Device for phototherapy with polarized non-coherent radiation

Iurie NICA, Valeriu CEBOTARI, Leonid POGORELISCHI, Aurel SAULEA
Ghitu Institute of Electronic Engineering and Nanotechnologies
tehmed@nano.asm.md

***Abstract* —Recently, a special application has obtained non-invasive stimulation methods with low energy laser beams (L.L.L.T- low level laser therapy) or non-coherent intensive light beams of different wavelengths, hereinafter called phototherapy. In the case of phototherapy, the tissues are not heated, they are not injured, the light beam only increases cellular metabolism.**

***Index Terms* — phototherapy, light emitting diodes, polarized non-coherent radiation.**

I. INTRODUCTION

Phototherapy is recognized as one of the oldest methods of medical treatment. Since ancient times it is recognized that water - is good, air – is better and light – is the best. As a confirmation, the third Nobel Prize for Physiology and Medicine was awarded in 1903 to Niels Ryberg Finsen "for the recognition of special merits in the treatment of diseases - especially lupus - with the help of concentrated light radiation, which opened for medical science new great horizons". As a result, at the end of the nineteenth and twentieth centuries, the curative properties of light were studied deep in the infrared, visible and ultraviolet regions of the spectrum. The elaborated medical device allowed for the selective and integral variants of the radiation used for differentiated phototherapy. A special application has obtained non-invasive laser-stimulation methods. In the case of low level laser therapy, the tissues are not heated, they are not injured, the laser beam only increases cell metabolism. Red light radiation and infrared radiation penetrate the tissues in depth, where the luminous energy is absorbed and transformed into biochemical energy. By increasing cellular energy in the treated area, laser phototherapy favors healing, reduces inflammation and pain without harmful side effects [1,2]. On the other hand, the use of low-intensity radiation to activate metabolic processes, enhances immunity, stimulates cellular energy stimulation, reduces drug use and speeds up rehabilitation, especially for patients with low immunity. However, medical devices based on laser diodes, are quite costly. Recently, devices that generate polarized non-coherent radiation have been developed and introduced into medical practice. Such a phototherapeutic device is BIOPTRON (Switzerland) having a radiation spectrum between 480 and 3400 nm [3]. In this region the UV component is absent and a small fraction of the IR is present. At the action of light, the temperature difference at the surface of the skin is 1 ° C and the penetration depth is 2 – 2,5 cm.

II. LIGHT EMITTING DIODE PHOTOTHERAPY

The emergence of light emitting diodes (LED) and, in particular, of ultra-luminescent diodes, the development of their manufacturing technology, the reduction of costs and the vertiginous increase in emission power, lead to a rapid development of phototherapy devices and procedures for various diseases. Knowing the wide use of highly effective laser therapies in the complex treatment of neurological diseases, neuralgia and neuritis, the temptation to develop phototherapy devices based on supraluminous diodes emitting polarized light of different wavelengths for neurological applications, appears. In the physiotherapeutic system being developed, combinations of blue, green, red, and infrared diapazon will be used, with the possibility of regulating the regimens within very wide limits, which will allow the reaction of the body both at reflex level and humoral level. The physiotherapeutic system consists of the command and control unit that contains the patients' database, working regimes and several types of probes with a different number of beams and various powers.

Developing of the radiation heads (probes) involves solving construction problems as well as satisfying the particularities of the operation of the device depending on the specificity of the patient's specific diagnosis.

Irradiation of small wounds or skin areas at local processing points involves the proximate location of the radiation head and low irradiation times. In these cases the probes could be localized manually, but the distance to the irradiated surface would be arbitrary and unstable. The need to repeat identical exposition calls for the use of adjustable supports with supports on the irradiated surface.
Irradiation of large areas of surfaces requires fairly long exposure intervals, which requires other probe positioning methods. In these cases, vertical tripod stands with probe clamping arms are appropriate.

The radiator's thermal regime is determined by the electrical power of the light diodes and the cooling system. Several cooling methods have been analyzed: passive, forced air cooling and forced cooling using thermal tubes. Passive cooling has been abandoned because of the concentration of dust between radiator valves and the difficulty of removing it. Moreover, when using powerful diodes (20-30 W), radiator gauges make radiation heads very uncomfortable in use.

Air forced cooling allows for fairly compact construction when using personal computer fans. The difficulty in this case is the need to evacuate warm air from the vicinity of the skin. The solution was found by combining forced cooling of the LED matrix fixators and insulation of the circulating air volume. Such constructions have been made.

The routing block of the light emitting diode modes consists of two parts. On the front, the liquid crystal indicator board is mounted, incorporating the deciphering system and the button plate. In the base case are mounted the microcontroller with the connection harness, the voltage stabilizer power supply unit, the power supply of the light diodes fans and the output stage. On the side is the cable coupler for radiant supply.

The memory block is designed to store information for 200 people. The device is ready to perform the procedure after accessing the number that corresponds to a particular patient. Subsequently, the power of the radiant beam is determined in percent with respect to the maximum radiation power and the beam modulation frequency. Frequencies are available: 0, 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000 Hz. Finally, the duration of the procedure is set to be up to 20 minutes. The interval is displayed on the liquid crystal panel. The procedure may be interrupted for break or completed before the set time.

All patient-specific information is memorized during all procedures and can be used in subsequent procedures. We hope that the device will be useful in the treatment of neurological disorders (asthenoneurotic syndrome, vascular encephalopathy, migraine), neuralgia (trigeminal, intercostal), neuritis (facial, ulnar, radial, medial, femoral, sciatic, poly - and mononeuropathy, musculoskeletal syndromes, multiple sclerosis, encephalopathy, traumatic brain injury, rehabilitation after acute stroke [4].

The project has an interdisciplinary character - engineering - medicine and the team consist of physicists, engineers and doctors. The originality of the proposed devices characterizes the course from the idea to the realization of the concrete object for application in the medical practice. Also, in the case of the emergence of the production infrastructure, we could even put our own developments on the market, thus making the laboratory path on the market easier.

REFERENCES

[1]http://medbookaide.ru/fold1002/book1005/p37.php

[2] К.В. Попов "О механизмах реализации клинических эффектов низкоинтенсивной лазерной терапии при ишемической болезни сердца" Бюллетень СО РАМН, №3 (117), ст, 21 – 25, 2005.

[3] http://ru.bioptron.com/

[4] Y. Fujimaki, T. Shimoyama, Q. Liu et al. "Low-level laser irradiation attenuates production of reactive oxygen species by human neutrophils", J. Clin. Laser Med. Surg., Vol. 21 (3). pp. 165-170, 2003.