

LOW-LEVEL LASER THERAPY for COVID-19:

Prevention, Treatment and Rehabilitation

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Low-level laser therapy has been successfully used in almost all fields of clinical medicine for more than 50 years. This method is notable for its versatility and high efficiency due to the effect of laser light energy on the basic regulatory mechanisms of the human body, including all phases of the infection process.

Our book substantiates promising approaches to the treatment and rehabilitation of patients who suffered coronavirus infection. Specific methods of low-level laser therapy are based on data from the literature and our own clinical experience. Particular attention is paid to the regulation of the immune system and endothelial dysfunction as the root cause of various complications arising from COVID-19 and to the methods of its correction.

Low-level laser therapy, if properly applied, is safe and does not have absolute contraindications or side effects, helping to even out the adverse effects of other treatment methods.

The features of several variants of specific low-level laser therapy techniques used for treatment, rehabilitation of COVID-19 patients, and disease prevention are considered. Emphasis is placed on the complex application of both invasive (intravenous laser blood illumination) and noninvasive techniques (on the projection of internal organs, locally, etc.), as well as the requirements of the current clinical guidelines for laser therapy.

This book is for a wide range of specialists (doctors and nursing staff): rehabilitation therapists, physiotherapists, clinicians with appropriate training in low-level laser therapy methods, and trainees in continuing medical education and professional development.

References are given in the original in Russian for searching in Russian libraries.

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LIST OF ABBREVIATIONS

AP	– acupuncture point
APTT	– activated partial thromboplastin time
BA	– bronchial asthma
BP	– blood pressure
CIC	– circulating immune complexes
CINC	– critical lower limb ischemia
COPD	– chronic obstructive pulmonary disease
CVD	– coronary vascular diseases
DF	– diabetic foot
DIC syndrome	– disseminated intravascular coagulation syndrome
DM	– diabetes mellitus
ED	– energy density
EnD	– endothelial dysfunction
ERF	– external respiratory function
GABA	– gamma-aminobutyric acid
ILBI	– intravenous laser blood illumination
INF	– interferon
IR	– infrared (band, spectrum)
LBI	– laser blood illumination
LED	– light-emitting diode
LILI	– low-intensity laser illumination
LLLT	– low-level laser therapy
LUVBI	– laser ultraviolet blood illumination
ML	– mean life
NLBI	– noninvasive (extravenous, percutaneous, transcutaneous) laser blood illumination
PD	– power density
PI	– protective index
PTT	– prothrombin time
RA	– rheumatoid arthritis
ROS	– reactive oxygen species
SNP	– single nucleotide polymorphism
TT	– thrombin time
UV	– ultraviolet (band, spectrum)
UVBI	– ultraviolet blood illumination

INTRODUCTION

A new strain of coronavirus isolated in late 2019 in Wuhan, China, SARS-CoV-2, spread worldwide within months. In January 2020, the World Health Organization (WHO) declared the epidemic associated with SARS-CoV-2 an international health emergency and later described the spread of the disease as a pandemic. In September 2021, the coronavirus cases exceeded 200 million, and more than 4.5 million people died.

The disease caused by SARS-CoV-2 is called COVID-19. The acute infection, which can be both mild and severe, is accompanied by complications such as pneumonia, acute respiratory distress syndrome, respiratory, heart, and kidney failure, septic shock, cardiomyopathies, and others [Wu Y.C. et al., 2020]. Many experts are convinced that the basis of severe organ involvement is endothelial dysfunction caused by SARS-CoV-2 and the resulting trophic tissue disruption [Pons S. et al., 2020]. There is now universal recognition of multiple and interrelated pathological changes in the immune system [Azkur A.K. et al., 2020] and the need for an integrated approach to treat COVID-19 patients [Иванов Д.В. и др., 2020; Lotfi M. et al., 2020].

The global pandemic COVID-19 has become a challenge for all mankind, scientists and doctors are tasked with finding ways for disease prevention, which is partially solved by vaccination. However, there are still no effective treatment regimens for patients with minimization of mortality and the development of complications, as well as rehabilitation of patients after a recent infection.

A characteristic feature of COVID-19 is the pronounced nonspecificity of injuries to various organs (a chain is only as strong as its weakest link), which endothelial dysfunction indicates [Москвин С.В. и др., 2020; Кочетков А.В. и др., 2020].

Data from numerous experimental and clinical studies, as well as 50 years of experience with large-scale applications, unambiguously testify to not only the complete safety but also the high efficiency of low-level laser therapy (LLLТ). The ability of low-intensity laser illumination (LILI) to have a normalizing effect on a variety of dysregulation processes at the level of cells, tissues, organs, and the body presents LILI as a promising method to treat COVID-19 patients during the acute phase of inflammation as well as the rehabilitation phase. Numerous facts also confirm the ability of LILI to prevent infection by restoring the work of the immune and other systems and thereby preparing the body to resist the infection.

Numerous studies have shown that LILI allows modulating the work of the immune system, normalizing the interaction of all its components [Москвин С.В. и др., 2020⁽¹⁾].

1. Cytokines, including interferons (IFN), play a key role in the first line of defense against viruses. Lymphocytes, macrophages, fibroblasts, some epithelial cells release IFN α and IFN β , that have antiviral and antitumor activity, stimulate macrophages and natural killers (NK); T cells and NK release IFN γ , also an immune response regulator with antiviral and antitumor effects.

2. Phagocytes are cells of the immune system that protect the body by absorbing (phagocytosis) harmful foreign particles (bacteria, viruses), as well as degrading autocytes.
3. Micro and macrocirculation, as well as trophic support of tissues, increasing their resistance to external negative influences.
4. Oxygen saturation of tissues, increased metabolism and cell proliferation, restoration of damaged tissues.

These properties of LILI allow fighting against a viral infection effectively, both as a means of prevention and as a treatment factor, preventing the development of pulmonary fibrosis. The positive results of the use of LLLT in the treatment of atypical pneumonia (SARS) caused by various coronaviruses also suggest high efficiency in the case of infection with COVID-19, due to the common pathogenesis of the disease [Thevarajan I. et al., 2020], and the mechanisms of biomodulating and therapeutic action of LILI [Москвин С.В., 2008, 2014].

Many people have responded to the challenge of COVID-19 within their capabilities. Information on the website of the Federal Institute of Industrial Property (FIPS) includes a list of non-medicinal methods of treating patients and preventing viral infections. It is noteworthy that most of them are patents using various low-level laser therapy methods (<https://fips.ru/doc-virus/doc-3-1.php>) [Pat. 2169592 RU; Пат. 2177811 RU; Пат. 2306157 RU; Пат. 2347595 RU; Пат. 2376045 RU; Пат. 2565107 RU]. According to the researchers of this institute, whose opinion we fully support, it is justified to use already known methods of nonspecific treatment successfully used for similar diseases, such as cases of pneumonia of various etiologies.

The need to use the achievements of both Western and Eastern medicine and the methods of both specific and nonspecific therapy in connection with COVID-19 is increasingly urgent. This book devotes much space to detailing our position on this issue since low-level laser therapy is exceptionally successful and concentrates the best of all medical fields.

We are not alone in this estimation; other specialists have supported our position. Almost two decades ago, the WHO published a report describing the success of this strategy in treating patients with SARS (SARS: Clinical trials on treatment using a combination of Traditional Chinese medicine and Western medicine. – Geneva: World Health Organization, 2004. – 194 p.).

Modern laser therapeutic devices allow for the implementation of practically all known methods of low-level laser therapy. Parameters of specific methods in their corresponding sections are compiled according to all regulatory requirements: wavelength, operating mode, power, power flux density, frequency for pulsed or modulated mode, exposure, localization, technical instructions, the number and periodicity of procedures.

Any questions related to the use of low-level laser therapy can be emailed to: 7652612@mail.ru.

PRIMARY AND SECONDARY MECHANISMS OF THE BIOMODULATING ACTION OF LOW-INTENSITY LASER ILLUMINATION

According to the current opinions, which are in good agreement with the practice of clinical application of low-level laser therapy, thermodynamic triggering of Ca^{2+} -dependent processes is the primary mechanism of the biomodulating action of LILI. After the absorption of laser light photon energy by various intracellular components, the intracellular calcium depot is activated, and Ca^{2+} ions with increased concentration are released in the form of two waves with half-periods of 100 and 300 seconds (Fig. 1) [Alexandratou E. et al., 2002; Løvschall H. et al., 1994].

This primary process is followed by the development of a cascade of responses at all levels (cellular, tissue, organ and systemic): activation of mitochondrial functions, cell metabolism and proliferation, normalization of the immune and vascular systems, and the inclusion of the VNS and CNS in the process, etc. (Fig. 2) [Москвин С.В., 2003, 2008, 2014].

The versatility and high efficiency of low-level laser therapy are explained precisely by the exposure to the minimum wavelength (or maximum frequency) in the optical range of electromagnetic waves at the cellular level and the coherence (monochromaticity) of laser light. Only low-intensity laser illumination allows triggering the response of the body of the required strength and direction through the enhancement of cellular metabolism and proliferation. This is the essence of the therapeutic action of LILI – the activation of the living organism’s own defense mechanisms, the coordination of internal physiological processes in order to restore the disturbed homeostasis.

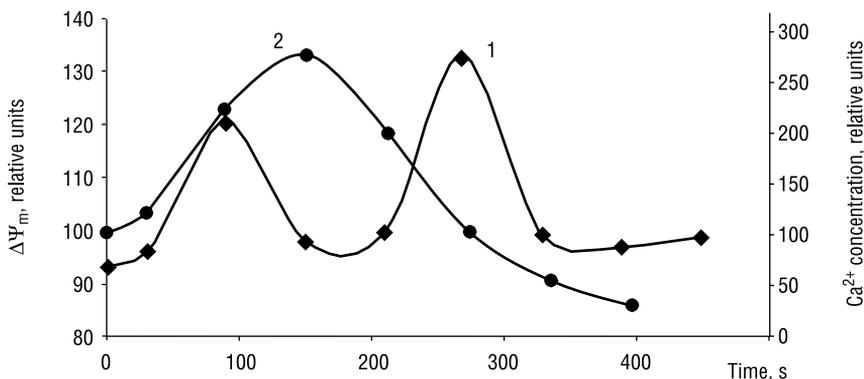


Fig. 1. Changes of Ca^{2+} concentration (1) in cytosol and mitochondria redox potential $\Delta\Psi_m$ (2) after laser stimulation (647 nm, 0.1 mW/cm², exposure 15 s) on human foreskin fibroblasts (Alexandratou E. et al., 2002)

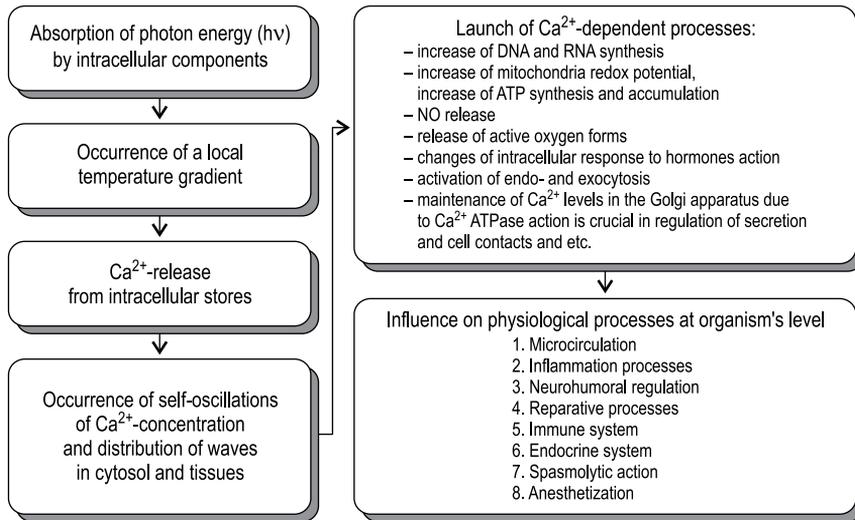


Fig. 2. The sequence of the development of biological effects from the impact of LILI on a living organism

After the primary process of the absorption of photon energy, a cascade of secondary responses of the body develops at all levels, triggering the response of all regulatory physiological systems without exception.

Numerous Russian and foreign clinical randomized controlled trials (RCTs) irrefutably prove the therapeutic properties of LILI, initially determined by the following effects [Moskvina S.V., 2014, 2016]:

- enhancement of macro- and microcirculation;
- immunomodulatory and anti-inflammatory action;
- anesthesia;
- activation of tissue proliferation and regeneration;
- impact on the nervous tissue, including reflex action.

All of these numerous regulatory processes are involved to varying degrees in the implementation of low-level laser therapy programs: prevention, treatment and rehabilitation.

EFFECTS OF DIFFERENT LOW-LEVEL LASER THERAPY TECHNIQUES ON THE IMMUNE SYSTEM

The book's title primarily invokes the immune system, on which the effect of LILI has been studied in recent years by many experts. Data from basic scientific research, which is extremely important, have been implemented for efficient low-level laser therapy techniques concerning neuroendocrine and oncological diseases [Кочетков А.В. и др., 2020⁽¹⁾; Москвин С.В., Рыжова Т.В., 2020; Москвин С.В., Стражев С.В., 2020].

To better understand our approach to treatment selection, it is necessary to consider concepts such as specificity and nonspecificity from a biomedical point of view. Closely related to the first term is so-called Western medicine, where one looks for the root cause, the specific (external) pathogenic factor, and directs all efforts to combat it. The second case is Eastern medicine which considers the person as a whole, and the primary source of the disease is the imbalance of internal mechanisms of regulation and treatment is aimed at restoring them [Moskvin S.V., 2017].

Low-level laser therapy is absolutely nonspecific since the mechanisms of biomodulating action of LILI are based on triggering the body's responses aimed at restoring the existing disorders, and from this point of view, LLLT is a kind of Eastern medicine. At the same time, the study of initiated self-regulation processes and identification of known regularities takes place strictly within the framework of Western biomedical science, rather than in Eastern empiricism, described through vital energy, body humors, fire, water, and other objectively uncontrolled terms. Thus, low-level laser therapy is almost a perfect synthesis of the two areas of modern medicine, combining them and using the better of the two practices [Moskvin S.V., 2017].

Specificity and nonspecificity are considered in detail in the well-known concept of stress and general adaptation syndrome, primarily in assessing the state and mechanisms of the immune system regulation. The need to consider several components of immunity and their relationships is emphasized, i.e., nonspecificity plays no less a role in the immune system than its specific components [Коляда Т.И. и др., 1995].

The view that every specific disease should have its own cause was created mainly in the 19th century. Thanks to the development of bacteriology, it became clear that the characteristic syndrome of any, for example, infectious disease can only be caused by a specific microorganism. In fact, very few pathological disorders are mono-causal when their development is due to a single cause. Most diseases are predominantly multi-causal, in the sense that the input factor (individual variations in disease manifestations) plays an important role: not everyone exposed to the influenza virus gets the flu but only susceptible individuals. Such a possibility should be assumed in all cases of idiopathic diseases. The specificity of any agent or pathogenic factor affecting the body is never absolute. Therefore, for an effective treatment, it is always necessary to involve specific and nonspecific methods that activate the body defenses [Селье Г., 1960, 1977].

which formulated the rules (protocols) and basic principles for the implementation of low-level laser therapy techniques [Лазерная терапия..., 2015].

Equipment for Low-Level Laser Therapy

A variety of techniques and applications of low-level laser therapy devices requires maximum versatility of the equipment used to ensure maximum efficiency of therapeutic effects, which, in turn, is ensured by the following procedures:

- (separate) use of LILI having different wavelengths, most often 365 and 405 nm (LUVBI®), 525 and 635 nm (ILBI, local and intracavitary techniques), 780 nm (laser biorevitalization), 904 nm (NLBI, locally, on the projection of internal organs);
- operation in modulated and pulsed modes;
- biosynchronization by means of external illumination modulation (BIO mode, modulation by musical rhythm, etc.);
- illumination through special light guides (ILBI, abdominal procedures);
- optimal spatial distribution of the laser illumination;
- reliable and continuous monitoring of the impact parameters;
- selection of the optimal time parameters of the technique (exposure);
- the use of associated and combined techniques (laser phoresis, EHF-laser therapy, laser-vacuum massage, etc.).

The proposed modular design concept allows the successful solving of all of these tasks, according to which the laser therapeutic equipment is conventionally divided into four mating parts (Figure 5) [Москвин С.В., 2003⁽¹⁾]:

- 1 – the base unit (usually 2- and 4-channel);
- 2 – laser heads for different LLLT techniques;
- 3 – optical and magnetic attachments;
- 4 – Matrix-Bio biocontrol unit.

The base unit is a basis of each set; it is the power supply and control unit. Its main functions include setting emission modes with mandatory control of the parameters: frequency, exposure (timer), illumination power. The base unit can contain both universal “laser” channels, to which only various laser emitting heads are connected, and special ones, for example, for vacuum (negative pressure) in Lasmik-03 device or vibration-magnetic laser head VMLG-10 in Matrix-Urolog device).

Control of the parameters not only insures against errors when selecting the initial values, but also provides the possibility of varying the exposure modes in a wide range, which, in turn, allows professionals to provide optimal treatment options.

In modern devices, the possibility of external modulation of the laser illumination power is necessarily provided, for example, by the biorhythms of the patient’s physiological changes. Various types of laser emitting heads are connected to the base units, which, in turn, are used with the corresponding magnetic and optical attachments.

The laser therapeutic devices of Lasmik® series are effective, easy to operate, have a modern design, enabling them to be applied successfully in the best medical centers in more than 100 countries of the world. In addition, the block design allows creating

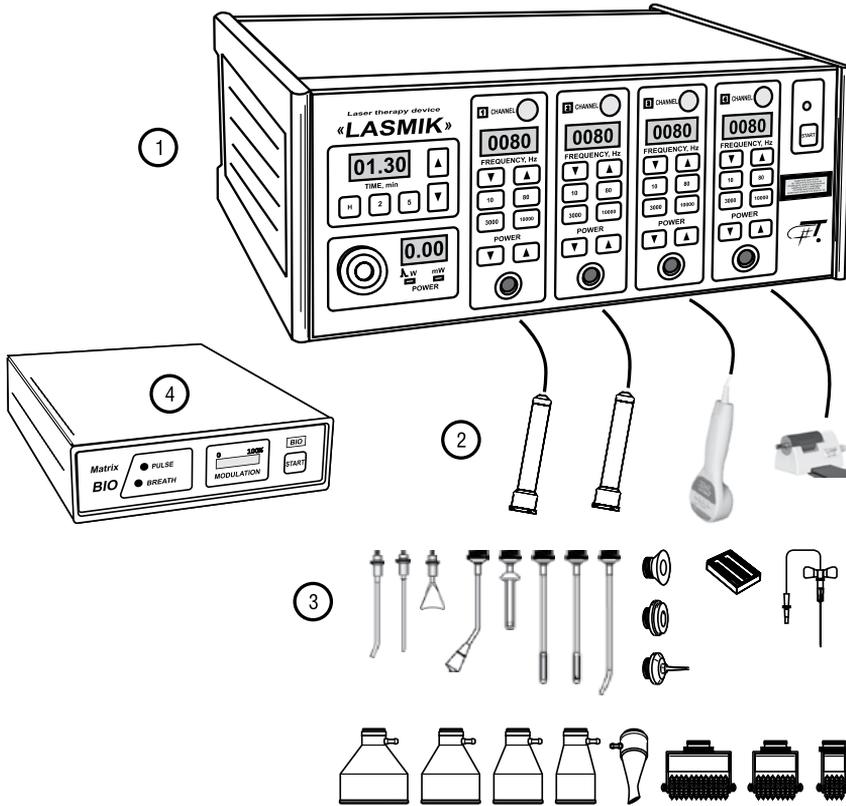


Fig. 5. Modular design concept of low-level laser therapy equipment

specialized highly efficient complexes, which have already proved themselves to be the best. Find more detailed information in a colour insert.

For the effective implementation of low-level laser therapy techniques for the treatment and rehabilitation of patients with COVID-19, it is necessary to use special equipment (see colour insert) and strictly follow the treatment protocols (see below). The kit includes specialized literature and detailed instructions for the use of LLLT in various fields of medicine (treatment protocols).

The section “Special techniques” also presents devices, laser emitting heads and attachments that are directly used in various variants of low-level laser therapy techniques for COVID-19, their characteristics and application features are described.

We draw attention to the fact that all kinds of “analogues” of Russian laser therapeutic devices LASMIK® and fake “techniques” (supposedly LLLT), offered by non-professionals and scammers, can lead to discrediting the method and human tragedy!

Basic methods of low-level laser therapy

The main goal and task of a person using low-level laser therapy is to select and ensure the *optimal* spatio-temporal parameters of each of the methods of laser exposure, taking into account their features:

- laser wavelength and operating mode;
- average or pulsed illumination power;
- frequency for pulsed or modulated mode;
- localization and area of impact;
- exposure per zone and the total time of the procedure;
- the number and frequency of procedures.

There are clinical rules, especially in relation to the principles of implementation of methodological schemes, for example, taking into account the condition and age of the patient, the stage of the disease, the presence of additional pathologies, etc.

All techniques have their own characteristics and are differentiated mainly by the localization of the impact:

- external;
- intracavitary;
- intravenous;
- associated and combined.

Another classification is based on the nature of the initiated response of the organism, systemic or local, despite the well-known fact of generalization of the effect under any local influence.

Systemic:

- laser acupuncture;
- laser blood illumination, carried out either by intravenous access (ILBI), or non-invasively, on the projection of large blood vessels (NLBI).

Local:

- all external and abdominal techniques, the purpose of which is to influence a specific pathological focus or organ.

It is most effective to carry out procedures using at least one systemic and one local method of exposure.

Requirements for protocols of low-level laser therapy procedures

Fulfilling the requirements listed below is mandatory, since the need to set **all** the parameters of the technique has been proven. Even one wrong value will not allow patients to get predictable and adequate responses to laser light action and the desired therapeutic effect, respectively.

Setting energy parameters substantially depends on the laser operating mode and technique. The majority of Russian devices have a laser hazard Class 1M or 2M according to IEC 60825-1:2014 (BS EN 60825-1:2014); I or II (21 CFR 1040.10), while foreign lasers have mainly the laser hazard Class 3R or 4 IEC 60825-1:2014 (BS EN 60825-1:2014); III-B or VI (21 CFR 1040.10 (i.e. very dangerous), which greatly



Laser therapy device LASMIK-01
(2 laser channels)

Matrix laser emitting head
ML-904-80



Matrix laser emitting head
ML-635-40



Optical attachment IPC



Laser head KL-ILBI-365-2
(UV, wavelength 365 nm)

Laser head KL-ILBI-525-2
(green, wavelength 525 nm)





Sterile light guides KIVL-01



The device can be equipped with an accumulator that allows you to work autonomously for up to 2 days



The external view of the laser therapy device LASMİK (2 laser channels) complete with laser emitting heads

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