Traumatic Brain Injury (TBI)

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TBI

- Damage to brain tissue from external mechanical forces
- Severity of the injury is dependent on location and trauma itself
  - Diffuse Axonal Injuries-90% never regain consciousness. Damage widespread to axons.
  - Injury to the Brain Stem
    - Regulates CNS, respiratory, and cardiac functions

Incidence and Epidemiology

- 2.8 million TBIs per year
- 214,110 required hospitalization in 2020 – 586 a day
- 80-90,000 long term or permanent disability
- 5.3 million Americans have TBI
- 69,473 TBI-related deaths in 2021 – 190 a day

https://www.cdc.gov/traumatic-brain-injury/index.html

https://www.biausa.org/public-affairs/public-awareness/brain-injury-awareness

Incidence and Epidemiology

- Major cause of disability in individuals under age 40
- Males nearly 2 times more likely to be hospitalized and 3 times more likely to die than females
- **Older adults (65+)** have the **highest rates of TBI-related hospitalizations and deaths**, primarily due to falls.
- **Children and adolescents** often experience TBIs from sports and recreational activities.

https://www.cdc.gov/traumatic-brain-injury/index.html

Etiology

Cause	Description
Falls	Leading cause, especially in children under 4 and adults over 65.
Motor Vehicle Crashes	Major cause in adolescents and young adults.
Struck by/Against Events	Includes sports injuries, workplace accidents, and being hit by objects.
Assaults	Includes domestic violence, gunshot wounds, and physical altercations.
Blast Injuries	Rare in civilians but common in military personnel (especially combat veterans).
Sports and Recreation	Football, soccer, cycling, and skateboarding are frequent contributors.

TBI by Age Group

Age Group	Common Causes	Notes
0–4 years	Falls, abuse	Highest rate of ED visits for TBI
5–14 years	Sports injuries, falls	Sports-related TBIs are common
15–24 years	Motor vehicle crashes, sports	High risk-taking behavior
25–64 years	Falls, assaults, vehicle crashes	Workplace injuries also contribute
65+ years	Falls	Highest rate of TBI-related hospitalizations and deaths

https://www.cdc.gov/traumatic-brain-injury/index.html

Primary Damage
Occurs at the moment of impact

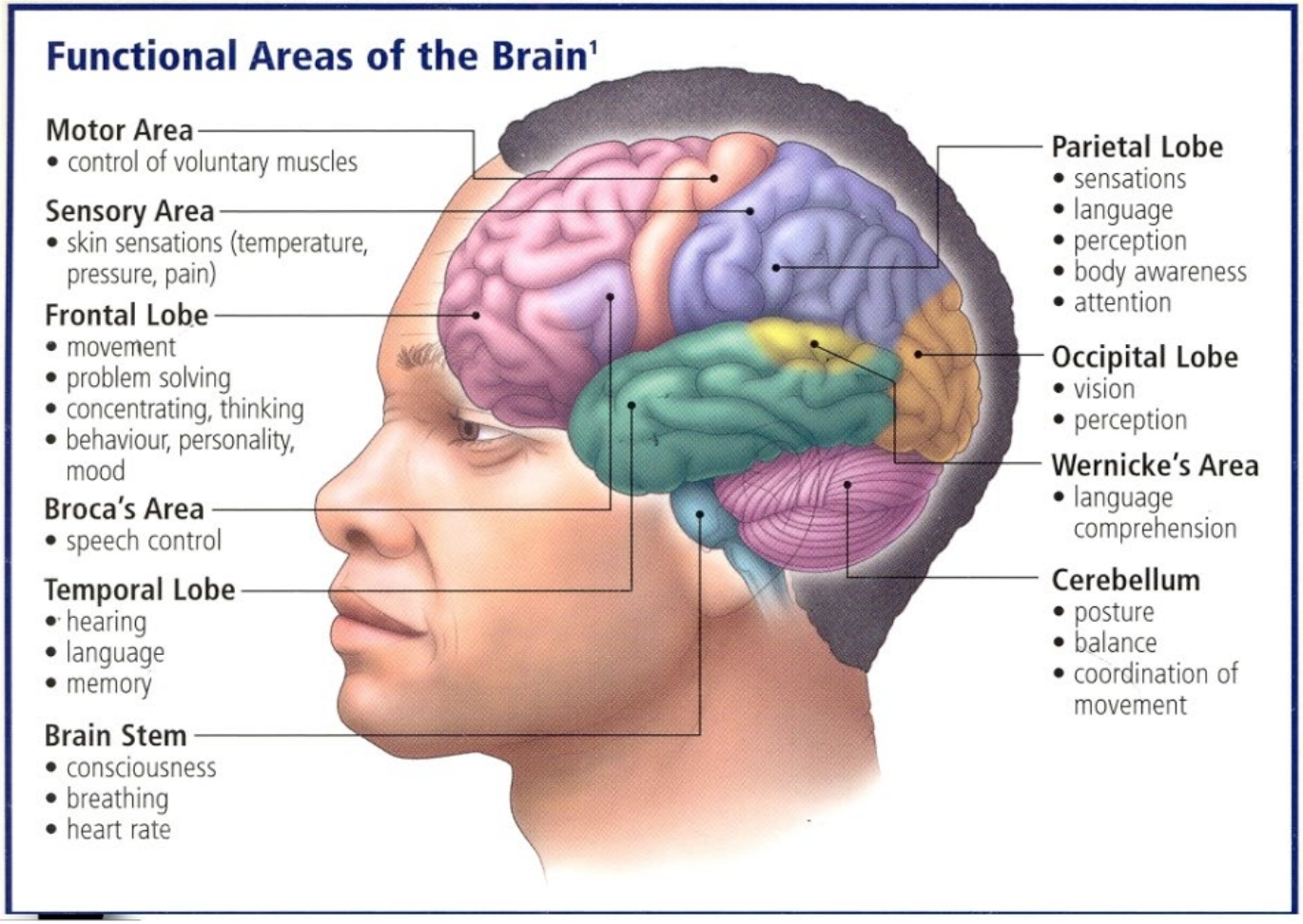
- Acceleration – deceleration (Coup- Contracoup)
- Rotation with shearing of white matter axons (diffuse axonal injury)
- Combination of the above
- Focal damage – consolidated areas of tissue destruction, hemorrhage, and/or edema

Secondary damage/complications Can compound primary damage

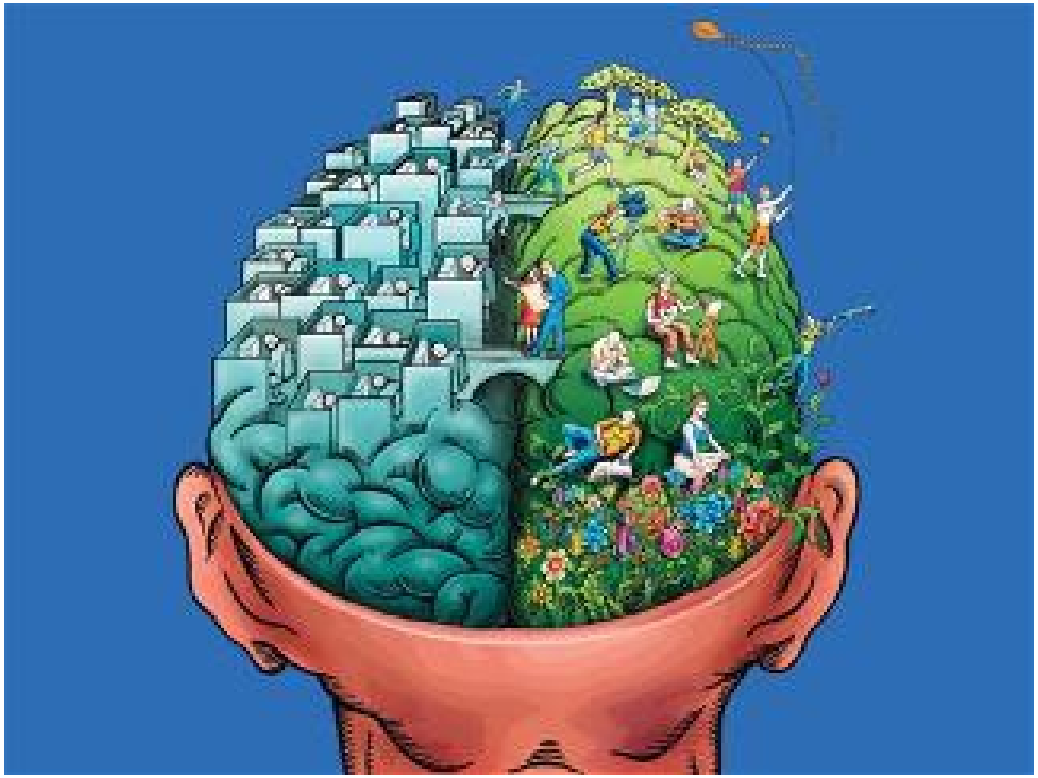
- Cerebral edema
- Increased ICP
- Hypoxemia & ischemia
- Hypotension
- Infection, abscesses
- Electrolyte imbalance
- Hydrocephalus
- Vasospasm
- Seizures

Types of Injuries

- Closed head injury
  - Concussion
  - Contusion
  - Anoxic
- Open head injury
  - Penetrating
  - Skull fractures
- Hemorrhagic
- Subdural hematoma
- Epidural hematoma
- Intracerebral hemorrhage
- Subarachnoid hemorrhage


Functional Areas of the Brain[1]
Motor Area
• control of voluntary muscles
Sensory Area
• skin sensations (temperature, pressure, pain)
Frontal Lobe
• movement
• problem solving
• concentrating, thinking
• behaviour, personality, mood
Broca's Area
• speech control
Temporal Lobe
• hearing
• language
• memory
Brain Stem
• consciousness
• breathing
• heart rate
Parietal Lobe
• sensations
• language
• perception
• body awareness
• attention
Occipital Lobe
• vision
• perception
Wernicke's Area
• language comprehension
Cerebellum
• posture
• balance
• coordination of movement

Left Brain – Right Brain



Hemispheric Specialization

LEFT

- Motor control right side of body
- Typically, dominant for language
- Reading & writing
- Analytical
- Linear processing, mathematical skills
- Detail oriented
- Logic, problem solving

RIGHT

- Motor control left side of body
- Visual perception
- Spatial awareness
- Insight/awareness
- Humor
- Creativity/imagination
- Intuition/perception
- Emotional processing

Concussion

- Mild TBI – most cases, no lasting sx or ill effects
- May or may not report LOC
- Momentary loss of reflexes or memory
- Headache, confusion, dizziness, nausea
- Irritability, change in mood or sleep
- Visual and gait disturbances

Contusion

- Bruising to the brain
- May be moderate or severe
- Outcomes vary according to location and severity of injury

Subdural Hematoma

- Bleeding between the dura and arachnoid interface
- Acute, subacute, or chronic
  - Immediate, 4-21 days, 21 days +
- Occurs 5-22% of patients with intracranial injuries
- More common in older adults
- Changes in LOC, elevated ICP
- Seizures
- Paresis

Epidural Hematoma

- Rapid arterial or venous bleed often associated with skull fracture
- Most common cause lacerated meningeal artery
- 2% of traumatic intracranial insults
- More common in older adults
- Changes in LOC, elevated ICP
- Seizures
- Paresis

Intracerebral Hemorrhage

- Bleeding into cerebral tissue
- Associated with contusions
- May act as a space-occupying lesion compressing brain tissue; poor prognosis
- Headache, deteriorating consciousness, coma
- Contralateral paresis
- Ipsilateral dilated pupil
- Signs of herniation

Subarachnoid Hemorrhage

- Bleeding into the subarachnoid space
- Severe head injury and aneurysmal ruptures
- Symptoms related to elevated ICP and meningeal irritation

Penetrating Injuries

Missile injuries (high velocity trauma)

- Gunshots, nail guns, other missiles
- Severity depends on location, pathway, depth
- Associated with infection caused by bone, skin, hair entering the brain

Stab wounds

- Piercing of the scalp, skull, or brain by foreign object
- May cause severe neurological impairment depending on location

Prognosis for Recovery Following TBI

- Duration of coma
- Longer in coma, poorer prognosis

- Age-60 y/o and under 4
- Injury location

Classification of TBI

- Mild TBI or post-concussive syndrome
- Moderate TBI
  - A moderate TBI is a term used when a person experiences changes in brain function for longer than a few minutes following trauma. Symptoms may similar to a mild TBI, but the symptoms do not go away or may even get worse.
- Severe TBI-May require LTC or supports

Glasgow Coma Scale

Glasgow Coma Scale		
Response	**Scale**	**Score**
Eye Opening Response	Eyes open spontaneously	4 Points
	Eyes open to verbal command, speech, or shout	3 Points
	Eyes open to pain (not applied to face)	2 Points
	No eye opening	1 Point
Verbal Response	Oriented	5 Points
	Confused conversation, but able to answer questions	4 Points
	Inappropriate responses, words discernible	3 Points
	Incomprehensible sounds or speech	2 Points
	No verbal response	1 Point
Motor Response	Obeys commands for movement	6 Points
	Purposeful movement to painful stimulus	5 Points
	Withdraws from pain	4 Points
	Abnormal (spastic) flexion, decorticate posture	3 Points
	Extensor (rigid) response, decerebrate posture	2 Points
	No motor response	1 Point

Glasgow Coma Scale

Total GCS Score = E + V + M

- **Maximum score**: 15 (fully alert)
- **Minimum score**: 3 (deep coma or death)

GCS Score	Severity
13–15	Mild brain injury
9–12	Moderate brain injury
≤8	Severe brain injury (coma)

Mild TBI

- Accounts for 75-90% of all brain injuries
- Loss of consciousness < 30 minutes
- Glasgow Coma Scale 13 – 15
- Negative neuroimaging
- Alteration in mental status
- Loss of memory

Loss of Memory

- Posttraumatic amnesia (PTA)
  - Retrograde
  - Anterograde
    - PTA < 1 hour; mild severity
    - PTA 1-24 hours; moderate severity
    - PTA 1 day – 1 week; severe
    - PTA > 7 days; very severe

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC155413/

Mild TBI – Physical Symptoms

- Nausea
- Headache
- Dizziness
- Insomnia, fatigue
- Decreased memory
- Irritability
- Confusion/Decreased concentration
- Vision changes
- Tinnitus

Moderate TBI

- Glasgow Coma Scale 9 – 12
- Abnormal CT findings
- Physical, cognitive, & behavioral symptoms last several months or are permanent
- May have good recovery or learn to compensate

Severe TBI

- LOC hours - years
- Glasgow Coma Scale 8 or lower
- Injuries focal & diffuse

  - Focal: hemorrhage or hematoma

  - Diffuse: result from secondary complications
- Usually left with permanent residual neurological deficits

Residual Deficits: Memory Dysfunction

- Retrograde memory-preinjury
- Posttraumatic amnesia (PTA)-post injury
- Selective memory deficits-relationships, special talents, traumatic events.

Residual Deficits: Motor Skills

- Hemiplegia
- Spasticity
- Ataxia-loss of full body movements
- Apraxia-inability to plan motor movements.

Residual Deficits: Visual-perceptual Disturbances

- Agnosias- is the inability to process sensory information. May not recognize objects.
- Dysfunction of senses
- Somatosensory agnosias-May not recognize by touch.
- Visual and/or spatial deficits
- Spatial relations
- Depth perception
- Relationship of figure to ground

Residual Deficits: Behavioral Changes

- Social behavior
- Withdrawal, apathy
- Mood swings or emotional lability
- Decreased cooperation
- Insatiable appetite
- Loss of inhibition
- Impulsivity or poor judgement
- Excessive talking
- Irritability or short temper
- Agitation

Residual Deficits: Attention and/or Concentration

- Arousal
- Orientation
- Selective attention
- Processing speed

Residual Deficits: Emotional Responses Blunted or increased

- Flat affect: Inability to smile
- Crying, emotional lability
- Inappropriate smiling
- Anger
- Emotional control
- Depression or anxiety
- Initiation

Residual Deficits: Cognitive and Intellectual Functions

- Problem solving
- Judgment
- Abstract reasoning
- Planning and reasoning
- New learning
- Increased response time

Residual Deficits: Denial/Egocentricity

- Lack of awareness of physical or mental limitations (Anosognosia)
- Unrealistic expectations of present or future abilities
  - Pt and families
- Focus on self
- Attention-seeking behavior
- Difficulty in sharing with others

Communication Strategies

- Try to help patient calm down before they escalate
- Use simple directions – tell them what you want them to do
- Keep your voice calm and supportive
- Repeat commands, cues, and explanations often
- Decrease noise/ activity around the patient

Communication Strategies

- Look for antecedents and patterns for what upset the patient
- Communicate the above to other staff
- Assess comfort – cold, hot, hungry, tired, or pain can make patient act out
- Anticipate their needs and plan to meet them
- Orient the patient with each task

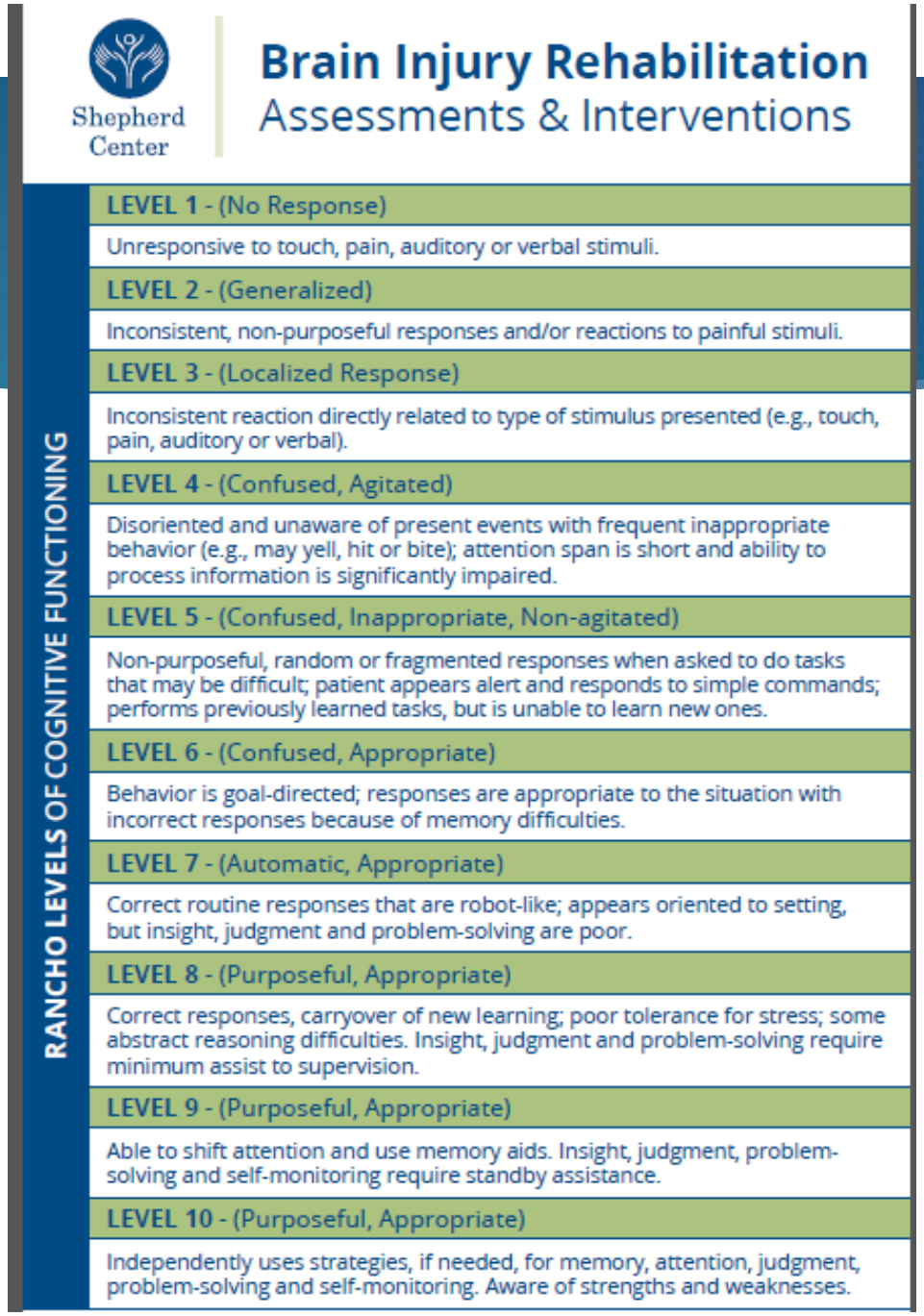
Communication Strategies

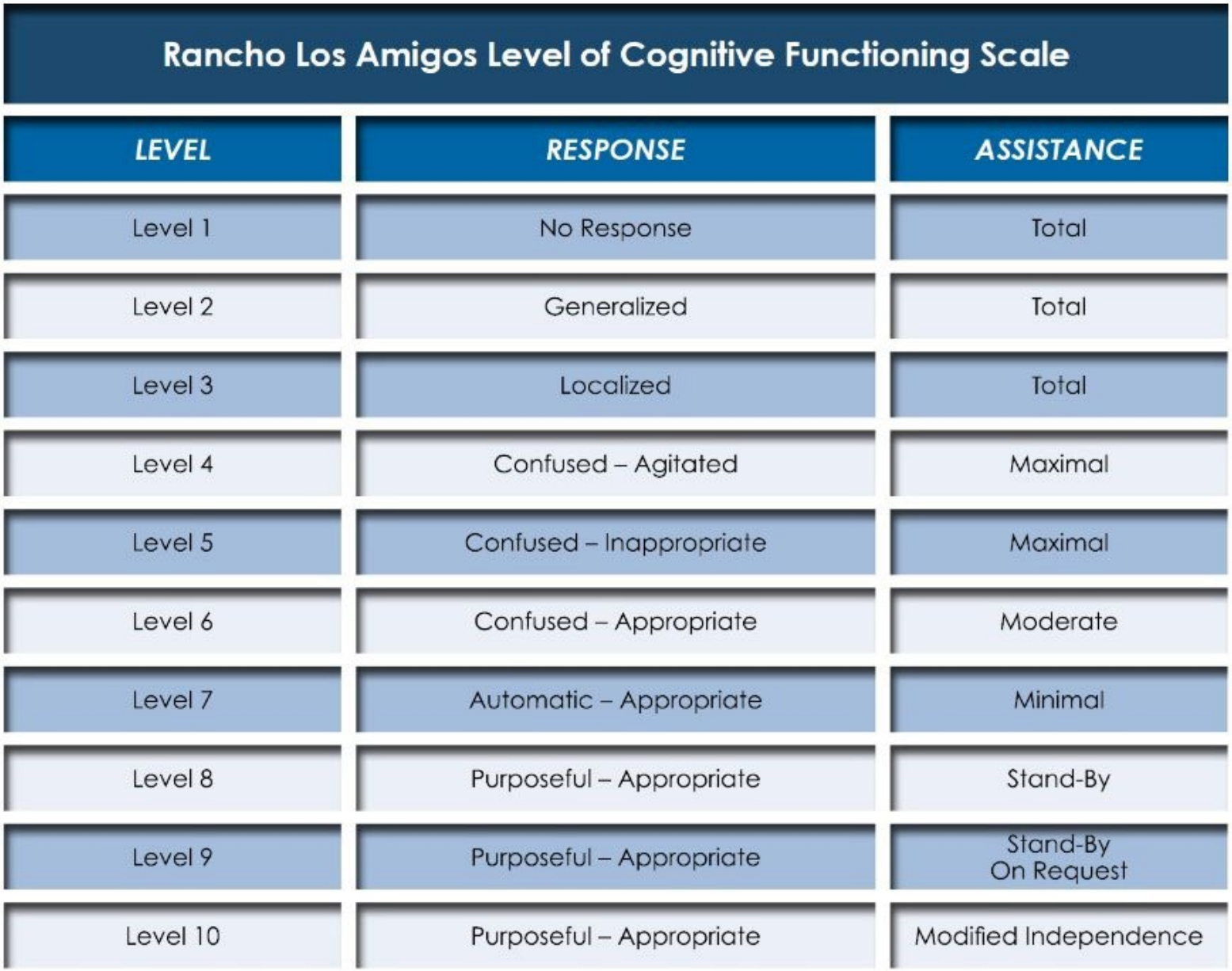
- Approach the patient slowly from the side
- Let the patient know you are going to touch him/her before doing so
- Pay attention to your body language and that of the patient
- Respect the patient's personal space as much as possible

Assessment
Ranchos Los Amigos Scale

Measure of behavior

- Levels 1 – 3, levels of coma
- Levels 4 – 6, typical acute rehab TBI client
- Levels 7 – 10, functioning in the community


Shepherd Center
Brain Injury Rehabilitation
Assessments & Interventions
RANCHO LEVELS OF COGNITIVE FUNCTIONING
LEVEL 1 - (No Response)
Unresponsive to touch, pain, auditory or verbal stimuli.
LEVEL 2 - (Generalized)
Inconsistent, non-purposeful responses and/or reactions to painful stimuli.
LEVEL 3 - (Localized Response)
Inconsistent reaction directly related to type of stimulus presented (e.g., touch, pain, auditory or verbal).
LEVEL 4 - (Confused, Agitated)
Disoriented and unaware of present events with frequent inappropriate behavior (e.g., may yell, hit or bite); attention span is short and ability to process information is significantly impaired.
LEVEL 5 - (Confused, Inappropriate, Non-agitated)
Non-purposeful, random or fragmented responses when asked to do tasks that may be difficult; patient appears alert and responds to simple commands; performs previously learned tasks, but is unable to learn new ones.
LEVEL 6 - (Confused, Appropriate)
Behavior is goal-directed; responses are appropriate to the situation with incorrect responses because of memory difficulties.
LEVEL 7 - (Automatic, Appropriate)
Correct routine responses that are robot-like; appears oriented to setting, but insight, judgment and problem-solving are poor.
LEVEL 8 - (Purposeful, Appropriate)
Correct responses, carryover of new learning; poor tolerance for stress; some abstract reasoning difficulties. Insight, judgment and problem-solving require minimum assist to supervision.
LEVEL 9 - (Purposeful, Appropriate)
Able to shift attention and use memory aids. Insight, judgment, problem-solving and self-monitoring require standby assistance.
LEVEL 10 - (Purposeful, Appropriate)
Independently uses strategies, if needed, for memory, attention, judgment, problem-solving and self-monitoring. Aware of strengths and weaknesses.



Rancho Los Amigos Level of Cognitive Functioning Scale

LEVEL	RESPONSE	ASSISTANCE
Level 1	No Response	Total
Level 2	Generalized	Total
Level 3	Localized	Total
Level 4	Confused – Agitated	Maximal
Level 5	Confused – Inappropriate	Maximal
Level 6	Confused – Appropriate	Moderate
Level 7	Automatic – Appropriate	Minimal
Level 8	Purposeful – Appropriate	Stand-By
Level 9	Purposeful – Appropriate	Stand-By On Request
Level 10	Purposeful – Appropriate	Modified Independence

Figure 4. The Rancho Los Amigos Level of Cognitive Functioning Scale. Measures response and assistance by level.[1]

https://biausa.org/wp-content/uploads/Rancho-Los-Amigos-Scale.jpg

Management/ Interventions Behavior for Rancho Levels I, II, III

Disorders of Consciousness

- Medical stability and care
- Sensory stimulation
- Environmental management
- Periods of activity interspersed with periods of low stimulation

Management/ Interventions Behavior for Rancho Levels IV, V, VI

Posttraumatic Confusional State

- Decreased general stimuli
- Structured environment and stimulation
- Behavioral regulation
- Safe environment
- Discourage inappropriate response patterning

Management/ Interventions Ranch Levels VII - X

Emerged from confused state yet likely still suffering significant cognitive difficulties

- Decreased structure
- Increase responsibility
- May require frequent, consistent reminders

Management/ Interventions General Environment

- Calm
- Consistent
- Low stimulation
- Low density
- Visitor restriction

Management/ Interventions Individual Environment

- Consistent schedule by team
- One-to-one supervision
- Limit television
- Limit telephone
- Limit visitors
- Frequent rest periods
- Restrict travel/ confine to unit

Family Restructuring

- Modify system to allow client's return home
- Options for destination and activity patterns
- Target outcome goals; develop structured post discharge activities
- Home eval
- Empower the family to assume responsibility

Client, Family, & Community Education

- Prevention of further injury
- Safety devices for motor vehicles
- Psychosocial components of prevention
- Safety measures for the home
- Proper use of assistive devices
- Home modifications

Client, Family, & Community Education

- Client's psychosocial adaptions to own needs-Adjustment
- Low level of anxiety or depression
- Control over self and behavior
- Intact self-concept
- Socializing
- Verbalizes feelings
- Achieves developmental tasks

Special Needs of Spouses or SO's

- Counseling
- Support groups

- **REMEMBER!!!** TBI affects the family and friends as well. There is often guilt on the family's part associated with the survival of the individual, who now may be very different from prior to injury.

Conclusions

- Working with TBI can be very challenging.
- Proactive planning is often the key to success and avoiding situations of conflict.
- Education of family and friends is key to successful rehab of individuals with brain injury.

Question

Which of the following types of brain injury causes widespread shearing and rotational injuries?

A. Cerebral contusion
B. Concussion
C. Diffuse axonal injury (DAI)
D. Contracoup injury

Answer

The correct answer is: C

A DAI produces damage throughout the brain. DAI is associated with a poorer prognosis than a focal lesion or ischemia.

Cerebral contusions are a diffuse form of injury but do not cause the damage extent that DAI does.

Concussion is a mild BI w/ microscopic bruising

Contracoup injury occurs dt an impact w/ the skull on the side opposite the initial force.

Question

The behavior of a patient with a Ranchos Los Amigos of Cognitive Function Scale Level V is:

A. Confused and agitated
B. Confused and appropriate
C. Confused and non-agitated
D. Automatic and appropriate

Answer

The correct answer is: C

A patient with a Level V demonstrates confusion without the agitation expressed at Level IV. The patient at Level V can pay gross attention to the environment but is highly distractible and requires continuous redirection.

Question

Which of the following is an example of an “executive” function?

A. Setting the table
B. Heating an item in the microwave
C. Doing dishes
D. Grocery shopping

Answer

The correct answer is: D

Executive functions require anticipation, goal selection, planning, self-monitoring, and incorporating feedback.

Grocery shopping requires all of these. All the other activities are less complex tasks.

Question

Damage to what part of the brain results in impaired voluntary movement, altered social functioning, problems w/ short term memory, and inhibition of impulses and emotions?

A. Frontal lobe
B. Temporal lobe
C. Occipital lobe
D. Brainstem

Answer

The correct answer is: A

Damage to the brain's temporal lobe produces impaired hearing and long-term memory deficits.

Damage to the occipital lobe produces visual perception problems.

Damage to the brainstem produces impaired wakefulness, life-sustaining regulation symptoms, and cranial nerve deficits.

Question

Deficits with socialization, motivation, and sexual behaviors seen after brain injury are due to damage to:

A. Reticular activating system
B. Right hemisphere
C. Left hemisphere
D. Limbic lobe of both hemispheres

Answer

The correct answer is: D

The reticular activating system is responsible for arousal and alertness.

The right hemisphere controls recognition of faces and forms or artistic intelligence.

The left hemisphere controls memory for language, math, and analytical skills.

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