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A Review of Current Trends in Coma Arousal Techniques Used in Physiotherapy for Disorders of Consciousness (DOC)

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Abstract

Background and Introduction: Comatose patients require a great amount of therapy to increase their level of consciousness and improve arousal. With evading time, increases the risk of side effects and secondary complications and financial as well as psychological burden on patient and their family. Therefore, there is a requirement for understanding coma and DOC better and engage in current recent advances which helps with patient's arousal response more efficiently and with better results.

Content: The coma arousal techniques include stimulation of arousal response in patients in unconscious state. These techniques have been followed from time after time. But, how can we fasten the process more? How can we assure accuracy and decide timeframe within which it's expected for consciousness to improve? This article aims to shed light on the recent research being done and current trends in coma arousal techniques for patients suffering from disorders of consciousness.

Conclusion: This article focuses on the current trends and recent advances in coma arousal techniques used by physiotherapists to treat patients with disorders of consciousness (DOC) and how it can be used to fasten the arousal response.

Keywords: *Coma, Disorders of consciousness, coma arousal techniques, awareness, median nerve stimulation, transcranial direct current, music therapy*

Introduction

Consciousness is defined by how humans interact with the world. It is how we intercept the world. It's definition is not isolated to one field rather its meaning tweaks and modifies according to the field one talks about for example clinically, philosophically, literary and even psychologically. But in pure clinical medical terms, consciousness is the state of full awareness of the self and one's relationship to the environment[(1)]. It includes distinct functions which are implemented in specific neuroanatomical networks in the brain and can be separated into systems necessary for controlling the level of consciousness, and systems involved in generating the content of consciousness. The content refers to the anatomical structures which govern the function and level depends on the harmonious working of multiple systems together [(2)]. There are different terms which come under impaired consciousness such as confusion, drowsiness, obtundation, stupor and coma. Disorders of consciousness

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(DOC) can be categorized into coma, vegetative state (VS) and minimally conscious state (MCS) [3]. Comatose patients require a great amount of therapy to increase their level of consciousness and improve arousal. With evading time, increases the risk of side effects and secondary complications and financial as well as psychological burden on patient and their family. Therefore, there is a requirement for understanding coma and DOC better and engage in current recent advances which helps with patient's arousal response more efficiently and with better results.

Coma and Disorders of Consciousness: Coma is a state of unarousable unresponsiveness[4], that is, it's a condition in which a person does not open eyes, obeys commands or utter recognisable words [5]. It's followed after a loss of consciousness mostly seen in case of a diffuse brain injury like in case of stroke, traumatic brain injury etc. The duration and level of coma may estimate the severity of a patient's condition. The cortical functions are depressed and usually it rarely lasts longer than 2 to 4 weeks, as almost all either further worsen in state or go into a vegetative state or get better during this time. Patients in coma are in a deep unconscious condition and show no signs of arousal even on vigorous stimulation. But, some responses such as reflexes mediated by brainstem and spinal cord remain visible [6].

In the initial weeks, patient is in deep coma but with time they will show slight changes in presentation and then cycles of arousal, wakefulness or alternating pattern need to be established. There may be response shown on primitive postural reflexes or reflex limb movement and respiration may change according to stimulation response. Patient may blink and start to track with eye movements. This phase is called the vegetative state (VS) but this is a transient phase and if it lasts, then it is called as persistent vegetative state (PVS). As the patient condition gets better with therapy and time, purposeful movements start to begin. It can be presented as following simple gestures and commands, attempting and speaking brief words or phrases. This phase is known as minimally conscious state (MCS). There are also states which resemble and mimic impaired consciousness like locked-in syndrome, dissociative disorders and somatoform disorders. [5, 6, 7]

It requires experience and astute observation to distinguish these stages. There exists numerous tools and scales to assess and categorize their status as well. The most common scale used is the Glasgow Coma Scale (GCS) and the Coma Recovery Scale (CRS-R) also known as the JFK Coma Recovery Scale-revised. Other lessen known scales used are, The Full Outline of UnResponsiveness Scale (FOUR), The Wessex Head Injury Matrix (WHIM), The Nociception Coma Scale (NCS) etc. [7]

Coma Arousal Techniques and/or Sensory Stimulation Program: The coma arousal techniques include stimulation of arousal response in patients in unconscious state. It utilizes the sensory stimulation program which is stimulation of the visual, auditory, tactile, kinetic, positional, olfactory and oral systems in order to evoke wakefulness [8]. Along with respiratory therapy and management of secondary complications of lying on bed, the coma arousal techniques are the first line of therapy for initiation of restoring cortical as well as physical function. These techniques work on the principles of neuroplasticity.

Neural plasticity or neuroplasticity is the ability of the nervous system especially the brain to change and adapt itself in response to repeated stimulus and formulating new connections and routes. Local cortical connections and responses are continuously reorganized as a result of peripheral and central alterations of input [9]. As we know from previous studies [10] that, increase of synaptic efficacy in existing neural circuits in the form of long-term potentiation and thus formation of new synapses may be involved in earlier stages of motor learning. These techniques have been followed from time after time. But, how can we fasten the process more? How can we assure accuracy and decide timeframe within which it's expected for consciousness to improve? This article aims to shed light on the recent research being done and current trends in coma arousal techniques for patients suffering from disorders of consciousness.

Current Trends: Utilizing electrical stimulation to maintain the muscle bulk in comatose patients has been in application from quite some time [11]. But it can also influence the level of consciousness and instigate arousal. Right Median Nerve stimulation (RMNS) is a safe and low cost therapy which requires surface stimulation of the right median nerve to increase the arousal and stimulation of a comatose individual. It is a technique which aims to rehabilitate by bridging the gap between peripheral nervous system and central nervous system through the median nerve. Even according to the homunculus model,

the somatosensory representation of the hand is relatively large. The main mechanism involving RMNS is the involvement of the neurons of the ascending reticular activating system (ARAS), which connect the brainstems reticular formation to the cerebral cortex via thalamus [12, 13, 14]. Thus, the median nerve synapses with these neurons of ARAS which further on stimulates the area and hence increases the activity. Another mechanism it emphasizes is on neuroplasticity. It has been found that Brain-derived neurotrophic factor (BDNF) increases neuron survival rates after a hypoglycaemic coma. RMNS has a direct relationship with BDNF levels with help in fastening the process of healing. [15, 16]. Although present from around two decades, there was scarce evidence available which caused hesitations on execution and application. But, with recent researches proving RMNS as beneficial through positive outcome on level of consciousness gives a new ray of hope [17, 18]. A current Asia Coma Electrical Stimulation (ACES) trial is underway in [19] aims to enrol 381 TBI patients and administering RMNS along with conventional treatment.

While mentioning electrical stimulation, Transcranial direct current (tDCS) which utilizes the concept of neuromodulation and is applied through small scalp electrodes is found to be clinically useful in coma arousal treatment especially in MCS patients. Repeated anodal tDCS of the left dorsolateral prefrontal cortex [20] provided significant results in MCS patients and use of high definition transcranial direct current stimulation (HD-tDCS) which is more precise and brings better outcomes than the traditional tDCS model has shown a marked increase in the functional brain networks in the resting state and there was not only a local effect but rather a global effect was seen in the entire brain areas. [21]

High frequency repetitive transcranial magnetic stimulation (rTMS) also uses neuromodulation and has shown impact on improvement of coma scale scores positively by increasing the neuronal activity and enhancing metabolic levels. There are studies which show that there is increase in alpha band energy which further improves cognitive ability and consciousness [22]. rTMS also showed that there is a direct positive correlation of the angular gyrus with the level of consciousness. Legostaeva,L et al 2019 [23] conducted a 10 session 2 week protocol in which high frequency rTMS protocol was delivered over the left angular gyrus. They found that a 20 hertz rTMS improved the coma recovery scale revised score in minimally conscious patients but no effects on vegetative patients.

Neurologic music therapy (NMT) is a holistic and engaging therapy which utilizes music and its components like tempo, rhythm etc. in different parameters to achieve cortical stimulation and improvement in consciousness level. O'Kelly et al 2013 [24, 25] emphasized in their study how music in the form of live salient music improved eye blinking in vegetative state patients. Music can also increase awareness/arousal as one study noted how there was an increased cerebral response to their own name callout after music session. Music can activate superior temporal gyri which hand can help in early detection of signs of consciousness [24, 26]. Music is a powerful stimulus that induces and communicates emotions and meaning through the perception of its intrinsic symbolic structure of musical elements, as well as through emotional responses that have become connected to it through an associative learning process [27, 28].

A fairly new therapy called coordination dynamics therapy (CDT) shows promising results in case reports wherein a 22 year old patient lost approx. 50% of brain tissue and was in a permanent coma state started CDT for 20 hours a week and slowly reached minimally consciousness stage and eventually was out of coma in a long term period of 5 years [29]. Although, research on this intervention is less, it showcases future potential for patients in extreme conditions.

Conclusion

Even after coming out of coma, there remains months of therapy to bring the patient back to society. Hence, there is a need for novel coma arousal techniques which would provide better prognosis and show improvement in expected time period. With the current ongoing trends, there is a lot of future scope for research.

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