

RULE 17, EXHIBIT 2B

Moderate/Severe Traumatic Brain Injury Medical Treatment Guideline

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DIVISION OF WORKERS' COMPENSATION



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DEPARTMENT OF LABOR AND EMPLOYMENT
Division of Workers' Compensation

CCR 1101-3

RULE 17 EXHIBIT 2B

Moderate/Severe Traumatic Brain Injury Medical Treatment Guideline

A. Guideline 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 who qualify as injured workers with traumatic brain injury (TBI) under the Colorado Workers' Compensation Act.

Although the primary purposes of this document for practitioners are advisory and educational, this guideline is enforceable under the Workers' Compensation Rules of Procedure, 7 CCR 1101-3. The Division recognizes that acceptable medical practice may include deviations from this guideline, as individual cases dictate. Therefore, this guideline is 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 all Division of Workers' Compensation medical treatment guidelines and critical to the reader's application of the guidelines in this document.

B.1 Application of the 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.

B.2 Education

Education of the individual and family and/or support system, as well as the employer, insurer, policy makers, and the community, should be the primary emphasis in the treatment of TBI. Currently, practitioners often think of education last, after medications, manual therapy, and surgery. Practitioners must implement strategies 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 that provides recovery, function-focused, patient-centered, and evidence-based information to the individual with TBI. More in-depth education is currently a component of treatment regimens that employ functional, restorative, preventive, and rehabilitative programs. No treatment plan is complete without addressing issues of individual and/or group patient education as a means of facilitating self-management of symptoms and prevention. Facilitation through language interpretation, when necessary, is a priority and part of the medical care treatment protocol.

B.3 Informed decision making

Providers should implement informed decision making as a crucial element of a successful treatment plan. Patients, with the assistance of their health care practitioner and support system, should identify their personal and professional functional goals of treatment at the first visit. Progress towards the individual's identified functional goals should be addressed by all members of the health care team at subsequent visits and throughout the established treatment plan. Nurse case managers, psychologists, physical therapists, and other members of the health care team play an integral role in informed decision making and achievement of functional goals. Patient education and informed decision making should facilitate self-management of symptoms and prevention of further injury.

B.4 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 the individual's adherence, as well as availability of services. Clinical judgment may substantiate the need to accelerate or decelerate the time frames discussed in this document.

B.5 Active interventions

Active interventions emphasizing patient responsibility, such as therapeutic exercise and/or functional treatment, are generally utilized over passive modalities, especially as treatment progresses. Generally, passive interventions are viewed as a means to facilitate progress in an active rehabilitation program with concomitant attainment of objective functional gains.

B.6 Active therapeutic exercise program

Exercise program goals should incorporate patient strength, endurance, flexibility, coordination, and education. This includes functional application in vocational or community settings.

B.7 Positive patient response

Positive results are defined primarily as functional gains that can be objectively measured. Objective functional gains include, but are not limited to: positional tolerances, range of motion (ROM), strength, endurance, activities of daily living, ability to function at work, cognition and communication, psychological behavior, and efficiency/velocity measures that can 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 on objective findings. Patient completed functional questionnaires such as those recommended by the Division as part of Quality Performance and Outcomes Payments (QPOP, see Rule 18-8), the Patient Specific Functional Scale, or other validated function scales can provide useful additional confirmation.

B.8 Re-evaluation of treatment no less than every 3 to 4 weeks

If a given treatment or modality is not producing positive results within 3 to 4 weeks or within the time to produce effect in the guidelines, the treatment should be either modified or discontinued. Before discontinuing the treatment, the provider should have a detailed discussion with the patient to determine the reason for failure to produce positive results. Reconsideration of diagnosis should also occur in the event of a poor response to a seemingly rational intervention.

B.9 Surgical interventions

Surgery 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 conditions.

B.10 Six-month time frame

The prognosis drops precipitously for returning an injured worker to work once he/she has been temporarily totally disabled for more than six months. The emphasis within these guidelines is to move patients along a continuum of care and return to work within a six-month time frame, whenever possible. It is important to note that time frames may be less pertinent for injuries that do not involve work-time loss or are not occupationally related.

B.11 Return to work

When considering return-to-work options following TBI, the practitioner must skillfully match the individual's abilities (physical, cognitive, communicative, psychological, and behavioral) and the work requirements. Qualified vocational rehabilitation practitioners may be used for moderate/severe cases.

The practitioner must write detailed restrictions when returning an individual with TBI to limited duty. An individual with TBI should never be released to "sedentary or light duty" without specific physical, psychological, and cognitive limitations. The practitioner must understand essential job functions and job requirements/duties, as well as all of the physical, visual, cognitive, psychological, and behavioral demands of the individual's job position before returning him/her to full duty. Job duty clarification should be obtained from the employer or others if necessary, including but not limited to: employer supervisor or co-worker, an occupational health nurse, occupational therapist, physical therapist, speech-language pathologist, vocational rehabilitation specialist, case manager, industrial hygienist, or other appropriately trained professional.

B.12 Delayed recovery

All individuals with moderate/severe TBI (M/S TBI) will require an integrated system of care. Interdisciplinary rehabilitation treatment and vocational goal setting may need to be initiated for those who are failing to make expected progress 6 to 12 weeks after an injury. Neurological recovery following M/S TBI is greatest in the first 12 months post-injury, but may occur for up to 2 years post-injury, with further functional improvements beyond 2 years. The Division recognizes that 3–10% of all industrially injured individuals will not recover within the timelines outlined in this document despite optimal care. Such individuals should have completed a full neuropsychological evaluation. These individuals may require treatment beyond the limits discussed within this document, but such treatment will require clear documentation by the authorized treating provider focusing on objective functional gains afforded by further treatment.

M/S TBI may have a prolonged recovery and frequently requires continuing treatment as addressed in the post Maximum Medical Improvement (MMI) care section.

B.13 Guideline recommendations and inclusion of medical evidence

All recommendations are based on available evidence and/or consensus judgment. A Division staff methodologist (MD, MSPH) researched and adopted literature critique criteria. Literature critiques were performed in a manner congruent with national standards and were completed independent of the multidisciplinary task force group which drafted initial recommendations. The methodology is described in detail on the Division's website. Please also refer to the Division's website for evidence tables and study critiques which provide details on the studies used to develop the evidence statements.

When possible, guideline recommendations note the level of evidence supporting the treatment recommendation. It is generally recognized that early reports of a positive treatment effect are frequently weakened or overturned by subsequent research. When interpreting medical evidence statements in the guideline, the following apply:

- Consensus means the judgment of experienced professionals based on general medical principles. Consensus recommendations are designated in the guidelines as “generally well-accepted,” “generally accepted,” “acceptable/accepted,” or “well-established.”
- “Some evidence” means the recommendation considered at least one adequate scientific study, which reported that a treatment was effective. The Division recognizes that further research is likely to have an impact on the intervention's effect.
- “Good evidence” 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. The Division recognizes that further research may have an impact on the intervention's effect.
- “Strong evidence” 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. The Division recognizes that further research is unlikely to have an important impact on the intervention's effect.

There is limited and varied literature on TBI. Therefore, many of the studies cited focus on athletes, military personnel, or stroke survivors.

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

B.14 Treatment of pre-existing conditions

The conditions that preexisted the work injury/disease will need to be managed under two circumstances: (a) A pre-existing condition exacerbated by a work injury/disease should be treated until the patient has returned to their objectively verified prior level of functioning or Maximum Medical Improvement (MMI); and (b) A pre-existing condition not directly caused by a work injury/disease but which may prevent recovery from that injury should be treated until its objectively verified negative impact has been controlled. The focus of treatment should remain on the work injury/disease.

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.

B.15 Post maximum medical improvement (MMI) care

This document includes recommendations for post-MMI care in appropriate cases. (Refer to Section H, Maintenance management.)

C. Introduction to traumatic brain injury (TBI)

C.1 Definitions of TBI

Before a diagnosis of TBI is made, the physician should assess the level of trauma exposure to the individual using available objective evidence. According to the Institute of Medicine of the National Academies, TBI is an injury to the head or brain caused by externally inflicted trauma (Institute of Medicine, 2006). The Department of Defense defines TBI as a “traumatically induced structural injury and/or physiological disruption of brain functions as a result of an external force” (Management of Concussion-Mild Traumatic Brain Injury Working Group, 2016, p. 6). TBI may be caused by a blow to the head from an object or by striking an object, by acceleration or deceleration forces without impact, or by blast injury or penetration to the head that disrupts the normal function of the brain (Management of Concussion-Mild Traumatic Brain Injury Working Group, 2016).

A diagnosis of TBI is based on acute injury parameters and should be determined by the criteria listed below. Severity of initial impairment following TBI is subdivided into two major categories, mild TBI (mTBI) and moderate/severe TBI (M/S TBI). These definitions apply to the initial severity of impairment and do not necessarily define or describe the degree of subsequent impairment or disability.

After sustaining a TBI, whether initially diagnosed as mTBI (including complicated mTBI) or M/S TBI, assessment, evaluation, and testing under the Division’s Moderate/Severe TBI Medical Treatment Guideline is appropriate when there are complex questions related to differential diagnosis (brain injury versus other diagnosis) or when the patient is not progressing in cognitive function and/or activities of daily living (ADLs). There should be a clear rationale for undertaking testing and/or treatment under the M/S TBI Guideline.

C.1.a Mild TBI (mTBI)

mTBI is a traumatically induced physiological disruption of brain function, as manifested by at least one of the following, documented within 24 to 72 hours of an injury (American Congress of Rehabilitation Medicine Head Injury Interdisciplinary Special Interest Group, 1993):

- any loss of consciousness
- any loss of memory for events immediately before or after the injury
- any alteration of mental status at the time of the injury (e.g., feeling dazed, disoriented, or confused) (Management of Concussion-Mild Traumatic Brain Injury Working Group, 2016)
- focal neurological deficit(s) that may or may not be transient but where the severity of the injury does not exceed the following:

- loss of consciousness for approximately 30 minutes or less,
- at 30 minutes, a Glasgow Coma Scale (GCS) of 13–15, and
- post-traumatic amnesia (PTA) not greater than 24 hours.

If the GCS is not available, the closest approximation to the patient’s state at 30 minutes post-injury should be used.

If the patient presents with any of the above after 72 hours, the clinician will need to use available information to construct a diagnosis.

Refer to the Division’s Mild Traumatic Brain Injury Medical Treatment Guideline.

C.1.b Complicated mTBI

Complicated mTBI is an mTBI accompanied by structural brain damage visualized on initial structural neuroimaging. More patients in this group have slow or incomplete recovery as compared to patients without this finding. However, the imaging finding alone may not fully predict the clinical course of an individual with mTBI (G. L. Iverson, 2009). Based on a reanalysis of data from the Dikmen study, there is some evidence that mTBI and complicated mTBI – whether the GCS is 15 or 13-14 – are similar with respect to the frequency of persistent concussion symptoms at one month and one year (Dikmen, Machamer, & Temkin, 2017). The term is not separately addressed in this guideline to determine care, but it should be understood that **complicated mTBI cases will frequently require more extensive treatment than that described under mTBI and may be given care listed under this guideline for M/S TBI as appropriate for the individual.**

C.1.c Moderate/severe TBI (M/S TBI)

M/S TBI is a traumatically induced physiological and/or anatomic disruption of brain function as manifested by at least one of the following (American Congress of Rehabilitation Medicine Head Injury Interdisciplinary Special Interest Group, 1993):

- altered state of consciousness or loss of consciousness for greater than 30 minutes,
- an initial GCS of 12 or less, and/or standardized structural neuro-imaging evidence of trauma, and/or
- post-traumatic amnesia (PTA) greater than 24 hours.

If the GCS is not available, the closest approximation to the patient’s state at 30 minutes post-injury should be used.

C.1.d Other terminology

Once a patient has met the definitions above in C.1.c for M/S TBI or C.1.b for complicated mTBI, which requires more care, the treatment patterns and diagnostic tools of this guideline apply. The following terms are noted for information only.

- Acquired brain injury (ABI): ABI refers to any type of brain injury that occurs after birth and that is not related to a congenital disorder or degenerative disease. In addition to TBI, ABI also includes damage to the brain from internal factors such as lack of oxygen, brain bleed, exposure to toxins, infection, or pressure from a tumor. Although non-traumatic ABI may have symptoms and treatments in common with TBI, this guideline was developed specifically for TBI. It is possible that some of these treatments may be useful for other types of ABI.
- Concussion: There is some disagreement in the literature regarding definitions and terminology. “Concussion” is used synonymously with mTBI in many papers. The term is only referenced in this guideline when describing studies using the terminology.
- Post-Concussive Syndrome (PCS): PCS is an accepted diagnosis that is generally determined by the number of symptoms present after an mTBI and how long they persist. However, the symptoms used to determine the presence of PCS are frequently present in those without mTBI (Dean, O'Neill, & Sterr, 2012). In this guideline, once a person has been diagnosed with mTBI, any of the treatments for continuing symptoms may be used. Thus, the diagnostic category of PCS is not necessary and should not be used in isolation to access the treatments in this guideline.

C.2 Prevention

Prevention of injuries such as TBI is an essential component of any medical treatment guideline or injury management program. TBI is a dynamic condition, and patients may deteriorate over time in the areas of physical and mental health, cognition, employment, and activities of daily living (ADLs). The following guideline-specific 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 section C.4, Disability.

- Primary prevention

The goal is the prevention of disease in a susceptible, or potentially susceptible, population through specific measures, including general health promotion efforts. All health providers should remind individuals, supervisors, and employers of the primary measures for preventing recurring TBIs.

Always use appropriate protective equipment on jobs that require protection, including following all of the employment policy and procedures related to the safety of the individual, co-workers, or external customers. Examples of primary prevention include:

- Provide safety guidelines for employer premises;

- Wear protective helmets, complying with the American National Standards Institute (ANSI), on jobs requiring protection from falling objects or electrical hazards;
 - Wear protective helmets and headwear when involved in contact, collision, and other sports such as biking, horseback riding, skating, skiing, and snowboarding;
 - Wear safety goggles or glasses on jobs that require protection from flying objects or debris;
 - Avoid walking on wet, slippery floors on the worksite, or wear the appropriate footwear for the conditions;
 - Ensure that scaffolding has appropriate railings/or harnesses, and that they and are in good working order;
 - Use ladders in accordance with Occupational Safety and Health Administration (OSHA) recommendations (e.g., make sure that ladders over 20 feet tall have cages);
 - Provide and use airbags, safety belts, etc., in motor vehicles;
 - Avoid alcohol and other drug use, including marijuana, during recreational activities such as boating, hunting, skiing, snowboarding, etc., while driving or operating equipment, when working from elevated surfaces, and at work;
 - Avoid distracted driving (e.g., driving while texting, using cell phone, etc.);
 - Practice fatigue management techniques, such as limiting duty hours and night shifts, to maintain optimal energy levels for the required work tasks;
 - Weight management and regular exercise may decrease the likelihood of an injury as well as length of recovery when an injury occurs.
- Secondary prevention

Secondary prevention includes efforts to decrease duration of illness, severity of disease, and sequelae through early diagnosis and prompt intervention.

Early diagnosis of individuals with M/S TBI is critical in helping to avoid secondary symptoms and problems in living. Individuals with a previous history of TBI, comorbid conditions, psychiatric disorders, cognitive disorders, and substance abuse are also at greater risk for poor outcome and represent an opportunity to reduce the effects of TBI. Such individuals should receive appropriate referrals for the comorbid conditions, and treatment of these comorbid conditions should be integrated into the individual's rehabilitation program.

Workers who have sustained a recent TBI should be especially cautious about returning to work activities that may lead to a second TBI since second injuries occurring prior to a full recovery from the initial TBI 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 Section G, Return to work.)

- Tertiary prevention

Tertiary prevention encompasses 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. Life-long management and follow-up services may be required for select individuals with TBI with persistent medical, cognitive, psychological, and/or functional skill deficits.

The majority of this guideline addresses secondary and tertiary prevention of disability for workers with TBI.

C.3 Interdisciplinary rehabilitation professionals

An interdisciplinary treatment team is an alliance of professionals from different medical or therapeutic disciplines (as described below) that provides a coordinated treatment program. The particular treatment needs of the individual with TBI will determine the disciplines that make up the team. 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 to optimize treatment outcomes. It is highly recommended that the individual with TBI participate in team planning, along with his or her family and/or support system, insurance carrier, case manager, and sometimes the employer or return-to-work specialist when addressing return-to-work planning. (Refer to Section G, Return to work.)

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

- Behavioral psychologist: a psychologist with special training, credentials, and licensing who specializes in the area of behavior analysis and treatment.
- Behavioral analyst: a master's level, certified behavioral analyst who designs and supervises behavioral interventions. Behavioral assessments by an analyst do not substitute for neuropsychological assessments.
- Case manager: Case managers are initially trained under a variety of disciplines such as nursing, social work, and other health and human services fields and should be certified

through the Commission for Case Manager Certification (CCMC). In order to achieve the best possible outcome for everyone involved, it is best to provide case management services in an environment in which the case manager, the client, the client's family and/or support system, and the appropriate service personnel are able to communicate directly (Case Management Society of America (CMSA), 2016). It is crucial that the case manager be thoroughly educated in the complexities of treating individuals with TBI.

Case managers may perform Utilization Review (UR) as a part of case management duties, but UR alone is not case management.

The primary functions of TBI case management are:

- to obtain information through a comprehensive assessment of the injured individual and his/her family and/or support system;
 - to work with the health care team, the injured worker, and family and/or support system in development, monitoring, and implementation of a comprehensive case management plan. Plan reassessment should be completed on a regular basis;
 - to optimize access to appropriate health care services and maintain cost effectiveness;
 - to integrate and coordinate service delivery among all providers and to prevent fragmentation of services by facilitating communication and by involving the injured worker and family and/or support system in the decision-making process;
 - to educate and collaborate with the injured worker, family and/or support system, and the health care team when necessary about treatment options, compliance issues, and community resources;
 - to predict and avoid potential complications.
- **Chiropractor:** a credentialed and licensed doctor of chiropractic who assesses and treats human illness and injury, including, but not limited to: musculoskeletal injuries; movement dysfunction; impairments in strength, muscle tone, motor control, posture coordination, endurance, and functional mobility; neurological injuries; and loss of function. Chiropractic utilizes joint manipulation and spinal and joint rehabilitation, along with various therapies and modalities.
 - **Clinical pharmacist:** a pharmacist with expertise in medication management. He/she might be useful for patients with multiple medication regimens.
 - **Clinical psychologist:** a psychologist with special training, credentials, and licensing who specializes in the assessment and treatment of personality and psychological disorders, education and adjustment counseling, psychotherapy, and management of behavior.

- Driver rehabilitation specialist: an individual who is trained in the health care field and certified by the Association for Driver Rehabilitation and the American Occupational Therapy Association.
- Independent life skills trainer: an individual with documented training to develop and maintain an individual's ability to independently sustain him or herself physically, emotionally, and economically. Services may include: assessment, training, and supervision or assistance to an individual with self-care; medication supervision; task completion; communication skill building; interpersonal skill development; socialization; therapeutic recreation; sensory motor skills; mobility or community transportation training; reduction or elimination of maladaptive behaviors; problem solving skill development; benefits coordination; resource coordination; financial management; and household management.
- Music therapist: an individual who is board certified and trained to use music within a therapeutic relationship to improve cognitive, sensory, motor, communication, and behavioral functions that have been affected by neurologic disease.
- Neurologist: a physician with special training and credentials in the area of the nervous system who has successfully completed an approved residency in neurology.
- Neuro-ophthalmologist: an ophthalmologist or neurologist who has completed an approved residency in ophthalmology or neurology, who has completed a fellowship in neuro-ophthalmology, and who specializes in the treatment of visual disorders related to the nervous system.
- Neuro-otologist: a physician who has completed a fellowship in neurotology or oto-neurology.
- Neuropsychologist: a licensed psychologist with knowledge of and special training in brain-behavior relationships, including neuropsychological assessment, causality of neurobehavioral changes, and treatment and management of neurobehavioral disorders.
- Neuroscience nurse: a registered nurse (RN) who has certification in the treatment of individual and family and/or support system responses to nervous system function and dysfunction across the healthcare continuum.
- Neurosurgeon (neurological surgeon): a physician who has special training and credentials in the surgery of nervous system disorders and who has successfully completed an approved residency in neurological surgery.
- Nurse: an RN with specialty training, credentials, and licensing who specializes in the collection and assessment of health data, health teaching, and the provision of treatment that is supportive and restorative to life and well-being.

- Occupational therapist: a registered and licensed therapist who specializes in participation in activities of daily living (ADLs). He/she assesses and treats the physical, perceptual, behavioral, and cognitive skills needed to perform self-care, home maintenance, and community skills. He/she also provides patient and family and/or support system education.
- Occupational medicine physician: a physician who has education and training in occupational medicine and preferably qualifies for board certification.
- Optometrist: a specialist with training, credentials, and licensing who examines, assesses, diagnoses, and treats select abnormal conditions of the eye and adnexa. Optometric scope of practice varies from state to state. It is defined by statute and may include topical or systemic medical therapy. Neuro-optometrists are preferred.
- Ophthalmologist: a physician with training and credentials in the diagnosis and treatment of visual disorders, including related systemic conditions, who has successfully completed an internship and an approved residency in ophthalmology. Ophthalmologists are able to perform medical and surgical procedures on the eye, orbit, and adnexa. Neuro-ophthalmologists are preferred.
- Otolaryngologist: a physician who specializes in ear, nose, and throat medical treatment. He/she has completed a residency in otolaryngology.
- Physical therapist: a licensed therapist with expertise in managing movement dysfunction who specializes in the assessment and treatment of individuals with impairments, deficits and functional limitations in the areas of strength, muscle tone, motor control, posture, coordination, balance, endurance, and general functional mobility. He/she works to improve functional independence, as well as provide family and/or support system and patient education.
- Psychiatrist / physical medicine and rehabilitation physician: a physician with special training, credentials, and licensing in the field of physical medicine and rehabilitation. He/she has successfully completed an approved residency.
- Psychiatrist/neuropsychiatrist: a physician with special training, credentials, and licensing who specializes in the field of mental health and psychological disorders. He/she has successfully completed an approved residency in psychiatry. A neuropsychiatrist is a psychiatrist who has specialized training, credentials, and licensing in neurologically based behavioral, cognitive, and emotional disturbances, including specialized training in TBI.
- Rehabilitation counselor: a bachelor's or master's level counselor who specializes in assisting individuals in the process of independent living, productive activity, and vocational pursuits. This includes assistance with financial resources, housing, community

resources, social skills, vocational evaluation and treatment, integration back into the workforce, and patient and family and/or support system counseling.

- Rehabilitation nurse: an RN who has certification in rehabilitation nursing. Rehabilitation nursing is a specialty practice area within the field of nursing. It involves recognizing, reporting, and treating human responses of individuals and groups to present or future health problems resulting from changes in functional ability and lifestyle (Association of Rehabilitation Nurses (ARN), 2016).
- Rehabilitation psychologist: a specialty within psychology requiring additional training that focuses on interdisciplinary teamwork to achieve optimal physical, psychological, and interpersonal functioning for those with chronic or traumatic injuries (American Board of Professional Psychology, 2017).
- Social worker: a master's level, licensed social worker who specializes in patient and family relationships, as well as housing, financial resources, and society reintegration.
- Speech-language pathologist: a certified, licensed, and master's or doctoral level therapist who specializes in the assessment and treatment of individuals in the areas of communication (speech, language, social skills, voice), cognition, swallowing, and family and/or support system patient education.
- Therapeutic recreation specialist: a bachelor's or master's level 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.

C.4 Disability

The World Health Organization (WHO) conceptualizes disability as the interaction of health conditions with environmental factors (such as social and legal structures) and personal factors (including age, education, and coping styles).

For the purposes of this guideline, we are adopting the International Classification of Functioning, Disability, and Health (ICF).

This model recognizes the interaction between the health condition and three major components: body functions and structures, activity, and participation. These in turn are influenced by environmental and personal issues. The following definitions are used:

- Body functions: physiological functions of body systems, including psychological functions.
- Activity limitations: difficulties an individual may have in executing activities.
- Participation restrictions: problems an individual may experience in involvement in life situations.

- Disability: activity limitations and/or participation restrictions in an individual with a health condition, disorder, or disease.

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

Referenced Version

D. Overview

Care for individuals with moderate/severe brain injuries is highly individualized. A significant amount of therapy performed by multiple types of providers may be required to return the patient to reasonable function. Therefore, many of the providers described in Section C.3, Interdisciplinary rehabilitation professionals, may be required as part of the treatment team. The number and level of acute non-operative, operative, and rehabilitative care is highly dependent on the full extent of the injury and its neurologic effects. Therefore, the M/S TBI guideline recommendations may differ based on a patient's specific neurological injury pattern, polytrauma, psychosocial issues, and comorbidities.

Payers and providers should refer to specific treatment and diagnostic sections to determine coverage for payment.

The following areas should be considered.

D.1 Early specialty intervention

Early identification and early intervention by providers with specialty training and experience is critical in the diagnosis, treatment, and management of individuals with M/S TBI. 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 on a comprehensive data set, inclusive of both functional goals and outcome-oriented goals, and delivered in the least restrictive setting(s) possible. Treatment settings may include acute care settings, hospitals, rehabilitation hospitals, outpatient settings, residential and behavioral settings, home, and community settings. Treatment should be well managed, time appropriate, and progress based.

Providing on-site case managers familiar with TBI rehabilitation treatment protocols is well accepted and recommended for all M/S TBI cases and for select mTBI cases, based on complexity and need.

D.2 Support system education

Outcome following TBI often depends on the health, education, and resources of the individual's family and/or support system. Therefore, educating the individual and family and/or 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 and/or support system members with the interdisciplinary treatment team. Education for individuals and their family and/or support system should include, but is not limited to: basic information about the brain and the effects of TBI on behavior,

cognition, communication, physical function, and emotional function; appropriate family and/or support system interventions; and possible short-term and long-term outcomes. Written information and referral to credible internet resources may be helpful as the individual and their family and/or support system may not be able to remember the vast amount of information provided to them. For similar reasons, they may need to be provided repeated or ongoing information. Insurance carriers, case managers, and treatment providers are highly encouraged to give hands-on personal consultations, education (written, verbal, internet-based), and support services to families in order to maximize treatment outcomes and their durability. Long-term life planning may be discussed. 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 and self-management and preventing secondary disability. (Refer to Section F.4.g, Education, for further details.)

D.3 Course of recovery

Following M/S TBI, neurological recovery is greatest in the first 12 months post-injury but may occur for up to two years post-injury; further functional improvements may occur beyond two years. Due to the variable and dynamic nature of disability secondary to TBI, individuals may either improve or deteriorate over time. In most cases, 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.

There is good evidence that TBI is associated with an important increase in risk of all-cause mortality six months and more after injury. This includes death from suicide, assault, and unintentional injuries. The increase in risk is approximately threefold, and it appears to be independent of sociodemographic factors such as income and marital status (Fazel, Wolf, Pillas, Lichtenstein, & Langstrom, 2014). Thus, it is important that patients with TBI have follow-up for long-term concerns.

In at least 40% of cases, TBI is accompanied by other substantial trauma (e.g., internal, endocrine, orthopedic injuries) which may involve dysfunction in other bodily systems. Psychological issues also occur frequently; they are discussed in this guideline. Users of this TBI guideline are encouraged to employ appropriate guidelines by the Division for other disorders and dysfunction as needed.

D.4 Guardianship and conservatorship

Individuals with TBI may be clinically determined to lack capacity to make competent 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 incompetency, guardianship, conservatorship, medical and durable power of attorney, advanced

directives, living wills, etc., in order to provide family and/or support system members with the appropriate education and/or resources concerning these issues when clinically indicated.

D.5 Systems of care

Integration of systems of care has the goal of assisting individuals with TBI in progressing along a continuum of care toward achieving optimal clinical outcomes as efficiently and cost-effectively as possible. See Figure 1. Long-term outcome and “value” are recognized as superior to short-term, price-driven management. Consumers should also be aware that CARF (Commission on Accreditation of Rehabilitation Facilities) definitions of programs and Centers for Medicare and Medicaid Services (CMS) licensing designations do not always coincide.

Figure 1: Model systems continuum of care for individuals with M/S TBI (updated from the Rocky Mountain Regional Brain Injury Center [RMRBIC], 1989-1993)

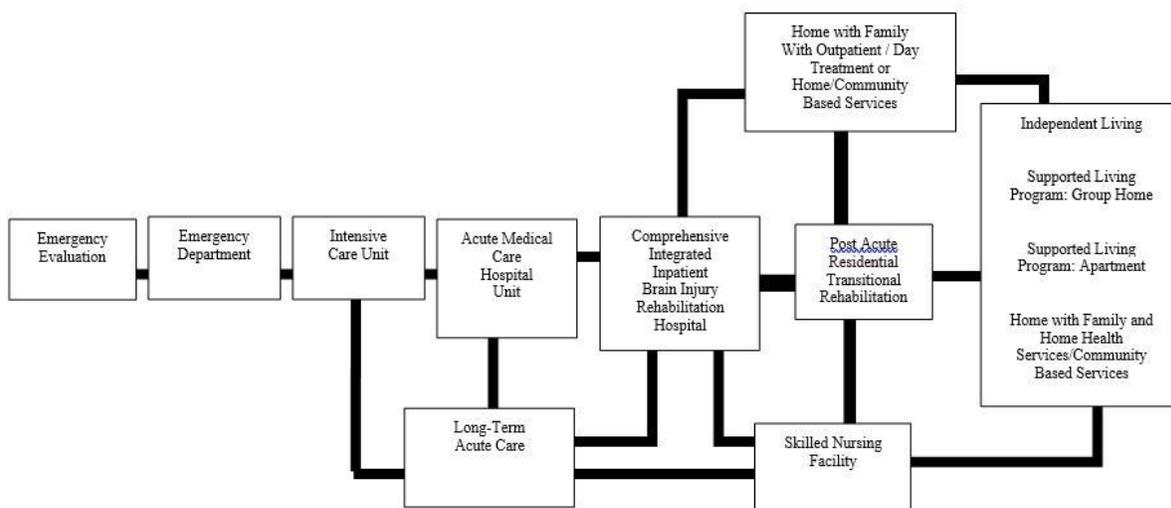


Figure 1 shows a schematic depicting an organized continuum of care for individuals with M/S TBI. The system is not a lock-step progression but a spectrum of TBI programs and services based on the individual’s unique condition and needs.

“The term rehabilitative and habilitative services includes items and services used to restore functional capacity, minimize limitations on physical and cognitive function, and maintain or prevent deterioration of functioning as a result of an illness, injury, disorder or other health condition. Such services also include training of individuals with mental and physical disabilities to enhance functional development” (Congressional Record - Extension of Remarks E462 (Hon. Bill Pascrell Jr), March 23 2010).

The type, amount, frequency, and duration of medical, rehabilitation, and long-term services are determined by the individual’s condition and needs, 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 TBI in conjunction with the individual with TBI and family and/or support system. The following paragraphs describe care programs commonly used by individuals with M/S TBI.

- Acute care

Established emergency medical services (EMS) triage guidelines and organized pre-hospital trauma systems should be utilized because they improve the delivery of trauma care. Trauma systems with identified regionally-designated neuro-trauma centers (preferably Level I or Level II Trauma Centers) should be utilized for the acute care of individuals with TBI. Neuro-trauma centers should have a multidisciplinary trauma team, an in-house trauma surgeon, a promptly available neurosurgeon, a continuously staffed operating room, neuroscience nurses, a neuro-intensive care unit, a laboratory, and a CAT scanner immediately available at all times. Other team members should include orthopedists, radiologists, anesthesiologists, occupational therapists, physical therapists, and speech-language pathologists. Patients with M/S TBI are usually admitted to the intensive care unit initially and then progress to acute care units where they also should receive rehabilitation services. Once M/S TBI is identified, insurance carriers should develop programs to respond quickly to individuals with TBI and their families and/or support systems. In these instances, insurance carriers are encouraged to deploy on-site certified case managers (CCM) to assist treatment providers, individuals, and family and/or support system.

- “Acute rehabilitation” - Comprehensive TBI-specialized inpatient interdisciplinary rehabilitation

Following medical stability, individuals with M/S TBI should be transferred from acute hospital care to acute rehabilitation - in the form of a comprehensive TBI-specialized inpatient interdisciplinary rehabilitation program. Acute brain injury rehabilitation hospitals should have a specialty program that includes designated beds for patients with brain injuries, designated staff with interdisciplinary management protocols, designated treatment areas, specialized therapy programs tailored to specific patient and/or family needs, equipment prescription and procurement expertise, and a sufficient number of individuals with TBI to constitute peer and family education and support milieu. Acute rehabilitation hospitals should be accredited by the Joint Commission on Accreditation of Healthcare Organizations (Joint Commission) 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. (Refer to Section F.5.a, Comprehensive TBI-specialized inpatient interdisciplinary rehabilitation programs.) It should be understood that Medicare CMS regards all programs after acute care as “post-acute,” including acute care inpatient rehabilitation hospitals. Some acute

care inpatient rehabilitation hospitals are licensed as inpatient rehabilitation facilities (IRF) by CMS, others are licensed as long-term acute care hospitals.

- Post-acute rehabilitation

Most patients with M/S TBI will require post-acute rehabilitation following a stay at a comprehensive TBI-specialized inpatient interdisciplinary rehabilitation hospital. Post-acute rehabilitation should not be used in lieu of comprehensive TBI-specialized inpatient interdisciplinary rehabilitation programs as described above. These post-acute rehabilitation programs include skilled nursing facilities (SNFs), outpatient rehabilitation, residential or transitional living rehabilitation, neuro-behavioral treatment programs, home- and community-based programs, and formal occupational rehabilitation programs. Alcohol, substance abuse, opioid, chemical, or more specific psychiatric treatment programs may also be necessary. The most appropriate post-acute rehabilitation program is dependent on the individual's needs following inpatient hospital rehabilitation, as well as proximity and availability of services, family and/or support system dynamics, and projected long-term outcomes. Individuals with significant deficits or who require behavioral treatment or supervision for safety may require neurobehavioral residential rehabilitation. Other individuals may be able to use a combination of home- and community-based rehabilitation and outpatient or day treatment rehabilitation. Refer to Section F.5, Interdisciplinary rehabilitation programs, for more information on these programs.

- Long-term acute care hospital (LTCH/LTACH) programs

Some individuals will be unable to participate in a full inpatient program immediately following acute care because of medical instability; he/ she may need an LTCH for a period of time prior to entering a comprehensive TBI-specialized inpatient interdisciplinary rehabilitation program. LTCH is a designation by the Centers for Medicare and Medicaid Services for LTCH and rehabilitation hospitals whose average length of stay is greater than 25 days. They generally are used for medically complex patients who require long-stay hospital-level care. LTCHs 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 full rehabilitation programs. LTCH programs should be accredited by the Joint Commission. LTCH rehabilitation is generally accepted but should not be used in lieu of comprehensive TBI-specialized inpatient interdisciplinary rehabilitation programs. When managing patients and families coping with severe TBI, LTCH programs should have minimal competencies for all disciplines appropriate to manage TBI related neurological, medical, and rehabilitative needs until patients are stable enough to be transferred to an acute specialized inpatient rehabilitation program as described above. Some comprehensive TBI-specialized inpatient interdisciplinary rehabilitation programs are licensed as LTCHs.

Consumers are encouraged to research rehabilitation programs, regardless of their licensing designation.

- Long-term support care

Across patients, the extent of long-term outcomes following TBI is diverse, ranging from virtually complete independence and function to severe and permanent disability. Therefore, the range of necessary services is complex and individualized. In almost all cases, patients with M/S TBI should have received post-acute rehabilitation before long-term support care. Following post-acute rehabilitation, some individuals with M/S TBI will require significant care and supervision in order to perform ADLs safely. This can be done either at home by family and/or support system members with appropriate training or attendant care, in a skilled nursing care facility, or in a long-term supported living residential program. (Refer to Sections F.5.i, Supported living programs or long-term care residential services, or F.5.b, Sub-acute skilled nursing facilities.) Individuals may also benefit from periodic re-evaluations based on condition and needs. (Refer to Section H, Maintenance management.) Long-term care programs should have components consistent with certification by CARF, as CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

E. Diagnosis

E.1 Initial diagnostic procedures

E.1.a History of injury

In order to establish the TBI diagnosis and treatment plans/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 generally should include:

- Identification data: Identification data should include name, address, age, gender, and marital/relationship status.
- Precipitating event: Information regarding the detailed circumstances of the TBI 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. This may necessitate acquiring information from other sources if the patient does not have full recall. Reports from first responders should be obtained. If possible, collaborative information (e.g., witnesses, paramedic report, etc.) should be obtained to seek details of the event and the injured person's behavioral and cognitive responses immediately following the injury. The presence of alcohol and/or drug use at or prior to the time of the injury should be noted. All of this history should be used when establishing the presence of a TBI caused by a work-related event.

If the injury occurred as a result of a motor vehicle crash, information should be obtained as to: the speed of the vehicle; position or location of the injured worker; use of restraints or helmet; degree of damage to the vehicle; all other involved vehicles, if known; involvement of EMS system, if any; and acute or sub-acute accident-related physical complaints or injuries, including other people involved, if known. The crash outcome regarding non-TBI complaints/injuries may enhance an understanding of the forces involved in the accident and will minimize the possibility of unrecognized physical injury. The accident report and any police records should be obtained and reviewed if available.

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.

- Alteration in consciousness: History should include a review of chief complaints, presenting problems, and symptoms, with the goal of obtaining additional information regarding the alteration of consciousness associated with the index injury. Generally accepted data should include information about duration of alteration of mental status, including consciousness, degree and length of retrograde and PTA, as well as cognitive, behavioral, and physical impairments, with collateral sources of information when

possible. Information should be collected regarding various time intervals for the following:

- Current status: This is a report of the individual's current condition, symptoms, complaints, functional problems, etc.
- Initial status: This is a report of the individual's neurological condition at the time of the injury, symptoms, complaints, functional problems, etc. The GCS, when performed in the field and the emergency department, may aid in grading the severity of TBI. Serial GCS scores may be helpful when intoxication may be a factor. It may be helpful to ask the patient to describe in detail the first event they remember after the injury in order to assess PTA or loss of time sequence and what events they remember immediately prior to the injury (Ruff et al., 2009). 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. As a practical example, the provider should contemplate whether the feeling of "being dazed" could be a manifestation of emotional numbing. It is possible to have dazing due to TBI including emotional reactions (e.g., numbing and/or detachment) or even acute pain in relation to the event.
- Evolution of neurological status: This is a report of change in the individual's recovery 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 the course of the injury. A family and/or support system member's history of the patient's ability to perform his/her usual duties is often helpful. Other measures of functional activity that are standardized and can be repeated during treatment may also be useful.
- 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, pre-injury medical records, etc. The practitioner should utilize this information to establish or verify the probable degree of trauma involved in the incident and the consistency between these reports and current symptoms.
- Medical/health history: Taking a history is a generally accepted practice and should include a history of past and current illnesses, injuries, previous TBIs or other disabilities, seizures/epilepsy, stroke, cerebrovascular disease, developmental/intellectual disabilities, neurodegenerative disorders, any previous intracranial pathology (such as infections, tumors, congenital malformations), pain, previous surgeries of any kind, mental health and medication history, sleep disorders, educational history, and other medical/health data. A report from family and/or support system members or other persons knowledgeable about

the individual with TBI relevant to pre-injury as compared to post-injury function should be obtained.

- Activities of daily living (ADLs): A thorough history should be taken of daily activities. Basic ADLs include: self-care and personal hygiene, communication, ambulation, attaining all normal living postures, travel, non-specialized hand activities, sexual function, sleep, and social and recreational activities. Instrumental activities of daily living (IADLs) are complex self-care activities that may be delegated to others (e.g., financial management, medications, meal preparation). This assessment should delineate the changes in the individual's ability to perform ADLs prior to and after the injury and any assistance needed from family members or others.
- Family history: Family history should include psychiatric, including substance use and abuse, medical-legal involvement, and medical history of illness or disability within the family that is relevant to the individual's condition.
- Social history
 - Living situation: This should include marital history, family and/or support system members, household makeup, significant others, etc.
 - Occupational history: This should include the name of the individual's current employer, job title, primary job duties, special licenses or certifications, length of employment, prior places and dates of employment, and previous work-related injuries and their outcomes.
 - Developmental history: This should include educational history, highest level of education obtained, learning disabilities or disorders, any developmental delay, abuse, or neglect, etc.
 - Avocations: This should include common non-occupational activities, including leisure activities such as sports, hobbies, and personal interests.
 - Substance use history: This should be obtained (particularly if there is data to suggest substance abuse was involved in the injury) along with information related to the amount and duration of alcohol, drug, and marijuana use, licit and illicit, including prescription drug use and/or abuse.
 - Legal history: DUIs, violence, speeding/reckless driving violations, and other medical/legal issues.
- Review of systems: This is a generally accepted practice and should include a complete review of body systems and functions.

- Pain diagnosis: This is recommended, especially during the first visit to document all body parts involved. This should include a pain diagram completed by the patient, if able.
- Psychiatric history: Psychiatric history should be assessed at the initial visit and at follow-up visits. Depression and anxiety are common conditions pre-injury and following TBI, and symptoms may be subtle or unapparent unless directly assessed. Individuals may not always present with complaints of sadness or anxiety, but instead they may express feeling other symptoms that are commonly seen in clinical depression or anxiety, particularly disturbances of sleep and energy. 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, family and/or support system, and pre-injury medical records about significant changes in appetite, sleep disturbances (including nightmares), decreased interest in pleasurable activities, loss of energy, diminished ability to think or concentrate, irritability, suicidal ideation, history of suicide attempts, psychiatric hospitalizations, mental health treatment, and feelings of emptiness, worthlessness, and excessive guilt.

E.1.b Physical examination

This is a well-accepted practice and should be performed by a qualified practitioner. A thorough trauma exam should be done during the initial exam and the first follow-up visit to ensure all complaints are addressed. The exam should include a complete cervical spine exam.

E.1.c Neurological examination

A neurological examination should be performed by a qualified practitioner and should include a mental status examination. A comprehensive neurological examination includes, but is not limited to, mental status, cranial nerves, motor status, sensory status, balance and coordination, and gait and station. The mental status examination involves both formal and informal observations. It includes observations about the individual's presentation, social/behavioral decorum, 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 (Guskiewicz, Perrin, & Gansneder, 1996; Guskiewicz & Register-Mihalik, 2011). Using a standard approach for all visits assists serial functional assessment.

E.1.d Neuropsychological evaluation

This is the evaluation of cognitive processes and behavior using psychological and neuropsychological testing to assess central nervous system function and to diagnose specific behavioral or cognitive deficits or disorders. Neuropsychological assessments are generally accepted and widely used as a valuable component of the diagnosis and management of

individuals with TBI. They include sensitive tests that are used to detect cognitive deficits, severity of impairment, and improvement over time. Neuropsychological assessment assists in the differential diagnosis of neurobehavioral disorders and the cumulative effect of multiple TBIs.

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

Neuropsychological assessments utilize standardized testing procedures. Test reliability and validity are important considerations. Examiners should be aware that abnormal cognitive function may occur in the setting of chronic pain, psychological disorders, sleep deprivation, medication use, malingering, developmental/intellectual disabilities, acute or chronic substance abuse, and comorbid or pre-existing cognitive or neurologic disorders. In cases where comorbid diagnoses are suspected, formal psychological evaluation should accompany the neuropsychological battery to assist in characterization and differentiation of diagnoses. Multiple sources of data (self-report information, medical history, Emergency Medical Services [EMS] records, psychosocial history, family report, etc.) are integrated with test performance factors to draw inferences about brain-behavior relationships. The individual's cultural background, race, age, primary language and developmental and educational history should be considered. Neuropsychological testing may not be valid when English is not the patient's primary language. When practical, educational records including history of learning disability should be obtained and reviewed.

The specific neuropsychological tests used may vary according to the symptom presentation of the individual and the purpose of the evaluation. Tests usually assess the following cognitive domains: level of orientation, attention, language, memory, praxis, executive function, speed of processing, visual-spatial ability, recognition, personality, and function. All reports should include a clinical interview that notes the patient and family medical / psychiatric / substance abuse history, developmental milestones, educational history, psychosocial issues, and current medical conditions and treatment. Interpretation of these tests should always discuss the impact of information from the clinical interview that might affect test results, such as medications causing confusion or drowsiness, lack of sleep, anxiety, depression, and similar issues.

In the *acute setting*, neuropsychological consultation and assessment in M/S TBI is indicated for:

- determining emergence from post-traumatic amnesia (PTA);
- documenting the early course of improvements in attentional functioning, memory, visual-perceptual abilities, language, and executive functions. This information may be utilized in:
 - treatment planning and team consultation;
 - family and/or support system education/support and use of community services;

- education for developing insight and use in supportive psychotherapy;
- educating and counseling patients with pre-existing psychological issues or other history predisposing to delayed recovery.

During the *sub-acute phase*, when 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;
- design treatment plans such as psychotherapy;
- educate the individual and family and/or support system about TBI;
- assess or recommend behavioral management interventions.

During this time, test selection will be dependent on the individual's neurobehavioral status and other aspects of his/her 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 PTA. Administration of a full battery of neuropsychological tests should not be initiated until attentional functioning has improved to the point where such extensive testing will be meaningful and contribute to long-term treatment planning and rehabilitation.

Post-acute testing: Once the individual's behavior has improved from attentional disturbance, lack of sleep, pain from other injuries, and neurobehavioral disinhibition to the point where valid test data may be obtained, testing with a full neuropsychological test battery is appropriate.

E.1.e Neurodiagnostic tests

E.1.e.1 Imaging procedures

E.1.e.1.1 Skull x-rays

These are well-established diagnostic tools used to detect a fracture of the cranial vault.

Skull x-rays are generally accepted only if CT scans are not available or in cases where there is only a low suspicion of intracranial injury.

E.1.e.1.2 Computed axial tomography (CT)

For acute brain trauma, iodine contrast enhancement is not necessary. CT scans are noninvasive and will reveal the presence of blood, skull fracture, and/or structural changes in the brain. They do, however, expose the patient to higher doses of ionizing radiation than skull radiographs. CT scans provide somewhat limited information compared to MRI about intrinsic cerebral damage involving deep brain structures, although many types of intrinsic damages can be seen on CT scans.

CT is a well-established brain imaging x-ray study comprised 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.

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.

If fractures are suspected, CT scanning is preferred over skull x-rays because of its much higher sensitivity and accuracy and its ability to identify clinically significant fractures as well as potentially co-existent contusions or hemorrhages.

CT scans are recommended for abnormal mental status (GCS less than 13 on admission), focal neurologic deficits, or acute seizure. CT scans are recommended for the following patients (Amyot et al., 2015; MDCalc, 2018):

- High risk
 - GCS less than 15 at two hours post-injury;
 - suspected open or depressed skull fracture;
 - any sign of basilar skull fracture (e.g., hemotympanum, raccoon eyes, Battle's Sign, CSF oto-/rhinorrhea);
 - greater than or equal to two episodes of vomiting;
 - age equal to or greater than 60.
- Other risk
 - retrograde amnesia to the event greater than or equal to 30 minutes;
 - "dangerous" mechanism (e.g., pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from greater than three feet or more than five stairs);
 - coagulopathy, including use of anticoagulant medication;
 - focal neurologic deficits;

- acute seizure;
- severe and persistent headache;
- physical evidence of trauma above the clavicles and/or multiple trauma and/or basilar skull fracture;
- drug or alcohol intoxication;
- any recent history of TBI, including mTBI.

E.1.e.1.3 Magnetic resonance imaging (MRI)

MRI is a well-established brain imaging study for patients with TBI 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. Altered signal intensity compared to normals may indicate trauma or other disease.

CT is superior to MRI in detecting acute intracranial bleeds and remains the preferred initial imaging study in the first 24 hours following TBI.

Initially, MRI scans are clinically useful in the following situations to:

- determine neurological deficits in TBI not explained by CT;
- evaluate prolonged intervals of disturbed consciousness or other prolonged alteration in mental status;
- define evidence of acute changes super-imposed on previous trauma or disease.

MRI scans are also useful to assess transient or permanent changes, to determine the etiology of subsequent clinical problems, and to plan treatment.

MRI may reveal an increased amount of pathology compared to CT. Due to their high contrast resolution, MRI scans are superior to CT scans for the detection of some intracranial pathology (e.g., axonal injury, subtle cortical contusions, small extra-axial fluid collections, etc.) but not bone injuries such as fractures. MRI is more sensitive than CT for detecting traumatic cerebral injury.

Specific MRI sequences and techniques are very sensitive for detecting acute traumatic cerebral injury. They may include, but are not limited to: diffusion weighted imaging (DWI), susceptibility weighted imaging, gradient echo weighted imaging, and fluid attenuated inversion recovery (FLAIR). Some of these techniques are not available on an emergency basis.

E.1.e.2 Vascular imaging tests

Vascular imaging tests reveal arterial or venous abnormalities in the chest, neck, head, or extremities (e.g., thrombosis, dissection, spasm, emboli, or tearing).

These tests are generally used if standard CT/MRI scans fail to demonstrate suspected vascular abnormalities. They may be useful in M/S TBI as an adjunct to aforementioned studies. (Refer to Section E.1.e.1, Imaging procedures, under Skull x-rays, Computed axial tomography (CT), and Magnetic resonance imaging (MRI).) Often, patients with clinical signs of blunt trauma to the neck or with a significant mechanism of injury require imaging to detect injuries to the carotid or vertebral arteries that cannot be diagnosed on physical exam.

Generally accepted procedures include:

- **CT angiography (CTA):** At the time of this guideline, this is the most common and accepted test for screening patients for injuries to the carotid or vertebral arteries in the acute setting of trauma or focal neurologic (stroke like) symptoms. CTAs are noninvasive tests that are readily available in essentially all emergency rooms that treat patients with traumatic injuries. They can be obtained rapidly, often just subsequent to the screening CT head exam. They provide excellent 2D and 3D imaging of the vessels from the aortic arch to the skull vertex and also show the relationship of those vessels to surrounding bones and soft tissues. Some limitations include poor vessel opacification if the timing of the study is incorrect, artifact from dental hardware and the skull base, and patient motion. CTAs should generally only be performed on scanners with at least 16 detectors, with 64 being the preferable number of detectors. CT venography (CTV) is the most commonly utilized technique to evaluate the dural venous sinuses for injury in a trauma setting.
- **Arteriography:** Arteriography is generally accepted when the above noted traumatic vascular abnormalities are suspected but unproven with the techniques discussed thus far or when further investigation of the vascular lesion is necessary. This is particularly true with arteriovenous fistulous change.
- **Venography:** This is generally accepted if increased venous flow and pressure are suspected and still undemonstrated. This is done via either the jugular or orbital venous system.
- **Noninvasive vascular assessment (NIVA):** NIVA is the least invasive procedure 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]):** This is indicated when vessel changes are suspected but not demonstrated by other simpler tests. Internal obstruction of an artery may be

demonstrated (e.g., thrombosis, spasm, dissection, neck injury, or emboli from concomitant injuries). Arterial compression due to external pressure may be demonstrated (e.g., bony fracture or mass effect from a large intra-axial hemorrhage or cerebral edema). Dissection or arteriovenous fistula formation may be seen, but as with other vascular abnormalities, conventional contrast arteriography/venography may be needed 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.

Brain acoustic monitor: This device identifies turbulent blood flow in the brain. It is considered investigational for the purpose of detecting deficits requiring CT scanning in the emergency room. Based on the evidence listed in the table below, it is *not recommended* at the time of this guideline (Dutton et al., 2011).

Evidence against use of a brain acoustic monitor as an initial diagnostic procedure for TBI			
Some evidence	Evidence statement	Citation	Design
	A Brain Acoustic Monitor cannot reliably predict the development of post-concussive symptoms.	(Dutton et al., 2011)	Diagnostic cohort study

E.2 Further diagnostic procedures

E.2.a Electrodiagnostic studies

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

E.2.a.1 EMG and nerve conduction studies

These 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.

E.2.a.2 Electroneuronography (EnoG)

EnoG is a well-established and generally accepted test that measures facial nerve function. This test measures the action potential of different branches of a 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.

E.2.a.3 Dynamic electromyographies

These 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.

E.2.a.4 Evoked potential responses (EP)

EPs are generally accepted, well-established diagnostic procedures. EPs are central nervous system electrophysiologic responses to a stimulus, either externally generated via one or more sensory modalities or internally generated via the processing of information. Multisensory EP studies are limited to visually evoked potentials, brain stem auditory evoked potentials, somatosensory evoked potentials, and cognitive evoked potentials. In M/S TBI, including vegetative state (unresponsive wakefulness syndrome or UWS) and/or minimal conscious state

(MCS), 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.

E.2.a.4.1 Auditory brainstem response (ABR)

ABR 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. 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, three, and particularly five are most useful in assessing injury. While amplitude and the presence of wave are important, the latency and interwave latency are equally important. This test is often sensitive but non-specific. It may be useful in some cases. It requires **prior authorization**.

E.2.a.4.2 Electroretinogram (ERG)

ERG is a generally accepted diagnostic procedure for occult retinal trauma accompanying TBI. Most traumatic retinal pathology presents as a field deficit detected by direct examination. ERG cannot detect mild changes in retinal function, and normal results should not be taken as evidence against ocular dysfunction. ERG requires **prior authorization**.

E.2.a.4.3 Cognitive event-related potential

This is an acceptable diagnostic procedure for M/S TBI. It may be justified if other neurological diagnoses are suspected. It requires **prior authorization**.

E.2.a.4.4 Somatosensory evoked potential (SSEP)

SSEP is a generally accepted diagnostic procedure for M/S TBI. It may be used when other diagnoses are suspected. It requires **prior authorization**.

E.2.a.4.5 Visual evoked potential (VEP)

VEP 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. Unfortunately, VEP is highly susceptible to artifact and has a low specificity for structural injury to the visual pathways. Therefore, **prior authorization** is required.

E.2.a.4.6 Vestibular evoked myogenic potentials (VEMP)

Refer to Section E.2.i.3.6, VEMP, in the Neuro-otology section.

E.2.b Electroencephalography

E.2.b.1 Electroencephalography (EEG)

EEG is a well-established diagnostic procedure that monitors brain wave activity using scalp electrodes and provocative maneuvers such as hyperventilation and photic strobe for the purpose of seizure diagnosis. Information generated includes alterations in brain wave activity such as frequency changes (non-specific) or morphologic (seizures). EEG is not generally indicated in the immediate period of emergency response or during acute 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 assess seizures, focal encephalopathy due to persistent effects of hemorrhage, diffuse encephalopathy due to the injury, or other complicating factors such as hydrocephalus or medications. A normal EEG does not definitively rule out a seizure disorder. If there is sufficient clinical concern that a seizure disorder may exist despite a normal EEG, then a 72-hour ambulatory EEG or inpatient video-EEG monitoring may be appropriate.

E.2.b.2 Quantified electroencephalography (QEEG) (Computerized EEG)

QEEG 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.

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 (Arciniegas, 2011; Coburn et al., 2006). In M/S 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 M/S TBI.***

E.2.c Neuroimaging

Practitioners should be aware of the radiation doses associated with various procedures. Coloradans have a background exposure to radiation, and unnecessary CT scans or x-rays increase the lifetime risk of cancer death (Hendrick et al., 2011).

E.2.c.1 Structural imaging

E.2.c.1.1 Computed axial tomography (CT)

CT may be used to follow identified pathology or to screen for late pathology. Subsequently, CT scans are generally accepted when there is suspected intracranial blood, extra-axial blood, hydrocephalus, altered mental state, or a change in clinical condition, including development of

new neurological symptoms or post-traumatic seizure (within the first days following trauma). Once the initial acute stage has passed, MRI scans are frequently ordered as opposed to CT.

A systematic review concluded that routine CT repetition rarely identified conditions needing surgical intervention (Stippler et al., 2012). Nevertheless, risk factors for a further bleed or neurological deterioration from the following conditions would warrant repeat CTs:

- skull fracture,
- coagulopathy or anticoagulation,
- age over 60,
- epidural hematoma,
- suspected open or depressed skull fracture,
- continuing severe headache,
- moderate to severe TBI (Stippler et al., 2012), and
- continuing TBI symptoms.

E.2.c.1.2 Magnetic resonance imaging (MRI)

MRI is the image of choice to detect the late, sub-acute, and chronic structural changes in the brain which underlie abnormal functioning. It 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. (Refer to Section E.2.c.3, Advanced MRI techniques, for more advanced imaging.)

Diffusion tensor imaging (DTI), susceptibility-weighted imaging, and magnetic transfer imaging: DTI may be useful for identifying pathology and guiding treatment in patients with documented physiological deficits, such as hemianopsia (Yeo, Kim, Kim, Kim, & Jang, 2012), but interpretation of results is very dependent upon the experience and skill of the neuroradiologist. DTI may be used when an accompanying MRI is ordered for purposes other than diagnosing mTBI.

E.2.c.2 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. Both PET and SPECT scans can subject the patient to significant radiation levels (Shetty et al., 2016). **Prior authorization** is required for these procedures.

E.2.c.2.1 Single photon emission computed tomography (SPECT)

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. The 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. Its interpretation should take into account its low specificity, making the predictive value of SPECT no better than CT (Gowda et al., 2006).

For severe TBI, 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, **prior authorization** is required and it is recommended that medical necessity and clinical usefulness for this study be justified (Wintermark et al., 2015).

E.2.c.2.2 Positron emission testing (PET)

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 M/S TBI, PET findings are closely correlated with the site and the extent of cerebral dysfunction derived from neurological and neurobehavioral examinations. 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. Any requested use requires **prior authorization** (Belanger, Vanderploeg, Curtiss, & Warden, 2007; Wintermark et al., 2015).

E.2.c.3 Advanced MRI techniques

At the time of writing this guideline, all advanced MRI techniques are ***not recommended for diagnostic purposes*** (Douglas et al., 2015; Ellis et al., 2016; Ma, Zhang, Wang, & Chen, 2016; Toth, 2015). While they can identify anatomic physiologic variation, the changes cannot clearly be related to the need for specific treatment. In complex moderate/severe cases, they could be useful for surgical and other long-term planning. They require **prior authorization** and justification of the medical necessity and clinical usefulness of the study.

E.2.c.3.1 Magnetic resonance (MR) spectroscopy

This 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 that 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 that 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 and guide treatment planning. It may be useful information in determining long-term outcome. MR spectroscopy remains predominantly a research tool at this time and should not be used solely to diagnose the presence of TBI. MR spectroscopy requires **prior authorization** for patients with M/S TBI. It may be considered with adequate documentation of its medical necessity in unusual cases, such as in patients with a minimally conscious state, when the information will assist in clarifying the pathology to direct a therapeutic approach to the individual with TBI.

E.2.c.3.2 Functional MRI (fMRI)

This uses MRI to detect physiologic responses of brain tissue to various tasks. Blood oxygenation level dependent (BOLD) contrast is the most popular fMRI technique. It 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. Functional MRI studies have shown functional reorganization as a general response to TBI (Belanger et al., 2007). Alterations in patterns of cerebral activity seen on fMRIs may correlate with cognitive deficits in individuals with TBI, but the specificity of the test is not sufficient to make fMRI a diagnostic tool. At the time of this guideline, it is a research tool and **not recommended for clinical use**. Recent publications report problems with the mathematical formulas used, relating false positives and false negatives (Sanders, 2009).

E.2.d Laboratory testing

Laboratory testing is a generally accepted, well-established procedure. In M/S TBI, extensive lab testing will be necessary to monitor electrolyte status, organ and endocrine 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 therapeutic drug levels and the effects on organ function.

E.2.e Lumbar puncture

Lumbar puncture is a well-established diagnostic procedure for examining 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 intracranial pressure, lumbar puncture should be preceded by fundoscopic examination and a CT scan or MRI.

E.2.f Nerve blocks – diagnostic

These 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 ROM, dystonia, or spasticity and assist in planning subsequent, specific therapy.

E.2.g Further neuropsychological assessment and testing

Neuropsychological assessment after three months is appropriate in the following situations when:

- input is needed to plan treatment to maximize long-term cognitive and overall functional outcomes;
- documentation of accommodations is needed to establish adjustments to the neurocognitive challenges;
- assessment will assist in increasing insight and be used to assist with supportive psychotherapy;
- there is a question of the individual's ability to perform work-related duties and/or 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 TBI;
- it is deemed necessary to evaluate and/or monitor effectiveness of treatment approaches (i.e., cognitive rehabilitation therapy, somatic therapies, or medication trials) in specific individuals;
- the patient's presentation is such that symptom validity testing and performance validity testing may be helpful in treatment planning;
- 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);
- there are questions of competency, guardianship, or conservatorship.

Neuropsychological testing should be used to document the patient’s level of effort and to provide data regarding symptom validity. Testing should not be used to diagnose malingering.

Neuropsychological testing may take into account validated testing in other areas without a direct relationship to psychological issues.

Evidence statements regarding neuropsychological assessment			
Some evidence	Evidence statement	Citation	Design
	There is an association between poor effort on verbal memory tests and poor effort on computerized tests of postural stability in patients with TBI who are being evaluated for disability ratings.	(Armistead-Jehle, Lange, & Green, 2017)	Retrospective review of consecutive charts

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

- The administration of a full neuropsychological test battery after the acute period is appropriate in a number of situations when:
 - there are questions of competency, guardianship, or conservatorship;
 - developmental issues are interacting with a history of TBI (e.g., determining if age related memory or cognitive changes are impairing functioning in a person with a history of M/S TBI);
 - late complications develop that affect cognition and overall function (e.g., seizures, depression, anxiety disorders);
 - it is necessary to address any of the issues on the initial indications tests;
 - change in support system and ancillary support may require reevaluation of the patient’s status;
 - cognitive declines associated with aging need to be evaluated with symptom complaints and included in treatment recommendations;
 - the patient and family have questions/concerns about symptom management (with specific attention to future needs).

E.2.h Psychological, psychiatric, or psychosocial evaluations

These are generally accepted and well-established diagnostic procedures with selective use in the TBI population. They have more widespread use after three months. Diagnostic testing may be indicated for individuals with symptoms of post-traumatic disturbances of sleep, mood, anxiety, psychosis, substance use, aggression/agitation, and pain, as well as depression, delayed recovery, chronic pain, recurrent painful conditions, and disability problems. An individual with a PhD, PsyD, or psychiatric MD/DO credentials may perform these evaluations if listed as an authorized user by the test publisher. Practitioners' familiarity with patients with TBI is preferred.

Psychosocial evaluations can help to determine if further psychosocial or behavioral interventions are indicated for patients diagnosed with TBI. The interpretations of the evaluation can provide clinicians with a better understanding of the patient in his or her social environment, thus allowing for more effective rehabilitation. Psychosocial assessment requires consideration of variations in experience and expression resulting from affective, cognitive, motivational, and coping processes, as well as other influences such as gender, age, race, ethnicity, national origin, religion, learning disability, language, or socioeconomic status.

A comprehensive psychological evaluation should attempt to identify both primary psychiatric risk factors (e.g., psychosis, active suicidality, lack of awareness) as well as secondary risk factors (e.g., moderate depression, job dissatisfaction) (Bruns & Disorbio, 2009). Significant personality disorders should also be taken into account in treatment planning.

Psychometric testing is a valuable component of a consultation to assist the physician and other members of the treatment team in making a more effective treatment plan. Psychometric testing can assist in enhancing general medical outcomes and in predicting a patient's likely adherence to and cooperation with medical treatment plans.

Several meta-analyses have evaluated the occurrence of depression and anxiety with non-penetrating TBI. Both anxiety and depression appear to occur at a rate about one-third higher than the general population (Osborn, Mathias, & Fairweather-Schmidt, 2014, 2016). Both conditions are likely to increase during the initial 2-5 years post-injury, although anxiety may decrease after five years (Osborn et al., 2014; Osborn, Mathias, & Fairweather-Schmidt, 2016). Mild and M/S TBI are both likely to suffer from psychological stress. Increased physical activity and decreased alcohol consumption may be useful to decrease symptoms (Osborn, Mathias, Fairweather-Schmidt, & Anstey, 2016). One study found that pre-injury alcohol abuse and longer PTA predicted symptoms lasting longer than six months (Hart et al., 2014).

Even in cases where no diagnosable psychological condition is present, these evaluations can identify social, cultural, coping, and other variables that may be influencing the patient's recovery process and may be amenable to various treatments, including behavioral therapy.

- **Qualifications**

- A psychologist with a PhD, PsyD, or EdD credentials or a physician with psychiatric MD/DO credentials may perform the initial comprehensive evaluations.
- Psychometric tests should be administered by psychologists with a PhD, PsyD, or EdD credentials or health professionals working under the supervision of a doctorate level psychologist. Administration and interpretation of psychological/neuropsychological measures must adhere to standards set forth by test publishers.

- **Indications**

A psychological 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, TBI, or mTBI. This includes conditions that may have been pre-existing or are concurrent, such as depression, anxiety, chronic pain, somatoform disorders, and factitious disorders. At times, a set of symptoms may not coincide with expected objective findings for those with 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 delayed access to appropriate care,
- there is a question of whether a brain injury has occurred,
- neuropsychological testing yields a pattern of test results that is not consistent with the clinical history,
- neurologically improbable symptoms are present, or
- it is necessary to assess for accompanying psychological components.

- **Clinical evaluation**

Special note to health care providers: Most providers are required to adhere to the federal regulations under the Health Insurance Portability and Accountability Act (HIPAA). Unlike general health insurers, workers' compensation insurers are not required to adhere to HIPAA standards. Thus, providers should assume that sensitive information included in a report sent to the insurer could be forwarded to the employer. The Colorado statute provides a limited waiver of medical information regarding the work-related injury or disease to the extent necessary to resolve the claim. It is recommended that the health care provider either (1) obtain a full release from the patient regarding information that may go to the employer or (2) not include sensitive health information that is not directly related

to the work-related conditions in reports sent to the insurer.

The clinical evaluation should address the following areas:

- History of injury

The history of the injury should be reported in the patient's words or using similar terminology. Certified medical interpreters are preferred. Collateral information should be obtained as appropriate. This may include family, support systems, witnesses, and EMS records.

- nature of injury
- psychosocial circumstances of the injury
- current symptomatic complaints
- extent of medical corroboration
- treatment received and results
- compliance with treatment
- coping strategies used, including perceived locus of control, catastrophizing, and avoidance behaviors
- perception of medical system and employer
- history of response to prescription medications
- medication history related to this injury

- Health history

- nature of injury
- medical history
- psychiatric history
- history of alcohol or substance abuse, including abuse of prescription medication
- ADLs
- previous injuries, including disability, impairment, and compensation
- complete medication history, including prescription and over-the-counter medications

- Psychosocial history
 - childhood history, including abuse/neglect and developmental/intellectual disability or delay
 - educational history
 - family history, including disability
 - relationship/marital history and other significant adulthood activities and events
 - legal history, including criminal and civil litigation
 - employment history
 - military duty: Because post-traumatic stress disorder (PTSD) might be an unacceptable condition for many military personnel to acknowledge, it may be prudent to screen initially for signs of depression or anxiety – both of which may be present in PTSD.
 - symptoms of pre-injury psychological dysfunction
 - current and past interpersonal relations, support, and living situation
 - financial history
- Mental status exam including cognition, affect, mood, orientation, thinking, and perception. May include the Mini-Mental Status Examination or the Frontal Assessment Battery, if appropriate, and detailed neuropsychological testing.
- Assessment of any danger posed to self or others.
- Barriers to care should be considered as the patient may experience problems with transportation and access to appropriate care.
- Psychological test results, if performed.
- Current psychiatric/psychological diagnosis consistent with the standards of the American Psychiatric Association's most recent Diagnostic and Statistical Manual of Mental Disorders.
- Pre-existing psychiatric conditions. Treatment of these conditions is appropriate when the pre-existing condition affects recovery.
- Causality (to address medically probable cause and effect, distinguishing pre-existing psychological symptoms, traits, and vulnerabilities from current symptoms or aggravation of prior symptoms).

- Treatment recommendations with respect to specific goals, frequency, timeframes, and expected outcomes.

Evidence statements regarding psychometric testing			
Good evidence	Evidence statement	Citation	Design
	Psychometric testing can predict medical treatment outcome.	(Block, Ohnmeiss, Guyer, Rashbaum, & Hochschuler, 2001)	Prospective cohort study
		(Sinikallio et al., 2009)	Observational cohort study
		(Sinikallio et al., 2010)	Observational cohort study

E.2.i Neuro-otology: vestibular and audiological evaluation

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. An individual with TBI may experience these symptoms. Any patient with complaints of vertigo or significant neurological findings on clinical exam, such as ataxia, should be referred to appropriate specialists expeditiously. Diagnostic testing for significant pathology usually requires the listed evaluations for audiometry, tympanometry, and vestibular function (ENG/VNG, rotary chair testing, computerized dynamic platform posturography, ECoG, VEMP). Some tests may need to be repeated to clarify diagnosis.

E.2.i.1 Audiometry

Audiometry is a generally accepted and well-established procedure that measures hearing. An audiologist or skilled trained technician administers the test using an audiometer. The machine presents individual frequencies to the person with TBI (typically ranging from 125–8000 Hz) at different levels of loudness (in dB HL). The individual is asked to respond to the sound at its lowest detectable intensity (threshold). Normal thresholds are from 0-25 dB HL and are depicted on an audiogram. The audiologist or physician should determine the presence and type (non-organic, conductive, sensorineural, presbycusis, or mixed) of hearing loss based on the audiogram and other tests reasonably deemed necessary.

If available, obtain pre-injury baseline audiograms / audiometry studies to include a summary of past audiometric history, if known (e.g., prior hearing loss, prior tinnitus, prior vestibular problems, prior injury, etc.).

Baseline audiometry following TBI 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.

Specific audiometric testing can be done to assess the presence of tinnitus and complaints of unilateral hearing loss (Stinger test).

E.2.i.2 Tympanometry

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 the presence of fluid in the middle ear.

E.2.i.3 Vestibular function tests

The most common type of vertigo is benign paroxysmal positional vertigo (BPPV), which usually does not require additional testing because it is diagnosed with the clinical Dix-Hallpike maneuver and treated with a variety of canalith repositioning maneuvers (CRM), such as Epley and Semont maneuvers (Fife et al., 2000). (Refer to Section F.4.1, Neuro-otology: vestibular and audiology, under Treatment of recurrent, non-progressive otologic disorders.) The following tests are used to verify the presence of vestibular dysfunction and specify the origin when possible.

E.2.i.3.1 Electro- or video-nystagmography (ENG/VNG)

This is a generally accepted and well-established procedure that measures inner ear/central balance function. The test measures eye movement responses 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 and positioning nystagmus testing, and caloric testing. This series of tests may identify peripheral and central abnormalities, abnormalities in oculomotor function, positional nystagmus, and unilateral and bilateral vestibular dysfunction. The ENG/VNG can be helpful in identifying 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.

E.2.i.3.2 Rotary chair testing

This is a generally accepted, although not commonly used, test that evaluates the ocular responses of the inner ear to rotation. It is used to identify the extent of bilateral vestibular loss and is more accurate than VNG caloric tests for this purpose. It is also useful in assessing the ability of vision to compensate for vestibular impairments and so provides prognostic information regarding recovery.

E.2.i.3.3 Video head impulse testing (vHIT)

This is a generally accepted, although not commonly used, test that evaluates the ocular responses of the inner ear to high acceleration head rotation. vHIT is used to evaluate the ability to maintain visual focus during head movement that can be impaired with moderate to high grade unilateral or bilateral vestibular injuries. It detects dysfunction of individual vertical semicircular canals in vestibular patients as accurately as scleral search coils but is non-invasive and easy to use (MacDougall, McGarvie, Halmagyi, Curthoys, & Weber, 2013). It is used to identify the extent of bilateral vestibular loss and is more accurate than VNG caloric tests for this purpose.

E.2.i.3.4 Computerized dynamic platform posturography

This is a generally accepted, although not commonly used, test that assesses the contributions of vision, somatosensation, and the inner ear to balance control. It separately evaluates the role of lower extremity motor control to balance. It can be used to determine whether a vestibular lesion is present, but it does not localize the lesion. 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. Non-physiologic findings on this exam can result from either symptom exaggeration, anxiety, psychiatric disorders, atypical results, or malingering and should not be interpreted as malingering without other evidence. One study demonstrated positive VNG testing in a number of cases where dynamic posturography was non-physiologic (Larrosa, 2013).

E.2.i.3.5 Electrocochleography (ECoG)

This is a well-established and generally accepted procedure that indirectly tests endolymphatic fluid pressures. It identifies the affected ear in cases of post-traumatic endolymphatic hydrops and 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, sporadic dizziness, tinnitus, aural fullness, and sensitivity to sound.

The ECoG is a 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). An increase in the ratio of the summing potential of the action potential (SP/AP) suggests the presence of hydrops or perilymphatic fistula. The test varies in sensitivity and specificity. Diagnosis of endolymphatic hydrops requires a characteristic clinical picture with progressive hearing loss, fluctuating hearing, and recurrent vertigo episodes lasting for hours. (Refer to section F.4.1, Neuro-otology: vestibular and audiology, under treatment of progressive otologic disorders.) In the absence of these clinical features, diagnosis should not be based solely on an abnormal ECoG test result.

E.2.i.3.6 Vestibular evoked myogenic potentials (VEMP)

This is a generally accepted test that evaluates the function of the saccule, one of the gravity-sensing organs of the inner ear. It is the only objective test of these organs. It is a form of auditory evoked response and is measured using the ABR and EMG equipment. A loud sound stimulus is introduced into the ear, and a vestibulo-colic reflex response from the saccule is recorded as a brief relaxation of the ipsilateral sternocleidomastoid muscle by EMG. A characteristic wave form is recorded for each ear that is analyzed for presence or absence, threshold, amplitude, and latency. Absence of a response in persons under age 60 suggests saccular damage. Reduced thresholds are indicative of semicircular canal dehiscence. It is not useful in diagnosing benign paroxysmal positional vertigo or vestibular migraine (Fife et al., 2017).

E.2.i.3.7 Acquired visual dysfunction

This is usually not the primary cause of imbalance. However, if ocular and/or visual abnormalities are found on testing, the patient may be further evaluated by a qualified optometrist or ophthalmologist (with training and experience in TBI, balance disorders, and underlying neurology) or a neuro-ophthalmologist. The goal is to 1) determine if there is a visual component or not, 2) determine if it is central or peripheral, 3) determine if the problem is a manifestation of an underlying vestibular disorder or a true vision problem, and 4) coordinate with the treating providers regarding most appropriate treatment.

E.2.i.3.8 Other clinical referrals

The treating physician may refer individuals with TBI who have balance problems to other clinicians with appropriate training in balance dysfunction, such as neuro-otologists, neurologists, and otolaryngologists, to assist in their assessment. The referrals may include, but are not restricted to: neuro-ophthamology, optometry, physical therapy, vestibular therapists, occupational therapy, and chiropractic therapy. There should be a coordinated approach between these disciplines and the physician specialist in the individual's treatment.

E.2.j 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 aspiration, airway obstruction, pneumonia, inadequate nutrition, dehydration, weight loss, failure to thrive, and death.

E.2.j.1 Clinical assessment

E.2.j.1.1 Clinical bedside swallow assessment

This generally accepted clinical examination of oral-pharyngeal swallow function consists of

- pertinent medical history;
- examination of dentition and function of the jaw, lip, tongue, soft palate, pharynx, and larynx;
- examination of oral sensitivity;
- observation of dry swallow(s) and, if appropriate, swallows with various food/liquid consistencies; and
- ability to follow directions and to discipline own behaviors.

If pharyngeal dysfunction or aspiration is suspected, an instrumental assessment may be indicated.

E.2.j.1.2 Modified Evans blue-dye test (MEBDT)

This 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, ice chips, or food items. Aspiration is assumed if tracheal suctioning reveals blue-tinged secretions. The MEBDT has not been found reliable in identifying individuals who aspirated trace amounts (less than 10% of the bolus).

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.

E.2.j.2 Instrumental evaluation

Instrumental evaluations of swallow function are generally accepted diagnostic tests. They are conducted by a speech-language pathologist and a physician in collaboration (radiologist, ENT, or other physician familiar with the procedure as appropriate) or by a speech-language pathologist under the supervision of a physician.

E.2.j.2.1 Modified barium swallow studies (MBS) or videofluoroscopic study

MBS is well-established and the most common instrumental procedure used to study swallow function. The individual's swallowing function involving the oral cavity, larynx, pharynx, and upper esophagus is visualized while swallowing various quantities and textures of food and/or liquid containing 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. Specific factors assessed during the MBS may include the anatomy and physiology of the swallow, clearance of material through the mouth and pharynx, the timing of the swallow, the percentage of penetration/aspiration, and the effectiveness of treatment techniques and strategies to improve swallow safety and efficiency. Recommendations are made concerning the safety of oral intake, medication administration, optimal delivery method for diet and hydration, diet texture/sensation modifications, therapy techniques, compensatory postures, and strategies to ensure optimum swallow safety and efficiency. Repeated studies may be needed to determine change in swallow function over time.

E.2.j.2.2 Fiberoptic endoscopic evaluation of swallowing (FEES)

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 for 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.

E.2.j.2.3 Fiberoptic endoscopic evaluation of swallowing with sensory testing (FEEST)

This is a modification of the FEES procedure that adds quantification of 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.

E.2.j.2.4 Manofluorographic swallowing evaluation (MSE)

MSE is a videofluoroscopic swallowing study with the addition of an 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.

E.2.k Vision evaluation

There are standard examination techniques and ancillary tests to establish the diagnosis of visual disorders. It is a generally accepted practice for a qualified practitioner to provide a comprehensive vision evaluation.

The qualified practitioner (optometrist, neuro-optometrist, ophthalmologist, neuro-ophthalmologist) should have training and experience in the neurology of TBI.

The comprehensive visual evaluation should assess afferent visual function (visual acuity, visual fields / peripheral vision), efferent function (ocular movement, fixational stability/instability, binocular alignment), and anatomic integrity of the eye and its adnexal structures. In doing so, the practitioner will obtain information about the functional status of the eyes and visual system including the presence or absence of refractive error; loss of visual acuity and/or visual field; oculomotor dysfunction with or without diplopia; ocular, orbital, and adnexal injuries; and other pathology involving intraocular structures. Vision evaluation may be necessary to evaluate acquired/traumatic central and peripheral nervous system disorders, visual acuity loss, visual field loss, nystagmus, ocular motility impairment, cranial nerve palsy, diplopia, suspected or noted ocular and visual pathology, pupillary disorders, and visual perceptual disorders.

The diagnosis/diagnoses determined following a comprehensive neuro-ophthalmic examination should be based upon objective findings that correlate with the known or suspected underlying neuro-pathology and symptoms. A simple description of symptoms may be used but should not be understood as explanatory or diagnostic, as the practitioner should seek to identify the underlying pathology.

Signs and symptoms of visual dysfunction commonly include, but are not limited to:

- Signs
 - ocular mis-alignment (strabismus),
 - nystagmus or other instability of fixation,
 - ocular discharge,
 - red or swollen eyes,
 - ptosis,
 - lagophthalmos (inability to fully close the eyelid),
 - globe dystopia (lack of orbit alignment).

- Symptoms, including complaints of
 - blurred vision or loss of vision,
 - difficulty with visual tracking or scrolling,
 - focusing problems,
 - double vision,
 - having to close or cover an eye to improve vision,
 - problems with depth perception,
 - impaired peripheral vision,
 - headache or eye strain with use of eyes,
 - head tilt to improve vision,
 - dizziness or balance problems with use of eyes,
 - photophobia,
 - reduced attention or concentration for visual tasks.

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 or solely attributable to other causes (e.g., cognitive, vestibular, medication, psychological) indicate the need for vision evaluation as soon as reasonably possible post-injury. Mild signs and symptoms do not require referral but may be monitored for several weeks to allow for resolution or improvement.

Patients with M/S TBI are more likely to have eye movement and/or visual spatial deficits. Such patients should have a comprehensive evaluation if these signs are noted or symptoms are reported (Adams, 2009).

A formal vision examination may be intermediate, extended, or comprehensive, depending on the nature of the deficits. The vision examination may include, but is not limited to: case history; visual acuity at a distance and near; refraction; color vision testing; pupillary examination; visual field by confrontation; Amsler grid testing; ocular motility examination; binocularity examination; accommodation testing; external/adnexal examination; intraocular pressure testing; and anterior and posterior segment examinations.

Ancillary diagnostic tests may include, but are not limited to: visual field testing (tangent screen campimetry, manual or automated perimetry), ultrasonography, fluorescein angiography, anterior segment and fundus photography, optical coherence tomography, electrodiagnostic studies, low vision assessment, and visual perceptual testing.

E.2.k.1 Visual field testing

This is a well-established technique to evaluate central and peripheral vision. It is indicated when a deficit is suspected by the practitioner or noted by the patient and should be considered in any patient with TBI and subjective visual field loss. Visual field testing beyond the basic examination should be performed using a procedure and tool that is well-established and standardized. Examples include computerized perimetry and Goldmann perimetry.

E.2.k.2 Ultrasonography

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.

E.2.k.3 Fluorescein angiography

This 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.

E.2.k.4 Visual perceptual testing

This testing may be conducted informally by an ophthalmologist or optometrist or with a standardized battery of tests employed by a neuropsychologist. 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 be used in a standardized battery, and caution should be exercised in using other instruments.

E.2.k.5 Low vision evaluation

Low vision evaluation is well-established and indicated in the presence of subnormal bilateral visual acuity or visual field. The goal is to provide vision aids for distance or near vision that improve visual functioning.

E.2.k.6 Electrodiagnostic studies

These are well-established and possibly 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.2.a, Electrodiagnostic studies, for further description.)

E.2.k.7 Optical coherence tomography

This is an interferometric technique, usually with near-infrared wavelengths, used to evaluate optic nerve and retinal structural integrity. This study should be used in conjunction with tests of visual function to establish the possible causes of visual deficits. Serial assessments can provide objective longitudinal data about retinal and optic nerve structure.

E.2.1 Return-to-work assessment and special tests

A return-to-work procedure should be part of a company's policies and procedures, knowing that return to work can decrease anxiety, reduce the possibility of depression, and reconnect the worker with society. Evaluations used to define these abilities, such as the functional capacity evaluation (FCE) and the worksite analysis, should be objective. The professional performing the FCE and worksite analysis should be specifically trained and familiar with the unique presentation of the individual who has sustained 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 suggestive of malingering.

Caution should be used in returning an individual to work and other activities too early. Both physical and cognitive duties should generally be non-stressful initially, with a gradual increase in activity based on improvement and/or resolution of symptoms. The individual should be competent in most basic ADLs before return to work is considered. Return to full duty depends on the rate of decrease of symptoms. Generally, if symptoms recur during increasing job duties or exertion, duties should be decreased accordingly. Because a prolonged period of time off work will decrease the likelihood of return to work, the first weeks of treatment are crucial in preventing and/or reversing chronicity and disability mindset. In complex cases, experienced nurse case managers or occupational therapists may be required to assist in return to work. Other services, including psychological evaluation and/or treatment and vocational assistance should be employed. Two evaluations that may be used are job site evaluations and alterations and FCEs.

E.2.1.1 Job site evaluations and alterations

For many patients with TBI, job alterations may be needed. These may be in the form of: (1) instructing the worker how specific duties might be performed to avoid excessive mental stress; (2) actual job worksite or duty changes; and/or (3) a formal job site evaluation and alterations at the worksite.

Job site evaluation and alteration should include input from the employee, the employer, and a health care professional with experience with TBI cases. The employee should be observed performing all job functions in order for the job site evaluation to be a valid representation of a typical workday.

A formal job site evaluation is a comprehensive analysis of the physical, mental, and sensory components of a specific job and may be important initially to determine causation. These

components may include, but are not limited to: (a) postural tolerance (static and dynamic), (b) aerobic requirements, (c) ROM, (d) torque/force, (e) lifting/carrying, (f) cognitive demands, (g) social interactions, (h) interpersonal skills management, (i) visual perceptual challenges, (j) environmental requirements of a job, (k) repetitiveness, and (l) essential functions of a job.

Changes that provide a therapeutic benefit or relieve the patient’s ongoing symptoms are part of the required medical treatment for TBI, and therefore, it is assumed that the insurer will be responsible for paying for reasonably necessary job site alterations.

Job descriptions provided by the employer are helpful but should not be used as a substitute for direct observation.

A job site evaluation may include observation and instruction of how work is done, what material changes should be made, and determination of readiness to return to work. Refer to the Division’s Chronic Pain Disorder Medical Treatment Guideline.

Requests for a job site evaluation should describe the expected goals for the evaluation. Goals may include, but are not limited to:

- Provide a detailed description of the physical and cognitive job requirements;
- Make recommendations for and assess the potential for job site changes;
- Assist the patient in his/her return to work by educating on how he/she may be able to do his/her job more safely; and/or
- Give detailed work/activity restrictions.

Time frames

Time frames regarding job site evaluations and alterations	
Frequency	One time with additional visits as needed for follow-up.

E.2.1.2 Functional capacity evaluation (FCE)

FCE may be indicated to identify residual physical limitations. FCE is a comprehensive assessment of the various aspects of physical and cognitive 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. The physical portion of any FCE should include all of the physical skills required for specific job placement.

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, mood changes, 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, inconsistent or erratic behavior, or the inability to get along with coworkers and supervisors.

FCEs include tools that are an extension of the basic medical 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 therapy, occupational therapy, and physical therapy to determine physical, cognitive, and psychological abilities in order for the patient to function safely and productively in a work setting. FCEs are typically conducted in four to six hours, but for individuals who have sustained a TBI, 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 eight to ten hours.

When an FCE is being used to determine return to a specific job site, the provider is responsible for fully understanding the job duties. A job site evaluation is frequently necessary. FCEs cannot be used in isolation to determine work restrictions. The authorized treating provider must interpret the FCE in light of the individual patient's presentation and medical and personal perceptions. FCEs should not be used as the sole criteria to diagnose malingering.

FCEs may be beneficial in the TBI population to assist in return to work.

Time frames

Time frames regarding functional capacity evaluation	
Frequency	2 times. When the patient is unable to return to the pre-injury position and further information is desired to determine permanent work restrictions. A repeat FCE may be needed if additional treatment is deemed necessary after the first FCE. Prior authorization is required for more than 3 FCEs.

F. Treatment

Due to the complex nature of the brain, individuals with TBI require coordinated interdisciplinary treatment. Usually, the impairment(s) and functional limitations are appropriately treated by more than one therapeutic discipline. Treatment should include functional, outcome-oriented, and community reintegration goals. Treatment session duration and frequency will vary depending on the individual's tolerance and may evolve over time.

The location of treatment sessions may be in a clinical setting initially, but eventually may be more effective in the home, workplace, or community, based on functional goals. M/S TBI may result in lifetime deficits, so 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 approximately every three to four weeks or within the time to produce effect in the guidelines. (Refer to Section B, General guideline principles.) Experienced practitioners should not use all of the therapies and modalities listed in this guideline. Periodic modification or consultation may be necessary throughout an individual's lifetime following TBI. Therapy for specific impairments and functional limitations may be reinitiated for goal-specific, time-limited treatment as new goals are identified and developed. Treatment should be based on medical diagnosis and associated impairment, cognitive ability, clinical evaluations, anticipated functional gains, and progress demonstrated by documented functional outcomes.

F.1 Acute-stage therapeutic procedures

F.1.a Resuscitation

Definition and background

The first priority in treating TBI is complete and rapid physiologic resuscitation.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Recommendations for M/S TBI resuscitation

Special considerations for isolated communities without neurosurgical support:

- Trauma surgeons and emergency physicians may perform the initial resuscitation and neurologic treatment in the deteriorating individual. Important initial factors affecting TBI outcomes are hypotension (systolic less than 90mmHg) and hypoxemia.
- Once feasible, transport to a designated neuro-trauma center should occur expeditiously for further evaluation and management.

F.1.b Intracranial pressure (ICP) management and cerebral perfusion pressure (CPP)

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for M/S TBI ICP and CPP

ICP monitoring is usually indicated in individuals with low GCS (less than 9) and an abnormal CT scan or when the individual cannot have continual neurologic evaluation (e.g., use of anesthesia, pain medicine for other injuries that preclude a neurologic exam), and it should also be considered when the individual's age is over 40 or systolic blood pressure is less than 90 mmHg (Brain Trauma et al., 2007).

Recommendations for M/S TBI ICP management

- The patient's head is usually elevated above the heart about 30 degrees.
- Hyperventilation may be used briefly. However, prolonged hyperventilation will eventually result in decreased cerebral blood flow and is **not recommended** (Brain Trauma Foundation, 2016).
- Osmotic therapy such as hypertonic saline or mannitol is frequently used; however, no one agent has been proven superior to another (Brain Trauma Foundation, 2016).
- Steroids are **not recommended** due to worse outcomes (Brain Trauma Foundation, 2016).
- Sedatives and/or paralytic agents may be used as needed.
- EEG monitors may be applied and anti-seizure medication may be used.
- Ventriculostomy assists in lower pressure and with hydrocephalus.

F.1.c Hyperventilation

Definition and background

Hyperventilation may be used to temporarily decrease ICP.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Recommendations for hyperventilation

In rare cases, controlled hyperventilation may be necessary for brief periods in acute neurological deterioration not attributable to systemic pathology (i.e., hypotension), but it is **not recommended** for prolonged periods of time. It should generally be avoided during the first 24 hours because it

may decrease cerebral blood flow (Brain Trauma Foundation, 2016; [Cochrane] Ian Roberts & Schierhout, 1997).

F.1.d Medications

F.1.d.1 Hyperosmolar agents

Definition and background

Hyperosmolar agents have been used to temporarily decrease ICP.

Supporting literature and evidence tables

Studies not resulting in evidence statements
A meta-analysis did not support any particular osmotic agent for the reduction of intracranial pressure in the setting of severe TBI, and hypertonic saline solution has not been shown to be superior to or inferior to any other agent with respect to mortality in the setting of increased intracranial pressure (Berger-Pelleiter, Emond, Lauzier, Shields, & Turgeon, 2016; Brain Trauma Foundation, 2016; Wakai, McCabe, Roberts, & Schierhout, 2013).

Indications/recommendations for hyperosmolar agents

Hyperosmolar agents may be used prior to ICP monitoring if there is neurologic deterioration not attributable to systemic pathology (i.e., hypotension) and/or signs of transtentorial herniation.

F.1.d.2 Glucocorticoids

Definition and background

Glucocorticoids (steroids) were initially thought to decrease acute cerebral damage.

Supporting literature and evidence tables

Evidence statements regarding medications: glucocorticoids			
Good evidence	Evidence statement	Citation	Design
	Glucocorticoids do not decrease mortality.	(CRASH trial collaborators, 2004)	Randomized clinical trial
Some evidence	Evidence statement	Citation	Design
	Glucocorticoids may even increase the mortality rate in individuals with TBIs.	(CRASH trial collaborators, 2004)	Randomized clinical trial

Recommendations for glucocorticoids

Glucocorticoids are not useful or generally accepted for improving outcome or decreasing ICP, and in some instances, they may be harmful.

F.1.d.3 Anti-epileptics

Definition and background

Anti-epileptic agents are intended to prevent or treat seizures.

Supporting literature and evidence tables

Evidence statements regarding medications: anti-epileptics			
Good evidence	Evidence statement	Citation	Design
	In the setting of M/S TBI, treatment within 24 hours from the time of trauma with an antiepileptic drug reduces the risk of seizures in the first 7 days after trauma.	(Thompson, Pohlmann-Eden, Campbell, & Abel, 2015)	Meta-analysis of randomized clinical trials

Studies not resulting in evidence statements

There is a lack of evidence that treatment with an antiepileptic drug reduces the risk of seizures occurring later than 7 days after trauma (Thompson et al., 2015). There is also a lack of evidence that treatment with an antiepileptic drug reduces all-cause mortality after TBI (Thompson et al., 2015).

Indications/recommendations for anti-epileptics

Anti-epileptic treatment may be used to prevent early post-traumatic seizures in a high-risk individual. They are also usually administered for one week in those with intracranial hemorrhage. Prevention of early seizures is reasonable to reduce seizure-associated complications during acute management (Brain Trauma Foundation, 2016; Chang & Lowenstein, 2003).

Prophylactic anti-epileptics should be administered on a case by case basis after the first week. Clinical indicators warrant their use, such as but not limited to: brain penetration, excessive intraparenchymal bleeding, or continued seizures.

F.1.d.4 Barbiturates to induce coma

Definition and background

Barbiturates were initially thought to improve outcomes by decreasing ICP and perhaps decreasing surgeries.

Supporting literature and evidence tables

Studies not resulting in evidence statements

There is no evidence to suggest barbiturates used to decrease intracranial pressure improve outcomes, which may be due to the fact that they lower both intracranial pressure and cerebral perfusion pressure (Brain Trauma Foundation, 2016; [Cochrane] I. Roberts & Sydenham, 2012).

Recommendations for barbiturates

Barbiturates are *not recommended* for use in TBI to induce coma.

F.1.d.5 Branched chain amino acids (BCAAs)

Definition and background

BCAAs were initially thought to improve cellular metabolism.

Supporting literature and evidence tables

Studies not resulting in evidence statements
BCAAs have been trialed to reduce functional deficits post TBI. There is no evidence of their efficacy (Sharma, Lawrence, & Hutchison, 2017).

Recommendations for BCCAs

BCCAs are *not recommended* (Sharma et al., 2017).

F.1.d.6 Erythropoietin (EPO)

Definition and background

Erythropoietin has been used to increase the production of red blood cells in the setting of hypoxia.

Supporting literature and evidence tables

Evidence statements regarding medications: erythropoietin			
Good evidence	Evidence statement	Citation	Design
	In the setting of acute M/S TBI, erythropoietin reduces mortality.	(Liu, 2016)	Meta-analysis of randomized clinical trials

Studies not resulting in evidence statements
There is a lack of evidence that erythropoietin improves the rate of favorable neurological outcomes, as defined by the ability to function outside the home (Liu, 2016).

Indications/recommendations for EPO

EPO is not currently in common use. However, it may be used at the clinician’s discretion for M/S TBI. Ongoing studies could affect this recommendation.

F.1.d.7 Progesterone

Definition and background

Progesterone was initially thought to improve mortality.

Supporting literature and evidence tables

Studies not resulting in evidence statements
In a meta-analysis, 3 of 5 trials showed increased mortality with progesterone versus placebo, and the overall evidence would not shift to show a clear benefit of progesterone over placebo even if there were a new, very large trial with a very dramatic effect on mortality ([Cochrane] Ma, Huang, Qin, You, & Zeng, 2016).

Recommendations for progesterone

Progesterone is *not recommended* and may have detrimental effects ([Cochrane] Ma, Huang, et al., 2016).

F.1.d.8 Tranexamic acid (TXA)

Definition and background

TXA improves blood clotting.

Supporting literature and evidence tables

Evidence statements regarding medications: tranexamic acid (TXA)			
Some evidence	Evidence statement	Citation	Design
	When there is a risk of intracranial bleeding in the setting of TBI, TXA is more effective than placebo in reducing the risk of in-hospital mortality and unfavorable neurologic outcomes.	(Zehtabchi, Abdel Baki, Falzon, & Nishijima, 2014)	Meta-analysis of randomized clinical trials

Indications/recommendations for TXA

When reviewing the evidence statement listed above, note that many studies on TXA are small. Individual patient factors will need to be considered when choosing to prescribe TXA.

F.1.e Hypothermia

Definition and background

Therapeutic hypothermia involves lowering of core body temperature by techniques such as surface heat exchange devices, intravascular infusion of cold crystalloid, and body cavity lavage (Seder & Van der Kloot, 2009). Theoretically, it would be performed to decrease some metabolic and physiologic processes that result in neural damage after TBI, including increased intracranial pressure (ICP).

Supporting literature and evidence tables

Evidence statements regarding therapeutic hypothermia			
Good evidence	Evidence statement	Citation	Design
	In the setting of severe TBI with intracranial pressure greater than 20 mmHg for at least 5 minutes despite stage 1 treatment such as mechanical ventilation, sedation, elevation of the head of the bed, IV fluids with or without inotropes, analgesia, surgical removal of space-occupying lesions, and ventriculostomy with or without CSF removal, the addition of therapeutic hypothermia lowering core temperature to 32 to 35° C does not improve outcomes at 6 months and may be harmful by increasing mortality and the risk of unfavorable neurological outcome.	(Andrews et al., 2015)	Randomized clinical trial

Recommendations for therapeutic hypothermia

Based on the evidence listed above, therapeutic hypothermia is ***not recommended***.

F.1.f Surgery

Definition and background

In many cases, surgery is appropriate. Refer to Section F.2, Operative procedures, for details.

Supporting literature and evidence tables

Studies not resulting in evidence statements
In patients with acute extradural hematomas and bilateral fixed dilated pupils, the mortality rate was 29.7%, while in patients with acute subdural hematomas and fixed pupils, the mortality rate was 66.4% (Scotter, Hendrickson, Marcus, & Wilson, 2015).

Studies not resulting in evidence statements

In patients with acute extradural hematomas, a favorable outcome was observed in 54.3%. In patients with acute subdural hematomas, a favorable outcome was seen in 6.6% of patients. All of these patients had surgery. Of these patients, younger patients are likely to have extradural hematomas while older patients are more likely to have subdural hematomas (Scotter et al., 2015).

F.1.g Hyperbaric oxygen (HBO2)

Definition and background

HBO2 was initially thought to improve outcomes.

Supporting literature and evidence tables

Studies not resulting in evidence statements

Despite evidence of limited physiological changes with hyperbaric oxygen, there is insufficient evidence to suggest that hyperbaric oxygen would functionally benefit stroke survivors or patients with TBI (Bennett, Trytko, & Jonker, 2004; Bennett, Wasiak, Schnabel, Kranke, & French, 2005; Rockswold et al., 2010).

Some benefit with respect to mortality or level of consciousness in the setting of acute moderate-to-severe TBI cannot be ruled out (Crawford, Teo, Yang, Isbister, & Berry, 2017).

Complications

Complications can occur, including tension pneumothorax (Lee, 2012).

Recommendations for HBO2

Hyperbaric oxygen is *not recommended* acutely or chronically. Ongoing studies could affect this recommendation.

F.2 Operative procedures

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

F.2.a Brain

- Debride penetrating injury, gunshot wound, or foreign body.
- Decompression and evacuation
 - Hematoma: epidural, subdural, intraparenchymal.
 - Contusion.
 - Infections: abscess or empyema.

F.2.b Decompressive craniectomy

Definition and background

Decompressive craniectomy is the removal of a large portion of the skull and dural opening to manage cerebral edema causing increased intracranial pressure (ICP). The bone flap is then stored. Often, cranioplasty is later required to correct the skull defect. When the autologous graft cannot be replaced, an alternative method allograft may be used.

Supporting literature and evidence tables

Evidence statements regarding decompressive craniectomy			
Good evidence	Evidence statement	Citation	Design
	In patients with severe TBI and raised ICP, a decompressive craniectomy procedure initiated when the ICP rises above 20 mmHg for 15 minutes out of 60 minutes despite use of first tier treatments does not improve the frequency of death or severe disability compared to continuation of nonsurgical treatment.	(Cooper et al., 2011, DECRA trial)	Randomized clinical trial
	Decompressive craniectomy leads to improved mortality when utilized as a last tier approach for severe and refractory intracranial hypertension in patients with severe TBI. However, while operative treatment with craniectomy appears to reduce mortality, it does appear to be associated with slightly increased rates of vegetative state as well as complications. Additionally, the study found no difference in favorable functional neurologic outcomes between surgery versus medical management, although the high cross-over rate may have affected these findings.	(Hutchinson et al., 2016, RESCUEicp trial)	Parallel group randomized clinical trial

The most recent randomized controlled trial, the RESCUEicp trial, assessed the effectiveness of craniectomy as a last tier intervention in patients with TBI and refractory intracranial hypertension (ICH) (Hutchinson et al., 2016). The study compared medical management for severe TBI with either a bifrontotemporoparietal craniectomy for diffuse cerebral edema or unilateral frontotemporoparietal craniectomy for unilateral hemispheric edema. The study demonstrated that decompressive craniectomy decreased rates of death compared to the medical management group. There was no difference between favorable functional neurologic outcomes between the two groups. However, the operative group demonstrated higher rates of vegetative state. The operative group also demonstrated higher rates of complication, including surgical site infections, myocardial infarct, bleeding, disseminated intravascular coagulation, intra-operative respiratory failure, liver failure, and subgaleal collection.

Patients who had received an immediate hematoma evacuation procedure were included in the RESCUEicp trial if the procedure was not a craniectomy. Of note, however, there was no significant difference in percentage of patients undergoing immediate craniotomy between the medical management and surgical groups. The RESCUEicp study also had a high cross-over rate, with 37% of patients initially randomized to the medical group receiving a decompressive craniectomy due to worsening condition. This may indicate that craniectomy may have an even more significant effect on improved mortality over standard medical management.

The RESCUEicp trial study departs from previous randomized controlled trials in its use of craniectomy as a last tier approach for more severe cases with refractory ICH. It uses a 25mmHg ICP trigger, which differs from the 20mmHg trigger used in the DECRA trial (Cooper et al., 2011), with surgery not occurring until at least 1 hour had passed (median 2.2 hours) as opposed to 15 minutes.

The indications and outcomes from the RESCUEicp trial are used for the indications and recommendations in this guideline.

Complications

- Craniectomy: subdural hygroma or hemorrhage, contra-lateral contusions, outcome of a vegetative state, cerebral herniation.
- Syndrome of the trephined, a.k.a. sinking flap syndrome: This condition presents with progressive neurologic decline in conjunction with progressive sinking of the craniectomy skin flap. It is likely related to dysregulated brain physiology when intracranial pressure equals atmospheric pressure.
- External hydrocephalus: This is when CSF tends to accumulate in extra-axial spaces after craniectomy and puts the patient at high risk for development of post-traumatic hydrocephalus and need for permanent CSF diversion after reconstructive cranioplasty.

- Cranioplasty: infection, wound break down, bone resorption, increased rate of complication for patients with bilateral craniectomies. Reconstructive options include autologous native bone reimplantation, titanium mesh, or custom synthetic PEEK prosthesis.

Indications/recommendations for decompressive craniectomy

If craniectomy is considered, it should be undertaken in patients with severe TBI and intracranial hypertension refractory to other medical management strategies such as head elevation, ventilation, sedation, inotropic therapy, ventriculostomy, and osmotic medications. Decompressive craniectomy may be performed in conjunction with evacuation of mass lesions or for intracranial hypertension with elevated intracranial pressures above 25mmHg that are refractory to tiered medical management. The possibility of death despite surgery, a vegetative state, or prolonged disability should be discussed extensively with patients and/or their families in a shared decision-making model.

F.2.c Cerebral spinal fluid (CSF)

F.2.c.1 CSF leak or fistula

Lumbar spinal drain, serial lumbar puncture, or external ventricular drain placement may be used as options to promote spontaneous resolution of CSF leak or as adjuncts to surgical repair. Repair of the leak or fistula may require surgical exploration of the anterior cranial fossa, the temporal bone, and/or sinuses to identify the CSF leak and seal it.

F.2.c.2 Ventricular shunting

Definition and background

The treatment of hydrocephalus may require ventricular shunting. Even though ventricular shunting is frequently regarded as a routine procedure, clinicians should recognize the possibilities of mechanical, biological, or technical complications. See complications listed below. 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 the methods of long-term follow up management. A recent advancement in this type of intervention includes the use of programmable shunt valves. This treatment may require periodic reprogramming of the shunt valve and is a generally accepted procedure. Refer to section F.3.k, Post-traumatic hydrocephalus.

Supporting literature and evidence tables

Studies not resulting in evidence statements

A 2017 study reported that patients meeting the criteria for ventricular shunt, based on diagnostic criteria and clinical findings, demonstrated significant increases in outcomes at discharge when the shunt was placed earlier in the first 69 days (Kowalski, Weintraub, Rubin, Gerber, & Olsen, 2018; Weintraub, Gerber, & Kowalski, 2017).

Complications

Complications for ventricular shunt placement have been reported up to 12%. These include but may not be limited to:

- Later seizures may be related to shunt placement. Thus, longer prophylaxis may be indicated;
- Hemorrhage;
- Delayed wound closure;
- Infections;
- Shunt malfunction or failure and the need for revisions.

Indications/recommendations for ventricular shunt placement

- Progressive ventriculomegaly not due solely to cerebral atrophy and symptoms of hydrocephalus, such as nausea, headache, and unexplainable hypertension.
- A triad of gait apraxia, persistent cognitive impairment especially abulia and/or akinesia, and incontinence.
- Clinical plateau or decline.
- Persistent and/or prolonged disorder of consciousness without explainable anatomical evidence for such and with coinciding progressive ventriculomegaly on imaging.
- Following a high-volume lumbar puncture, elevated CSF pressures and/or transient improvement in the patient's clinical status.

F.2.c.3 Ventriculostomy

- Control of ICP.
- Acute hydrocephalus
 - Obstructive.
 - Communicating (usually with sub-arachnoid hemorrhage).

F.2.d Extracranial soft tissue

- Debridement and closure.
- Plastic or reconstructive.

F.2.e Maxillofacial

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

F.2.f Cranial nerve decompression or repair

F.2.f.1 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, then 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.

F.2.f.2 Other cranial nerve repair or decompression

This may be required for functionally disabling conditions such as diplopia.

F.2.g Ophthalmologic

- Direct trauma to globe and/or orbital contents.
- Repair orbital fractures, decompression of orbital contents.
- 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.
- Strabismus: Surgery may be required to eliminate or decrease diplopia. Individuals may require several revision operations to achieve maximal results.

- Vitrectomy may be indicated in cases of vitreous hemorrhage.
- Surgery may be indicated in cases of eye-lid abnormalities, lacrimal disorders, and other traumas to the external ocular structures.

F.2.h Orthopedic

- Fracture management.
- Adjunctive tenotomies and myotomies.
 - Common upper extremity procedures may require pre-surgical evaluation inclusive of occupational therapy, physical therapy, ROM, function, diagnostic nerve blocks, and dynamic EMG. Definitive procedures include, but are not limited to:
 - Shoulder muscle release;
 - Functional elbow release: brachioradialis myotomy, biceps lengthening, and brachialis lengthening;
 - Fractional lengthening of wrist and/or finger flexors;
 - Flexor digitorum superficialis (FDS) to flexor digitorum profundus (FDP) transfer;
 - Intrinsic muscle contracture release;
 - Surgical release of thenar muscles for thumb-in-palm deformity;
 - Individualized and customized procedures for spastic upper extremity deformities with adjunctive selective musculotendinous transfers, neurotomy, and neurectomies.
 - Common lower extremity procedures include, but are not limited to:
 - Fractional muscle lengthening of knee flexors/hamstrings;
 - Hip flexor releases/myotomies;
 - Percutaneous vs. open release of the hip adductors;
 - Percutaneous tendon Achilles lengthening;
 - Ankle/foot motor balancing surgery adjunctive to tendon-Achilles lengthening (TAL procedure) includes: (1) toe flexor release, (2) split anterior tibial tendon transfer (SPLATT procedure), (3) inter-phalangeal joint fusions, and (4) ankle fusions;

symptoms. Use should be reserved for cases with documented progressive hearing loss and/or progressive vestibular damage.

- Repair of superior canal dehiscence: This is an uncommon condition that occurs when a congenital defect becomes symptomatic. This may occur after a head injury. Symptoms include vertigo and sound distortion (from conductive hyperacusis).

F.2.i.4 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 neuro-otologist and a neurosurgeon. There are several approaches, but the final step is sectioning the vestibular nerve as it exits the brainstem. Being destructive in nature, it is not indicated in bilateral disease. This procedure has been largely supplanted by gentamicin perfusion for first-line ablation. It can be utilized when other ablative procedures fail to control symptoms. Use should be reserved for cases with documented progressive vestibular damage.

F.2.j Peripheral nerve injury

- May include decompression and repair and/or fracture management.

F.2.k Skull

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

F.2.l Spasticity

- Spinal cord procedures, including percutaneous and open selective dorsal rhizotomy (SDR).
- Intrathecal baclofen (ITB) pump: The pump is surgically implanted in the abdomen. (Refer to Section F.4.j, Muscle tone and joint restriction management, including spasticity, under recommendations for Intrathecal baclofen drug delivery.)
- Other “tone management” procedures.

F.2.m Vascular injury

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

F.3 Complications

The following are listed in alphabetical order.

F.3.a Cardiopulmonary complications

F.3.a.1 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, paroxysmal sympathetic hyperactivity, or hyperadrenergic syndrome (autonomic storm) includes fever, hypertension, tachycardia, tachypnea, posturing, 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 should carefully consider the potentially negative cognitive, behavioral, and/or emotional side effects of those medications.

F.3.a.2 Pulmonary system

M/S TBI and related trauma to the chest wall may adversely affect respiratory function by compromising respiratory drive, swallow function, 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 hygiene.

F.3.b Dental, oral, and jaw complications

Individuals may have oral, mandibular, and/or dental problems that are a direct result of the TBI, secondary to it, or iatrogenic. These involve issues with dental hygiene, dental decay, the temporomandibular joint (TMJ), jaw range of motion, bruxism, and xerostomia. Complications include, but are not limited to:

- impaired ability to maintain desired hygiene effectiveness;
- impaired ability to remove and insert removable prosthetics;
- altered oral sensation; oral sensation may be decreased, and normal sensations may be perceived as painful;

- impaired proprioception, motor control, or strength of teeth, soft palate, tongue, and/or lips. This could affect oral articulation for speech, control of food and liquid in the oral cavity, and chewing ability and efficiency;
- premature bone loss, periodontal disease, premature restoration failure, premature tooth loss, and peri-implantitis;
- xerostomia, which is caused by many medications and can lead to higher rates of decay and tooth loss.

Success of dental treatment is evaluated by the ability to chew, speak, and swallow. Esthetics and oral articulation are integral to speaking comfortably. When recovering from a TBI, the ability to eat healthy foods in quantities large enough to maintain or increase weight can improve morale and improve success of therapy. Thus, referral is appropriate for diagnosis and treatment.

Possible interventions include, but are not limited to:

- There may be a need for electric brush, flossing, aids, topical fluoride (varnish and trays), and/or medicated rinses.
- Fixed prosthetics may be a necessity.
- If TBI is associated with facial trauma, orthodontics and orthognathic surgery may be required to align the jaw bone prior to dental reconstruction.
- Other interventions recommended by the dentist, orthodontist, oral surgeon, and speech-language pathologist.

F.3.c Fluid and electrolyte complications

Abnormalities in individuals with M/S 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 diabetes insipidus (DI) may occur. This may require careful evaluation with laboratory studies initially and serially on a follow-up basis.

F.3.d Gastrointestinal complications

Individuals with M/S TBI have demonstrated delays in gastric emptying with frequent regurgitation of nasogastric administered feedings. This, accompanied with dysphagia, places 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 an endoscopically placed percutaneous (PEG) 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 and acid reflux / GERD may be a

frequent complication, and the use of H2 blockers, proton pump inhibitors (PPIs), and antacid treatments are usually efficacious. Individuals with TBI may also be at risk for neurogenic bowel, which includes 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.

F.3.e Genitourinary complications

M/S 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 / adult brief is used for incontinence.

Following assessment of bladder emptying utilizing ultrasonography for post-void residual checks and urodynamic studies, 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 may also be necessary; they may include, but are not limited to: cystoscopy, urodynamics, and renal functions studies.

Sexual dysfunction may also occur, secondary to M/S TBI. Examples include disinhibition, arousal disorders, and erectile dysfunction. If present, comprehensive assessment is appropriate in guiding therapeutic management.

F.3.f Immobilization and disuse complications

In an immobile individual, skin is at risk for the development of pressure decubitus ulcers that may slowly progress and increase the length of hospital stays. Tissue pressure, shear, and deformation cause the ischemia. Vigilant rehabilitation nursing protects the individual from these complications, including accurate staging, specialized beds, wheelchair cushions, padding, positioning, and weight shift management.

F.3.g Musculoskeletal complications

F.3.g.1 Long-bone fractures

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. Fixation may be external or internal with surgery.

F.3.g.2 Heterotopic ossification (HO)

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 11–75% following M/S TBI (Harrington, Blount, & Bockenek, 2008). If diagnosis and treatment are delayed, ankylosis (bony fusion) may occur with consequent functional limits in mobility. The greatest risk for development is within the first six months post-injury. Observation by nurses, physical therapists, and occupational therapists is essential and may include documentation of decreased ROM, joint inflammation, pain, 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, MRI, 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.

F.3.h Neuroendocrine complications

Neuroendocrine abnormalities following M/S TBI are common and may occur during the acute or rehabilitation stages (Tritos, Yuen, & Kelly, 2015). Hypopituitarism occurs in approximately 28% of all TBI and although more common in M/S TBI, may also occur in mTBI with a rate approximating 17% (Schneider, Kreitschmann-Andermahr, Ghigo, Stalla, & Agha, 2007). It is estimated that one-third of patients with TBI have persistent anterior pituitary disorders. Older age, TBI severity, and skull fractures are more commonly associated with these lesions (Lauzier, 2014). 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. Pharmaceutical treatment for other complications may also affect endocrine systems and require treatment.

F.3.i Neurological complications

Often, ongoing evaluation is necessary to detect the delayed development of space occupying intraparenchymal lesions, pneumocephalus, hydrocephalus, hygromas, and extra-axial lesions

such as subdural and epidural hematomas. If an individual's neurological status worsens or plateaus, neuroimaging studies may be warranted.

F.3.j 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 after seven days remains controversial in high-risk individuals. For acute management, refer to Section F.1.d.3, Anti-epileptics.

F.3.k Post-traumatic hydrocephalus

Post-traumatic hydrocephalus (PTH) is a common complication following severe TBI with an incidence as high as 45%. It is either the result of blockage or inadequate passage of CSF within the ventricular system of the brain (non-communicating) or, most commonly, malabsorption of CSF back into the ventricular system of the brain (communicating). If not recognized, this complication may interfere with optimal recovery. PTH is treatable with CSF diversion and ventricular shunting. It may be difficult to differentiate the clinically significant symptoms of PTH from the disabling primary TBI-related symptoms that patients experience. It is also challenging for the clinician to differentiate the imaging characteristics of clinically significant PTH from ventriculomegaly (enlarged ventricles) due to atrophy - a condition referred to as hydrocephalus ex vacuo. Refer to section F.2.c.2, Ventricular shunting.

F.3.l Sleep complications

Disturbances of sleep is appropriate to consider for patients with M/S TBI as well as mTBI. Refer to Section F.4.o, Sleep disturbances, for more information including indications and time frames.

F.3.m 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, intermittent compression devices (ICDs), or sequential compression stockings may reduce the incidence of both complications. If the diagnostic use of the mentioned noninvasive studies are equivocal and/or non-confirmatory, 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. Other newer pharmaceutical agents may also be appropriate. 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 appropriate for some patients.

Referenced Version

F.4 Specific treatments

The following procedures are listed in alphabetical order.

F.4.a Activities of daily living (ADLs)

Definition and background

ADLs are also referred to as daily living skills, life skills, or living skills. These are tasks necessary for an individual's day-to-day functioning, including both basic and instrumental level tasks.

- **Basic ADLs:** These include daily activities that tend to be repetitive, routine, and that may be gained more readily through procedural learning, such as grooming, maintaining personal hygiene, bathing/showering, toileting, dressing, feeding/eating, and using basic social skills.
- **Instrumental ADLs (IADLs):** IADLs include a wide range of activities that require higher level cognitive skills, including the ability to plan, execute, and monitor performance and the ability to 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).

By including ADLs in treatment, cognitive improvements may occur through the application of cognitive rehabilitation principles to the task performance. Likewise, physical deficits may be improved by applying neuromuscular rehabilitation principles to the task performance.

ADL functional limitations and disabilities in ADLs are common following TBI and are often due to changes in physical, cognitive, and emotional/behavioral abilities. Functional limitations and disability in these areas may range from mild to severe and from short-term to life-long.

Supporting literature and evidence tables

Evidence statements regarding activities of daily living			
Good evidence	Evidence statement	Citation	Design
	In the stroke population, occupational therapy provides a modest reduction in disability and risk of death.	([Cochrane] Legg, Drummond, & Langhorne, 2006)	Meta-analysis of randomized clinical trials

Indications/recommendations for M/S TBI ADLs training

Therapeutic intervention is generally accepted and widely used to improve performance of ADLs. The goal of treatment is to improve one's ability to perform daily tasks in order to increase functional levels of independence. All treatment should be interdisciplinary.

Treatment in sub-acute and acute rehabilitation is provided by one or more therapeutic disciplines, including occupational therapy, physical therapy, speech therapy, social work, family counseling, psychology, nursing, and/or vocational rehabilitation as tolerated. In post-acute settings, either 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; or (3) the individual is unable to participate in treatment due to medical, psychological, or social factors. When the skilled services are no longer needed for any of those reasons, the patient should be appropriately transitioned to self-care or other care.

The results of treatment intervention provided throughout the continuum of progress beginning with acute care may not be realized until the final stages of integration back into the individual's community setting. 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.

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

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).

To alleviate the effects of the injury on the performance of ADLs, standard equipment 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.

As new goals are developed, therapy may be re-initiated for time limited, goal-specific treatment.

Time frames

Time frames regarding M/S TBI ADLs training	
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 1 month, with ongoing progress noted over a longer period, which may last up to 2 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	Up to daily, depending on the individual’s progress. Sessions may vary from 1 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 or the need for maintenance to retain ADLs.

F.4.b Behavior

Definition and background

The neuropathological deficits occurring in TBI often result in behavioral changes and deficits in the skills needed to: (1) monitor and control one’s behavior; (2) interpret the behavior of others; and (3) respond effectively to social situations. Functional limitations and behavioral disabilities include: deficits regarding functional skills, insight judgment, self-monitoring, and behavioral and

emotional regulation. These may be compounded by secondary emotional reactions such as depression or anxiety.

Behaviorally-based therapies rely on an interdisciplinary treatment team approach and are frequently implemented in conjunction with cognitive and/or other psychological treatment.

Post-traumatic neurologically-based behavioral problems may be exacerbated by comorbidities such as personal history, personality issues, family and/or support system issues, psychiatric illnesses, cognitive impairment, medication side effects, and substance abuse. TBI may be a risk factor for alcohol or other substance abuse. Successful resolution of behavioral problems will usually require treatment of these associated comorbidities. Behavioral problems are also influenced by developmental issues. Treatment requires appropriate consideration of developmental and life stage issues (i.e., adolescent, elderly).

Treatment may require specialized settings with professionals experienced in the management of these patients. Depending on the severity of the behavior problem, treatment may require focused, applied behavioral analysis available only in a specialized rehabilitation or psychiatric setting. In less severe situations, applied behavior analysis can be provided in outpatient and community settings. The setting of treatment should consider individual resources and circumstances. Inpatient and outpatient settings may require one-on-one supervision at critical phases of recovery. Treatment consistency across all environments is an important variable in the behavioral treatment outcome. Therefore, it is essential to coordinate treatment resources and professionals and to train the family and/or support system and other caregivers in the behavioral plan.

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 factors and learned behavior relations.

Effective behavioral management and treatment requires individualized approaches. Behavioral analysis and treatment involves:

- identification and prioritization of undesirable or negative target behaviors to be managed or extinguished;
- identification of behavioral strengths and positive/desirable target behaviors (frequently called alternative, competing, or replacement behaviors) to be encouraged and positively reinforced;
- analysis and modification of environmental variables to reduce antecedents or precursors of maladaptive behaviors (i.e., loud noise, crowds, requests to do non-preferred activities, changes in daily routines);

- analysis and modification of internal precursors of maladaptive behaviors (i.e., pain, sleep-deprivation, anxiety, helplessness, depression, thought disturbance) and environmental issues to reduce antecedents or precipitants of maladaptive behaviors;
- analysis of the function of maladaptive behavior and developing strategies that replace the need to engage in maladaptive behavior (i.e., teaching and reinforce asking for assistance instead of yelling or aggression);
- progressive refinement of the strategies of internal and environmental modifications in response to an analysis of changes in behavior;
- extensive training and monitoring of treatment plan adherence for all treating staff and family and/or support system interacting with the patient during neurobehavioral interventions;
- behavioral changes are preferably monitored using validated tools (Prouteau, Stefan, Wiart, & Mazaux, 2016).

Supporting literature and evidence tables

The following recommendations are based on consensus.

Indications/recommendations for behavior

Behavioral therapy is well-accepted and widely used for TBI. It acknowledges that behavioral problems are always multi-factorial, and therefore, treatment should consider medical, neurosurgical, neurological, psychiatric, environmental, and psychosocial issues.

A behavioral therapy plan should be approved and monitored by a neuropsychologist, psychologist, behavior analyst, or physician familiar with TBI. Progress should be re-evaluated and documented every four weeks. (Refer to Section B, General guideline principles.)

Time frames

As with the behavioral therapy plan described above, time frames should be approved and monitored.

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, behavior analyst, or physician familiar with TBI. Progress should be re-evaluated and documented every 4 weeks. (Refer to Section B, General guideline principles.)

F.4.c Brain stimulation therapies

F.4.c.1 Deep thalamic stimulation

Definition and background

This technique has been used in some cases of stroke with motor and cognition problems.

Supporting literature and evidence tables

There are no studies reported on patients with TBI.

Indications/recommendations for deep thalamic stimulation

It is considered investigational at this time and generally *not recommended*. It may be used for patients with severe spasticity or motor problems who have failed other treatments.

F.4.c.2 Transcranial magnetic stimulation

Definition and background

This noninvasive treatment and exploratory diagnostic tool is FDA approved for use in major depression that is resistant to other therapy.

Supporting literature and evidence tables

There is no evidence for its use in TBI.

Complications

Some patients have experienced seizures as a side effect.

Indications/recommendations for transcranial magnetic stimulation

It is *not recommended* for TBI or for patients who are comatose or vegetative. It is considered experimental for these conditions. Refer to section F.4.n, Psychological interventions, for use of repetitive transcranial magnetic stimulation (rTMS) in treatment-resistant depression.

F.4.d Cognitive treatment

Definition and Background

In individuals with M/S TBI, rehabilitation of cognitive deficits is appropriate, clinically necessary, and based on evidence.

“Cognitive rehabilitation is a systematic, functionally oriented service of therapeutic cognitive activities, based on an assessment and understanding of the person’s brain-behavior deficits. Services are directed to achieve functional changes by (1) reinforcing, strengthening, or reestablishing previously learned patterns of behavior, or (2) establishing new patterns of

cognitive activity or compensatory mechanisms for impaired neurological systems” (Harley et al., 1992).

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.

Deficits in cognition are a frequent result of TBI. They may persist and may vary from mild to severe. There may be deficits involving self-awareness, or the “process of knowing,” by which individuals: (1) effectively or efficiently attend to or engage in their environment, (2) make decisions as to the most functional ways of interacting with their environment, (3) execute those decisions, (4) monitor their responses to determine appropriateness and accuracy of their decisions, and (5) adjust their behavior if it is determined to be inappropriate and/or inaccurate.

Rehabilitation is most beneficial when an individual demonstrates adequate arousal, appropriate responsiveness to stimulation, and at least a minimum ability to focus attention. Prior to demonstration of these skills, rehabilitation efforts should focus on monitoring and attempting to elicit responses, structuring the environment (e.g., maintaining a normal sleep/wake cycle), and educating staff and family and/or support system.

A treatment plan outlining current functional 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 or TBI-related problems develop.

A cognitive therapy plan should be approved and monitored by a speech-language pathologist, rehabilitation psychologist, neuropsychologist, or physician experienced with TBI. Physicians may also be involved in pharmacological treatment and management of cognitive disorders. Rehabilitation treatment for cognitive deficits may be provided by speech-language pathologists, neuropsychologists, occupational therapists, music 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). Family and/or support system members, caregivers, and partners should always be included in the therapy plan. Thus, therapy is routinely multi-disciplinary for patients with M/S TBI.

All cognitive rehabilitation should focus on functional goals relative to the individual patient’s needs to perform activities of daily living and work. Tasks are improved through three steps according to the Cognitive Rehabilitation Manual by the American Congress of Rehabilitation Medicine (Haskins, 2012):

1. Acquisition: Identification of the goal and tools necessary to achieve the goal,

2. Application: Learning the strategy with repetition, and
3. Adaptability: Demonstrating the use of these skills in a variety of applicable daily activities, including generalization of learned strategies or procedures to new settings and transfer of training to similar tasks.

Strategies for achieving goals are generally broken down into the major areas of memory, attention, executive function, and social communication. In addition, anger management may also improve through training a patient in cognitive labeling of arousal and subsequent possible responses.

Examples of training techniques from the manual include:

- Executive function: problem solving strategies, self-monitoring of results, correcting mistakes, and dealing with frustration;
- Memory: use of external sources such as schedules and smartphones, and use of other sources such as family and caregivers;
- Attention: working with time pressure management, persistence, multiple task demands;
- Social communication: Learning to recognize a conversational partner's linguistic or facial cues, interpreting verbal and nonverbal messages, setting time limits on talking while in a conversation, attending to other's responses. Refer to Section F.4.e, Communication, for details.

The INCOG Guidelines for Cognitive Rehabilitation Following Traumatic Brain Injury (Bayley et al., 2014) also discuss therapy recommendations in their published series on attention and information processing speed (Ponsford et al., 2014), executive function and self-awareness (Tate et al., 2014), cognitive communication (Togher et al., 2014), and memory (Velikonja et al., 2014).

Supporting literature and evidence tables

Evidence statements regarding M/S TBI cognitive therapy			
Good evidence	Evidence statement	Citation	Design
	Cognitive training has small to moderate positive effects in improving cognitive and functional outcomes in patients with mild to severe TBI who are at least 1-year post-acute TBI when compared to waiting list controls or standard rehabilitation.	(Hallock et al., 2016)	Systematic review and meta-analyses of randomized clinical trials
	Structured, goal-oriented, individualized multidisciplinary cognitive rehabilitation for patients requiring hospitalization improves mobility, personal care, and independence in ADLs for individuals with TBI. This type of multi-disciplinary rehabilitation of patients with M/S TBI is likely to provide functional and symptomatic benefit once the patient is able to participate.	(Turner-Stokes, Disler, Nair, & Wade, 2005)	Systematic review of randomized trials, quasi-randomized trials, and quasi-experimental studies

Evidence statements regarding M/S TBI cognitive therapy

Some evidence	Evidence statement	Citation	Design
	<p>Intensive therapy - 15 hours/week for 16 weeks - in a group setting emphasizing integration of cognitive, interpersonal, and functional gains is superior to the same amount of therapy from multiple individual providers for severe TBI.</p>	<p>(Cicerone et al., 2008)</p>	<p>Randomized clinical trial</p>
	<p>From an older study of young military patients with M/S TBI who could safely live at home without continual supervision: Psychological treatment in a supported home environment had similar results to inpatient multidisciplinary treatment.</p> <p>Note: This program is not recommended for patients with work related injury as the population in this study differs from the work related injury population.</p>	<p>(Salazar et al., 2000)</p>	<p>Randomized Clinical Trial</p>

Evidence statements regarding M/S TBI cognitive therapy

Some evidence, continued	Automated, audiovisual prompts and reminders delivered on home television were more effective in increasing the number of tasks completed than using self-selected or typical reminder strategies for persons with moderate to severe acquired brain injury needing to compensate for memory failures.	(Lemoncello, Sohlberg, Fickas, & Prideaux, 2011)	Randomized controlled crossover trial
	A cognitive program aimed at high order reasoning instruction is likely to improve some aspects of executive function (e.g., working memory, inhibition, switching tasks) for individuals with chronic TBI.	(Vas, Chapman, Cook, Elliott, & Keebler, 2011)	Randomized clinical trial
	A multi-faceted cognitive rehabilitative intervention focused on aspects of executive function can lead to lasting improvement. In this study, group treatment sessions occurred twice per week for 1 hour over a period of 3 months and were focused on self-awareness, self-initiation, goal setting, planning, flexibility, strategic behavior, self-monitoring, and self-inhibition.	(Spikman, Boelen, Lamberts, Brouwer, & Fasotti, 2010)	Randomized clinical trial

Evidence statements regarding M/S TBI cognitive therapy

Some evidence, continued	Video feedback training in addition to verbal feedback significantly improved intellectual self-awareness in M/S TBI participants compared with verbal feedback alone and with no feedback after 4 training sessions.	(Schmidt, Fleming, Ownsworth, & Lannin, 2012)	Double-blind randomized clinical trial
	8 weeks of occupational therapy training in the use of a personal digital assistant provided significant improvements in patients' daily memory function and decreased functional memory failures compared with standard memory training that uses non-electronic memory aids in participants with moderate to severe acquired brain injury.	(Lannin, 2014)	Randomized clinical trial
	Up to 8 telephone counseling calls focused on independent problem solving over 1 year was no more effective than usual care on improving function, health/emotional status, community/work activities, and well-being at 1 and 2 years after moderate TBI.	(Bell et al., 2011)	Single-blind randomized clinical trial

Evidence statements regarding M/S TBI cognitive therapy			
Some evidence, continued	Patients with a history of a severe TBI (characterized by 24 hours or more of post-traumatic amnesia) are better equipped to plan a complex task such as organizing a vacation when they are asked in a structured way to recall a time in their personal history when they successfully planned a complex task, such as organizing a move to a new place to live (i.e., autobiographical cueing).	(Cicerone et al., 2011)	Systematic review of clinical trials and observational studies

Studies not resulting in evidence statements
There is inadequate evidence to support that computerized cognitive rehabilitation adds any benefits over conventional rehabilitation for patients with mild to severe TBI or stroke (Bogdanova, Yee, Ho, & Cicerone, 2016; Haskins, 2012; Ponsford et al., 2014).

Indications for M/S TBI cognitive treatment

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

Cognitive processes that are often impaired after TBI and targeted for treatment may include, but are not limited to:

- arousal and attention;
- processing of information (rate, amount, and complexity);

- perception of sensory (auditory, visual, olfactory, and tactile) information;
- verbal and written expression;
- auditory and reading comprehension;
- acquisition, retention, and retrieval of verbal and visual information, which impairs new learning and memory skills;
- executive functioning skills: problem solving, insight, reasoning and judgment, self-awareness and evaluation (including awareness of strengths and weaknesses), goal setting, planning, organizing, initiation, self-inhibiting (or disinhibition and self-monitoring);
- social awareness and behavior.

Recommendations for M/S TBI cognitive treatment

Based on the evidence listed above, cognitive treatment is recommended for patients with cognitive impairment.

Services are directed to achieve functional changes by (1) reinforcing, strengthening, or reestablishing previously learned patterns of behavior, or (2) establishing new patterns of cognitive activity or compensatory mechanisms for impaired neurological systems (Harley et al., 1992).

Computer-based treatment with active therapist involvement: Computer-based treatment must be accompanied by oversight from the treating provider either in person or by telehealth. Integrated computer-based treatment (i.e., both individualized cognitive and interpersonal therapies) may improve functioning within the context of an interdisciplinary, neuropsychological 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. Computer-based treatment is ***not recommended in isolation***.

Computer-based treatment without active therapist involvement: Sole reliance on repeated exposure and practice on computer-based tasks without extensive involvement and intervention by a therapist is ***not recommended***. 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.

Assistive technology: A variety of devices are available to assist individuals with language and functional problems. These should be trialed within a rehabilitation therapy program by physical therapists, occupational therapists, and speech-language therapists to determine which tools are most suitable for individual cases.

Time frames

Time frames regarding M/S TBI cognitive treatment	
Frequency	Acute and post-acute – daily. Sub-acute outpatient and home/community setting – daily to weekly.
Optimum duration	Typically 8 weeks with evaluation at the 4-week mark.
Maximum duration	Beyond 8 weeks requires documentation of progress with the exception of periodic consultations and new treatment goals.

F.4.e Communication

Definition and background

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.

- Motor speech disorders
 - Dysarthria

Dysarthria is a reduction in speech intelligibility due to weakness and/or incoordination of the speech musculature secondary to a 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 or 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).

- Apraxia of speech

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 produce any functional speech volitionally.

- Voice disorders

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

- 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, ranging from very mild difficulty with word finding (anomia) to global impairment involving severe impairment in all language areas.

- 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 skills as well as impairments in non-linguistic cognitive functions (e.g., perception, attention, discrimination, organization, reasoning, memory, and self-regulation) interfere with communication of basic needs and communication in wider social contexts.

Social communication skills, also known as pragmatic language skills, encompass the meaning and use of language and other behavior in social situations. They include the interpretation of contextual clues, non-verbal communications, and other interpersonal skills. Social communication skills training is also appropriate for these cases.

Aprosodia is characterized by difficulty understanding or expressing oneself using prosody (i.e., the elements of speech that include variations in rhythm, pitch, stress, intonation, melody, pauses, and intensity). It is common following damage to the right

hemisphere. It influences verbal expression or comprehension of attitudes, emotions, or communicative intent.

Supporting literature and evidence tables

Evidence statements regarding speech-language disorders and treatment			
Strong evidence	Evidence statement	Citation	Design
	Patients who have had a TBI are likely to have deficits with respect to processing and expressing the social aspects of verbal communication, such as recognizing the emotional content of utterances on the basis of voice tone and other variables.	(Ilie, Cusimano, & Li, 2017)	Systematic review of observational studies
Good evidence	Evidence statement	Citation	Design
	Many patients with TBI may have difficulty with respect to the recognition and expression of emotional markers of verbal communication even though they score within normal limits on standardized tests of verbal comprehension.	(Ilie et al., 2017)	Systematic review of observational studies
Some evidence	Evidence statement	Citation	Design
	Group instruction, 90 minutes weekly over 12 weeks, by a skilled leader, results in improved communication skills for patients with M/S TBI.	(Dahlberg et al., 2007)	Randomized clinical trial

Studies not resulting in evidence statements

There is insufficient evidence to support or refute the use of oral-motor exercises to affect change in speech physiology, production, and functional outcomes (McCauley, Strand, Lof, Schooling, & Frymark, 2009; [Cochrane] Mitchell, Bowen, Tyson, Butterfint, & Conroy, 2017).

Aphasia, ranging from mild to severe, is common following TBI, and intensive language action or constraint therapy is likely to achieve benefits in both quantitative measures and qualitative patient and caregiver reported outcomes (Meinzer et al., 2004; Norman et al., 2013).

Indications/recommendations for cognitive-communicative treatment

Speech-language therapy is well-accepted and widely used. Music therapy may be appropriate for some patients.

Certified speech-language pathologists are qualified to identify, evaluate, 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 who are 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 among 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. Non English speakers should have a speech-language pathologist who speaks the native language of the patient, when possible. The evaluation includes:

- a collaborative goal-setting discussion identifying realistic functional goals and recommendations. Goal setting should include the individual and their family/support system and consider the pre-morbid level of function;

- a thorough review of relevant medical and social history;
- a comprehensive assessment of communication skills including standard and non-standard 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;
- estimated 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 these approaches, depending on individual needs.

There is insufficient evidence to recommend specific types of therapy ([Cochrane] Kelly, Brady, & Enderby, 2010).

- As there is insufficient evidence to support or refute the use of oral-motor exercises (see studies listed above), clinicians should consider what a particular oral motor activity is likely to accomplish and if it addresses the impairment.
- Treatment for language impairment is acceptable, including approaches such as intensive language action therapy or constraint therapy (Meinzer et al., 2004).
- Melodic Intonation Therapy is a structured therapy that trains verbal reproduction with melodically intoned phrases while tapping the patient's hand. A number of case series have supported its use in cases with non-fluent aphasia and/or auditory communication deficits when there is minimal or no damage to the right hemisphere. The therapy can take place as late as six months or longer after injury (van der Meulen, van de Sandt-Koenderman, & Ribbers, 2012). It is often done 3–5 hours per week for six weeks.

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 choosing from these techniques or devices and the training in their use is integrated into the individual’s ongoing evaluation and therapy plan.

Time frames

For M/S TBI, the following are recommended guidance:

Time frames regarding cognitive-communicative treatment	
Frequency	(1) Acute setting – once to twice daily sessions; (2) Sub-acute or outpatient and home/community setting – 1 to 5 sessions per week.
Optimum duration	12 weeks with re-evaluations at 4-week intervals. A minimum of 24 sessions for M/S TBI.
Maximum duration	Intervention beyond 8 weeks requires documentation of continued functional progress towards established goals. Post-acute therapy could extend for 6 to 12 months, or more, if the individual with TBI has significant speech impairment and is making gradual documented improvement.

Ongoing reassessment and modification of therapy approaches is a part of skilled therapy. It is especially necessary with the dynamic nature of communication impairments that occur 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 should be flexibility in frequency, intensity, and duration of treatment. Many cases require follow-up visits at various points to assist individuals with changes in their life, such as increasing job demands.

F.4.f Complementary and integrative treatment (CIT)

Definition and background

CIT is a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medical care (National Center for Complementary and Integrative Health (NCCIH), 2016). It includes a wide range of interventions and uses methods of treatment based on a broad range of knowledge with roots in both eastern and western medicine. These integrative treatments include, but are not limited to: art therapy, craniosacral trauma release, EEG neuro feedback, dance therapy, hippotherapy, hypnosis, and horticulture therapy. Many providers may combine procedures. 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.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for CIT

Integrative therapies should not be employed as the primary treatment modality, but they 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, when shared decision making has occurred, and when treatment goals are directed to documentable, functional improvement.

Some therapies that are listed as integrative by NCCIH are considered conventional in the Division's guidelines. Examples include: acupuncture, biofeedback, and cervical spinal manipulations. These are widely accepted and may be used for headaches or other painful conditions. They do not require prior authorization. (Refer to Sections G.1, Acupuncture, G.2, Biofeedback, and G.19.d, Manual treatment including manipulation, in the Division's Chronic Pain Disorder Medical Treatment Guideline). CIT therapies that are not addressed in the Division's guidelines **always require prior authorization.**

Time frames

Time frames regarding complementary and integrative treatment (CIT)	
Time to produce effect	3 to 6 treatments.
Optimum duration	4 to 6 weeks.

Time frames regarding complementary and integrative treatment (CIT)	
Maximum duration	Not well-established for CIT and should be based on specific CIT treatment, physician's clinical judgment, and demonstration of positive symptomatic and functional gains.

F.4.g Education

Definition and background

Formal treatment team conferences involving the individual with TBI, family and/or support system, and case managers (including insurance case manager) should be held regularly during the inpatient, residential, neurobehavioral, and outpatient phases of rehabilitation and periodically during the home and community-based phases of community reintegration.

Education may include, but may not be limited to: brain-behavior relationships, health issues related to TBI and comorbid illnesses or injury, family and/or support system interventions, emotional adjustments, and family and/or support system roles changes. Families and/or support systems and individuals with TBI require education, support, and caregiver training as part of the long-term maintenance plan. Considerations of treatment for grief/loss may be a variable that complicates clinical progress. Education for the individual and family and/or support system can be provided by case managers, social workers, rehabilitation counselors, family counselors, licensed mental health professionals, therapists, psychologists, and/or nurses.

Supporting literature and evidence tables

The following recommendations are based on consensus.

Indications for education

Education for the patient and for the patient's family and/or support system is indicated for all patients with TBI. Family and/or support systems may also benefit from education without the patient.

Recommendations for education

Education for individuals with TBI and their family and/or support system is appropriate, generally accepted, and widely used in TBI rehabilitation (Management of Concussion-Mild Traumatic Brain Injury Working Group, 2016).

Time frames

Time frames regarding education	
Frequency and duration	May require daily 1-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.

F.4.h Medications

The use of medications requires careful monitoring and collaboration between the individual, physician, family and/or 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.) (Refer to the Division’s Chronic Pain Disorder Medical Treatment Guideline.);
- sensory alterations (dysesthesias);
- motor symptoms (motor control, coordination, spasticity, weakness, Parkinsonism, tremor, etc.);
- mood disorders (depression, mania, anxiety, etc.);
- affective disorders (inappropriate social responses usually due to frontal lobe damage);
- behavioral problems (poor self-monitoring, disinhibition, irritability, aggression, poor initiation, etc.);
- cognitive issues (arousal, attention, speed of processing, memory, executive function);
- psychotic symptoms (disturbances of thought content such as hallucinations and delusions, thought process, and thought disorganization, which can contribute to behavioral problems);
- neurological issues (seizures, paroxysmal sympathetic hyperactivity, etc.);
- disturbances of sleep (insomnia, hypersomnia, sleep-wake cycle reversals);

- endocrine dysfunction. (Refer to Section F.3.h, Neuroendocrine complications.)

There is no single formula for pharmacological treatment of patients with acute, sub-acute, or chronic problems due to TBI of any level of severity. Clinical pharmacists can provide useful guidance in medication selection.

A thorough medication history, including use of alternative and over-the-counter medications, should be performed initially and when medication changes are made. The medication history may consist of gathering corroborating information from caregivers and prescribing pharmacies, particularly if the individual has memory or other deficits which may impair ability to accurately report medications and adherence to the prescriber.

Appropriate application of pharmacological agents depends on the patient's age, past history (including history of substance abuse), drug allergies, and all medical problems. It is incumbent upon the health care provider to thoroughly understand pharmacological principles when dealing with the different drug classes and their respective side effects, drug interactions, bioavailability profiles, and the primary reason for each medication's usage.

Non-pharmacologic interventions should be used in combination with pharmacologic treatments to minimize the amount of medication necessary in patients with all levels of severity of TBI. Patients and their caretakers should be aware that medications alone are unlikely to provide complete symptom relief. A primary goal of drug treatment is to improve the patient's function as measured behaviorally. Essential elements of post-traumatic deficits require continuing participation in rehabilitative programs appropriate to and consistent with the level of recovery and techniques such as cognitive rehabilitation, cognitive behavioral therapy, and other individualized physical and psychological practices, as described elsewhere in this guideline.

Control of chronic post-traumatic deficits, particularly in M/S TBI, is expected to involve the use of medication. Strategies for pharmacological control of post-traumatic symptoms cannot be precisely specified in advance. Rather, drug treatment requires close monitoring of the patient's response to therapy, the prescriber's flexibility, and a willingness to change treatment when circumstances change. This includes lowering and/or discontinuing medications when symptoms improve and periodic trials of lowering medications when symptoms are stable.

Prescribed medications should be given an appropriate trial in order to test for therapeutic effect and tolerance to the medication. The length of an appropriate trial varies widely depending on the drug, as well as the individual and his or her response to the drug. Certain medications may take several weeks to months (e.g., antidepressants) to determine efficacy, while others require only a few doses (e.g., psychostimulants).

It is generally wise to begin management with lower cost medications whose safety and efficacy equals that of higher cost medications and medications with a greater safety profile. Decisions to

progress to more expensive, non-generic, and/or riskier medications are made based on the drug profile, patient/caregiver feedback, and improvement in function.

Many of the drugs discussed in the medication section are FDA approved for other indications but may appropriately be used for various aspects of TBI treatment and associated conditions. When prescribing off-label FDA use of a medication, indications and functional goals should be clearly stated as part of a comprehensive, functionally-based treatment plan. Providers should recall that many medications, whether used on-label or off-label, have not been tested on individuals with TBI.

Drugs of potential abuse, such as sedative/hypnotics or benzodiazepines, should be used sparingly in properly selected patients (e.g., for refractory insomnia), although total elimination of these medications is desirable whenever clinically feasible. It is strongly recommended that such pharmacological management be monitored or managed by an experienced physician. Referral to a specialist experienced in TBI may be necessary.

The clinician should use professional resources to determine dosages, side effects, and drug interactions. The provider should carefully balance the untoward side effects of different drugs with therapeutic benefits, as well as monitor for any drug interactions. A number of medications are not appropriate for women of childbearing age. Problems associated with mild, moderate, and severe TBI can be treated with a variety of medications. However, all have specific side effects and drug-drug interactions of which clinicians should be mindful. Persons who sustain a TBI, particularly M/S TBI, are especially sensitive to central nervous system side effects, such as sedation, dizziness, cognitive impairment, and motor impairment. Usually, starting doses need to begin low and titrating medications need to proceed slowly. Target doses may also be lower than when using these medications in a person without a TBI. It is recommended that patients with chronic post-TBI symptoms who require maintenance medications use those that have the least serious side effects and potential for drug-drug interactions.

The following section is a general summary of the most commonly used medications. SSRIs (selective serotonin reuptake inhibitors) are recommended as first line therapy. Tricyclic antidepressants, dextromethorphan/quinidine or dopaminergic agents can be useful alternatives. Other medications, like antidepressants (venlafaxine, mirtazapine, and lamotrigine), are also used (Wortzel, Oster, Anderson, & Arciniegas, 2008). Specialists should generally be involved for TBI cases requiring multiple medications. Clinicians should refer to informational texts or consult a pharmacist before prescribing unfamiliar medications or when there is a concern for drug interactions.

F.4.h.1 Mood and anxiety disorders medications

These medications are classified into a number of categories based on their chemical structure and their effects on neurotransmitter systems. Their effects on depression are attributed to their actions on norepinephrine, serotonin, and dopamine at the level of the synapse. Although these

synaptic actions are immediate, the symptomatic response in depression is delayed by several weeks.

Pharmacologic treatment for depression and anxiety will need to consider the individual patient's needs and responses (Salter, McClure, Foley, Sequeira, & Teasell, 2016).

- Selective serotonin reuptake inhibitors (SSRIs) or Serotonin-norepinephrine reuptake inhibitors (SNRIs) may be used first line, although there is more data to support the use of SSRIs as first line intervention (Fann, Hart, & Schomer, 2009; Plantier & Luauté, 2016). Doses should be started low and slowly increased with attention to any headache, insomnia, or drowsiness, which could impede cognitive progress.
- Tricyclic antidepressants (TCAs) may also be used; however, some have sedating qualities. (Refer to the Division's Chronic Pain Disorder Medical Treatment Guideline for details, and consider the patient's age when prescribing medications.)

F.4.h.2 Affective disorders medications

Affective disorders can manifest as pathologic crying and laughing. These are not mood disorders and may be provoked by a variety of stimuli. This can be seen in M/S TBI and should be distinguished from depression and mania/hypomania to ensure that the correct medication is used. The initial choice of medications is similar to those for mood and anxiety disorders.

F.4.h.3 Behavior/aggression medications

There are no FDA approved drugs for the treatment of aggression in TBI, but many agents have been shown to possibly have efficacy, including antipsychotics, antidepressants, mood stabilizers, anti-epileptic drugs, and beta blockers.

All medication use should consider the effects on cognition and interaction with other medications. If a medication is started and questionable improvement is seen, consider stopping or tapering the initial drug and trialing another drug. In some cases, adding a second drug may be preferable.

Depending on the likely source of the behavioral problem, amantadine, methylphenidate, dextroamphetamine, or bromocriptine may be used.

- If the behavior is felt to be due to regulation of ventral brain structures, the goal may be to reduce limbic catecholaminergic function and/or dopaminergic overdrive and anatomical systems, which mediate such. Agents that may be used include atypical antidepressants, beta-adrenergic receptor antagonists, SSRIs, anti-epileptic drugs, or amantadine.
- For chronic aggressive behavior, SSRIs or amantadine are first line. Usually anti-epileptic drugs (valproate, oxcarbazepine, lamotrigine or carbamazepine) are trialed. Next, other

adjunctive agents include lithium, buspirone, and beta-adrenergic receptor antagonists or atypical antidepressants (Arciniegas & Wortzel, 2014).

Propranolol is frequently used to treat aggression and agitation. Carbamazepine, oxcarbazepine, lamotrigine, and valproate may be effective for treating agitation and aggression (J. P. Luaute, D.; Wiart, L.; Tell, L., 2016; Plantier & Luaute, 2016).

Anti-epileptic drugs (such as oxcarbazepine, carbamazepine, valproate, and other alpha 2-receptor agonist antihypertensive medications such as clonidine) may also be beneficial.

Beta blockers are relatively contraindicated in patients with asthma, heart block, or diabetes.

Although there is some data suggesting that both conventional and atypical antipsychotics can slow recovery from TBI, they may assist in the management of highly agitated or psychotic patients and those patients with comorbid mood disorders. Use of these drugs should include careful monitoring for the development of tardive dyskinesia, weight gain, impaired cognition or coordination, hyperlipidemia, and glucose intolerance. An attempt to periodically reduce the dose or completely eliminate the drug should be made once the patient has stabilized, and clinicians should have a low threshold for consulting a psychiatrist if prolonged use of the class of medication appears likely.

F.4.h.4 Cognitive enhancers

Most cognitive enhancers fall into the general categories of stimulants, cholinesterase inhibitors, or dopamine enhancers. Several areas addressed by these agents are memory, attention, speed of information processing, executive function, and other general cognitive domains.

Medications given to improve cognition should be monitored with periodic neuropsychological assessment or cognitive screening to confirm positive response and the need to continue the medication. Many of the medications are off-label use, and all should be carefully followed for side effects that may interfere with recovery. A number of the drugs used for cognitive enhancement have abuse potential, and risk screening for drug abuse and urine drug testing may be appropriate in some cases. These medications should also have trial decreases periodically for eventual weaning.

M/S TBI cases will require individual management due to the number of issues being addressed, cognitive changes over time, and drug interactions. Considering these issues and the limited number of adequate studies in this area (with many published articles having small case sizes or non-randomized controls), medication regimes for patients with M/S TBI have wide variation.

The cognitive enhancer table below describes classes of medications frequently used for patients with TBI (Hammond, Bickett, Norton, & Pershad, 2014; Hammond et al., 2015; Jha et al., 2008; Kaiser et al., 2010; McDowell, Whyte, & D'Esposito, 1998; Neurobehavioral Guidelines Working

Group et al., 2006; Sheng et al., 2013; Silver et al., 2006; Tenovuo, Alin, & Helenius, 2009; John Whyte et al., 2004; J. Whyte et al., 2008; Willmott & Ponsford, 2009; Zafonte et al., 2012; Zhang, Plotkin, Wang, Sandel, & Lee, 2004). Carefully review the evidence tables before prescribing.

Evidence statements regarding cognitive enhancers			
Good evidence	Evidence statement	Citation	Design
	Citicoline: Citicoline does not improve functional scores in patients with M/S TBI or mild complicated TBI.	(Zafonte et al., 2012)	Phase 3 randomized clinical trial
Some evidence	Methylphenidate: Methylphenidate has a short-term effect on improving test performance on standardized measures of attention in patients with M/S TBI.	(John Whyte et al., 2004; Willmott & Ponsford, 2009)	Randomized crossover trials.
	Evidence statement	Citation	Design
	Amantadine: Short-term use of amantadine at daily doses in the setting of severe TBI improves disability more than placebo during the first four weeks of treatment, but effects beyond this timeframe are not known.	(Giacino et al., 2012)	Randomized clinical trial
	Donepezil: From a small study of sub-acute patients with M/S TBI: there is improvement in working memory, retrieval of declarative information, sustained attention, and the rate of cognitive recovery with use of donepezil. The effect was evident at ten weeks and may persist after stopping the medication.	(Zhang et al., 2004)	Randomized crossover trial

Table 1: Limited examples of medications used as cognitive enhancers (not a comprehensive list)

Class of Drug: Examples of Drugs	Cognitive Domain					
	Somnolence	Attention Deficiency	Lack of Motivation/Initiation	Memory Difficulty	Slowed Speed of Processing	Motor Disturbances
NMDA Receptor Antagonists: Amantadine	X	X	X		X	X
Dopamine Modulators: Bromocriptine Pramipexole Ropinirole Rotigotine patch	X	X	X		X	X
----- Carbidopa Levodopa	X		X			X
Sympathomimetics (stimulants): Dextroamphetamine Methylphenidate	X	X		X	X	
Acetylcholinesterase Inhibitor: Donepezil Rivastigmine patch	X		X	X		
Non-Amphetamine CNS Stimulant: Modafinil Armodafinil	X	X				

Medications are listed alphabetically. These medications are often not effective in clinical states for which they were developed.

F.4.h.5 Hypnotics and sedatives

Sedative and hypnotic drugs decrease activity, induce drowsiness, and may cause moderate agitation in some individuals. Many other medications, such as antihistamines and antidepressants, also produce these side effects. Due to the addiction potential, withdrawal symptoms, and sedating side effects, benzodiazepines and other similar drugs found in this class are not generally recommended to be initiated or continued if previously prescribed for another condition.

There is an increased likelihood of death when opioids and benzodiazepines are used together. Therefore, it is recommended that no more than 30 morphine milligram equivalents (MMEs) should be used when hypnotics or sedatives are prescribed. If a patient has been regularly taking these medications prior to the injury, they should be assessed by a psychiatrist to determine the need for continued treatment. When used, extensive patient education should be documented. Many unintentional drug deaths are related to concomitant opioid and benzodiazepine drug use.

Retrograde amnesia can occur and is implicated in “sleep driving,” “sleep eating,” and other activities. Some of these medications have long half-lives and sleep apnea can occur or be aggravated on these medications. Nocturnal oximetry or other sleep studies may be appropriate to identify hypoxia.

Evidence statements regarding hypnotics and sedatives			
Some evidence	Evidence statement	Citation	Design
	Zolpidem does not appreciably enhance the effectiveness of Cognitive Behavioral Therapy.	(Morin, 2009)	Randomized clinical trial

- Zaleplon (Sonata), Eszopiclone (Lunesta, Lunestar), Zolpidem (Ambien, Edluar, Intermezzo, Zolpimist)
 - Description: a nonbenzodiazepine hypnotic.
 - Indications: As of the time of this guideline writing, formulations of zaleplon, eszopiclonem, and zolpidem have been FDA approved for insomnia.
 - Dosing and time to therapeutic effect: Time of onset is 30 to 60 minutes.
 - Major side effects: dizziness, dose-related amnesia. There are many reports of significant side effects with Zolpidem, particularly in older patients.

- Drug interactions: increases sedative effect of other central nervous system (CNS) depressant drugs.
- Laboratory monitoring: none required, based on individual patient history.
- Benzodiazepine-based hypnotics include temazepam (Restoril, Gelthix), triazolam (Halcion), and flurazepam (Dalmane)
- None are recommended because of habit-forming potential, withdrawal symptoms, and sedating side effects. Flurazepam has an active metabolite with a very long half-life, resulting in drug accumulation and next-day somnolence.
- These medications are ***not recommended*** for use in the working populations.

F.4.h.6 Other pain relievers

F.4.h.6.1 Acetaminophen

Acetaminophen is an effective analgesic with anti-pyretic, but not anti-inflammatory, activity.

Acetaminophen is generally well-tolerated. It causes little or no gastrointestinal (GI) irritation and is not associated with ulcer formation.

However, acetaminophen can exacerbate headache when used chronically. Acetaminophen also has been associated with liver toxicity in overdose situations or in chronic alcohol use. Patients may not realize that many over-the-counter preparations contain acetaminophen. The total daily dose of acetaminophen is recommended not to exceed three grams per 24-hour period, from all sources, including narcotic-acetaminophen combination preparations.

Time frames regarding acetaminophen	
Optimum duration	7 to 10 days.
Maximum duration	Long-term use as indicated on a case-by-case basis. Use of this substance long-term (for 3 days per week or greater) may be associated with rebound pain upon cessation.

F.4.h.6.2 Non-steroidal anti-inflammatory drugs (NSAIDs)

NSAIDs are useful for pain and inflammation. In mild cases, they may be the only drugs required for analgesia. Chronic use of NSAIDs is generally ***not recommended*** due to increased risk of cardiovascular events and GI bleeding.

There are several classes of NSAIDs. The response of the injured worker to a specific medication is unpredictable. For this reason, a range of NSAIDs may be tried in each case, with the most effective preparation being continued.

Patients should be closely monitored for adverse reactions. The FDA advises that many NSAIDs may cause an increased risk of serious cardiovascular thrombotic events, myocardial infarction, and stroke, which can be fatal. Administration of proton pump inhibitors, histamine 2 blockers, or prostaglandin analog misoprostol along with these NSAIDs may reduce the risk of duodenal and gastric ulceration in patients at higher risk for this adverse event (e.g., age > 60, concurrent antiplatelet or corticosteroid therapy). They do not impact possible cardiovascular complications (Hooper et al., 2004).

NSAIDs are associated with abnormal liver function and renal function, including renal failure. Patients with hepatic or renal disease may need increased dosing intervals with chronic use.

Due to the cross-reactivity between aspirin and NSAIDs, NSAIDs should not be used in aspirin-sensitive patients, and they should be used with caution in all patients with asthma.

Topical NSAIDs may be more appropriate for some patients; see evidence statements in table below ([Cochrane] Derry, Moore, Gaskell, McIntyre, & Wiffen, 2016).

NSAIDs may be associated with non-unions. Thus, their use with fractures is questionable (Jeffcoach et al., 2014).

Certain NSAIDs may have interactions with various other medications. Individuals may have adverse events not listed above. Intervals for metabolic screening are dependent on the patient's age and general health status and should be within parameters listed for each specific medication. Complete blood count (CBC) and liver and renal function should be monitored at least every six months in patients on chronic NSAIDs and initially when indicated.

There is no evidence to support or refute the use of oral NSAIDs to treat neuropathic pain conditions ([Cochrane] Moore, 2015).

- Non-selective non-steroidal anti-inflammatory drugs: This includes NSAIDs and acetylsalicylic acid. Serious GI toxicity, such as bleeding, perforation, and ulceration can occur at any time, with or without warning symptoms, in patients treated with traditional NSAIDs. Physicians should inform patients about the signs and/or symptoms of serious GI toxicity and what steps to take if they occur. Anaphylactoid reactions may occur in patients taking NSAIDs. NSAIDs may interfere with platelet function. Fluid retention and edema have been observed in some patients taking NSAIDs.

Time Frames regarding non-selective non-steroidal anti-inflammatory drugs	
Optimum duration	1 week.
Maximum duration	1 year. Use of these substances long-term (3 days per week or greater) is associated with rebound pain upon cessation.

- Selective cyclo-oxygenase-2 (COX-2) inhibitors: COX-2 inhibitors differ from the traditional NSAIDs in adverse side effect profiles. The major advantages of selective COX-2 inhibitors over traditional NSAIDs are that they have less GI toxicity and no platelet effects. COX-2 inhibitors can worsen renal function in patients with renal insufficiency; thus, renal function may need monitoring.

There is an absence of evidence concerning the relative safety of celecoxib at doses greater than 200 mg per day (Nissen et al., 2016). See also evidence statements in table below.

COX-2 inhibitors should not be first-line for low risk patients who will be using an NSAID short-term. COX-2 inhibitors are indicated in select patients who do not tolerate traditional NSAIDs. Serious upper GI adverse events can occur even in asymptomatic patients. Patients at high risk for GI bleed include those who use alcohol, smoke, are older than 65 years of age, take corticosteroids or anti-coagulants, or have a longer duration of therapy. Celecoxib is contraindicated in sulfonamide allergic patients.

Time frames regarding selective cyclo-oxygenase-2 (COX-2) inhibitors	
Optimum duration	7 to 10 days.
Maximum duration	Chronic use is appropriate in individual cases. Use of these substances long-term (3 days per week or greater) is associated with rebound pain upon cessation.

Evidence statements regarding nonsteroidal anti-inflammatory drugs (NSAIDs)			
Good evidence	Evidence statement	Citation	Design
	Celecoxib in a dose of 200 mg per day, administered over a long period, does not have a worse cardiovascular risk profile than naproxen at a dose of up to 1000 mg per day or ibuprofen at a dose of up to 2400 mg per day.	(Nissen et al., 2016)	Randomized noninferiority trial
	Celecoxib has a more favorable safety profile than ibuprofen or naproxen with respect to serious GI adverse events, and it has a more favorable safety profile than ibuprofen with respect to renal adverse events.		
	Topical NSAIDs are associated with fewer systemic adverse events than oral NSAIDs, e.g., reduced risk of gastrointestinal adverse effects by approximately one third.	([Cochrane] Derry et al., 2016)	Meta-analysis of randomized clinical trials

F.4.h.7 Opioids

Refer to the Division’s Chronic Pain Disorder Medical Treatment Guideline for appropriate use.

F.4.h.8 Skeletal muscle relaxants

These are most useful for acute musculoskeletal injury or exacerbation of injury. Refer to Section F.4.h.5, Hypnotics and sedatives, for benzodiazepines. Chronic use of benzodiazepines or any muscle relaxant is **not recommended** due to their habit-forming potential, seizure risk following abrupt withdrawal, and documented contribution to deaths of patients on chronic opioids due to respiratory depression. (For more detailed descriptions, refer to the Division’s Chronic Pain

Disorder Medical Treatment Guideline.) Due to increased mortality, opioids should not be combined with benzodiazepines or most skeletal muscle relaxants.

F.4.i Mobility

Definition and background

Individuals who have sustained an M/S 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, including a propensity for falls, and may be seen in bed mobility, wheelchair mobility, seating and positioning, transfers, and ambulation.

Impaired cognition significantly affects mobility as noted by problems with attention, judgment, organization of auditory and/or visual instructions, memory, concentration, problem solving, behavior, and initiation. Therefore, cognition should also be addressed.

Supporting literature and evidence tables

The following recommendations were based on consensus and evidence regarding music interventions.

Evidence statements regarding mobility treatment			
Good evidence	Evidence statement	Citation	Design
	Rhythmic auditory stimulation music interventions significantly improve gait velocity and stride length in people with moderate to severe acquired brain injury compared with standard treatment or controls.	([Cochrane] Magee, Clark, Tamplin, & Bradt, 2017)	Systematic review and meta-analyses of randomized clinical trials
	Music interventions for gait may be enhanced when a trained music therapist delivers the intervention.		

Indications for M/S TBI mobility treatment

Indications include any difficulty with mobility.

Recommendations for M/S TBI mobility treatment

- **Therapy**

Therapeutic intervention supervised by a physical and/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 bed and mat mobility skills, sensory integration, endurance, balance, coordination, strengthening, stretching, gait training, neuromuscular re-education and postural control. Training is also indicated for individuals and their family and/or support system in the areas of wheelchair mobility, seating and positioning, ROM, functional mobility (bed mobility, and transfers, ambulation), and therapeutic exercise.

The use of modalities (functional electrical stimulation, TENS, neuromuscular electrical stimulation (NMES), 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.

Therapy to improve gait after M/S TBI or stroke, with foot drop or other gait impairments, is variable and includes treadmill training with body weight support, unsupported treadmill walking, electromyographic biofeedback with therapy, functional electrical stimulation assisted gait, lower extremity bracing, use of gait assistive devices, and other therapist facilitated therapy. None of these therapies is clearly superior to another (Brown et al., 2005; Intiso, Santilli, Grasso, Rossi, & Caruso, 1994; [Cochrane] Moseley, Stark, Cameron, & Pollock, 2005; [Cochrane] Williams et al., 2011).

- **Adaptive devices**

Individuals with M/S 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.

Technology is advancing rapidly in this area, and each year more adaptive equipment is available. Each case should be considered individually to determine the medical need for the equipment. 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 equipment, accessibility, and safety aids (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;
- communication aids and devices including computers;
- visual adaptive aids;
- other adaptive equipment for independent ADLs, such as specialized eating utensils.

Environmental modifications may include, but are not limited to: ramping, modifications of the living environment to achieve reasonable levels of independence, and adaptive equipment for mobility and safety. Typically, these evaluations are done by a licensed contractor and occupational or physical therapist with experience in ADA standards. Equipment and modifications must be medically necessary. 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.

Time frames

Time frames regarding M/S TBI mobility treatment	
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 1 month with ongoing progress noted over a longer period, which may last up to 2 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	Initially, daily for most patients with M/S TBI. Depending on the individual's progress, sessions may vary from 1 to several hours, based on the individual's ability to respond to treatment and the setting.
Optimum duration	1 to 12 months.
Maximum duration	24 months or beyond. Requires documentation of progress or the need for maintenance to retain mobility. Periodic upgrading or consultation may be necessary throughout the individual's lifetime following TBI. Short-term, goal-directed mobility interventions may be periodically indicated on an ongoing basis as new changes occur in an individual's functional mobility.

F.4.j Muscle tone and joint restriction management, including spasticity

Definition and background

This is 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.

Individuals with M/S 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, speech-language pathology, occupational therapy, and music therapy.

Supporting literature and evidence tables

Evidence statements regarding muscle tone and joint restriction management			
Strong evidence	Evidence statement	Citation	Design
	Botulinum toxin A has objective and symptomatic benefits over placebo for cervical dystonia.	([Cochrane] Costa et al., 2005)	Meta-analysis of randomized clinical trials
	<p>Botulinum toxin A injection is effective in reducing muscle tone in the setting of symptomatic spasticity when patients have had a stroke.</p> <p>The effects of botulinum toxin on functional ability are less certain, in part because motor weakness is an important component of the functional limitations imposed by upper motor neuron lesions.</p> <p>The optimum dose of botulinum toxin is not certain.</p> <p>Note: It is likely, although unproved, that botulinum toxin would have similar effects on patients with TBI and severe muscle spasm.</p>	(Dong, Wu, Hu, & Wang, 2017)	Systematic review and meta-analyses of randomized clinical trials

Evidence statements regarding muscle tone and joint restriction management			
Good evidence	Evidence statement	Citation	Design
	<p>Mirror therapy improves upper or lower limb motor function after a stroke.</p> <p>Note: It is likely that mirror therapy may benefit TBI patients.</p>	([Cochrane] Thieme, Mehrholz, Pohl, Behrens, & Dohle, 2012)	Meta-analysis of randomized clinical trials

Indications for M/S TBI muscle tone and joint restriction management, including spasticity

If spasticity is interfering with the individual's general functioning (which may include ROM limitations, limitations in care and/or ADLs, and limitations in mobility), then treatment is often warranted.

Recommendations for M/S TBI muscle tone and joint restriction management, including spasticity

Therapeutic intervention should concentrate 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:

- **Orthotics and casting:** Serial casting may be effective to increase ROM by inhibiting tone and increasing passive muscle length. Serial casting should be reapplied every 4-7 days as appropriate with increasing stretch and may require an overall treatment period of one to two 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. Orthotics are often prescribed to protect affected joints and to prevent contracture. Additionally, special seating positioning devices and techniques may be required above and beyond a standard positioning method.

- Postural control: Trunk control is essential for the body to remain upright and to adjust and control movements against gravity. Postural control, mobility, tone, and stability are 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 positions. The last level involves strength and stability for power production for activities such as walking, stair climbing, jumping, running, and throwing.
- Functional and therapeutic activities: These are provided with instruction for the individual and family and/or support system in the proper positions, sequences, timing, and level of assistance. Periodic functional upgrading or consultation may be necessary throughout an individual's lifetime following M/S 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. (Refer to Section F.4.q, Therapeutic exercise, for further details.)
- Therapeutic nerve blocks and motor point ablations: These are useful in targeting specific muscles or muscle groups for diagnostic and therapeutic purposes. Nerve blocks can be useful for short-term reduction in pain and inflammation. The purpose of the motor point ablation 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 motor point ablations 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. Refer to the Division's medical treatment guideline for the appropriate area of injury.
- Botulinum toxin injections: Botulinum toxin injections are used to temporarily weaken or paralyze muscles. They may reduce muscle pain in conditions associated with spasticity, dystonia, or other types of painful muscle spasm. The duration of treatment effect of botulinum toxin for cervical dystonia has been estimated to be approximately 12 weeks. EMG needle guidance may permit more precise delivery of botulinum toxin to the target area.
 - Complications: Over-weakening of injected muscles, migraine, and allergic reaction to medications. Rare systemic effects include flu-like syndrome and weakening of distant muscles. There is an increased risk of systemic effects in individuals with motor neuropathy or disorders of neuromuscular junction.

- Indications: Botulinum toxin injections are used to improve ROM and reduce painful muscle spasm, as 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 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.

Time frames

Time frames regarding botulinum injections for spasticity	
Time to produce effect	24 to 72 hours post-injection with peak effect by 4 to 6 weeks.
Frequency	Approximately 3 months between re-administration.
Optimum duration	3 to 4 months.
Maximum duration	Unknown at the time of this guideline. Repeat injections should be based on functional improvement and therefore used sparingly in order to avoid development of antibodies that might render future injections ineffective.

- Pharmaceutical agents: A variety of oral and transdermal antispasticity medication may also be used.
- Intrathecal baclofen drug delivery: The intrathecal administration of baclofen is indicated for use in the management of severe spasticity. Individuals with M/S 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 for those who experience intolerable CNS side effects at effective doses. 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.

- 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 psychiatry.
 - 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 to 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 or more prior to injection), and (c) shellfish allergy if contrast is to be used.
- Surgical pump implantation
 - Complications: Intrathecal delivery may be associated with significant complications such as infection, catheter disconnects, CSF leak, arachnoiditis, pump failure, nerve injury, and paralysis.
 - Surgical indications: Individuals who meet the following criteria should be considered candidates for intraspinal baclofen infusions:
 - The individual should have quantifiable 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 initiating and discontinuing a trial.
 - Failure of conservative therapy, including active and/or passive therapy, medication management, or other therapeutic injections.
 - The individual and family and/or support system should be motivated for the procedure and should understand the potential for complications and the requirements of treatment maintenance.
 - 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.

F.4.k Neuromuscular re-education

Definition and background

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.

Medical treatment may be divided into two major areas:

- Motor control: This involves 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.
- Motor learning: 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 ensure proper repetition, practice schedules, variable type of practice, and type and timing of feedback. Active problem solving should be part of a rehabilitation program to learn motor skills more appropriately. Continuous, accurate, and immediate feedback about muscle contraction and movement is important in the early stages. Therapist provided feedback and cues can be faded as appropriate for the patient.

Supporting literature and evidence tables

Evidence statements regarding neuromuscular re-education			
Strong evidence	Evidence statement	Citation	Design
	Early onset neurorehabilitation in a trauma centre and more intensive neurorehabilitation in a rehab facility have beneficial effects on the functional recovery of patients with M/S TBI as compared to usual care.	(Königs, Beurskens, Snoep, Scherder, & Oosterlaan, 2018)	Systematic review
Good evidence	Evidence statement	Citation	Design
	Constraint induced motor therapy (CIMT) provides a favorable effect immediately post treatment for stroke victims with paresis of one arm and good cognition.	([Cochrane] Sirtori, Corbetta, Moja, & Gatti, 2009)	Meta-analysis of clinical trials

Evidence statements regarding neuromuscular re-education			
Some evidence	Evidence statement	Citation	Design
	<p>The motor function associated with CIMT is maintained at 24 months after treatment.</p> <p>Note: It is likely that mirror therapy may benefit patients with TBI. Therefore, CIMT is a recommended therapy for similarly affected patients with TBI.</p>	(Wolf et al., 2008)	Meta-analysis of clinical trials

Indications/recommendations for M/S TBI neuromuscular re-education

Individuals with neuromuscular impairments may require physical, therapeutic, and medical and/or surgical management to improve their movement and mobility.

Time frames

Time frames regarding M/S TBI neuromuscular re-education	
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 1 month, with ongoing progress noted over a longer period, which may last up to 2 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	Initially, daily for M/S TBI. Depending on the individual's progress, sessions may vary from 1 to several hours, based on the individual's ability to respond to treatment and the setting.
Optimum duration	1 to 12 months.

Time frames regarding M/S TBI neuromuscular re-education	
Maximum duration	24 months or beyond, requires documentation of progress or the need for maintenance to retain motor skills. Periodic upgrading or consultation may be necessary throughout the individual's lifetime following TBI.

As the individual progresses, treatment frequency should be decreased. Continued treatment is based on attainment of functional goals as outlined in the treatment plan.

F.4.1 Neuro-otology: vestibular and audiology

Definition and background

For patients with dizziness causing nausea or affecting balance, treatment of these conditions may be necessary before other rehabilitative therapy can be accomplished.

Supporting literature and evidence statements

The following recommendations were based on consensus. Supporting literature and evidence statements are also included in the subsections when available.

Indications/treatment for neuro-otology, vestibular and audiology

- Treatment of fixed lesions
 - Post-traumatic tinnitus: Individuals with TBI may experience debilitating tinnitus (ringing in the ears). Tinnitus may be associated with pressure or noise related trauma and ossicular or perilymphatic fistula disorder (Kreuzer et al., 2014). Tinnitus can be evaluated with specific audio-metric testing techniques. Patients may benefit from anti-depressants, anti-seizure medicines, and anxiolytics. In many situations, devices are recommended. These may include hearing aids, maskers, and tinnitus trainers. Tinnitus trainers require a 30-day trial to determine the effectiveness of masking. More sophisticated devices that use music as opposed to masking are **not recommended** due to no proof of their superiority ([Cochrane] Hobson, Chisholm, & El Refaie, 2010).
 - Hyperacusis: Individuals with TBI may experience significant sensitivity to sound. This is more common in association with tinnitus. These individuals may benefit from devices such as tinnitus trainers, musician's plugs, and simple noise plugs. Continuous exposure to broadband sound may also be used (Lindsey, 2014).
 - Sensorineural hearing loss: Individuals with TBI may experience nerve hearing loss that may be treated with amplification (hearing aids). A full audiometric evaluation,

including the Stinger Test, may determine if the individual could benefit from such devices. Difficulty in auditory processing, such as speech understanding and speech segregation has also been identified in blast exposed military (Saunders et al., 2015).

- Vestibular loss: Individuals with TBI may experience loss of inner ear balance function resulting in dizziness and imbalance. This can result from labyrinthine concussion, penetrating injuries, injury to the eighth cranial nerve, and explosive pressure changes. Patients may compensate for vestibular deficits more quickly with vestibular rehabilitation than without it.

Persistent postural perceptual dizziness: This is a condition in which patients continue to experience persistent dizziness due to mis-calibration of the sensorimotor, cerebellar, and vestibular inputs. This condition may be comorbid with anxiety. Treatment with aggressive vestibular rehabilitation and either SSRI or SNRI may be beneficial.

- Repeat testing may be necessary to confirm diagnosis.
- Treatment of recurrent, non-progressive otologic disorders
 - Benign paroxysmal positional vertigo (BPPV): BPPV is the most common cause of post-traumatic vertigo. It is an otologic disorder in which particles normally adherent to the gravity sensors of the ear become displaced into the semicircular canals, which cause the sensation of spinning. It is characterized by recurrent, brief spells of vertigo triggered by head movements such as getting in and out of bed, rolling over in bed, tipping the head upward, or bending over. It is diagnosed by the Dix Hallpike maneuver and treated with canalith repositioning maneuvers (CRM) specific to the affected semicircular canals. Patients treated by CRM should be re-evaluated within the first month to ensure resolution of symptoms. Recurrences are common after trauma. These may be treated by repeating the CRM, home exercises, or referral to physical therapy.

Some individuals may require an exercise-based approach following, or instead of, the CRM. Home exercises are safe and effective in this disorder.

Time frames regarding vestibular rehabilitation for benign paroxysmal positional vertigo	
Frequency	1 to 3 sessions with repeated CRM at each session and follow-up at 1 month.
Optimum duration	1 month with re-evaluation.

Time frames regarding vestibular rehabilitation for benign paroxysmal positional vertigo	
Maximum duration	Reoccurrence can occur randomly for many years following trauma. Home exercises are necessary for those with frequent recurrences. Some patients are unable to perform home exercises, so repeated visits for CRM may be required.

- Semicircular canal dehiscence: This is an abnormal communication between the CSF space in the skull and perilymph surrounding the inner ear. It can result from blunt head trauma with fracture of the bone separating these spaces. Symptoms include vertigo brought on by loud sounds or straining and autophony, which is the magnification of internal bodily sounds (chewing, eye movement, joint movement, heartbeat) in the affected ear. Vestibular suppressants and avoidance of provoking sounds can be used; surgery is required in severe cases.
- Vestibular migraine: Individuals experiencing an exacerbation of migraine after TBI frequently have an associated dizziness. Treatment includes trigger avoidance, vestibular suppressants, and migraine prophylactic medications such as calcium channel blockers, anti-seizure medication, beta blockers, and SSRIs. (Refer to Section F.4.m, Post-traumatic headache treatment.)
- Treatment of progressive otologic disorders
 - Progressive vestibulopathy with or without hearing loss: Injury to the ears that results in acute auditory or vestibular injuries occasionally converts to a progressively damaging disorder with recurrent vertigo spells and gradual loss of hearing and/or balance function over time. Cases with discrete vertigo spells of hours in duration associated with tinnitus and fluctuating hearing are called post-traumatic endolymphatic hydrops or Ménière’s disease. Hydrops refers to dilation of the endolymph space of the inner ear at the expense of the surrounding perilymph space and is highly associated with Ménière’s disease, although the mechanism of the ear dysfunction is not yet known. Treatments include diuretics, calcium channel blockers, steroids, gentamicin perfusion, and surgery.
 - Perilymphatic fistula: Ruptures of the round or oval windows of the inner ear or fractures through the ear can result in leakage of perilymph. This can cause progressive hearing loss and recurrent dizziness that is often triggered by straining. Treatment is bed rest with the head elevated and avoidance of straining for mild cases. Surgery is required for severe cases and those not responding to a week of bed rest.

- Treatment options including vestibular rehabilitation
 - Steroid perfusion: During this procedure, steroids are injected into the middle ear space, allowing absorption into the inner ear via the round window membrane. It can provide a temporary reduction in the frequency of vertigo spells in progressive vestibulopathy and may improve hearing after sudden losses.
 - 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 hearing function. This procedure has a 95% success rate, but cannot be used in bilateral disease because of its destructive nature. Use should be reserved for cases in which a unilateral progressive hearing loss and/or loss of vestibular function has been documented.
 - The Meniett device: This is a portable, alternating pressure generator that transmits low-pressure pulses to the middle ear.

Evidence statements regarding the Meniett device			
Good evidence	Evidence statement	Citation	Design
	The Meniett device produces short-term symptomatic and functional benefit with daily use in individuals with established Ménière’s disease, reduced vestibular function, and severe vertigo, which persist despite adequate medical therapy.	(Gates, Green, Tucci, & Telian, 2004; Gurkov et al., 2012)	Randomized clinical trials

The mechanism of benefit is not yet understood. Individuals must be able to tolerate tympanostomy tubes and 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 F.2.i.2, Tympanostomy.)

- Vestibular rehabilitation

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

Vestibular rehabilitation is performed by qualified practitioners, such as audiologists, otologists, trained nurses, vestibular therapists, physical therapists (preferably neurology certified), or occupational therapists.

Evidence statements regarding vestibular rehabilitation			
Good evidence	Evidence statement	Citation	Design
	Vestibular rehabilitation incorporating visual motion performed by the patient alone with brief instruction from a health care provider reduces dizziness and improves function.	([Cochrane] McDonnell & Hillier, 2015)	Meta-analysis of randomized clinical trials
Some evidence	Evidence statement	Citation	Design
	2 to 6 sessions of Mulligan sustained natural apophyseal glides (SNAGs) or Maitland mobilizations over 6 weeks are significantly more effective in reducing the intensity and frequency of cervicogenic dizziness than a placebo intervention in patients with chronic cervicogenic dizziness. The effects are maintained at 12 weeks	(Reid, Rivett, Katekar, & Callister, 2014)	Double-blind randomized clinical trial

Evidence statements regarding vestibular rehabilitation			
	post treatment.		

o Balance disorders:

Balance disorders occur frequently following TBI. This may be due to a peripheral vestibular lesion or central vestibular lesion secondary to trauma, fracture, hemorrhage, or intracranial pressure changes (Kleffelgaard, Roe, Soberg, & Bergland, 2012).

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.

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 integrated at the central level between the two sides of the body and three sensory systems. These key areas are associated with maintenance of balance or posture. 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 level, or peripheral sensory level will affect balance and equilibrium.

Common clinical tests used to evaluate balance include the Balance Error Scoring System (BESS), Berg Balance Scale (BBS), Community Balance and Mobility Scale (CB&M), Clinical Test of Sensory Interaction on Balance (CTSIB), Motion Sensitivity Quotient, Sensory Organization Test (SOT), tandem gait task from the Sport Concussion Assessment Tool-3, Functional Gait Assessment (FGA), and an instrumented gait speed assessment. The disadvantage to most of these tests is that they were developed for specific age groups and may not have been studied for TBI (Valovich McLeod & Hale, 2015). However, the CB&M has been studied for TBI (Inness et al., 2011; Pape, Williams, Kodosky, & Dretsch, 2016). Self-report instruments are also available to evaluate balance: ABC scale for dizziness, Dizziness Handicap Inventory (DHI), Vertigo Handicap Questionnaire (VHQ), and the Vestibular Disorder Activities of Daily Living Scale (VADL) (Valovich McLeod & Hale, 2015).

Sources of imbalance include vestibular, ocular, somatosensory, and cervicogenic. Vestibular-ocular type may have visual abnormalities on testing and impaired clinical balance. It is usually treated with a vestibular rehabilitation program. Visual or ocular

motor training alone has no demonstrated benefit, and treatment should be done using an interdisciplinary approach. Cervicogenic imbalance is associated with neck pain and headaches associated with head movement. It is usually treated with head and neck proprioceptive re-training and cervical manual therapy (Ellis, Leddy, & Willer, 2015).

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 (Ellis et al., 2015). Exercises may be directed at: habituation, desensitization by repeat exposure; substitution, alternative strategies; or adaption, improved use of remaining functioning vestibular system (Valovich McLeod & Hale, 2015).

Special equipment for vestibular treatment in the clinic may include dynamic platform posturography or a foam/dome apparatus for sensory integration and balance as well as tilt or rocker boards. Other virtual reality devices used in isolation are not suggested for use with this treatment because therapist intervention and supervision are important for success. 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 individuals 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 (Marzo, Leonetti, Raffin, & Letarte, 2004).

Time frames regarding vestibular rehabilitation for balance disorders	
Time to produce effect	6 to 12 weeks depending on severity.
Frequency	1-2 times per week initially for training with 2-4 follow-up visits to reinforce treatment. Individuals are expected to perform self-directed exercises twice daily at home, but they may require supervision for guidance and safety.

Time frames regarding vestibular rehabilitation for balance disorders	
Optimum duration	2 to 6 months with re-evaluation. Limited to 24 visits within 6 months.
Maximum duration	Therapy will be more intense and requires more frequent therapy for patients with moderate to severe dysfunction. If reports document treatment progress but the individual is not at maximum therapeutic gain, then additional therapy may be indicated.

- Postural control: Treatment involves remediation of stability within the constraints following TBI in the musculoskeletal, neuromuscular, sensory/perceptual, and cognitive areas. Concurrent physical injuries and/or medication treatment 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, biofeedback, re-education, and other therapies. A vestibular rehabilitation program needs to be individualized considering cognitive impairments and involves:
 - increased need for physical assistance because of movement problems;
 - increased need for supervision because of cognitive and behavioral problems;
 - slower progression of program.

F.4.m Post-traumatic headache treatment

For patients with M/S TBI, headaches seem to present approximately 35% of the time up to 60 months post-injury. About 40% of patients with headaches at one year experience several per week (Stacey et al., 2017).

If evaluation and treatment for headache is needed, refer to the Division's Mild Traumatic Brain Injury Medical Treatment Guideline.

F.4.n Psychological interventions

Definition and background

M/S TBI may result in a variety of cognitive, psychological, and/or behavioral symptoms that can negatively impact each other, recovery from TBI, and/or functional outcomes if left untreated. Therefore, psychological treatment is recommended for patients with any of these symptoms (Hudak, Hynan, Harper, & Diaz-Arrastia, 2012).

Supporting literature and evidence tables

Evidence statements regarding M/S TBI psychological/educational interventions			
Some evidence	Evidence statement	Citation	Design
	<p>For patients with complicated mTBI and moderate TBI who have completed initial therapy, 12 weeks of telephone-based and in-person Cognitive Behavioral Therapy (CBT) interventions are no more effective than usual care for treating Major Depressive Disorder (MDD).</p> <p>Due to the differences noted between groups in this study, it is not possible to determine if telephone CBT is preferable to in-person CBT after initial treatment has been completed.</p> <p>However, telephone CBT allowed more participation by support persons, and this may be important to patients with TBI. It is interesting that secondary data showed high satisfaction with CBT, 84%, and only 26% with usual care.</p>	(Fann et al., 2015)	Single-blind randomized clinical trial

Studies not resulting in evidence statements

Several meta-analyses have evaluated the occurrence of depression and anxiety with non-penetrating TBI. Both anxiety and depression appear to occur at a rate about 1/3, much higher than the general population (Osborn et al., 2014; Osborn, Mathias, & Fairweather-Schmidt, 2016). Both conditions are likely to increase during the initial 2-5 years post-injury, although anxiety may decrease after 5 years (Osborn et al., 2014; Osborn, Mathias, & Fairweather-Schmidt, 2016). Mild and M/S TBI are both likely to suffer. Increased physical activity and decreased alcohol consumption may be useful to decrease symptoms (Osborn, Mathias, Fairweather-Schmidt, et al., 2016). One study found that preinjury alcohol abuse and longer PTA predicted symptoms lasting longer than 6 months (Hart et al., 2014).

One study identified significant anxiety, affecting activities of daily living, for most M/S TBI cases and in 21% of participants 1 year post-injury (Hart et al., 2016).

Window to Hope is an intervention used to decrease hopelessness in US veterans with TBI. It is a 20-hour manualized CBT intervention with problem solving modules (S. M. Barnes et al., 2017; Matarazzo et al., 2014).

Indications for M/S TBI psychological interventions

Psychological treatment is indicated for all M/S TBI patients. Patients may exhibit compromised self-awareness, behavioral problems, or mood disorders. Those problems include, but are not limited to: heightened irritability; agitation; aggression; rage reactions; impulsivity; uninhibited behaviors including sexually disinhibited behaviors; emotional lability; confabulation; perseveration; impaired judgement; memory disorders; feelings of apathy, anxiety, loss, frustration, or grief; depression; suicidal risk; and sleep disturbance.

Recommendations for M/S TBI psychological interventions

Psychological interventions may include, or be performed in conjunction with, cognitive and behavioral treatment. Although the effect of this treatment for the brain injured population is unknown, psychological treatment is recommended for all patients with M/S TBI. The inclusion of family support systems may serve to promote consistency, compliance, and recognition of change over time. Family and support systems may also benefit from psychological support services without the patient.

- Acutely symptomatic phase: During the period of PTA, self-awareness is often compromised, and behavioral problems such as impulsivity, agitation, uninhibited behaviors, aggression, 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 safety of the individual and staff; (2) consultation with other team members, support of the nursing staff, and ongoing contact with the individual's family and/or support system; and (3) education of the family and/or support system about TBI and its behavioral manifestations. Cognitive status is monitored during this time period as the level of environmental stimuli is gradually and slowly increased. The psychological interventions described here typically occur throughout the period of PTA. Furthermore, psychological intervention to help manage problematic behaviors (such as perseveration, aggressive behaviors, and disorders of memory), typically continues into the acute rehabilitation phase of treatment as PTA resolves. Behavior treatment, which may include applied behavior analysis and a focused behavioral plan based on the results of a functional analysis, is frequently used in these cases. Psychological interventions may be delivered by licensed mental health clinicians.

- Early recovery phase: Once PTA has completely resolved and the patient is fully oriented in all spheres, psychological clinical services are typically provided to educate him/her about the injury, increase insight into deficits, and support the development of positive coping. Treatment also typically involves psychotherapeutic intervention to assist in dealing with feelings of anxiety, loss, frustration, and grief. Psychological treatment is often required to address depression, heightened irritability, sleep disturbance, and anxiety. Psychological interventions including psychotherapy, sleep hygiene, cognitive behavior modification, and environmental restructuring may be required to address social skills, behavioral deficits, and impulsivity 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 in order to train team members and family and/or support system members to support the process of recovery. Family therapy and educational sessions are often indicated.
- 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, preservative and disinhibited impulsive behaviors, apathy, memory problems and disorders related to diminished or impaired judgment) may necessitate ongoing psychological treatment. Individuals with TBI 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 home and community. Depression may be linked to a permanent decrease in functioning after treatment (Hudak et al., 2012). These services are typically individualized and may take a variety of forms including individual psychotherapy for the patient and support system, skills training (e.g., parenting), marital/family psychotherapy, medication

management, and group psychotherapy. For treatment-resistant depression, repetitive transcranial magnetic stimulation (rTMS) may be considered.

Treatment should be evidence-based and tailored to the needs of the individual and his/her cognitive deficits. For example, an individual with significant memory problems may need to have information from psychotherapy sessions video or audio recorded. For those with behavioral problems, outpatient psychotherapy may be held initially 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 approach. French guidelines suggest the use of pain management and therapeutic partnerships with caregivers and local facilities to decrease behavioral and effective problems (J. H. Luaute, J.; Pradat-Diehl, P., 2016). The inclusion of family support systems may serve to promote consistency and compliance.

- Consultation in regard to usage of medications: Medication management for emotional, behavioral, and cognitive and physical functioning for patients with M/S TBI is often needed. An interdisciplinary team approach is beneficial and encouraged. Thus, attending physicians will often request consultation from other physicians (including psychiatrists) and non-physician team members (such as psychologists, social workers, and family service counselors) to provide data and input regarding behavioral observations that may assist in assessing how the person is responding to various medications.

Time frames regarding M/S TBI psychological interventions

Time frames will vary based on the individual's needs. Functional status should be re-evaluated every 4 weeks for the first 2 years and quarterly thereafter to determine need for termination or continual treatment.

F.4.o Sleep disturbances

Definition and background

There is a growing awareness in society of the importance of sleep in health and well-being. Research has shown that sleep is vital for memory, cognition, creativity, behavior, cardiovascular and cerebrovascular health, and even life expectancy (Walker, 2017). Disrupted sleep and activity cycles have long been known to the clinician taking care of patients with M/S TBI, though investigation into the mechanism and treatment of these phenomena is only beginning (Duclos et al., 2014; Orff, Ayalon, & Drummond, 2009). It is likely that sleep disturbance after an M/S TBI in the immediate post-injury period is very different from the sleep disturbance seen in the chronic period of recovery or, for that matter, the sleep disruption seen in mTBI. Although the field is only beginning to understand the problem mechanistically, it is probably worth noting that each stage of recovery following M/S TBI might hold a different problem. In terms of approach, common themes will be evident. To address the problem of disrupted sleep in these patients and

to raise awareness of its existence with caregivers, families, and patients, providers must first objectively monitor sleep, either through nursing observation logs or by actigraphy. Second, providers must understand the potential impact of institutional environments and routine care in settings, like the ICU or the rehabilitation center, which may have an adverse impact on quality sleep. Finally, centrally acting medications commonly used in these patients often have a significant impact on sleep centers and may even slow neurologic recovery. (See Table 2 below.) Because of this, the recommendation for the clinician is to employ pharmacology at the lowest effective dose and short term when needed.

Supporting literature

- ICU / acute trauma center

There is a limited body of literature about sleep disturbance in the acute trauma center after M/S TBI. Baumann and colleagues measured levels of orexin in the CSF of patients with M/S TBI while in the acute trauma centers (Baumann et al., 2005). Orexin is a neuropeptide produced in the posterior lateral hypothalamus that is the primary “on” switch for the cycle of wakefulness (Saper, Fuller, Pedersen, Lu, & Scammell, 2010). Patients with the sleep disorder narcolepsy are found to have extremely low to nonexistent levels of orexin in their CSF, and this may be the primary deficit in this disorder. Baumann’s patients with M/S TBI had a marked decrease in orexin levels compared to age matched controls. Patients with the lowest levels of orexin were the least responsive patients (Baumann et al., 2005).

There is a growing body of literature looking at disrupted sleep in the ICU setting. Helton et al. studied 62 patients in an ICU setting and found that 40% of the patients had moderate to severe sleep deprivation (Helton, Gordon, & Nunnery, 1980). They also found a positive correlation between the severity of sleep deprivation with the occurrence of delirium. The ICU environment - with ventilators, monitors, and the need for frequent vital signs and nursing assessments - works against good quality sleep. Disrupted sleep in the ICU is multifactorial and chronic underlying illness such as COPD or CHF may be associated with poor sleep quality (Krachman, D'Alonzo, & Criner, 1995). There have been a number of heterogeneous interventions tried in the ICU to improve sleep and reduce delirium including earplugs, bright light therapy, and medications all with varying success (Kamdar, Martin, Needham, & Ong, 2016).

- Rehabilitation center

Sleep disturbance following M/S TBI seen in the acute rehabilitation center is more widely studied, and initial prevalence of this phenomenon has been reported to be between 70% and 86% (Makley et al., 2008). Patients identified with disrupted sleep were noted to have longer stays in both acute trauma centers and acute rehabilitation centers, suggesting

a more severe and costly injury (Makley et al., 2008). Confused patients who are awake during the night are at risk for falls or other injuries, and patients who are asleep during the day are less able to participate and benefit from a rehabilitation program.

The common types of sleep disturbance seen in the post-acute period include hypervigilance, insomnia, hypersomnia, and circadian phase shift. (See Table 3: Types of sleep disturbance after M/S TBI). Here it is important to distinguish between insomnia and hypervigilance. Insomnia is defined as difficulty getting to sleep, staying asleep, waking up too early, or awakening with the feeling that sleep was not restorative (Harvey & Spielman, 2011). Hypervigilance, on the other hand, is the almost complete absence of consolidated sleep or highly fragmented brief sleep episodes with protracted periods of wakefulness. Not surprisingly, hypervigilance often comes with psychotic symptoms of paranoia and agitation. Others have differentiated the hypersomnolent patient from the patient with pleiosomnia. The patient with pleiosomnia has an increased sleep need that is at least two hours per 24 hours longer than pre-injury sleep history (Baumann, 2016). Approaches to each of these types of sleep disturbance are very different and, therefore, highlight the need to define the type of sleep disturbance for each individual in order to provide the appropriate treatment. To this end, an objective measure of a patient's sleep such as nursing observation logs or actigraphy data becomes essential.

In addition to monitoring the patient's sleep patterns, the clinician in the rehabilitation center should also work to raise awareness of the problem among the patient, caregivers, and family. A comprehensive sleep history should be taken from the patient or the family if the patient is unable to provide this. It is important to note from the patient or family what type of biologic preference or "chronotype" the patient was before the injury. Specifically, if the patient was a night owl or a morning bird. Such information can play an important role in guiding therapeutic treatment. For example, M/S TBI is an injury with a high prevalence of young adult males who typically have a phase delay to their sleep interval, meaning that they tend to go to bed late and get up late. For these chronotypes, it may be counterproductive to begin early morning ADL training at 6 a.m. After establishing pre-injury chronotype, it is important to establish sleep habits such as timing and duration of sleep exhibited by the patient prior to injury.

The prevalence of obstructive sleep apnea (OSA) in patients with TBI has been reported between 25-35% (Castrionta et al., 2007). Thus, another important part of the sleep history taken from family or bed partner should be inquiring about symptoms related to OSA such as loud snoring or apnea. A screening tool for obstructive sleep apnea such as the STOP-BANG questionnaire is useful to identify patients at a high risk for this condition. Patients with a high score on the STOP-BANG or similar tool should be referred for overnight sleep study from appropriate consultative service (pulmonary or sleep medicine).

In addition to a comprehensive sleep history, the clinician should also take a close look at institutional norms and culture to understand the impact that day-to-day operations have on sleep cycles of patients in an ICU or rehabilitation unit. The recommendations below should be implemented. This requires a full review of nursing procedures or evaluations that occur after the patient has gone to bed.

In order to ameliorate institutional challenges to sleep, many aspects of a sleep hygiene intervention can be undertaken in a rehabilitation setting (Ouellet & Morin, 2007). See recommendations below for aspects of a sleep hygiene intervention.

Often times, the clinician must intervene with pharmacology to try to improve sleep in patients who are not responding to environmental and behavioral interventions. Trazadone is the most frequently used medication for sleep in patients with M/S TBI. Quetiapine is also frequently used, particularly for confused or agitated patients with poor sleep. Melatonin has little research supporting its efficacy. Melatonin quality control can vary widely with manufacturer. Another concern is the possibility that exogenous melatonin may inhibit the patient's own melatonin production and excretion. In general, it is thought that benzodiazepine, which suppresses slow wave sleep, and other GABA agonists should be avoided as they may delay neurologic recovery. A new orexin antagonist has been approved, although there are no clinical trials in TBI to guide its use in these patients. Given the work of Baumann and colleagues, some patients may be orexin deficient, at least in the acute phase of recovery. Finally, many clinicians use wakefulness agents like modafinil or armodafinil to improve daytime wakefulness, which then promotes consolidated sleep at night for patients with TBI. Methylphenidate or other stimulants could be used along the same lines of reasoning. Again, the recommendation for any pharmacologic approach would be to use the lowest effective dose of medication and for a limited time.

Indications/recommendations for M/S TBI sleep disturbances

ICU / acute trauma center and the rehabilitation center

- Raise awareness of sleep disturbance following M/S TBI with caregivers, families, and patients.
- Obtain a comprehensive sleep history from patient, family, and bed partners about preinjury sleep habits and chronotype or biologic preference for sleep.
- Obtain a history from bed partner or family for signs or symptoms suggestive of sleep apnea.

- History of snoring, BMI > 33, male, HTN, neck circumference > 40cm. (See, for example, the STOP-BANG questionnaire or similar tool discussed above.)
- Patients at high risk should be referred to a specialist for sleep study.
- Objectively track sleep patterns of patients with nursing observation logs or actigraphy, particularly on initial admission to ICU or rehabilitation center.
- Provide a healthy sleep environment for patients in ICU and rehabilitation settings with comfortable dark environments during sleep period and brightly sunlit environments or exposure during wake period.
- Examine institutional barriers to good sleep for patients: night time vitals, baths, leg measurements, and other intrusions into sleep period.
- Institute common aspects of a sleep hygiene intervention where practical and medically appropriate:
 - regular wake and bed times scheduled according to preinjury chronobiologic preference 7 days a week;
 - increase daytime physical activity and exercise;
 - limit day time napping to < 30 minutes;
 - limit caffeine intake to before noon;
 - limit screen technology 1 hour before bed time.
- For pharmacologic approach, use the lowest effective dose for a limited time.

The community/outpatient center: Sleep disturbance is a very common complaint in the outpatient clinic for patients following M/S TBI, with an incidence reported to be up to 50% at one year (Clinchot, Bogner, Mysiw, Fugate, & Corrigan, 1998). Approach to the patient with complaints of sleep-wake cycle disturbance in the outpatient center will essentially follow the same approach as described for patients with mTBI. (Refer to the Division's Mild Traumatic Brain Injury Medical Treatment Guideline). The clinician should first look for easily remedial causes such as obstructive sleep apnea. Non-pharmacologic interventions should be first line. Pharmacy should be the last measure taken and only for limited time.

Table 2: Sleep centers, neurotransmitters, and commonly used pharmacology affecting these centers

Sleep center	Neurotransmitter	Pharmacology
Ventrolateral preoptic	Gaba	Baclofen, BZD
Locus coeruleus	Norepinephrine	Duloxetine, venlafaxine
Lateral hypothalamus	Orexin	Suvorexant, modafinil
Pedunculopontine	Acetylcholine	Donepezil, rivastigmine
Raphe nucleus	Serotonin	Sertraline, fluoxetine
Ventral tegmental	Dopamine	Amantadine, methylphenidate, carbidopa levodopa

Table 3: Types of sleep disturbance after M/S TBI

Insomnia	<ul style="list-style-type: none"> ● difficulty initiating sleep, sleep fragmentation, and early morning awakening ● more often reported in mTBI than M/S TBI
Hypervigilance	<ul style="list-style-type: none"> ● different than insomnia ● often associated with development or presence of psychosis
Circadian phase shift	<ul style="list-style-type: none"> ● delayed sleep phase or irregular sleep-wake type
Hypersomnolence	<ul style="list-style-type: none"> ● excessive daytime sleepiness ● inability to maintain wakefulness and alertness during the day
Pleiosomnia	<ul style="list-style-type: none"> ● increased need for sleep

F.4.p Swallowing impairments (dysphagia)

Definition and background

The incidence of swallowing disorders in the M/S TBI population is high. Presenting dysphagia is usually characterized by a combination of oral and pharyngeal stage deficits. Co-existing cognitive and behavioral deficits compromise swallowing safety. Physical damage to the oral, pharyngeal, laryngeal, and esophageal structures complicates neurogenic dysphagia. Traumatic intubation in the field, prolonged ventilation, endotracheal intubation, and the presence of tracheostomy may also have a negative impact on swallow function.

Supporting literature and evidence tables

Studies not resulting in evidence statements
<p>Swallowing involves multiple neurologic connections including: sensation from the oropharynx, larynx, and esophagus; cortical recognition of sensation and motor response; brainstem interaction; and multiple cranial nerves. Therefore, multiple areas could be targeted for treatment (Cabib et al., 2016).</p> <p>There is insufficient evidence to support or refute the use of oral sensory-motor treatment to improve swallow function (Lazarus, 2011).</p> <p>The following therapies have been trialed on stroke survivors: intrapharyngeal electrical stimulation, surface neuromuscular electrical stimulation, pharmacological stimuli (capsaicin, menthol, and piperine), repetitive transcranial magnetic stimulation (rTMS), and transcranial direct current stimulation (tDCS). The available studies evaluating these therapies do not meet evidence standards. Thus, they are not routinely recommended but may be used (Cabib et al., 2016; Carnaby-Mann & Crary, 2007; Permsirivanich et al., 2009).</p>

Indications/recommendations for dysphagia treatment

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 compensatory/therapy techniques.

Therapeutic strategies may be divided into two categories:

- **Compensatory treatment:** Compensatory techniques do not involve direct treatment of the swallowing disorder and may not affect the physiological function of the swallow. They may reduce or eliminate the dysphagic symptoms and risk of aspiration by altering the movement of the bolus through the mouth and pharynx. They include strategies such as postural adjustments of the head, neck, and body to alter the dimensions of the pharynx and the flow of the bolus; altering consistency and viscosity of foods or liquids; and varying the volume and rate of presentation of the food or drink.
- **Therapy techniques:** This is 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 that target specific aspects of the pharyngeal phase of the swallow, and swallowing maneuvers to facilitate laryngeal closure during the pharyngeal phase of the swallow.

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

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 provided by Ear, Nose, and Throat (ENT) doctors.

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 re-evaluation. During the early phases of recovery, change may occur rapidly, and formal re-evaluation (including instrumental evaluation) may be completed frequently.

Time frames

Time Frames regarding dysphagia treatment	
Frequency	(1) Acute Care – 1 to 2 times daily; (2) Post-Acute – Once per day; (3) 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.

F.4.q Therapeutic exercise

Definition and background

Therapeutic exercises, with or without mechanical assistance or resistance, may include a number of modalities as part of the integrated occupational therapy or physical therapy program. A therapeutic exercise program should be initiated at the start of any treatment program and coordinated in an interdisciplinary approach. Such programs should emphasize education, independence, and the importance of an on-going exercise regime.

Supporting literature and evidence tables

Studies not resulting in evidence statements
Both animal and human studies suggest therapeutic exercise has a direct relationship on recovery from a TBI (Archer, 2011; D. E. Barnes, Yaffe, Satariano, & Tager, 2003; S. Colcombe & Kramer, 2003; S. J. Colcombe, Kramer, McAuley, Erickson, & Scalf, 2004; Ferris, Williams, & Shen, 2007; Griesbach, Gomez-Pinilla, & Hovda, 2004; Griesbach, Hovda, Molteni, Wu, & Gomez-Pinilla, 2004; Griesbach, Tio, Vincelli, McArthur, & Taylor, 2012; Knaepen, Goekint, Heyman, & Meeusen, 2010; Kramer et al., 1999; Lojovich, 2010; Weuve et al., 2004).

Indications for therapeutic exercise

Indications include the need for:

- cardiovascular fitness,
- improved muscle strength,
- improved connective tissue strength and integrity,
- increased bone density,
- promotion of circulation to enhance soft tissue healing,
- improvement of muscle recruitment,
- improved proprioception and coordination, and
- increased ROM.

Recommendations for therapeutic exercise

Therapeutic exercise may be done as part of the overall occupational therapy or physical therapy program. It is not to be used in isolation. It should occur in an interdisciplinary treatment setting. As with all treatments, specific objective goals should be set initially and monitored during treatment.

The patient and/or caregiver should be instructed in and receive a home or community exercise program that is progressed as functional status improves.

Upon discharge from inpatient or residential rehabilitation, the patient and/or caregiver would be independent in the performance of the home exercise program and would have been educated in the importance of continuing such a program. Educational goals would be to maintain or further improve function and to minimize the risk for aggravation of symptoms in the future.

Time frames

Time frames regarding therapeutic exercise	
Time to produce effect	2 to 6 treatments.
Frequency	1 to 3 times per week.
Optimum duration	4 to 8 weeks and concurrent with an active daily home or community exercise program.
Maximum duration	8 to 12 weeks of therapist oversight. Home exercise should continue indefinitely.

F.4.r Visual treatment

Definition and background

Visual treatment is appropriate to consider for TBI. Visual impairments may occur secondary to TBI and in one or more of the following categories:

- visual acuity and visual field function;
- ocular motor control and ocular alignment;
- visual perception.

Note: Visual rehabilitation is also performed for dizziness. (Refer to Section F.4.1, Neuro-otology: vestibular and audiology, under Vestibular rehabilitation for details.)

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for visual treatment

An ophthalmologist, neuro-ophthalmologist, neurologist, occupational therapist, certified vision therapist, or optometrist may treat visual impairment resulting from TBI. Treatment of visual impairments should be based on a comprehensive evaluation and diagnosis. When possible, therapy should be provided in an interdisciplinary integrated approach for the purposes of best outcomes and greatest convenience for the patient.

Treatment should be functionally-based and goal-directed. Individuals should be evaluated at intervals depending on his/her impairment, and progress should be clearly documented. Reliance on unvalidated outcome measures, such as performance on tests of “eye teaming” or “eye tracking,” should be avoided.

- Visual acuity and visual field function

These 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, the best data argues against the use of corticosteroid in almost all cases, in part because of the risk of increased morbidity and mortality from a concomitant head injury (Steinsapir & Goldberg, 2011). Surgery may be indicated if the trauma results in progressive visual acuity loss in the setting of demonstrable compression of the nerve or if a hematoma is present within the optic nerve sheath. These cases are extremely rare. If visual acuity or visual field deficits are caused by intracranial visual pathway damage, acute treatment should be directed toward the specific injury.

Vision aids may be prescribed for individuals with documented visual acuity or visual field loss after acute injury. Lenses may be used to improve visual acuity. Tinted FL41

lenses may be useful to treat photophobia and glare sensitivity (Digre & Brennan, 2012; Katz & Digre, 2016).

The use of optical and digital compensatory devices may benefit some individuals with documented visual field loss from visual pathway disorders that affect 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 without developing compensatory visual scanning are **not recommended**. The use of computers as a primary and independent form of visual treatment 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. Integrated computer-based treatment (i.e., both individualized cognitive and interpersonal therapies) may improve functioning within the context of an interdisciplinary, neuropsychological rehabilitation program. Sole reliance on repeated exposure and practice on computer-based tasks without extensive involvement and intervention by a therapist is **not recommended**. Virtual reality tools may prove useful for ADL assessment and training; however, they are experimental at the time of this guideline, as there are no strong studies supporting its success ([Cochrane] Laver, George, Thomas, Deutsch, & Crotty, 2011; Schultheis, Himelstein, & Rizzo, 2002). Computerized visual restoration therapy programs or other computerized visual treatment programs, such as virtual reality, are **not recommended** due to lack of proven clinically meaningful efficacy and cost (McFadzean, 2006; Pelak, Dubin, & Whitney, 2007; Reinhard et al., 2005; Schreiber et al., 2006).

- Disorders involving ocular motility and binocular vision

These should be treated according to the underlying diagnosis. Ocular motility includes ductions, versions, smooth pursuit, saccade, vergence, and vestibular eye movements. Disorders of binocular vision include strabismus with double vision and disturbances of accommodation and vergence.

Treatment may include the use of lenses, prisms, vision rehabilitation, and/or surgery. For individuals with disorders of ocular motor and ocular alignment that result in diplopia, the following should be considered based on severity and duration of impairments: monocular eye patching, occlusion of central or peripheral vision, prisms lenses, or strabismus surgery.

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 strabismus, particularly in cases with cranial nerve palsy.

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

- 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 the overall rehabilitation treatment and is overseen by an authorized treating provider with experience in TBI. The therapy may be provided by specialists with experience in visual perceptual disorders. They may be from various disciplines, including, but not limited to: occupational therapy, speech therapy, neuropsychology, optometry and ophthalmology, neurology, and neuro-ophthalmology.

- Visual inattention

This is inattention of a visual spatial region. Treatment may include the use of prisms and scanning techniques. Visuospatial rehabilitation with scanning is recommended for individuals with visuospatial perceptual deficits associated with visual neglect following TBI and especially after right parietal stroke. Scanning training is recommended as an important, even critical, intervention element for individuals with severe visual perceptual impairment that includes visual neglect after right hemispheric stroke and TBI (Haskins, 2012).

Time frames

Time frames regarding all vision therapy (orthoptic therapy)	
Time to produce effect	4 hours of treatment should result in a measurable functional improvement.
Frequency	Outpatient: once weekly with a daily home exercise program. In-patient: determined by the rehabilitation team, considering the patient's medical needs and best possible outcomes. Frequency of treatment is dependent on in-patient versus outpatient and the medical condition of the individual.
Optimum duration	12 hours.
Maximum duration	20 hours. Throughout the treatment process, 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 may be indicated. Additional therapy should take into consideration the overall rehabilitation plan for the individual.

These time frames are not meant to be applied to each section separately. The time frames are to be applied to the totality of all vision rehabilitation regardless of the type or combination of therapies being provided.

F.5 Interdisciplinary rehabilitation programs

Interdisciplinary brain injury programs are characterized by a variety of disciplines that participate in the assessment, planning, and/or implementation of the treatment program. These programs provide outcome-focused, coordinated, goal-oriented interdisciplinary team services to measure and improve the functioning of persons. They are for patients with greater levels of disability, dysfunction, de-conditioning, and psychological involvement. Programs should have sufficient personnel to work with the individual in the following areas: neurological, medical, cognitive, behavioral, functional, pain management, psychological, social, and vocational. All programs for M/S TBI should be able to address all of the associated neuromedical conditions listed in this guideline. Programs should share information about the scope of the services and the outcomes achieved with patients, authorized providers, and insurers.

This is the recommended treatment for individuals with M/S TBI. These programs should assess the impact of the injury on the patient's medical, physical, psychological, social, and/or vocational functioning. The number of professions involved in the team in a TBI program may vary due to the complexity of the needs of the patient.

When referring a patient for integrated interdisciplinary rehabilitation, the Division recommends that the program meets the criteria of the Commission on Accreditation of Rehabilitation Facilities (CARF).

Programs should include the following dimensions:

- **Communication:** To ensure positive functional outcomes, communication between the patient, insurer, and all professionals involved must be coordinated and consistent. Any exchange of information should be provided to all professionals, including the patient. Care decisions should be communicated to all and should include the family and/or support system.
- **Documentation:** Functional goals should be actively pursued and objectively measured on a regular basis to determine their achievement or need for modification.
- **Risk assessments:** The following should be incorporated into the overall assessment process, individual program planning, and discharge planning: aberrant medication related behavior, addiction, suicide, and other maladaptive behavior.
- **Patient/caregiver education:** Patients with TBI need to re-establish a healthy balance in lifestyle. All providers should educate and provide training and resources for patients/caregivers on how to overcome barriers to resuming daily activity, including management of behavioral issues, cognitive losses, decreased energy levels, financial constraints, decreased physical ability, and change in family and/or support system dynamics.
- **Family / support system services as appropriate:** The following should be considered in the initial assessment and program planning for the individual: ability and willingness of the family to participate in the plan, coping, expectations, educational needs, insight, interpersonal dynamics, learning style, problem solving, responsibilities, and cultural and financial factors. Support would include counseling, education, assistive technology, and ongoing communication.
- **Neuropsychological evaluation and treatment:** Initial full neuropsychological evaluation should occur with periodic assessments to document progress and re-evaluate treatment plans. Treatment may include cognitive, behavioral, and psychological aspects.
- **Psychosocial evaluation and treatment:** Psychosocial evaluation should be initiated, if not previously done. Providers of care should have a thorough understanding of the patient's

personality profile, especially if dependency issues are involved. Psychosocial treatment may enhance the patient's ability to participate in rehabilitation, manage stress, and increase their problem-solving and self-management skills.

- Treatment modalities: Use of modalities may be necessary early in the process to facilitate compliance with and tolerance to therapeutic exercise, physical conditioning, and increasing functional activities for M/S TBI. Active treatments should be emphasized over passive treatments. Active treatments should encourage self-coping skills and compensatory behavior, which can be continued independently at home or at work. Treatments that can foster a sense of dependency by the patient on the caregiver should be avoided. Treatment length should be decided based on observed functional improvement. For a complete list of active and passive therapies, refer to Sections F, Specific treatments, and G, Return to work and vocational rehabilitation. All treatment time frames may be extended based on the patient's positive functional improvement.
- Therapeutic exercise programs: A therapeutic exercise program should be initiated at the start of any treatment program. Such programs should emphasize education, independence, and the importance of an on-going exercise regime.
- Medical management: The ability to serve a variety of medical issues including, but not limited to: bladder and bowel function, cardio-pulmonary function, metabolic function, musculoskeletal function, and others (CARF, 2016).
- Return to work: An authorized treating provider should continually evaluate the patient for potential to return to work. For patients who are currently employed, efforts should be aimed at keeping them employed. Formal rehabilitation programs should provide assistance in creating work profiles. For more specific information regarding return to work, refer to Section G, Return to work.
- Vocational assistance: Vocational assistance can define future employment opportunities or assist patients in obtaining future employment. (Refer to Section G, Return to work, for detailed information.)

The following areas should be addressed to promote seamless service delivery for the persons served (CARF, 2016):

- The brain injury specialty program proactively coordinates, facilitates, and advocates for appropriate transitions.
- Discharge/transition planning addresses:
 - life routines;
 - the level of understanding of the family/support system regarding the current status of the person served;

- expectations of the person served and family/support system;
- contingency plans;
- the environment of the next component of the continuum of services or discharge location, including facilitation factors and barriers;
- self-advocacy;
- capability of the family/support system;
- financial resources;
- access to healthcare;
- transportation;
- equipment and/or adaptive devices;
- identification of resources in the community that are or will be involved with the person served;
- mechanisms for coordination with other resources;
- a follow-up plan for each person served;
- follow-up services, including services for persons who leave the program's geographic service area;
- designation of the individual(s) who will be responsible for coordination of the follow-up plan of the person served;
- discharge planning from inpatient rehabilitation hospital or post-acute residential: Follow-up visits will be necessary to ensure adherence to treatment plan. Programs should have community and/or patient support networks available to patients on discharge.

The following programs may be necessary.

F.5.a Comprehensive TBI-specialized inpatient interdisciplinary rehabilitation programs or “acute rehabilitation”

Definition and background

These are generally accepted and widely used. Inpatient brain injury rehabilitation programs should have designated staff for TBI, rooms designated for patients with TBI, designated TBI treatment facilities and programs, and they should serve at least 25 to 30 individuals with TBI per year.

Supporting literature and evidence tables

Evidence statements regarding acute rehabilitation			
Strong evidence	Evidence statement	Citation	Design
	Early onset neurorehabilitation in a trauma centre and more intensive neurorehabilitation in a rehab facility have beneficial effects on the functional recovery of patients with M/S TBI as compared to usual care.	(Königs et al., 2018)	Systematic review

Studies not resulting in evidence statements
One 6-week, non-randomized study with blinded outcome evaluators and a neuropsychological focus demonstrated improvement in overall productivity (Sarajuuri et al., 2005).

Indications/recommendations for acute rehabilitation

Following medical stability, individuals with M/S TBI should be transferred from acute hospital care to acute rehabilitation - in the form of a comprehensive TBI-specialized inpatient interdisciplinary rehabilitation program - unless they are unable to participate in the program.

Inpatient rehabilitation programs may be necessary for patients with any of the following conditions: (a) high risk for medical instability; (b) moderate-to-severe impairment of functional status; (c) moderate impairment of cognitive and/or emotional status; (d) dependence on medications; and (e) the need for 24-hour supervision.

The interdisciplinary team maintains consistent integration and communication to ensure that all interdisciplinary team members are aware of the plan of care for the patient, are exchanging information, and are implementing the care plan. The team members make interdisciplinary team decisions with the patient and then ensure that decisions are communicated to the entire care team.

The Medical Director of the program should be board certified in physical medicine and rehabilitation, or be board certified in his or her specialty area, and either have completed a one-year fellowship in rehabilitation or have two years of experience in an interdisciplinary brain injury rehabilitation program.

Interdisciplinary rehab disciplines include but are not limited to registered rehabilitation nursing, nutritionist, physical therapist, occupational therapist, speech-language pathologist, recreational therapist, psychologist, neuropsychologist, family service / case management, music therapist, exercise physiologist, biofeedback therapist, chiropractor, optometrist, and podiatrist. Medical specialties may include, but are not limited to: neurosurgery, neurology, internal medicine and hospitalist-based critical care, pulmonary medicine, gastroenterology, hematology, infectious disease, ophthalmology, plastic surgery, general surgery, orthopedic surgery, etc.

On-site insurance case managers are encouraged to be a part of the treatment team; attend team conferences; and assist in goal setting, facility discharge planning, and short-term and long-term management of care.

Inpatient programs should be accredited by the Joint Commission on Accreditation of Healthcare Organizations (Joint Commission) 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.

Time frames

The length of initial rehabilitation depends on the severity of deficits, complications, and the individual’s medical progress. Continued lengths of stay should be based on documented functional progress. The individual should be re-evaluated every 30 days.

Time frames regarding acute rehabilitation	
Time to produce effect	2 to 12 weeks
Frequency	Full time programs – No less than 3 hours per day, 5 days per week. Part-time programs – 1-3 hours per day, 2–3 days per week.
Optimum duration	2 to 16 weeks with 24/7 programming.
Maximum duration	4 months for cases without severe medical complications. Periodic review and monitoring thereafter for 1 year. Additional follow-up based on the documented maintenance of functional gains.

F.5.b Sub-acute skilled nursing facilities (SNFs)

Definition and background

SNFs provide care in specialty licensed units of nursing homes.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for SNFs

SNF care is generally accepted and widely used for those who have completed extensive inpatient rehabilitation therapy and who are not able to be managed by a home care agency, 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 (if medications are involved, it is skilled care).

Recommendations for SNFs

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 the Joint Commission is recommended.

F.5.c Post-acute rehabilitation: outpatient rehabilitation services

Definition and background

Outpatient rehabilitation services are generally accepted and widely used. These therapeutic interventions may be delivered in a hospital, free-standing outpatient facility, or community-based post-acute facility with focused goals for home and community functioning.

Typically, outpatient treatments are interdisciplinary and include one or more of the following disciplines: physical therapy, occupational therapy, speech therapy, music therapy, mental health counseling, neuropsychology, therapeutic recreation, family counseling, vocational rehabilitation, and chiropractic treatment.

Supporting literature and evidence tables

Evidence statements regarding outpatient rehabilitation services			
Good evidence	Evidence statement	Citation	Design
	Multidisciplinary rehabilitation by expert neurological rehabilitation services for patients with M/S TBI who required hospital admission are likely to benefit functionally and symptomatically.	([Cochrane] Turner-Stokes et al., 2005)	Systematic review of randomized trials, quasi-randomized trials, and quasi-experimental studies

Indications/recommendations for outpatient rehabilitation services

Immediately following inpatient rehabilitation, outpatient rehabilitation is usually intensive and followed by a systematic and gradual reduction in therapy as appropriate.

Outpatient rehabilitation should be functionally oriented, goal specific, time limited, and case managed.

Formal outpatient rehabilitation programs should be accredited by the Joint Commission and have components consistent with certification by CARF. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

Time frames

Time Frames regarding outpatient rehabilitation services	
Frequency	2 to 8 hours per day, 1 to 5 days per week. More intensive treatment initially; M/S TBI usually require extended sessions.
Optimum duration	Up to 24 months or beyond with monthly re-evaluations.

F.5.d Post-acute rehabilitation: residential or transitional living rehabilitation

Definition and background

Residential rehabilitation, also called residential or transitional living, is clinically appropriate and generally accepted for individuals who have completed initial inpatient rehabilitation.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for residential or transitional living 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.

Recommendations for residential or transitional living rehabilitation

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 (1) those whose condition has changed, such as in caregiver death, disability, or unavailability, (2) those who may not have had access to appropriate or adequate inpatient or sub-acute rehabilitation treatment, or (3) those in whom cognitive, communicative, physical, or behavioral status has deteriorated.

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

Time frames

The length of residential rehabilitation treatment depends on the severity of deficits, complications, progress, and available discharge options.

Time frames regarding residential or transitional living rehabilitation	
Optimum duration	Residential rehabilitation is a generally adopted and widely used practice, ranging typically from 90 to 180 days, depending on the individual's condition and discharge needs, with re-evaluations every 30 days (Ashley et al., 2018).

F.5.e Post-acute rehabilitation: neuro-behavioral programs

Definition and background

These are generally accepted TBI inpatient or residential rehabilitation programs designed for individuals with TBI who have persistent and significant maladaptive behaviors.

Behavioral programs may be physically located in secured hospital units or in community-based residential programs, which may also be secured.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for neuro-behavioral programs

While all TBI rehabilitation programs treat behavior, behavioral programs are usually required for individuals who are unsafe; who have suicidal, homicidal, or violent behavior; or who cannot be treated in less restrictive environments.

Behavioral programs are also appropriate for severe behavioral problems due to other concomitant diagnoses (such as alcohol or substance abuse) and psychiatric disorders (including any personality disorders). Categorical adolescent inpatient hospital and residential programs may be appropriate for adolescent behavioral disorders due to TBI.

Recommendations for neuro-behavioral programs

Behavioral programs generally use an interdisciplinary approach that may include behavior analysis and modification, medications, socialization skills training, substance abuse treatment, family therapy, and physical management programs, as well as traditional interdisciplinary treatment.

Use of psychiatric hospitals that are not experienced in TBI rehabilitation is ***not recommended***. Sole reliance on psychoactive medications for behavioral management is ***not recommended***.

Upon discharge from behavioral programs, disposition is either back to inpatient acute rehabilitation, inpatient programs, supported living programs, or home and community-based programs.

Time frames

Time frames regarding neuro-behavioral programs	
Optimum duration	Length of stay may greatly vary depending on etiology and severity of the behavioral disorders and may typically range from 1 to 6 months or longer.

F.5.f Post-acute rehabilitation: home and community-based rehabilitation

Definition and background

This 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.

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.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for home and community-based rehabilitation

These post-acute services are generally accepted and widely used for individuals with TBI who have completed inpatient or residential rehabilitation or for those who have not required inpatient or residential services.

Recommendations for home and community-based rehabilitation

One or more therapeutic disciplines are appropriate to deliver home and community-based services, including qualified/credentialed clinicians from physical therapy, occupational therapy, speech therapy, music therapy, medicine, neuropsychology, clinical psychology, behavioral treatment, 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 the Joint Commission and have components consistent with CARF certification. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

Time frames

Time frames regarding home and community-based rehabilitation	
Frequency	1 to 7 hours per day, 1 to 5 times per week.
Optimum duration	Up to 24 months or beyond with monthly re-evaluations.

F.5.g Post-acute rehabilitation: formal occupational rehabilitation

Definition and background

This is a formal interdisciplinary program addressing a patient's employability and return to work. It includes a progressive increase in the number of hours per day in which a patient completes work simulation tasks until the patient can tolerate a full work day. A full work day is case specific and is defined by the previous employment of the patient. Safe workplace practices and education of the employer and family and/or social support system regarding the person's status should be included. This is accomplished by addressing the medical, psychological, behavioral, physical, functional, and vocational components of employability and return to work.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for formal occupational rehabilitation

The following are best practice recommendations for an occupational rehabilitation program:

- work assessments, including a work-site evaluation when possible. (Refer to Section G, Return to work.);
- practice of component tasks with modifications as needed;
- development of strength and endurance for work tasks;
- education on safe work practices;
- education of the employer regarding functional impairments of the worker when possible;
- involvement of family members and/or support system for the worker;
- promotion of responsibility and self-management;
- assessment of the worker in relationship to productivity, safety, and worker behaviors;
- identification of transferable skills of the worker;
- development of behaviors to improve the ability of the worker to return to work or benefit from other rehabilitation;
- discharge includes functional/work status, functional abilities as related to available jobs in the community, and a progressive plan for return to work if needed (CARF, 2016).

The occupational medicine rehabilitation interdisciplinary team should, at a minimum, be comprised of a qualified medical director who is board certified with documented training in occupational rehabilitation, team physicians with experience in occupational rehabilitation, an occupational therapist, and a physical therapist. As appropriate, the team may also include any of

the following: a chiropractor, an RN, a case manager, a psychologist, a vocational specialist, or a certified biofeedback therapist.

Programs should preferably be accredited by the Joint Commission and have components consistent with CARF certification. CARF eligibility or certification implies that programs meet specific care standards of design and efficacy.

Time frames

Time frames regarding formal occupational rehabilitation	
Time to produce effect	2 weeks.
Frequency	2 to 5 visits per week, up to 8 hours per day.
Optimum duration	2 to 4 weeks.
Maximum duration	6 weeks. Participation in a program beyond 6 weeks must be documented with respect to need and the ability to facilitate positive symptomatic and functional gains.

F.5.h Post-acute rehabilitation: opioid/chemical treatment programs

Definition and background

Patients with addiction and/or substance abuse problems or high dose opioid or other drugs of potential abuse may require inpatient and/or outpatient chemical dependency treatment programs before or in conjunction with other interdisciplinary rehabilitation. Guidelines from the American Society of Addiction Medicine are available and may be consulted relating to the intensity of services required for different classes of patients in order to achieve successful treatment.

Refer to the Division's Chronic Pain Disorder Medical Treatment Guideline. Recent programs which incorporate both interdisciplinary therapy and weaning from opioids appear to demonstrate positive long-term results (Huffman et al., 2017).

F.5.i Supported living programs or long-term care residential services

Definition and background

These 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.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for supported living programs or long-term care residential services

SLPs are designed for those who, due to their TBI, are not able to care for themselves safely and independently in the community and for whom home placement is unavailable or inappropriate. Such programs are appropriate for individuals who are at risk for medical, cognitive, physical, and psychological complications but who do not require a secured setting.

Recommendations for supported living programs or long-term care residential services

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. Housing, food, supervision, activity programs, sheltered employment, transportation, and case management are typical components of supported living programs.

Specialty supported living programs are available for behaviorally challenged individuals.

G. Return to work and vocational rehabilitation

G.1 Return to work

Definition and background

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 Safety and Health Administration (OSHA), Federal Motor Carrier Safety Administration (FMCSA), and the Department of Transportation (DOT).

Supporting literature and evidence tables

Evidence statements regarding return to work			
Strong evidence	Evidence statement	Citation	Design
	In the setting of TBI, there is a negative association between psychiatric comorbidity (anxiety, depression, PTSD) and return to work; however, the magnitude of this effect has not been clearly established.	(Garrelfs, Donker-Cools, Wind, & Frings-Dresen, 2015)	Systematic review of observational studies

Studies not resulting in evidence statements
<p>One study found a relationship between perceived self-efficacy in cognitive areas and life satisfaction. The same study found a relationship with employed or volunteer work and satisfaction (Cicerone & Azulay, 2007).</p> <p>A 10 year follow-up study of patients with severe brain injuries suggested that for some patients there is a decline in employment between 5 and 10 years (Cuthbert et al., 2015).</p>

Indications/recommendations for return to work

Following M/S TBI, some individuals are unable to return to work. Successful return to work among individuals with moderate/severe injury may require an interdisciplinary approach including neuropsychological assessment, speech-language assessment, functional capacity

evaluation, assessment of vocational feasibility, transferable skill analysis, mental health counseling, family counseling, and follow-up services. The employer should be contacted to assist in establishing the essential job duties and demands, job site analysis, as well as supervisor education and the potential need for a skillful increased titration of job duties and demands.

In work situations where the employer is unable to accommodate and a return to the previous occupation is not suitable or appropriate, other options include volunteer placements or supported employment opportunities. See the above return-to-work literature table for a study on volunteer work and life satisfaction. Consider vocational re-training, individualized/specialized job placement services, and job coaching as needed.

Based on the evidence listed in the evidence table above, all patients with TBI should have psychological/neuropsychological evaluations and treatment as needed.

Additional return-to-work assistance may be necessary after the initial return to work (see literature table above for related study).

The following should be considered when attempting to return an injured worker with M/S TBI to work:

- Job history interview

The authorized treating provider should perform a job history interview at the time of the initial evaluation and before any plan of treatment is established. Documentation should include the worker's job demands, stressors, duties of current job, and duties of job at the time of the initial injury. In addition, cognitive and social issues should be identified, and treatment of these issues should be incorporated into the plan of care.

- Coordination of care and communication

Management of the case is a significant part of return to work and may be the responsibility of the authorized treating provider, occupational health nurse, risk manager, or others. Case management is a method of communication between the primary provider, referral providers, insurer, employer, and employee. Because case management may be coordinated by a variety of professionals, the case manager should be identified in the medical record. Communication is essential between the patient, patient's support system/team, authorized treating provider, employer, and insurer. Employers should be contacted to verify employment status, job duties and demands, and policies regarding injured workers. In addition, availability and duration of temporary and permanent restrictions, as well as other placement options, should be discussed and documented. All communications in the absence of the patient are required to be documented and made available to the patient.

- Establishment of return-to-work status

Return to work for persons with TBI should be thought of as therapeutic, assuming that work is not likely to aggravate the basic problem or increase discomfort. The goal of return to work would be to implement a plan of care to return the worker to any level of employment with their current employer or to return them to any type of new employment even though the worker may not be currently working or employed due to their recovery time.

- Establishment of activity level restrictions

A formal job description is necessary to identify physical and cognitive demands at work and assist in the creation of modified duty. A job site evaluation may be utilized to identify tasks such as pushing, pulling, lifting, reaching above shoulder level, grasping, pinching, sitting, standing, posture, balance, ambulatory distance and terrain, and if applicable, environment for temperature, air flow, noise, tolerance for scanning, scrolling and other computer use, cognitive activities, and the number of hours that may be worked per day. Due to the lack of predictability regarding exacerbation of symptoms affecting function, an extended and occupationally focused functional capacity evaluation may be necessary to determine the patient's tolerance for job type tasks over a continuing period of time. Job requirements should be reviewed for the entire eight hours, or more, of the working day. When prescribing the functional capacity evaluation (FCE), the physician must assess the probability of return to work against the potential for exacerbation of the work related condition. Work restrictions assigned by an authorized treating provider may be temporary or permanent. The case manager should continue to seek out modified work until restrictions become less cumbersome or as the worker's condition improves or deteriorates. Ergonomic changes recommended by the worksite evaluation should be put in place.

Between one and three days after the evaluation, there should be a follow-up evaluation by the treating therapist and/or an authorized treating provider to assess the patient's status. Patients should be encouraged to report their status post-FCE.

- Rehabilitation and return to work

As part of rehabilitation, every attempt should be made to simulate work activities so that the authorized treating provider may promote adequate job performance. The use of ergonomic or adaptive equipment, therapeutic breaks, assistive devices, and interventional modalities at work may be necessary to maintain employment.

- Vocational assistance

Formal vocational rehabilitation is a generally accepted intervention and can assist disabled persons in returning to viable employment, when they are unable to return to their previous work duties. Assisting patients to identify vocational goals will facilitate medical recovery and aid in the maintenance of Maximum Medical Improvement (MMI) by (1) increasing motivation towards treatment and (2) alleviating the patient's emotional distress. Patients with TBI will benefit most if vocational assistance is provided during the interdisciplinary rehabilitation phase of treatment. To assess the patient's vocational capacity, a vocational assessment utilizing the information from occupational and physical therapy assessments may be used to identify rehabilitation program goals and to optimize both patient motivation and utilization of rehabilitation resources. It may be useful to initially work in volunteer settings or for community groups. This may be extremely helpful in decreasing the patient's fear regarding an inability to earn a living which can add to their anxiety and depression.

G.1.a Recommended vocational rehabilitation assessment

According to Inter-Professional Clinical Practice Guidelines, a vocational evaluation should include some of the following (Stergiou-Kita, Dawson, & Rappolt, 2012):

- initial intake process, including:
 - pre-injury history;
 - educational and work histories;
 - current social status;
 - pre-injury job performance and performance evaluations; and
 - successes and failures in post-injury work trials;
- assessment of the person (individual's perspective), including:
 - work goals, values, and meaning he/she attached to work pre- and post-injury;
 - work performance, strengths, weaknesses, current work competency;
 - compensatory strategies and support needs;
 - readiness to work and anticipated challenges/barriers to work or return to work;
 - individual's own assessment of the costs and benefits of working;
 - individual's view of the implications of a decision not to work (e.g., insurance and benefits);

- assessment of an individual’s functional status and level of independence;
- observations of an individual’s work-related skills and behavior during performance in real work setting, or if unavailable, simulated work tasks;
- assessment of the physical workplace environment;
- assessment of supports (i.e., formal and informal) and opportunities within the workplace and the individual’s support network including: availability of accommodations and/or job modifications;
- assessment of the occupational/job requirements.

G.2 Driving

Definition and background

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.

Supporting literature and evidence table

Evidence statements regarding driving evaluation and treatment			
Some evidence	Evidence statement	Citation	Design
	The Useful Field of View (UFOV) tool is a large screen computer that uses specialized software to evaluate and retrain 3 aspects of visual attention (visual processing speed, divided attention, and selective attention). It can improve driving performance in patients with a right hemisphere stroke and may be useful in patients with TBI.	(Cicerone et al., 2011)	Systematic review of clinical trials and observational studies

Indications/recommendations for driving evaluation and treatment

Self-report of feeling confident with driving ability may not be reliable; some studies of patients

have demonstrated this (D. J. Iverson et al., 2010). An individual's ability to drive is typically evaluated and treated under physician orders by a certified driver rehabilitation specialist.

Physicians, neuropsychologists, or rehabilitation therapists can perform an initial screening to determine driving ability by assessing visual acuity, visual fields, memory, visual perception, visual processing, visual spatial skills, selective and divided attention, executive skills, motor and sensory function coordination, pain, and cognitive and physical fatigue (American Medical Association, 2009; Defense Centers of Excellence for Psychological Health & Traumatic Brain Injury, 2009).

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

- certified driving rehabilitation specialist;
- ophthalmologist or optometrist for visual evaluation;
- commercial vendor and rehab engineer for adaptive equipment;
- neuropsychologist for cognitive evaluation;
- speech-language pathologist for communication evaluation and compensatory strategies;
- occupational or physical therapist with expertise in acquired brain injury.

Unfortunately, at the time of this guideline, there is no evidence for the use of one system of assessment over another to predict driving skills (Marino et al., 2013; [Cochrane] Martin, Marottoli, & O'Neill, 2009).

- The Useful Field of View (UFOV) tool has been shown to be effective in stroke survivors to evaluate visual attention. It may be useful in the TBI population. See related evidence statement above.
- The AMA suggests confrontational field testing, Snellen E acuity testing, Trail Making Test part B, clock drawing test, and rapid pace test (walk 10 feet back and forth in 9 seconds) as an initial screening, along with ROM and motor strength testing (American Medical Association, 2009).
- In addition, a thorough history should be taken which includes: (1) a review of all medication that might affect cognition or coordination; (2) screening for sleep apnea (BMI > 35, neck size > 15.5 inches for females or 17 inches for males, daytime sleepiness, Eppworth Sleepiness Scale score of 10 or greater, 2 or more hypertension medications); (3) history of accidents and/or tickets; and (4) consultation with family and/or support system members or others regarding driving ability. Reluctance of others to ride with the patient may be an indication of problems. Patients may also fill out surveys that have some predictive abilities (American Automobile Association, 2011; Eby, Molnar, & Shope, 2000).

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.

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. 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 required 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. Individuals with M/S TBI may or may not be able to successfully compensate for these impairments.

Time frames

Time frames regarding driving evaluation and treatment	
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	Between 2 to 6 sessions of behind-the-wheel driving evaluation and training on the road.

G.3 Vocational rehabilitation

Definition and background

Vocational rehabilitation is a generally accepted intervention, but the Colorado Workers’ Compensation statute limits its use.

Supporting literature and evidence tables

Studies not resulting in evidence statements

In one study, a brain injury vocational rehabilitation program was successful at returning 41% of clients to competitive employment. The majority of the cases were 2 years or more from date of injury and had injuries classified as severe (PTA duration of 1 or more days). These cases were also without significant behavioral problems and able to function independently for ADLs. The program included cognitive training for those who had not previously received it and job trials with job coach support (Murphy et al., 2006).

Indications/recommendations for vocational rehabilitation

Initiation of vocational rehabilitation requires adequate evaluation of individuals with TBI for quantification of highest functional level, motivation, and achievement of MMI. Vocational rehabilitation should involve a comprehensive job analysis and a carefully planned return-to-work strategy with input from the treating physician and interdisciplinary team. In some instances, retraining may need to occur to access new job markets. (Refer to Section G, Return to work.)

G.4 Work conditioning

Definition and background

These well-accepted programs are work-related, outcome-focused, and individualized treatment programs. Objectives of the program include, but are not limited to, improvement of cardiopulmonary and neuromusculoskeletal functions (strength, endurance, movement, flexibility, stability, and motor control functions), patient education, and symptom relief. The goal is for patients to gain full or optimal function and return to work.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for work conditioning

These programs are usually initiated once re-conditioning has been completed, but they may be offered at any time throughout the recovery phase. It should be initiated when imminent return of a patient to modified or full duty is not an option but the prognosis for returning the patient to work at completion of the program is at least fair to good.

Recommendations for work conditioning

The service may include the time-limited use of modalities, both active and passive, in conjunction with therapeutic exercise, functional activities, general conditioning body mechanics,

and re-training of lifting techniques. The patient should be assisted in learning to pace activities to avoid exacerbations.

Time frames

Time frames regarding work conditioning	
Length of visit	1 to 4 hours per day.
Frequency	2 to 5 visits per week.
Optimum duration	2 to 4 weeks.
Maximum duration	6 weeks. Participation in a program beyond 6 weeks should be documented with respect to need and the ability to facilitate positive symptomatic and functional gains.

G.5 Work simulation

Definition and background

Work simulation is a generally accepted program where an individual completes specific work-related tasks for a particular job and return to work.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for work simulation

Use of this program is appropriate when modified duty can only be partially accommodated in the work place, when modified duty in the work place is unavailable, or when the patient requires more structured supervision. The need for work place simulation should be based on the results of a functional capacity evaluation and/or job site analysis.

Time frames

Time frames regarding work simulation	
Length of visit	2 to 6 hours per day.

Time frames regarding work simulation	
Frequency	2 to 5 visits per week.
Optimum duration	2 to 4 weeks.
Maximum duration	6 weeks. Participation in a program beyond 6 weeks should be documented with respect to need and the ability to facilitate positive symptomatic and functional gains.

Referenced Version

H. Maintenance management

Management of M/S TBI continues after the individual has met the definition of Maximum Medical Improvement (MMI). MMI is reached when an individual's condition has plateaued and the authorized treating provider believes no further medical intervention is likely to result in improved function. For patients with M/S TBI, this is not likely to occur for at least two years post-injury. Injured workers are entitled to lifetime medical benefits that are reasonable, necessary, and related to maintaining them at MMI. When the individual has reached MMI, a physician must describe in detail the plan for maintenance treatment, including the level and type of care and support services. (Refer to Section D.3, Course of recovery.) 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.

Individuals with M/S TBI may experience lifetime impairment, functional limitations, and disabilities. They are at risk the remainder of their lives for long-term medical, psychiatric, physical, and cognitive complications. Subsequent brain injuries, the onset of seizures, endocrine or other medical conditions, maladaptive social skills, aggressive behaviors, substance abuse, and psychiatric disorders are common examples of some negative long-term consequences of TBI. Patients with M/S TBI are also at a higher risk of isolation and depression. Individuals with M/S TBI 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. These long-term supports should include avocational activities, socialization, and activities designed to foster connectedness through community and family activities.

Maintenance care of individuals with M/S TBI requires a close working relationship among the insurance carrier, the clinical providers, the family and/or support system, 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 ensure that medically appropriate, cost effective programs are authorized in a timely manner. A designated primary physician for maintenance team management is recommended.

Health professionals with experience in life care plans are frequently involved in making assessments for long-term care. Providers and carriers should adopt a long-term case management model for these individuals. Common lifetime supports that are reasonable and necessary include, but are not limited to: physician oversight, nursing services, various periodic rehabilitation therapies, life skills training, supported living programs, attendant care, supported employment, productive activity recreation, transportation, medication, psychological services, and individual/family/support system education. Supported employment may assist in return to work outside a sheltered work setting.

The specific type and amount 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 certified case manager who may intervene quickly when necessary. Case management should not be discontinued when a person completes acute rehabilitation; it should continue at a frequency necessary for successful long-term management.

Medical and rehabilitation providers are encouraged to educate individuals and their family and/or support systems regarding anticipated ongoing medical and rehabilitation needs. Because the long-term medical needs of individuals with M/S TBI are uncertain, each individual, his/her family and/or support system, and providers should plan for unforeseen medical, psychiatric, social, physical, and cognitive complications as individuals with TBI age. As time since injury progresses, patients and their family/support systems require assistance with overall quality of life, as well as basic medical management.

When developing a maintenance plan of care, the individual, his/her physician, and the insurer should attempt to meet the following goals:

- Maximum independence will be achieved through the use of home and community-based programs and services.
- Individuals with TBI shall maximally participate in decision-making, self-management, and self-applied treatment.

Treatment involving more than one provider shall be coordinated through an authorized treating provider with the assistance of a case manager.

The authorized treating provider should reassess treatment at least every six months.

Treatment by all practitioners should focus on establishing the highest possible level of self-sufficiency. Most passive modalities are oriented toward pain management. They should be limited and emphasize self-management and self-applied treatment with a demonstrated goal of increasing activity, function, and quality of life.

Patients and families and/or support systems should understand that failure to comply with the elements of the self-management program or therapeutic plan of care may affect consideration of other interventions.

Periodic reassessment of the individual's condition will occur as appropriate. The overall maintenance plan should be reassessed at least annually by the authorized treating provider.

Programs should be individualized to specific needs and may include the following.

H.1 Neuromedical management

Definition and background

Patients with M/S TBI will have ongoing medical issues requiring treatment on a regular basis.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for neuromedical maintenance management

Examples of related medical diagnoses include, but are not limited to: neuro-endocrine dysfunction, urinary incontinence, heterotrophic ossification, seizures, and other conditions described in the treatment sections of this guideline.

Time frames

Time frames regarding neuromedical management: maintenance	
Frequency	Medical management visit frequency will depend on the severity of the medical condition but may occur monthly or more frequently.
Maximum maintenance duration	Visits should occur at least at 6-month intervals for extremely stable conditions.

H.2 Medication management

Definition and background

Medications may be necessary for management of chronic conditions for individuals with M/S TBI.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for medication maintenance management

Medications may be used for medical, physical, perceptual, cognitive, neuroendocrine, and psychological reasons, and they should be prescribed by physicians experienced in TBI medication management. Reasons for possible medications and the types and names of medication are numerous, individualized for each person, and beyond the scope of these guidelines.

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.

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. Physicians must follow patients who are on any chronic medication or prescription regimen for compliance, efficacy, and side effects. 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, medications and drug levels should be closely monitored.

Individuals with TBI may forget to take medications and/or have difficulty with complicated medication regimens. They may need assistance with medication management, such as reminders, medication boxes, assistance with filling medication boxes, or medication administration supervision. Some medications may need to be prescribed in small amounts or locked due to safety in patients who are impulsive, forgetful, inconsistent, or otherwise unsafe in independent medication management.

Time frames

Time frames regarding medication management: maintenance	
Frequency	Medication and medical management 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 performed as appropriate.
Maintenance duration	As new medications become available and side effects of other medications are established, there may need to be changes in medical management.

H.3 Physical, occupational, and speech therapy

Definition and background

Exacerbation of symptoms or decline in functional status may require short-term intensive treatment to return the individual to maximized function.

Supporting literature and evidence tables

Evidence statements regarding outpatient rehabilitation: maintenance			
Good evidence	Evidence statement	Citation	Design
	<p>Physical, occupational, or multi-disciplinary outpatient therapy reduces deterioration of ADLs and independence for stroke survivors living in the community.</p> <p>Note: It is likely that this also applies to patients with M/S TBI.</p>	([Cochrane] Stroke Unit Trialists, 2007)	Meta-analysis of randomized clinical trials

Indications/recommendations for PT/OT/ST

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 that 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 this guideline apply.

Over time, speech, language, and/or cognitive functioning may deteriorate due to changes in life's stressors, support systems, and/or the individual's living situation, role, and responsibilities at home or work. Short-term speech therapy emphasizing patient education, compensatory strategies, and objectively measured functional goals may be indicated. Aging issues of the individual or the caregiver may also result in a decline of speech, language, and/or cognitive functioning requiring speech therapy.

Participation in a PT, OT, or ST maintenance program must be documented with respect to need and the ability of the program to facilitate positive symptomatic gains or functional gains and/or to prevent further deterioration.

Time frames

For time frames to address changes due to aging or acute aggravations, refer to Section F.4, Specific treatments, and Section G, Return to work and vocational rehabilitation.

H.4 Cognitive/behavioral/psychological management

Definition and background

Due to the fact that deficits from M/S TBI can 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, the onset of medical/neurologic/psychiatric comorbidities, or changes in environmental structure.

Researchers are learning more about long-term mood disorders, such as depression and anxiety, as well as executive dyscontrol, emotional dysregulation, and all other disorders for which medication may be beneficial. Regaining insight or self-awareness 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 also requires psychotropic medication and close monitoring. Refer to Section F.1.d, Medications.

Supporting literature and evidence tables

Studies not resulting in evidence statements
One study followed patients with M/S TBI for 20 years and found depression rates of up to 28% (Fisher et al., 2016).

Indications for cognitive/behavioral/psychological maintenance management

Developmental issues, changes in the individual's support system, and development or exacerbation of a mood or other psychiatric disorder may require psychological treatment to return the individual to the highest level of functioning possible.

Individuals with or without TBI frontal involvement may need periodic reassessments and psychiatric and/or psychological interventions.

Some individuals with persistent behavioral problems (i.e., impulsivity or other behavioral dyscontrol) may require regular psychological maintenance therapy to help the individual to function maximally in the community.

Recommendations for cognitive/behavioral/psychological maintenance management

The maintenance program for individuals with M/S TBI should be oriented toward maintaining the highest level of independent function that he/she has been able to achieve. When possible, the person with moderate/severe injury should be involved in social skills training, support groups, and/or other community-based activities to promote socialization. Some individuals with severe injuries will require periodic consultation to correct problems that have developed to allow them to continue to function in the community.

Health care providers who provide services to maintain the functioning of individuals with TBI in the community are obligated to identify the specific diagnosis and symptoms on which treatment is focused and to document the ongoing results of such treatment.

Periodic assessment by the treating physician and/or an occupational therapist, physical therapist, or speech-language pathologist may be necessary to maintain and/or upgrade the patient's program and provide additional strategies if needed.

Supportive education and counseling may also be needed for the family/support system and, when necessary, should be available to primary care givers individually and with the patient.

Substance abuse, particularly alcohol abuse, can occur or recur after TBI and can worsen psychiatric and psychological comorbidities. It should be screened for and treated if present.

Time frames

Periodic psychological treatment, upgrading, or consultation may be necessary throughout a person's lifetime following TBI. Therapy may be reinitiated for time limited, goal-specific treatment as new goals or TBI related problems develop. Aging or significant life change is likely to have an effect on cognitive, psychological, and behavioral function and may require further treatment.

Time frames regarding cognitive/behavioral/psychological management: maintenance	
Maintenance duration	The number of sessions will depend on the individual and the situation.

H.5 Durable medical equipment: purchase, rental, and maintenance

Definition and background

It is recognized that some patients 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.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications for purchase or rental of durable medical equipment

Purchase or rental of this equipment should be done only if the assessment by the physician and/or therapist has determined the safety, effectiveness, compliance, and improved or maintained function by its application.

Recommendations for purchase, rental, and maintenance of durable medical equipment

Equipment may include, but is not limited to:

- exercise equipment;
- bathroom ADL equipment;
- assistive devices, such as shower/bath seats, assistive mobility devices, splints and/or braces, and assistive technology for memory and medication support;
- functional electrical muscle stimulators;
- TENS units; and
- Continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP).

Periodic maintenance and replacement of the equipment may be indicated and should be considered in the maintenance plan.

Time frames

Time frames regarding durable medical equipment: maintenance	
Maximum maintenance duration	Not to exceed 6 months for rental of large equipment. If effective, purchase and maintenance should occur.

H.6 Patient education maintenance management

Definition and background

Functional abilities and support systems for individuals with M/S TBI may change over time and frequently require additional support.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for patient education maintenance management

Educational classes, sessions, or programs may be necessary to reinforce self-management techniques and social skills training and to help the individual and their support system adjust to life changes. This may be performed as formal or informal programs, either group or individual.

Time frames

Time frames regarding patient education management: maintenance	
Frequency	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.

H.7 Home exercise programs and exercise equipment

Definition and background

Most patients have the ability to participate in a home exercise program after completion of a supervised exercise rehabilitation program. Some patients with M/S TBI may benefit from the purchase or rental of equipment to maintain a home exercise program.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for home exercise maintenance programs

Programs should incorporate an exercise prescription including the continuation of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, stabilization, balance, and strength. Home exercise programs are most effective when done three to five times a week.

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. Prior to purchasing or renting the equipment, a therapist and/or exercise specialist who has treated the patient should visit a facility with the patient to ensure proper use of the equipment. The patient 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 ADLs or work activity.

For chronic pain, refer to the Division's Chronic Pain Disorder Medical Treatment Guideline.

Time frames

Follow-up evaluations in the home should occur to ensure compliance and to upgrade the home program. Occasionally, compliance evaluations may be made through a 4-week membership at a facility offering similar equipment to that purchased/rented for the patient.

H.8 Exercise programs requiring gym memberships or special facilities

Definition and background

Some individuals with TBI may have higher compliance with an independent exercise program at a health club or a community activity-based wellness program versus participation in a home program, although individuals with TBI may require supervision or guidance.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for exercise programs requiring special facilities

All exercise programs completed through a health club facility should be approved by the treating therapist and/or physician and focus on the same parameters of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, balance, stabilization, and strength. Prior to purchasing a membership, a therapist and/or exercise specialist who has treated the individual should visit the facility with the individual to ensure proper use of the equipment. Periodic program evaluation and upgrading may be necessary by the therapist. The use of a personal trainer may be necessary.

Time frames

Time frames regarding exercise programs requiring special facilities: maintenance	
Frequency	Approximately 2 times per week. Regular attendance is necessary for continuation, with an exception for a medical or sufficient intervening cause.
Maximum maintenance duration	Continuation beyond 3 months after MMI should be based on functional benefit and compliance. At MMI, health club membership should not extend beyond 3 months if attendance drops below 2 times per week on a regular basis without a medical cause.

H.9 Sustained return to work

Definition and background

The functional status of patients with M/S TBI is likely to change over time. Therefore, additional assistance may be needed to support work.

Supporting literature and evidence tables

Studies not resulting in evidence statements
A 10-year follow-up study of patients with severe brain injuries suggested that for some patients there is a decline in employment between 5 and 10 years (Cuthbert et al., 2015).

Indications/recommendations for sustained return to work.

Based on the study described above, additional return-to-work assistance may be necessary after the initial return to work.

H.10 Maintenance home care

Definition and background

Individuals with M/S TBI may require ongoing home care to assist with a variety of services necessary to maintain their MMI.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for maintenance home care

The type of the services required will be dependent on the nature and severity of residual deficits. Services may include skilled nursing, certified nursing assistants, life skills trainer, homemaker, companion care, or a combination of these services. Transportation services may also be required.

It is essential for providers to be very specific about 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 care that 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 and/or support system's 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.

Time frames

Time frames regarding home care - maintenance	
Frequency	The frequency of the services required will be dependent on the nature and severity of residual deficits.
Maintenance duration	Care may be necessary for limited periods of time or, in some cases, may be required for the course of the individual's lifetime.

H.11 Long-term residential care

Definition and background

A number of individuals with M/S TBI will require residential care as it is unsafe for them to live without supervision.

Supporting literature and evidence tables

The following recommendations were based on consensus.

Indications/recommendations for long-term residential care

Some individuals with M/S 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 support 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 skilled nursing facilities. (Refer to Section F.5.b, Sub-acute skilled nursing facilities, or Section F.5.i, Supported living programs or long-term care residential services.)

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