinated trunk, extremity patterns and the power production involved in equilibrium and protective reactions. Basic movement components of the trunk are then progressed to the linking of trunk and extremity movements in supine, sitting and standing. The last level involves strength and stability for power production for activities such as walking, stair climbing, jumping, running and throwing.

- ii. Therapeutic techniques: such as exercise, casting and orthotic techniques, and modalities such as ultrasound, functional electrical stimulation, heat and cold applications may be of use to assist with exercise and stretching techniques to minimize tone and subsequently allow active and functional movement to occur. Passive modalities should not be used in isolation from other therapeutic activities such as described above, and effort should be made to incorporate problem solving and functional activity with active movement once passive movement has improved. Serial casting may also be effective to increase ROM by inhibiting tone and increasing passive muscle length. Serial casting should be reapplied every two weeks with increasing stretch and may require an overall treatment period of two to three months. An orthosis may be applied across the joint involved as well as at the joints above and below to maintain tone inhibition and muscle length. These orthoses may be removed to allow therapeutic activity, hygiene and modification based on progress in ROM and movement. Functional activity, such as reaching, grasp with the upper extremity and gait involving the lower extremity should be performed with the orthosis in place. Functional electrical stimulation may be used as a functional orthosis, and both devices may be required to be long-term, if not permanent.
- iii. Consideration of various oral and transdermal antispasticity medication: Invasive techniques include chemical denervation (nerve blocks), and botulinum toxin type A and B injections may be indicated (Refer to section G.9.b Therapeutic Nerve and Motor Point Blocks, 9.c Botulinum Toxin Injections and 9.d Intrathecal Baclofen Drug Delivery). Medications, nerve blocks and other surgical interventions serve as an adjunct to physical therapy and occupational therapy programs.

d. Cardiopulmonary Complications:

- i. Cardiac System: Elevated intracranial pressure and hypoxia may injure the hypothalamus and cardiac regulating centers of the brain, causing pathological changes in autonomic nervous system function. The resulting dysautonomia or hyperadrenergic syndrome (autonomic storm) includes fever, hypertension, tachycardia and hyperhidrosis (increased sweating and flushing). Hypertension in TBI is associated with tachycardia and increased cardiac output with normal or decreased peripheral vascular resistance. This is different from essential hypertension in which there is normal cardiac output with increased peripheral vascular resistance. The preferred treatment for this type of hypertension from hyperadrenergic activity is a beta adrenergic blocking agent or alpha-2 central agonist. However, these approaches must carefully consider the potentially negative cognitive, behavioral and/or emotional side effects of those medications.
- ii. Pulmonary System: TBI and related trauma to the chest wall may adversely affect respiratory function by compromising respiratory drive, swallow reflex and cough. Brain and brain stem injuries also cause abnormal neurogenic breathing patterns and a dysfunctional swallowing mechanism with the potential for aspiration and a weakened cough with

poor mobilization of secretions. These individuals are at increased risk for hypoxemia leading to further central nervous system (CNS) injury, pneumonia and adult respiratory distress syndrome. The main principle of therapeutic intervention is the avoidance of respiratory failure with appropriate oxygenation, ventilation and airway control. Treatments may include mechanical ventilation, tracheostomy, routine swallow evaluation to evaluate for aspiration risk, and aggressive pulmonary toilet.

- e. **Sleep Complications:** Sleep disturbance is a relatively common complication following TBI. Common sleep disorders for which individuals are at risk include, but are not limited to, posttraumatic hypersomnia, narcolepsy, central sleep apnea, obstructive sleep apnea, nocturnal seizures, periodic limb movement disorder (PLMD) and insomnia. Generally accepted subjective measures of post-traumatic sleep disturbance include self-rating scales. Objective measures include techniques that monitor changes in select physiologic processes (heart rate, temperature, cortisol levels, blood/oxygen levels, etc.) up to full polysomnography and sleep lab studies. These subjective and objective measures combined with serial clinical evaluation are useful clinical tools in guiding appropriate management. Depending on etiology, management strategies include, but are not limited to, extension of time in bed, naps, surgery, various medical devices (e.g., oral appliance, continuous positive airway pressure) and medication therapy.

- f. **Musculoskeletal Complications:**
 - i. **Long-Bone Fractures:** When long-bone fractures occur in individuals with a TBI, the Committee on Trauma of the American College of Surgeons recommends that aggressive, early surgical treatment be performed within two to twelve hours after injury, providing hemodynamic stability has been achieved. This would include open reduction and internal fixation, although the specific optimal technique has not been well-documented. Maximal functional use of all extremities should be the goal in this early phase of care. Early stabilization allows the prevention of prolonged immobility that has the subsequent greater risk of infection, venous thrombosis development, pulmonary complications, skin breakdown and contractures. Fracture healing challenges unique to TBI include the deforming effect spasticity exerts on fracture alignment and an exaggerated healing response that may represent an iatrogenic form of heterotopic ossification (HO). Noncompliance secondary to confusion and agitation often requires reinforced immobilization, strategies and prolonged time frames of immobilization and may preclude the use of common external fixation devices. Therefore, it is generally accepted that early, aggressive, surgical management with an emphasis on internal fixation to allow early mobilization to be instituted when medically indicated in this population.

 - ii. **Heterotopic Ossification (HO):** is defined as the development of new bone formation in soft tissue planes surrounding neurologically affected joints, especially the hips, elbows, shoulder and knees, in order of common concurrence. Research puts the incidence at 10 to 20% following TBI in young adults. If diagnosis and treatment is delayed, ankylosis (bony fusion) may occur with consequent functional limits in

mobility. Additional risk factors that often accompany TBI include spinal cord injury, tissue hypoxia, venous stasis, spasticity and autonomic dysfunction. The greatest risk for development is within the first six months post-injury. Surveillance by nurses and physical therapists is essential and may include documentation of decreased ROM, joint inflammation and/or a low-grade fever. Appropriate work-up may include laboratory studies revealing an elevated sedimentation rate, and/or alkaline phosphatase with a normal complete blood count (CBC). Plain x-rays are necessary and appropriate; however, the most sensitive radiological study includes the three-phase bone scan and/or gallium scan, and color Doppler ultrasound. These may be necessary in both the initial diagnostic and follow-up phases to guide treatment. Optimal treatment outcome involves early diagnosis, ROM exercise, and the use of disodium etidronate, which prevents mineralization. Other treatment options include non-steroidal anti-inflammatory drugs (NSAIDs), radiation and surgery in the chronic state.

g. Gastrointestinal Complications: Individuals with TBI have demonstrated delays in gastric emptying with frequent regurgitation of nasogastric administered feedings. This, accompanied with dysphagia and/or an inadequate swallow reflex, place the individual at risk for aspiration pneumonia. Dysphagic individuals and those at risk may require total parenteral nutrition (TPN), gastric and/or post-pyloric feeding techniques. Either a percutaneous or surgically placed gastrostomy and/or jejunostomy may be necessary for adequate ongoing nutritional support. Individuals with gastrointestinal hypomotility may require medications. Also erosive gastritis may be a frequent complication, and the use of H2 blockers and antacid treatments are usually efficacious. Individuals with TBI may also be at risk for constipation, impactions, bowel obstructions and/or loose stools. A nursing care regimen on a routine and then consultative basis, may be necessary to establish routine bowel programs.

h. Genitourinary Complications: Moderate/severe diffuse and/or focal TBI may involve cerebral structures controlling bladder storage and emptying functions. This may result in a neurogenic bladder. Treatment of a neurogenic bladder is aimed at adequate emptying, prevention and treatment of infection, preservation of upper renal tract function and avoidance of skin soiling from incontinence. An indwelling urethral catheter is often appropriate in the early stages of recovery. Once the urethral catheter is discontinued, either a condom catheter or diaper is used for incontinence.

Following assessment of bladder emptying utilizing post-void residual checks, decisions may be made regarding longer-term management strategies. This may include intermittent catheterization or rehabilitative bladder training utilizing anticholinergic medications and time-interval voiding techniques. Urological consultation and more comprehensive diagnostic studies that may include, but are not limited to, cystoscopy, urodynamics, and renal functions studies may also be necessary. Sexual dysfunction may also occur, secondary to TBI, and if present, comprehensive assessment is appropriate in guiding therapeutic management.

i. Neuroendocrine Complications: Neuroendocrine abnormalities following TBI are common. The degree of neuroendocrine dysfunction may vary based on

differential injuries to the hypothalamus, anterior/posterior pituitary, upper or lower portions of the pituitary stalk and connections to other brain and brainstem structures. Secondary endocrine effects may include, but are not limited to the abnormalities of the following: salt and water metabolism including syndrome of inappropriate antidiuretic hormone (SIADH) and temporary or permanent diabetes insipidus (DI), thyroid function, sexual function, hormonal reproductive function, control of body temperature, ACTH-cortisol levels, glucose metabolism, gonadotropin and growth hormones. These potential complications may require specialized medical evaluation and treatment if correlative symptoms exist and/or persist.

- j. **Fluid and Electrolyte Complications:** abnormalities in individuals with TBI are usually iatrogenic or trauma induced. Specific problems may include, but are not limited to, a resulting water and salt retention with decreased urine output. There may also be problems with hyponatremia from inappropriate antidiuretic hormone, cerebral salt wasting, and increased production of aldosterone. Also, hypernatremia from dehydration or DI may occur. This may require careful evaluation with laboratory studies initially and serially on a follow-up basis.
 - k. **Immobilization and Disuse Complications:** In an unresponsive individual, skin is at risk for the development decubiti ulcers that may slowly progress and increase length of hospital stays. Tissue pressure and deformation cause the ischemia. Vigilant rehabilitation nursing, specialized beds, padding, positioning and weight shift management protects the individual from these complications.
 - l. **Vascular Complications:** Individuals with TBI are at risk for developing deep venous thrombosis (DVT) and pulmonary embolus (PE). Since diagnosis by clinical examination is difficult in this population, a high degree of suspicion is warranted. While in the hospital, daily nursing screening with lower extremity measurements is recommended. Abnormalities requiring confirmation may entail noninvasive studies such as Doppler ultrasonographic flow examination and impedance plethysmography. Also, hematologic conditions, such as, but not limited to, coagulopathies may require comprehensive specialized hematologic evaluation. It is generally accepted that prophylaxis with low molecular weight heparin and/or sequential compression stockings may reduce the incidence of both complications. If the diagnostic use of noninvasive studies as mentioned are equivocal and/or nonconfirmatory, then venography and/or angiography may be necessary. If thrombotic complications occur, standard treatment includes intravenous heparin or subcutaneous low molecular weight heparin followed by oral warfarin sodium. If neuromedical risks of anticoagulation are present and/or complications related to anticoagulation or progressive thrombosis arise, then placement of an inferior vena cava filter may be necessary.
4. **MEDICATION** Pharmacological agents are useful to treat symptoms related to the neuropathological effects of the injury, associated injuries to the brain, skull, spinal axis, soft tissues, etc. They are also useful in the treatment of secondary cognitive, behavioral and emotional sequelae of TBI. The use of medications (pharmacological rehabilitation) requires careful monitoring and collaboration between the individual, physician, family/support system and other members of the interdisciplinary team. Common symptom categories targeted for medication treatment may include, but are not limited to:

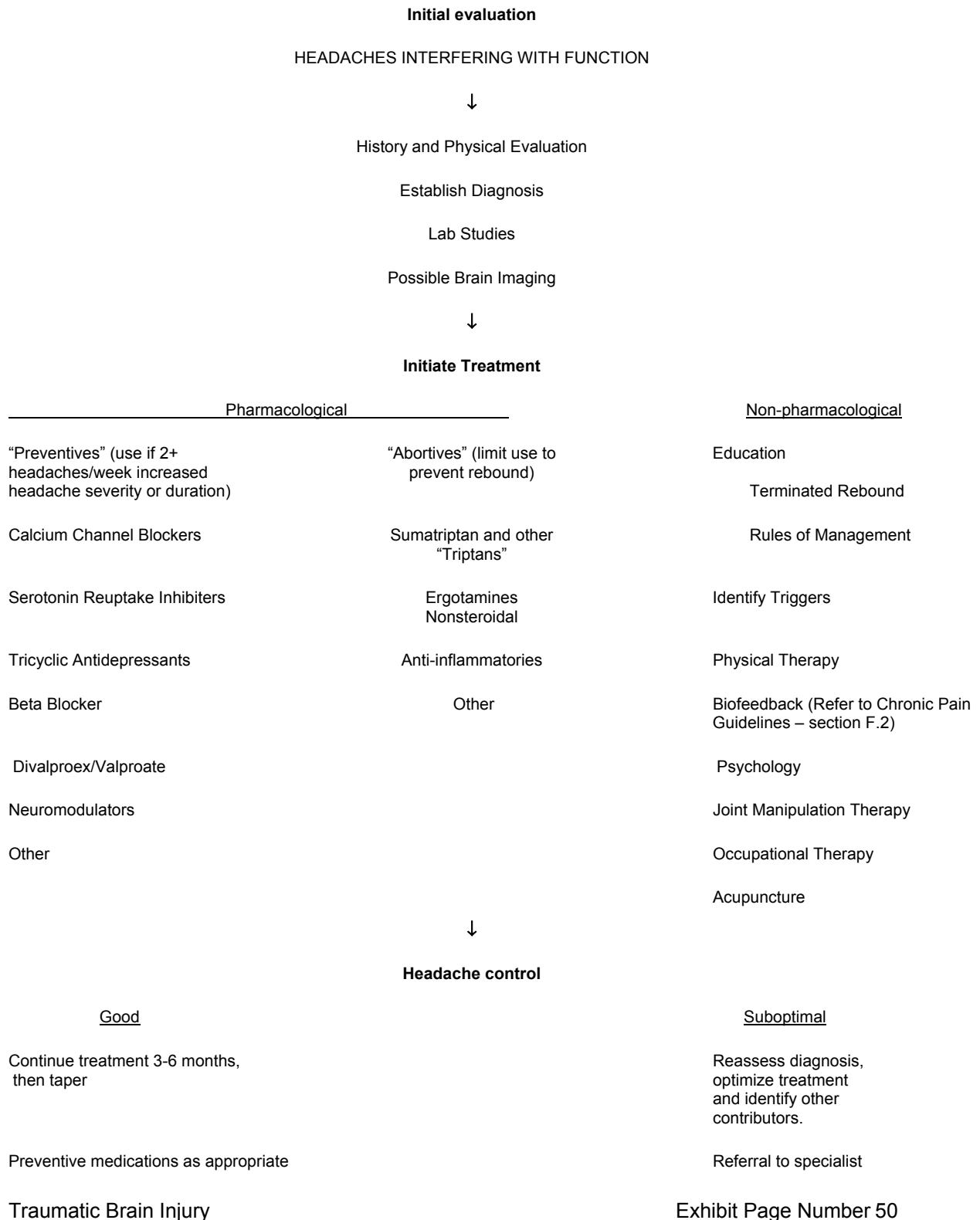
- pain (headache, axial, soft tissue, etc.)
- sensory alterations (dysesthesias)
- motor (motor control, coordination, spasticity, weakness, Parkinsonism, tremor, etc.)
- emotional (depression, liability, anxiety, etc.)
- behavioral (poor self-monitoring, dyscontrol, irritability, aggression, poor initiation, etc.). Medications used for behavioral treatment may be effective, but benefits versus side effects should be carefully evaluated and justified with documentation of functional improvement in each individual, as per the National Institute of Health's recommendations.
- cognitive (arousal, attention, speed of processing, memory, thought process and content). Medications used for cognitive enhancement may be effective but benefits versus side effects should be carefully evaluated and justified with documentation of functional improvement in each individual
- psychotic symptoms
- neurological (seizures, etc.)

Indications for the use of medications following TBI frequently differ from those outlined by the Food and Drug Administration (FDA) due to the paucity of clinical research on the use of medications for the above symptoms when present in brain injured individuals. Categories of specific medications for some of the aforementioned sequelae of TBI include, but are not limited to, antiepileptic drugs, anxiolytics including minor and major tranquilizers, psycho-stimulants, anti-psychotics, antidepressants and memory enhancing agents.

5. **HEADACHE** is one of the most common symptoms seen in general medical practices. Following head trauma, 50% or more of injured individuals may be expected to experience headache. The majority of these are self-limited, but headache persisting for more than three months may occur. Brain damage is unlikely to be responsible for post-traumatic headache, which is seen more commonly after mild TBI than after moderate/severe TBI. Rather, involvement of extra-cranial structures, such as the temporomandibular joint (TMJ), the sinuses, and the muscles attaching to the occiput accounts for most headaches following TBI. (Refer to the Division's Cervical Spine Guidelines when appropriate.)

Management of post-traumatic headache should be tailored to the class of non-traumatic (chronic tension, migraine, etc.) headache into which it fits. Both traumatic and non-traumatic headaches may be made worse by overuse of analgesics. Treatment should be directed toward re-establishment of activities and away from rumination on the injury. Education, medication adjustment and interdisciplinary team approaches may be called for. If depression is present, a sedating antidepressant such as amitriptyline may alleviate the insomnia that often complicates headache. See treatment algorithm (next page). Referral to a specialist may be necessary if initial treatment is not effective.

a. **Headache Treatment Algorithm:**



Widely accepted treatments for post-traumatic headache may include, but are not limited to: interdisciplinary treatment, pharmacology, joint manipulation, physical therapy, massage, acupuncture, biofeedback, psychotherapy and diet. These procedures should only be continued if functional gains are documented.

Psychological evaluation is a generally accepted intervention to identify factors for delayed recovery and the potential need for cognitive assessment. Refer to the Chronic Pain Guidelines for specific time frames. Special procedures may be useful for specific or intractable head pain syndromes including nerve blocks for neuralgia, trigger point injections for myofascial pain syndromes, botulinum toxin injections for headaches (Refer to G.9 Muscle Tone and Joint Restriction Management) and use of dental splinting for temporomandibular joint syndrome.

Inpatient admission is sometimes required when intravenous medications (e.g., Dihydroergotamin[e]) and close monitoring are necessary to control migraine or analgesia rebound, especially in individuals with severe depression, suicidal ideation or complicated medical problems. When greater than two disciplines are necessary, when there is significant dysfunction secondary to headache, when the individual has not returned to work for greater than three months or when treatment is geographically inaccessible, an individualized interdisciplinary outpatient treatment program may be appropriate.

Headaches may persist longer when associated with other symptoms such as dizziness, memory problems or weakness. Therefore, every effort should be made to treat headaches and other symptoms as early as possible.

Long-term maintenance plans are necessary in chronic headache management. Medications may be necessary for an indefinite period. All other treatment modalities should be independent and functional. Even if headaches are permanent, it is expected that the individual will be functional and able to return to work.

6. MOBILITY

- a. **Therapy:** Individuals who have sustained a TBI may experience changes in their mobility control and may require medical, surgical, physical and functional therapeutic management to improve their movement and function. Impairments may affect functional skills and may be seen in the following areas: bed mobility, wheelchair mobility, seating and positioning, transfers and ambulation.

Therapeutic intervention supervised by a physical or occupational therapist is generally accepted and widely used to improve performance of mobility impairments. Treatment may include, but is not limited to, the areas of developmental sequence, bed and mat mobility skills, sensory integration, endurance, balance, strengthening and postural control. Training is also indicated for individuals and their family/support system in the areas of wheelchair mobility, seating and positioning, ROM and transfers. The use of modalities (functional electrical stimulation, TENS, ultrasound, phonophoresis, biofeedback), may be indicated to improve function. Passive modalities should not be utilized in isolation without a comprehensive therapeutic intervention program. Other indicated therapies may include pool therapy, casting/splinting programs and facility-based exercise programs. Orthopedic and/or

neuromuscular problems may develop along with mobility impairments. These may include, but are not limited to, heterotopic ossification, limb contractures, and abnormal tone, which may interfere with the advancement of independence with mobility skills.

- ❖ Frequency: Number of hours will vary depending upon the individual's ability and treatment activity. Treatment frequency should decrease as goals are met and independence is gained
- ❖ Optimum duration: 4 to 8 months with reevaluation every 4 weeks
- ❖ Maximum duration: beyond 12 months requires documentation of progress

Short-term, goal-directed intervention may be periodically indicated on an ongoing basis as new changes occur in an individual's functional mobility. Impaired cognition significantly affects mobility as noted by problems with attention, judgment, organization or auditory and/or visual instructions, memory, concentration, problem solving, behavior and initiation. (Refer to discussion at the beginning of Section G, Therapeutic Procedures).

Individuals with TBI may be compromised in their mobility and accessibility to their home, work and community environments. In order to relieve the effects of the injury, certain equipment, adaptive devices and home modifications may be reasonable and necessary. These items may be necessary to reduce impairment and disability and to enhance functional independence and safety.

- b. **Adaptive Devices:** Individuals with TBI may be compromised in their mobility and accessibility to their home, work and community environments. Adaptive devices, equipment and home modifications may be reasonable and necessary to minimize disability that is secondary to the effects of the medical pathology condition. These items may be necessary to enhance functional independence and safety.

Possible equipment and devices may include, but are not limited to:

- hospital bed
- transfer devices and lift equipment
- standing frames
- manual wheelchair – standard or lightweight
- manual reclining and tilt wheelchair
- power wheelchairs with tilt and/or reclining mechanisms
- wheelchair positioning aids (laterals, headrests, seating systems, backs, lapboards)

- wheelchair cushions
- lower extremity bracing
- ambulation aids (walkers, crutches, canes)
- bathroom safety aid (shower/commode chair, bath seats and benches, tub and wall grab bars, hand held shower attachment, elevated and/or padded toilet seats, etc.)
- orthotics/prosthetics
- vehicle modifications

Environmental modifications may include, but are not limited to, ramping, modifications of the living environment to achieve reasonable levels of independence, adaptive equipment for mobility and safety. Periodic upgrading of equipment and devices or consultation may be necessary throughout a person's lifetime following TBI.

Therapy related to equipment and devices may be re-initiated for time-limited, goal-specific treatment as new goals are developed.

7. **COORDINATION** Ataxia is a common impairment in coordination resulting from inability to control muscle timing, and sequencing of agonist and antagonist contraction. This will affect fine motor and gross motor skills of the extremities as well as general mobility, balance, gait, condition and endurance, and activities of daily living. Therapeutic management/intervention includes medication, neuromuscular re-education as well as functional activities, which facilitate normal or inhibit abnormal muscle activity. Specific exercises and activities increase motor learning and control, force production (strength) and endurance. Biofeedback and functional electrical stimulation may assist in treatment. Cognitive impairment may interfere and prolong the course of therapy. Reasonable and necessary equipment may include splints and braces. Access to facility exercise equipment may be warranted.
8. **NEUROMUSCULAR MANAGEMENT** Neurologically based musculoskeletal impairment may include changes in reflexes, sensory integration, ROM, muscle tone, strength, endurance, postural control, postural alignment and soft tissue integrity. Functional abilities that are affected may include, but are not limited to, problems in gross and fine motor coordination, motor strength and control, sensory-motor bilateral integration and praxis. Individuals with neuromuscular impairments may require physical, therapeutic and medical and/or surgical management to improve their movement and mobility. Medical treatment may be divided into three major areas:
 - a. **Motor Control:** Stabilizing the body in space as it applies to postural and balance control, and moving the body in space through motor control as it applies to movement.
 - b. **Motor Learning:** is a set of processes leading to relatively permanent changes in the capability for producing skilled action. Motor performance of a skill, task or activity requires learning. Functional motor change requires skilled intervention

to insure proper practice schedules, variable type of practice, repetition and type of timing of feedback. The use of declarative strategies with verbal explanation as well as augmented feedback with or without manual guidance encourages procedures learning strategies. Active problem solving should be part of a rehabilitation program to learn motor skills more appropriately. Continuous accurate feedback is important in the early stages. Therapists need to provide feedback about muscle contraction and movement that is accurate and immediate.

- ❖ Frequency: daily, up to several hours per session
- ❖ Optimum duration: 6 months
- ❖ Maximum duration: 12 to 18 months with re-evaluation every 4 weeks – beyond 6 months requires documentation of progress

As the individual progresses, treatment frequency should be decreased. Continued treatment is based upon attainment of functional goals as outlined in the treatment plan established upon initial interaction with all members of the treatment team.

9. MUSCLE TONE AND JOINT RESTRICTION MANAGEMENT Hypertonicity or spasticity (Refer to section G.3.c Spasticity and Hyperreflexia) influence motor control and may vary based on the severity and location of the brain lesion, the individual's position, time of day or emotional state. Treatment should begin immediately following medical stabilization. This may include positioning techniques, splinting, serial casting and ROM treatment. Medical and surgical intervention is also generally accepted to influence tone such as anti-spasticity medication, phenol or other anesthetic blocks, botulinum toxins, and surgical techniques such as tendon lengthening, tendon transfers and orthopedic reconstruction to reduce joint deformity.

a. Functional and Therapeutic Activities: are provided with instruction for the individual and/or family/support system in the proper positions, sequences, timing and level of assistance.

- ❖ Frequency: Inpatient setting – initially twice a day, then decreasing in frequency as individual progresses; outpatient setting – twice per day initially then decrease to 2 to 3 sessions per week
- ❖ Optimum duration: 6 months
- ❖ Maximum duration: 2 years – maintenance care may extend beyond 2 years (Refer to section I. Maintenance Management)

Periodic functional upgrading or consultation may be necessary throughout an individual's lifetime following TBI. Therapy may be re-initiated for time-limited, goal-specific treatment as new goals are developed and as new abilities in physical and cognitive function are observed or attained.

b. Therapeutic Nerve and Motor Point Blocks: are useful in targeting specific muscles or muscle groups for diagnostic and therapeutic purposes. The purpose

of the nerve or motor point block is to reduce force produced by contracting spastic muscle or muscle group. This reduction in spasticity may lead to improved ROM and enhanced functioning. Therapeutic nerve and motor point blocks are primarily performed with aqueous solutions of phenol. When injected in, or near, a nerve bundle, phenol denatures protein in the myelin sheath or cell membrane of axons with which it makes contact. Either percutaneous or open neurolytic procedures are considered useful in a variety of spastic disorders related to TBI and are generally accepted procedures.

- c. **Botulinum Toxin Injections:** are useful to temporarily weaken or paralyze specifically treated muscles. These techniques may reduce muscle pain in conditions associated with spasticity, dystonia or other types of painful muscle spasm. Neutralizing antibodies develop in at least 4% of individuals with TBI treated with botulinum toxin type A, rendering it ineffective. Several antigenic types of botulinum toxin have been described. Botulinum toxin type B, first approved by the FDA in 2001, is similar pharmacologically to botulinum toxin type A, and there is good evidence of its efficacy in improving function in cervical dystonia (torticollis). It appears to be effective in individuals who have become resistant to the type A toxin. The immune responses to botulinum toxins type A and B are not cross-reactive, allowing type B toxin to be used when type A action is blocked by antibody. Experimental work with healthy human volunteers suggests that muscle paralysis from type B toxin is not as complete or as long-lasting as that resulting from type A. The duration of treatment effectiveness of botulinum toxin type B for cervical dystonia has been estimated to be 12 to 16 weeks. EMG needle guidance may permit more precise delivery of botulinum toxin to the target area.
- I. **Indications:** Used to improve ROM and reduce painful muscle spasm, a temporizing measure when spasticity is evolving and during the chronic phases to support increased function. Botulinum toxin injections may be useful in musculoskeletal conditions associated with muscle spasm, or headaches and in central neurologic conditions that produce spasticity or dystonia (e.g., brain injury, spinal cord injury or stroke). There should be evidence of limited ROM prior to the injection.
 - II. **Complications:** Over-weakening of injected muscles, and allergic reaction to medications. Rare systemic effects include flu-like syndrome, weakening of distant muscles. There is an increased risk of systemic effects in individuals with motor neuropathy or disorders of neuromuscular junction.
 - ❖ Time to produce effect: 24 to 72 hours post-injection with peak effect by 4 to 6 weeks
 - ❖ Frequency: No less than 3 months between re-administration
 - ❖ Optimum duration: 3 to 4 months
 - ❖ Maximum duration: Currently unknown. Repeat injections should be based upon functional improvement and therefore

used sparingly in order to avoid development of antibodies that might render future injections ineffective

d. Intrathecal Baclofen Drug Delivery:

I. Description: The intrathecal administration of baclofen is indicated for use in the management of severe spasticity. Individuals with TBI should first have a positive response to a diagnostic injection of intrathecal baclofen prior to a consideration of long-term infusion via an implantable pump. An implantable pump should be reserved for those individuals unresponsive to oral baclofen therapy, or those who experience intolerable CNS side effects at effective doses. Individuals with functionally limiting disabling spasticity due to TBI ideally should wait at least one-year post injury, unless there is clear documentation as to plateaued neurological functioning prior to the one-year post injury mark. Furthermore, there should be clear-cut documentation as to the deleterious effects of their persistent spasticity if not treated effectively, as well as to the specific goals of this invasive therapy. Intrathecal baclofen is intended for use via spinal catheter or lumbar puncture and for chronic use only in implantable pumps approved by the FDA, specifically for the administration of intrathecal baclofen via the intrathecal space.

II. Diagnostic Injection:

Special Requirements for Diagnostic Injections: Fluoroscopic and/or CT guidance may be used to document technique and needle placement. An experienced physician should perform the procedure. The subspecialty disciplines of the physicians may be varied, including, but not limited to, anesthesiology, radiology, surgery, neurology or physiatry.

Complications: General complications of diagnostic injections may include, but are not limited to, transient neurapraxia, nerve injury, infection, headache, urinary retention and vasovagal effects, as well as, epidural hematoma, permanent neurological damage, dural perforation, CSF leakage, and spinal meningeal abscess. Permanent paresis, anaphylaxis and arachnoiditis have been rarely reported.

Contraindications: Absolute contraindications of diagnostic injections include, but are not limited to, a) bacterial infection-systemic or localized to the region of injection, b) bleeding diathesis, c) hematological conditions and d) possible pregnancy. Relative contraindications of diagnostic injections may include: a) allergy to contrast, b) aspirin/antiplatelet therapy (drug may be held three days prior to injection), and c) shellfish allergy if contrast is to be used.

III. Surgical Pump Implantation:

Surgical Indications: Individuals who meet the following criteria should be considered candidates for intraspinal baclofen infusions:

- The individual must have good-to-excellent relief from the diagnostic baclofen intrathecal injection and have demonstrated clear functional improvement. Functional gains may be evaluated by an occupational therapist and/or physical therapist prior to and before discontinuation of the trial
- Failure of conservative therapy including active and/or passive therapy, medication management or other therapeutic injections
- The individual and/or family/support system must be motivated for the procedure and must understand the potential for complications and requirements of treatment maintenance

Complications: Intrathecal delivery may be associated with significant complications such as infection, catheter disconnects, CSF leak, arachnoiditis, pump failure, nerve injury and paralysis.

Contraindications: Infection or body size insufficient to support the size and weight of the implanted device. Individuals with other implanted programmable devices should not be given these pumps, since interference between devices may cause unintended changes in infusion rates.

Continuing Use: As with other routes of drug administration, escalation of dose may be required and routine clinical monitoring is warranted. Typically, pump refills are needed every two to three months.

10. **ACTIVITIES OF DAILY LIVING (ADLs)** (also called daily living skills, life skills or living skills) are tasks necessary for an individual's day-to-day functioning, and include both basic and instrumental level tasks. ADL functional limitations and disabilities in ADLs are common following TBI and due to changes in physical, cognitive and emotional/behavioral impairments. Functional limitations and disability in these areas may range from mild to severe, as well as from short-term to life-long.

Therapeutic intervention for ADLs is generally accepted and widely used. The goal of treatment is to improve one's ability to perform such tasks, in order to increase functional levels of independence. By including ADLs in treatment, cognitive improvements may occur by applying cognitive rehabilitation principles to the task performance. Likewise, physical deficits may be improved by applying neuromuscular rehabilitation principles to the task performance.

- Basic ADLs:** include daily activities which tend to be repetitive, routine and which may more readily be gained through procedural learning, such as grooming, personal hygiene, bathing/showering, toileting, dressing, feeding/eating and basic social skills.
- Instrumental ADLs (IADL):** include a wide-range of activities that require higher level cognitive skills, including the ability to plan, execute and monitor performance, evaluate information and make sound judgments. These abilities are essential to safe, independent functioning. They may include functional communication (e.g., writing, keyboarding, appropriate use of phone), home

management, childcare, time management, financial management, food management, management of interpersonal relationships and social skills, avocation, driving and higher level mobility skills (including navigation and public transportation).

Therapeutic intervention is generally accepted to improve performance of ADLs. Procedures and techniques may include, but are not limited to: 1) task analysis to develop strategies to improve task performance; 2) guided practice and repetition to develop consistent and safe performance; 3) training in safe use of adaptive equipment; and 4) training of caregiver(s).

Treatment in subacute and acute rehabilitation is provided by one or more therapeutic disciplines, including physical therapy, occupational therapy, speech-language pathology, social work, family counseling, psychology, nursing and/or vocational rehabilitation as tolerated. In post-acute settings (which may include residential or outpatient), treatment sessions may be provided by more than one discipline. For in-home and community-based treatment, interdisciplinary treatment continues until: 1) functional goals/outcomes are achieved; 2) plateau in progress is reached; 3) the individual is unable to participate in treatment due to medical, psychological or social factors; or 4) skilled services are no longer needed.

- ❖ Time to produce effect: while rate of progress will depend on the severity and complexity of the injury, effect of treatment should be noted within one month, with ongoing progress noted over a longer period which may last up to two years or more. Treatment may be provided on an episodic basis to accommodate plateaus in the individual's progress, with suspension of treatment for periods of time to allow for practice.
- ❖ Frequency: One to two sessions per day depending upon the individual's progress, sessions may vary from one to several hours depending upon individual's ability to respond to treatment. Periodic upgrading or consultation may be necessary throughout the individual's lifetime following TBI.
- ❖ Optimum duration: 1 to 12 months
- ❖ Maximum duration: 24 months or beyond, requires documentation of progress
- ❖ Therapy may be re-initiated for time-limited, goal-specific treatment as new goals are developed.

Impaired cognition significantly affects the rate, degree, and manner of progress toward independence in ADLs. In addition, skills learned in one setting or circumstance may facilitate transfer of skills. All treatment to improve performance in this area must include techniques to improve cognition as well.

Standard equipment to alleviate the effects of the injury on the performance of ADLs may vary from simple to complex adaptive devices to enhance

independence and safety. Certain equipment related to cognitive impairments may also be required. Equipment needs should be reassessed periodically.

The results of treatment intervention provided throughout the continuum of progress beginning with acute care may be realized in the final stages of integration back into the individual's community setting. As noted above, treatment is often indicated at this stage to ensure that the individual is able to reintegrate as successfully as possible, given the parameters of the injury.

11. **VISUAL TREATMENT** Visual impairments may occur secondary to TBI. Treatment of visual impairments should be based upon a comprehensive evaluation and diagnosis. Treatment should be functionally based and goal-directed. Individuals should be evaluated at intervals depending on their impairment and progress should be clearly documented. An ophthalmologist, neuro-ophthalmologist, neurologist, or optometrist may treat visual impairment resulting from TBI. Treatment may be supplemented by and coordinated with interdisciplinary team members.

Visual impairments may occur in one or more of the following categories:

- Visual acuity and visual field function
 - Ocular motor control and ocular alignment
 - Visual perception
- a. **Visual Acuity and Visual Field Function:** are determined by the eye, optic nerve, optic chiasm, optic tracts, optic radiations and visual cortex. If visual acuity deficits are caused by optic nerve trauma, treatment with high dose intravenous corticosteroids may be useful. Corticosteroid treatment should be given as early as possible after the injury. Time to effect is likely to occur within the first month after treatment. Duration of treatment beyond one to two weeks is unlikely to be of benefit, unless, neuroimaging, or clinical history indicates otherwise. Initiation of treatment after two weeks is unlikely to be of any benefit unless neuroimaging or clinical history indicates otherwise. Surgery may be indicated if the trauma results in entrapment, compression of the nerve, or if a hematoma is present within the optic nerve sheath. If visual acuity or visual field deficits are caused by intra-cranial visual pathway damage, acute treatment should be directed towards the specific injury.

Low vision aids may be prescribed for those individuals with documented visual acuity or visual field loss after the acute injury. Lenses may be used to improve visual acuity. Tinted lenses may be useful to treat photophobia and glare sensitivity.

The use of prisms may benefit some individuals with documented visual field loss from visual pathway disorders affecting the visual fields in both eyes.

Depending on the level of adaptation to the visual field loss, some individuals may need training and education in strategies to improve compensation. Efforts to use visuospatial interventions to improve visual field loss directly and without developing compensatory visual scanning are not recommended.

- b. **Disorders Involving Ocular Motor Control and Ocular Alignment** are treated according to the underlying diagnosis. Ocular motor control includes accommodation, versions, vergences, ductions, ability to fixate, pursuits, saccades, vestibulo-ocular responses (VOR), and optokinetic nystagmus (OKN). Multiple deficits may occur together.

Treatment may include the use of lenses, prisms, rehabilitation vision therapy techniques and/or surgery. For individuals with disorders of ocular motor and ocular alignment that result in diplopia, monocular eye patching, occlusion of central or peripheral vision, prisms lenses or strabismus surgery may be used.

Lenses may be used to help accommodation. Because of the interaction between accommodation and vergence, lenses may also at times be used to assist in the treatment of a vergence disorder.

Prisms may be prescribed to provide an immediate improvement in diplopia and other disorders with symptoms. If diplopia is not stable then appropriate patching (partial selective occlusion) may be more prudent. If deficits are permanent, prisms may be worn indefinitely.

Individuals may be instructed in orthoptic techniques to address problems related to ocular motility disorders particularly in cases with cranial nerve palsy or encephalopathy with a correlated shearing injury.

Strabismus surgery may be useful in certain circumstances if the deficit is stable for six to nine months. An immediate response is usually noted after the first surgery, but additional surgeries may be necessary.

- c. **Visual Perception:** problems should be treated with a goal to improve visual processing skills and promote adaptation and compensation to the relevant problem.

Visual perceptual therapy may be required for some individuals as part of their overall cognitive rehabilitation treatment. The therapy may be provided by various disciplines including, but not limited to, occupational therapists, speech therapists, optometrists and ophthalmologists, neurologists and neuro-ophthalmologists with experience in visual perceptual disorders and in treating individuals with TBI. The visual perceptual therapy should be integrated into the complete cognitive rehabilitation program and coordinated with a neuropsychologist or physician experienced in TBI. (Refer to section G.15 Cognition.)

- d. **Visual Neglect:** is inattention of a visual spatial region. Treatment may include the use of prism and scanning techniques. Visuospatial rehabilitation with scanning is recommended for individuals with visuoperceptual deficits associated with unilateral visual neglect with TBI and after right hemisphere stroke. There is some evidence that visuospatial rehabilitation with scanning is effective in those with right hemispheric stroke, therefore, it is recommended in TBI individuals with similar findings. Scanning training is recommended as an important, even critical, intervention element for individuals with severe visuoperceptual impairment that includes visual neglect after right hemispheric stroke and TBI.

Efforts to use visuospatial interventions to improve visual field loss directly and without developing compensatory visual scanning are not recommended.

- e. **Total Time Frames for all Vision Therapy (Orthoptic Therapy):** Time frames are not meant to be applied to each section separately. The time frames are to be applied to all vision therapy regardless of the type or combination of therapies being provided.

- ❖ Time to produce effect: 8 hours of treatment
- ❖ Frequency: 1 to 2 times per week. Frequency of treatment is dependent on in-patient versus outpatient, and the medical condition of the individual
- ❖ Optimum duration: 20 hours
- ❖ Maximum duration: Throughout the treatment progress, exams are performed to evaluate status. When progress is no longer occurring, then therapy should be stopped, unless there are mitigating circumstances. If after 20 hours of treatment, there is documented progress, but the individual is not at maximum therapeutic gain, then additional therapy is usually indicated

12. **NEURO-OTOLOGIC TREATMENTS**

a. **Treatment of Hearing Disorders:**

- i. Post-traumatic endolymphatic hydrops (Meniere's Disease): Medications used to treat this type of sensorineural (nerve) hearing loss include diuretics, calcium channel blockers, vasodilators and steroids.
- ii. Vestibular migraine: Just as visual migraines affect the visual system, basilar migraines may affect the inner ear. Medications used in this condition include beta-blockers, calcium channel blockers, anti-seizure medications, SSRI's, and the tryptans.
- iii. Post-traumatic tinnitus: Individuals with TBI may suffer from debilitating tinnitus (noise in the ears). They may benefit from anti-depressants, anti-seizure medicines and anxiolytics. In many situations, devices are recommended which may include hearing aids, maskers and tinnitus trainers.
- iv. Hyperacusis/Sonophobia: Individuals with TBI may suffer from significant sensitivity to sound. These individuals may benefit from devices such as tinnitus trainers, musician's plugs and simple noise plugs.
- v. Sensorineural hearing loss: Individuals with TBI may suffer from nerve hearing loss that may be treated with amplification (hearing aids). A full audiometric evaluation may determine if the individual could benefit from such devices.

b. Treatment of Balance Disorders:

- i. Gentamicin perfusion: this is an in office procedure where gentamicin is injected into the middle ear space. From there it is absorbed into the inner ear via the round window membrane. This procedure may have to be repeated several times to control dizzy spells. The gentamicin is toxic to the cells of the inner ear and therefore destroys the inner ear balance function. There is also a significant risk to the hearing function. This procedure has a 95% success rate, but because of its destructive nature, cannot be used in bilateral disease.
- ii. The Meniett device: This is a portable, alternating pressure generator which transmits low-pressure pulses to the middle ear, possibly affecting the flow of endolymphatic fluid and alleviating symptoms of vertigo. There is good evidence of short-term symptomatic and functional daily use benefit in individuals with established Meniere's disease, reduced vestibular function and severe vertigo despite adequate medical therapy. Individuals must be able to tolerate tympanostomy tubes, practice water precautions and aural hygiene to maintain tube patency. Effectiveness beyond four months of treatment has not been established. **Use of the Meniett device requires a surgical procedure (Refer to section H.7.b Tympanostomy.)**

c. Physical Therapy/Occupational Therapy/Vestibular Rehabilitation:

Symptoms of vestibular system dysfunction following TBI may be due to damage of central or peripheral structures and may include vertigo, eye-head dyscoordination affecting the ability to stabilize gaze during head movements, and imbalance affecting stability in standing or walking. Dizziness and balance disorders may or may not co-exist in the same individual with TBI.

- i. Balance disorders: Balance is a complex motor control task, requiring integration of sensory information, neural processing and biomechanical factors. It is the ability to control the center of gravity (COG) over the base of support in a given sensory environment. Balance disorders are frequently occurring symptoms following TBI. This may be due to a peripheral vestibular lesion or central vestibular lesion secondary to trauma, fracture, hemorrhage or intracranial pressure changes.

Assessment includes evaluation of the motor system, ROM, and sensory systems that affect the person's ability to maintain equilibrium. Movement strategies to maintain balance require functional ROM and adequate strength. Sensory information from the vestibular, visual and somatosensory systems are key areas associated with maintenance of balance or posture and are integrated at the central level between the two sides of the body and three sensory systems. Central motor planning is essential for proper strategies that are then transmitted to the peripheral motor system for execution. Deficits at the central level, peripheral motor or sensory level will affect balance and equilibrium.

The dynamic systems model recognizes that balance and dynamic equilibrium is the result of the interaction between the individual, the functional task, and the environment. Emphasis of treatments performed by a qualified physical or occupational therapist in vestibular and balance dysfunction are head exercises for habituation of vertigo, eye-head coordination exercises for improvement of gaze stabilization, and sensorimotor retraining to remediate postural dyscontrol in all functional movement positions. Treatment may also include surgery or pharmacologic interventions.

- ❖ Time to produce effect: 6 to 12 weeks; consider referral to neurology-certified physical therapist or occupational therapist specialist
- ❖ Frequency: may be daily initially, decreasing to 1 session per week after 1 to 2 weeks; individuals are expected to perform self-directed exercises twice daily at home, but may require supervision for guidance and safety
- ❖ Optimum duration: 6 months with re-evaluation
- ❖ Maximum duration: may require follow-up for up to 2 years

ii. Postural Control: treatment involves remediation of stability within the constraints following TBI in the musculoskeletal, neuromuscular, sensory/perceptual and cognitive areas. Biochemical limitations may limit the individual's ability to move in ways necessary for compensation. Treatment in this area may include physical modalities to increase ROM, joint mobility and flexibility. Treatment for muscular incoordination may include therapeutic exercise, electrical stimulation and biofeedback. A vestibular rehabilitation program needs to be individualized considering cognitive impairments and involves:

- Increased physical assistance because of movement problems
- Increased supervision because of cognitive and behavioral problems
- Slower progression of program

iii. Dizziness: is an abnormal sensation of motion ranging from light-headedness to spinning (true vertigo) and may be due to vestibular hypofunction, inability to tolerate head movements, and poor gaze stabilization. Physical therapy exercise treatment approaches are based on principles of adaptation, substitution, and habituation, and require the development of specific individual exercises aimed at the person's specific area of deficit. Progression, speed and intensity of the exercise program must be tailored to the individual in order not to increase the symptoms and hinder compliance. Programs are developed based on integrating sensory input from the somatosensory, visual and vestibular systems based on the individual's function.

If it is found that the balance problem is from a visual disturbance, referral to an ophthalmologist, neuro-ophthalmologist or optometrist (knowledgeable in TBI) may be necessary. Special equipment for vestibular treatment may include dynamic platform posturography or a foam/dome apparatus for sensory integration and balance, as well as tilt or rocker boards in the clinic. No special equipment is needed at home unless identified by the treating professional and documented as medically necessary.

Individuals with central traumatic vestibular lesions take longer to improve than those with dizziness from other causes. Studies indicate that at six months, only one-third of individual's with unilateral loss from trauma were symptom-free, as compared with other causes. At 18 months, many individuals continued to show symptoms. Of those with central vestibular loss, 60-70% had persisting symptoms at five years, and half were unable to return-to-work.

- ❖ Frequency: 1 session per week initially decreasing to once every 3 weeks; individuals are expected to perform self-directed exercises twice daily at home, but may require supervision for guidance and safety
- ❖ Optimum duration: 6 months with re-evaluation
- ❖ Maximum duration: may require follow-up for up to 2 years

iv. Benign Positional Vertigo (BPV) is the most common cause of vertigo due to a peripheral vestibular disorder. It is characterized by brief episodes of vertigo when the head is moved into certain positions such as lying down, rolling over in bed, bending over or looking up. Treatment consists of having a canalith repositioning treatment (CRT) performed by a qualified provider based on a diagnosis and localization of the proper canal involvement. Confirmation of the diagnosis is based on the Dix-Hallpike test. Some individuals may require an exercise based approach following, or instead of the CRT.

- ❖ Frequency: 1 to 2 sessions with follow-up at one month
- ❖ Optimum duration: 1 to 2 months with re-evaluation
- ❖ Maximum duration: may require follow-up for up to 6 months. Reoccurrence is possible. Individuals with BPV may also require vestibular rehabilitation secondary to compensated changes in their head movement and function

13. SWALLOWING IMPAIRMENTS (DYSPHAGIA) The incidence of swallowing disorders in the TBI population is high with presenting dysphagia usually characterized by a combination of oral and pharyngeal stage deficits. Co-existing cognitive and behavioral deficits provide compromise to swallowing safety. Physical damage to the oral, pharyngeal, laryngeal and esophageal structures complicates neurogenic dysphagia.

Prolonged ventilation, endotracheal intubation and the presence of tracheostomy may also have a negative impact on swallow function.

The initial goal in oral-pharyngeal dysphagia intervention involves lessening the impact of the dysphagia through prevention of medical complications such as aspiration pneumonia or malnutrition, and the establishment of alternative nutrition if necessary for the maintenance of adequate nutrition. A stimulation program without presentation of food may be provided early in the course of therapy in preparation for later feeding. In subsequent therapy, there is gradual introduction of oral nutrition using an array of treatment techniques designed to target the physiological impairments underlying the dysphagia while the individual continues to receive alternate nutrition. There is an eventual progression towards total oral nutrition without need for supplementation and independence with any safety precautions or therapy techniques.

Therapeutic strategies may be divided into two categories:

- a. **Compensatory Treatment:** techniques do not involve direct treatment of the swallowing disorder and may not affect the physiological function of the swallow, but reduce or eliminate the dysphagic symptoms and risk of aspiration by altering the movement of the bolus through the mouth and pharynx. These include, strategies such as postural adjustments of the head, neck and body to alter the dimensions of the pharynx, the flow of the bolus, altering consistency and viscosity of foods, varying volume and rate of presentation of the food or drink.
- b. **Therapy Techniques:** are designed to change the swallowing physiology. These include, but are not limited to, strategies such as, ROM and bolus control tasks to improve neuromuscular control, swallowing maneuvers which target specific aspects of the pharyngeal phase of the swallow, and swallowing maneuvers to facilitate laryngeal closure during the pharyngeal phase of the swallow.

Medical consultation may be necessary to assist with clinical improvement in swallowing function. Medical interventions may include, but are not limited to: medications to reduce production of saliva; elimination of medications associated with reduced saliva production; and vocal fold injection (Teflon, absorbable gelatin sponge) for unilateral vocal fold weakness.

It is generally accepted that the speech-language pathologist in consultation with the physician establishes the dysphagia treatment plan. Self-feeding and the use of adaptive equipment for this may be coordinated by the occupational therapist. Additional disciplines participate in a team approach to the treatment of dysphagia. These may include, but are not limited to, professionals such as physicians (including otolaryngologist, gastroenterologists, or other), registered dietitian, nurse and physical therapist.

Ongoing reassessment and modification of therapy techniques and treatment goals to optimize effectiveness are integral components of therapy. Initial treatment plan and goals should be updated whenever needed, but at least with each reevaluation. During the earlier phases of recovery, change may occur rapidly and formal reevaluation (including instrumental evaluation) may be completed frequently.

- ❖ Frequency: Acute Care – 1 to 2 times daily; Post Acute – Once per day; subacute outpatient/community settings – 1 to 5 sessions weekly
- ❖ Optimum duration: 6 to 8 weeks with 4-week re-evaluations
- ❖ Maximum duration: Beyond 8 weeks documentation of progress is required

Therapy is discontinued when goals are met or when it is apparent that the individual is no longer making progress. In the latter case, re-evaluation and further therapy may be appropriate if/when the individual shows new or renewed potential.

14. **COMMUNICATION** is basic to all daily activity and is necessary for the maintenance of positive quality of life and psychological well-being. Even the most subtle communication impairment may seriously interfere with an individual's ability to achieve occupational, personal and interpersonal goals.

Communication (speech-language) impairments are a common result of TBI and may be classified into the following groups: 1) motor speech disorders, which may take the form of dysarthria and/or apraxia of speech; 2) voice disorders; 3) language disorders; 4) communicative/cognitive disorders; and 5) fluency disorders. These may occur together in varying combinations in TBI.

a. **Motor Speech Disorders:**

- i. Dysarthria is a reduction in speech intelligibility due to weakness and/or incoordination of the speech musculature secondary to central or peripheral nervous system injury that involves the processes of articulation, resonance, phonation and respiration. It accounts for approximately one-third of communication impairments following TBI. Any type level of severity of dysarthria may occur subsequent to TBI, from very minimal slurring or hypernasality in connected speech to the absence of intelligible speech (anarthria).
- ii. Apraxia of speech is a motor impairment that disrupts central motor planning and interferes with voluntary positioning and sequencing of the movements of the speech musculature in the absence of paralysis or muscular weakness. Symptoms may range from very mild articulation errors to inability to volitionally produce any functional speech.

- b. **Voice Disorders:** Any compromise to airway structures (nasal-pharyngeal cavities, larynx, trachea, lungs, the muscle of respiration), or their function may cause voice disorders. These involve impairment in respiration, phonation and/or resonance. A present voice symptom may have one or several causes and may range in severity from mild vocal fatigue to the absence of voicing (aphonia).

- c. **Language Disorders:** Language impairment is often present in the early stages of TBI. In some cases specific language impairment (aphasia) persists as a result of a focal lesion. Language impairments include those of receptive and expressive language in both spoken and written form, as well as gestural

expression and reception. These may be impaired to varying degrees from very mild difficulty with word finding (anomia) to global impairment involving severe impairment in all language areas. In TBI, language deficits tend to occur against a backdrop of cognitive impairment.

- d. **Cognitive-Communicative Disorders:** Cognition and language are intrinsically and reciprocally related. An impairment of language may disrupt one or more cognitive processes and an impairment of one or more cognitive processes may disrupt language. The ability to consciously, efficiently access and manipulate the semantic system requires the complex interplay of language, cognitive and executive processes. Impairments in linguistic and metalinguistic skill as well as impairments in non-linguistic cognitive functions such as perception, attention, discrimination, organization, reasoning, memory and self-regulation interfere with communication of basic needs and with communication in wider social contexts.

Certified Speech-Language Pathologists are qualified to identify, diagnose and determine the appropriateness of treatment for individuals with speech, language and cognitive-communicative disorders. When treatment is indicated, speech-language pathologists develop, supervise and/or implement a plan of treatment. Treatment of cognitive-communicative disorders has come to be included under labels such as cognitive retraining, cognitive rehabilitation, cognitive therapy, cognitive remediation and neurotraining. Speech/language pathologists should be integral members of interdisciplinary teams engaged in the identification, diagnosis and treatment of individuals with cognitive-communicative disorders. According to the American Speech-Language and Hearing Association (ASHA), certified Speech-Language Pathologists are qualified to identify, diagnose and determine the appropriateness of treatment for individuals with speech, language and cognitive-communicative disorders.

Interaction and consultation between the speech-language pathologist, medical specialists and other members of the interdisciplinary treatment team is an essential part of the treatment of TBI-related communication disorders. There is extensive overlap in professional domains, making it important that team members from different clinical fields collaborate in their approach to assessment and intervention.

Speech-language evaluation is recommended when there is evidence to support the presence of communicative symptoms. The evaluation includes:

- a thorough review of relevant medical and social history
- a comprehensive assessment of communication skills including standard and nonstandard measures
- evidence of consultation with family members and/or support system
- diagnosis of communication disorder
- indication of the severity of the disorder, the individual's candidacy for intervention, and the prognosis for improvement

- an intervention plan that is coordinated and integrated with other services being received
- realistic functional goals and recommendations that reflect consideration of the pre-morbid level of function and input from the individual and/or family/support system to assure social and ecological validity
- estimate need of therapy frequency and duration with attention to the anticipated ultimate outcome
- a plan for providing education and training to the individual's family members and/or support system

Constellations of communication-related deficits in TBI are extremely varied, depending on the characteristics of the individual who is injured, the nature, location, and severity of injury, and the post-trauma support systems. Coinciding with the great diversity within this group, there is a similar level of diversity in treatment approaches. These have been divided into various categories such as 'conventional' and 'functional,' or those that seek to improve communicative functioning through a restorative, compensatory or behavioral approach. Experienced therapists commonly use a combination of such approaches, depending upon the needs of each individual.

For certain individuals, prosthetic or alternative augmentative communication (AAC) devices may be necessary to optimize communicative success. These include, but are not limited to: 1) palatal lift prostheses for velopharyngeal dysfunction resulting in severe impairment in speech intelligibility; and 2) augmentative or alternative communication devices which may be indicated when speech is inadequate for functional communication. AAC may involve the use of simple gesture systems, alphabet boards, pictures, word books, or sophisticated use of computer technology (speech generation devices). AAC strategies may enhance communicative participation by replacing, supplementing or scaffolding residual natural speech and providing a means of repairing disrupted communication. The process of deciding upon these techniques or devices and the training in their use is integrated into the individual's ongoing evaluation and therapy plan.

- ❖ Frequency: Acute setting: once to twice daily sessions
- ❖ Subacute or outpatient and home/community setting: 1 to 5 sessions per week
- ❖ Optimum duration: 8 weeks with re-evaluations at 4-week intervals
- ❖ Maximum duration: intervention beyond 8 weeks requires documentation of continued functional progress towards established goals. Post acute therapy could extend for 3 to 6 months, or more, if the individual with TBI is not making documented improvement

Ongoing reassessment and modification of therapy approaches is a part of skilled therapy and is especially necessary with the dynamic nature of

communication impairment that occurs with TBI. Goal setting is an evolving and dynamic process that is pivotal to each therapy session. Because of wide variability in type, nature, and severity of communication impairments common to TBI, and the lack of unanimity in the literature with respect to the nature, and temporal course of post-TBI communicative dysfunction, there must be flexibility in frequency, intensity and duration of treatment.

15. **COGNITION** is defined as the “process of knowing” by which individuals: 1) make decisions as to the most functional ways of interacting with their environment; 2) execute those decisions; 3) monitor their responses to determine appropriateness and accuracy of their decisions; and 4) adjust their behavior if it is determined to be inappropriate and/or inaccurate. Deficits in cognition are a consistent and frequent result of TBI and may vary from mild to severe. Cognitive processes that are often impaired after TBI may include, but are not limited to:

- impaired arousal, attention and inefficient processing of information (rate, amount and complexity)
- impaired perception of auditory, visual and tactile information
- impaired acquisition, retention and retrieval of verbal and visual information which affects new learning and functional memory skills
- impaired executive functioning skills: problem solving, reasoning and judgment, self-awareness of strengths and weaknesses, goal setting, planning, organizing, self-initiating, self-inhibiting, self-monitoring and self-evaluating
- impaired or inappropriate social awareness and behavior

There is some evidence that structured, goal-oriented, individualized multidisciplinary cognitive rehabilitation improves mobility, personal care and independence in activities of daily living of individuals with TBI. Improvement in mobility and independence significantly reduce indirect costs over long period of time, which may not be accurately measured in the relatively short periods during which most clinical studies are conducted. Cognitive therapy is recommended by the NIH for treatment of individuals with TBI with cognitive deficits.

Although there is limited scientific knowledge of the effectiveness of cognitive rehabilitation and limited data about differing methods of service delivery, the effectiveness of cognitive treatment may be underestimated in published studies secondary to variation in populations studied and types of treatment. Available studies on cognitive rehabilitation measure a wide variety of outcomes associated with a wide variety of interventions. No standard set of TBI outcome measures has been agreed upon as a metric of intervention effectiveness. Scales, which assess performance in laboratory testing, are not strongly predictive of successful employment, or independence in activities of daily living. When vocational status and independent living are reported, their definitions are variable across studies. Cognitive rehabilitation is often studied in circumstances in which methodological rigor, while theoretically desirable, is impractical and imperfectly implemented. Sample sizes which are available for study often are too small to overcome the large amount of variation in the TBI population. Spontaneous

recovery often occurs at the same time that rehabilitation is being provided, making the effects of rehabilitation more challenging to detect.

- a. **Mild TBI:** In MTBI, acute cognitive deficits are common, and spontaneous cognitive improvement is expected within the first six months in the majority of injured individuals. Rehabilitation of cognitive impairments should only be initiated if:
- i. The individual is not demonstrating the expected cognitive improvement
 - ii. The individual exhibits more severe cognitive impairments on formal evaluation
 - iii. The individual's vocation or other life circumstances necessitate the learning of compensatory strategies and/or there are safety issues in question (i.e., possible harm to self or others)
- b. **Moderate/severe TBI:** In individuals with moderate/severe TBI, rehabilitation of cognitive deficits is appropriate and clinically necessary. This focus of rehabilitation is most beneficial when an individual has demonstrated adequate arousal, responsiveness to stimulation and a minimum ability to focus attention. Prior to demonstration of these skills, rehabilitation efforts should focus on monitoring and attempting to elicit responses, environmental structuring and staff/family education.

Rehabilitative treatment is indicated following a neuropsychological and/or full neurological evaluation that identifies cognitive impairments. The evaluation should include statements of TBI severity and prognosis for improvement, outline recommended goals/objectives, methodologies of treatment and establish frequency and duration parameters.

Rehabilitation includes procedures designed to improve cognitive efficiency, develop specific cognitive skills, enhance awareness of impairments and skills, and develop appropriate compensation strategies for residual cognitive deficits. Individuals with MTBI with memory deficits are more likely to improve with compensatory memory strategies training than individuals with moderate/severe TBI who may require memory notebooks or other external aids to improve memory.

It is generally accepted that rehabilitation treatment for cognitive deficits be provided by speech-language pathologists, the neuropsychologist, occupational therapists, physical therapists or paraprofessionals closely supervised by these professionals. It frequently may be necessary for other disciplines to apply cognitive rehabilitation techniques while addressing non-cognitive goals (i.e., mobility and daily nursing activities). A cognitive therapy plan should be approved and monitored by a speech-language pathologist, neuropsychologist or physician experienced with TBI. Physicians may also be involved in pharmacological treatment and management of cognitive disorders.

- ❖ Frequency: Acute and post-acute: daily
Subacute outpatient and home/community setting: daily-to-weekly
- ❖ Optimum duration: Typically 8 weeks with 4-week re-evaluations

- ❖ Maximum duration: beyond 8 weeks requires documentation of progress with the exception of periodic consultations and new treatment goals

A treatment plan outlining current goals is recommended with each evaluation. If documented improvement is not shown, the treatment goals and program should either be modified or discontinued. Periodic upgrading or consultation may be necessary throughout a lifetime following TBI. Therapy may be re-initiated for time-limited, goal-specific treatment as new goals are developed.

- c. **Computer-Based Treatment:** The use of computers as a primary and independent form of treatment in cognitive remediation has limited application because of: 1) limitations in the rationale and specific application of software programs to address the needs of the individual with TBI; and 2) difficulty with generalization of learned computer skills into functional environments. This guideline adopts the following recommendations from the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation. Integrated computer-based treatment (i.e., both individualized cognitive and interpersonal therapies) may improve functioning within the context of an interdisciplinary, neuropsychologic rehabilitation program. Computer-based interventions that include active therapist involvement to foster insight into cognitive strengths and weaknesses, development of compensatory strategies, and facilitation of transferring skills into real-life situations may be used as part of a multi-modal intervention for cognitive deficits. Sole reliance on repeated exposure and practice on computer-based tasks without extensive involvement and intervention by a therapist is not recommended.

16. **PSYCHOLOGICAL/EDUCATIONAL INTERVENTIONS - MTBI** may result in a variety of cognitive and behavioral deficits and symptoms. Psychological interventions may include, or be performed in conjunction with, cognitive and behavioral treatment.

- a. **Acute Psychological/Educational Interventions in MTBI:** Early interventions that educate individuals and/or their family/support system about the symptoms of MTBI and the management of symptoms are very important. Psychological interventions to educate the individual and/or family/support systems regarding coping may occur with the individual and/or family/support system, or alternatively with close friends and co-workers. Such treatment sessions may occur in the hospital before the person is discharged and/or may be provided on an outpatient basis.

When significant risk factors are present, psychological interventions are appropriate to promote positive coping and to manage symptoms. (These risk factors include the following: history of multiple brain injuries, the desire to return to a highly demanding job, significant injury stress, pre-injury psychiatric disorder, pre-injury learning disability, post-traumatic amnesia greater than four to six hours, loss of consciousness greater than 10 minutes, chronic pain or other associated orthopedic and soft tissue injuries.) The presence of other injuries requiring medical attention should not exclude anyone from appropriate psychological treatment. When licensed mental health professionals other than psychologists or psychiatrists are providing treatment, their therapy plan should be overseen by a psychologist, neuropsychologist, or psychiatrist.

- b. **Problem-Specific Referrals During the First Three Months Following MTBI:** Mental health services are appropriate to address specific problems that are directly caused by the injury (e.g., memory deficits, slowed speed of thinking, difficulties with decision making, irritability and fatigue) or that are secondary to the injury (e.g., anxiety, reactive depression, difficulties with self-acceptance and difficulties in adapting one's work schedule to diminished cognitive capacity). Mental health interventions to address such problems may take a variety of forms including individual psychotherapy, cognitive/behavioral therapy, instructions in specific techniques such as relaxation training or biofeedback, instruction in symptom management, marital therapy, group therapy and interventions in the community.

Therapists or speech-language pathologists may work with the individual with TBI in their own home or other community settings in order to teach individuals adaptive skills, compensatory techniques or new ways of solving problems that assist them in coping more effectively during recovery. Treatment generally includes cognitive therapy such as the use of training techniques to enhance attention-concentration, reduce distractibility and improve confidence in cognitive abilities, as well as teaching practical decision-making strategies to enhance coping and reduce stress. The interdisciplinary treatment team approach is particularly beneficial in these cases and it is strongly encouraged, especially during the first three months post-injury. Medications are frequently helpful to address the individual's symptoms.

- c. **Referrals Three or More Months Post-MTBI:** A referral for psychological services should be strongly considered three or more months post-injury when the individual is having difficulty coping with symptoms or stressors or when secondary psychological symptoms such as intolerance to certain types of environmental stimuli or reactive depression are severe. Pre-existing personality traits (e.g. perfectionism), demanding responsibilities or lack of experience on the current job may also interact with cognitive deficits and symptoms secondary to MTBI to necessitate the provision of ongoing psychotherapeutic services. Treatment may include individual psychotherapy, marital therapy, group therapy, instruction in relaxation and related techniques, cognitive/behavioral therapy, social skills training and interventions/consultation in the community.

17. **PSYCHOLOGICAL INTERVENTIONS – MODERATE/SEVERE INJURY**

Moderate/severe TBI may result in a variety of cognitive, psychological or behavioral symptoms. Psychological interventions may include, or be performed in conjunction with cognitive and behavioral treatment.

- a. **Acutely Symptomatic Phase:** During the period when the individual continues to suffer from post-traumatic amnesia, self-awareness is often compromised and behavioral problems such as impulsivity, agitation, uninhibited behaviors and confabulation may emerge. At this stage, psychological interventions are typically focused on: 1) development of specific environmental strategies to manage problematic behaviors and increase the individual's and staff safety; 2) consultation with other team members, support of the nursing staff and ongoing contacts with the individual's family; and 3) education of the family about the brain injury and its behavioral manifestations. Cognitive status is monitored during this time period. The psychological interventions described here typically occur throughout the period of post-traumatic amnesia. Furthermore,

psychological consultation to help manage problematic behaviors such as perseveration, aggressive behaviors and disorders of memory typically continue into the acute rehabilitation phase of treatment as the person comes out of post-traumatic amnesia. Psychological interventions may be delivered by a variety of license and qualified mental health clinicians. Behavior treatment is frequently used in these cases.

- b. **Early Recovery Phase:** Once the individual with TBI is out of post-traumatic amnesia, psychological clinical services are typically provided to educate him/her about the injury, promote the development of insight into deficits and support the development of positive coping. Treatment also typically involves psychotherapeutic intervention to assist the individual in dealing with feelings of anxiety, loss, frustration and grief. Psychological treatment is often required to address reactive depression, heightened irritability and anxiety. Psychological interventions including psychotherapy, cognitive behavior modification and environmental restructuring may be required to address social skills, deficits and behavioral excesses. In addition to psychological services provided directly to the individual, consultation by licensed mental health professionals with other team members is appropriate and encouraged to train team members and family members as to how they may positively support the process of recovery. Family therapy sessions and educational sessions are often indicated and are appropriate.
- c. **Stabilization Phase:** Once the individual's condition has stabilized, the goals of psychological treatment center on supporting the transition to, and functioning within the community. Alterations in cognitive and emotional functioning (e.g., mood disorders, emotional lability, irritability, persevering behaviors, memory problems and disorders related to diminished or impaired judgment may necessitate ongoing psychological treatment. Individuals with brain injury typically receive psychological services before discharge from the hospital in order to address specific deficits and abilities that will play an important role in successful functioning in their own home environment. These services are typically individualized and may take a variety of forms including individual psychotherapy, skills training (e.g., parenting), marital psychotherapy and group psychotherapy.

Cognitive deficits may necessitate that such forms of treatment are specially tailored to the needs of the individual. For example, an individual with significant memory problems may need to have information from psychotherapy sessions video or audio recorded. Depending upon the severity of the behavioral problems, outpatient psychotherapy may initially be held as frequently as once a day for severe problems (e.g., rage reactions, sexually disinhibited behaviors, or other behaviors that constitute safety risks). Sessions may occur several times a week to address adjustment issues in a psychotherapeutic format.

In view of the fact that deficits from moderate/severe brain injury typically persist throughout life, intermittent mental health interventions may be required during the course of the individual's lifetime in order to address the behavioral problems and emotional distress that may arise secondary to developmental issues or changes in environmental structure. Periodic upgrading or consultation may also be necessary throughout a person's lifetime following TBI. Therapy may be reinitiated for time-limited, goal-specific treatment as new goals are developed.

- d. **Consultation in Regard to Usage of Medications:** Medication management for emotional, behavioral, and cognitive functioning of individuals who have sustained moderate/severe brain injuries is often needed. An interdisciplinary team approach is beneficial and encouraged. Thus, physicians will often request that psychiatrists, psychologists, social workers, family service counselors and other team members provide data and input regarding behavioral observations that may assist in assessing how the person is responding to various medications.

18. **BEHAVIOR** TBI often results in functional limitations and behavioral disabilities due to neuropathological deficits in functioning skills, judgment, self-monitoring and behavioral, or emotional regulation. These organic disabilities may be compounded by secondary emotional reactions such as depression or anxiety. Behavioral treatment is a well accepted and widely used therapy for TBI and it acknowledges that behavioral problems are always multi-factorial and therefore must consider medical, neurosurgical, neurological, psychiatric and psychosocial issues. Behaviorally based therapies rely on an interdisciplinary treatment team approach and are frequently implemented in conjunction with cognitive and/or other psychological treatment. A behavioral therapy plan should be approved and monitored by a neuropsychologist, psychologist, or physician familiar with TBI.

Neuropathologically-based behavioral problems may be exacerbated by individual comorbidities such as personality or family issues, major psychiatric illnesses and substance abuse. Successful resolution of the behavioral problem will usually require treatment of these associated pathologies. Behavioral problems are also influenced by developmental issues. Treatment requires appropriate consideration of developmental and life-state issues (i.e., adolescent, elderly). Treatment may require potentially specialized treatment settings with professionals experienced in the management of these populations. Treatment may also require focused behavioral analysis available only in a specialized rehabilitation or psychiatric setting. Behavioral analysis and treatment involves:

- Identification and prioritization of target behaviors to be managed or extinguished
- Identification of behavioral strengths to be encouraged and positively reinforced
- Analysis of internal and environmental issues to reduce antecedents or precipitants of maladaptive behaviors
- Positive reinforcement of adaptive behaviors
- Modification of internal precipitants of maladaptive behaviors (i.e., pain, sleep-deprivation, anxiety, depression and thought disturbance)
- Analysis of the effects of internal and environmental modification on behavior
- Progressive refinement of the strategies of internal and environmental modifications in response to an analysis of changes in behavior

Effective behavioral management and treatment requires individualized approaches. The setting of treatment must consider individual resources and circumstances. Inpatient and

outpatient settings may require one-on-one supervision at critical phases of recovery. Coordination of treatment resources and professionals is essential. Analysis of the environment and personnel during periods of transition between treatment settings is generally essential to minimize the stress of change and to avoid the loss of critical environmental reinforcers.

In long-term maintenance programs, treatment may be appropriate on an episodic basis as follows: treatment may be 'on hold' for several weeks or months until certain goals are reached or until additional goals emerge. At such times, therapy may be restarted for a time-limited, goal specific treatment as prescribed and routinely monitored by a neuropsychologist, psychologist, or physician familiar with TBI. Progress should be re-evaluated and documented every four weeks (Refer to section B General Guideline Principles).

19. **VOCATIONAL REHABILITATION** is a generally accepted intervention, but Colorado Workers' Compensation statute limits its use. Initiation of vocational rehabilitation requires adequate evaluation of individuals with TBI for quantification of highest functional level, motivation and achievement of maximum medical improvement. Vocational rehabilitation should involve a comprehensive job analysis and a carefully planned return to work strategy. In some instance, retraining may need to occur in a new occupation. (Refer to section G.21 Return to Work)
20. **DRIVING** Independent driving is considered a complex activity of daily living. An individual's potential for safe driving is influenced by an intricate interaction of physical, cognitive, visual and behavioral impairments. An individual's ability to drive is typically evaluated and treated under physician orders by a certified driver rehabilitation specialist.

In addition, the treatment process may require the services of a:

- Commercial driver trainer for driving practice
- Ophthalmologist or optometrist for visual evaluation
- Commercial vendors and rehab engineers for adaptive equipment
- Neuropsychologist for cognitive evaluation
- Speech-Language pathology for communication evaluation and compensatory strategies
- Certified physical occupational therapist

Public and personal safety and compliance with state department of motor vehicles procedures ultimately determine individual driving privileges. Evaluation and treatment typically occur during the post-acute phase of rehabilitation. Usually successful driving results are obtained within the first two years post-injury, but this is not always the case.

Evaluation and treatment typically consist of:

- ❖ Frequency and time to produce effect: evaluation time of a minimum of 1 to 2 sessions to evaluate physical, perceptual, cognitive and behavioral skills and for collaboration with other interdisciplinary team members
- ❖ Optimum duration: behind-the-wheel driving evaluation and training on the road of between 2 to 6 sessions
- ❖ If the individual fails the evaluation, he or she may be required to participate in additional driving practice and repeat the behind-the-wheel test, or to wait 3 months or longer to repeat the evaluation. The evaluation may be repeated at 3 to 12-month intervals as determined by the evaluator and physician. Several repeat assessments may be necessary to determine safe driving readiness

Recommendations and physician prescriptions for necessary adaptive equipment and vehicle modification for safe driving or for dependent passenger transport in vehicles may be necessary. Van lifts and other adaptive equipment and vehicle modifications may be necessary for dependent individuals in order to provide access to community services and activities. Therapeutic assistance is necessary to help the individual and physician comply with state department of motor vehicles standards for practices and procedures for driver's licensure.

Significant and multiple cognitive impairments, as well as motor and visual impairment, may decrease, delay or prevent an individual from achieving functional driving independence. Important cognitive factors include ability to make complex judgments, organize information, anticipate and/or react quickly, maintain self-control and other factors. Individuals with a TBI may or may not be able to successfully compensate for these impairments.

21. RETURN-TO-WORK In addition to the treatment strategies described below, practitioners should be familiar with how various state and federal statutes and regulations may impact return to work planning. These may include, but are not limited to, Family and Medical Leave Act (FMLA), Americans with Disabilities Act (ADA), Occupational Health and Safety Administration (OSHA) and the Department of Transportation (DOT).

- a. **Return-to-Work - MTBI:** Following MTBI, many individuals are able to resume normal work duties with secondary prevention precautions and education requiring little or no additional therapeutic intervention. A smaller percentage of individuals with MTBI at the upper end of the definition such as age greater than 40, prior TBI, loss of consciousness close to 30 minutes or mental status changes lasting 24 hours, may require more assistance in return to work and accommodations. Individuals with MTBI may be instructed to temporarily reduce the amount, type and/or intensity of their work duties or temporarily remain out of work entirely, depending on their clinical condition.

If workers with MTBI have any loss of consciousness or prolonged disorientation, providers should consider restricting higher risk job duties, such as working at heights, working with power tools and operating heavy machinery, until they have been free from the symptoms, including dizziness, for two weeks. Second impact syndrome (Refer to section C.10.b Secondary Prevention) has been seen in younger age groups who suffer severe life threatening effects after a second head injury within a short interval of the first traumatic brain injury. Physicians should take this into account when writing work restrictions.

In addition to post-concussion symptoms, workers with MTBI may have cognitive deficits in memory, attention and executive function. Physicians should be aware of this, even if the worker has no complaints/symptoms. Memory, attention and executive function should be tested by asking specific questions regarding recent events and having individuals perform specified tasks. Physicians should inform the individual with TBI and their supervisor to expect memory and attention deficits and accommodate accordingly. Time to return to baseline function will differ according to the individual's pre-accident condition, age, medication and other factors. Studies of male athletes suffering MTBI, and having no co-morbidities demonstrated, returned to baseline levels of neuropsychological testing within five to seven days.

Physicians should attempt to be clear and specific in documenting vocational restrictions, and have a plan for re-entry to work and communication with the employer (e.g., supervisor, safety officer, employee health nurse). Having a significant physical disability, psychosocial impairment, cognitive impairment, and a history of alcohol abuse, has been suggested as factors that impede return to work. Other factors impeding return to work include difficulties regarding transportation, thinking, coordination and vision. An interdisciplinary team approach may be recommended, which may include a neuropsychological assessment, vocational evaluation, job site analysis, early contact with employer, assessment of vocational feasibility, supervisor education, transferable skills analysis, skillful increased titration of job duties and demands, job coaching, physical, occupational and speech-language pathology therapy and psychological services.

For individuals with MTBI who have persistent deficits, or who have difficulty once back at work, a return to work program should occur which requires a carefully designed and managed plan involving the person with TBI, his/her employer and the treatment team. Physicians should consider evaluation and treatment for co-morbidities such as chronic pain, stress level, pre-existing personality disorders or depression. Communication among all involved parties and the avoidance of fragmentation among treatment professionals is critical to successful outcome. Following return to work, maintenance support services are appropriate to best insure the durability of outcome.

- b. **Return to Work Moderate/severe TBI:** Following moderate/severe TBI, many individuals are unable to return to work. As stated above, successful return to work among individuals with moderate/severe injury may require an interdisciplinary approach including neuropsychological assessment, functional capacity evaluation, job site analysis, early contact with employer, assessment of vocational feasibility, transferable skills analysis, supervisor education, job coaching, skillful increased titration of job duties and demands, mental health, family counseling and follow-up services.

- 22. **COMPLEMENTARY AND ALTERNATIVE MEDICINE (CAM)** (as defined by the National Center for Complementary and Alternative Medicine [NCCAM]) a group of diverse medical and health care systems, practices and products that are not presently considered to be part of conventional medicine. CAM includes a wide range of interventions that at this time have not been supported by empirical data, or have widespread use for brain injury. These alternative treatments include, but are not limited to: acupuncture, chiropractic medicine, art therapy, craniosacral trauma release, EEG neurofeedback, dance therapy, hippotherapy, hypnosis, horticulture therapy and music therapy. CAM uses methods of treatment based upon a broad range of knowledge with roots in both eastern and western medicine. Many providers may integrate more than one procedure. Some of these interventions, including the exercise-based procedures, are currently integrated into ongoing rehabilitation programs. In general, most approaches place major focus

on the important relationship between physical and emotional well-being. Alternative therapies should not be employed as the primary treatment modality, but may be considered for individual cases when other treatments have failed to produce functional gains, when there is a valid clinical rationale for their use and when treatment goals are directed to measurable, functional improvement. CAM treatment requires prior authorization from the payer and agreement on fees in accordance with criteria in the Division of Workers' Compensation Rules 16 and 18.

- ❖ Time to produce effect: 3 to 6 treatments
- ❖ Optimum duration: 4 to 6 weeks
- ❖ Maximum duration: Not well-established for CAM and should be based upon specific CAM treatment, physician's clinical judgment and demonstration of positive symptomatic and functional gains

H. THERAPEUTIC PROCEDURES – OPERATIVE

It is not the intent of these medical treatment guidelines to provide an exhaustive list of surgical procedures associated with TBI. An overview of the general categories is presented to illustrate the wide range of procedures that are widely accepted for individuals with TBI. Combinations and variations on procedures should be tailored to specific cases; hence, a variety of procedures based upon the clinical judgment of the treating physician is to be expected. Common procedures include, but are not limited to:

1. EXTRACRANIAL SOFT TISSUE

- a. Debridement, closure
- b. Plastic or reconstructive

2. MAXILLOFACIAL

- a. Repair and stabilization of fracture
- b. Facial nerve decompression
- c. Repair and/or reconstruction

3. SKULL

- a. Debridement, elevation and/or repair of fracture or defect including cranioplasty

4. BRAIN

- a. Debride penetrating injury, gunshot wound, foreign body
- b. Decompression and evacuation
 - i. Hematoma: epidural, subdural, intraparenchymal
 - ii. Contusion
 - iii. Infections: abscess or empyema
- c. Decompressive Craniectomy: for diffuse brain swelling, midline shift and/or elevated intra-cranial pressure (ICP) refractory to medical management and not fully alleviated by evacuation of mass lesion/hematoma (or in the absence of mass lesion/hematoma) – (bone flap stored in freezer, or in the individual's abdominal wall)
- d. Bone flap replacement after resolved brain swelling

5. **CEREBRAL SPINAL FLUID (CSF)**

- a. **CSF Leak or Fistula:** Lumbar spinal drain or serial lumbar puncture may be used as option to promote spontaneous resolution of CSF leak, or as adjunct to surgical repair. Repair of leak or fistula may require surgical exploration of the anterior cranial fossa, or the temporal bone and/or sinuses to identify CSF leak and seal it.
- b. **Ventricular Shunting:** The treatment of hydrocephalus may require ventricular shunting. Even though ventricular shunting is frequently regarded as a routine procedure, clinicians must recognize the possibilities of mechanical, biological or technical complications. The complications of ventricular shunting for hydrocephalus may include, but are not limited to, shunt failure, hemorrhage, delayed wound closure, infection and seizures. Favorable outcome from CSF ventricular shunting in appropriately selected individuals will depend on the timing of intervention, the type of shunt valve used, seizure prophylaxis and methods of long-term follow up management. A recent advancement in this type of intervention includes the use of programmable shunt valves. This may require periodic reprogramming of the shunt valve and is a generally accepted procedure.
- c. **Ventriculostomy:**
 - i. Control of ICP
 - ii. Acute hydrocephalus
 - A) Obstructive
 - B) Communicating (usually with subarachnoid hemorrhage)

6. **OPHTHALMOLOGIC**

- a. Direct trauma to globe and/or orbital contents
- b. Repair orbital fractures, decompression of orbital contents
- c. Optic nerve decompression: immediate surgery may be indicated if the trauma results in entrapment or compression of the nerve, or if a hematoma is present in the optic nerve sheath
- d. Strabismus: surgery may be required to eliminate or decrease diplopia. Individuals may require several revision operations to achieve the expected results

7. **OTOLOGIC**

- a. **Direct Trauma Or Barotrauma:**
 - i. Ossicular discontinuity: the mechanism of head trauma causing TBI may result in dislocation of the hearing bones creating a conductive hearing

loss. This would require an exploratory tympanostomy with ossicular replacement to correct

- ii. Tympanic membrane perforation: this would cause a conductive hearing loss. Tympanoplasty is indicated for correction

b. **Tympanostomy:** tube placement may be needed for use of a Meniett device. The Meniett device is a portable, alternating pressure generator, which transmits low-pressure pulses to the middle ear, possibly affecting the flow of endolymphatic fluid and alleviating symptoms of vertigo. There is good evidence of short-term symptomatic and functional daily use benefit in individuals with established Meniere's disease, reduced vestibular function and severe vertigo despite adequate medical therapy. Individuals must be able to tolerate tympanostomy tubes, practice water precautions and aural hygiene to maintain tube patency. Effectiveness beyond four months of treatment has not been established.

c. **Acoustic Nerve Decompression**

d. **Middle Ear Exploration:**

- i. **Perilymphatic fistula repair:** This presents as a sensorineural hearing loss that usually worsens with exertion or altitude changes. Exploratory tympanotomy with patching or round and oval window niches is indicated in these individuals. The operation itself is as much a diagnostic tool as a therapeutic one. The success rate for treating dizziness due to fistula is 80%.

- ii. **Endolymphatic sac surgery:** This is a nondestructive procedure performed in the operating room under general anesthesia. The surgeon removes the mastoid bone and uncovers the endolymphatic sac. A drain may or may not be placed in the sac at the time of surgery. This operation has a 65% success rate at controlling dizzy spells.

- ii. **Labyrinthectomy:** This is a destructive procedure performed in the operating room under general anesthesia. The surgeon removes the semicircular canals using the operating drill. This procedure not only obliterates balance function on the operated side, but also renders the individual deaf in that ear. Because of its destructive nature, it is not indicated in bilateral disease.

e. **Vestibular Nerve Section:** This is a destructive procedure performed in the operating room under general anesthesia. It is usually performed by a team including a neurotologist and a neurosurgeon. There are several approaches but the final step is that of sectioning the vestibular nerve as it exits the brainstem. This operation has a 95% success rate at controlling dizzy spells. Being destructive in nature, it is not indicated in bilateral disease.

8. **DECOMPRESSION OF FACIAL NERVE** If there is immediate onset of total facial paralysis or if the electroneuronography (EnoG) shows greater than 90% degeneration of the facial nerve, exploration of the path of the facial nerve is indicated. This usually

involves a middle fossa craniotomy and mastoidectomy in order to completely decompress the facial nerve.

9. **OTHER CRANIAL NERVE REPAIR OR DECOMPRESSION** may be required for functionally disabling conditions such as diplopia.

10. **VASCULAR INJURY**

- a. Endovascular procedures (i.e., stent, embolism)
- b. Direct repair
- c. Occlusion, trapping, aneurysm repair

11. **PERIPHERAL NERVE INJURY**

- a. Fracture management

12. **ORTHOPEDIC**

- a. Fracture management
- b. Adjunctive tenotomies and myotomies
 - i. Common upper extremity procedures may require pre-surgical evaluation inclusive of occupation therapy, ROM, function, diagnostic nerve blocks and dynamic EMG. Definitive procedures include, but are not limited to:
 - A) Shoulder muscle release
 - B) Functional elbow release: brachial radialis myotomy, biceps and brachialis lengthening
 - C) Fractional lengthening of wrist and/or finger flexors
 - D) Flexor digitorum superficialis (FDS) to flexor digitorum profundus (FDP) transfer
 - E) Intrinsic muscle contracture release
 - F) Surgical release of thenar muscles for thumb in palm deformity
 - G) Individualized and customized procedures for spastic upper extremity deformities with adjunctive selective musculotendinous transfers, neurotomy and neurectomies
 - ii. Common lower extremity procedures include, but are not limited to:
 - A) Fractional muscle lengthening of knee flexors/hamstrings

- B) Hip flexor releases/myotomies
 - C) Percutaneous vs. open release of the hip adductors
 - D) Percutaneous tendon Achilles lengthening
 - E) Ankle/foot motor balancing surgery adjunctive to tendo-achilles lengthening (TALs procedure) includes: 1) toe flexor release, 2) split anterior tibial tendon transfer (SPLATT procedure), 3) interphalangeal joint fusions and 4) ankle fusions
 - F) Individualized and customized procedures for spastic lower extremity deformities with adjunctive selective musculotendinous transfers, neurotomy and neurectomies
- iii. Resection heterotopic ossification

13. SPASTICITY

- a. Spinal cord procedures, including percutaneous and open rhizotomies
- b. Intrathecal Baclofen pump
- c. Other “tone management” procedures

I. MAINTENANCE MANAGEMENT

1. **GENERAL PRINCIPLES** Many individuals following MTBI make a good neurological and functional recovery with minimal or no intervention, despite the possibility of subtle residual impairments or functional limitations. Other individuals with MTBI experience significant impairments, functional limitation, and disabilities. Individuals with MTBI who have co-morbid conditions, have suffered a longer period of confusion or loss of consciousness are more likely to have a poorer outcome and require maintenance care.

Individuals with moderate/severe brain injury are likely to experience lifetime impairment, functional limitations and disabilities and are at a great risk for the remainder of their lives for ongoing medical, psychiatric, physical and cognitive complications. Second brain injuries, late onset seizures, maladaptive social skills, aggressive behaviors, substance abuse and psychiatric disorders are common examples of some negative long-term consequences of brain injury.

Therefore, individuals with moderate/severe brain injury generally require long-term support to prevent secondary disability, and to maintain an optimal level of medical and psychological health and functional independence achieved through rehabilitation. Providers and carriers should adopt a long-term case management model for individuals with brain injury. Common lifetime supports include physician oversight, nursing services, various periodic therapies, supported living programs, attendant care, supported employment, productive activity recreation, transportation, and individual/family education. Supported employment may assist in return to work outside a sheltered work setting. The above services may be reasonable and necessary for individuals with TBI that have chronic disabilities. The specific type and amounts of support necessary will vary in each individual case and may change over time. Practitioners are encouraged to analyze risk factors and to establish viable long-term maintenance plans. Long-term maintenance programs should be managed by an experienced case manager who may intervene quickly when necessary. Case management should not be discontinued when a person finishes acute rehabilitation but continue with a frequency necessary for successful long-term management.

Medical and rehabilitation providers are encouraged to educate individuals and/or family/support system regarding anticipated ongoing medical and rehabilitation needs. Because the long-term medical needs of individuals with moderate/severe TBI, are uncertain, each individual, his/her family and providers should plan for unforeseen medical, psychiatric, physical and cognitive complications as individuals with brain injury age. Failure to address long-term management as part of the overall treatment program may lead to higher costs and greater dependence on the health care system. Management of TBI continues after the individual has met the definition of maximum medical improvement (MMI). MMI is declared when an individual's condition has plateaued and the authorized treating physician believes no further medical intervention is likely to result in improved function. When the individual has reached MMI, a physician must describe in detail the plan for maintenance treatment, level and type of care and support services. (Refer to section C.6 Course of Recovery.)

Maintenance care of individuals with TBI requires a close working relationship among the insurance carrier, the clinical providers and the individual with TBI. Clinical providers have an obligation to design a cost-effective, medically appropriate program that is

predictable and allows the carrier to set aside appropriate reserves. Insurers and adjusters have an obligation to assure that medically appropriate, cost effective programs are authorized in a timely manner. A designated primary physician for maintenance team management is recommended.

Maintenance care in MTBI, and when possible in moderate/severe TBI, will be based on principles of individual self-management. When developing a maintenance plan of care, the individual, his/her physician and the insurer should attempt to meet the following goals:

- a. Maximum independence will be achieved through the use of home and community-based programs and services
- b. Individuals with brain injury shall maximally participate in decision-making, self-management and self-applied treatment
- c. Treatment involving more than one provider shall be coordinated through an authorized treating physician

Periodic reassessment of the individual's condition will occur as appropriate.

2. **MAINTENANCE HOME CARE** Individuals with moderate/severe TBI may require ongoing home care to assist with a variety of services necessary to maintain their maximum medical improvement. The type and frequency of the services required will be dependent on the nature and severity of residual deficits. Services may include skilled nursing, certified nursing assistants, homemaker, companion care or a combination of these services. Care may be necessary for limited periods of time or in some cases may be required for the course of the individual's lifetime.

It is essential for primary care providers to be very specific as to the level and type of care necessary for each individual to maintain optimum health and safety. Long-term home health care is one of the most costly services of a maintenance program and availability of professional resources may be limited. Physicians should prescribe only that care which is reasonably necessary to maintain the individual's functional status or to cure and relieve the effects of the injury.

Over time, the individual's status or family/support system status may change resulting in the need to either increase or decrease the frequency, type or level of care. Therefore, with each evaluation, or at least annually, providers shall assess any possible need for a change in home care.

3. **LONG-TERM RESIDENTIAL CARE** Some individuals with moderate/severe TBI may require long-term residential care due to the aging process, loss of a caregiver, becoming unsafe in their environment or other similar changes. Such facilities or programs may provide the individual with TBI the necessary supervisory supports so that he/she may safely maintain his/her maximum level of function in as least restrictive an environment as possible. In most cases, these individuals may be referred to Nursing Care Facilities (Refer to section G.1.f, Nursing Care Facilities, or section G.1.g Long-Term Care Residential Services.)

4. **MEDICATION MANAGEMENT** Medications may be necessary in the long-term management of individuals with traumatic brain injury. Medications may be used for medical, physical, perceptual, cognitive and psychological reasons, and should be prescribed by physicians experienced in TBI medication management. Reasons for possible medications and the types and names of medication are numerous, are individualized for each person and are beyond the scope of these guidelines.

In the area of psychological function, researchers are learning more about long-term mood disorders, such as depression and anxiety, as well as executive dyscontrol, emotional dis-regulation, and all disorders for which medication may be beneficial. Regaining insight into the changes caused by TBI is often accompanied by an increase in symptoms of depression. Depression is common following TBI. Increased suicidal ideation has also been reported to occur for many years following TBI. Psychosis is an uncommon but serious sequela of TBI that will also require psychotropic medication that will need to be closely monitored.

As with all prescriptive regimens, physicians periodically reassess the efficacy and side effects of each medication. This is particularly true for individuals who are on long-term medication use. Individuals with TBI are particularly susceptible to certain medication side effects including compromised cognitive function, decreased seizure threshold and other neurological effects. Follow-up visits should document the individual's ability to perform routine functions. Laboratory or other testing is usually required on a regular basis to monitor medication effects on organ function. For some, medication drug levels should be closely monitored. In situations where there are multiple providers for multiple clinical issues, coordination of the total medication regimen is essential. It is strongly recommended that changes in medication be discussed with the physician who is primarily managing the case.

- ❖ Maintenance duration: Medication reviews may need to be monthly or more frequently if necessary for changes in medication. Frequency depends on the medications prescribed, with laboratory and other monitoring done as appropriate. As new medications become available and side effects of other medications are established, there may need to be changes in medical management

5. **HOME EXERCISE PROGRAMS AND EXERCISE EQUIPMENT** Many individuals have the ability to participate in a home exercise program after completion of a supervised exercise rehabilitation program. Programs should incorporate an exercise prescription including the continuation of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, stabilization and strength. Some individuals may benefit from the purchase or rental of equipment to maintain a home exercise program. Determination for the need of home equipment should be based on medical necessity to maintain MMI, compliance with an independent exercise program and reasonable cost. Before the purchase or long-term rental of equipment, the individual should be able to demonstrate the proper use and effectiveness of the equipment. Effectiveness of equipment should be evaluated on its ability to improve or maintain functional areas related to activities of daily living or work activity. It may be beneficial to assess use of equipment through a facility membership. Home exercise programs are most effective when done three to five times a week.

6. **EXERCISE PROGRAMS REQUIRING SPECIAL FACILITIES** Some individuals may have higher compliance with an independent exercise program at a health club versus

participation in a home program, although individuals with TBI may require supervision or guidance. All exercise programs completed through a health club facility should focus on the same parameters of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, stabilization and strength, if tolerated by the individual with TBI and approved by the treating therapist or physician. Selection of health club facilities should be limited to those able to track attendance, utilization and provide records available for physician and insurer review. Prior to purchasing a membership, a therapist and/or exercise specialist who has treated the individual should visit the facility with the individual to assure proper use of the equipment.

- ❖ Frequency: 2 to 3 times per week
- ❖ Optimal duration: 1 to 3 months
- ❖ Maximum maintenance duration: Continuation beyond 3 months should be based on functional benefit and compliance. Health club membership should not extend beyond 3 months if attendance drops below 2 times per week on a regular basis without medical cause

7. **COGNITIVE/BEHAVIORAL/PSYCHOLOGICAL MANAGEMENT** The maintenance program for individuals with moderate/severe brain injuries should be oriented toward maintaining the highest level of independent function that he/she has been able to achieve during acute rehabilitative period (the first two years post injury). In some cases of severe TBI which are complicated by other medical issues such as, but not limited to, seizure or hydrocephalus, acute treatment may last up to three years post injury. Developmental issues, changes in the individual's support system, development of or exacerbation of a mood disorder may require psychological treatment to return the individual to the highest level of functioning possible. Some individuals with persistent problems with impulsivity may require regular psychological maintenance therapy to assure the individual's ability to function in the community. Where possible, the person with moderate/severe injury should be involved in support groups or other community-based activities to promote socialization. Some individuals with severe-spectrum injuries will require periodic consultation to correct problems that have developed systems to allow them to continue to function in the community. Providers who provide services to maintain the functioning of individuals with TBI in the community have the obligation to be able to identify the specific diagnosis and symptoms that they are focusing their treatment on and to document the ongoing results of such treatment. The number of sessions will depend on the individual and the situation.
8. **PHYSICAL AND OCCUPATIONAL THERAPY** Aggravation of the physical components of the injury may require short-term intensive treatment to return the individual to the post-MMI baseline. Therapy with the individual actively involved and/or passive therapy may be indicated on a continued basis if the therapy maintains objective physical function, decreases pain or decreases medication use. Additionally, issues of aging which result in decreased function in mobility, balance, and overall physical function may require active or passive intervention. In those situations, frequency and duration parameters as defined (in section G. Therapeutic Procedures Non-Operative section) apply.
9. **PATIENT EDUCATION** Educational classes, sessions, or programs may be necessary to reinforce self-management techniques. This may be performed as formal or informal programs, either group or individual.

- ❖ Maintenance duration: 2 to 6 educational sessions during one 12-month period. Changes in life circumstances or the individual's condition may require greater frequency of educational sessions

10. PURCHASE, RENTAL AND MAINTENANCE OF DURABLE MEDICAL EQUIPMENT It is recognized that some individuals with TBI may require ongoing use of equipment for the purpose of maintaining MMI in the areas of strength, ROM, balance, tone control, functional mobility, ADLs and/or analgesic effect. This may include, but is not limited to, exercise equipment, assisting devices, functional electrical muscle stimulators, TENS units and Continuous Positive Airway Pressure (C-PAP). Purchase or rental of this equipment should be done only if the physician and/or therapist have determined its effectiveness for improved or maintained function and that there will be compliance in its use. Periodic maintenance of equipment may also be indicated.

- ❖ Maintenance duration: Not to exceed 3 months for rental equipment. Purchase and maintenance should occur if effective