Outcome measure after TBI
- clinical scores and scales
evaluating functioning following rehabilitation
TBI - rehabilitation

Praxeological course of action for comprehensive rehabilitation:

1. Diagnostics
2. Prognosis
3. Functional evaluation
4. Rehabilitation planning
5. Implementation
TBI - prognosis

- The lower initial Glasgow Coma Scale, the worse the outcome
- The longer the coma, the worse the outcome
- The longer the period of post-traumatic amnesia, the worse the outcome

These are many clinimetric scales that assess consciousness and disability after TBI, i.e. Glasgow Coma Scale (GCS), Grady Coma Scale, Comprehensive Level of Consciousness Scale (CLOCS), Full Outline of UnResponsiveness score (FOUR), JFK Coma Recovery Scale – Revised (CRS-R), Disorders of Consciousness Scale (DOCS), Disability Rating Scale (DRS), Coma/Near-Coma Scale (CNC), SMART,
Sensory Modality Assessment Rehabilitation Technique, Rancho Los Amigos Cognitive Levels (RLA), Western Neuro Sensory Stimulation Profile (WNSSP), Sensory Stimulation Assessment Measure (SSAM), Wessex Head Injury Matrix (WHIM), Loewenstein Communication Scale (SCS), Swedish Reaction Level Scale (RLS 85), Innsbruck Coma Scale (INNS), Glasgow Liege Coma Scale (GLCS), Neurological Outcome Scale for TBI (NOS-TBI) etc.
TBI - scales

- Glasgow Coma Scale (GCS) (Teasdale & Jennet, 1974)
- Grady Coma Scale (Feischer et al., 1976)
- Full Outline of UnResponsiveness score (FOUR) Wijdicks, 2005
- JFK Coma Recovery Scale – Revised (CRS-R) (Giaccino et al., 2004)
- Disorders of Consciousness Scale (DOCS) (Pape et al., 2005)
TBI – scales cont.

- Disability Rating Scale (DRS) (Rappaport et al., 1999)
- Coma/Near-Coma Scale (CNC) (Rappaport et al., 1992)
- Sensory Modality Assessment Rehabilitation Technique (SMART) (Gill-Thwaites, 1997)
- Rancho Los Amigos Cognitive Levels (RLA) (Hagen & Malkmus, 1983)
TBI – scales cont.

- Western Neuro Sensory Stimulation Profile (WNSSP) (Ansell & Keenan, 1989)
- Sensory Stimulation Assessment Measure (SSAM) (Rader & Ellis, 1994)
- Wessex Head Injury Matrix (WHIM) (Horn & Wilson, 1994)
- Loewenstein Communication Scale (SCS) (Borer-Alafi et al., 2002)
- Reaction Level Scale (RLS 85) (Starmark et al., 1988)
Innsbruck Coma Scale (ICS)  
(Benzer et al., 1991, Diringer et al., 1997)

Glasgow Coma Scale-Liege  
(Born et al., 1982)

Swedish Reaction Level Scale-1985  
(RLS-85) (Stalhammar, 1988)

Neurological Outcome Scale for TBI (NOS-TBI) (Wilde et al., 2010)
Clinimetrics scales in TBI

Glasgow Coma Scale (GCS)
(Revised 1974, Teasdale & Jennet, 1974)

Used in many trials:
ASCOT, APACHE II, APACHE III, CRAMS.
Glasgow Coma Scale (GCS) (Teasdale & Jennet, 1974) has been the gold standard of neurologic assessment for trauma patients since its development by Jennett and Teasdale in 1974. The GCS was found to be a simple tool to use. It became the method of choice for trauma care practitioners to document neurologic findings over time and predict functional outcome.
TBI - scales

- **Glasgow Coma Scale (GCS)** (Teasdale & Jennet)

Although the Glasgow Coma Scale has been shown to be effective, many authors have cited weaknesses in the scale including the inability to predict outcome, variation in inter-rater reliability, and the inconsistent use by caregivers in the prehospital and hospital settings.
Glasgow Coma Scale (GCS)

GCS is based on motor responsiveness, verbal performance, and eye opening to appropriate stimuli. Individual elements as well as the sum of the score are important. The final score, expressed in the form "GCS 9 = E2 V4 M3 at 07:35", ranges from 1 to 15. Generally, brain injury is classified as severe (with GCS < 9), moderate (GCS 9–12) and minor (GCS ≥ 13).
TBI - GCS

- Conditions that affect the calculation of three components of Glasgow Coma Scale (GCS):

  Ocular trauma, Cranial nerve injuries, Pain, Intoxication (alcohol, drugs), Medications (anaesthetics, sedatives), Dementia, Psychiatric diseases, Developmental impairments, No comprehension of spoken language, Intubation, tracheostomy, laryngectomy, Edema of tongue, Facial trauma, Mutism, Hearing impairments, Injuries (spinal cord, peripheral nerves, extremities).

TBI - scales

- **Grady Coma Scale** (Feischer et al., 1976)
  classes people on a scale of I to V along a scale of confusion, stupor, deep stupor, abnormal posturing, and coma.

- **JFK Coma Recovery Scale – Revised (CRS-R)** (Giaccino et al., 2004)
  Consist of six subscales: auditory function, visual, motor, oromotor/verbal function, communication and arousal. Interrater and test-retest reliability were high for CRS-R total scores. Subscale analysis showed moderate to high interrater and test-retest agreement although systematic differences in scoring were noted on the visual and oromotor/verbal subscales.
Wijdicks et al. validated in 2005 a new coma scale: the Full Outline of UnResponsiveness (FOUR) score. It consists of four components (eye, motor, brainstem, and respiration), and each component has a maximal score of 4. Compared to GCS the interrater reliability was excellent with the FOUR score (kappa(w) = 0.82) and good to excellent for physician rater pairs.
TBI - scales

- Full Outline of UnResponsiveness score (FOUR)
  Wijdicks, 2005  cont.

The agreement among raters was similar with the GCS (kappa(w) = 0.82). The FOUR score provides greater neurological detail than the GCS, recognizes a locked-in syndrome, and is superior to the GCS due to the availability of brainstem reflexes, breathing patterns, and the ability to recognize different stages of the brain herniation.
TBI - scales

- Disorders of Consciousness Scale (DOCS)
  (Pape et al., 2005)

A measure of neurobehavioral functioning after coma: Disorders of Consciousness Scale (DCOS). It consists of eight subscales: social knowledge, taste & swallowing, olfactory, proprioceptive & vestibular, auditory, visual, tactile and readiness. Validity analyses demonstrated that 23 of 34 test stimuli remained stable over time with no floor or ceiling effect.
DOCS measures obtained within 94 days of injury predicted recovery of consciousness up to 1 year after injury (c-indices of 0.70 and 0.86). Positive (0.71) and negative (0.68) predictive values indicate that the DOCS predicts recovery and lack of recovery.
TBI – scales

- Disability Rating Scale (DRS) (Rappaport et al., 1999)
- Coma/Near-Coma Scale (CNC) (Rappaport et al., 1992)
- Sensory Modality Assessment Rehabilitation Technique (SMART) (Gill-Thwaites, 1997)
- Rancho Los Amigos Cognitive Levels (RLA) (Hagen & Malkmus, 1983)
The Coma/Near Coma (CNC) scale was developed to measure small clinical changes in patients with severe brain injuries who function at very low levels characteristic of near-vegetative and vegetative states.
TBI – scales

- Coma/Near-Coma Scale (CNC)
  (Rappaport et al., 1992)
- Disability Rating Scale (DRS)
  (Rappaport et al., 1999)

The CNC essentially expands the levels of the DRS that incorporate the vegetative and extreme vegetative categories. The CNC has five levels, based on 11 items, that can be scored to indicate severity of sensory, perceptual, and primitive response deficits.
TBI – scales

- **Sensory Modality Assessment Rehabilitation Technique (SMART)**
  
  (Gill-Thwaites, 1997)

Assesses in five levels eight modalities: visual, auditory, tactile, olfactory and gustatory sensation, motor functions, communication, and arousal. In 2004 Gill-Thwaites and Munday proved that SMART is a valid and reliable assessment for discriminating awareness in vegetative state and minimally conscious state.
Western Neuro Sensory Stimulation Profile (WNSSP) (Ansell & Keenan, 1989)

- was developed to assess cognitive function in severely impaired head-injured adults (Rancho Los Amigos levels II-V) and to monitor and predict change in slow-to-recover patients.
- It consists of 32 items which assess patients' arousal/attention, expressive communication, and response to auditory, visual, tactile, and olfactory stimulation.
TBI – scales

- **Sensory Stimulation Assessment Measure (SSAM)** (Rader & Ellis, 1994)

- Patient responses on 15 items are divided into three six-point behavioural subscales (visual, auditory, tactile, gustatory, and olfactory). Each item is scored based on intensity of response to no invasive, noxious or painful stimuli in three categories: eye opening, motor and vocalization.
The Wessex Head Injury Matrix (WHIM) was developed by Shiel et al. (2000) and based on previous work by Horn et al. (1992, 1993) and Wilson et al. (1994). It consists of 62 items which are ordered in a hierarchical way, the hierarchy of behaviors assessed reflecting a statistically derived order of recovery from coma: item 1 should appear before item 2, item 2 before item 3, etc…
Majerus et al. showed that the WHIM scales presented good inter-rater agreement (fair to excellent inter-rater agreement was obtained for 93% of the items) and very good test-retest reliability. The study confirmed that the WHIM was largely superior to the GCS and Glasgow Liege Coma Scale for detecting subtle changes for patients emerging from the vegetative state and for patients being in a minimally conscious state.
Loewenstein Communication Scale (SCS) (Borer-Alafi et al., 2002)

measures five hierarchical functions: mobility, respiration, visual responsiveness, auditory comprehension and linguistic skills (verbal or alternative) - which are divided into five parameters and rated in developmental order on a 5-point scale by level of difficulty.
TBI – scales

- Reaction Level Scale (RLS 85)
  (Starmark et al., 1985, 1988)

Swedish Reaction Level Scale (RLS 85) has been developed in 1985 by Starmark et al. It is a single, eight grade lines scale where 1-3 means that the patient is conscious and 4-8 means that the patient is unconscious.
Innsbruck Coma Scale (ICS) has been created by Benzer et al. in 1991, and modified by Diringer and Edwards in 1997. It assess eight reactions in four-level scoring system. Validation made in 1997 proofed that both GCS and ICS are good at predicting independence (GCS and ICS, 71% correct) and mortality (GCS, 60% correct; ICS, 56% correct) and in predicting levels of outcome (help or independent).
Glasgow Coma Scale-Liege

(Born et al., 1982)

It combines the GCS with a quantified analysis of five brain stem reflexes: fronto-orbicular, vertical oculocephalic, pupillary, horizontal oculocephalic and oculocardiac. Study made in 1987 showed the good agreement achieved by different examiners in the evaluation of brain stem reflexes. Brain stem reflexes offer a slightly higher agreement (kappa = 0.69) than that of the study of motor response (kappa = 0.65). In conclusion: the reliability of the evaluation of motor and brain stem parameters justifies the use of the GLCS as a means for evaluating disturbances of consciousness.
TBI – scales

- **Neurological Outcome Scale for TBI (NOS-TBI)** (Wilde et al., 2010)
  - This is an adaptation of the National Institutes of Health Stroke Scale (NIHSS), specifically for clinical and research use in patients with TBI, including the addition of items specific to TBI, adjustment to the scoring algorithm to allow quantification of deficits in patients who are comatose/vegetative or agitated, and the reassignment of items (i.e., limb ataxia) that are problematic in TBI as supplemental items.
Neurological Outcome Scale for TBI (NOS-TBI) (Wilde et al., 2010) cont.

The total score for the NOS-TBI is the sum of the scores for items 1–13 (based on 3-, 4-, and 5-level ratings, where 0 represents no impairment or deficit. Items 14 and 15 are considered supplemental and do not factor into the total score; thus low scores reflect less severe neurological impairment. This scale is envisioned to serve as a tool for initial stratification of injury severity, and as an outcome measure in randomized clinical trials.
TBI - scales

- **Comprehensive Level of Consciousness Scale. (CLOCS)** Stanczak et al. 1984
- Alternative method of coma assessment compared with the Glasgow Coma Scale.
- CLOCS is a simple scale consisting of seven items assessing eye responses, motor, posture, communication and general responsiveness.
Which scale is the best?

Seel et al. published in 2010 a report of American Congress of Rehabilitation Medicine, Brain Injury-Interdisciplinary Special Interest Group, Disorders of Consciousness Task Force, Assessment scales for disorders of consciousness: evidence-based recommendations for clinical practice and research.
Seel et al. 2010, report of ACRM:

1. JFK Coma Recovery Scale – Revised (CRS-R) may be used to assess disorders of consciousness with minor reservations,
2. SMART, Western Neuro Sensory Stimulation Profile (WNSSP), Sensory Stimulation Assessment Measure (SSAM), Wessex Head Injury Matrix (WHIM), and Disorders of Consciousness Scale (DOCS) may be used to assess disorders of consciousness with moderate reservations.
TBI – which scale is the best?

- Seel et al. 2010, report of ACRM: cont.

3. Coma/Near-Coma Scale (CNC) may be used to assess disorders of consciousness with major reservations.

4. The FOUR, Innsbruck Coma Scale (INNS), Glasgow-Liege Coma Scale, Swedish Reaction Level Scale-1985, Loewenstein Communication Scale (SCS), and CLOCS are not recommended at this time for bedside behavioral assessment of disorders of consciousness because of a lack of content validity, lack of standardization, and/or unproven reliability.