Updated Management of TBI

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Items

- Types of TBI
- Diagnosis
- Review of Management

Introduction

- TBI is one of the most common causes of death and failure to return to society according to recent literature.

- Depending on the region, the mortality rate due to TBI ranges from 13/100,000 (China) [1] to 11/100,000 (Europe) and 17/100,000 (USA)

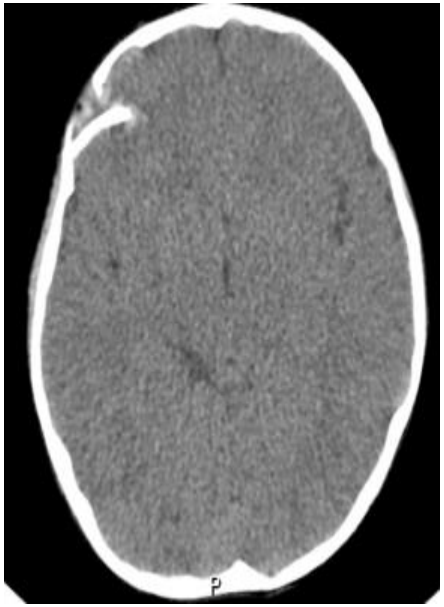
Classifications of Head Injuries

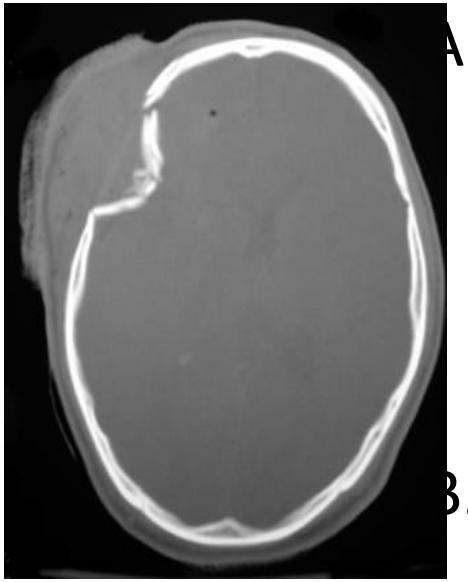
TABLE 6.1 Classifications of Brain Injury

Severity	• Minor • Moderate • Severe		• GCS Score 13–15 • GCS Score 9–12 • GCS Score 3–8
Morphology	• Skull fractures	• Vault	• Linear vs stellate • Depressed/nondepressed • Open/closed
		• Basilar	• With/without CSF leak • With/without seventh nerve palsy
	• Intracranial lesions	• Focal	• Epidural • Subdural • Intracerebral
		• Diffuse	• Concussion • Multiple contusions • Hypoxic/ischemic injury • Axonal injury

TBI: Bone

- Assess for skull fractures. Keep in mind that





A. Suture lines (joining of the bones of the cranial vault) may be mistaken for fractures.

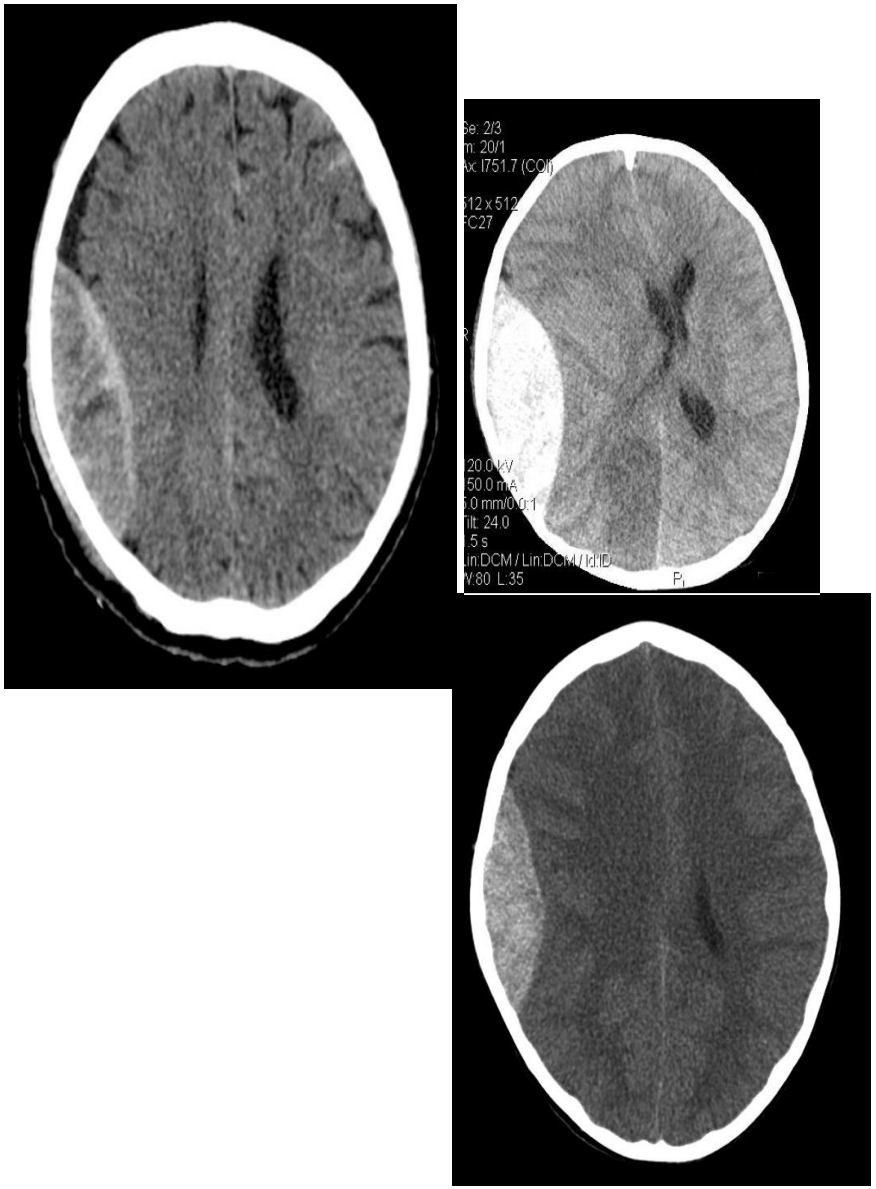
B. Depressed skull fractures (thickness of skull) require neurosurgical consultation.

TBI: Brain and Blood:

A. Acute subdural hematomas:

- Typically are areas of increased density covering and compressing the gyri and sulci over the entire hemisphere
- Can cause a shift of the underlying ventricles across the midline
- Occur more commonly than epidural hematomas
- Can have associated cerebral contusions and intracerebral hematomas

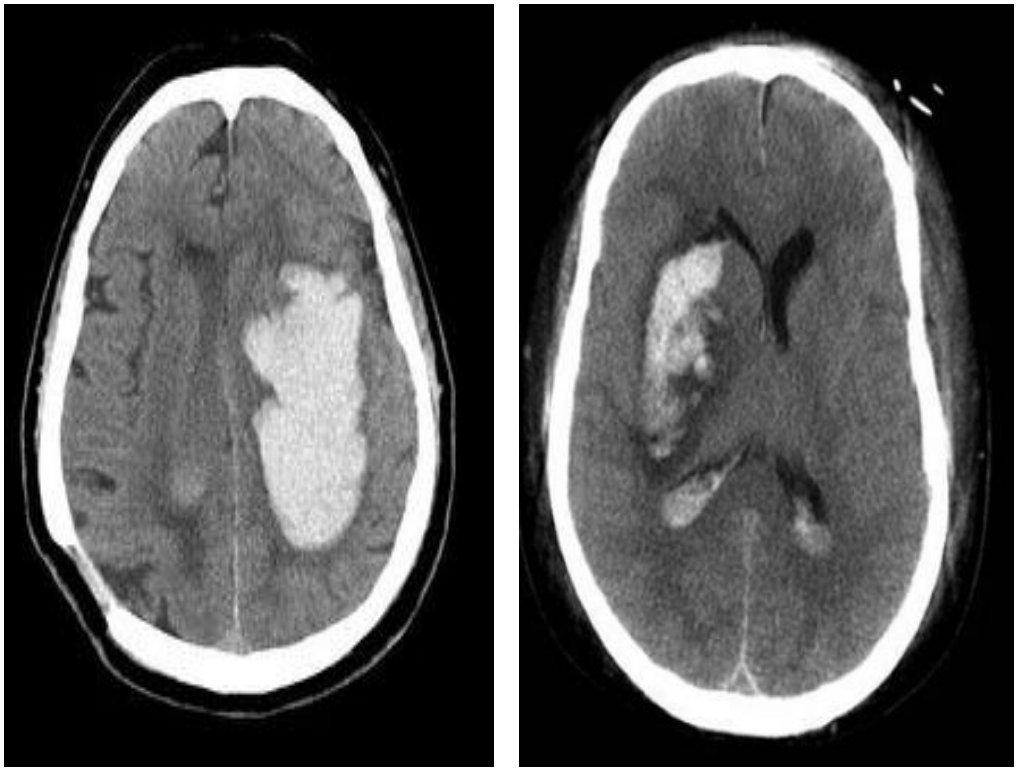
Acute epidural hematomas



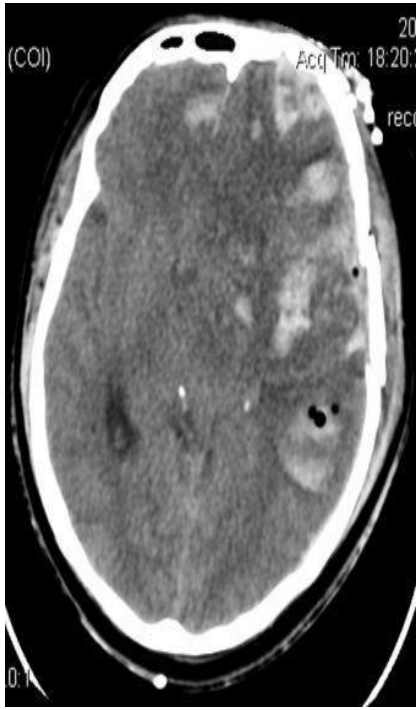
- Typically are lenticular or biconvex areas of increased density
- Appear within the skull and compress the underlying gyri and sulci
- Can cause a shift of the underlying ventricles across the midline
- Most often are located in the temporal or temporo-parietal region

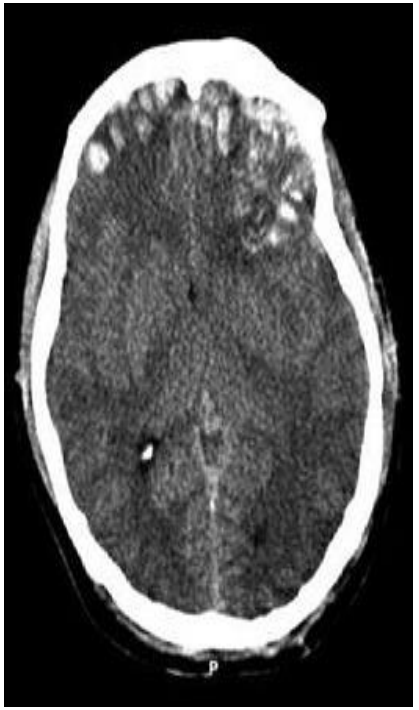
C. Cerebral and cerebellar hematomas.

- A. Compare both hemispheres for similar density and symmetry.
- B. **Intracerebral hematomas** appear as areas of high density.



C. **Cerebral contusions** appear as punctate areas of high density.





Diffuse axonal injury

can appear

normal or have scattered, small areas of cerebral contusion areas of low density.

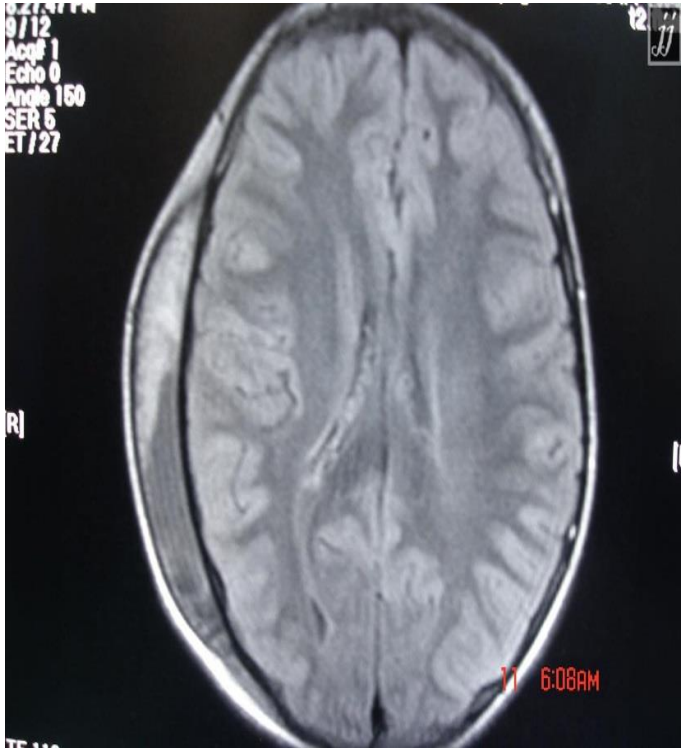
Ventricles

- Significant mass lesions compress and distort the ventricles, especially the lateral ventricles.
- Significant intracranial hypertension is often associated with decreased ventricular size.
- **Intraventricular hemorrhage** appears as regions of increased density (bright spots) in the ventricles.
- Determine the shift away from the midline


Se: 2/3
m: 20/1
Ax: I751.7 (COl)
512 x 512
FC27
R
120.0 kV
150.0 mA
5.0 mm/0.0:1
Tilt: 24.0
1.5 s
Lin:DCM / Lin:DCM / Id:ID
W:80 L:35
P1

Soft tissue:

- Assess the scalp component for contusion or swelling that can indicate a site of external trauma.



Primary Survey of Head trauma: Airway and Breathing

- Transient respiratory arrest and hypoxia are common with severe brain injury and may cause secondary brain injury.
- **Early endotracheal intubation should be performed in comatose patients.**
- The patient should be ventilated with **100% oxygen** until blood gas measurements are obtained, after which appropriate adjustments to the fraction of inspired oxygen (FIO2) are made.
- Pulse oximetry is a useful adjunct, and oxygen saturations of **>98%** are desirable. Ventilation parameters are set to maintain a PCO2 of approximately **35 mm Hg**. Hyperventilation (PCO2 <32 mm Hg) should be used cautiously in patients with severe brain injury and only when acute neurologic deterioration has occurred.

Primary Survey of Head trauma: Circulation

- **Hypotension usually is not due to the brain injury itself, except in the terminal stages when medullary failure supervenes or there is a concomitant spinal cord injury.**
- Intracranial hemorrhage **cannot** cause hemorrhagic shock.
- Euvolemia should be established as soon as possible if the patient is hypotensive, using blood products, whole blood, or isotonic fluids, as needed. It must be emphasized that the neurologic examination of patients with hypotension is unreliable. Patients with hypotension who are unresponsive to any form of stimulation may recover and substantially improve soon after normal blood pressure is restored. The primary source of the hypotension must be urgently sought and treated.

Primary Survey of Head trauma: Neurologic Examination

- It consists primarily of determining the GCS score, pupillary light response, and focal neurological deficit.
- Search for : drugs, alcohol, intoxicants, and other injuries

- **It is important to obtain the GCS score and to perform a pupillary examination prior to sedating or paralyzing the patient.**

- **Long-acting** paralytic and sedating agents should not be used during the primary survey. Sedation should be avoided except when a patient's agitated state could place him or her at risk

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Clustering identifies endotypes of traumatic brain injury in an intensive care cohort: a Center-TBI study

Background

While the Glasgow coma scale (GCS) is one of the strongest outcome predictors, the current classification of traumatic brain injury (TBI) as ‘mild’, ‘moderate’ or ‘severe’ based on this fails to capture enormous heterogeneity in pathophysiology and treatment response.

The authors hypothesized that data-driven characterization of TBI could identify distinct endotypes and give mechanistic insights

Results

- Six stable endotypes were identified with distinct GCS and composite systemic metabolic stress profiles, distinguished by GCS, blood lactate, oxygen saturation, serum creatinine, glucose, base excess, pH, arterial partial pressure of carbon dioxide, and body temperature.

- Notably, a cluster with ‘moderate’ TBI (by traditional classification) and deranged metabolic profile, had a worse outcome than a cluster with ‘severe’ GCS and a normal metabolic profile.

- In addition, it significantly improved the prognostic precision of the IMPACT (International Mission for Prognosis and Analysis of Clinical trials in TBI) extended model, for prediction of both unfavorable outcome and mortality

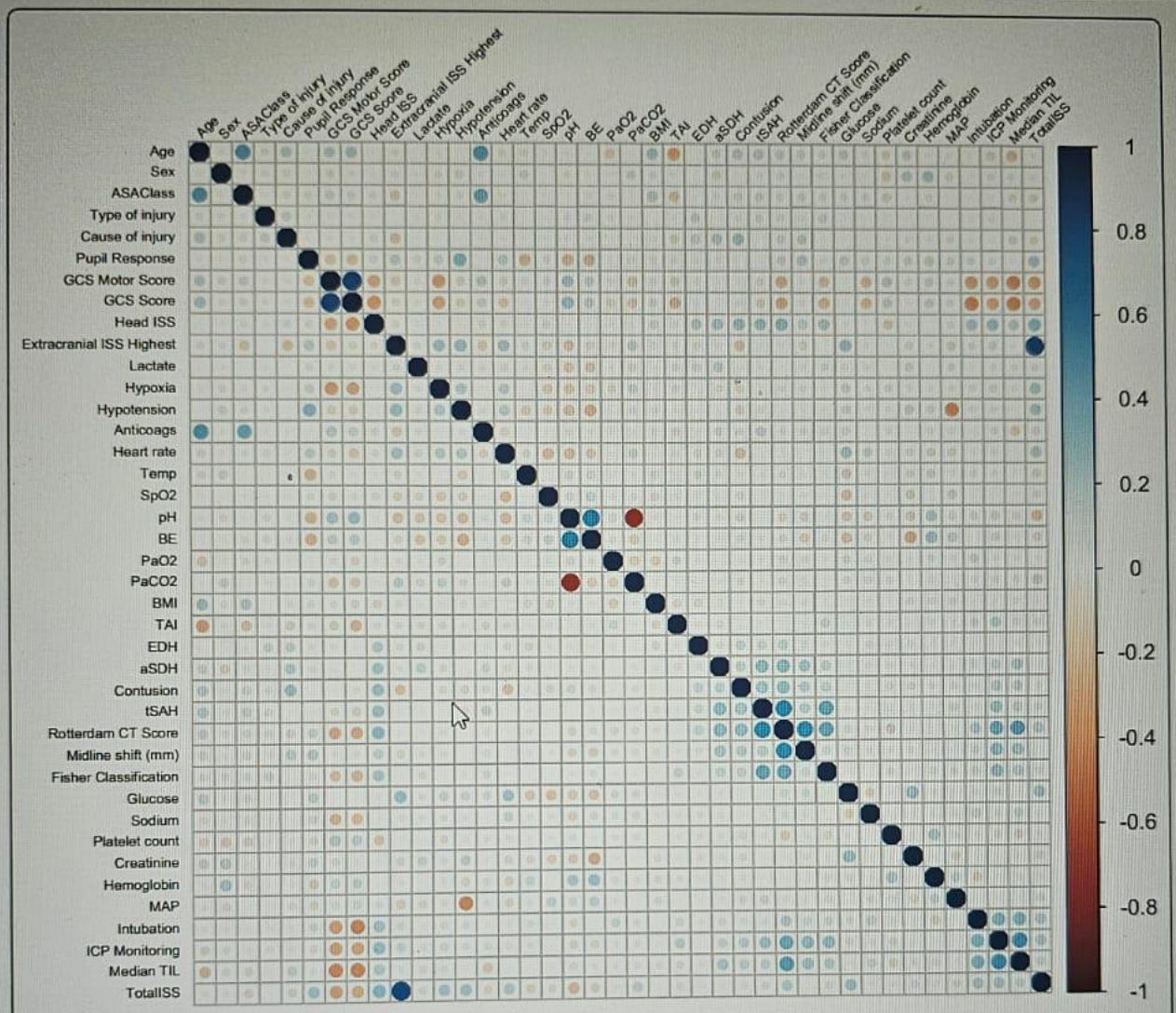

Fig. 1 Linear correlation between all pairs of features. To visualize the strength of linear correlation between each pair of features, the value of the Pearson correlation coefficient is represented by the size and colour of the dots in the matrix. Strongly correlated features (pH and base excess, pH and arterial partial pressure of carbon dioxide ($PaCO_2$), GCS motor and total score, Rotterdam CT score and midline shift, Rotterdam CT score and Fisher classification, GCS motor score and pupil response, age and ASA PS-class (American Society of Anesthesiologists physical status classification), and age and anticoagulants at baseline) were modelled as bivariate joint Gaussian distributions. GCS, Glasgow coma scale; ISS, injury severity score; SpO_2, oxygen saturation; PaO_2, arterial partial pressure of oxygen; $PaCO_2$, arterial partial pressure of carbon dioxide; BMI, body mass index; TAI, traumatic axonal injury; EDH, epidural hematoma; aSDH, acute subdural hematoma; tSAH, traumatic subarachnoid haemorrhage; MAP, mean arterial pressure; ICP, intracranial pressure; TIL, therapy intensity level

Treatment of Severe Traumatic Head Injury

- Front Neurol 2017 Jul 4;8:315. doi: 10.3389/fneur.2017.00315

Critical Evaluation of the Lund Concept for Treatment of Severe Traumatic Head Injury, 25 Years after Its Introduction

- When introduced in 1992, the Lund concept (LC) was the first complete guideline for treatment of severe traumatic brain injury (s-TBI).

- It was a theoretical approach, based mainly on general physiological principles—i.e., of brain volume control and optimization of brain perfusion and oxygenation of the penumbra zone. “Penumbra” is the reversibly injured brain tissue around the ischemic core which is the target for the treatment of acute stroke

- The concept gave relatively strict outlines for cerebral perfusion pressure, fluid therapy, ventilation, sedation, nutrition, the use of vasopressors, and osmotherapy.

Components where the Brain Trauma Foundation BTF guideline has approached or deviated from the Lund concept (LC)

LC (1992)	BTF at its introduction (1996)	BTF 2007/2016
Cerebral perfusion pressure (CPP) 50–70 mmHg	CPP above 70 mmHg	CPP 50–70 mmHg
Avoidance of osmotherapy	Osmotherapy a main intracranial pressure-reducing therapy	Osmotherapy still used, but with more caution
Avoidance of vasopressors	High doses of vasopressors accepted to keep CPP above 70 mmHg	Vasopressors can be used, but less frequent to avoid ARDS
Active cooling is not used	Active cooling is accepted	Active cooling is not used
Albumin recommended as plasma volume expander	Albumin recommended as plasma volume expander	Albumin not specifically recommended

treatment

- Treatment algorithms based on the Lund concept through the first Brain Trauma Foundation (BTF) recommendations led to a reduction of mortality among patients diagnosed with TBI [3,4].

Brain Trauma Foundation (BTF)

The main goals of the therapy are to keep

- ICP below 22 mmHg and
- Maintain Systolic Blood Pressure at particular levels for different ages.
- For CPP the main target should be 60–70 mmHg according to those guidelines.

It changed the approach for TBI treatment from the Lund concept, which included, among others, albumin and blood transfusion.

- Although mortality from TBI has decreased over the last 30 years, the proportion of patients with favorable outcomes have remained relatively unchanged, despite developments such as intracranial pressure (ICP) monitoring.

- A recent report identified large variation in TBI management in a European multi-centre cohort, without a corresponding variation in outcomes [6].

- While it is possible that these management variations truly had no impact on outcome, this result could also be due to a substantial heterogeneity of the disease masking treatment effect in relevant subgroups.

- Due to lack of high-quality evidence, variations in treatment strategies are based largely on local strategies rather than mechanistically aligned to injury types.
- A better characterization of patients could allow discrimination into more specific and biologically relevant sub-groups based on clinical, biomarker, patho-anatomic, and physiological features

Conclusions

Effective management of impairments in executive functioning can increase the success and well-being of individuals with mild- severe MS-TBI in their day-to-day lives.

These guidelines provide management recommendations based on the latest evidence, with support for their implementation, and encourage researchers to explore and validate additional factors such as predictors of treatment response