Section: Research Paper
ISSN 2063-5346

Role of sensory stimulation to improve consciousness matrix among traumatic brain injury patient: A Narrative Review

Authors: - Nandkishor Prasad Sah, PhD Research Scholar , Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad

Email id :-nandkishore.physiotherapy@tmu.ac.in

Dr. Ajay Pant, Professor, Department of Orthopedics, Teerthanker Mahaveer University, Moradabad

Dr. Abdur Raheem Khan, Professor, Department of Physiotherapy ,Integral University, Lucknow

Abstract

The Glasgow Coma Scale (GCS) is a standard method for evaluating the extent of brain damage and predicting a patient's prognosis .Eye response, verbal response, and motor response ,Scores on the Glasgow Coma Scale (GCS) vary from 3 to 15, with lower values indicating greater disability. Patients with head traumas or acute brain damage are frequently assessed with the Glasgow Coma Scale (GCS) to help direct emergency care. It's useful for establishing whether or not airway management and care are required.The scale is also used to track a patient's clinical development over time, allowing for more precise treatment decisions. Patients with brain injuries who have a lower GCS score have a higher risk of dying from their injuries, according to studies. Patients' prognosis can be predicted in part by the Glasgow Coma Scale (GCS), however this score should not be relied upon alone. The GCS score should be used in conjunction with other considerations, such as the nature of thetrauma, the existence of other injuries, and patient-specific characteristics.There have been ongoing efforts to refine the GCS and boost its predictive power in recent years. As a result, the range of early severity associated with mortality or independent recovery expands ,While the Glasgow Coma Scale (GCS) has shown reliability.

Providing sensory stimulation may activate the brain plasticity, excite the neural networks, and prevent the sensory impairment.

Keywords: Glasgow coma scale, Severe Traumatic brain injury, Brain injury, Sensory stimulation.

Introduction

A traumatic brain injury (TBI) can result from an object piercing the skull, entering the brain, and from a strong bump, jolt, or blow to the head or body. A TBI is not always the consequence of strikes or jolts to the head. Depending on the type of TBI, there may be temporary or short-term issues with a person's ability to think, move, understand, interact, and react. Profound and lasting disabilities and death can result from more severe TBI [1,2].

Some wounds are regarded as primary since the harm occurs right away. Other TBI effects may be secondary, meaning they may develop gradually over several hours, days, or weeks. There are broadly two types of head injuries: Penetrating, also known as open TBI, where the object pierces the skull and enters the brain, it causes damage to only a part of the brain and non-penetrating, also known as a closed injury, where a vigorous external force causes the brain to move within the skull [1,3].

Signs and symptoms

Physical: nausea, vomiting, headache, convulsions, seizures, blurred vision, slurred speech.

Cognitive or behavioural changes: decrease in the level of consciousness, disorientation, confusion, loss or change in the level of consciousness from a few seconds that can be prolonged to hours [1,2].

TBI and Risks

Elderly people over the age of 65 years are more likely to be affected by TBI, mostly due to falls. Men and more likely to be affected by TBI than women and 3 times more prone to death by TBI compared to women. The leading causes of TBI are falls, blunt trauma injuries, assaults (violence), and explosions [1].

CT scan is the most commonly used for diagnosing TBI in people with suspected severe or moderate TBI. It is a two-dimensional imaging technique used to image body parts. MRI, in other cases produces detailed images of tissues for which it can be used in initial assessment and treating the injuries in the very first case. For imaging mild TBI in people, Neuropsychological tests are also been used. Glass-gow Coma Scale assesses the level of consciousness after traumatic brain injury [1,2].

With the possible exception of a single pharmacological medication, no therapy has demonstrated its effectiveness in individuals with severe brain damage. Therefore, one of the most significant challenges facing doctors is consciousness recovery [1,3]. Long ago, during patients' neuron rehabilitation, sensory stimulation programmes were the most often used treatment. For some years, it has been widely recognised that adult wounded brains can reorganise themselves to compensate for impaired areas according to theories of brain plasticity. Providing sensory stimulation may activate the brain's plasticity, excite the afflicted neural networks, and prevent a sensory impairment that might hinder the patient's rehabilitation. However, this kind of intervention's effectiveness is still disputed today [2].

Sensory stimulation

To research the effects of the environment on the brain and behaviour, several studies conducted developed "environmental enrichment" as an area forty years ago of using animals for study. They demonstrated how altering the type and level of external stimulation may alter how the brain is structured and functions. An improved habitat offers the animals the best settings for greater inquiry, mental activity, and movement compared to a standard environment. Increases in cortical thickness and mass, dimension of the cell soma and nucleus, dendritic spine length, & synaptic size and density have all been linked. It has been discovered that being exposed to this kind of environment is beneficial for disorders of the neurological system, including brain damage, in animal models. Data shows that this method facilitates the restoration of physical and cognitive functions, including learning and memory skills, after experimental brain lesions [1-3].

Following a brain injury, an enriched environment positively impacts the brain, such as reducing lesion size or promoting dendritic branching [2].

It may be possible to get insight into the variables impacting initial neurological recovery immediately following a severe traumatic brain injury. During this time, there won't likely be any regular input of purposeful stimulation, and it's still debatable whether or not to shield the person from stimulation to prevent the injured central nervous system from becoming overloaded or to provide an individually tailored stimulation programme to aid in rehabilitation. Although the latter has attracted much public interest, the therapeutic practice has typically failed to take into account and use the information from experimental studies on brain-damaged individuals' responses to environmental enrichment patients [2,3]. A severe brain injury may produce a condition resembling sensory deprivation in that the balance of senses, crucial for maintaining optimal functioning, is severely upset. Traumatic brainstem damage may impair information processing normally in the brainstem sensory nucleus and the nearby reticular formation, which would restrict the information's use for memory and other higher-order cortical functions [2,4]. The other spinal cord and brain regions will be taken from the patient.Normal function and unable to maintain behaviour without such structured input from the more excellent cortical centres. External environmental management over the environment may be used to mitigate these consequences of deprivation and improve the chances of early arousal, activation, and consciousness. However, it is doubtful that identifying the fundamental issues in this sector would be facilitated by using reasonably obvious, gross change markers to assess the anticipated effects of stimulation. Coma may include an even more active process than previously thought, with subclinical reactions that may match clinical recovery or worsening and allow for therapeutic and prognostic implications to be drawn. It is well understood that including physiological measurements when recovering is essential. For instance, throughout attention operations in conscious and subconscious states, changes in brain activity are accompanied by modifications in heart rate [4,5].

It has long been known that changes in cerebral metabolism and the functional activity in the brain are related. Lowered metabolism and cerebral blood flow are linked to the depression of brain activity brought on by concussion. Social isolation and physical stress may substantially impact the dopamine system's activity in the brain. The temporary behavioural and physiological abnormalities caused by some types of brain injuries and in some populations may be reversed by environmental stimulation [3-5]. However, a persistent lack of significant sensory input may result in alterations in the number of putative neurotransmitters or chronic cerebrovascular insufficiency, preventing neurological growth and recovery. It has been observed that quick bursts of early stimulation for newborns with developmental delays employing a range of tactile, auditory, visual, and audio-visual stimulation can slow developmental decline and enhance psychosocial function. Coma stimulation therapy proponents emphasise the significance of caring for every element of the patient, going beyond simple physical upkeep [5,6].

Although there are additional senses that may not get as much attention, people engage in a minimum of five sensory experiences: the senses of touch, taste, smell, sight, and hearing. Like that used in environmental enrichment, environmental design may stimulate the senses. Direct stimulation via any sensory modality may also be a part of it [6]. However, there are two types of sensory stimulation: unimodal and multimodal. Recent neuroscience research indicates that multimodal sensory processing is preferable to unimodal processing because it allows for more efficient coordination of sensory modalities as part of a "whole of brain" response. Indeed, multimodal rather than unimodal methods of sensory stimulation have been more successful [6].

Multimodal stimulation

As modality-specific cortices are no longer widely accepted, it is not acceptable to study Following an ABI, sensorimotor recovery as a unimodal entity. According to Shimojo and Shams (2001), "interaction across modalities is the norm compared to the exception of brain function"; cross-modal cortical processing in the brain contributes significantly to routine adaptive behaviour. A variety of data supports the concept of multi-modularity. In the case of better sensorimotor performance after an ABI, this is due to behavioural compensation from different unaffected methods instead of functional recovery from affected brain areas. Additionally, stroke patients' visual dependency does not imply that other senses are underutilised because they still use visual, proprioceptive, & vestibular data for posture control. Family-centered sensory stimulation was found to be more beneficial when multimodal sensory techniques were used, even though enriching the environment is limited if the tasks involved are unimodal. Generally speaking, multimodal sensory techniques are affordable, straightforward, and excite several senses. They are also frequently provided via nurses or therapists. Give an example of a multimodal sensory approach that included chatting and reading to the patient (auditory), showing them pictures (visual), exposing them to their favourite smells (olfactory), and putting various materials on their arm (touch) [7].

Proper median nerve stimulation by TENS

Heavy traffic has led to a rise in brain injuries (TBI), which has become the biggest contributor to death and disability among those in the 15–30 age range. 15% to 20% Many people with severe TBI die in a coma or enter a vegetative state. Coma is currently thought to be a self-limiting condition that typically transforms into the unconscious state (MCS), the conscious state (CS), and the vegetative state (VS). After 2-4 weeks. Patients with VSs can spontaneously reopen their eyes but remain awake. are unable to comprehend, speak, or act in a deliberate manner. Modest but unmistakable behaviour signs of self- or environmental awareness distinguish a highly altered state of consciousness called an MCS.Examiners have been seen to extract unambiguous proof of volitional behaviour during one examination successfully but not during another that was done a few minutes later. Coma and its harmful aftereffects, VS and MCS, havebecome a significant burden for families and society [8,9].

The functional results & prognosis of these individuals are being improved by neuroscientists, who are also attempting to hasten recovery. To better meet rehabilitation goals, various therapies have been applied, such as proper middle stimulation of the nerve (RMNS), sensory stimulation, spine column agitation, transcranial magnet stimulation, deep brain stimulation, and therapy with hyperbaric oxygen. No treatment has conclusively shown to change the recovery rate from an unconscious patient's TBI or enhance their neurological results [5-9].

RMNS in coma arousal has a more than 20-year history as a straightforward, affordable, non-invasive method. To cure damage to the central nervous system, electrical current was initially applied to the extremities in 1972 at the University in Virginia. To simulate walking utilising an external switch, the paraplegic patient had bilateral femoral and sciatic nerves surgically implanted with radio-linked electrodes [8-10].

Unexpectedly, Duke Biomedical Engineering researchers in the middle of the 1980s The paraplegic patient had bilateral femoral and sciatic nerves surgically implanted with radio-linked electrodes in a quadriplegic subject's stimulated arm but also noted a crossover impact of increased power for the muscles closest to the body of the unstimulated arm. The discovery of electrical stimulation of the median nerve for coma arousal was made possible by this finding of intracerebral transmission. In 1999, the first piece on electrical stimulation of the median nerve for acute coma was released. Since then, several intensivists, rehabilitators, and clinical researchers have been more interested in RMNS.

Few effective therapies exist to speed up coma recovery in the initial stages following an accident. Invasive stimulations like spinal cord and deep brain stimulation are limited due to intracranial instability & the necessity of closely watching and treating Intensive care unit patients. Medications are momentarily successful in the long-term phase of TBI, but there is no evidence that they are beneficial for people in an acute coma. We currently lack effective therapies that might encourage coma emergence [11].

There is growing interest in the ability of simple transcutaneous electric stimulation to accelerate awakening from a coma or a disturbance of consciousness. Small trials carried out in the United States in the United States (USA) first investigated proper median nerve stimulation (RMNS), which was initially employed for the treatment of paralysed limbs after trauma, as a method to increase consciousness.

The ARAS neurons, or ascending reticular activating system, in the spinoreticular portion of the median nerve pathway, are synoptically improved by RMNS, which also increases blood perfusion and increases The brain-derived neurotrophic factor (BDNF), an example of an endogenous neurotrophic helps more neurons survive. However, to translate the bench results into the clinical setting and develop a more accurate model for therapy targeting, understanding the efficacy in practice would require further laboratory investigation [12].

Outcome measures of GCS score

The Glasgow Coma Scale, also known as the GCS, was developed in 1974 as a therapeutic tool for determining the extent of damage to consciousness over time. In various clinical research projects, the GCS is currently used as a categorisation tool and a severity-of-illness indication to help with patient comparison. The GCS is a component of the APACHE II, APACHE III, TRISS, Original Trauma Score, & Revised Trauma Score, all used to predict and compare patient outcomes. It is frequently used for prognostication and is widely employed in evaluating and caring for patients with posttraumatic changes in awareness [13]. According to the Trauma Coma Data Bank, the utilisation of the post-resuscitation GCS score is constrained by inconsistent application and a poorly known link to the resuscitation GCS rating, post-resuscitation GCS evaluation, and outcome. In certain situations, the GCS score used in APACHE II at the time of intensive care unit admission is performed following surgery to eliminate an intracranial space-occupying wound. However, it may not be comparable to a post resuscitation GCS score. give inaccurate estimations of the initial severity. The resuscitation GCS (P-GCS) score is the most widely used tool for evaluating neurologic function in wounded individuals. Due of its accessibility, this score has the potential to affect treatment and prognosis. When functional result data is available, it is often reported using the Glasgow result Scale, which only broadly defines the outcome. The majority of outcome research on patients with brain injuries concentrates on death [14].

Despite being evident, it has not been shown that there is a linear link between the Mortality regardless of its iterations and GCS score. People used to continuous category scales might not understand this. The successful reintegration a patient with a head injury into society requires additional effort challenge and is dependent on psychological, economic, and functional factors concerns, even though survival may be easily assessed. The Independent Function At hospital release, the measure evaluates self-feeding, movement, and expressiveness on a scale of 3 to 12, denoting total reliance to total independence [15].

Functions

Parameters and scoring: The most effective The Glasgow Coma Scale has three categories: eye response (E), most excellent verbal response (V), and most excellent motor reaction (M). The reaction levels on the Coma Scale of Glasgow are "scored" at 1, which signifies no response, to typical values of 4, 5, as well as 6, respectively, for opening one's eyes, speaking, and moving one's muscles.

Thus, the Coma Score is between three and fifteen, with three being the smallest & fifteen being the highest.

The total of each element's scores makes up the final result. GCS10 = E3V4M3 can represent a score of 10, for instance [16].

Best ocular reaction (4)

- None
- To pain
- To speech
- Spontaneously

Best verbal reaction (5)

- Unresponsive verbally
- Unintelligible noises
- inappropriate language
- Confused
- Orientated

Best motor response (6)

- There is no movement.
- abnormal pain extension
- Painful abnormal flexion
- Abstraction from suffering
- pain localisation
- obeys orders

Clinical significance

To assess the responsiveness and guide early care for people who have experienced a head injury or another sort of acute brain impairment, the Glasgow Coma Scale is routinely utilised. Immediate care decisions are made for patients who have been more gravely harmed, such as preserving the airway and using triage to identify individuals who need to be transported. Less severely impaired patients must determine if they require MRI, should be hospitalised for observation, and should be released. Periodic Evaluations of the Glasgow Coma Scale are crucial for monitoring a patient's clinical development and determining how to modify their medication [17].

Across the three scale components, the response spectrum informational output varies. In more seriously handicapped individuals, modifications to motor response predominate, whereas ocular and linguistic abilities are more beneficial to a lesser extent. As a result, each patient's clinical outcomes of the three components ought to be reported separately. Despite losing information, the total score provides a helpful summary index [18].

In both preverbal & verbal paediatric patients, the Glasgow Coma Scale provides a reliable indication of clinically severe brain damage (i.e., an injury requiring neurosurgical intervention, coma for over 24 hours, hospitalisation for more than two nights, and injury causing death). Numerous standards and evaluation results have taken into consideration the Glasgow Coma Scale. The severe TBI recommendations from the Brain Trauma Foundation, trauma standards (such as Enhanced Trauma Life Care), critical-care evaluations (such as APACHE II, SOFA), & Advanced Cardiac Live Support are some of these [19].

Relation to outcome

Who revealed a consistent, progressive link between increased mortality following an injury to the head and declines in GCS Scores between 15 to 3 in examinations of the GCS (usually given in the total GCS Score). Numerous later research has confirmed this connection. The results for the reactions from the verbal, visual, and motor systems are all connected to the result, albeit in different ways evaluating each one independently provides more information than evaluating them all together [20].

Although the GCS score constitutes one of the most robust clinical predictive indicators, neither it nor any other factor should be used for predicting the course of a particular patient. This is so because several factors affect how the score's prognostic implications are affected. These involve the diagnosis, the cause of the trauma, and the presence of extracranial injuries, as well as patient-related variables like age and additional clinical indicators (like pupillary dysfunction and imaging findings). The GCS score is an integral part of multifactorial algorithms for outcome prediction, including the ones used in the IMPACT and CRASH trials [21].

Glasgow Coma Scale Score

The Glasgow Coma Scale with Pupils Score (GCS-P), developed by Paul Brennan, Gordon Murray, and Graham Teasdale in 2018, combines the two leading indicators of the severity of brain damage into a single, simple score.

The student responsiveness score (PRS) is calculated by dividing the overall Glasgow Coma Scale (GCS) grade by the pupil responsiveness score GCS-P:

- GCS-P = GCS minus PRS
- This is how the pupil responsiveness score is determined.
- Unresponsive students to light - student reactivity score
- Both students: 2
- one student
- Both pupils: 0

The range where early severity may be linked to either mortality or independent recovery outcomes is increased by the GCS-P score, which ranges from 1 to 15 [22].

Classification of Severity of TBI

A typical categorisation of acute trauma to the brain is based on the correlation between the GCS Score & outcome. GCS between three and eight for severe, GCS between 9 and 12 for moderate, and GCS between13 and 15 for mild. A severe injury is one with a GCS-P score value between one and eight [23].

Other issues

Much research has been done on the GCS Scale's dependability. Although a few papers have questioned its repeatability, these have turned out to be the exceptions. Therefore, a thorough analysis of all 53 reports published in 2016 showed that 85% of the results from better-quality research had vital dependability, as determined by the usual threshold for a kappa (k) value greater than 0.6. The total GCS Score's repeatability was excellent, with 77% of observations having kappa values larger than 0.6. Training and education have a definite positive impact on dependability. A standardised, organised strategy for evaluation has been established to support this endeavour [24].

The GCS Scale's alternatives have been discussed. These often result from either shortening scale components or adding more features. The GCS Score outperforms in Simplified Motor Scale in predicting early death, however, it only recognises three categories of motor response, which may not be enough to support binary judgements in prehospital care within the emergency department, such as whether to intubate a patient. Such condensed scales inevitably express fewer data and fall short of the discrimination offered through For classifying patients over the whole spectrum of early severity, the GCS as well as GCS-P score, when tracking changes in the individual while receiving care, or in relation to the outlook for different late outcomes [25].

Its "Full Outline Among Unresponsiveness", called FOUR, established in acute neurological care, is one of the most complicated scales. FOUR has two extra components, the brain stem & respiratory, Notwithstanding the ocular & motor reactions that the GCS produces. The ocular and motor scales have been shown to have stronger relationships to the outcome than these different traits. The studies of pupil, corneal, & cough responses serve as the foundation for the 'brain stem' feature. It is commonly known that measuring pupil responsiveness has value, but it is unclear how much more the other parameters offer [26]. The rhythm of breathing serves as the foundation for the respiratory subscale. However, it is uncertain how reliable this feature is as the breathing sequence can vary and is impacted by extracranial variables, sedation, and ventilation method.

Even though the establishment established the Glasgow Coma Scale, also known as the GCS, with the Glasgow Outcome Scale (GOS) demonstrates that precise predictions can be produced 24 hours after an accident, they have proven challenging to validate on admission. However, making wise decisions requires a foundation in discovering trustworthy markers of outcomes following a brain injury. Clinicians frequently base their diagnosis and treatment choices on the patient's prognosis. Additionally, concise dissemination of this data is necessary for resource allocation, effective family counselling, and patient classification based on predictive risk. However, physicians think that they frequently forecast outcomes incorrectly [27].

Some studies have found that prognostic models, which are mathematical frameworks that incorporate two or more elements of a patient's characteristics to predict clinical outcomes, are more trustworthy than predictions made by doctors. Age, injury characteristics, and vital parameters are only a few of the variables that are predictive of TBI outcomes in previous investigations of TBI among the general population [28].Similarly, there is growing interest in the early identification of TBI patients with a high risk of death and morbidity in this era of cost restraint and managed care.However, both the recently suggested measures and other result scales have flaws.For example, they take a lot of time, can only measure functional impairment, are seldom applied in clinical settings, and are not tailored to the needs of the elderly population [29].

Disability rating scale

Particularly in young people, Traumatic brain injury, also known as TBI, is the leading cause of death and long-term disability impairment. Clinical and radiological evaluations are utilised to direct early prognostication and therapy when TBI patients first go to the emergency room. evaluation scales in function are crucial for directing continued care after the acute phase of evaluation and treatment, giving information about long-term outcomes, and supporting optimal health care planning.

The Disability Rating is used in TBI rehabilitation settings Score is a commonly utilised functional outcome metric [30]. The Global Classification of Impairments, Disability, & Handicaps, the World Health Organization's paradigm for categorising function and disability related to medical disorders, served as the foundation for creating the Disability Ratings Scale in 1980. The three categories of impairment, disability, & handicap make up the disablement model. These show the linear relationship between the impairment of a function, the following activity limitation, and the following social exclusion. The Rating of Disabilities Index tries to assess Handicaps by psychosocial adaptability, impairment of self-care cognitive capacity and impairment of degree of impaired consciousness [31]. For those with moderate-to-severe TBI, the Disability Rating Scale was developed. It may assess gains over a broad spectrum of functional recovery. It is beneficial for keeping track of patients as they go through recuperation and begin long-term rehabilitation programmes. The scale is used widely because It is quicker, easier to score, easier to administer, and more sensitive to small changes compared to other measurements, such as the Glasgow Coma Scale, in the progression of recovery. The patient or a family member may self-administer the Disability Rating Scale, or a clinician may do it in person or via the phone [32].

The disability rating (DR) tool was created with ease of use, speed of completion, validity, outcome prediction, and good inter-rater reliability in mind. Eight questions make up the DR Scale, which is broken down into arousal & alertness, cognitive ability to perform self-care activities, and physical dependence on others, including psychosocial adaption for work, housework, or other responsibilities, into four categories of education [33]. Inter-rater correlations were highly significant for more than 88 individuals with major head injuries and were completed separately by various raters. The degree of abnormalities in the patterns of evoked brain potentials, which is an electrophysiologic marker of brain dysfunction, and the clinical condition at 1 year following injury were both substantially correlated with the admission DR. Additionally, it may be used to determine whether patients will benefit from in-hospital intensive rehabilitation therapy. It offers a condensed, comprehensive explanation of the state of a brain damage sufferer that facilitates comprehension and conversation [34].

Reliability and validity of disability rating scale

The Disability Rating Scale (DRS) and The degree for Cognitive Functioning Scale (LCFS) are extensively used to track recovery from head injury despite a complete absence of published research on the validity and reliability of the LCFS as well as the fragmented as well as inconsistent reports in these characteristics of the DRS. Throughout their hospital stays for rehabilitation, 40 inpatients with brain injuries underwent four DRS and LCFS evaluations each week [30]. The capacity of the admission DRS and LCFS scores to predict discharge ratings centred on the Stover Zeiger (S-Z), Glasgow Outcome Scale (GOS), and Expanded GOS (EGOS), as well as the S-Z, GOS, and EGOS ratings which were collected concurrently at discharge, were all factors that contributed to the results. were compared between the DRS and LCFS. The findings imply that both scales have considerable concurrent or inter-rater reliability, test-retest reliability, and predictive validity. However, In practically every area, the DRS performs better than the LCFS. These results offer psychometric support for the DRS's usage in assessing head injury recovery [35].

Role of sensory stimulation to improve consciousness

The effects of sensory stimulation courses on the recovery of people with consciousness disorders (DOC) have been the subject of several investigations. However, Lombardi observed just three research with the suitable methodology when assessing papers published between 1966 to 2002, with the majority of the others having non-controlled design or descriptive reports of cases. The outcomes of these few research were insufficient to prove the effectiveness of programmes for sensory stimulation. The results were inconsistent. The kinds and doses of the therapies, as well as the primary outcomes investigated, varied, making it impossible to compare studies. In addition, the programme used was not well described. The influence of spontaneous recovery was another bias [36].

These trials were primarily carried out during the acute and subacute stages, when spontaneous recovery is most likely to occur. None of these studies could definitively separate gains attributed to spontaneous recovery from those related to the application of sensory stimulation treatment, due to the limited sample numbers. Since 2002, a number of researchers have looked into whether post-treatment benefits outweighed spontaneous recovery. Since the therapy was contrasted with baselines, time-series designs were employed. Results revealed more sophisticated behavioural reactions when therapy was present compared to when it wasn't, indicating that programmes for sensory stimulation increase patients' levels of consciousness when they emerge from comas. Nevertheless, only a small amount of patients (n = 15) were included in these trials [34]. Finally, just one research looked into how treatment-related changes in brain activity. Pape and associates investigated the outcomes of an audio-only stimulation programme. They discovered that the treated group outperformed the control group regarding neurobehavioral performance. fMRI recordings made before and after treatment showed that the treated group's language network was more active than it was in the control group, showing that the sensory stimulation programme impacted the patients' brain recovery. Such findings suggest that adding neuroimaging to behavioural measurements may increase our comprehension of sensory stimulation results within such a complicated environment population [35].

Impact of a sensory stimulation program on consciousness recovery

The only medication that has demonstrated effectiveness in helping individuals with severe brain injuries to yet is amantadine. Therefore, one of the most significant challenges confronting physicians is developing innovative approaches to treat patients who have recovered from disorders in consciousness [36]. Patients who experience consciousness disorders as the minimally conscious state which is described by the presence of fluctuating but recurring indicators of consciousness but the absence of reliable communication, or the vegetative state which is characterised by the existence of arousal but not awareness, may remain in these states for months to years, posing a financial and moral dilemma for the families. The neurorehabilitation field's most extensively researched therapy is sensory stimulation programmes (SSP). These programmes are based on the idea that stimulating environments increase brain plasticity and hasten the recovery of injured brains [37].

These programmes are based on the idea that stimulating environments increase brain plasticity and hasten the recovery of injured brains in animal studies. These programmes were supported on the premise that they could speed the recovery from problems in individuals with severe brain damage of consciousness through preventing environmental deprivation and encouraging synaptic reinnervation, despite the lack of scientific evidence within human subjects. SSP has been the subject of several investigations involving people with consciousness issues [38].

While Meyer and Cossu stated that there was disagreement regarding the clinical significance as well as beneficial effects of sensory stimulation for individuals coming out of comas, According to Padilla, there is significant evidence in the existing literature that multimodal sensory stimulation improves arousal as well as clinical outcomes for those who are in a coma or persistent vegetative state [39]. Numerous methodological flaws, such as the incomplete description of the underlying mental problems, low validity, including/or sensitivity of the outcome assessment, and small sample sizes. sizes, and spontaneous recovery, do impact the majority of research. In fact, most of these trials were carried out during the acute stage, when the likelihood of spontaneous recovery is highest [39,40]. It's interesting to note that recent research used a time-series approach to examine if the gains shown following SSP exceeded spontaneous recovery. However, only a limited amount of patients (n=15) were included in each study. Finally, information from neuroimaging was gathered from a subgroup of patients. Only one research recently looked into how treatment-related changes in brain activity. The language network was more activated When Pape & colleagues examined the outcomes from a single-modal stimuli programme utilising familiar auditory stimulation in 15 patients, the treated group was compared to the control group, suggesting that combining behavioural measures in neuroimaging could assist in understanding the effects that the benefits that sensory stimulation has on the recuperating brain [37-41].

Conclusion

In conclusion, the Glasgow Coma Scale (GCS) is a reliable method for measuring the extent of brain damage and forecasting the prognosis of individual patients. In 1974, the GCS found usage in clinical settings for making rapid care choices, tracking patients' clinical progress, and adjusting treatments. It has three sections, measuring responses from the eyes, the mouth, and the body movement. The Glasgow Coma Scale (GCS) is one of the most reliable clinical indications of patient prognosis. Multiple studies have shown that patients with head injuries who have lower The Glasgow Coma Scale (GCS) score have a higher risk of dying from their injuries. However, other elements, such as the trauma's etiology, the occurrence of other injuries, and patient-specific characteristics, are crucial for making precise prognosis. The effects of sensory stimulation on the recovery of people with consciousness disorders may activate the brain plasticity, excite the neural networks, and prevent a sensory impairment.

References

1. Jain S, Teasdale GM& IversonLM. *Glasgow Coma Scale*. Nih.gov; StatPearls Publishing. 2021.
2. Boyle MEand GreerRD. Operant procedures and the comatose patient. JAppl Behav Anal 1983;16:3-12.

3. Bradt J, Magee WL, DileoC, Wheeler B and McGillowayE. Music therapy for acquired brain injury. Cochrane Database Syst 2010. doi: 10.1002/14651858.CD006787.
4. Castro M, TillmannB, Luauté J, CorneyllieA, Dailler F, AndréObadia N. Boosting cognition with music in patients with disorders of consciousness. Neurorehabil. Neural Repair 2015; 29: 734-742.
5. Diamond MC, KrechD, and RosenzweigMR. The effects of an enriched environment on the histology of the rat cerebral cortex. J Comp Neurol 1964;123:111-120. doi: 10.1002/cne.9012 30110
6. STEIN DG.: Functional recovery from brain damage following treatment with nerve growth factor. In: M. W. Van Hof and G. Mohn (Eds). Functional Recovery from Brain Damage 1981; 424
7. ROSENZWEIG MR.: Animal models for effects of brain lesions and for rehabilitation. In: P. Bach Y Rita (Ed.). Recovery ofFunction: Theoretical Conside~ahnsfor Brain Injury Rehabilifation (Huber, Stuttgart) 1980; 127-172.
8. JOHNSONDA: Early recovery: can we help? In: D. A. Johnson, M. A. Wyke and D. Uttley (Eds). Children? Head Injury (Lawrence Erlbaum, Hove) 1989; 23-39.
9. ROSEFD and JOHNSON DA: Progress in understanding recovery of function after brain damage: the need for collaboration. Restor Neurol Neurosci 1992; 241-244
10. Abbasi M, MohammadiE & Sheaykh Rezayi A. Effect of a regular family visiting program as an affective, auditory, and tactile stimulation on the consciousness level of comatose patients with a head injury. Japan J NursSci 2009; 21-26.
11. AlnesSL, De Lucia M, RossettiAO & TzovaraA. Complementary roles of neural synchrony and complexity for indexing consciousness and chances of surviving in acute coma. NeuroImage 2021; 245:118638.
12. AttwellC, JöhrJ, PincherleA, Pignat JM, Kaufmann N, KnebelJF& DiserensK. Neurosensory stimulation outdoors enhances cognition recovery in cognitive motor dissociation: a prospective crossover study. NeuroRehabilitation 2019; 44(4): 545-554.
13. BaierB, KleinschmidtA & Muller NG. Cross-modal processing in early visual and auditory cortices depends on expected statistical relationship of multisensory information. The JNeurosci 2006;26(47): 12260-12265.

14. Benaroya-MilshteinN, HollanderN, Apter A, KukulanskyT, RazN, Wilf A, Yaniv I & Pick CG. Environmental enrichment in mice decreases anxiety, attenuates stress responses and enhances natural killer cell activity. Eur J Neurosci EUR J NEUROSCI2004;20(5): 1341-1347.
15. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. Lancet 1974;2:81-82.
16. Marshall LF, Becker DP, Bowers SA, et al. The national traumatic coma data bank: part I—design, purpose, goals, and results. J Neurosurg 1983;59:276-284.
17. Langfitt TW. Measuring the outcome from head injuries. J Neurosurg1983;48:673-678.
18. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;13;2(7872):81-4.
19. Teasdale G, Murray G, Parker L, Jennett B. Adding up the Glasgow Coma Score. Acta Neurochir Suppl (Wien) 1979;28(1):13-6.
20. Teasdale GM, Drake CG, Hunt W, Kassell N, Sano K, Pertuiset B, De Villiers JC. A universal subarachnoid hemorrhage scale: report of a committee of the World Federation of Neurosurgical Societies. J Neurol Neurosurg Psychiatry 1988;51(11):1457.
21. Teasdale G, Maas A, Lecky F, Manley G, Stocchetti N, Murray G. The Glasgow Coma Scale at 40 years: standing the test of time. Lancet Neurol. 2014;13(8):844-54.
22. Grinnon ST, Miller K, Marler JR, Lu Y, Stout A, Odenkirchen J, Kunitz S. National Institute of Neurological Disorders and Stroke Common Data Element Project - approach and methods. Clin Trials 2012;9(3):322-9.
23. ControlCfD. and Prevention, Injury prevention and control: traumatic brain injury. 2010. Centers for disease control and prevention [on-line] 2010.
24. CDC, https://www.cdc.gov/traumaticbraininjury/pdf/blue_book.pdf. CDC2016.
25. Colby SLand JM. Ortman, Projections of the size and composition of the US population: 2014 to 2060. Current Population Reports 2015; 1125-1143.
26. TeasdaleG and Jennett B. Assessment of coma and impaired consciousness: a practical scale. The Lancet 1974;304(7872): 81-84.
27. Jennett B. Disability after severe head injury: observations on the use of the Glasgow Outcome Scale. J Neurol Neurosurg Psychiatry 1981; 44(4):285-293.

28. Rappaport M, Hall KM, Hopkins K, Belleza T, Cope DN. Disability rating scale for severe head trauma: coma to community. Arch Phys Med Rehabil 1982; 63(3):118-23.
29. Hummel FC, Cohen LG. Drivers of brain plasticity. Curr OpinNeurol 2005;18:667-674.
30. Johansson BB. Functional outcome in rats transferred to an enriched environment 15 days after focal brain ischemia. Stroke 1996; 27:324-326.
31. Johnson D, Roethig Johnston K, Richards D. Biochemical and physiological parameters of recovery in acute severe head injury: responses to multisensory stimulation. Brain Inj 1993;7:491-499.
32. Kater K. Response of head-injured patients to sensory stimulation. Western J Nurs Res 1989;11:20-33.
33. Kolb B, Gibb R. Environmental enrichment and cortical injury: behavioral and anatomical consequences of frontal cortex lesions. Cereb Cortex 1991;1:189-198.
34. Giacino JT, Whyte J, Bagiella E, Kalmar K, Childs N, Khademi A. Placebo-controlled trial of amantadine for severe traumatic brain injury. N Engl J Med2012;366:819-26.
35. Whyte J. Disorders of consciousness: the changing landscape of treatment. Neurology 2014;82:1106-7.
36. The Multi-Society Task Force on PVS. Medical aspects of the persistent vegetative state. N Engl J Med1994; 330:1499-508.
37. Giacino JT, Ashwal S, Childs N, Cranford R, Jennett B, Katz DI, et al. The minimally conscious state: definition and diagnostic criteria. Neurology 2002;58:349-53.
38. Padilla R, Domina A. Effectiveness of sensory stimulation to improve arousal and alertness of people in a coma or persistent vegetative state after traumatic brain injury: a systematic review. Am J Occup Ther 2016; 70:1-8.
39. Schnakers C, Magee WL, Harris B. Sensory stimulation and music therapy programs for treating disorders of consciousness. Front Psychol20167:297.
40. Rosenzweig MR. Environmental complexity, cerebral change, and behavior. Am Psychol1966; 21:321-32.
41. Rosenzweig MR, Bennett EL, Hebert M, Morimoto H. Social grouping cannot account for cerebral effects ofenriched environments. Brain Res1978; 153:563-76.