PHYSIOTHERAPEUTIC SYSTEM FOR CRANIAL ELECTROTHERAPY STIMULATION

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Abstract. *Electrosleep, also known as CES, involves exposing the head to low-intensity electrical currents. It is known that gentle electrical currents can improve the balance of neurotransmitters, which leads to improved sleep patterns. Non-invasive cranial electrical stimulation has the ability to improve sleep by non-invasively increasing the release of endogenous opioids from areas of the brain responsible for pain control. Developing an electrosleep physiotherapy device is an exciting project that combines medical science and technology. The author offers some new ideas that could improve the performance of such a device. For example, by experimenting with overlapping different output frequencies to target treatments, new properties may be obtained. Biometric feedback for adjusting stimulation based on real-time data is also interesting. The work can have an interesting continuation and practical use.*

Keywords: *therapy device, low-intensity electrical currents, enhance neurotransmitter balance, device's effectiveness, clinical trials.*

Introduction

Developing an electrosleep physiotherapy device involves creating a tool that can induce a state of relaxation or sleep through the application of electrical impulses to the brain. This technology, also known as cranial electrostimulation therapy or transcranial electrotherapy, has been studied for its potential benefits in improving sleep patterns and aiding in relaxation [1]. The introduction of such a device typically starts with understanding the underlying principles of electrosleep therapy, which includes the generation of weak impulse currents designed to stimulate the brain and induce sleep.

Clinical studies suggest that the most effective impulses are those with a duration of approximately 0.3–0.5 ms and a frequency ranging from 0.5–2 to 80–100 Hz, with current levels typically between 50–5 mA [2].

1. Improvement of the CES system.

Improvement an electrosleep therapy system involves a blend of science, innovation, and creativity. Electrosleep, also known as Cranial Electrotherapy Stimulation System (CES), involves applying low-intensity electrical currents to the head. It originated in Russia in the 1950s and gained interest due to its potential impact on sleep quality.

Researchers found that these mild electrical currents could enhance neurotransmitter balance, leading to improved sleep patterns. Modern CES devices are pocket-sized, battery-operated, and pulse at varying frequencies (from 100 to 15,000 times per second) with current intensity around 1 mA or slightly higher.

Let's explore some ideas to create an effective system:

a) Design Considerations:

Electrode Placement: Determine optimal electrode placement on the head. Traditionally, electrodes were placed on closed eyelids and behind the skull base.

Comfort and Portability: Design a compact, comfortable device that users can easily carry and wear during sleep.

Adjustable Parameters: Allow users to customize pulse rate, intensity, and duration based on their individual needs.

b) Safety and Regulation:

FDA Compliance: Ensure your device adheres to safety standards set by the FDA or relevant regulatory bodies.

Risk Assessment: Evaluate potential risks associated with electrical stimulation (e.g., skin irritation, interference with other medical devices).

User Instructions: Provide clear instructions for safe usage.

***c) Enhancements and Innovations*:**

Biometric Feedback: Integrate sensors (e.g., heart rate, brainwave activity) to adjust stimulation based on real-time data.

Smartphone Connectivity: Develop an app that syncs with the device, allowing users to track their sleep patterns and adjust settings remotely.

Multimodal Approach: Combine CES with other relaxation techniques (e.g., aromatherapy, white noise) for a holistic sleep solution.

***d) Clinical Trials and Research*:**

Efficacy Studies: Conduct rigorous clinical trials to validate the device's effectiveness in improving sleep quality.

Long-Term Effects: Investigate the long-term impact of electrosleep therapy on overall health and well-being.

Safety, user comfort, and scientific validity are paramount. Collaborate with experts in neuroscience, sleep medicine, and engineering to refine your device.

2. Features of the development of the CES system.

Developing an electrosleep physiotherapy system is a fascinating project that combines medical science with technology. Here are some ideas that could help in the development of such a system:

Master-Slave System: Design a system with a master-slave architecture where the master block controls the user interface and the slave block generates the appropriate voltages and currents for treatment [3].

Microcontroller Utilization: Incorporate a microcontroller to manage the wave generation, ensuring precise control over the electrical signals used in the therapy.

Frequency Overlap: Experiment with overlapping two frequencies in the output signal to target specific treatments, such as anticellulite or antiflaccidity, as tested in aesthetic mesotherapy [4].

Non-Invasive Cranial Electrotherapy Stimulation (CES): Explore CES for its potential to improve sleep by noninvasively increasing the release of endogenous opioids from pain management regions of the brain [5].

Comprehensive Review and Research: Conduct a thorough review of the history and evolution of electrosleep and transcranial electrical stimulation (TES) to inform the design and functionality of your device [6].

Clinical Trials: Plan for clinical trials to test the effectiveness of the device in a real-world setting, focusing on safety, efficacy, and patient comfort [7].

User-Friendly Interface: Develop an intuitive user interface that allows for easy adjustments of treatment parameters and monitoring of patient responses.

Portable Design: Aim for a compact and portable design that can be used in various settings, including clinics and home environments [8].

Regulatory Compliance: Ensure that the device meets all regulatory requirements for medical devices in your target markets.

Modern methods of electrosleep therapy

Let's consider the most common methods of electrosleep therapy.

1. A widely known method for treating diseases of the central nervous system is the method of neurogenic central electroanalgesia. This method is based on the use of rectangular current pulses from 50 to 2000 Hz, which creates optimal conditions for enhancing self-regulation processes in the cerebral cortex and causes an analgesic effect. The method is based on the effect of electrotranquilization, which allows, by slowing down the conduction of pathological impulses in the frontal areas of the cortex, to ensure a persistent weakening of the cortical component of emotional reactions and their vegetative manifestations [9].

2. Currently, along with the use of rectangular pulsed current in electrosleep therapy, currents with other characteristics have begun to be used, in particular, sinusoidal modulated currents with a carrier frequency of 5000 Hz. This method is called transcerebral amplipulse therapy [10]. The direct effect of sinusoidally modulated currents on nerve formations and cerebral vessels is more pronounced than with rectangular currents, and the reflex component is less pronounced, which determines their differences in physiological effects. The most pronounced hemodynamic effects during amplipulse therapy are manifested in the correction of both central and regional (cerebral and renal) hemodynamic parameters, regardless of the initial disorders.

3. Interference currents are also used to influence the central nervous system. This electrotherapy method is called transcerebral interference therapy [10]. The mechanism of the physiological action of interference currents, although close to the action of rectangular pulsed currents, differs in that the use of higher frequencies facilitates the almost unimpeded passage of currents through the skin barrier. Consequently, the reflex component of their influence on the central nervous system is negligible, while the direct effect on excitable brain structures is quite pronounced. The following physiological effects are most pronounced during transcerebral interference therapy: antiarrhythmic, lipotropic, hormonal and immunocorrective, and hemodynamic.

Prospects for the use of electrosleep therapy

Electrosleep has the ability to increase the threshold of reaction to stress, reduce fatigue and increase mental and physical performance. During the course of electrosleep treatment, patients note calmness, an increased feeling of vigor, freshness, energy, activity, increased performance, improved or normalized night sleep. Self-observations of patients indicate that even an hour or an hour and a half procedure of electrosleep in terms of the degree of rest can be equated to a full eight-hour physiological night sleep.

The positive results of the use of electrosleep in people in dispatcher and driver professions have given rise to the use of electrosleep as a method of preventing neuroses and increasing performance in similar professions in other departments, for example, pilots, vehicle drivers, etc.

The problem of rapid restoration of microcirculation is one of the pressing problems of resuscitation. The pharmacological agents used do not fully satisfy doctors due to the presence of side effects, complications, intolerance and allergic reactions. Positive results of using electrosleep in the treatment of such vascular pathologies as obliterating diseases of the arteries of the extremities, hypertension, atherosclerosis and in obstetric and gynecological practice have shown the possibility of using electrosleep in intensive care.

In psychiatry, the development of more adequate complexes of electrosleep and psychopharmacological agents has proven promising both for more effective treatment of functional disorders and for the treatment of psychotic disorders - schizophrenia, manic-depressive, presenile and other psychoses.

Further development of adequate modifications of electrosleep for more effective antipsychotic effects is also promising in psychiatry. The discovery of ever new properties of the therapeutic effect of electrosleep makes it promising to further expand the scope of its use in various fields of medicine. At the same time, the therapeutic effect of electrosleep can be enhanced by the development of pathogenetic substantiated treatment complexes with an individual approach to each patient.

Without a doubt, further research in the practical application of electrosleep will make it possible to develop new methods of electrosleep therapy, as well as formulate requirements for modern equipment for carrying out procedures.

Conclusions

The development process would also involve designing the system's electrode parameters, such as the number, location, and shape of electrodes, as well as the signal's intensity, shape, amplitude, duration, polarity, repetition rate, and pulse series interval. These parameters are crucial as they can affect the efficacy and safety of the therapy. The development of an electrosleep physiotherapy system is a multidisciplinary endeavor that requires a deep understanding of neurophysiology, electrical engineering, and clinical therapy to create a safe and effective product for users.

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