INNOVATIVE TECHNOLOGIES

IN THE TREATMENT AND REHABILITATION OF WAR VICTIMS

Lidiia V. Butska
Viktor A. Cherniak

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ІННОВАЦІЙНІ ТЕХНОЛОГІЇ
В ЛІКУВАННІ ТА РЕАБІЛІТАЦІЇ ПОСТРАЖДАЛИХ ВІД ВІЙНИ

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ABSTRACT

The monograph "Innovative Technologies in the Treatment and Rehabilitation of War Victims" by Lidiia V. Butska and Viktor A. Cherniak presents original clinical and technological approaches to the diagnosis, treatment, and rehabilitation of military and civilian patients suffering from severe injuries and combat-related trauma.

The authors summarize modern experience in reconstructive and regenerative medicine, vascular and reconstructive surgery, and the use of advanced physical therapy and cell-based methods. Special attention is paid to the management of chronic pain syndromes, post-traumatic stress disorders, and functional recovery in individuals with war-related disabilities.

The publication outlines innovative therapeutic concepts integrating laser and magneto-laser technologies, physiotherapy, and multidisciplinary rehabilitation protocols, highlighting their practical effectiveness in restoring both physical and psychological health.

The research was conducted within the framework of the National Research Fund of Ukraine's competition "Science for Strengthening the Defense Capability of Ukraine" (Project No. 2023.04/0145) and approved for publication by the Academic Council of the V State Institution „V.K. Gusak Institute of Urgent and Recovery Surgery of the National Academy of Medical Sciences of Ukraine". (Protocol No. 3/9/2025, September 19, 2025).

Keywords

war trauma, rehabilitation, innovative technologies, physiotherapy, laser therapy, magneto-laser treatment, reconstructive surgery, post-traumatic stress disorder, chronic pain, multidisciplinary rehabilitation.

АНОТАЦІЯ

Монографія «Інноваційні технології у лікуванні та реабілітації постраждалих від війни» авторів Буцької Лідії Володимирівни та Черняка Віктора Анатолійовича присвячена сучасним підходам до діагностики, лікування та реабілітації військових і цивільних пацієнтів, які зазнали тяжких поранень та травм унаслідок бойових дій.

У роботі систематизовано результати клінічних досліджень і практичних напрацювань у сфері реконструктивної, судинної та регенеративної медицини, а також представлено новітні методики фізіотерапії, клітинної терапії та використання апаратних технологій у комплексних програмах реабілітації.

Особливу увагу приділено питанням лікування хронічних больових синдромів, посттравматичних стресових розладів та відновлення функціональних можливостей осіб із воєнною інвалідністю. Монографія містить опис принципів застосування лазерної та магнітолазерної терапії, фізичних факторів, системних та метамерних підходів у фізіотерапії, а також практичні рекомендації для лікарів, фізичних терапевтів та реабілітологів.

Дослідження виконано в межах гранту Національного фонду досліджень України за конкурсом «Наука для зміцнення обороноздатності України» (№ 2023.04/0145).

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Ключові слова

військова травма, реабілітація, інноваційні технології, фізіотерапія, лазеротерапія, магнітолазерна терапія, реконструктивна хірургія, посттравматичний стресовий розлад, хронічний біль, мультидисциплінарна реабілітація.

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ABOUT THE BOOK

The monograph *Innovative Technologies in the Treatment and Rehabilitation of War Victims* by L.V. Butska and V.A. Cherniak presents a comprehensive exploration of advanced medical and rehabilitation strategies tailored to the needs of individuals affected by armed conflict. Focused on the treatment of gunshot wounds, their long-term consequences, and associated systemic disorders, the work offers a multidisciplinary perspective on restoring health and functionality in severely injured patients.

The authors delve into cutting-edge methods of foreign body detection and removal, emphasizing the importance of precision and minimally invasive techniques in surgical practice. Special attention is given to vascular reconstruction, a critical component in managing trauma-related circulatory damage, where innovative approaches are shown to significantly improve outcomes. A central theme of the monograph is the application of autologous mesenchymal stem cell therapy. This regenerative technique is presented as a promising avenue for tissue repair, immunomodulation, and functional recovery, particularly in cases of complex trauma. The authors provide evidence-based insights into the mechanisms of action, clinical protocols, and therapeutic potential of cell-based interventions.

Equally important is the integration of modern physiotherapeutic technologies. The monograph outlines the synergistic use of ultrasound, magnetic fields, and electromagnetic radiation to stimulate healing processes, reduce inflammation, and enhance neuromuscular function. These modalities are discussed not only in terms of their individual benefits but also as part of a combined therapeutic strategy that maximizes rehabilitation efficiency.

A notable contribution of the work is the practical guidance on the use of the MIT-11 device – a multifunctional physiotherapy system developed for simultaneous application of low-frequency ultrasound, laser, and magnetic stimulation. The authors present detailed treatment algorithms and case-based recommendations, demonstrating how this technology supports targeted recovery across the central and peripheral nervous systems and localized pathological zones.

The monograph emphasizes the value of an interdisciplinary approach that combines surgical, cellular, and physical therapy methods to create individualized rehabilitation plans. This holistic model is designed to address both physical and psychological dimensions of recovery, recognizing the complex needs of war victims.

Intended for a broad professional audience, the publication is recommended for physicians, rehabilitation specialists, physiotherapists, medical students, and researchers engaged in military medicine and trauma care. It serves as both a scientific resource and a practical manual, contributing to the advancement of evidence-based practices in the treatment and rehabilitation of combat-related injuries.

CONTENTS

ABBREVIATIONS

AP	acupuncture points
BAP	biologically active points
CMF	constant magnetic field
EMF	electro magnetic filed
EMR	electromagnetic radiation
FB	foreign body
LILR	low-intensive laser radiation
MF	magnetic field
MLT	magnet laser therapy
MLUST	magnet laser ultrasound therapy
MPLT	multipurpose laser therapy
MT	magnet therapy
PMF	pulse magnetic field
POL	peroxide oxidation of lipids
PT	physiotherapy
REG	rheoencephalography
RMF	rotating magnetic field
SBR	secondary biogenic radiation
SP	sonopuncture
TPF	therapeutic physical factors
UCSG	upper cervical sympathetic gangly
UphP	ultra phonophoresis
UST	ultrasonic therapy
US	ultrasound
USP	ultrasound punctures

INTRODUCTION

Combat injuries remain a pressing medical and social challenge, particularly in countries enduring military conflicts. In Ukraine, the prolonged war has led to a dramatic rise in the number of victims with severe combat injuries (Salenko et al., 2023). These injuries are frequently complicated by the presence of radiolucent foreign bodies – glass, plastic, or composite fragments – which are invisible on standard X-ray images. Their undetected presence can result in chronic pain, infections, or delayed wound healing, creating significant obstacles for surgical management and subsequent rehabilitation (Butska, 2023). Beyond the physical damage, such injuries often cause long-term disability and profound psychological consequences for patients (Butska (ed.), 2024).

Effective treatment and rehabilitation of war victims demand a multidisciplinary approach that integrates surgical, medical, physiotherapeutic, and psychological strategies (Malec et al., 2017). Evidence demonstrates that multidisciplinary rehabilitation programs accelerate functional recovery, restore psychosocial adaptation, and significantly improve quality of life (Eades et al., 2013; Cao, 2025; Korompeli et al., 2025). In modern wartime conditions, when the number of trauma cases continues to grow, it becomes crucial to implement innovative diagnostic and therapeutic technologies that ensure both effective treatment and comprehensive rehabilitation (Malec et al., 2017; Murray, 2022; Cao, 2025; Korompeli et al., 2025).

In therapeutic and rehabilitation medicine, there has long been a dynamic interaction, and sometimes competition, between pharmacological methods of treatment, on the one hand, and physiotherapy or balneological methods of treatment, on the other. Despite the broad arsenal of modern pharmacology, medications may cause adverse reactions, allergies, or drug dependence. On the contrary, preformed physical factors such as ultrasound (US), magnetic fields (MF) and electromagnetic radiation (EMI) offer unique advantages. They stimulate functional systems of the body, normalize physiological responses, improve microcirculation and innervation, and activate immune and reparative processes, typically without severe side effects. Importantly, these modalities represent natural components of the body's environment, making their therapeutic integration both physiological and effective.

The potential of these factors is maximized when used in combination. Simultaneous or sequential application of EMR, MF, and US has demonstrated enhanced therapeutic outcomes compared to their isolated use. This rationale guided the development of complex devices, such as the "MIT-11" system by MEDINTEH (1995), which enables combined ultrasound, laser, and magnetic-laser therapies with flexible modulation frequencies, targeting both central and peripheral nervous systems alongside the local pathology zone.

Within the context of war-related injuries, such innovations are especially valuable. Advanced methods of fragment detection and retrieval, vascular reconstruction, cell-based therapies, and multimodal physiotherapy are becoming essential components of treatment protocols. Their integration ensures not only the resolution of acute surgical challenges but also the long-term rehabilitation of patients with complex trauma.

This monograph „Innovative Technologies in the Treatment and Rehabilitation of War Victims" presents scientific and clinical achievements in this field. It highlights the synergy between modern surgery, cellular and regenerative medicine, and advanced physiotherapeutic technologies, offering a new paradigm for the effective recovery of those affected by combat injuries.

With deep respect and heartfelt gratitude, the authors of the monograph „Innovative Technologies in the Treatment and Rehabilitation of War Victims" bring sincere appreciation to the memory of two outstanding Ukrainian scientists, founders and innovators in the field of modern physiotherapy and medical rehabilitation – academician, professor Ivan Zakharovych Samosyuk and professor, engineer, inventor, director of the Institute of Medical Innovative Technologies Nikolai Viktorovich Chuhraev.

Their scientific legacy, groundbreaking innovations, and tireless dedication laid the foundation for the development of rehabilitation medicine in Ukraine, especially in the context of treating and restoring the health of war victims. Through their ideas, inventions, and teaching, countless professionals were trained, and thousands of patients were given hope and a chance for recovery.

We bow our heads in honor of their contributions to science, medicine, and humanity. Their work lives on in our research, in every step toward healing, and in every patient whose life has been changed. Eternal gratitude and remembrance.

CHAPTER 1

DIAGNOSIS AND TREATMENT OF COMBAT TRAUMA

Viktor A. Cherniak

1.1. Introduction

Combat injuries remain a serious medical and social problem, especially in countries experiencing military conflicts. In Ukraine, due to prolonged hostilities, the number of victims with combat injuries has significantly increased [1]. These injuries often lead to complex medical complications, long-term disability, and severe psychological consequences for patients [2]. One of the major challenges in treating combat wounds is the presence of radiolucent foreign bodies, such as glass, plastic, or composite materials. Due to their invisibility on standard X-ray images, the diagnosis and removal of such fragments become difficult tasks for surgeons [3]. Undetected fragments may cause chronic pain, wound graft infections, and other complications, further complicating the rehabilitation process. At the same time, effective rehabilitation of combat trauma victims requires a multidisciplinary approach [3]. Such an approach provides a comprehensive rehabilitation of the patient, taking into account physical, psychological, and social aspects of healing [3]. Research indicates that multidisciplinary rehabilitation programs contribute to faster functional recovery and improved quality of life for patients [3]. In modern conditions, as the number of victims with combat trauma increases, it is particularly important to introduce innovative methods of diagnosis and treatment, as well as to ensure comprehensive rehabilitation to improve treatment outcomes and patients' quality of life [1, 2, 3].

1.2. Control of bleeding

Effective tools in soldiers' first aid kits, alongside weapons and diplomacy, strengthen the state's position on the international arena. For this reason, developed countries devote considerable attention to improving the available means of providing emergency pre-hospital care. The application of a tourniquet and the occlusion of blood flow is one of the most crucial life-saving interventions in cases of bleeding from major limb vessels. Delayed application of a tourniquet most often results in the death of the casualty. At the same time, a properly applied tourniquet, together with the necessary skills, saves the life of a soldier on the battlefield or a civilian in a critical situation (accident, armed assault, injury, etc.) [4].

Étienne Morel, Jean-Louis Petit, Friedrich von Esmarch, and Bernhard von Langenbeck – names that are not widely known to the public. Yet millions of people whose lives were saved by tourniquets owe their survival primarily to this group of pioneers. From the 17th century until the Second World War, each of them made a significant contribution to the development of instruments for stopping life-threatening bleeding. In the late 1990s, the first models of modern tourniquets with a windlass mechanism began to be actively implemented (an advanced version of Morel's early concept). The

United States played a leading role in this process. Prototypes were gradually improved and modified, gaining popularity first among military personnel and medical professionals, and later among civilians.

The annexation of Crimea and the war in eastern Ukraine had a significant impact on the development of global military field (tactical) medicine. It can be said that within just a few years, military medicine in Ukraine underwent rapid transformation, and already within three years, the country began to manufacture modern hemostatic devices and share its unique experience of their application in real combat conditions with the world.

We studied such tourniquets made in Ukraine as „SICH-Tourniquet", „Paramedic" (Tourniquet-1), „ARONIA", as well as a new development of Brightfield Ukraine LLC – BFT-01 tourniquet.The BFT-01 is a modern, compact, and highly effective device for the temporary control of bleeding of varying intensity from injuries to the upper and lower extremities. It works by being wrapped around the limb (arm or leg) and tightened manually. It is suitable for use in home, outpatient, field, or travel conditions. The tourniquet resembles a strap with a special tightening mechanism and a patented one-way buckle for pre-tightening. If necessary, when there is no possibility to apply the tourniquet as a loop, the buckle can be detached from the mechanism. The device can be used in any weather conditions. It has successfully passed testing and is registered as a medical product in Ukraine. The tourniquet is intended for first aid use in ambulances, field conditions, and other emergency situations. According to the Technical Regulations on Medical Devices, approved by the Resolution of the Cabinet of Ministers of Ukraine dated October 2, 2013, No. 753, and DSTU 4388, the tourniquet is a non-invasive, non-sterile medical device without a measuring function, classified as Class I depending on potential risk.

Recommendations for Use

Before use, be sure to read these instructions.

The tourniquet may be applied independently, even with one hand.

The maximum recommended application time is no more than two hours.

The tourniquet should be folded in such a way that it can be applied with one hand, in case it must be placed on the opposite arm.

Warnings

The tourniquet is a single-use medical device.

Do not tighten the tourniquet more than is necessary to achieve stable bleeding control.

Use the tourniquet only for stopping bleeding on the upper and lower extremities.

Do not apply the tourniquet to the neck or head.

If the tourniquet has been applied for more than two hours, do not attempt to remove it yourself. Removal must only be performed by medical professionals.

General Rules for Tourniquet Application

- The tourniquet should be applied only in cases of absolute necessity and ideally within 15–20 seconds. This applies to situations where severe limb bleeding poses a real threat to life.
- The tourniquet should be applied 5–8 cm (up to 10 cm) above the wound site on the shoulder, forearm, thigh, or shin.
- In combat conditions, if the exact wound location is unknown, it is acceptable to apply the tourniquet as high as possible on the limb (upper third of the thigh or arm – four main points).
- Ensure that the tourniquet is not applied over a joint or fracture site.

- Avoid placing the tourniquet on the middle third of the upper arm or the popliteal fossa, as there is a high risk of nerve injury in these areas.
- If the tourniquet is applied correctly, bleeding will stop and no distal pulse (wrist or posterior tibial pulse) should be detected. The limb should not swell or turn bluish.
- If bleeding has stopped but a pulse is still present, do not overtighten the tourniquet.
- Do not cover the tourniquet with bandages or clothing.
- Always record the time of application on the tourniquet itself or on a visible part of the casualty's body. Write the letter "T" (tourniquet, time) before the recorded time so that medical personnel know when the tourniquet was applied.

Monitor casualties carefully, as they may attempt to loosen the tourniquet due to severe pain. Administer analgesics when possible.

1.3. Duration of tourniquet application

Applying a tourniquet for up to two hours is generally considered relatively safe. Within this time, efforts should be made to stop the bleeding by other methods or evacuate the casualty to a surgical department. If evacuation or alternative bleeding control is not possible, it is recommended to loosen the tourniquet for 30 seconds and assess the condition of the casualty. If there are no changes in consciousness, breathing, pulse, or skin appearance, this maneuver may be repeated up to three times.

1.4. One-handed application of the tourniquet (Fig.1).

1. Put the tourniquet loop (3) on the injured limb above the bleeding wound, with the buckle (4) towards you.
2. Pull the free edge (6) of the tape, trying to pre-tighten the tourniquet as tightly as possible.
3. Use sectoral movements of the handle (2) of the mechanism for final tightening.
4. Tighten the tape until arterial bleeding stops and the pulsation of the injured vessel disappears. Wrap the rest of the tape around the limb.
5. On the white information patch (9), indicate the time of application of the tourniquet using a permanent marker or ballpoint pen.

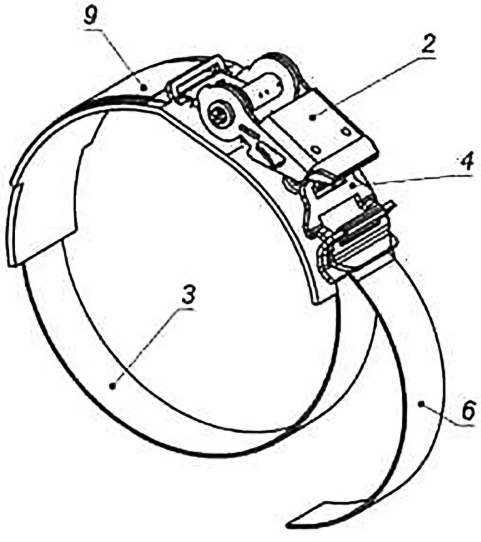

Figure 1. Order of use one-handed application of the tourniquet.

1.5. Two-handed application of the tourniquet (Fig.2).

1. Disconnect the buckle (4) from the mechanism (1), having previously pressed the latch (8).
2. Wrap the tourniquet around the wound area above the bleeding area.
3. Fix the buckle (4) on the frame of the mechanism (1), putting the corresponding rectangular hole of the buckle (5) on the hook (7) on the frame (1).
4. Pull the free edge of the tape (6), trying to pre-tighten the tourniquet as tightly as possible.
5. Use sectoral movements of the handle (2) of the mechanism for final tightening. Tighten the tape until the arterial bleeding stops and the pulsation of the damaged vessel disappears.
6. Wrap the rest of the tape around the limb.
7. On the white information patch (9), indicate the time of applying the tourniquet using a permanent marker or ballpoint pen.

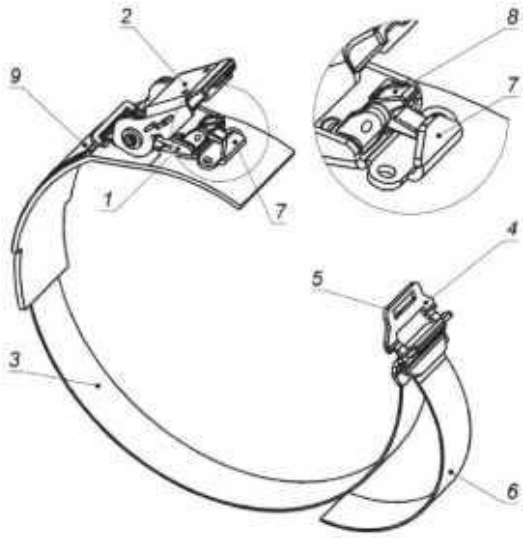

Figure 2. Order of use two-handed application of the tourniquet.

1.6. Partial loosening of the tourniquet (Fig.3).

1. In the case when it is necessary to loosen the compression of the limb, it is necessary to pull the opening lever (10), which is located on the side surface of the handle of the mechanism (2) of the turnstile in the direction of the edge of the handle.
2. After that, without releasing the lever, it is necessary to move the handle (2) to a position slightly beyond its working stop.
3. After that, each press on the open handle (2) will lead to the release of the mechanism drum by one tooth and a small dosed weakening of the compression of the limb.

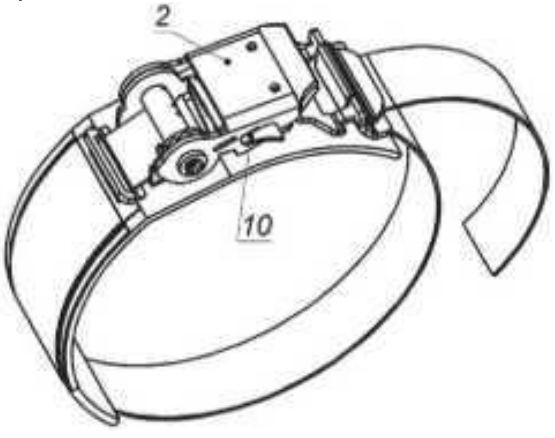

Figure 3. Order of use partial loosening of the tourniquet.

1.7. Tourniquet – opening and removal instructions (Fig.4).

In the case when it is necessary to completely loosen the compression of the limb and remove the tourniquet, it is necessary to pull the opening lever (10), which is located on the side surface of the handle of the mechanism (2) of the turnstile in the direction of the edge of the handle.

Then, without releasing the lever, it is necessary to move the handle (2) to the maximum open position.

The toothed drum will then be unlocked, and the compression of the limb will completely stop.

After that, disconnect the buckle (4) from the mechanism by removing it from the hook (7), having previously released it by pressing the latch (8).

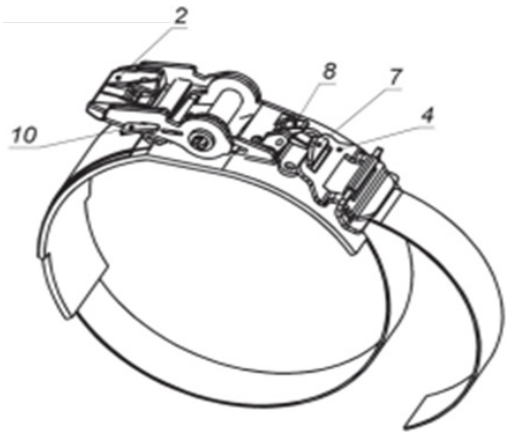

Figure 4. Order of use tourniquet – opening and removal instruction.

1.8. Advantages of the BFT-01 hemostatic tourniquet

I. Rapid and reliable bleeding control

The device features a metal clasp that allows quick closure of the tourniquet loop, reducing application time. This is particularly critical in cases of severe hemorrhage, where every second is vital.

II. Ease of use

The tourniquet has a simple design and is easy to apply to the limb. It is equipped with a special mechanism that stops bleeding without creating excessive pressure. The release mechanism also allows to quickly loosen the fastening if necessary.

III. Compact size and convenient storage

The tourniquet is small in size, making it convenient to store in a medical kit or first-aid box. It is also lightweight and portable, ensuring it can always be kept on hand in emergencies.

IV. Safety

The tourniquet is made of safe, hypoallergenic materials, which eliminates the risk of adverse reactions in patients.

1.9. Pain management, pharmacotherapy of blood rheology disorders, and suppurative-septic complications in gunshot wounds with tourniquet application

One of the most important components of successful treatment of the wounded is comprehensive pain control, covering various levels of intensity [5]:

- Mild pain (VAS 10–40 mm): Infugan, Keidex.
- Moderate pain (VAS 40–70 mm): Infugan, Keidex, Ropilong at a rate of 6–16 ml/hour via epidural catheter.
- Severe pain (VAS 70–100 mm): Infugan, Keidex, Ropilong at 6–16 ml/hour via epidural catheter, and Nalbuphine.

Additionally, the use of Yumerox® Inhal is recommended – an individual device for inhalation administration of Methoxyflurane.

Disorders of homeostasis are often observed during major surgical interventions and critical conditions such as trauma. A crucial aspect of management is the administration of intravenous fluids as part of resuscitation. Incorrect or excessive fluid infusion may lead to severe consequences, including increased mortality [6].

One of the solutions is individualized therapy based on an understanding of the pathophysiology of disturbances occurring at each stage of critical illness. The ROSE concept of fluid resuscitation has proven useful, consisting of four phases:

- R – Resuscitation (minutes): focused on correcting the critical state and early adequate fluid dosing to correct hypovolemia and increase vascular resistance.
- O – Optimization (hours): aimed at preventing complications and avoiding fluid overload.
- S – Stabilization (days): maintaining organ function.
- E – Evacuation (days to weeks): restoring organ function and removing fluid overload.

Our observations indicate that the inclusion of the multifunctional hyperosmolar solution Reosorbilact in infusion therapy helps to achieve the treatment goals at the O, S, and E phases, while preventing fluid overload risks.

For detoxification, the following agents should be used: Xylate, Reosorbilact, Sorbilact. In cases of progressive arterial ischemia, the "Trio" therapy scheme is recommended:

- Basic therapy + Reosorbilact 400 ml/day,
- Latren 400 ml/day,
- L-arginine 100 ml/day.

For the prevention of infectious complications, the most commonly used drug is Leflocin (levofloxacin) – a broad-spectrum antibacterial agent from the fluoroquinolone group with a pronounced bactericidal effect [5]. Leflocin is active against a wide range of Gram-negative and Gram-positive microorganisms, anaerobes, Helicobacter pylori, and atypical forms such as *Mycoplasma, Chlamydia, Legionella*.

- Leflocin is administered intravenously (250–500 mg, 50–100 ml, once daily for 5–7 days) to prevent postoperative complications.
- In particularly severe cases, the Ukrainian drug Grandazol is used – a combined antibacterial agent containing levofloxacin hemihydrate and ornidazole, available in vials of 100 and 200

ml for intravenous infusion.

- In extremely severe cases, systemic antimicrobial agents should be used, e.g., Piperacillin with β-lactamase inhibitors (ATC Code J01C R05). One of such drugs is Refex, which is administered intravenously over 20–30 minutes. The dosage is determined individually, depending on infection severity and localization. Elderly patients may receive the same dosage as adults, except those with renal insufficiency.

For local antiseptic treatment of gunshot wounds, the most effective option is Dekasan® (250 ml, bottle-pack with twist-off system).

Studies have shown that Dekasan is:

- 16 times more active than Chlorhexidine;
- effective against all Gram(+) and Gram(-) bacteria, viruses (including HIV, hepatitis), and fungi;
- non-allergenic and free of significant side effects.

Thus, Dekasan is considered the antiseptic of choice, while Gorosten is recommended for skin treatment around wounds and tourniquet areas.

1.10. Features of primary surgical treatment of gunshot wounds with foreign bodies – fragments

The invasive route of penetration of a foreign body (FB) involves a violation of the integrity of the integumentary tissues, primarily the skin, with the subsequent migration of FB deep into biological tissues. This mechanism of FB entry into the human body is a consequence of unintentional trauma or the result of the action of a lethal weapon. The presence of FB is often complicated by the presence of complex wounds and deep soft tissue defects. Complications caused by FB include inflammation, delayed or pathological healing, and damage to surrounding tissues. Organic FB (of biological origin), such as plant parts, can cause severe inflammation, hypersensitivity reactions, or infection. Inorganic FBs are most often complicated by the development of a severe inflammatory reaction, the development of nonspecific and specific (tetanus) infection. A separate important issue in the detection of FBs is their intraoperative detection and navigation [5-7].

Removal of a FB resulting from combat trauma is often a complex technical task that requires special skills of the surgeon and high-tech medical equipment that can be used during surgical intervention. Such equipment must comply with medical safety standards, be mobile and convenient to use, as well as resistant to multiple sterilization and exposure to aggressive chemicals and biological fluids [7]. Traditional radiography is a first-line diagnostic imaging method that can be used to detect a FB, however, for planning further surgical extraction of the fragment, additional imaging methods are needed that can provide clear anatomical landmarks and assess the presence of damage to surrounding tissues and structures [8]. The introduction of a probe in the form of a flexible, non-rigid elastic rod into the wound channel and its contact with the front part, protruding beyond the elastic-plastic guide tube to the entire depth of the wound, leads to the occurrence of resistance to movement both from the side of the channel walls (muscle and fatty tissue, surfaces of bone tissue, blood vessels, cartilage and tendon connections; and at the end of the channel from the side of the foreign body [9]. Detection will occur both at the moment of change in the noise radiation of the probe movement in the wound channel and at the moment of movement along the surface (contact) with a foreign body. The device is built on the principle of changing the established vibration characteristics of a dynamic system consisting of a long elastic thread with a distributed mass, which

oscillates in a viscous medium, and can contact a foreign quasi-elastic object, which is also in viscous contact with an inhomogeneous medium (the patient's body) [10-12]. Thus, using the methods of spectral analysis of noise emitted from mechanical contact of a flexible probe with a foreign body in the wound, which does not require incision of the wound, but allows manipulation through the wound canal, we can always conclude about the presence of a foreign body, its type and position in the wound channel. The theoretical prerequisites for creating an innovative device for detecting fragments in a gunshot wound were previously determined [13-14].

The search echo signal from a foreign body in a rheological environment V_d (t) in the form of a time function can be represented as the inverse Fourier transform (IFT) of the product of two independent quantities (1):

$$V_д (t)=F^(-1) (P_4 (f)·(V_и)~(f)), (1)$$

where (V_и)~(f)- Fourier transform of the impulse response of the system V_и (t), which determines the spectral characteristic of the system as a linear filter. It takes into account the frequency characteristics of the converter, the generator of probing pulses, the receiving electrical path of the system.

P_4 (f) – spatial frequency response (SFR) of the acoustic path, which describes the influence on the signal of the processes of diffraction, attenuation, refraction, interference and reflection from the surface of the OK of ultrasonic waves during their propagation from the PEP to the OK and back. SFR is the Fourier transform of the spatial impulse response (SIR) of the acoustic path [15-17].

First of all, an innovative device was created, which was tested in an experiment after simulated gunshot wounds in the laboratory (Fig. 5-8)

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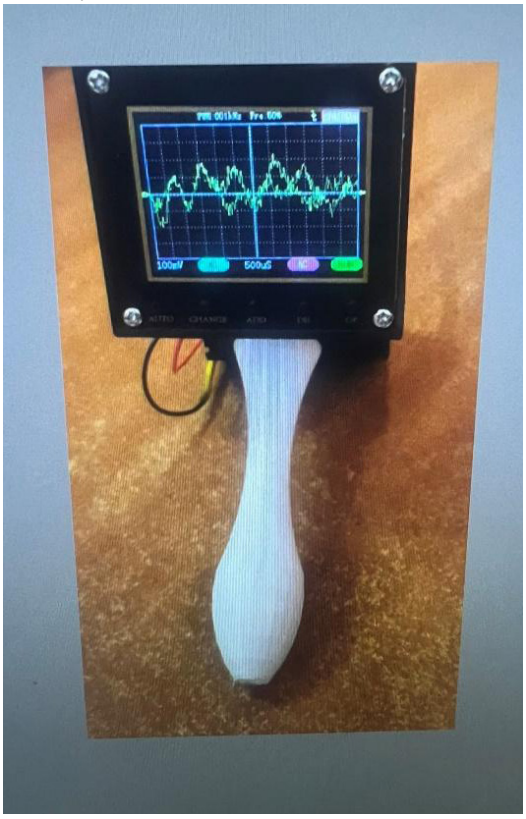

Figure 5. Tested in an experiment.

Figure 6. Tested in an experiment.

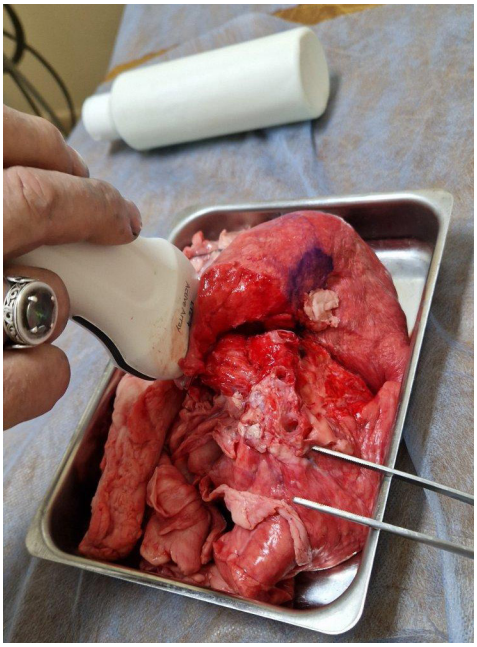

Figure 7. Tested in an experiment.

Figure 8. Tested in an experiment.

Secondly, the device was tested in clinical conditions and the results were better than the use of ultrasound and X-rays on glass, wood, plastic and ceramics. The device's decoder qualitatively identified the quality material, location and size of the fragments (Fig. 9-11).

Figure 9.
View of the entrance hole after a bullet wound to the thigh.

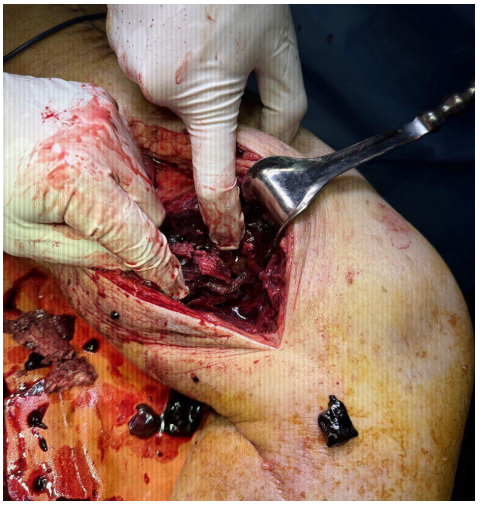

Figure 10.
Gunshot wound revision and hematoma removal.

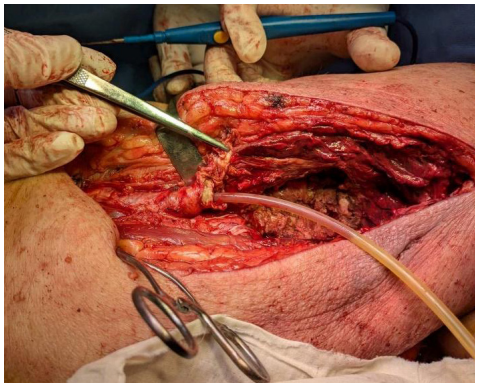

Figure 11.
Searching for gunshot fragments using an innovative device developed.

And finally, our efforts to introduce into clinical practice a new method of detecting gunshot fragments in the wound showed its high efficiency and simplicity, and the device can be actively used during primary surgical treatment, which prevents secondary infectious lesions of vascular grafts.

1.11. Procedure for using the device to detect fragments in the human body

The device consists of a handle with a base and a replaceable probe, which can either be sterilized or manufactured as a sterile disposable component.

The working process with the device is illustrated in the figures (Fig.12-15).

Figure 12. Assembling the device into working condition.

The device is powered by a „crown" battery. Turning on the device requires inserting the battery into the compartment located in the handle.

Figure 13.
Location of the container for the device's power supply.

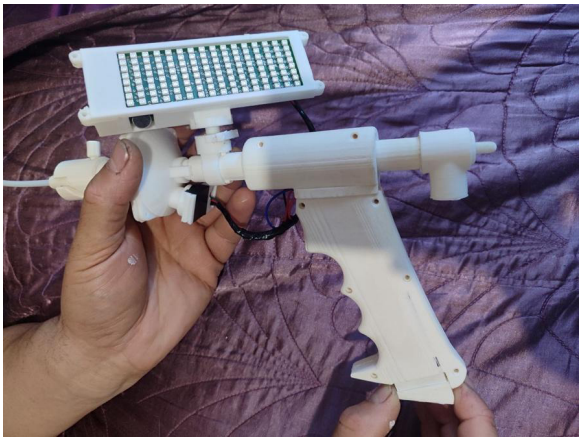

Figure 14.
Power source – compact battery installed.

Figure 15.
Characteristics and appearance of the electrical power element.

The battery must be installed correctly with respect to polarity.

Before the procedure for searching for fragments, the sterilized part (probe with probe) is separated and subjected to sterilization.

For this purpose, it is advisable to open the sound emission fixation chamber and carefully pull out the probe, having previously pressed the collet drive with your finger in accordance with Fig. 16-18.

Figure 16.
Connecting the sterile replacement part of the device to the base element.

Figure 17.
The device is ready to use.

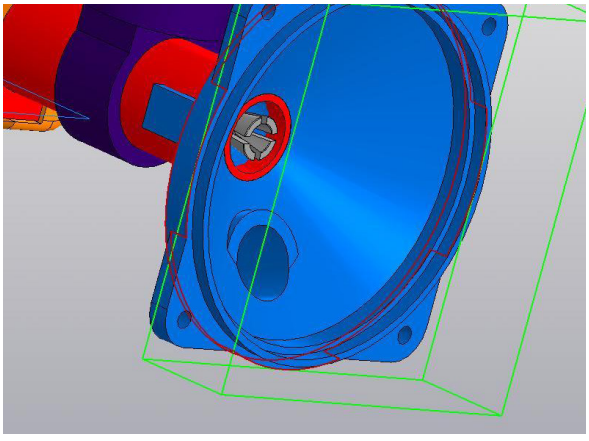

Figure 18.
Schematic view of the innovative device from inside the base part.

The collet will be opened, and the probe will freely come out of the holder.

The sterilized probe is assembled in the reverse order. In this case, attention is paid to the fact that the probe itself passes through the hole in the membrane and is securely fixed by the collet before closing the noise emission fixation chamber (Fig. 19-20).

Next, the chamber is closed, checking the correct operation of the device components. (Fig. 21).

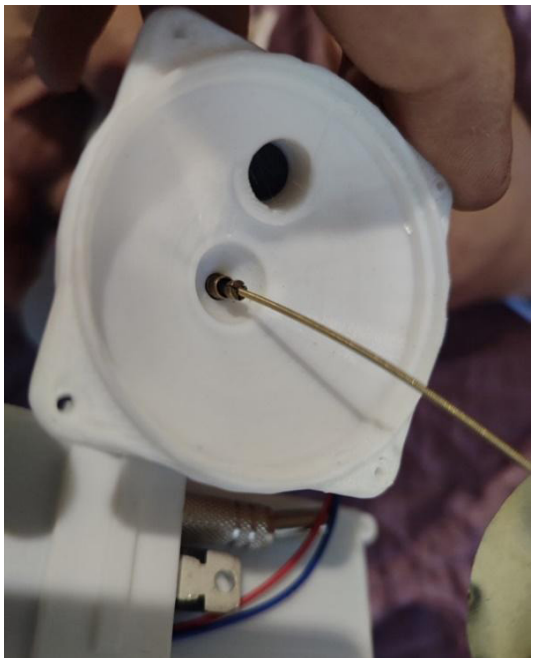

Figure 19.
The process of assembling the probe in reverse order:
Probe itself passes through the hole in the membrane.

Figure 20.
Probe fixed by the collet before closing
the noise emission fixation chamber.

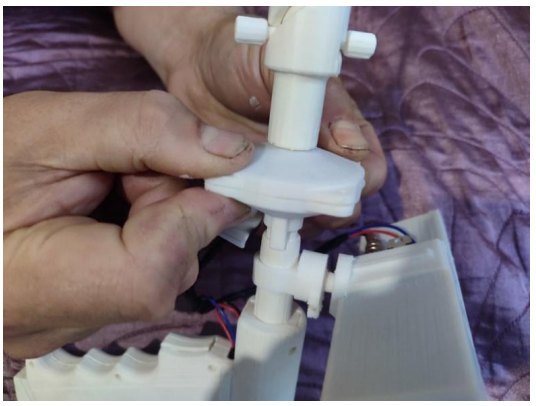

Figure 21.
Checking the correct operation of the device components.

A protective tube is installed on the probe, which forms a solid structure with the probe. The tube should completely cover the probe and not create an obstacle before insertion into the wound channel. The tip of the probe can be released only after the probe is fully inserted into the wound channel before recording noise emission.

After applying power, the red indicator on the handle will light up, and the base frequency scale will appear in the form of a blue bar on the display (Fig. 22).

Figure 22.
The red indicator on the handle light up, and the base frequency scale appear in the form of a blue bar on the display.

Then the end of the probe is carefully inserted into the wound channel until the resistance to the advance increases sharply, after which the end of the probe is released by turning the handle of the protective tube nozzle.

Now, when the probe is moved back and forth, there will be oscillations in the contact zone caused by the sliding of the tip of the probe on a foreign body, which after transformations will be displayed on the analyzer screen: the resulting spectral pattern will indicate:

1. The presence of a foreign body (due to the appearance of individual clearly detected signal peaks), while the absence of foreign bodies provides a picture of the distribution of noise emission close to the Gaussian distribution;
2. The type of foreign body. The shape of the pattern allows you to assess the type of foreign inclusion (more elastic bodies have more pronounced frequency spikes);
3. The approximate size of the body: larger bodies are in contact with the probe during its movement for a longer time.

A prerequisite is to maintain silence during diagnostics, as well as to perform several repetitive movements with the probe. At the same time, the further introduction of machine learning and object identification tools (in particular, in the form of typical fragments) will make it possible to move from visual observation of the vibration spectrum to the detection of foreign bodies using LED indicators.

It is also planned to install mechanical excitation and probe control tools on the device, which will increase the accuracy of identification and simplify the procedure for searching for foreign bodies while simultaneously increasing efficiency.

The main advantages of the noise emission method are:

1. High sensitivity to the presence of radiopaque fragments that may not be detected by other diagnostic methods, such as radiography or computed tomography.
2. The absence of ionizing radiation makes the method safer for patients, especially if repeated examinations are necessary.
3. Speed and accuracy of diagnosis, as the method allows for the detection of fragments in real time without the need for complex and costly procedures.
4. The ability to detect microscopic fragments that may be missed by traditional methods.

The practical application of the method in military medicine has allowed for:

1. Faster and more accurate localization of fragments, which allows for a prompt decision on the need for surgical intervention.
2. Monitoring of injury healing, as the method allows for the detection of changes in the structure of fragments or their movement during the patient's recovery process.
3. In field conditions, noise emission allows for diagnostics in conditions of limited access to modern medical equipment, which is important during the evacuation of the wounded from the battlefield.

Diagnostic algorithm when working with radiopaque fragments:

1. Initial examination of the patient: Assessment of the general condition, identification of symptoms that may indicate the presence of fragments (pain, swelling, restriction of movement).
2. Use of noise emission'. Use of sensors to detect acoustic signals generated by interaction with radiopaque fragments.
3. Data analysis: Processing of the received signals to determine the exact location, shape and size of the fragments.
4. Confirmation of the diagnosis. Comparison of noise emission results with other methods, such as radiography or computed tomography, to clarify the diagnosis.
5. Decision-making. Determination of further steps in treatment (surgical intervention, conservative treatment, observation).

This algorithm allows you to work effectively and safely with patients who have received combat injuries and promptly make the necessary medical decisions to reduce risks and improve treatment outcomes. We propose to use tactile probing and a special elastic probe, with the help of which a direct search for a foreign body in the tissues of the wounded person is carried out [1]. It was shown that it is advisable to use the wound channel during the initial surgical treatment for the introduction of the probe, which can be open for a certain time. Searching for fragments in this way turned out to be effective, since upon contact with the probe, such interaction leads to the generation of vibrations that propagate through the elastic part of the probe, and upon reaching the element of the device – the membrane, they are converted into noise emission, which is subsequently visualized by an oscilloscope as a signal, which, based on comparison with sample pictures, allows us to draw a conclusion about the presence and approximate size of a foreign body.

Along with the undeniable advantage of such a method as simple and not requiring complex equipment, a significant disadvantage is that the accuracy of detection and identification of the object will be determined not least by the doctor, his qualifications and experience; at the same time, the presence of a fragment in the body, its encapsulation and changes in the body over a certain time can cause certain violations of the patterns obtained in our work [1].

1.12. Conclusions

Injuries received in combat conditions represent a complex interdisciplinary challenge that requires the integration of emergency care, advanced diagnostic technologies, and evidence-based treatment protocols. Effective hemorrhage control remains the cornerstone of battlefield medicine, and the introduction of modern Ukrainian-manufactured tourniquets such as the BFT-01 demonstrates the rapid advancement of national tactical medical capabilities.

Comprehensive pain management and pharmacotherapy are essential for stabilizing wounded personnel and preventing life-threatening complications such as sepsis, ischemia, and shock. At the surgical stage, the presence of radiolucent foreign bodies significantly complicates wound management. The development and clinical testing of an innovative acoustic emission device for fragment detection provide new diagnostic opportunities for identifying radiolucent materials that are invisible on traditional radiographs.

The integration of this technology into primary surgical treatment allows for more accurate localization and safe removal of foreign bodies, reducing secondary infections and postoperative complications. The proposed diagnostic algorithm ensures timely decision-making and enhances treatment outcomes.

Overall, the combination of advanced bleeding control techniques, multidisciplinary pharmacotherapy, and novel diagnostic innovations represents a significant step toward improving survival rates and recovery quality among victims of combat injuries.

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CHAPTER 2

AUTOLOGOUS MESENCHYMAL STEM CELLS AS A COMPONENT OF MULTIDISCIPLINARY REHABILITATION OF WAR PARTICIPANTS WITH SEVERE FORMS OF CHRONIC CRITICAL LOWER LIMB ISCHEMIA AND PAIN SYNDROMS

Viktor A. Cherniak, Lidiia V. Butska

2.1. Stem cell therapy overview

It is well known that stem cells possess self-renewal properties and have multilineage differentiation potential, making them an attractive tool for clinical cell therapy. However, due to many ethical and legal restrictions, clinical development and progress in the field of stem cell therapy are developing relatively slowly.

On the other hand, adult stem cells are free from these ethical and legal limitations and have excellent regenerative properties, making their therapeutic use safer than pluripotent cells, such as embryonic or induced pluripotent stem cells.

Research has shown that stem cell therapy is becoming one of the new treatment strategies for a number of difficult-to-treat conditions and diseases for which there are no reliable treatments, including chronic critical limb ischemia (CCLI) in cases where surgical correction is not possible. In such cases, mesenchymal stem cells (MSCs) are often considered a last resort therapy.

We analyzed sources of domestic and international peer-reviewed medical literature regarding the therapeutic use of mesenchymal stem cells. The key feature of these publications is that they reflected best medical practices but lacked a systematic approach to defining the optimal MSC dosage in terms of efficacy and safety. If no contraindications exist, the physician chooses the treatment strategy according to the disease and submits a request to the Cord Blood Bank for expansion of the therapeutic MSC dose.

If autologous stem cell use is planned, the physician collects the patient's biomaterial (bone marrow or adipose tissue) and sends it to the Cord Blood Bank for expansion of the therapeutic MSC dose.

Before biomaterial collection, the patient must provide "Informed Voluntary Consent for Diagnosis, Treatment, Surgery, and Anesthesia" (Form No. 003-6/o).

2.2. Cell therapy procedure

Medical preparation of the patient before the procedure.

To prevent complications during and after the cell therapy procedure, the patient may receive premedication, which may include:

- Antihistamines (e.g., chlorpheniramine, dexchlorpheniramine);
- Glucocorticosteroids (e.g., methylprednisolone, hydrocortisone);
- Prokinetics (e.g., metoclopramide);
- Paracetamol (1 g);
- Anticoagulants and other drugs as necessary.

Algorithm of "Aspirate Collection"

Bone marrow aspiration is a procedure used to obtain a sample of the liquid part of bone marrow for further processing and isolation of mesenchymal stem cells.

Lipoaspiration is a surgical procedure used to collect adipose tissue for subsequent processing and isolation of mesenchymal stem cells.

The patient undergoes preliminary laboratory and instrumental examinations to determine indications and possible contraindications. All manipulations with biological material are performed under strict aseptic and antiseptic conditions.

During bone marrow aspiration, anesthesia is achieved with sedation and/or local infiltration anesthesia under continuous monitoring and anesthesiologist supervision.

With the help of a Jamshida-type bone needle, up to 50 ml of red bone marrow is aspirated from the iliac crest through a small skin incision (Fig. 1).

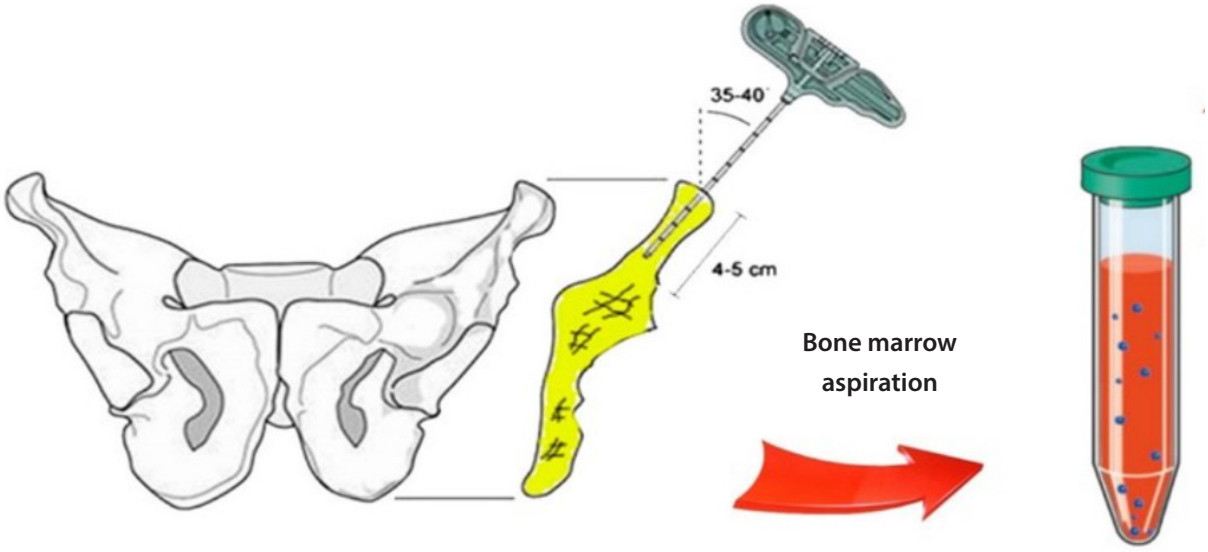

Figure 1. Obtaining bone marrow from the iliac crest by aspiration.

Before bone marrow collection, the syringe and needle must be rinsed with a heparin solution (Heparin 5000 IU/ml 5 ml). Immediately after bone marrow collection, the obtained aspirate must be IMMEDIATELY transferred to a sterile 50 ml tube containing heparin solution (Heparin 5000 IU/ml 5 ml), in the amount of 5 ml of heparin per 50 ml of bone marrow, and carefully mix the aspirate layer

and the heparin solution layer with each other. It should be remembered that the minimum volume of bone marrow required for the purposes of culturing human cells is a volume of 10 to 25 ml. But in some cases, the required volume increases to 100 ml. The required volume of bone marrow for the laboratory process is determined in each individual case with official representatives of the biotechnology laboratory by phone or e-mail in advance before the collection of biomaterials. The tube (sterile) is dry and sent in the required quantity to the medical center upon prior request.

The liposuction procedure is performed using a metal cannula attached to a syringe. Before the procedure, the doctor injects (splits) the subcutaneous fatty tissue at the site of lipoaspiration with a special solution containing a local anesthetic and adrenaline. Infiltration provides anesthesia, reduces blood loss, and facilitates the lipoaspirate procedure. Through a small incision, the cannula is inserted into the subcutaneous fat, several jerky movements are made in the direction from the incision to the navel, after which, by pulling the syringe piston, from 20 to 100 ml of lipoaspirate is obtained (Fig. 2).

After lipoaspirate is completed, an aseptic bandage is applied to the incision.

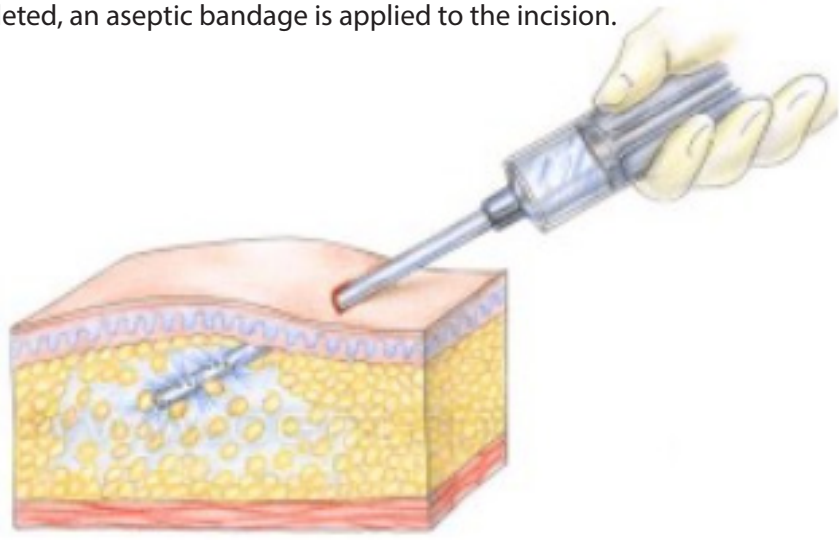

Figure 2. The procedure of liposuction.

2.3. Algorithm for culturing autologous stem cells

After marking, the patient is in the operating room after the preparation of the surgical field, local anesthesia is administered in the area where the bone marrow will be taken. A 1% lidocaine solution can be used to anesthetize the access site, after which a Frank needle is inserted and the bone marrow aspirate is collected under all aseptic and antiseptic conditions.

The obtained bone marrow aspirate in an amount of at least 20 ml should be placed in a sterile container, with the addition of 5 ml of heparin solution (5000 IU/ml). The container with the bone marrow aspirate and heparin should be closed and placed in a container for transportation containing a large amount of ice.

The work is carried out under sterile conditions of a laminar flow cabinet of biological safety class II. The suspension of pure bone marrow, obtained with the help of a dispenser with adjustable volume, should be selected, transferred to a test tube, labeled and sent for phenotyping by flow cytometry.

The cell material should be diluted one to one with MEM Alpha medium and mixed. It is necessary to add a heparin solution (5000 IU/ml). Carefully, with the help of a 20 ml syringe, tilting the test tube at an angle of 45°, the bone marrow aspirate with the medium should be added

along the wall into the pre-prepared centrifuge tubes with the hystopak solution (with a density of 1.077 g/cm^3). The bone marrow aspirate should be centrifuged at 450g for 30 minutes at a temperature of 15C°. After centrifugation, bone marrow is obtained, which is divided into the following fractions: plasma, mononuclear cells, histopak and erythrocytes. The supernatant liquid in the form of plasma and sediment of erythrocytes should be collected for disposal. The suspension of mononuclear cells in the form of a white furrow above the histopak together with the plasma should be transferred to another centrifuge tube with a single solution of DPBS and centrifuged again for 15 minutes. The cell concentration is determined by the routine method in the Goryaev chamber or with an LUNA automated cell counter. After that, the cell suspension should be added to bottles with nutrient medium. During monolayer cultivation, the cultures are gradually cleared of weakly adhesive cells, and on the 5th day of cultivation, uniform cell growth is observed over the entire surface of the culture plastic.

By the 10-12th day of cultivation, adhesive cells isolated from the bone marrow form 70-80% of a continuous monolayer.

During subculturing, the heterogeneity of the initial suspension gradually decreases, and after 3-4 passages, the mesenchymal stem cell culture is represented by a population of predominantly fibroblast-like cells.

During each passage, the number of cells increases by an average of 2 times.

After 4-6 passages, the cells should be removed from the specific medium, preserved and transported in appropriate transport containers at a temperature of 2-8 ° C for transplantation into the ischemic limb of the patient.

Each obtained preparation of MSC cells from bone marrow should be accompanied by an appropriate biotechnological product passport, which contains information on the total number of cells in the preparation, the number of nucleated cells in the preparation, and the viability of the cells. The number of nucleated cells in the preparations varied from 15 to 40 million cells, and the viability was from 89% to 95%. The cell preparation is diluted in 10 ml of physiological solution before administration.

2.4. Algorithm for obtaining autologous stem cells

Transport of biomaterial

The aspirate obtained from the patient (bone marrow or adipose tissue) is delivered to the biotechnology laboratory under sterile conditions for further processing.

Isolation of mesenchymal stem cells (MSCs)

Biomaterial is processed using enzymatic or mechanical methods to isolate MSCs.

Cultivation and expansion

The isolated cells are placed in special culture media under controlled laboratory conditions to stimulate proliferation and obtain the required therapeutic dose.

Quality control

At each stage of cultivation, the cells undergo mandatory testing according to the following parameters:

- sterility;
- viability;
- identity (phenotypic markers);
- functional activity;
- cryopreservation (if necessary).

If the therapeutic dose is not intended for immediate use, the expanded MSCs may be frozen in liquid nitrogen for long-term storage.

Preparation for infusion

Before administration to the patient, the MSCs are resuspended in a physiological solution with albumin or other appropriate stabilizers, ensuring sterility and safety.

Methods of using mesenchymal stem cells in HKINC

Methods of using mesenchymal stem cells are very diverse and depend mainly on the degree and prevalence of the ischemic process.

The most common of them are:

- intravenous infusion (volume from 20 to 400 ml at a rate of 0.5 – 6 ml/min);
- intramuscular (from 10 to 25 injections with a volume of 0.2-0.5 ml), etc.

2.5. Features of intravenous infusions

Peculiarities of carrying out intravenous infusions:

- infusion should be carried out in the thick vein of the upper limb;
- a system for intravenous transfusion of blood and its components should be used;
- each bag, vial or syringe with MSC suspension must be shaken before use and this procedure must be repeated every 10-15 minutes of infusion to prevent cells from settling to the bottom of the vial (infusion bag);
- infusion of the cell suspension should be started at a slower speed within 10-15 minutes in the absence of serious reactions; the rate of infusion can be increased;
- after the infusion of the cell suspension is completed, an additional infusion of balanced salt solution can be performed.

2.6. Features of intramuscular infusions

Peculiarities of carrying out intramuscular infusions:

- infusion should be carried out into the muscles of the lower limb according to the appropriate scheme (Fig.3);
- each syringe with MSC suspension must be shaken before use;
- in the case of arterial occlusion above Poupart's ligament, a suspension of mesenchymal stem cells is injected into the thigh and lower leg.;
- in the case of arterial occlusion below the knee joint, a suspension of mesenchymal stem cells is injected into the lower leg;
- the MSC suspension is administered at intervals of no more than 6 cm from each other.

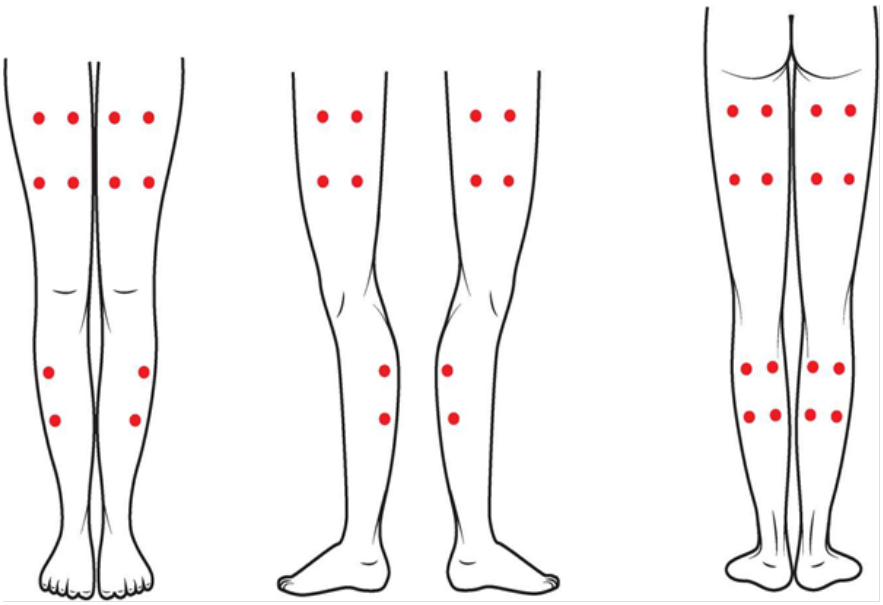

Figure 3. Scheme of MSC injection into the muscles of the lower limb.

2.7. Post-procedural patient support

After the completion of the cell therapy procedure, it is necessary to maintain contact with the patient to monitor changes in his health condition, the course of the disease and the effectiveness of the treatment.

Since mesenchymal stem cell therapy does not have an immediate effect, the maximum therapeutic effect should be expected 1-6 months after the procedure.

We present clinical examples of the use of mesenchymal stem cells with immediate and long-term results.

Clinical case No.1: Patient B., born in 1950, woman. DS: CLI, shunt thrombosis on the left, trophic ulcer of the left foot (Fig. 4).

Figure 4 (a,b,c). Patient B.

View of the foot, angiographic and doppler imaging of critical ischemia of the affected limb. 100 million autologous stem cells were injected and after 3-6 month the following result was obtained (Fig. 5).

Clinical case No.2: Patient V., born in 1968, man. DS: CLI, obliterating atherosclerosis of the right l. limbs, state after reconstruction of the vessels of the thigh and lower leg, thrombosis of the reconstructed segments, trophic ulcer of the right foot (Fig. 6).

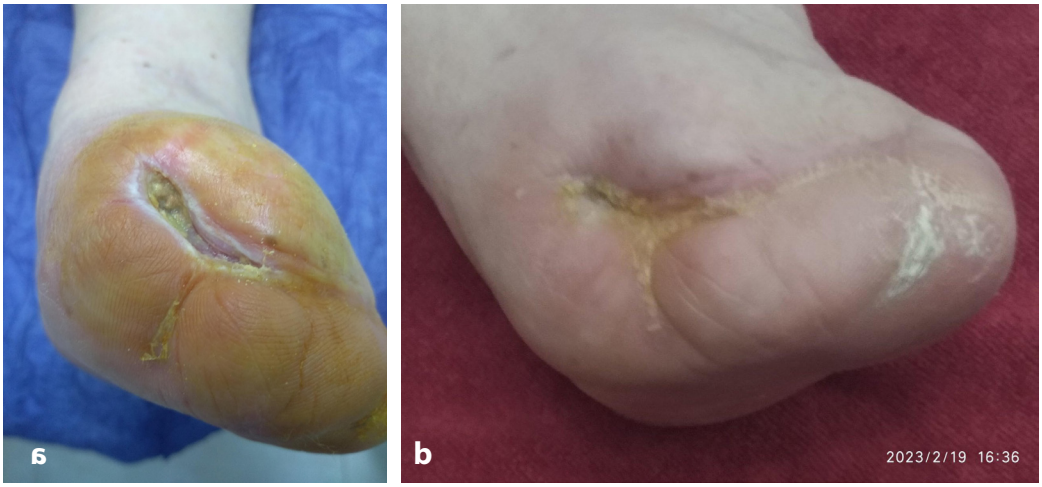

Figure 5 (a,b). View of the foot 3 and 6 month after stem cells injected.

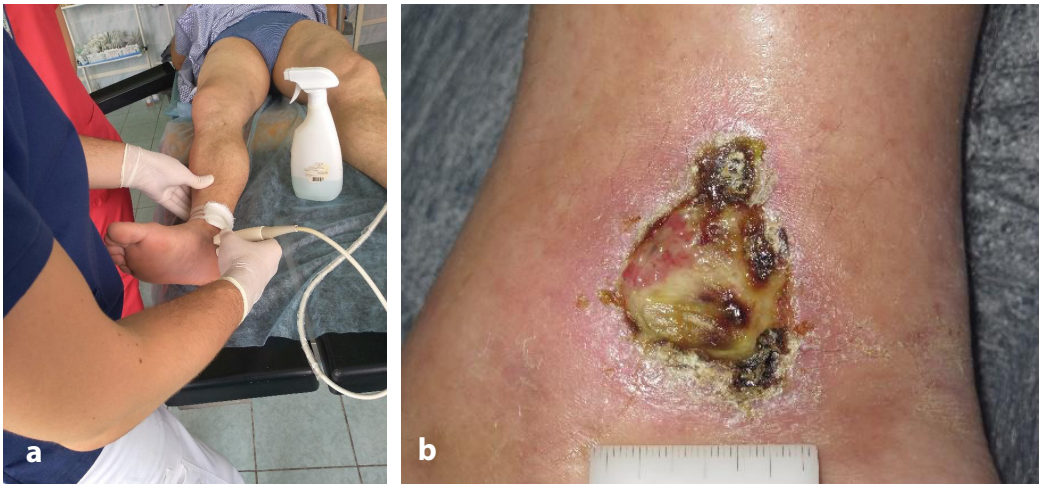

Figure 6 (a,b). View of the foot patient V., doppler segmental pressure measurement procedure of the affected limb.

100 million autologous stem cells were injected and after 3 month the following result was obtained (Fig. 7). The wound cleared and the patient managed to close the ulcer with an autocutaneous flap.

After 6 month the following result was obtained in the form of complete healing of the ulcer (Fig. 8).

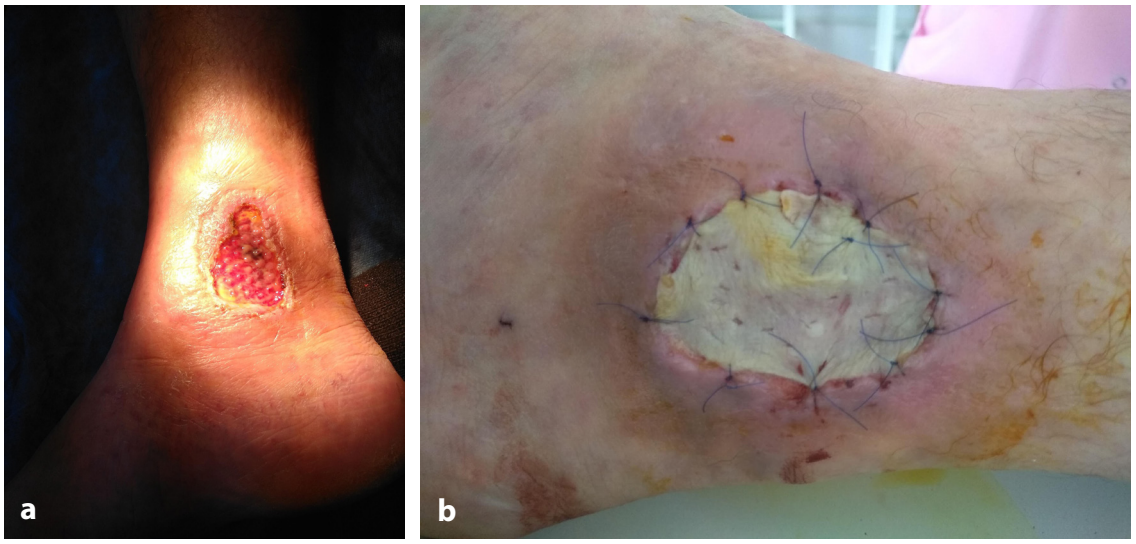

Figure 7 (a,b). The appearance of a cleaned and prepared ulcer and its autodermoplasty.

Figure 8. Complete healing of the ulcer in patient V.

Figure 9 (a,b). View of the foot patient C., doppler segmental pressure measurement procedure of the affected limb.

Clinical case No.3: Patient C., born in 1948, man. DS: CLI, obliterating atherosclerosis of the left l, occlusion of tibial arteries, necrosis of the 1st toe. (Fig. 9).

100 million autologous stem cells were injected and after 3 month the following result was obtained (Fig. 10).

Figure 10 (a,b). View of the foot patient C. after 3 and 6 month introduction autologous stem cells.

Clinical case No. 4: patient Z., born in 1957, serviceman after a gunshot wound. DS: CLI, resting ischemia on the right, condition after shunting on the right, shunt thrombosis, trophic ulcers of the right foot. (Fig. 11).

23 million own (autologous) + 30 million allogeneic stem cells were injected, and after 3 months the following result was obtained (Fig. 12).

After 6 month stem cells injected complete healing of the ulceres in patient Z. (Fig. 13).

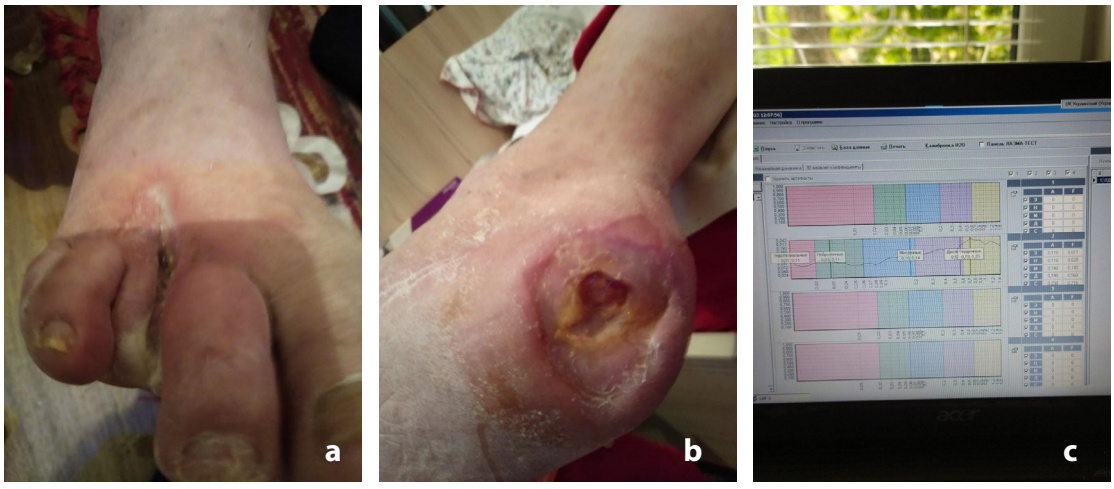

Figure 11 (a,b,c). View of the foot patient Z, and laser Doppler flowmetry to determine the level of microcirculation.

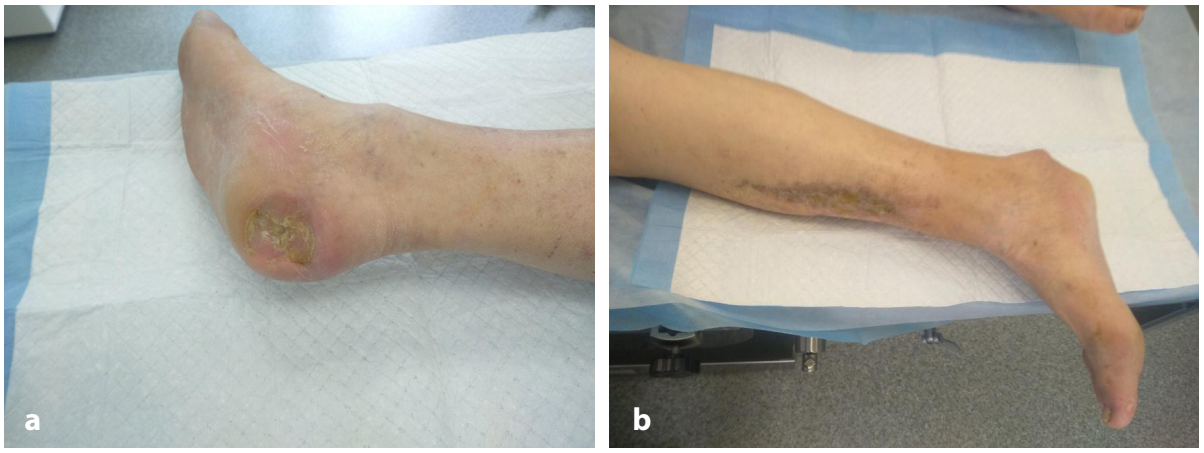

Figure 12 (a,b). After 3 months of stem cell injections,
a 25% reduction in the heel part and complete healing of the amputated third toe was observed.

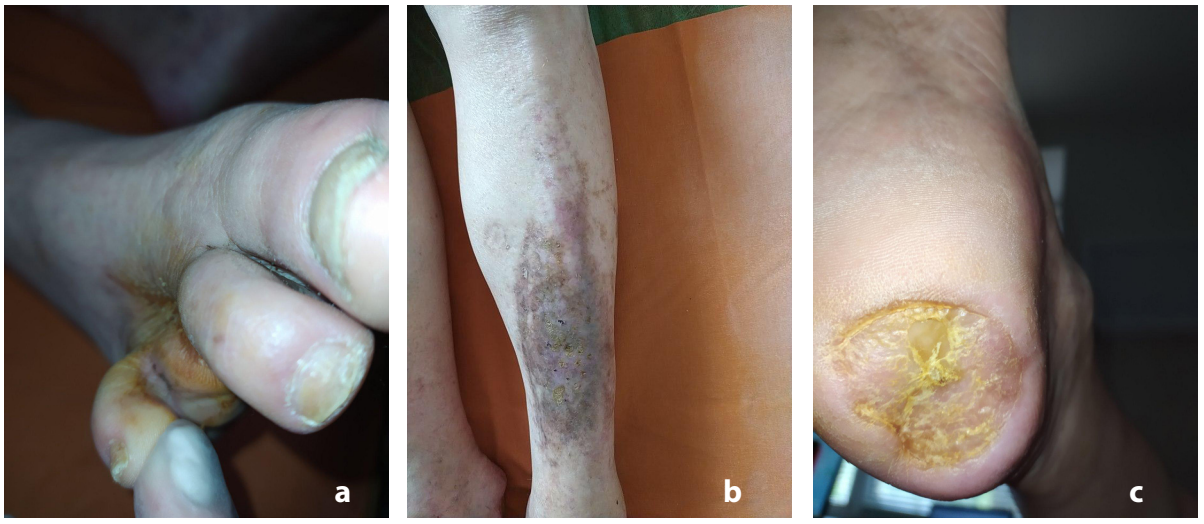

Figure 13 (a,b,c). Complete healing of the ulceres in patient Z. after 6 month stem cells injected.

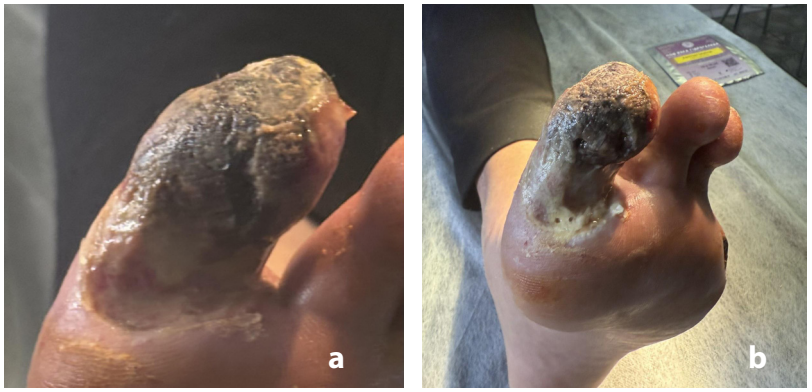

Figure 14 (a,b). View of the foot patient S.

Clinical case No. 5: Patient S., born in 1965, serviceman after a gunshot wound. DS:CLI, resting ischemia on the left, condition after shunting on the right, shunt thrombosis, necrosis and trophic ulcers of the right foot. (Fig. 14).

100 million autologous stem cells were injected and after 3 month the following result was obtained. After that, the first toe was amputated and the VAK system was applied to the trophic ulcer of the stump of the fifth toe (Fig. 15).

After six months, complete healing of trophic changes in the foot was noted (Fig. 16).

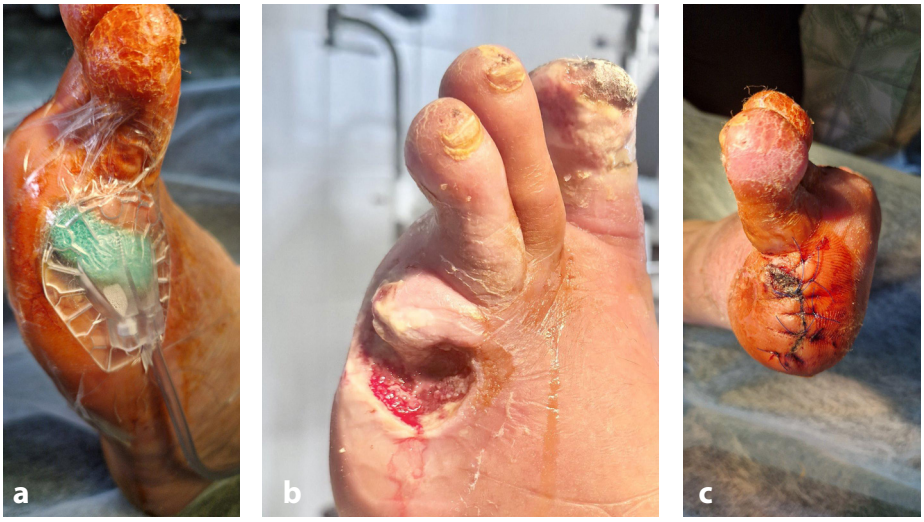

Figure 15 (a,b,c). After 3 months the following result was obtained.

Figure 16. Complete healing of trophic changes in the foot.

Cell therapy using mesenchymal stem cells (MSCs) is a promising direction of modern regenerative medicine, opening up new opportunities for the treatment of pathologies resistant to standard methods. The analysis shows that the use of autologous stem cells provides high biocompatibility, minimizes the risk of immune reactions and promotes faster regeneration of damaged tissues.

Compliance with the stages of the algorithm – from patient preparation, biomaterial collection, MSC cultivation to their administration and post-procedural monitoring – is a key condition for the safety and effectiveness of therapy. Despite the encouraging results, further studies should be aimed at determining the optimal dosages, duration of effect and long-term consequences of the use of MSCs.

Thus, cell therapy is gradually moving from experimental to clinical practice, forming the basis of a personalized approach to the treatment of patients with severe chronic and ischemic diseases.

2.8. Autologous mesenchymal stem cells as a component of interdisciplinary rehabilitation of war participants with severe forms of chronic critical ischemia of the lower extremities and pain syndromes

Critical limb ischemia (CLI) represents the terminal stage of peripheral arterial disease (PAD), most frequently associated with atherosclerosis and severe vascular dysfunction, including those arising from traumatic damage during armed conflicts [1,2]. This pathology is defined by critical obstruction of arteries supplying essential regions, particularly the lower extremities, and is most commonly observed among individuals aged 61–70 years [3,4].

Military conditions considerably elevate risk factors for developing vascular complications. Chronic critical lower limb ischemia (CCLLI) occurs in approximately 20–40% of PAD patients, often resulting in limited treatment success [5]. In cases of combat-related injuries to the lower limbs, innovative diagnostic devices have been applied to screen gunshot wounds for retained debris, including radiolucent fragments invisible on conventional imaging [6].

Because CLI is chronic and poorly responsive to conventional therapeutic strategies, increasing attention is being directed toward therapeutic angiogenesis based on mesenchymal stem cells (MSCs). These cells demonstrate potential in stimulating tissue regeneration and revascularization. When combined with multidisciplinary rehabilitation approaches, such as non-pharmacological pain management, acupuncture, physical therapy, and the application of preformed biological factors, therapy using MSC may provide an integrated strategy for restoring perfusion and promoting faster tissue repair [7,8].

Such a combined approach has particular significance in the context of combat-related pathology, where patients often present with multiple, interlinked disorders. Careful optimization of MSC dosing protocols, informed by clinical and international evidence, may improve both immediate recovery and long-term prognosis in patients with CCLLI.

Aim of the study. The research sought to evaluate the effectiveness of a multidisciplinary rehabilitation program (MRP) integrating mesenchymal stem cell (MSC) therapy with acupuncture (AP), physiotherapy (PT), and structured physical exercise (PE) in enhancing functional recovery among patients suffering from chronic critical lower limb ischemia (CCLLI) due to combat-related trauma.

Materials and Methods. A prospective comparative study was conducted over six months, involving 40 patients diagnosed with CCLLI, 10 of whom had sustained combat-related injuries. The main objective was to test the clinical value of an MRP that incorporated MSC therapy alongside acupuncture, physiotherapy, and physical exercise.

Study Design. Participants were randomized into two equal groups: the MSC group (n=20) and the control group (CG, n=20). Each group included 5 patients with gunshot wounds. The MSC group received autologous stem cell therapy at a dosage of 2×10^6 cells/kg, delivered through 20 intramuscular injections, in addition to standard medical management.

The injections were administered into ischemic muscle tissue following a structured protocol. The syringe was agitated before each injection to maintain cell suspension. For arterial blockages above Poupart's ligament, both thigh and lower leg muscles were treated; in cases of occlusion below the knee, only the lower leg was targeted. Injection sites were positioned ≤6 cm apart to ensure accurate delivery, sterility, and optimal therapeutic effect.

2.9. The rehabilitation protocol

The rehabilitation protocol included several specific modalities:

- Acupuncture (AP): therapeutic sessions were performed with stimulation of standardized acupoints, including ST36 (Zu San Li), SP6 (San Yin Jiao), and BL57 (Cheng Shan), which are traditionally associated with improved peripheral blood flow and reduction of pain intensity.
- Physiotherapy (PT): patients underwent a complex program of electrotherapy, magnetotherapy, light therapy, and ultrasound exposure. These procedures were aimed at stimulating tissue repair processes, enhancing muscle tone, and increasing joint mobility.
- Physical exercise (PE): all participants were engaged in an individualized exercise program designed to restore motor activity, functional independence, and overall endurance.

The multimodal rehabilitation program (MRP) was implemented in three consecutive stages of recovery. Each stage consistently included clinical monitoring, mesenchymal stem cell (MSC) therapy, as well as AP, PT, and PE interventions.

The control group received conventional treatment according to the clinical guidelines issued by the Ministry of Health of Ukraine [9].

Irrespective of group allocation, all patients were additionally provided with psychological support aimed at managing post-traumatic stress disorder (PTSD) symptoms and anxiety, structured smoking cessation interventions, and individualized nutritional recommendations to optimize rehabilitation outcomes.

Statistical processing was carried out using Student's t-test for dependent samples and independent groups, as well as one-way ANOVA followed by Tukey's post hoc analysis when comparing three or more independent samples. Results are presented as mean values (M) with their standard error (±m). A p-value <0.05 was considered statistically significant, with Bonferroni correction applied where appropriate. All data were analyzed using SPSS Statistics software, version 26.

Ethical considerations: The investigators confirm full adherence to ethical and legislative requirements in biomedical research. The study protocol was developed in accordance with Articles 43 and 45 of the Law of Ukraine "Fundamentals of Health Legislation of Ukraine", as well as the principles of the Declaration of Helsinki (1964, with subsequent revisions, the latest in 1983). Compliance with Directive 2001/20/EC of the European Parliament and the Council of the European Union (April 4, 2001, as amended) was ensured. All procedures strictly followed bioethical standards, aligning national and international regulatory frameworks.

2.10. Results

Despite the limited sample size, the study revealed notably better outcomes in the main group of patients who received mesenchymal stem cell therapy in combination with non-pharmacological methods as part of a multidisciplinary rehabilitation program. This group demonstrated significant improvements compared to their pre-treatment condition, including enhanced blood circulation (measured by the ankle-brachial index), healing of trophic ulcers, reduced leg pain, increased functional mobility, and limb preservation, which lowered the need for amputation.

The primary outcome measures included:

- Ankle-Brachial Index (ABI) dynamics – used to evaluate peripheral blood flow and vascular health;

- Pain reduction – assessed using the Visual Analog Scale (VAS) [10];
- Walking Distance Improvement (WDI) – measured by the distance each patient could walk during a 30-minute walking test;
- Trophic ulcer healing – determined by the percentage of patients achieving complete ulcer closure;
- Risk of amputation – evaluated based on the necessity for limb amputation during the study period.

While the control group also showed positive changes in these parameters, the improvements in the main group were significantly more pronounced – both in comparison to baseline values and relative to patients treated according to standard clinical protocols. A summary of treatment outcomes for both groups is presented in Table 1.

Table 1. Treatment outcomes in the main and control groups.

Outcome Measure	Main Group (MG), N=20			Control Group (CG) , N=20			Difference between groups MG and CG: p, before treatment	Difference between groups MG and CG: p, after treatment
	Ankle-Brachial Index (ABI) Dynamics	after treatment	p after treatment	before treatment	after treatment	p after treatment		
Ankle-Brachial Index (ABI) Dynamics	0,39 ± 0,05	0,70 ± 0,05	< 0,01	0,40 ± 0,05	0,55 ± 0,05	< 0,05	n.s.	< 0,05
Pain Reduction (VAS)	7,4 ± 0,7	4,3 ± 0,6	< 0,01	7,4 ± 0,6	6,1 ± 0,5	< 0,05	n.s.	< 0,05
Walking Distance Improvement (WDI) - number of patients	-	15 (75%)	-	-	8 (40%)	-	n.s.	< 0,05
Trophic Ulcer Healing - number of patients	-	20 (100%)	-	-	5 (25%)	-	n.s.	< 0,01
Patients at risk for amputation*	-	1 (5%)	-	-	8 (40%)	-	n.s.	< 0,05

** Patients at risk for amputation – in the case of a non-healing ulcer or severe pain.*

In clinical settings, it was noted that even after ulcer closure, some patients continued to suffer from poor peripheral circulation, intense pain, and a persistent threat of limb amputation. Nevertheless, the data outlined in the table indicate that the likelihood of amputation was significantly lower among individuals in the experimental group.

In the Main Group (MG), the ankle-brachial index (ABI) showed a marked improvement, rising from 0.39 ± 0.05 prior to therapy to 0.70 ± 0.05 following treatment ($p < 0.01$). Meanwhile, the Control Group (CG) experienced a more modest increase, from 0.40 ± 0.05 to 0.55 ± 0.05 ($p < 0.05$). Initially, there was no statistically significant difference between the groups (p = n.s.), but post-treatment results revealed a substantially greater enhancement in ABI within the MG ($p < 0.05$).

Pain intensity, measured via the Visual Analog Scale (VAS), dropped considerably in the MG – from 7.4 ± 0.7 before intervention to 4.3 ± 0.6 afterward ($p < 0.01$). The CG also showed pain relief, with scores decreasing from 7.4 ± 0.6 to 6.1 ± 0.5 ($p < 0.05$). Although both groups started at similar pain levels (p = n.s.), the MG exhibited a significantly stronger reduction in pain post-treatment ($p < 0.05$).

Regarding mobility, 15 patients (75%) in the MG demonstrated improved walking capacity after therapy, compared to only 8 patients (40%) in the CG. This difference was statistically significant ($p < 0.05$).

Complete resolution of trophic ulcers was achieved in all 20 patients (100%) in the MG, whereas only 5 patients (25%) in the CG reached full healing. The disparity in healing rates was highly significant ($p < 0.01$), favoring the MG.

Initially, all participants in both groups faced the risk of limb amputation. After treatment, only 1 patient (5%) in the MG remained at risk, in contrast to 7 patients (35%) in the CG. The difference in amputation risk was statistically significant both before ($p < 0.01$) and after treatment ($p < 0.05$), with the MG showing a notably lower risk.

The integration of mesenchymal stem cell (MSC) therapy with acupuncture, physiotherapy, and structured physical activity within a comprehensive rehabilitation framework proved to be highly effective for patients suffering from advanced lower limb ischemia.

Figure 17 illustrates the wound healing progression in a patient from the MG. Prior to treatment, the individual was wheelchair-bound and unable to walk. The ulcer measured 8 cm^2, and the administered MSC dose was 60 million cells. The therapeutic benefits of this approach are well-documented in existing literature [15].

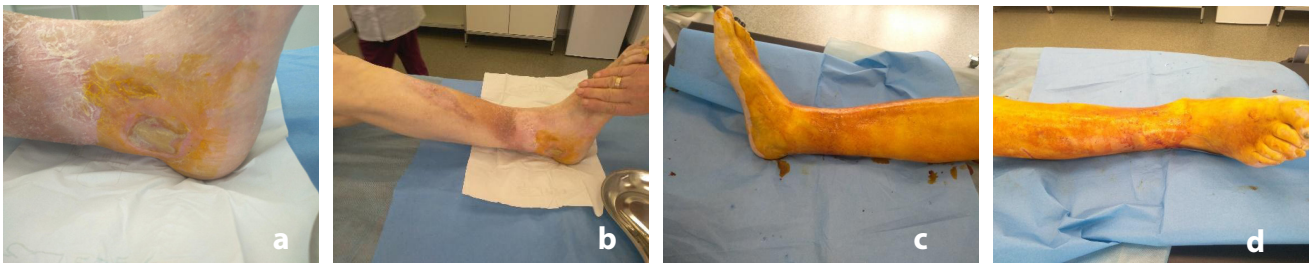

Figure 17 (a,b,c,d). Dynamics of wound healing after the introduction of MSCs into the muscles of a separate lower limb.

The physiotherapeutic component of the rehabilitation program encompassed methods such as electrostimulation, magnetic field application, light-based therapy, and ultrasound treatment. These modalities contributed to accelerated tissue repair, increased muscular strength, and enhanced joint flexibility. Both acupuncture and physiotherapy played a pivotal role in the recovery process. Acupuncture, in particular, facilitated better microvascular circulation and alleviated pain by stimulating specific therapeutic points, including ST36 (Zu San Li), SP6 (San Yin Jiao), and BL57 (Cheng Shan) [14, 15].

Overall, patients in the MSC-treated group experienced marked progress in pain relief, physical function, vascular perfusion, and ulcer healing. Their clinical outcomes were significantly superior to those observed in the control group. These findings reinforce the therapeutic value of mesenchymal stem cell therapy in improving peripheral blood flow, minimizing the likelihood of limb amputation, and enhancing both limb viability and patient quality of life in cases of advanced lower limb ischemia.

2.11. Discussion

Mesenchymal stem cells (MSCs), harvested from a patient's own bone marrow or adipose tissue, offer distinct therapeutic benefits due to their low immunogenicity and their capacity to support tissue repair via the secretion of paracrine signaling molecules. These cells have shown promise in improving vascular perfusion, promoting the formation of new blood vessels, and mitigating inflammatory responses – key factors in treating chronic critical limb ischemia (CCLLI) [5, 9].

Although clinical validation of MSC therapy for CCLLI is still evolving, early-stage trials and preclinical research have yielded encouraging outcomes. Improvements have been noted in symptoms such as resting pain, walking endurance, and tissue oxygenation. Metrics like the Ankle-Brachial Index (ABI), transcutaneous oxygen pressure ($TcPO_2$), and pain-free walking time have served as reliable indicators of therapeutic success, with MSC-based interventions demonstrating meaningful progress in these areas [2, 3].

Autologous MSCs have become a cornerstone of integrated rehabilitation strategies, combining various therapeutic modalities to enhance both short-term recovery and long-term prognosis for individuals with advanced ischemia and chronic pain syndromes.

Nonetheless, several challenges persist, including the need to standardize treatment protocols, determine optimal cell dosages, and ensure sustained safety and effectiveness – particularly in complex cases such as war-related injuries. Notably, current literature lacks documented studies on the application of stem cell therapy for limb ischemia resulting from gunshot wounds.

To fully realize the benefits of MSCs in such contexts, a multidisciplinary approach is essential. Physical rehabilitation, including targeted exercise regimens, plays a vital role in preserving joint function, preventing muscle wasting, and restoring limb mobility.

Combining MSC therapy with non-invasive interventions – such as acupuncture, physiotherapy, and biologically active compounds – creates a more holistic framework for managing pain, accelerating tissue regeneration, and improving functional outcomes. Acupuncture, for instance, has been shown to enhance circulation, modulate immune responses, and relieve pain, thereby supporting the healing of ischemic tissues [14, 15].

This integrative model not only addresses the physical dimensions of recovery but also aligns with the principles of personalized medicine, tailoring care to each patient's unique clinical profile and injury history.

In summary, incorporating autologous MSCs into a comprehensive rehabilitation protocol holds considerable promise for improving the health and quality of life of war-affected individuals with severe CCLLI. The combined effect of cellular therapy and supportive treatments may offer a robust solution that targets both physiological restoration and psychological well-being. However, further investigation is needed to refine therapeutic strategies, validate long-term outcomes, and expand the scope of application.

2.12. Conclusions

1. Critical limb ischemia (CLI) represents a severe and potentially life-threatening vascular condition that demands the rapid adoption of innovative therapeutic strategies. In cases of combat-related injuries, particularly among military personnel, the integration of mesenchymal stem cell (MSC) therapy with complementary non-pharmacological interventions – such as acupuncture, physiotherapy, and structured rehabilitation exercises – has demonstrated sub-

stantial clinical value. This multimodal approach not only accelerates tissue regeneration and functional recovery but also contributes to effective pain management and significantly reduces the risk of limb amputation. By addressing both the vascular and neuromuscular components of CLI, this strategy enhances overall limb viability and improves patients' quality of life.

2. Regulatory considerations currently permit the clinical use of MSCs in the treatment of chronic critical limb ischemia (CCLLI), particularly when derived from autologous sources such as bone marrow or adipose tissue. These cells offer immunological compatibility and minimize the risk of rejection. However, practical challenges remain, including the complexity of harvesting procedures, variability in cell yield, and the need for specialized culturing techniques to obtain sufficient therapeutic doses. Despite these limitations, MSC therapy has proven to be a safe intervention with a low incidence of early adverse effects, making it a viable option for integration into advanced clinical protocols.
3. Clinical evidence increasingly supports the inclusion of MSC-based therapies in standardized treatment pathways for limb ischemia. When combined with a multidisciplinary rehabilitation framework, MSC therapy enhances recovery outcomes, particularly in patients with combat-related vascular injuries. Improvements in pain levels, walking capacity, and tissue oxygenation have been consistently observed. Nevertheless, further research is essential to optimize treatment regimens, determine ideal dosing strategies, and validate long-term efficacy and safety. Expanding the evidence base will help establish MSC therapy as a cornerstone of personalized care for individuals suffering from severe ischemic conditions, especially in complex scenarios such as war-related trauma.

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CHAPTER 3

THE USE OF PREFORMED PHYSICAL FACTORS IN THE REHABILITATION OF WAR VICTIMS

Lidiia V. Butska

In therapeutic sections of clinical medicine and rehabilitation, there is constant competition between physical factors and spa procedures, on the one hand, and medicinal preparations, on the other. Unfortunately, most of this competition ends in favor of the latter, not only because of the extensive advertising of drugs and the lack of qualified doctors doctors who can use modem methods of physiotherapy.

Undoubtedly, modem medicine has a significant arsenal of active medication which is make treatment of many diseases effective. However, the uses of drugs on a wide scale in some cases are causes of addictive, allergic reactions and also can make adversely affecting the patient's condition.

Advantages of the majority of physical factors consist in the fact that they stimulate the organ or functional system, normalizing its function, improving microcirculation and innervations and accelerating the biochemical processes taking place in the area affected by stimulating the immune system and the body's own forces to fight the disease or to prevent it without causing thus usually serious side effects. The above fully applies to the ultrasound (US) waves, magnetic fields (MF) and electromagnetic radiation (EMR). These «relationships» of the body and the physical factor are due to the fact that in essence the majority of the physical factors are is the part of the natural environment for the body.

These data suggest the need for equipment and procedures, wherever provided for therapeutic or prophylactic use of simultaneous or sequential effects on the human body the main above-mentioned preformed natural factors – EMR, MT and UT. It is expected that such a combination will provide a significant therapeutic effect than their separate use. The first experience of using such a combination is already known – magnetic treatment are one of the best combination with medication treatment, which is well established in the practice of physiotherapy.

For over the past five years, we have worked out various options for physiotherapy effects using EMR, MT, UT. For this purpose, a special company «MEDINTEH» in 1995 developed a unique device «MIT-11», allowing to carry out separately and combine the low-frequency ultrasound therapy, laser therapy or magnetic laser with different variants of their therapeutic modulation frequencies and simultaneous action on three areas – central and peripheral nervous system and the area of pathology.

The device was developed under the scientific supervision of Prof. Samosyuk Ivan Zakharovich and Chuhraev Nikolai Viktorovich.

3.1. Modern principles of choice of impact zones in the physiotherapy treatment

Contemporary physical therapy literature often emphasizes the mechanisms behind physical factors, their technical parameters, and theoretical foundations. While these aspects are undoubtedly important, there remains a noticeable gap in research concerning the selection of treatment zones, the body's specific responses to stimulation in different areas, and the physiological appropriateness of applied parameters.

Interestingly, that traditional Chinese physiotherapy, in particular Zhen-jiu therapy, also known as physiopuncture, has been addressing these issues for over three thousand years. This approach focuses on identifying precise points of action, determining optimal exposure times based on biological rhythms (daily, monthly, seasonal), and selecting appropriate methods and intensities of stimulation, such as acupuncture, acupressure, moxibustion, or warming techniques. These principles remain highly relevant to modern physiotherapy practice.

In clinical medicine and rehabilitation, physical therapy and spa treatments often compete with pharmacological approaches. Unfortunately, medications tend to dominate, largely due to aggressive marketing and a lack of sufficient training among healthcare professionals in contemporary physiotherapy techniques.

Modern medicine certainly offers a wide range of effective drugs, but their extensive use can lead to dependency, allergic reactions, and other side effects. In contrast, physical factors typically work by stimulating organs or functional systems, helping to restore normal function, enhance microcirculation and nerve activity, and accelerate biochemical processes. They also activate the immune system and the body's natural defenses, often without causing significant side effects. This is especially true for modalities like ultrasound waves, magnetic fields, and electromagnetic radiation, which are inherently part of the body's natural environment.

These insights point to the value of developing equipment and protocols that combine or sequence the use of these natural physical factors – EMR, MF, and UT – for therapeutic or preventive purposes. Such combinations are expected to yield stronger therapeutic outcomes than when used individually. One well-established example is magnetic therapy, which has proven its effectiveness when paired with medication in physiotherapy settings.

3.2. Bioresonance and preformed physical factors in rehabilitation medicine

Rehabilitation medicine is a dynamic and rapidly advancing field, constantly exploring new ways to restore health and improve patient function. A particularly relevant area of study is the scientific and educational basis for the use of bioresonance and preformed physical factors, such as specific frequencies, light, and magnetic fields, in therapeutic practice. These methods are gaining attention worldwide as non-invasive, low-risk alternatives to conventional pharmacological treatments.

To implement these approaches into mainstream medicine, it's essential to build a solid scientific foundation. This means conducting thorough research to evaluate their clinical effectiveness, understand how they influence physiological processes, and determine the best ways to apply them in practice. Without this evidence, such therapies remain on the fringes of medical care.

Another challenge lies in preparing healthcare professionals to use these methods safely and effectively. Physicians, physiotherapists, and nurses need structured education that explains the underlying science, clinical applications, and ethical considerations. Without proper training, there's a risk of misuse, which could compromise patient safety. Therefore, the development of standardized curricula is a key step in integrating these techniques into modern rehabilitation.

Understanding how bioresonance and physical factors interact with the human body also opens the door to more personalized treatment strategies. By tailoring therapy to individual needs, clinicians can achieve better outcomes and support long-term recovery. This kind of interdisciplinary research, integrating biophysics, clinical medicine and education, is vital for shaping the future of rehabilitation and improving quality of life.

In physical therapy literature, much attention is given to the mechanisms and parameters of physical factors. However, there's a noticeable lack of focus on how to select the most effective zones of impact, how different areas of the body respond to stimulation, and how to match treatment parameters to the physiological characteristics of each zone.

Traditional Chinese physiotherapy, particularly Zhen-chiu therapy (physiopuncture), has long addressed these questions. For over three millennia, it has emphasized the importance of choosing precise points for stimulation, scheduling treatments according to biological rhythms, and selecting the appropriate method and intensity – whether through acupuncture, acupressure, moxibustion, or warming. These principles remain highly relevant today.

This section aims to review scientific literature on the use of preformed physical factors in multidisciplinary rehabilitation programs. The goals are to assess current research on how these factors work, identify priority areas for their application, explore theories that explain physiological changes under their influence, and demonstrate their value in treating patients with internal diseases.

3.3. Let's speak more detail on the possible areas of choice for physical therapy

In the field of physical therapy (PT), one of the fundamental considerations for effective treatment is the strategic selection of therapeutic zones. While the field has made significant strides in understanding the mechanisms and parameters of physical modalities, the question of where to apply these interventions remains a critical and sometimes underexplored aspect of clinical practice.

A commonly employed and straightforward method involves targeting the anatomical area directly affected by the pathology. For instance, in cases of lumbalgia, therapeutic interventions are typically directed at the lumbar region where the pain is localized. Similarly, for respiratory conditions involving the bronchopulmonary system, treatments often focus on the thoracic area to support breathing and lung function. In hepatobiliary disorders, the liver and gallbladder regions become the primary zones of influence, while in degenerative joint diseases such as gonarthrosis, the knee joints themselves are the focal point of therapy.

Although this localized approach is widely practiced and often yields symptomatic relief, it does not always address the deeper, systemic mechanisms underlying the disease. Many conditions, particularly chronic or degenerative ones, involve complex interactions in the nervous, vascular and endocrine systems. For example, in gonarthrosis, the segmental organization of the autonomic nervous system – in particular, the spinal segments L1 to L3 – plays a crucial role in the trophic regulation of the knee joint. Therefore, in addition to treating the knee directly, it is beneficial to include

interventions targeting these spinal segments to enhance therapeutic outcomes. This concept forms the basis of the metameric or segmental approach to physical therapy, which is one of the most scientifically grounded and clinically validated strategies in the field.

The segmental method is complemented by the classic „three pillars" of physical therapy: the cervical region, the lumbar region, and the so-called zones of Zakharyin-Ged. These zones correspond to areas of the skin that reflect internal organ dysfunction through viscerocutaneous reflexes. Their selection is not arbitrary, but is supported by both empirical clinical evidence and theoretical neurophysiological models. By stimulating these regions, therapists can influence internal organ function and systemic processes, making this approach particularly valuable in complex rehabilitation cases.

An additional level of complexity in the practice of physiotherapy includes the use of reflex zones and biologically active points. Often associated with traditional Eastern medicine, concepts such as acupuncture and reflexology are increasingly recognized in modern rehabilitation for their ability to modulate physiological responses and promote healing. Understanding the location and function of these points allows therapists to engage the body's intrinsic regulatory systems in a targeted and non-invasive manner.

The therapeutic benefits of stimulating reflex zones and biologically active points are multifaceted:

- Pain Modulation: By activating specific points, therapists can influence neural pathways that regulate pain perception. This can lead to the release of endogenous opioids like endorphins, providing natural pain relief without the side effects associated with pharmacological agents.
- Improved Circulation and Tissue Repair: Targeted stimulation enhances blood and lymphatic flow, which facilitates the delivery of oxygen and nutrients to damaged tissues while promoting the removal of metabolic waste. This accelerates the healing process and reduces inflammation.
- Psychophysiological Balance: Rehabilitation is not only a physical journey but also an emotional one. Techniques that engage reflex zones can help reduce stress, decrease anxiety levels, and promote relaxation by modulating the autonomic nervous system. This holistic effect supports both mental and physical recovery.
- Systemic Integration: Perhaps most importantly, this approach encourages a shift from symptom-focused treatment to a more integrative, patient-centered model. By considering the body as a network of interconnected systems, therapists can design interventions that address root causes rather than just surface symptoms.

In conclusion, the thoughtful selection of therapeutic zones – whether based on lesion localization, segmental innervation, or reflexive pathways – plays a pivotal role in the success of physical therapy. Integrating knowledge of metameric structures, reflex zones, and biologically active points enriches the therapist's toolkit, enabling more precise, effective, and individualized care. As rehabilitation medicine continues to evolve, embracing these principles will be essential for optimizing patient outcomes and advancing the field toward a more holistic and scientifically grounded future.

3.4. Zones of Zakharyin-Ged and metameric segmental principle of choosing zones in physiotherapy

The priority in describing special zones on the human body belong to one of the founders of the physical therapy Zakhary'in-Ged [1]. He was first who clinically discover areas of the body with a

modified structure and drew attention to this fact, that in the presence of a pathological process in the internal organs coming from them the pain is often projected in well-defined areas of the skin. The author gave a description of the phenomenon of pain palpatory – the determined by pressure and the frequent presence of hyperalgesia in these areas. Although to date, in many areas, the mechanism of the appearance of Zakhary'in-Ged is not quite clarified, still in the pathogenesis of their formation is important anatomical and functional (metameric) connection between the skin and the internal organs through the segmental apparatus of the spinal cord. The reason of their occurrence is pathological changes at the level of the autonomic nervous system. In modern conditions, the Zakhary'in-Ged zones can be interpreted as a zone with altered skin sensitivity and other tissues (muscles, bones) in the specific metameasure zone, the complex of vasomotor and motor-trophic reflexes, which is a kind of cutaneous projection of the metameasure of the diseased organ. Palpation in the Zakhary'in-Ged area revealed trophic changes, soreness, pain, changes in skin electrical conductivity, sweating, changes in skin temperature and disturbance of superficial sensitivity, and the appearance of hyper- or hypoalgesia. In this case, the size of the zones, their resistance, the nature of the sensitivity of changes in the electrical conductivity and may be an important clinical factor in determining the dynamics of the disease. However, the value of these areas is important not only for diagnosis, but also for a variety of physical therapy options. The impact of physical factors on a specific area of Zakhary'in-Ged allows selectively influence on the functional state of a particular organ. In fact, we are able to make direct stimulation of the paths formed as a result of the disease, so we can speak about a kind of feedback principle: every internal organ is certain complies a specific area of the skin, and vice versa. Such feedback, of course, is realized through the segmental apparatus of the spinal cord. As it is known, the structure of the human body to a degree, retains metameric principle that is essential for the selection and understanding the impact zones of PT mechanisms. The commonality of the autonomic segmental innervation of internal organs and certain metameres (i.e., when the source of innervation of an internal organ and a certain metamere serve the same segments or the same autonomous structures) underlies the metameric-segmental principle of PT. Close ties between somatic and autonomic entitieses at the spinal cord level, create preconditions for switching pulses from a physical body at the autonomic department and vice versa. For example, the effect on metamers Th11-L1 (Th10-Th12) can affect the functioning of the basic parameters of kidney and adrenal gland (Fig. 1).

Possible Neurohumoral Changes During Stimulation of Metamers Associated with Kidney Function (Fig. 1).

According to Yu. Natochin (1985), stimulation of metamers related to kidney function can induce a variety of neurohumoral responses, including:

1. Activation of the renin–angiotensin–aldosterone system (RAAS):

Increased renin release from juxtaglomerular cells;

Elevation of angiotensin II levels;

Stimulation of aldosterone secretion by the adrenal cortex.

2. Modulation of sympathetic and parasympathetic activity:

Reduction of sympathetic tone in segmental ganglia;

Enhancement of parasympathetic influences, contributing to vasodilation and improved renal perfusion.

3. Influence on electrolyte and fluid balance:

Changes in sodium, potassium, calcium, magnesium, chloride, and bicarbonate concentrations;

Adjustment of extracellular and intravascular volume.

4. Effects on erythropoiesis:

Activation of erythropoietin production in response to altered renal perfusion.

5. Metabolic and protein-lipid regulation:

Modulation of protein, lipid, and carbohydrate metabolism through kidney-liver-adrenal interactions.

6. Regulation of metabolic waste excretion:

Enhanced renal clearance of urea and nitrogenous products;

These neurohumoral changes form the basis for the systemic effects observed during reflex therapy or segmental stimulation targeting the kidney, supporting homeostasis, blood pressure regulation, and tissue perfusion.

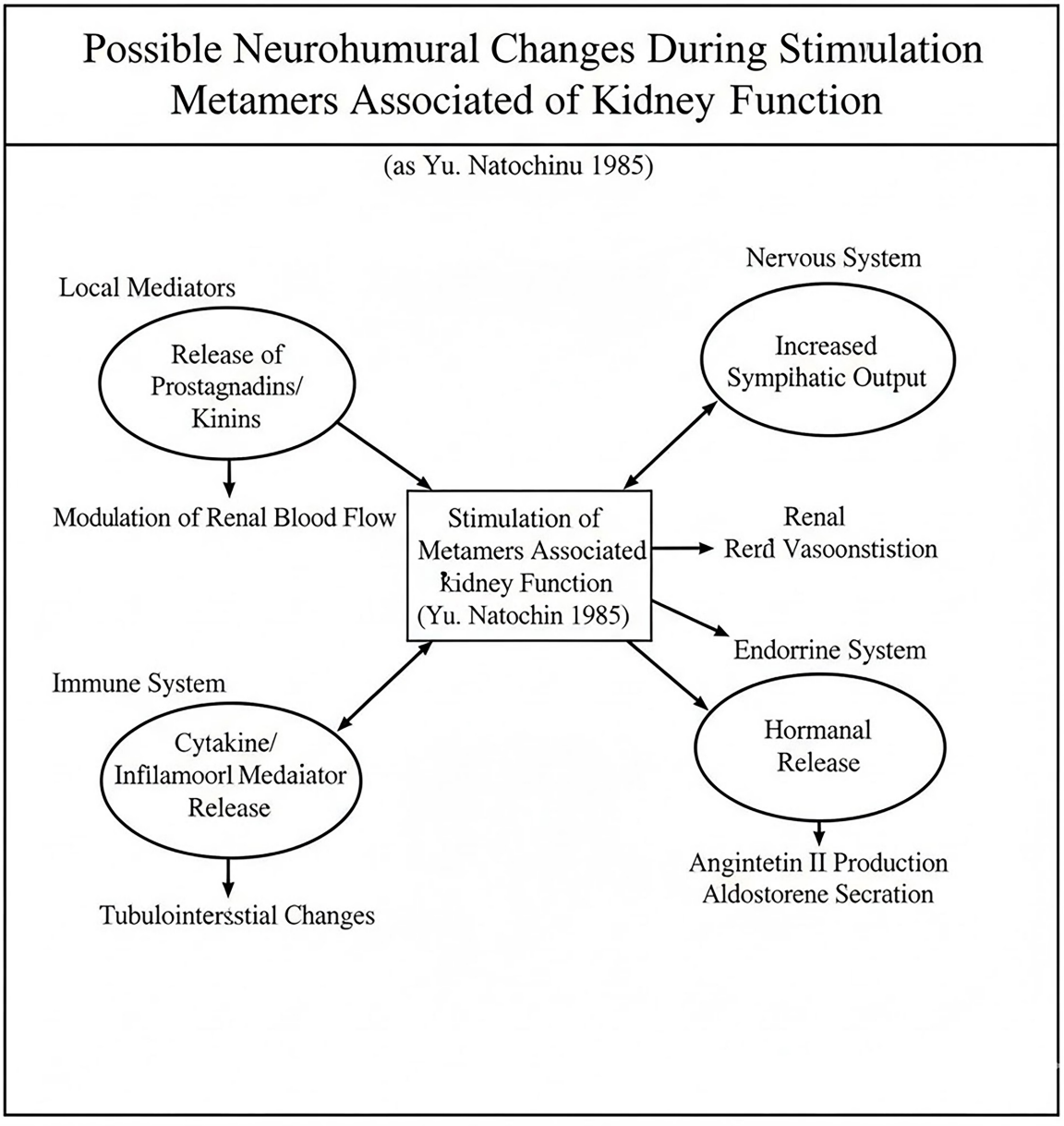

Figure 1. Possible neurohumoral changes during stimulation of metamers associated with kidney function (as Yu.Natochinu 1985).

Table 1. Segmental innervation of the skin and internal organs

Innervation area	Segments and nerves
Face	Trigeminal nerve
Auricle	V, VII, IX, X pairs of cranial nerves, C2-C3
Back of the head, neck	C1-C3
Shoulder girdle	C4
Radial half shoulder, forearm and hand	C5-C7
Ulnar half of the shoulder, forearm and hand	C8-D2
Nipple line	Th5
The lower edge of the costal arch	Th7
The level of the navel	Th10
The level of the inguinal ligament	Th12-L1
The front of the thigh	L1-L4
The front surface of the tibia	L5
The back surface of the leg	S1-S3
The perineum, inner buttocks surface	S4-S5
Sympathetic innervation of the skin	
Face, neck	C8-Th3
Upper extremity	Th4-Th7
Torso	Th8-Th9
Lower extremity	Th10-L2
Vegetative innervation of internal organs	
Heart	C3-C5, C8, Th1-Th3 (Th4-Th6)
Aorta	Th1-Th3
Lungs	C3-C4 (Thl), Th2-Th5, (Th6-Th9)
Esophagus	Th3-Th5 (Th6)
Stomach	(Th6), Th7-Th8
Intestines	Th6-Th12
Rectum	S2-S4
The liver and gallbladder	(Th7), Th8-Th10, L1-L2
The kidney and ureter	Th11-L1 (Th10-Th12)
Bladder: • walls • mucous membrane of the cervix	 Th11-L1 S2-S4
Prostate gland	Th10-Th11 (Th12, L5); S1-S2
Testicle and ovary	Th10-L1, (L2)
Uterus: • body • neck	 Th10-L1 S1-S4

Possible neurohumoral changes during stimulation metameres related to renal function (Yu. Natochinu, 1985) [15]. This metameric principle of «small» physical therapy has been described yet, by M.N. Lapinski [1] and «disclosed» as classics physiotherapy by A. E. Shcherbak [1] and A. R. Kirichinskim [2]. It has found its application in the practice of acupuncture in the form of a recommendation of folk doctors of the East on the use of the so-called signal points or heralds points (these are nothing but the epicenter of zones Zakharyin-Ged) and sympathetic points (the latter are located in the same metameres as the internal organs and are recommended for the impact on them during diseases).

When a large capacity of the physical factor is using, the initial response of the organism are caused by the nervo reflex and humoral mechanisms. In the cases of the threshold value or above-threshold stimulus[1] in response involved segmental unit with the inclusion of the autonomic nervous system, and through the last – internal organs, blood vessels, and others. Most likely, that the therapeutic effect of a zone Zakharyin-Ged, by herald's points (signal), trigger points, pain points just is based on a similar mechanism, ie, metameric segmental principle.

Table 1 shows the segmental innervation of the skin and internal organs, using which you can choose a more targeted area for PT.

However, the convergence of somatic and visceral afferent innervation occurs not only in spinal neurons and neurons of the reticular formation of the brain stem, hypothalamus, thalamus and cerebral cortex [1,2]. These facts are the physiological basis for explaining the effectiveness of PT of the visceral pain and other pathologies. In these cases we are talking about multi-level principle of regulation of the nervous functions as a principle of the system [3, 5,9,29].

3.5. A systemic principle of the human body functions organization and the selection of treatment zones

In the process of evolution has been developed multiple safety regulation of the same functional-dynamic system (a kind of a stability system with the presence of 3-5 or more levels of its regulation). These facts formed the basis of the teachings of P.K Anokhin and his disciples [21; 36] about functional systems. Within the framework of a functional system, these authors understand the dynamic, self-regulating organization, which is selectively combining various organs and subsystems of the nervous and humoral regulation to achieve specific, useful for the organism results. An example of a multilevel organization of the system can serve as a breathing system.

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[1] In this section, we do not dwell on the primary interaction of physical factors with biological substrate. These issues are widely debated in the literature (Samosiuk I. Z., ta in. (2004); Lyseniuk V. P., Samosiuk I. Z., & Kozhanova A. N. (2000). Kaluhin V. O., ta in. (1996), Samosyuk I.Z. L.V. Buts'ka (2010), Bakaliuk T. H., ta in. (2020), Mykhaliuk Ye. L., & Reznychenko Yu. H. (2020), Butska L. V., & Chukhraiev M. V. (2017), Butska L. V., Drevitska O. O., & Chukhraiev M. V. (2017)) [1,2,5,6,7, 8, 9, 39] and partially covered with respect to ultrasound, MP and EMF in other chapters. However, whatever the primary mechanism of action of physiotherapy, the subsequent reaction is developed with the inclusion of the nervous, endocrine and humoral immune and other systems. In the primary acception the physical factor is set to the impact zone, specificity, which determines the specificity of the response. Of course, for that particular response (no stress reaction!) Required value chosen stimulus (its power, frequency, wavelength, etc.), time and duration, the system state, which is directed impact. At low power, but adequate physical stimuli, they seem to play mainly the role of information and reference, which leads to the so-called bio-resonance therapeutic effect.

In this system we can distinguish:

1. the motor zone of the cerebral cortex, which is providing a conscious (arbitrary) performing respiratory movements, cough;
2. the respiratory center of the medulla oblongata, which regulates involuntary (automatic) breathing;
3. the segmental apparatus of the spinal cord, which is providing autonomic-trophic functions of both for the lung and the corresponding nerves and muscles;
4. the respiratory muscles and the nerves innervating them;
5. the lungs as an organ and the respiratory tract.

It is understood when treating respiratory diseases it is important to influence on various levels (not one) of the respiratory system with the possible focus on one or the other levels, depending on the cause of the disease.

No less indicative the use of systemic principles of sensitive and motor functions:

sensitive function:	cortex ↔brain stem, including eye bugor ↔segments of the spinal cord spinal ganglia and peripheral nerve receptors.
motor function:	the brain subcortex ↔cortex ↔the brain sterm ↔segments of the spinal cord ↔peripheral nerves and osteo-muscular-articular apparatus.

Naturally, in the construction of treatment and rehabilitation programs, the principle of organization of the nervous system should be taken into account.

For example, a multi-level, systematic approach to post-stroke rehabilitation helps patients «unite disparate functions» [11,12]. For instance, electrical stimulation of paretic muscles (spasticity predominantly antagonists) not only prevents the malnutrition, but also has a positive effect on brain neurodynamics. Effects on subcortical and stem structures (central electroanalgesia, endonasal electrophoresis of delargin or vitamin E on the base of the Dimexidum) helps to reduce muscle tone, which is apparently due to the gradual recovery of cortical-subcortical relations, and active influence on the reticulo-spinal ways of the regulation of the muscular tone [3,9, 14,15].

Regarding increased muscle tone, it should be noted that in many diseases of the central nervous system (CNS) spasticity becomes one of the main obstacles to the restoration of motor function [6; 7].

A number of modem electrophysiological studies performed on patients with spasticity have shown that the latter is not a result of a breach of any single system or a neurophysiological mechanism, as determined by a set of violations at different levels of functional motor system, although it is realized mainly on the segmental level (hyperactivity of spinal a-motoneuron change in neuronal excitability annular spinal cord circuits pathological increase polysynaptic reflexes etc.) [4; 5].

In patients with the pathology of central nervous system, such as cerebral palsy, is necessary the effective reduction of muscle tone, possible through the use of multilevel (system) of the principle of the regulation as follows:

- by influence on the motor parts of the brain cortex, subcortical and stem structures;
- by influence on segmental apparatus of the spinal cord and the autochthonous muscles of the trunk (the latter is provided by a bilateral innervation from the formations of striopallidarum system, so there is practically absent paralysis of the trunk muscles) and also contributes to the normalization of ion exchange processes in the neuron.

As a result of the therapy, the level of calcium channel blocker Ca2++ in cells decreases, which leads to a decrease in the excitation of motor neurons and, consequently, to a decrease in spasm and spasticity of the flexor muscles [39; 14,15,16].

According to some authors, the antispastic effect of MT is superior of many known antispastic drugs [10]. But, the majority of drugs tend to act on any one link pathologic system [4; 5, 14,15].

For example, Baklafen, by acting on GABA-P receptors, causes a reduction of the Ca2++, but does not normalize the pre- and postsynaptic disinhibition in neurons [5].

A major shortcoming of antispasmodic medications is that they cause an increase in the paretic weakness of muscles, which greatly reduces the effectiveness of the treatment of patients with post-stroke movement disorders [4, 14,15].

A systemic and multi-level approach is needed not only in patients with motor disorders which are the the results CNS diseases, but also in patients with lesions of the peripheral nervous system. Thus, the effects on the motor system inpatients who are suffered from consequences of injuries of nerve trunks, polyneuropathy, should be implemented at the following levels: affected (denervated) muscles, nerve trunk or nerve trunks which are damaged; segmental level, that is, segments of the spinal cord, neurons which form respective nerve axons; suprasegmental centers, i.e. afferent centers of the brain, the effects on which contribute to a more rapid regeneration of peripheral nerve structures.

In these cases, it is also very important to act on the healthy side of the body, since the effect on the intersegmental connection of the left and right spinal segments stimulates the segments of the affected nerve structures [8, 16,17].

Such an approach in the PT may be called as system multi-level , it provides exposure to different levels of functional systems and contributes to «unite disparate functions» [14.15,39, 41]. This approach can be implemented only by the methods of physical therapy and physiopuncture and virtually impossible by drug therapy.

The multi-level systemic principle of PT explains the possibility of compensatory reactions of the organism in various pathological conditions and is the basis of the sanogenesis.

It also gives the doctor a basis for selecting optimal areas of exposure: in some cases is enough to impact on the unit of the segment of spine and the affected organ, while in others, requires to impact on stem of the brain or cortical parts of the brain, or a combination thereof.

An analysis of current approaches in the choice of impact zones at PT show us that it is necessary to consider the dualistic base (system and anti-system) of the principle of the regulation of any function.

There are many dual phenomena in biology:

- decompensation and compensation;
- assimilation and dissimilation;
- stress and protection;
- adaptation and maladjustment;
- the predominance of sympathetic.

The third level of impact is on the paretic limb. This approach is implemented by professor V.I.Kozyavkin [7] in the treatment of cerebral palsy. He named it the polysegmentary method. The therapeutic effect of this manipulation by the adequate methods provided on all parts of the spine

and the muscles (autochthonous muscles, segmental apparatus of the spinal cord and structures of the brain stem, by the manipulation of the cranial-cervical junction) and general kinesitherapy.

The importance of combining different variants of kinesitherapy and certain physical factors (perhaps in subthreshold doses in order to avoid increasing the tone of spastic muscles) in cases spastic paresis, due to the fact that the corticospinal tract provides both function of efferent (organization of movements and the regulation of muscle tone) and functions of afferent neural pathways (delivery information the cortex, subcortical structures, the cerebellum and the reticular formation of the peripheral sensory receptors and spinal motoneurons) [6].

Application of physical factors (eg, magnetic therapy (MT) of a certain frequency – iono-parametric MT) for MR patients with diseases of the central nervous system also contributes to the normalization of ion exchange processes in the neuron.

At the same time, in many cases it is preferred to impact by PT not on the diseased system, but on the physiologically intact anti-system.

These data have been successfully used in the treatment of pain syndromes, when using a low-frequency electrical stimulation of the skin with short pulses (TENS), which are excites the predominantly antinociceptive system and thereby suppress pain. It is also important to understand that activation of neurons in the pain system can be caused not only by harmful stimulus, but also by artificial (after longterm use of certain medications) or by the natural inhibition of the activity of the system which make the analgesic effect: violation of serotonin metabolic processes, synthesis of opiate peptides, changes in emotional tone, etc.

The mechanism of occurrence of pain of central origin (inhibition of the activity of the antinociceptive system) is the basis of the appearance of pain in the masked (hidden), depression, and disappearing in the appointment antidepressants or adequate physiotherapy methods (electric, central electroanalgesia, etc.).

Unfortunately, it should be noted that in European medicine the use of systemic and antisystemic principles in the therapy of PT is little in demand and has been little studied. This cannot be said about Eastern medicine, where these principles are widely used in the rules and the theory of 5 Elements («U-SHIN»). These rules clearly define the relationship of various organs and systems, such as the heart and liver, the liver and spleen, and others. Knowledge of these rules help the physician to freely navigate the selection of systems (and anti-systems) in each case and, in addition to the impact on the pathological system, choose a system that can help for the «sick» systems. Figure 2 shows the scheme of «relationship» between the main organs (systems, meridians), which regulates their influence on each other.

If we are referring to the so-called organ-trophic principle of PT, when the impact of physical factors take place directly on the projection of the required organ or some part of it, it should be noted some progress in this regard.

For example, in the case of detection of initial pulmonary tuberculosis, as shown by our study [31], effective is the use of low-frequency ultrasound on a proj ection of focal changes in the lung together with TB chemotherapy. N.V. Karmazin [14,15] convincingly proved the immunomodulatory prospects of the impact of various physical factors on the spleen. The influence of physyotrapy techniques on blood is becomes classical [43]. We study and hav good results by direct stimulation by the physical factors of the endocrine glands [6, 14, 33].

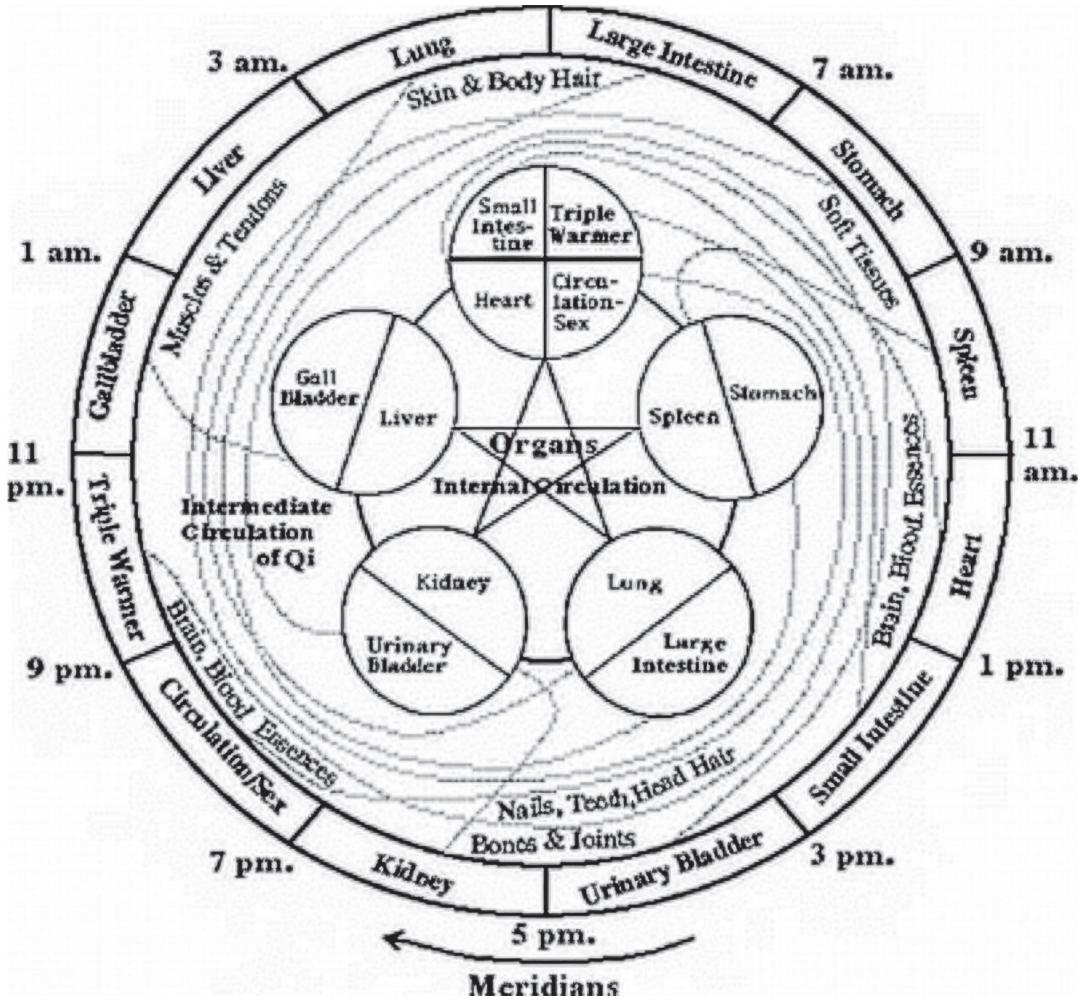


Figure 2. «Interactions» between the main bodies (systems, meridians), which regulate their influence on each other (according to the theory of« U-SHIN»).

It is worth recalling that in Vedic medicine the impact on the so-called chakras (which are the mostly projection on the skin of the endocrine glands) for the purpose of stimulation, were given special importance to the choice of a specific color (electromagnetic radiation of a certain wavelength).

So, for «sexual chakra» (the sex glands, the first chakra, the area of the womb) need to act in red, on the chakra, located midway between the vagina and the navel (stimulation of the adrenal gland, the second chakra) – orange; on the chakra, located midway between the navel and the xiphoid process (the projection of the solar plexus, the third chakra) – yellow; on the thymus (4th chakra) – green; thyroid (5th chakra) – ligth blue; pituitary (6th chakra) – dark blue; epiphysis (7th chakra) – purple or white. In order to reduce the definite function of gland is require the effect of opposite color (by contrast to Goering), which is causing the opposite reaction (photoreactivation). For example, if the thyroid gland has hyperfunction, it is good to wear amber (yellow) colored clothes, and this color is making the contrast to the light blue color, which is stimulating the gland.

3.6. Special and specific zones of influence and choice in the practice of physical therapy

In physiotherapy, as noted above, along with the impact on the area of local pain or area of lesion, are using a choice of zones based on the system multi-level, and system-antisystemic metamerically segmental principles (Table 2).

Table 2. Innervation zones and associated symptoms.

Vertebrae	Organs & Systems	The symptoms and pathological conditions
C1	The sympathetic nervous system, the brain, the pituitary gland, inner ear	Headaches, neurosis, migraine, hypertension, sleep disturbance
C2	Eyes, optic and auditory nerves, temporal bone	Allergies, fainting, diseases of the eye and ear
C3	Cheeks, face. The nerves of the teeth, the outer ear	Neuralgia, neuritis, acne
C4	The nose, lips, mouth, eustachian tubes	Hearing impairment, enlarged adenoids
C5	Throat ligament	Sore throat, tonsillitis, laryngitis
C6	The muscles of the neck	Foreann pain in the neck, shoulders, back of the head
C7	Thyroid, shoulder and elbow joints	Hypotension, disturbance of mobility in the shoulders and elbows
Th1	Hands, wrists, hands, esophagus.	Trachea asthma, cough, pain in the anns and hands
Th2	Hands, wrists, hands, esophagus	Trachea arrhythmia, coronary heart disease, chest pain
Th3	Bronchi, lungs, pleura, chest, nipples	Asthma, bronchitis, pneumonia, pleurisy
Th4	The gall bladder and ducts	Stones gallbladder, jaundice, abnonnal fat digestion
Th5	Liver, solar plexus	Jaundice, liver disease, bleeding disorder
Th6	Liver, solar plexus	Gastritis, ulcers, indigestion
Th7	Pancreas, duodenum 12	Diabetes, ulcers, upset chairs
Th8	The spleen, diaphragm	Hiccups, respiratory and digestive disorder
Th9	Adrenal glands	Allergies, weakness of the immune system
Th10	Kidneys	Kidney disease, fatigue, weakness
Th11	The kidneys, meters	Chronic kidney disease, impaired urination
Th12	Small and large intestines, fallopian tubes	Digestive disorders, infertility, diseases of the female genital organs
LI	The appendix, cecum, abdominal cavity	Hernia, constipation, colitis, diarrhea
L2	Appendicitis, cecum, abdomen, upper thighs	Appendicitis, intestinal cramps, pain in the groin
L3	Sexual organs, urinary QSP, knee	The disorder of the bladder, impotence, pain in the knees
L4	The prostate gland, lower leg, foot	Sciatica, lumbodynia, pain in the knees, feet
L5	Legs, feet, toes	Swelling and pain in the ankle, flat feet
Sacrum	Thighs, buttocks	Pain in the sacrum
Coccyx	The rectum, anus	Hemorrhoids violation of pelvic organs

Established PT methods, as well as the ongoing development of new physical therapy methods with specialized or specific treatment areas.

As previously mentioned, the area of cervical spine and lumbar area, are widely used in the PT.

Lumbar region

The importance of the lumbar region, the impact on which is recommended in the treatment of many diseases due because most physical factors are provide effective impact to the kidney and adrenal glands.

Figure 2 shows a certain degree of a possible reaction of these bodies on the stimulation of zones of spinal, which are responsible for their innervations. It becomes clear why the lumbar region is one of the «pillars» of the physiotherapy treatment.

Cervical spine region

The effect on the region of the neck, including the region of the sympathetic chain neck, primarily for upper cervical sympathetic ganglion (UCSG), are shown in various brain diseases. This is due to the specificity of these zones in respect to the brain function, its metabolism, and cerebrospinal fluid hemodynamic. From classical neurology it is known that the autonomic centers of the spinal cord segments (C8-Th2) are the main source of autonomic (sympathetic) providing a head in general and cranial nerves particularly including blood vessels, vascular plexus of the brain ventricles and others. UCSG fibers are a peculiar manager of innervations in humans, they come from vegetative segments (C8-Th2) of the spinal cord.

From the last UCSG, the conductors of autonomic sympathetic afferentation are located in the perivascular plexus of the external and internal carotid arteries, after contact with the autonomic ganglia (pterygopalatine, auricular, ciliary and submandibular) and are directed to the structures of the face and brain. Moreover, individual fibers from the autonomic node come into back roots of C1-C4 and then through the cervical inter-ganglion branch go to the Thl-Th4. It turns out a kind of feedback: C8-Th2 segments form UCSG, and from there on the said fiber arrives feedback, in fact, to the same segment. Indeed, the cervical region is a single whole.

It should also be emphasized that there is the second way of autonomic sympathetic ensure of the head and the skull contents is the vegetative perivascular plexus of vertebral artery.

Therefore, the only source of sympathetic innervations of the head, are the lower cervical and upper thoracic segments of the spinal cord, lateral vegetative horns and through these paths are sent innervations to the brain and other entities of the head. This explains the importance of the impact on the neck and area of the collar. However, will speak greater detail on UCSG function and possible mechanisms of action of physical factors in its stimulation.

Even in 1930 E.A. Asratyan [3,4,5] noted changes in the formation of food conditioned reflexes in dogs after the UCSG extirpation. These data were later confirmed by other investigators [27; 38]. A series of experimental studies and clinical observations have shown the role of the sympathetic nervous system, and in particular UCSG in auto regulation of cerebral blood flow [9; 39].

It is known that venous, neurogenic, metabolic and myogenic factors play a leading role in the mechanisms of regulation of cerebral circulation, including. At the same time, in neurogenic regulation the major role belongs to the noradrenergic intracerebral system (the brain stem structure, blue spot, and others.), which has a significant impact on the UCSG. Hypo- or overproduction

(secretion) CSF in pathology UCSG are associating with the change in blood flow in the choroid plexus of the ventricles of the brain [1,3].

These findings were confirmed by long-term experiments with electrical stimulation UCSG [42]. There are studies [33], indicating a change in the content of RNA, the activity of RNase in sub cellular structures of the brain and the disappearance of noradrenalin in the pineal gland after removal UCSG.

In a detailed experimental work, G.A.Sokolova et al. [1] showed the influence of the UCSG regulation on the energy metabolism of the brain and the cortex. The authors emphasize that only with a continuous energy supply, in synapses canbe intense protein synthesis, polypeptides, neurotransmitters and other metabolites, as well as the taking part of the synapses in the nerve impulses.

These data largely explain the importance of using PT influence through the segments C8-Th2 and area of the UCSG, for actively influence the circulation of the blood and the energy processes in the brain. It should also be noted that the cervical spine and its segments are the source of sympathetic innervation (via the stellate ganglion) of the thoracic cavity, including the heart. Not surprisingly, the impact on the neck and collar area is one of the most popular in the PT, that is one of her «whales».

Transcerebral techniques

The impact of various physical factors on the scalp and face has become a constant practice in physiotherapy. Some of them (electric, central electroanalgesia, endonasal electrophoresis and electrophoresis on Bourguignon) have become classics, other options (effects on specific areas of the scalp) are being actively developed.

The impact on the area of the scalp is different both in terms of the adequacy of the choice of physical factor, of the choice of parameters and the area of influence.

For example, the endonasal Bourguignon technique is unique in that electrophoresis of drugs in these areas allows the blood-brain barrier to be overcome. Of course, these data are taken into account in clinical practice, however, their further improvement also requires the study of the possibility of expanding the number of drugs used in these procedures, and options which can include combined endolyumbalno injection, endonasal injection, the medical drugs for severe neurological diseases and others.

Particularly noteworthy transcerebral impact technique, since, depending on the use of physical factors and its parameters can be obtained diverse therapeutic effects: analgesic effect [1; 20; 26], vaso regulating effect [13; 24; 35], immunomodulatory effect [21; 25], the hormone regulatory effect of [11] antidepressant effect [39], and others.

The promising for the transcerebral physiopuncture techniques is a «sighting» impact on the necessary areas of the cerebral cortex (motor, sensory, etc.) [19] or other functionally important structures. For example, the impact on the parasagittal region and the projection of a large cerebral tank.

The choices of these areas are due to the following facts. The projection of the parasagittal region corresponds to the superior sagittal sinus, and here a significant concentration of the arachnoids villi, localized top (large) upper the anastomotic vein (vein of Trolyara), the parietal emissaries vein. These anatomical structures are directly related to the venous circulation and resorption the cerebrospinal fluid of the brain [5]. The said zone is important in other aspects. Thus, according to Oriental medicine, there is localized (the epicenter of the parasagittal areas) the important energy band-to-point T (XIII) 20, which corresponds to the 7 chakra (Vedic Medicine) [30].

The functional significance of this area is confirmed by modem research. In a literature review about the melatonin and its role in neuroimmunology [39] draws attention to the fact that in the embryological period in this area are pawned the pineal gland (epiphysis). Currently, the role of the prostate is intently studied by many scientists. However, it is already known that the gland secretes two important hormones – epithalamion and melatonin. The source of melatonin, are serving the serotonin of the pinealocytes, which constantly and in a larger amount than in other organs were found in the mammalian pineal gland. So we can see how these two glands are connected

Melatonin is pharmacologically less active than serotonin, but its sedative effects on the CNS is more pronounced. The activating effect of serotonin is caused by the excitation of the serotoninergic systems of the reticular formation of the caudal portion of the midbrain and the bridge. These nuclei, in turn, send long descending axons into the spinal cord. Probably, this serotoninergic system plays most important role in modulating of nociception, and in conjunction with the hormones of the pineal gland are influence on the person's mood (depression to a great extent depend on the dysfunction of the pineal gland).

These facts also explain the results of using high efficiency white light and phototherapy in the treatment of many depressions.

Epiphysis actively affects the biorhythms of the organism, immune status and function of the pituitary. Interestingly, the well-known fact that the influence of light on the synthesis of melatonin and serotonin in the pineal gland depends on the state of peripheral sympathetic innervation, and these light effects is not observed when was resection of the both superior cervical sympathetic ganglia [14, 15, 25].

The dependence of the functional activity of the pineal gland from lighting is an important prerequisite for the targeted use of light exposure in order to normalize its functions. In this case, if linear photostimulation of the pineal gland is difficult because of its depth of occurrence in the brain (pineal gland is anatomically located in the rear of the III ventricle), the impact of it can be mediated through the zone embryological associated with it, that is, parasagittal region. It is possible, that the pulsed laser radiation in the infrared range can sometimes directly affects on the epiphysis (penetration depth of about 7 cm).

Consequently, the impact on the parasagittal region in the treatment of many diseases, especially depression, in our view, is well founded.

The choice of the projection zone of the large cistern, the cone of the serebromedullaris for laser stimulation, EHF therapy, etc. is also related to the importance of this formation. It is known that the cisterna magna of the brain is an important regulator of movement of the cerebrospinal fluid, but, for example, skull trauma often involved in the pathological process. Normalization of its functions, reduction of reactive (inflammatory) changes is an important precondition for the normalization of the CSF dynamics. It should also be borne in mind that in the projection of cistema magna, c. serebromedullaris are laid important brain stem structures, including the reticular formation. Stimulation of these structures is directly related to the processes sanogenesis.

Speaking about the specificity of the areas of influence, we must remember the high sensitivity to physical factors of the zones of epy palms, of the feet, the ear and others [17,18,19,20].

The carotid sinus area is particularly sensitive to the effects of physical factors, including magneto- and laser; exposure to it can cause significant therapeutic effects (Fig. 3).

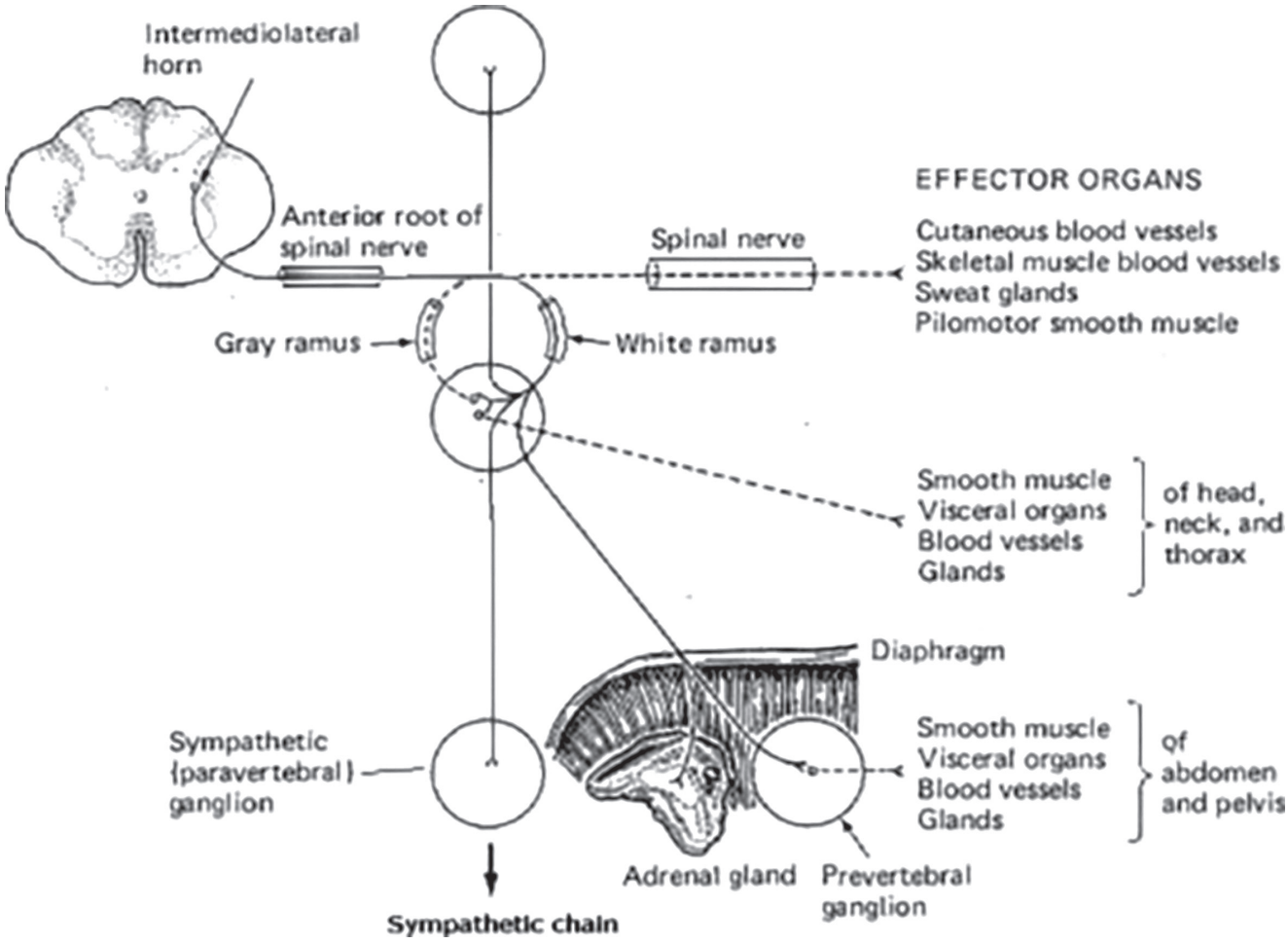


Figure 3. Distribution scheme of reflexes arising, at the excitation carotidreceptors.

Hardware diagnostic methods help in choice of impact zones in the PT: they help to identify areas with low electric resistance and high potential, «interested» vascular pool rheoencephalography (REG) or Doppler [9] and others.

In this context, the diagnostic variants of acupuncture (systemic, meridian) (methods of Nakatani, Akabane, Nogier, hardware pulse diagnostics and others) are of interest, allowing to identify on the preclinical level the true pathological system, thereby defining the zone of influence [30]. This last fact is particularly important for prevention of exacerbations of the disease and for monitor the effectiveness of treatment.

Thus, the modern PT has ample opportunities in the choice of treatment zones. It is important that every medical specialist has mastered the basic ones and skillfully used in clinical practice, bearing in mind that each zone has «individual» charactristics and requires adequate physical factor.

Conclusions

1. Bioresonance therapy and preformed physical factors (such as magnetotherapy, ultrasound, electrotherapy, light and vibration stimulation) are effective components of modern rehabilitation medicine. They influence key regulatory mechanisms including neurohumoral, energy, and psycho-emotional systems.
2. The concept of energy-informational homeostasis is a central therapeutic target. Supporting this balance contributes to pain reduction, normalization of organ and system functions, and restoration of neurovegetative regulation.
3. The integration of principles from Traditional Chinese Medicine (TCM) with modern clinical physiology enhances understanding of how physical factors affect the human body. TCM concepts such as meridian regulation, biorhythms, and functional interactions have been partially confirmed by contemporary experimental data.
4. Analysis of scientific literature and empirical evidence supports the importance of a personalized approach to selecting physical modalities, considering the patient's psychophysiological state, chronotype, functional reserves, and comorbid conditions.
5. Future studies should focus on systematizing and standardizing bioresonance and physiotherapeutic interventions, particularly in the context of multidisciplinary rehabilitation of individuals with chronic pain syndromes, PTSD, and psychosomatic disorders.

3.7. Biological rhythms and bioresonance therapy

It is known that the functioning of the body, its systems, organs, tissues, cells and subcellular structures has rhythmic character with the presence of a large number of oscillating processes from the periods of daily, monthly, seasonal, annual and perennial biological rhythms till microsecond periods repeating the processes inside the cell. The main characteristic of rhythm is the repetition frequency of the process. V.P. Lysenyuk (1999), summarizing the literature data, gives the following classification rhythms depending on the period and recurrence [2,3,4]

In today's view, biological rhythms are considered as «... swinging shift and intensity of processes and physiological reactions, which are based on changes in the metabolism of biological systems, due to the influence of external and internal factors. External factors include: changes in illumination (photoperiodism), temperature (termoperiodizm), perhaps the magnetic field, and the intensity of cosmic radiation, tides, seasonal and solar-lunar influence. Internal factors is, in particular, neurohumoral processes, genetically determined speed and rhythm [1,2].

Biorhythmology can probably be described as the science of the nature and relationships of internal (endogenous) rhythms with external (exogenous) environmental rhythms environment.

Traditional Oriental medicine, based on the recognition of the unity and harmony of the deep relationship, between man and the surrounding nature, when an assessment of the human condition and its treatment tactics, connects with cosmic influences and terrestrial natural factors. Cosmic processes, solar flares and magnetic storms generated by them in the world, the movement of weather fronts and weather changes correlate with the incidence of colds, cardiovascular accidents (hypertensive crises, heart attacks, heart and brain), with the disregulatory aggravation and mental illness. It is expected that the solar activity and related geomagnetic disturbances cause misalignment of internal body rhythms with the rhythms of the environment [19, 20]. It is not excluded that the role of pacemaker can perform frequency of geomagnetic field 0,1-0,006 Hz, varies with solar

activity [14, 20, 21]. Founder of heliobiology A.L. Chizhevsky (1965) [2, 3] wrote: «At any given moment the organic world is under the influence of the space environment and the most sensitive way reflects itself, its features changes or fluctuations that occur in it. We are surrounded by the flow of cosmic energy, which flow to us from distant nebulae, stars, meteor showers, and it would be totally wrong to consider only the sun's energy the only creator of life on earth. The living cell is the result of cosmic, solar and telluric influences, and is the object, which was created by the voltage of creative abilities of the entire universe. »

It is the rhythm of natural phenomena appeared the background against which proceeded evolutionary processes that, in turn, led to the emergence biorhythmological activity in living systems as a mechanism adaptation to ever-changing conditions of life.

Indeed, right now reliably proven that the body is a dissipative (open) self-organizing system to external influences, exchanging with the environment of matter and energy, ie information, but the ability to maintain functioning at a certain constant level, called «homeostasis.»

However, from today's perspective, the concept of homeostasis is not a strict constant of an index, and its fluctuations within certain limits. For example, fluctuations in serum glucose levels from 3.1 to 5.5 mmol/L during a day is legal, and the fluctuations in total serum cholesterol in different individuals within the range of 3,9-6,5 mmol/L, are considered normal. Schematically, the level of homeostasis can be represented as a kind of corridor (Fig. 4).

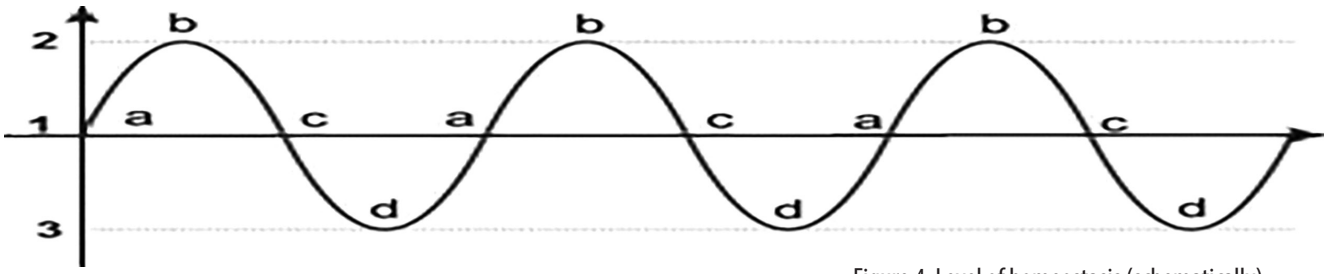


Figure 4. Level of homeostasis (schematically).

1 – the average (meaning) value of parameters, which vary with respect to certain changes (e.g., the average serum glucose level – 4.3 mmol/L); 2 – the upper limit of the corridor – the maximum permissible average of the function of the system; 3 – the minimum permissible value of the same function; a – increase in value or enhancement of function (anacrotics); c – decrease in value or reduction of function (catacrotics); b,d – plateau, that is, the achievement of an indicator or a certain level of function: b – the maximum value, d – the minimum value.

Fluctuations in certain functions, system components and others within certain limits, respectively, and is the «homeostasis», ie the ability to maintain function at an optimal level for the body. Stable inclusion indicators, higher or lower than the corridor, may indicate the inability of the system to compensate for disturbances and the development of pathological changes in the form of hyper- or hypo function condition of the body or system. This principle «works» in diagnostic system «Ryodoraku» by I. Nakatani and others. The oscillations (rhythms) themselves in physiological limits are necessary in order that the cells (the system) are periodically moved from one extreme physiological state, which is dominated by anabolic processes, in another, wherein the catabolic processes dominate. Knowledge of one or other biorhythms has not only of theoretical interest, but also of practical importance, especially for physiotherapy and physiopuncture. It is no accident that the subsection «chronomedicine» stands out in modern medicine as part of chronobiology (Fig. 5).

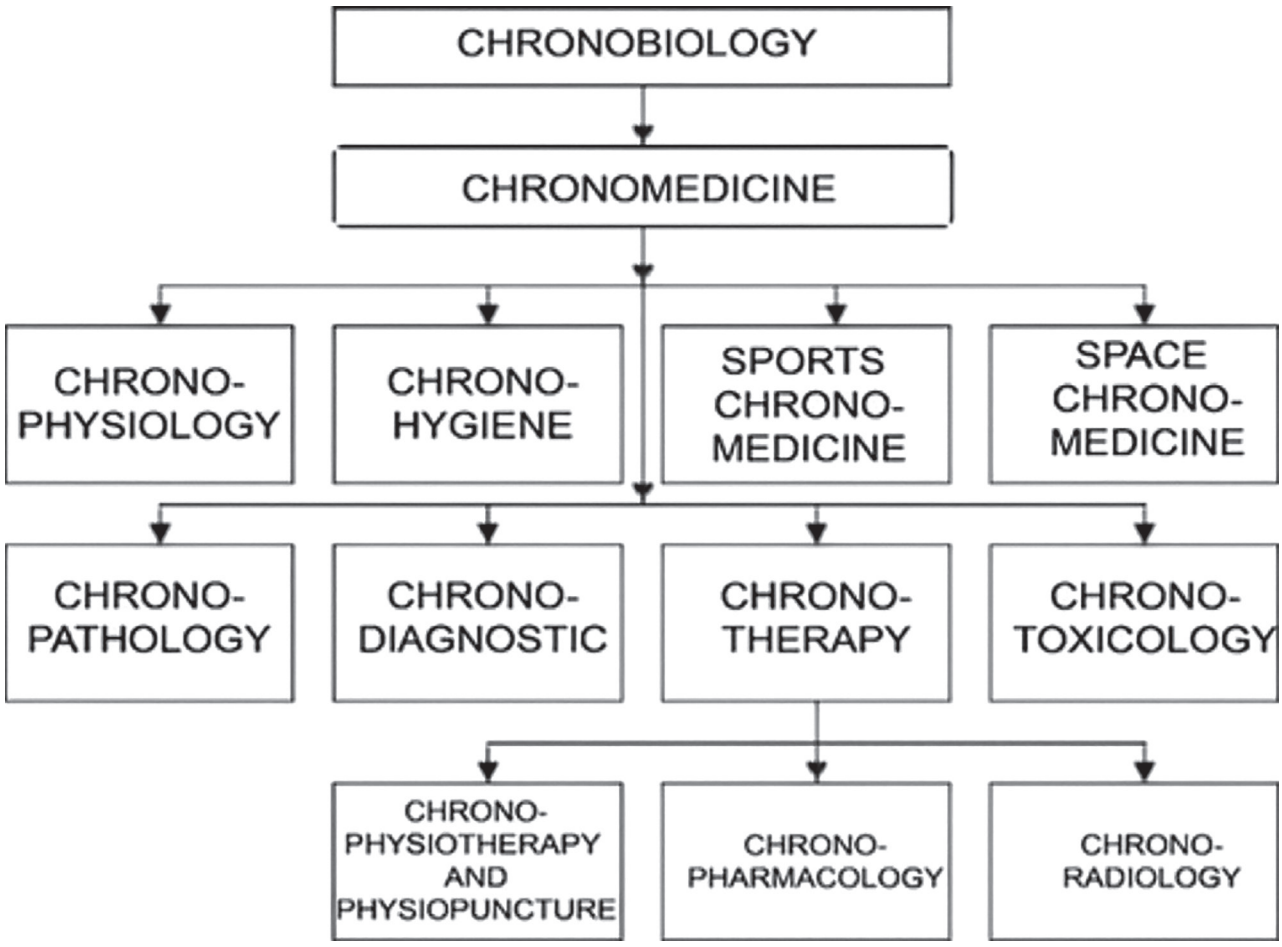


Figure 5. The Components of the chronomedicine in a section of chronobiology.

In the modem tactics of physiotherapy and physiopuncture (acupuncture, reflexology) the choice is not only the zones and method of the impact, but also the optimal time of the medical procedures.

Effective therapy is only possible at the individualization of therapy for each patient, which involves a detailed study of the original condition of the body, under which the patient's condition should be understood in a certain period of time (especially in the period of treatment) with strict regard to its individual features of the disease, the prevalence of a particular syndrome etc. The entire range of therapeutic measures is built on this data, including physiotherapy. To understand the cyclical course of many diseases is important to teach the doctors about practics of the Ancient East practics about the time of activity and passivity meridians (Table 3).

Table 3. Theimpacton the actual sedative, tonic-point andon thepoint accomplices according to the hourly relationship of the rhythm (for I.Manaka, I. Urquhart, 1979, with amendments) [2,3,4,14,15,19].

Meridians	Activity period		Refluence period		Inaction period		
	Time, h	Sedative point	Time, h	Toning point	Time, h	Toning point	Point-to-aider
Lungs	3-5	P(I)5	5-7	P(I)9	15-17	P(I)9	P(I)9
Large intestine	5-7	GI(11)2	7-9	GI(11)11	17-19	GI(II)11	GI(11)4
Stomach	7-9	E(III)45	9-11	E(III)41	19-21	E(III)41	E(III)42
Spleen & Pancreas	9-11	RP(IV)5	11-13	RP(IV)2	21-23	RP(IV)2	RP(IV)3
Heart	11-13	C(V)7	13-15	C(V)9	23-1	C(V)9	C(V)7
Small intestine	13-15	I G(VI)8	15-17	IG(VI)3	1-3	IG(VI)3	I G(VI)4
Bladder	15-17	V(V11)65	17-19	V(V11)67	3-5	V(V11)67	V(VII)64
Kidneys	17-19	R(VI11)1	19-21	R(V111)7	5-7	R(VI11)7	R(VI11)3
Pericardium	19-21	MC(IX)7	21-23	MC(IX)9	7-9	MC(IX)9	MC(IX)7
Three cavities of the trunk	21-23	TR(X)10	23-1	TR(X)3	9-11	TR(X)3	TR(X)4
Gallbladder	23-1	VB(XI)38	1-3	V B(XI)43	11-13	VB(XI)43	VB(XI)40
Liver	1-3	F(X11)2	3-5	F(X11)8	13-15	F(X11)8	F(X11)3

The modem interpretation is consistent with the notion of circadian (daily, about daily) rhythms. This evidence about the hourly daily activity of meridians coincides with modem data on the functional activity of internal organs and body systems. Thus, the summary data on accidents and injuries in Kyiv and the region show that in the morning (from 3:30 to 6:00) the most frequent calls are to patients with bronchial asthma attacks, in the evening (from 17:00 to 20:00) – to patients with kidney pathology, and at night (from 23:00 to 3:00) calls to patients with gallbladder and liver pathology predominate. It actually corresponds to the time of maximum activity of the meridians of the lung, kidney, gall bladder and liver. Features of the functioning of organs and systems of the body throughout the day associated primarily with the change of day and night It is obvious that there is no need for the work of all organs and systems of the body throughout the day. The nature of the process of evolution has provided the activity or inactivity of a system (the body) in most suitable time frame for the body. From this moment it becomes clear how active the large intestine is (5-7 hours), since after active work (hunting in primitive people, animals – at the beginning of the day) the digestive tract must be emptied. Then became too active the gastric channel (79 hours), presumably, this time was the most frequent for ingestion of food, which evolutionarily had established. Then, in the hours following the meal, the channels of the spleen, pancreas, etc. are activated, which explains the maximum activity at certain hours in other meridians.

Thus, the liver channel is most active at night (1 to 3 hours), that is, while the parasympathetic nervous system (trophotropic) dominates over sympathetic, the liver's role in these processes is well known. Empirical data were found that confirm the information of doctors about the lung channel activity (from 3 to 5 hours), as it is in these hours (± 1 hour) is most pronounced predominance of the parasympathetic part of the autonomic nervous system. It is known that the role of the meridian of the lungs, in the occurrence of asthma attacks.

In recent years, interest in the characteristics of the daily functioning of organs and systems has increased significantly among European doctors. This is due to the need to study the rhythm of task completion by people (Fig. 6).

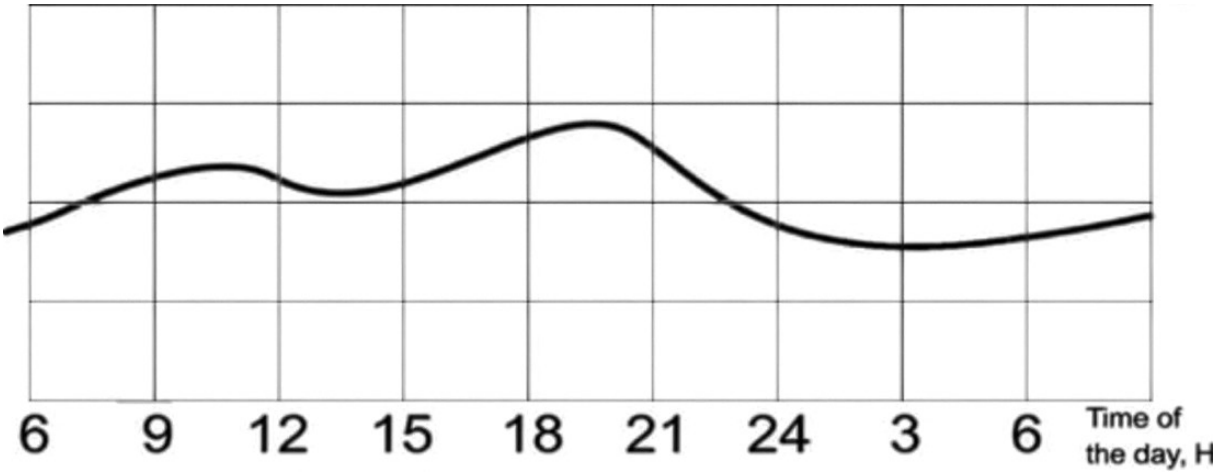


Figure 6. The daily rhythm (medium type) human performance (by N. Aghajanian, 1980) [15].

Information about the rhythm of the body's functions is of great value to medical practice, because they may refuse from a generic approach to the prescribing of 1 tablet 3 times a day.

R.M. Zaslavskaya et al. (1987) [15] showed that each patient has its own rhythm in blood pressure rise. Once this is established, your doctor may prescribe a drug for 1-1.5 hours before the expected «jump» in a more doses, but only once a day. The average dose with this scheme is 2.5-3 times less than the usual. A.Reinberg, one of the founders chronopharmacology, straight points out the dependence of the therapeutic effect and toxicity of drugs on time of day. There is also other evidence of periodic increasing or decreasing the activity of the organs and body systems.

Knowing these facts, optimally select time of the appointment of a drug, and in relation to physiopuncture (reflexology) and time of the session. For example, when treating asthma, it is important to arrange so that the maximum concentration of drug in the blood was observed by the time the intended attack, which may prevent it. In such cases, reflexology (prolonged exposure in the form of micro-needles, tsubo, magnitoforov, etc.) is used. The patient can massage the own imposed micro-needles in day before the alleged astma-attack to prevent it.

Folk Eastern doctors believed that acupuncture sessions carried out on the eve of the attack is a «fight against tainted energy» that is, preventing an attack by harmful energy dissipation. In classical acupuncture, it is considered that the greatest sedative effect on the meridian is reached during the period of its activity, and the maximum tonic effect is achieved during the low tide, that is to say in the next 2 hours after a period of activity passed, or in the period ofinactivity.

D.M. Tabeeva (1980) [2,14,15] gives the following example. If, after the diagnosis by acupuncture revealed and if the patient needs to toning the channel of heart meridian, then for the patient with heart disease is best to do a session of acupuncture in 13-15 hours or 15-17 hours, rather than every 11-13 hours. If a patient needs to sedation of the channel of heart meridian, is best to do a session of acupuncture in 11-13 hours. In the Table 3 presents data on the effect on the sedative and tonic points, hourly according to the relationship of rhythm.

The knowledge about the rhythm of the organs and systems of the body helps the doctor to accurately select the optimum time of treatment. In some cases, it is possible to prevent the attack (eg, asthma), in the other – to find the optimal time to strengthen the function of a specific organ or system. For example, for the treatment of chronic colitis with constipation optimal time for physiotherapy is the morning hours (7-9 hours).

To achieve maximum sedative and tonic effect in regularly recurring attacks, such as migraine, at one and the same time (23 hours), you should not wait for this time to work on the point VB (XI) 38 (the optimal time for sedation in the meridian of the gallbladder).

In this case, it is advisable to use the recommendation «fight against tainted energy» because attack is easier to prevent than to stop. Therefore, in such cases, individual income is required.

Knowledge about activity and inactivity of the meridians (organ systems) has a certain value in both – in the European medical tradition and in the diagnosis of acupuncture. For example, research on blood glucose contents conducted on the maximum channel activity of the spleen and pancreas (9-11 hours) and revealed upper bound glucose values. There are no reasons to exclude diabetes in such cases, because during the activity of the channel, is marked spontaneous lowering blood glucose to a minimum level. The same applies to the study of functions of the stomach where the conclusions about a decrease or increase in its functions without taking into account the time of the research are difficult.

If, over a period of time (week, month, year), a patient experiences worsening heart condition or heart attacks at a certain point in time, for example, from 11:30 am to 12 am, a dysfunction of the cardiac canal can be suspected. It is known that the development time (maximum severity or worsening) of a disease depends on compensatory possibilities of the system. Thus, diseases that occur with signs of hyperfunction (excess), will be sharply active in the hours of maximum daily activity of the system, and diseases that occur with signs of hypofunction (lack of) are more pronounced in the hours of minimum activity of the system.

Thus, knowledge of the characteristics of the daily activity of organs and systems of the body helps not only diagnose diseases (including conduct acupuncture diagnosis), but also to choose the optimal time of a medical treatment and physiotherapy. Currently, more than 300 physiological processes are known to undergo daily rhythmic fluctuations. Biorhythms are not limited to daily fluctuations, and as outlined above, known month (lunar), seasonal, related to solar activity and other changes biorhythms.

Consideration of these rhythms, which mainly relate to the rhythms of the average frequency, meso- and macro-rhythms, is paramount in choosing the time of treatment or prevention of a disease at a particular time of day, week, month, season, etc. For example, for the prevention of exacerbations disease of liver and gallbladder in winter, spa treatments or physiotherapy are preferable; of the cardiovascular system – in the spring, of the bronchopulmonary system – in summer, of kidney – in autumn, etc.

Each organ is a complex rhythmic structure, characterized by a set of oscillating processes, differing in frequency and amplitude.

The presence of oscillatory processes allows for the development of new functional and dynamic links, depending on the specific needs of any organ system, or whole organism, which is important in the formation of adaptive reactions.

In general, to get the maximum effect it is necessary to achieve resonance effect (it must be remembered that the organs and systems resonate not only to fluctuations in external factors that coincide with the natural frequency, but also on the fluctuations which are in multiple regard to them).

A popular explanation of the resonance effect can serve as a classic example of two tuning forks. If you take two tuning forks of the same sound «La» or «Si» and one of them is set stationary and the second to give the sound and put side by side, the sound starts after a few seconds of the first. This is the original variant of the same resonance tuning forks, which does not occur if the tuning forks have of different sound – «Do» and «Si», etc.

The biological response is the result of the sharp increase in the amplitude of the fluctuations in the biological system when subjected to forced vibrations at a frequency of the system outside; gradually approaching the one that is the system has inside.

Achieving a "resonance effect," when external oscillatory processes (physical agents) coincide with the internal, it is an important and quite solved task.

It has been established that most disease begins begin with arrhythmia, with possible formation of the subsequent pathological process of functional system, and then certain organic changes.

According to modern concepts, the development of the pathological process can be divided into 3 stages passing:

1. Violations in the informational or information-energy level of interaction.
2. The occurrence of a temporary error or disruption of the rhythm of the work.
3. Metabolic and structural disorders.

Therapy without frequency modulation acts mainly on the last stage, which is undoubtedly important.

However, normalization the rhythm of the body, tissues, cells, or an integrated system is important in the treatment process for the recovery of their functional state. In these cases, it seems essential to choose the frequency characteristics of such effects, which would be made close to the frequency of oscillatory processes in the affected organ, tissue or system.

In such cases, one can expect resonance: changes in the functional system of the body with its characteristic frequency and the impact frequency. Naturally, such characteristics of the coincidence frequency (reaction) will contribute to a more rapid restoration of functions, and subsequently the structure of the affected organs.

Consequently, the selection of appropriate frequencies during physiotherapy or physiopuncture is an important component in the treatment process. It is known that the low-frequency processes which are predominate, are reflecting the state of the functional-dynamic system and its metabolic status in the organs and systems of the human body.

Table 4 shows some endogenous rhythms of human, grouped by E. Kushnir [5](with amendments).

For example, on the electroencephalogram (EEG) the basic rhythm of a healthy person – alpha rhythm, its frequency ranges from 8 to 13 Hz (10 Hz on the average). In certain diseases of the central nervous system, when the percentage of the alpha rhythm is reduced as compared with the other (delta, beta, theta) rhythms and the modulation frequency it is recommended to use 10 Hz ± 0,7.

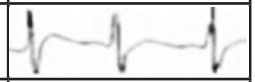
It has been observed that when the violation of cortical impact neurodynamics, we can take the red laser range (0.63 m) to the point MC (IX) 66, and with early frequency modulation, this leads to the restoration of the alpha rhythm in the occipital and parietal lobes of the brain in 3-4 sessions, whereas with frequency modulation, a minimum of 8-10 laser puncture sessions are required to achieve this effect.

With this in mind, for all diseases associated with impaired cortical neurodynamics, we recommend setting the modulation frequency of 9.4 Hz and act simultaneously on three areas:

- in the medulla oblongata area using magneto-red emitter;
- the corresponding spinal segments using magnetic infrared laser emitter;
- in the area of the affected organ using an ultrasonic emitter.

When peripheral paresis or paralysis (neuropathy), it is also recommended to use low frequency (18, 37.5, 75 or 10-100 Hz), because higher frequencies are limiting for learning neuro-muscular system (Table 4).

Table 4. Major human endogenous rhythms.

Physiological Rhythm	**Type of Rhythm / Process**	**Period (T), s**	**Frequency (F), Hz**	
Brain rhythms	Alpha (α) rhythm	0.12–0.07	8–13	
	Beta (β) rhythm	0.07–0.03	13–35	
	Theta (θ) rhythm	0.30–0.14	3–7	
	Delta (δ) rhythm	2.0–0.30	0.5–3.0	
Respiratory rhythm	Breathing cycle	≈ 3.3	≈ 0.3	
Cardiac rhythm	Cardiac cycle	≈ 0.8	≈ 1.25	
Muscle activity	Average frequency of muscle bioelectric currents	0.008–0.03	33.3–120	
Nerve conduction	Impulses along nerve fibers	0.01–0.016	62.5–100	

Notes:

T — period [seconds]

F — frequency [Hertz]

Values represent physiological ranges typical for healthy adults

Endogenous rhythms form a hierarchical system of neurophysiological and psychophysiological regulation

When the low-frequency pulse make action, it is necessary to remember, that the length of the main enzymatic processes does not exceed 3-25 seconds (necessary dark period). Therefore, the minimum interval between the pulses of the impact should be at least 0.001 seconds, in order not to interfere in the already running enzymatic reactions. This corresponds to a frequency up to 1000 Hz (V.E. Illarionov, 1994) [1,2,3,4,5].

The materials of the French association of «soft» lasers «The Lazer Focus» (1982) contains information about the root of many rhythmic processes in the body is the «functional» (universal) frequency – 1.2 Hz (1.14 Hz), the multiplicity to which are detecting in many functional systems. This is the rhythm of cardiac activity: 72 beats per minute (1.2 Hz r 60 = 72). The modulation frequency of 1.2 Hz is recommended for use in the treatment of focal infection, and twice as likely (2.4 Hz) in the treatment of rheumatic diseases and the impact on sedative acupuncture points. Alpha-rhythm and rhythm tremor, affecting capillary blood flow and vascular elongation – 9.4 Hz.

The same frequency is most effective when used in traumatology and for tonic effect on the acupuncture points it affects (enhances) the capillary blood flow.

18 Hz – effective when subjected to signal on points (heralds) and for excitation of the energy channels (V.E.Illarionov, 1994) [1,2,3,4,5].

37.5 Hz is the the frequency of physical blocking calcium channels – for diseases of the neuromuscular system and for influence on the point of entry meridians.

75 Hz is the frequency of analgesic action, as well as the frequency of impact on the exit points of the meridians.

1-10 Hz is the frequency is suitable for the treatment of chronic diseases and for stimulating regeneration.

10-100 Hz expedienttoapply to use in the case of organicpathology of the central nervous system and, if necessary, to cause vasodilation large diameter (Z. Gamuszewski, 1995) [1,2,3,4,5]..

The effects of modulated impact of low frequencies is used mainly in the distal acupuncture points, points signaling, and sympathetic points.

These recommendations are consistent with the classical ideas about the phenomenon of the propagation velocity of the PSC (propagated sensation through the channels) along the meridians component is 3.3-3.6 cm/s (Zhang Jin, 1979) [1,2,3,4,5].. The relatively low rate of spread of the phenomenon of the PSC (slow wave processes) requires adequate exposure, that is, the use of lower frequencies, calculated in units or tens of hertz. The exposure of high frequencies (hundreds of hertz) will not be perceived as frequency fluctuations of the meridian system, that is, the response of the system to the exposed of high frequencies or continuous radiation will actually be the same type.

Based on various sources and experience with the «MIT-11» device, it can be recommend the following frequencies for local action (Figure 7).

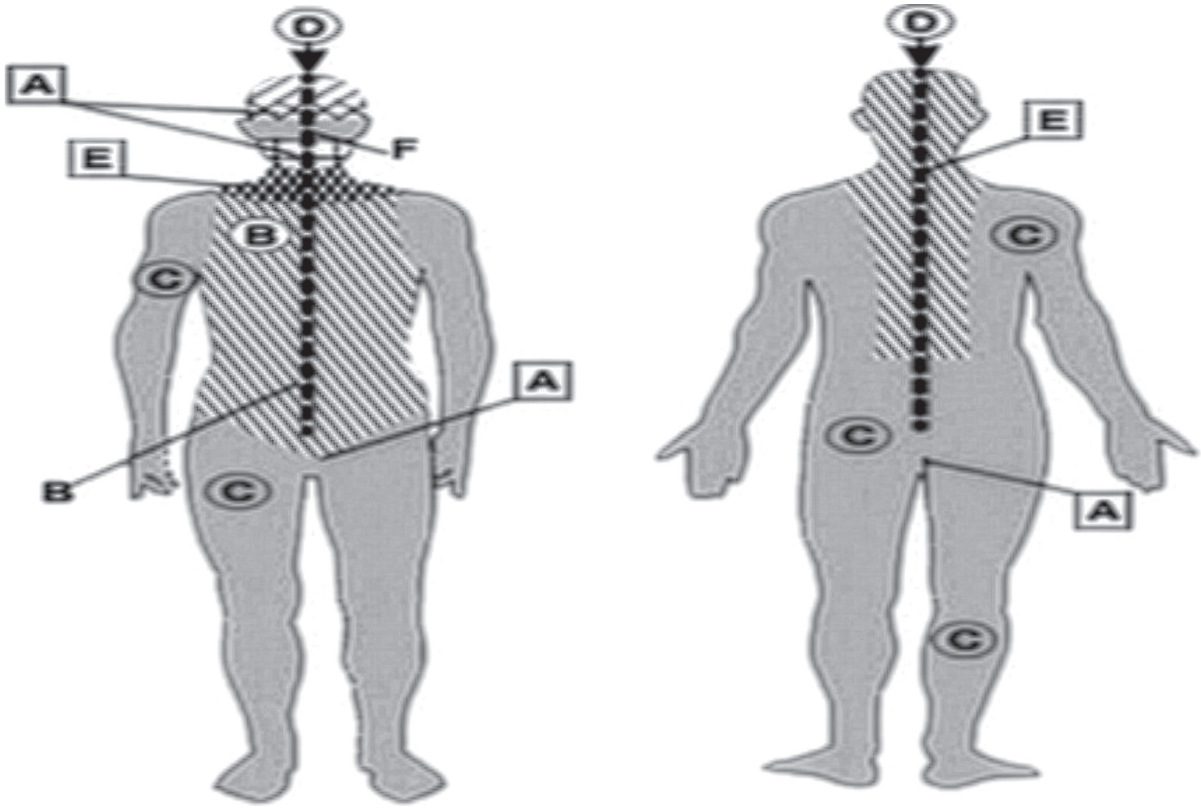


Figure 7. Frequencies therapeutic effect for various areas of the body by P. Nogier (1987):

U = 1,2 Hz (universal basic frequency);

A = 2.4 Hz, the mucous membranes of the lips, nose, inner ear canal, perineum (the mucous membranes of the genitals and rectum), the front surface of the chest (on the collarbone), the stomach;

C = 9.4 Hz triangular and navicular fossa, and anthelion antitragus the ear, upper limb with shoulder girdle, lower extremities with pelvic girdle;

D = 18 Hz, front and rear median lines (meridians);

E = 37.5 Hz, middle and lower third of the curl of the ear, the front of the neck from the lower jaw to the clavicle, head (forehead and nose to the eyebrows) and the rear surface of the head, paravertebral zone to the lumbar (L3 vertebra level);

F = 75 Hz base of the ear lobe, the person (on the level of nasolabial junction and the entire lowerjaw).

It should be keep in mind that the selection of the modulation frequency in the treatment of various diseases is individual.

The probability of the high rate assimilation directly into the tissues and cells of the patient's body is higher than the peripheral structures. In this regard, the obvious fact that the local area (the area-affected organs) necessary to act with high modulation frequencies (from 10 to 100 Hz) and the acupuncture points on the distal – low frequency (1 to 10 Hz).

Such an approach, according to our information, is optimal for the treatment of many diseases, especially chronic course.

Table 5 shows the resonant frequency of the therapeutic influence in some pathological disorders.

Table 5. The resonant frequency of the therapeutic influence, in some pathological disorders.

Frequency, Hz	Diseases, conditions, syndromes, symptoms
1,2	The universal or basic frequency (the frequency of «superdelta» - the frequency of the heart rhythm). The main indications: Diseases of the cardiovascular system, especially accompanied by heart palpitations, inflammation and autoimmune diseases, focal infection. Cardiopsychoneurosis.
2,4	Universal frequency, multiple (1.2 Hz), and enters the delta range (0.5-3 Hz) of biocurrents affect the brain. The delta wave frequency of the brain have a sedative effect and promote the normalization of physiological (delta) sleep with insomnia. Stimulation of hormonal function in women (hypermenorrhea, mennoragiya, uterine fibroids). Dyskinesia of biliary tract, kidney disease, fatigue (tiredness), sinusitis and headache associated with it, bruises, injuries from bruises, infectious and toxic liver disease, rheumatic diseases.
9,40±0,5	The frequency of spectrum of the alpha rhythm (8-13 Hz) of brain biocurrents, the frequency of tremor of capillaries and frequencies that are multiples (0.1 Hz), alpha-rhythm of circulation. The resonant frequency of the release of ions. Increased efficiency due to normalization the neurodynamics of the brain. Other diseases and symptoms: headache of various origins, essential hypertension, accompanied by angina, respiratory disease (obstructive bronchitis), insufficient function of the endocrine glands (diabetes, impotence), adnexitis, prostatitis, cystitis, tonsillitis, peptic ulcer and 12 duodenal colon and other.
18,75	Diseases of the musculoskeletal system, phantom pain, burns, ophthalmic practice in patients with lesions of the cornea, acute respiratory infections.
37,5	Frequency of physical blocking of calcium channels (Ca2 +), and diseases associated with this process (instead of antihypertensive drugs, calcium channel blockers, to reduce the spastic muscle tone - post stroke patients, cerebral palsy, poorly healing fractures, etc.). Diseases of the neuromuscular system, dlyasnizheniya weight, in violation of thermoregulation, tonsillitis.
75	A universal frequency of analgesic, it has antidepressant effect, reduces fear, strengthens kidney function. It stimulates the «color» vision, and it is also recommended for diseases of the respiratory system, increases the content of leukocytes in the blood, and stimulates lymphocirculation.
1-10	Scanning frequency (LF «swing») helps the body recover from physical and mental overvoltage (asthenic gipofunktsionalnye and condition of the body), diseases of the cardiovascular system and parenchymal organs.
10-100	Scanning frequency (midrange «swing») has a sedative effect and normalizes hyperactivity conditions associated with neurotic disorders.

Studies has shown that each component of the functional system is unique to its own frequency range (biorhythm), which is associated with all spatial and temporal organization of the body. And this is true not only for the system, organs, cellular and intracellular structures, but also for the individual chemical components of cells, for example – lipids and nucleic acids. As a result, biorythmological activity has different levels between a strict mutually synchronized frequency phase and amplitude relationships.

Our bodies are equipped with most perfect synchronizers, where in addition to the nervous system and play a role other code-synchronizers. For example, a ciliate shoe, with no nervous system, lives, feeds, breeds, and all of these complicated processes are not chaotic.

Probably biorythmological (code-frequency) control is the most ancient (primary), inherent in the simplest forms of biological objects, but have not lost their importance in the complex organisms in connection with the superstructure appeared – the humoral and neural regulation.

In the body, there are approximately 1015 cells (a million billion) and each of them has a specific function, is clearly interact with each other. The ability to fully manage this armada can not afford even the nervous system, which is only about a few billion cells [20]. It is natural to assume that each of the biorhythms, possessing a certain autonomy or its own biorhythmological activity in the general scheme, is subject to control signals from a certain «control organ», that is, from the heart rate.

Systemic or organ rhythms cover organs, systems and organism as a whole, whereas the «molecular» (code-frequency) are present in the structure of the cell and the cell itself.

In humans and animals, it is probably the union of a set of pacemaker cells that obey a common pacemaker, and the latter is synchronized with the external periodic processes (A.E. Kushnir, 1999) [6]. For the de-synchronization of rhythms (of the disease) or their recovery, an important principle of biogenesis, which suggests the possibility of a quantized code transition of bio-system from one state to another , which is characterized by spasmodic or erratic.

According to this concept, any physiological variable, including heart rate should return after a disturbance to the value corresponding to the state of stable equilibrium, and the variations in heart rate – it just temporary responses to environmental fluctuations (Le Chatelier-Braun principle). However, during illness, it becomes more difficult to maintain a constant heart rate and its amplitude variation increases.

It was found that the heart and other physiological systems, when the body is young and healthy, can act abruptly, showing elements of chaotic behavior, and more regular operation, which is described as continuous functions are associated with aging and disease, so irregular and chaotic behavior are very important characteristics of the health. Reduced variability and frequency of symptom occurrence are often associated with many diseases.

Therefore, along with the widely known system of biological circadian clocks, chaotic dynamics arise in response to constant periodic changes in living organisms.

These billions of nerve cells vary in structure, although they are similar to each other. At the same time, our nervous system is capable of varying, highly diverse specific activities. What is the reason of such specifics? It was found that the cause lies in the molecular organization of the surface of nerve cells in the presence of each type of neuronal cell specific set of very complex molecules. Finding ways to influence these moleculesand, accordingly, the certain functions for which they are «responsible», it need to be addressed in various ways, including the one for which the resonant frequencies (Fig. 8).

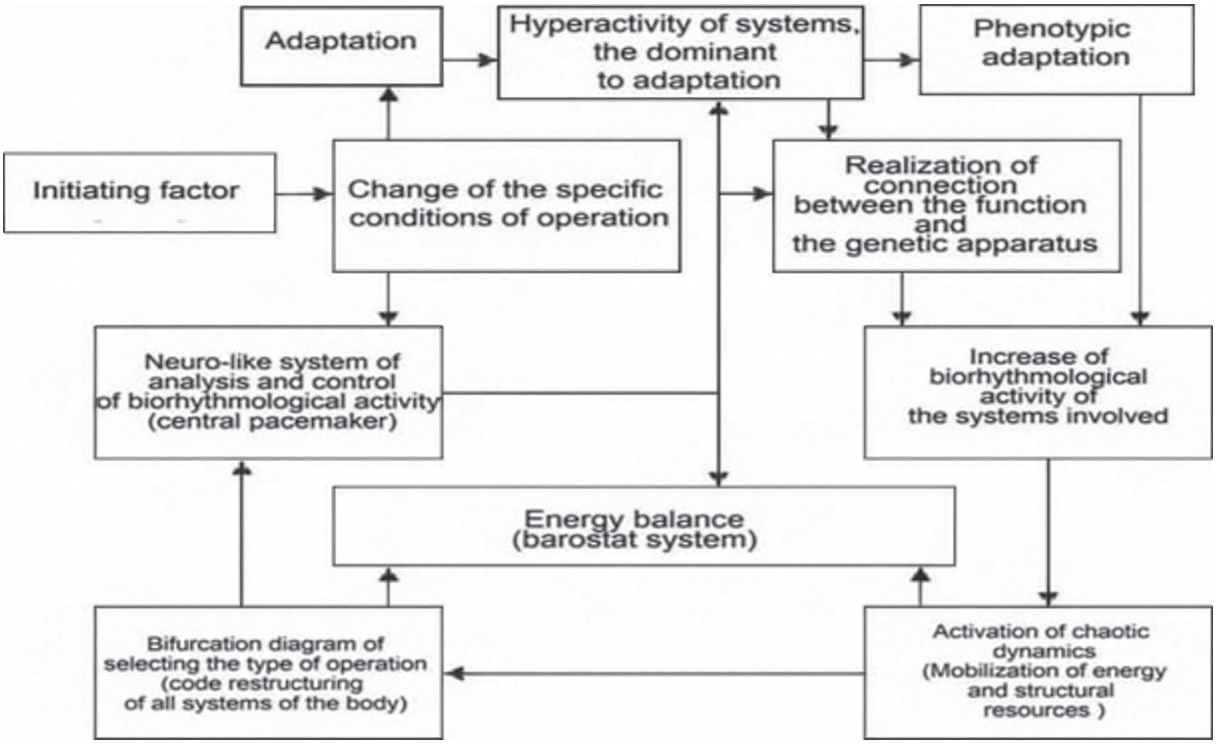


Figure 8. Functional diagram of the frequency-code control (AE Kushnir, 1999) [6].

Any functional system, organ, and even cells have a certain autonomy, but functional and structural reorganization of any system in the body is consistent the change of biorhythmological activity of functionally related systems.

Possible fluctuations in the activities of biorhythms of specific functional systems are in strict accordance with its function, structure and reserves free of ATP cellular energy and determine its physiological corridor and adaptive capabilities.

The exit from a pathological condition is carried out by successive saccadic bifurcation transitions from one biorhythmological state to another.

When we talk about the influence of physical factors, we need to know the essential parameters of the integrated spatial-temporal spectrum of it, which in some cases can serve as a pacemaker of the required rhytm (the etalon-informative role of natural factors in its appropriate parameters).

Figure 9, by A.E. Kushnir (1999) [6], shows the variability of the chaotic dynamics of the system around the stable area (1), characterized by a strange attractor, with an abrupt transition (bifurcation point B1) to a new state in the area of sustainable limit activity. In the future, the system successively passes through an unstable state of bifurcation (point B2-B3) to a state with reduced biological activity. As can be seen from the figure, the higher the level of biological activity, and then higher the level of variability chaotic dynamics of the system. As the level of variability decreases (point B4), an unstable zone (5) appears, characterized by pronounced periodicity and a limit cycle in the phase plane. The further evolution of the system is associated with the mobilization of its energy and structural resources, with the obligatory selection of one of the possible stable states (or reduced activity zone or pathological zone).

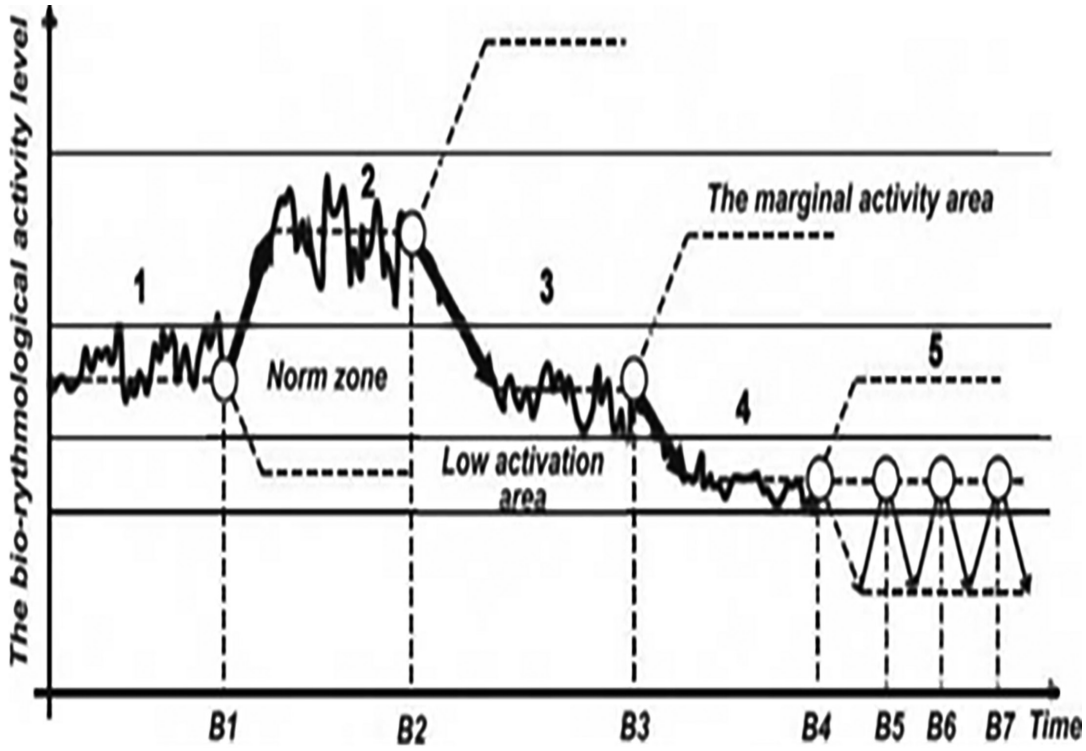


Figure 9. The dependence of variations of chaotic dynamics of the system from time to time. (A.E. Kushnir, 1999).

Naturally, the process of exit of the biological system from the pathological condition requires ATP – a cellular energy reserve, which in an integrated system of organism are regulates by the general homeostasis system. The most effective way of targeted reallocation of existing resources of the reserve, in terms of their pathological deficit is the direct transformation the action of external energy.

Figure 10 shows two ways of maintaining the power of cells. First, there is a serial conversion of solar energy into chemical energy by photosynthetic organisms, followed by converting the energy and transportation materials in the cell structure in the form of ATP. And the second – straight external energy transformation in biological cells – works through bioresonance stimulation (A.E. Kushnir, 1999).

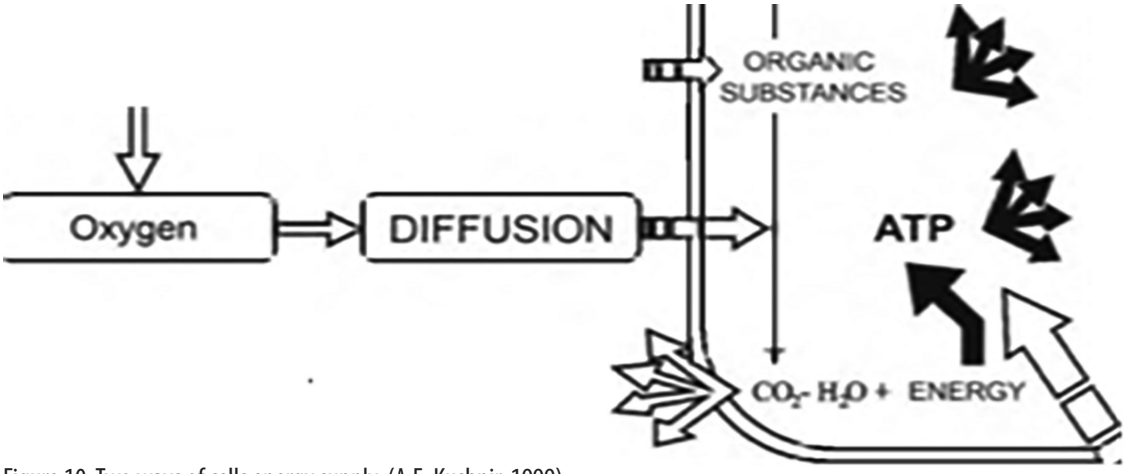
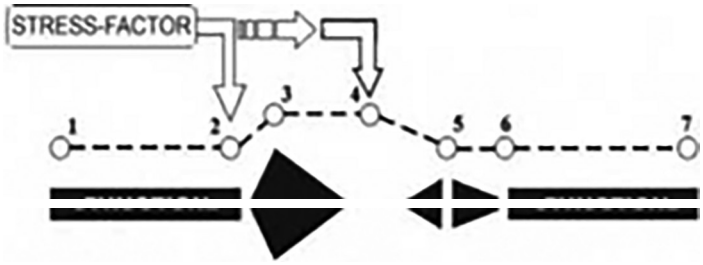


Figure 10. Two ways of cells energy supply. (A.E. Kushnir, 1999).

Figure 11 shows a diagram of the possible formation of pathological dysfunction due to exposure to stress factors and restore functions with adequate bio-resonance therapy (A.E. Kushnir, 1999).

Supplementation with free external energy, without compromising the overall orientation of the functional systems of the body, has a stimulating and normalizing effect on energy balance, blood circulation and lymph flow, metabolism, redox processes, membrane transfer, development of regulatory peptides, helps to normalize the tone of the autonomic nervous system, increase elasticity vessels and in general increases the adaptive ability of the organism. As a general rule, the final result of treatment is the restoration of structural and energy ties, as well as lost body functions. An example of the «resonant interaction» of physical factors and some of the structures of a biological object is magnetic resonance imaging (MRI), one of the most informative diagnostic methods. The main contribution to the observed signal is a nuclear magnetic resonance (NMR), which allows the identification of water protons – intra- and extracellular, low hydrogen-containing molecules, and molecules with high mobility, for example, the lipids that make up the fat tissue. The very intensity of the NMR signal is provided by the spin relaxation time of water protons under the influence of the radio-frequency pulse voltage of more than 2 MRI. Relaxation characteristics are mainly determined by the interaction between itself and spins, respectively, with the environment, and their mobility (frequency fields generated in their motion).



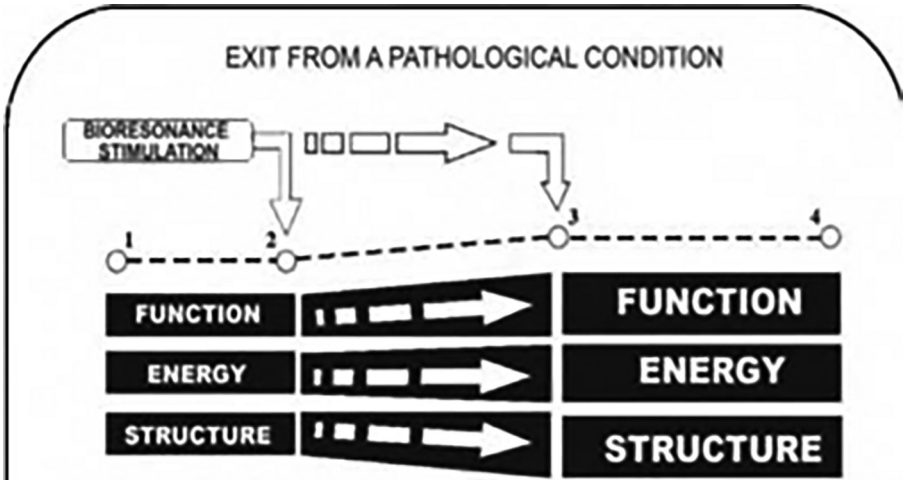
(t – 2) the initial level of compliance functions and structures (2 – 3) phase of urgent adaptation

(3.4) phase of the marginal activation and the formation of desinhroz V

(4 – 5) bifurcation phase, (5) * bifurcation point

(S – 6) narrowing the corridor adaptation (disadaptative)

(6 – 7) the formation of pathological dysfunction



(1 – 2) Me initial level of compliance with functions and structures

(2 – 3) the accumulation of free energy

(3 – 4) expansion of the adaptation of the corridor and out of the pathological zone

Figure 11. The process of forming dysfunction and restoration of normal functional state.

For NMR, it is important the essential matter content in biological tissues of the compounds which are having the so-called, paramagnetic properties. The latter refers to such substances, whose total magnetization (the sum of the dipole moments) oriented towards the external a magnetic field (MF) and amplifies it (F. Bloch et al., 1946) [3]. A characteristic of the paramagnetic properties of substances is the presence in it of unpaired electrons and nucleons, respectively. Electrons, in the same way as the nucleons, have spin angular momentum-own movement and its own magnetic moment. The magnetic moment of an electron is 800 times higher than the value of the proton and therefore has a significant effect on the magnetic properties of paramagnetic element (F. Bloch et al., 1946) [2].

Elements that have paramagnetic properties have unpaired electrons and are characterized by significant largest magnetic moment. This class includes metals such as Mn^{2+}, Fe^{3+}, Ni^{2+}, Cr^{3+}, Co^{3+}, Cu^{2+}, Ti^{3+}, in which the paramagnetic properties are most pronounced, as well as elements of the rare earth group as Gd^{3+}, Eu^{2+}, Du^{3+}. Some of the latter (Gd^{3+}), are used as contrast agents in MR imaging. Since the paramagnetic substances have a large dipole moment, they contribute to the transfer of energy from the excited nuclei in the atomic lattice, and at the same time increase the heterogeneity of the magnetic field.

These data about NMR indicate a significant effect of the possibilities of physical factors act on the molecular-atomic levels of biological objects, causing them to predictable changes. These data are confirmed by the so-called ion-parametric magnetic therapy (G.N. Ponomarenko et al., 1998; S.M. Zubkova et al., 1998; 2000) [14,15,19,20]. Thus, until recently, the mechanisms of registered medical effects of magnetic therapy, most authors associate exclusively with the emerging vortex electric fields, leading to the formation of closed conduction currents (A.N. Kuznetsov, 1994) [3,14,15,16,20].

However, the level of energy of the magnetic interaction between the ions and biological molecules (10^{-19}J) is 3 orders of magnitude lower than the energy of thermal motion of disordering (10^{-16}J) and clearly insufficient to change their orientation in space (A.R. Liboff, 1985) [1, 14,15,19,20. The linear model which exist now can not explain the paradox of «energy». In this regard, it is difficult to predict the specificity and importance of the therapeutic effects of low-frequency magnetic therapy, as confirmed by clinical observations (A.M. Demetsky et al., 1991) [2,14,15,19,20].

In the last decade, another non-linear model of interaction of weak magnetic fields with biological systems has been proposed, in which the direct target of selective action of weak magnetic fields are cations. Thus, the model of the «cyclotron resonance» implies that the motion of ions along a helical path at accelerating cyclotron frequencies are defined by mutual influence of the parallel component of the DC and AC magnetic fields, the latter provides a selective energy absorption and increases their speed of movement in the ion channels of biological membrane (V.V. Ledneo, 1991) [2,4,14,15,19]

Subsequent analysis showed that an increase in the probability of displacement the cations through the biomembrane can be achieved without external «pumping» energy into a-protein complex ion channel, and by periodically changing the kinetic energy of moving thereon cations.

This model of «ion parametric resonance» (IPR) suggests that the primary link in the chain of cooperative reactions of biological systems is the Ca^{2+} ion, specifically associated with the Ca^{2+} binding the centers of proteins and which is a messenger action of various stimuli on the metabolism of cells and other cations capable of modulating the kinetics of cell metabolism of enzymatic reactions (V.V. Lednev et al, 1996) [2,4,14,15,19].

The model of ion parametric resonance (IPR) suggests that a key element in the chain of cooperative reactions in biological systems is the Ca^{2+} ion, which is specifically associated with calci-

um-binding sites of proteins. Calcium ions act as universal intracellular messengers, mediating the effects of various external stimuli on cellular metabolism. In addition, other biologically relevant cations are capable of modulating the kinetics of enzymatic reactions and cellular metabolic processes (Lednev et al., 1996) [2,4,14,15,19].

This model is based on the effect of ion parametric resonance occurring when the vectors of the constant magnetic field (B_{dc}) and the alternating magnetic field are oriented in parallel. Under these conditions, IPR can be observed when the amplitude of the alternating magnetic field is comparable to the induction of the Earth's static magnetic field (approximately 40–70 μT).

The resonance frequency of the alternating magnetic field that induces ion parametric resonance is determined by the following expression:

$$f=q B_{dc}/2\pi n m$$

where:

- f – resonance frequency of the alternating (variable) magnetic field (Hz);
- q – electric charge of the ion (C);
- m – mass of the ion (kg);
- B_{dc} – magnetic induction of the constant (static) magnetic field (μT);
- n – valence of the ion (an integer equal to 1, 2, 3, …).

By now, there are a sufficient number of experimental studies confirming the phenomenon of selective activation («oscillation buildup») of different cations atthe frequencies corresponding to their IPR (the principal possibility of modulation cation mobility in biological membranes). At the same time, depending on the magnetic field parameters that meet the conditions of the IPR of various ions, it is possible to modulate the associated mobility (according to the electro-diffusion equation of Nernst-Planck) cation flux across the biological membrane and the likelihood of their distribution between lipid and aqueous phases, is calculated according to Bourne.

The study conducted by G.N. Ponomarenko et al. (1998) [2,15], was made to evaluate the possibility of therapeutic use of the phenomenon of IPR and clinical testing based on it a fundamentally new method of magneto-ion-parametric magnetic therapy. The source of its energy was the «Effect» machine (production RNIITO name R.R. Vreden). It consists of two inductors and a control that contains a control voltage source DC and AC magnetic field and magnetometer with a remote transmitter (accuracy of 0.01 mT). The analysis of clinical effectsconducted by the authors was carried out in groups of patients with a disease in the pathogenesis of which play a leading role violations exchange of Ca^{2+}, – heart disease, vascular and musculoskeletal system.

These results are show positive results of the feasibility of introducing IPR magnetic therapy and complex treatment of patients with diseases of the circulatory system and the musculoskeletal system. The mechanisms of action of the magnetic field, parametric resonance, causes Ca2+ ions, brings the system of ion channel in an unstable state and the strengthening of small amplitude fluctuations of ions, which are inevitable in such an oscillating system, which is a living cell. In this system, there is always a corresponding external structure of MT and the oscillation frequency of the synchronous phase with it. The authors suggest that such structures may be the calcium cations, directly or indirectly involved in the implementation of reliably reported therapeutic effects. Under these circumstances, low-intensity MP enhances the amplitude of oscillations and movements of such structures, which form the basis of cooperative generalized reactions that form the basis of «information» exposure.

The possibility of active influence of certain parameters on the IP exchange of Ca^{2+} in the body is a very promising trend in modern medicine from the point of view of the uniqueness of the value of this element in the body.

Calcium is the basis of many metabolic and regulatory processes (just to name muscle contraction, blood sedimentation, hormonal regulation, vitamin metabolism and others).

For example, vascular tone is strongly dependent on the intracellular concentration of free Ca^{2+}. A decrease in intracellular Ca^{2+} levels leads to a reduction in vascular tone, as well as in the tone of skeletal and cardiac muscles, particularly when calcium concentrations fall below approximately 10^{-7} mol/L. Accordingly, calcium antagonists occupy a leading position in the pharmacological treatment of essential hypertension, alongside β-blockers, diuretics, and peripheral vasodilators.

Disruptions of Ca^{2+} homeostasis associated with hypervitaminosis D play a significant role in the pathogenesis of atherosclerosis and pathological calcification. Furthermore, the presence of specific calcium–protein complexes may serve as molecular markers of malignant neoplasms. This principle has been successfully applied in Kyiv over the past five years within the framework of the "Onkotest" diagnostic program

B. Siesjö and F. Bengtsson (1989) formulated a unique theory of calcium overload, according to which an excess of intracellular Ca^{2+} in neurons leads to dysfunction of cellular structures of the brain with the formation of ischemic lesions. Such mechanism may be the cause of in hypoglycemia, depression and other neurological diseases.

Consequently, the search for the physical factors, that can actively influence the exchange of Ca^{2+} in the body, is an important branch of modem physiotherapy, the use of the MP, one of the most promising directions.

This calcium-protein complex in the brain is represented by the S100b (Ca^{2+} binding protein), is synthesized by glia and has a predominantly glial localization (cytoplasm astrocyte), and is also found in synaptic structures and bodies of individual neurons. S100b is atrophic factor for serotonergic neurons. There are plenty of circumstantial evidence pointing to the fact that S100b functions relate to the regulation of the permeability of ion channels, as well as the integrative activity of the brain (the mechanism of learning, memory, emotional and motivational reactions). Change in the content (abnormal increase or decrease) of this protein in brain tissue (for titer determination of serum antibodies there to) characteristic for various pathologies ofthe nervous system (A.B. Poletaev 1995; G.V. Morozov et al., 2000) (14,15,19).

Conclusions

1. Biological rhythms play a fundamental role in maintaining homeostasis and regulating vital physiological processes, including sleep-wake cycles, hormonal secretion, immune function, and pain perception.
2. Bioresonance therapy, when applied in synchrony with individual biological rhythms, enhances the effectiveness of rehabilitation interventions by restoring autonomic balance and improving energy metabolism.
3. Chronobiological principles should be considered in the timing and personalization of therapeutic protocols, particularly in patients with chronic pain syndromes, fatigue, and psychosomatic disorders.
4. Experimental and clinical data confirm the regulatory potential of resonance-based stimulation in optimizing neuroendocrine and psychophysiological responses.

5. Integration of bioresonance therapy with circadian- and biorhythm-informed strategies offers a promising, non-invasive approach to personalized medicine, particularly in the context of multimodal rehabilitation systems.
6. The synergy of modern biophysical methods with traditional principles of energy regulation, including those described in traditional Chinese medicine, opens new pathways for the development of adaptive, patient-centered therapeutic models.

3.8. Ultrasound therapy

Ultrasound treatment (UST), or treatment with ultrasonic waves (ultratonotherapy), providing for the use of therapeutic or prophylactic energy that is inaudible to the human ear – mechanical vibrations of an elastic medium with a frequency above 20 kHz, has found considerable application in medical practice. However, it should be emphasized that this is a unique physical effects that can and should be more widely used in various fields of clinical medicine and, above all, in physical therapy offices, rehabilitation centers, sanatoria and health resorts and other organizations. Explanations and facts, that speak in favor of the use of ultrasound therapy, quite a lot. Consider the most important of them.

1. Ultrasound treatment (UST) is a unique physical factor that is capable make „massage" not only to microtissues, but also of individual cells.
2. The ultrasound treatment has a universal therapeutic action, which consists of:
   - Mechanical micro-massage of cells and tissues;
   - The energy impact of ultrasonic waves on the body to produce heat tissue and activation of physical and chemical action (changing the course of oxidation – reduction processes, accelerating the digestion of complex protein complexes, activation of enzymes).

That is, ultrasound can be viewed as a kind of physical catalyst of biochemical, biophysical and physico-chemical reactions and processes in the body. Arising under the action of ultrasonic wave energy, alternative micro-changes in cellular structures, such as lipoprotein membranes of lysosomes, leading to changes in the homeostasis of the intracellular environment and are stepping sanogenetic mechanisms inter cell regeneration, etc.

3. Ultrasound is an ideal physical factor for combined use with drug therapy, as he „loosens" histological barriers whereby circulating blood drug may penetrate the pathological lesion in larger quantities. These facts are confirmed by modern clinical observations, such as the treatment of tuberculosis, when the combination of specific and low-frequency ultrasonic treatment on lung area leads to faster recovery time repeatedly.
4. Ultrasound can be combined with virtually all types of physical therapy: magnetic therapy, electrotherapy, massages, balneotherapy, laser, EHF-therapy and other therapy options electromagnetic waves, amplifying their effects.
5. Ultrasound intensity is easily controlled, and modern equipment allows us to accurately determine the depth of its penetration, allowing purposefully affect the organs and tissues depending on the depth of their location, using a low-, medium- or high-frequency ultrasonic vibrations. New perspectives are opened by using focused ultrasound and modulated.
6. Increase the ability of permeation of drugs with phonophoresis, another feature of ultrasound, proving the feasibility of its application. In addition, the impact of this factor changes (usually increases) pharmacological activity of most drugs, while it changes their pharmacokinetics and

pharmaco dynamics. Medicinal products given to the use of ultrasound acquire a new dimension to action – information, which is close to the action of well-chosen homeopathic remedies. Small doses of drugs that are administered and the particular method phonophoresis kinetics (within an hour after the treatment drug appears in the blood, through the watch is 12 and the maximum concentration is in the tissues within 2-3 days), it was confirmed the energy information and the mechanism of their actions. Consequently, phonophoresis is not only the ultrasound treatment and medicine, but also a kind of variant of homeopathy (small doses of drugs administered by ultrasound, but a sharp increase in the energy of his action), who will undoubtedly find further development.

7. Ultrasonic puncture is a relatively new trend in ultrasound therapy. It provides exposure to ultrasonic waves focused on biologically active points (BAP).

The advantages of this are obvious:

- High effectiveness of the procedures;
- The possibility of precise dosage of energy and depth of action (this is achieved by selecting the vibration frequency of the ultrasonic waves, and more on their modulation of the resonant frequencies of organs, as well as the use of special focusing nozzles);
- The relative simplicity of the procedure;
- Compatibility with other options physio-puncture (magneto, laser, and other methods of EHF puncture therapy).

8) Ultrasound, although a preformed physical factors, but is a natural and constantly part of the peoples environment, which we have not learned to use (or have lost the ability to!) knowingly use in their livelihoods, unlike many animals (dolphins, whales, sharks, bats, etc.). Probably, the person perceives ultrasonic vibrations on a subconscious level, and thus they affect many systems of the body. The „naturalness" of this factor explains its main advantages:

- High efficiency and repeatability of results;
- The absence of allergies or intolerances;
- The lack of habituation or any significant complications while respecting the elementary rules of dosage;
- A significant therapeutic effects corridor intensity: from 0.05 to 1.0 W/cm^2 (from 1 to 5 microns), which makes use of ultrasound therapy virtually secure.

It would also like to emphasize that ultrasound, as well as some other physical factors, has the main advantage: makes the organism to fight the disease by launching and promoting mechanisms sanogenesis. The objective of any medical specialty is to pay attention to this aspect of the action of physical factors, and predict their use at home and, in general, in everyday life. It would not be an attractive pharmacotherapy (ease of use, the relative speed of action), its use should be limited to „for health reasons", since in most cases it is not indifferent to human (allergy, addiction, side effects, or, often, small or short-term efficiency etc.). Many of these unwanted (side) pharmacotherapy action can be avoided with a combination with physical therapy, ie physio pharmacotherapy. The advantages of such combinations are expressed in increasing the effectiveness of the treatment, reduction of allergic reactions, a significant decrease drug dosage and others.

Basic terms and concepts

To date, are produced a large number of devices for ultrasonic therapy of various classes and systems designed to affect areas of the body, from the acupuncture points and ending reflexogenic zones for areas of significant areas. Due to the large different options of exposure (generating mode, the power of ultrasonic vibrations, etc.), many doctors practicing ultrasound therapy, have questions about the difference between one and another kind of ultrasound exposure. For a better understanding of the problem of ultrasound therapy in medicine, it is necessary to have a clear idea about the advantages and disadvantages of various methods of influence, to determine with sufficient accuracy for each patient's specific type of ultrasound exposure. To this end, we offer the reader to acquaint with the brief characteristics of the types of ultrasound therapy used in everyday therapeutic practice, as well as with the accepted terminology.

Ultrasound is an oscillatory wave process, characterized by a wavelength (l), period (T), frequency (f), vibration amplitude (A) and propagation velocity (v) in a medium. The main dosimetric parameters when performing ultrasound therapy are the power and intensity of the ultrasonic vibrations, mode and duration of exposure.

The amplitude of oscillations (A) is the maximal displacement of oscillating particles from the equilibrium position and it is determined in micrometers (microns).

In accordance with the requirements of ukrainian DSTU, low-frequency ultrasound is dosed in the amplitude of oscillation. However, most physicians are accustomed to the intensity values. Conventionally, it can be assumed that the 1 W/cm^2 correspond to 5 microns in their therapeutic effect.

Penetration depth is the distance, the passage of which the intensity of ultrasonic vibrations decreases in 2 (approximately 7.3) times. It is determined in millimeters (mm).

The depth of therapeutically effective penetration of ultrasonic vibrations is inversely related to their frequency, which is explained by the frequency-dependent attenuation of acoustic waves in biological tissues. As ultrasound propagates through tissue, its energy is progressively absorbed and scattered, and these effects increase with rising frequency due to higher acoustic impedance and absorption coefficients.

Ultrasound with a frequency of approximately 880 kHz typically penetrates tissues to an average depth of 4–6 cm, making it suitable for the treatment of superficial and moderately deep soft-tissue structures. In contrast, low-frequency ultrasound (22–44 kHz) exhibits significantly lower attenuation, allowing acoustic energy to penetrate to depths of 10–12 cm. This deeper penetration is further enhanced by mechanical effects such as stable cavitation, microstreaming, and increased membrane permeability, which are more pronounced at low frequencies.

High-frequency ultrasound with an intensity of 0.05–1.0 W/cm^2 is therefore predominantly used in clinical practice for localized pathological processes situated at depths of up to 3 cm, including inflammatory, degenerative, and post-traumatic conditions of soft tissues. Its therapeutic action is mainly associated with controlled thermal effects, increased local blood flow, and stimulation of tissue metabolism.

To increase the penetration depth and systemic biological effects, low-frequency ultrasound (LFUS) at 22 and 44 kHz was applied. The therapeutic efficacy of LFUS is primarily mediated through non-thermal mechanisms, including modulation of cellular signaling pathways, enhancement of transmembrane ion transport (particularly Ca^{2+} fluxes), activation of enzymatic processes, and improvement of microcirculation and lymphatic drainage.

From a clinical perspective, low-frequency ultrasound has demonstrated the greatest effectiveness in the treatment of gynecological, urological, and gastrointestinal disorders, where pathological processes are often located deep within the pelvic and abdominal cavities. Additionally, LFUS has been successfully incorporated into rehabilitation protocols for metabolic disorders such as diabetes mellitus, chronic inflammatory conditions, and infectious diseases including tuberculosis, where its systemic regulatory and anti-inflammatory effects contribute to improved tissue perfusion, metabolic balance, and regenerative capacity.

In modern rehabilitation medicine, the choice of ultrasound frequency and intensity is therefore determined not only by the anatomical depth of the pathological focus but also by the dominant pathophysiological mechanisms involved, allowing ultrasound therapy to be integrated into multimodal, individualized clinical protocolsLow-frequency ultrasound makes the human body and its internal organs acoustically „semitransparent", and it makes possible to influence them through the skin on which they are projected. For these purposes the ultrasound oscillations with an amplitude of 2, 3, 4, 5 (before heating). It is expedient to carry out with low-frequency ultrasound all tissue of human, including deeply located organs, including those containing a lot of air (for example, the lungs), as well as bone and joints.

Tissues absorb ultrasound unevenly: poorly by subcutaneous adipose tissue, strongly by muscles, nerves, and especially in the bones, which is due to the properties of the tissues. The tissues, which have reference function and tissues which experiencing mechanical stress, have higher absorption than absorption in parenchymal tissue. The absorption coefficient for the ultrasonic bone 12-15 times higher compared to the muscle tissue. The depth of penetration of ultrasound in the bone is minimal and is about 0.3 cm.

Maximum ultrasonic energy is absorbed at the interfaces of different tissues: skin – subcutaneous fat, fascia – muscle, periosteum – bone. When, pathological processes of absorption of ultrasound are changes. If the pathological process is accompanied by swelling of the tissue, the absorption coefficient decreases. The infiltration of tissue by the cellular elements increases the absorption coefficient.

Intensity is the amount of ultrasonic energy passing through an area of 1 cm^2 in 1 second. It is expressed in watts per square centimeter (W/cm^2). In modern physiotherapy, ultrasound diagnostics confirmed the division into small intensities (0.05-0.4 W/cm^2 – 1-2 m), medium (0.4-0.8 W/cm^2 – 3-4 μm), and high (0.8-1.0 W/cm^2 – 4-5 μm).

Power (P) is the number of energy which emitted by an ultrasonic transducer through its surface. It is measured in watts, (W).

The experimentally and clinically substantiated advantage of the use of low-intensity ultrasound is more appropriate for therapeutic and prophylactic effects.

Only when using ultrasound with low intensity (often W/cm2 0.1-0.3) with a predominance of modulated or pulsed influences and short exposures (several minutes), it acts as the catalyst of the biochemical, enzymatic processes and trophic activation underlying sanogenesis. The most effective exposure of ultrasound is achieved in pulsed mode with an intensity of 0.1-0.3 W/cm^2. In this case, we have the combined of low destructive reaction with high physical and chemical activity in the form of increased speed (fluctuations) molecules. Under the influence of low-intensity ultrasound, there is marked activation of microcirculation, an increase in membrane permeability and transcapillary exchange. With this in mind, the procedure is advisable to start with small doses (a feeling weak heat on the skin in the affected area) and only after 3-4 treatments move on to medium intensity mode (the feeling of warmth on the skin in the affected area).

Period (T) is the time for it takes for any point of the wave moves a distance equal to one wavelength. It is determined in seconds (s).

The regime of generation of the ultrasonic waves is specifies the ratio of the emission time between the ultrasonic waves and pauses there between. The regime may be continuous (no pause between the pulses), which is modulated (additionally performs modulation ultrasonic vibrations at the resonant frequencies bodies) or pulse (oscillation in separate bursts). In case of using modulated or pulsed mode with the same vibration intensity for the same time, the average energy radiated less than continuous exposure.

Propagation velocity (v) is the distance by which to move any point of the ultrasonic waves per unit of time. It depends on the properties of the medium, in particular the density, elasticity, compressibility coefficient, molecular structures, temperature and the like, that is, the acoustic impedance of the medium. Determined in meters per second (m/s).

The propagation velocity of ultrasound in solids is more than in liquids, and in a liquid more than in gaseous. In muscle tissue ultrasound propagation velocity (at a frequency of 880 kHz) typically 1540 m/s, that is, close to its propagation velocity in water. But in bones, ultrasound propagates faster – about 3400 m/s.

Physical basis of ultrasound attenuation and its relevance to military and post-war rehabilitation

The propagation of ultrasonic waves in biological tissues is accompanied by a progressive reduction in acoustic intensity due to absorption, scattering, and reflection. This phenomenon is quantitatively described by the law of exponential attenuation:

$$I(x) = I_0 \cdot e^{-\alpha x}$$

where I(x) is the ultrasound intensity at a depth x (cm), I_0 is the initial intensity at the tissue surface, α is the attenuation coefficient (cm^{-1}), and x is the penetration depth. The attenuation coefficient is frequency-dependent and increases approximately linearly with increasing ultrasound frequency.

This relationship has critical clinical implications, as it determines the effective therapeutic depth at which ultrasound energy can exert biologically meaningful effects. High-frequency ultrasound is characterized by a large attenuation coefficient, resulting in rapid energy loss and limiting its action to superficial tissues. In contrast, low-frequency ultrasound exhibits significantly lower attenuation, allowing deeper penetration and preservation of therapeutic intensity at greater depths.

Ultrasonic waves in a homogeneous medium are distributed almost straightforward, are easily focused, are reflected from the boundaries of separation media, and they are characterized by the phenomenon of diffraction and interference. Reflection, refraction, and absorption of ultrasonic waves mainly determined the acoustic impedance of the medium, the oscillation frequency and the angle of incidence of ultrasonic waves. Due to the fact that ultrasonic waves are absorbed rapidly by air environment and they are reflected from air space which is boundary with the biological tissues (99.7%), and the effect of ultrasound on the human body is held through the contact space (degassed water, vaseline, lanolin, paraffin oil, glycerine, and etc.). As the frequency increases, ultrasonic vibrations increases their absorption medium and decreases the depth of penetration in the body tissue. Furthermore, the amount of ultrasonic energy absorbed depends on the type from the sonicated tissues: the bone most absorbs ultrasonic, then less – the nervous – and very little muscle – fat. Attenuation, that is, the total loss of acoustic energy in biological tissue, due to the combined effect of refraction, reflection, scattering and absorption of ultrasound.

Relevance to military and post-war rehabilitation. In the context of military medicine and post-war rehabilitation, pathological conditions are often characterized by deep-seated tissue damage, chronic inflammation, neurovascular dysfunction, and persistent pain syndromes associated with blast injuries, musculoskeletal trauma, prolonged immobilization, and stress-related disorders. These conditions frequently involve structures located beyond the reach of conventional high-frequency ultrasound modalities.

The application of low-frequency ultrasound (22–44 kHz) is therefore particularly justified in military and veteran populations. Due to its longer wavelength, reduced attenuation coefficient, and predominance of non-thermal mechanical effects, low-frequency ultrasound can effectively influence deep muscular, fascial, and neurovascular structures. The preservation of acoustic intensity at depth enables modulation of microcirculation, enhancement of lymphatic drainage, and activation of reparative and anti-inflammatory processes in tissues affected by chronic hypoxia and fibrosis.

Furthermore, the exponential attenuation model provides a physical basis for individualized rehabilitation protocols, allowing clinicians to adjust initial ultrasound intensity and frequency according to the depth and extent of tissue damage. This approach minimizes the risk of excessive superficial heating while ensuring adequate energy delivery to deeper pathological zones.

Methodological implication. In military and post-war rehabilitation programs, the integration of frequency-dependent attenuation principles into ultrasound therapy planning enhances both safety and therapeutic efficacy. The selection of low-frequency ultrasound for deep and complex injuries aligns with the need for non-invasive, systemic, and repeatable interventions capable of addressing the multifactorial consequences of combat-related trauma and prolonged stress exposure.

Features of action of ultrasonic waves on the body

After the penetrating into the body, the ultrasound has on it a complex biological and therapeutic effect. The mechanism of action of ultrasound on the body has thermal (non-specific), the mechanical and physical-chemical (specific) factors.

The thermal factor is related to the processes of heat by absorption of ultrasound in biological tissues. The absorption depends on the type of sounded tissue, and the frequency of the ultrasonic vibrations. According to theoretical calculations, the ultrasound absorption coefficient for a single type of tissue is proportional to the square of the frequency. In practice, however, this dependence can vary from linear to quadratic, so low-frequency ultrasound penetration ability is much higher than with high frequency (HF). The zone of high temperature formed unevenly in the body.

Most of them occur at the interface of the spaces, due to the difference in acoustic impedance and the formation of waves which are highly damped shear (transverse), as well as tissues, absorbs ultrasonic energy (nerve, bone), and in the areas which poorly supplied with blood, because for the latter removes heat , therefore, there may overheat. Because these tissues have no thermoreceptors virtually no possibility feel of local temperature rise. Pain receptors are stimulated, and the patient feels pain only when the local temperature exceeds 45°C. Most authors believe that the short-term rise in temperature to 45°C is not dangerous. To avoid overheating of tissues with ultrasound therapy should be preferred labile technique.

The consequence of the thermal effects of ultrasound can be considered as an increase in the flow rate of metabolic processes, the occurrence of temperature gradients, which improves blood and lymphocirculation, improves tissue elasticity, etc.

The mechanical factor is due to the alternating of acoustic pressure and manifests itself in a kind of „micro-massage" at the cellular and subcellular levels. Thus, there is an increase in the permeability of cell membranes, thereby facilitating the process of transport of substances through the membrane and consequently increased the penetration of substances into the cell and the body as a whole. Equally important the effect, which make by ultrasound of depolymerization on hyaluronic acid. There activation electrokinetic (electrocapillary) phenomena observed in the micropores at the interface with different acoustic impedance, which plays an important role in phonophoresis. There are acoustic micro-showers in the protoplasm, movement of intracellular inclusions, and changes in their spatial relative position that causes stimulation of the functions of the cellular elements and cells in general.

The physico-chemical action is due to the fact that the signs of variables elastic vibrations cause in the tissue mechanical resonance. As a result of this accelerated movement and oscillation of molecules, intermolecular bonds are weakened and, as a consequence, increasing their decay into ions, the formation of new electric field is disturbed isoelectric state; there are electronically excited states, and electrical changes occurring in cells and tissues. Tribo-luminescence of water, serum and other fluids, the change of the structure of water and the state of hydration shells: release of biologically active substances, are formed the free radicals (HO, H, HO2, singlet oxygen) and a variety of products of biological solvent which are were made by sonolysis, are changed the processes of peroxidation lipid, are intensification of physico-chemical and biochemical processes in tissues. This is particularly reflected in the change of mitochondrial oxidative phosphorylation of the liver, the kidneys, the intensity of tissue respiration, glycolysis processes and the activity of the pentose phosphate pathway of carbohydrate metabolism, revitalizing the metabolism of proteins and nucleotides mitotichekoy enhancing cell activity.

The effect of all three factors (thermal, mechanical, physical and chemical) is closely related to each other and has on the body combined action Under the influence of the ultrasound, intracellular microflows occur by rotational movements of the cytoplasm, which contributes to stimulation of cell functions and elements in whole cells. Exposure of ultrasound energy on cellular structures, including lipoproteins of the liposomal membrane, lead to changes in the medium and intracellular homeostatic mechanisms activate defense responses, the intracellular regeneration of other processes, which is important in the mechanism of action of ultrasound.

Thus, ultrasound may be considered as physical catalyst physicochemical and biophysical processes within the body.

The therapeutic effect of ultrasound waves

The therapeutic effect of ultrasound depends on the frequency of ultrasonic vibrations, the intensity of the exposure time and the body's condition. With optimal variants of ultrasound exposure alters membrane permeability, enhances the diffusion and osmosis processes, increases the activity of ions, hormones and other biologically active substances due to their transition to a free state, it activates the enzyme activity, increases metabolism. By the influence of the ultrasound, the bioelectrical activity of tissues improves, the phagocytic function of leukocytes increases, and the mechanisms of non-specific immunological reactivity of the body are activated, including by increasing the histamine binding protein of blood and the splitting it by histaminase.

Under the influence of ultrasonic vibrations improves local blood circulation, lymph flow, accelerates reparative processes in the nerves, bones, muscles, normalizes the activity of the cardiovascular system, respiratory function, increases the absorption of oxygen to tissues.

Micro-massage with ultrasound has the anesthetic value, stimulates the activity of the nervous and endocrine systems, improves the functional state of connective tissue, and increases the protective reaction of the human body.

Ultrasound therapy has a significant anti-inflammatory, antispasmodic, resolving, trophic, analgesic, and hiposensibilic fibrinolytic effect, stimulates regeneration processes, promotes the resorption of adhesions and scarring. The latter is associated with the activation of intracellular processes of protein synthesis, and enzymatic reactions. It was found that the scar tissue, which was formed under the influence of ultrasound, is firmer and more elastic.

Ultrasound affects the location of the newly forming collagen and contributes to the recovery process, and at the same time it increases the strength of scar tissue. However, the effect of ultrasound on bone inflammation at the proliferative stage leads make it more slow the differentiation of osteoblastic and enhancing cartilage growth.

The effect of ultrasound on the connective tissue promotes its rejuvenation by showing changes in the cellular composition and fibrous structure. In mast cells, there is a marked transient infiltration of histamine with quick activation of diamine, binding and neutralization excessive amounts of histamine by the blood proteins (gistaminopektichesky effect), free heparin (mast cells) and the normalization of the blood coagulation system. Ultrasound show have revealed an increase the body's resistance to histamine shock, anaphylactic and allergic reactions, activating effect on phagocytosis.

In an experimental model of the disease, the action by ultrasound in low intensities inhibits the development of degenerative process after injury of joint, stimulate the consolidation of the bone after a fracture and bone-plastic operations, promotes the resorption of the inflammatory infiltrate in the damaged disc with osteochondrosis, improves recovery of the fibrous ring of the structure and the nucleus pulposus to the accumulation in the last glycogen and acid mucopolysaccharides.

When exposed to ultrasound to the skin it is enhanced physiological and reparative regeneration in the skin, its permeability increases, redox potential and active reaction (pH) varies, skin excretory function (increasing the number of functioning the sebaceous and sweat glands) activates, and the excretion of lipids chlorides increases, antibacterial properties increased, the barrier function of the skin rise and the normalization of its reactivity is normalized. Segmental affects of ultrasound changes the resistance of the skin constant electric current (impedance), which is an objective criterion for the neuroreflexive effect of ultrasound on the body. The sensitivity of the skin of various areas of the body to the ultrasound is different. Thus, is the more sensitive skin – the skin of the face, and then – the abdomen, much less sensitive skin of the limbs.

Ultrasonic waves enhance the physiological lability of nerve centers and peripheral neuromuscular structures, helps to eliminate parabiotic foci, increasing the adaptive-trophic function of the body. According to some researchers, despite the impact of the local ultrasound, in the formation of the body's reactions take part and the higher autonomic centers, hypothalamo-pituitary region, reticular formation and limbic system.

Small doses of ultrasound have a stimulating effect on the brain glia and alter energy metabolism in neurons. The reaction of the spinal cord neurons to ultrasound by electron microscopy has a phase character, the primary irritation to the restoration of the broken structures. It is known that the influence of ultrasound on the function of motor axons, increase conduction velocity along the peripheral nerves upon exposure to low intensity and pulse mode.

Ultrasound therapy activates and normalizes the function of the pituitary-adrenal axis, the sympathetic-adrenal system, thyroid and sex glands, normalizes exchange of catecholamines. More-

over, under the influence of ultrasound, activated not only trans-pituitary, but para-pituitary pathway of neuroendocrine regulation.

Ultrasound has a vasodilatory effect, normalizes vascular tone, improves the local blood circulation, microcirculation, increasing the circulation of blood and lymph flow, revealing the reserve capillaries, reducing their spasms and venous stasis. Ultrasound exposure increases the activity of mast cells, increased tolerance of plasma to heparin, and normalizes blood, increases tolerance of plasma to heparin, and normalizes blood, had made free heparin, affects plasma cells of lymphoid tissue. Ultraphonotherapy slows down blood clotting, mainly due to inhibition of the activity of the coagulation system has made deviations coagulation after a course of ultrasonic irradiation to normal (A.G.Mrochek et al., 1995) [10,11,12,13].

Ultrasound therapy stimulates transcapillary metabolism in tissues, neovascularization, increases protein synthesis (V. S. Kotlyarov, 1991) [16,17,21,22]. As shown by experimental studies (T. A. Bozhko, 1993) [21,22], the effect of small doses of ultrasound on the thyroid gland helps correct stress disorders myocardial contractile function. According to the authors, this is due to the inherent that ultrasound increase the permeability of cell membranes and passing histological-hematic barriers that contribute better capture of iodine by the thyroid gland and by thyroid hormone synthesis increase its functional activity. For normal functioning of the myocardium, a sufficient level of thyroid hormones is necessary.

Ultrasound therapy contributes to the normalization of respiratory function, increases the absorption of oxygen to tissues; increasing the enzymatic activity of lysosomal enzymes alveolocytes leads to the purification of the inflammatory focus from the cellular debris, from the clots of fibrin degradation products; stimulates the regeneration of alveolar tissue, removes spasm of the bronchi and pulmonary vessels. Ultrasound therapy improves motorics, evacuation, absorptive functions of the stomach and intestines, relieves intestinal cramps, biliary tract, increases diuresis.

Ultrasound has a pronounced anti-inflammatory, analgesic, antispasmodic, fibrolytyc, resolving, trophic, antipruritic, and anti-allergic effect. Under its influence, the content of endogenous serotonin increases, which apparently has a protective effect in inflammatory, allergic and radioactive tissue lesions. However, an experimental study of the effect of ultrasound on inflammatory edema showed that ultrasound has no effect on acute inflammatory edema with exudation and does not reduce the inflammatory response of cells (D.H.Goddard et al., 1983) [25,27,28].

Under the influence of ultrasound, the bioelectrical activity of tissues improves, the phagocytic function of leukocytes increases, and the mechanisms of non-specific immunological reactivity are activated due to an increase in the content of histamine-binding protein in the blood and the breakdown of its histaminase. When articulating human blood leukocytes revealed a positive effect of low-intensity ultrasound on T-lymphocytes; changes in the B-lymphocytes is not detected. Ultrasound has a bactericidal action primarily by damaging the cell walls of microorganisms. The sensitivity of different bacteria kinds are different; most sensitive staphylococcus, viruses die under the influence of ultrasound.

Thus, the principle of the biological effect of ultrasound on the body is to increase the activity and adaptive defense mechanisms. The therapeutic effect of this influence is expressed in anti-inflammatory, analgesic, antispasmodic, absorbable and desensitizing influence.

Ultrasound enhances the penetration of liquid medications and ointments through the skin and mucous membranes (phonophoresis). This is especially true for low-frequency ultrasound, because its amplitude of oscillation of about two orders of magnitude higher than that of high-frequency ultrasound. In some cases, an ultrasound may be more effective form of thermotherapy than microwave radiation, paraffin baths or infrared radiation.

Ultrasonic vibrations are brought into contact through the scoring zone of space (typically petroleum jelly, apricot, lavender and others oil or drugs in the form of impregnated tampon).

All of the above allows the use of ultrasound therapy in a number of diseases.

Ultrasound therapy, neuroplasticity, and chronic pain management in veterans: integration into a multimodal rehabilitation system

Chronic pain syndromes in military personnel and veterans represent a complex biopsychosocial phenomenon resulting from combat-related injuries, blast exposure, prolonged physical overload, and sustained psychological stress. At the neurophysiological level, chronic pain is associated with maladaptive neuroplastic changes, including altered excitability of nociceptive pathways, dysregulation of descending pain modulation systems, and persistent sensitization of central and peripheral neurons.

Low-frequency ultrasound (LFUS) has emerged as a promising non-invasive modality capable of influencing both peripheral and central mechanisms of pain through its mechanical and neuromodulatory effects. By penetrating deeply into musculoskeletal and neurovascular tissues, LFUS facilitates modulation of afferent signaling, reduces neurogenic inflammation, and indirectly affects central pain processing through normalization of peripheral input. These effects create favorable conditions for adaptive neuroplastic reorganization, which is a prerequisite for sustained pain reduction.

Ultrasound-induced neuromodulation and neuroplasticity

The mechanical effects of low-frequency ultrasound, including stable cavitation and acoustic microstreaming, contribute to enhanced membrane permeability and modulation of ion channel activity, particularly Ca^{2+} – dependent signaling pathways. These mechanisms are known to play a critical role in synaptic plasticity, neurotransmitter release, and long-term potentiation or depression within neural circuits.

In veterans with chronic pain, normalization of aberrant afferent input from injured tissues reduces pathological reinforcement of pain-related neural networks. When combined with active rehabilitation strategies, ultrasound therapy supports a shift from maladaptive to adaptive neuroplasticity, facilitating restoration of motor patterns, body awareness, and pain coping mechanisms.

Integration into a multimodal rehabilitation framework Within a community-based rehabilitation (CBR) model, ultrasound therapy should not be considered as an isolated intervention but rather as a component of a broader multimodal system that includes medical, psychological, educational, and social dimensions.

Ultrasound therapy serves as a physiological primer, reducing pain intensity, muscle hypertonicity, and tissue stiffness, thereby enhancing the effectiveness of subsequent rehabilitation interventions. This creates a therapeutic window during which patients are more receptive to therapeutic exercise, cognitive-behavioral strategies, and self-management training.

The educational component, grounded in principles of andragogy, focuses on helping veterans understand the mechanisms of chronic pain, neuroplasticity, and the role of active participation in recovery. By linking ultrasound-induced symptom relief with education on movement retraining, pacing strategies, and stress regulation, patients transition from passive recipients of care to active agents in their rehabilitation process.

Peer support within the CBR framework further reinforces these effects by normalizing the rehabilitation experience, enhancing motivation, and promoting long-term adherence to self-management strategies.

Clinical cases

Case 1. A 38-year-old male veteran with chronic lumbosacral pain following blast-related injury presented with persistent muscle spasm, sleep disturbances, and high pain catastrophizing. Integration of low-frequency ultrasound (22 kHz) targeting deep paraspinal tissues into a multimodal program resulted in significant reduction of pain intensity after two weeks. This improvement enabled active participation in therapeutic exercises and pain neuroscience education, leading to sustained functional gains and reduced analgesic dependence over three months.

Case 2. A 45-year-old serviceman with chronic pelvic pain syndrome and autonomic dysregulation following prolonged deployment underwent rehabilitation combining low-frequency ultrasound (44 kHz), breathing-based self-regulation techniques, and psychoeducation. Ultrasound therapy reduced visceral hypersensitivity and muscle tension, facilitating engagement in self-management practices and improving quality of life indicators.

Case 3. A 29-year-old veteran with post-traumatic cervical pain and symptoms of central sensitization demonstrated limited response to pharmacotherapy alone. The inclusion of low-frequency ultrasound as part of a CBR-oriented program improved cervical mobility and reduced pain-related fear, supporting adaptive neuroplastic changes through gradual exposure to movement and peer-supported rehabilitation activities.

Methodological implications for post-war rehabilitation

The integration of ultrasound therapy into multimodal, community-oriented rehabilitation programs offers a scientifically grounded approach to addressing chronic pain in veterans. By targeting both peripheral tissue pathology and central neuroplastic mechanisms, ultrasound therapy enhances the effectiveness of educational, psychological, and self-management interventions. This synergy supports long-term functional recovery, social reintegration, and resilience in military and post-war populations.

The methods and techniques of treatment with ultrasonic waves

The term „ultrasound" (UST) involves to the use of ultrasonic waves to act on the human body for therapeutic or prophylactic purposes. Experience in the use of ultrasound therapy suggests the following options and its principles of application. Ultrasonic wave is most often done directly on the area of pathological changes. For example, sound influence on the psoriatic plaques, keloid scars or contact, on one or more affected joints with arthritis. Likewise, ultrasound can affect internal organs, placing the emitter region of the liver, lung, stomach, spleen, etc. This principle is widely used in UST; it is easily carried out and fairly effective. At the same time, as a rule, using this option of the UST does not require long training.

However, this principle of ultrasound therapy can not always be used. For example, how to influence the pathological focus in hypertension, neurosis and others.

In such cases, preference is given to ultrasonic therapy with an impact on reflex zones or acupuncture points (AP), that is, the ultrasound puncture, ultraphonopuncture (UPP).

It should be noted that the most effective is the combination of the two above-mentioned principles of ultrasound therapy, i.e the impact on the pathological focus area should unite with UPP to the distal point. Thus, professionals involved in the practical application of UST, have a choice of four basic methodological approaches:

- Direct impact on the pathological center;

- Impact on reflex (segmental) zone;
- Impact on the acupuncture points in accordance with the basic principles and laws instead of the traditional acupuncture needle that is holding ultraphonopuncture;
- Effects on the pathological focus, combined with the impact on reflex (segmental) zones or acupuncture points.

Naturally, in each case, the doctor chooses the most appropriate methodological approach. However, if the impact on the pathological center at UST requires more purely technical training, then during the UPP necessary basic knowledge of acupuncture, the rules to select the appropriate points, features a combination thereof in each case. The use of UPP allows accurately dosing intensity of the impact on the acupuncture points, which are not easy to achieve the classical method chen-chiu therapy.

Currently, three main types of ultrasound treatment have been methodically identified: ultrasound therapy (including underwater), phonophoresis and ultrasound puncture.

For this embodiment, the impact mode with a change in modulation frequency (1-10 or 10-100) is optimally used.

Ultrasound therapy

Apply two main methods of ultrasound exposure: fixed and labile. When using the fixed technique, the emitter is mounted fixed for the duration of the procedure. When using the labile method at a speed of 1-2 cm/s, first making stroking movements – a line, and then circular ones. In some cases, this method may be useful with a slight delay (up to 30-45 minutes) in the most painful areas. In this case, the fixed-frequency modulation mode is better. In all cases, the contact of the vibrator (oscillator) with the skin should be maximized (at a right angle, perpendicular to the skin) in order to eliminate the air gap between the emitter and the skin. For this exposure area is exposed, thick hair coat is removed and the skin is rubbed copious, amounts of contact substances (mineral oil or glycerin). Then the emitter is pressed tightly against the skin. Especially the close contact, necessary to achieve near the bones, joints and rough surfaces of the body.

When ultrasonic treatment modality is through the rubber bag (glove), with water on parts of the body complex configurations (the joints of the foot or hand). One element represents the contact area with the surface, and the other contacts the transmitter. When underwater irradiation (irregularities, acute inflammation or ulcers when touching the vibrator to undesirable lesions, the emitter is held at a distance of 1-2 cm from the affected area.

As already emphasized, ultrasound treatment is carried out by acting on the affected area, reflex zones or acupuncture points in one procedure. Announces, a certain size to 250 cm^2 area of the body. If necessary, act on its larger surface is divided into several areas. On the first day we make sounds of fields 1-2, and then fields 3-4. Sounding is carried out in pulsed mode at fixed frequencies using frequency scanning. The latter option is gentler, and it is usually used in more severe stages of the disease, when expressed neuro-vegetative manifestations of the disease, when exposed on a reflex-segmental zone, for children, etc.

Switching of the fixed mode is advised in more severe inflammatory activity, moderately severe diseases of the cardiovascular system, sensitization and, where necessary to limit the thermal effect. The ultimate value of a therapeutic dose of ultrasound is the appearance of heat.

The feeling a strong burning sensation or pain, even when we work by the fixed method, should not be!

Currently, low- and medium-intensity ultrasound, and rarely high-intensity ultrasound, is prescribed as a treatment method. The maximum duration of sound is 15 min. Sounding is carried out every day or every other day, the course of treatment – 6-14 procedures. Repeated treatment may be administered in two or more months.

Ultraphonophoresis (UPP)

The drug phonophoresis and phonophoresis (the name of the outdated, not exact, because there are sound and ultrasound) is a combination of physiopharmacological treatment, in which the effects on the body we do by ultrasound and administered with the help of it medicinal substances (V.V.Orzheshkovsky, V.V.Orzheshkovsky, 1998) [33,35].

In medical practice, this method takes a significant place. It provides for the simultaneous combined effect of ultrasonic vibrations and of drugs on the body. To this end, an ultrasound is performed through contact of the medium in which the drugs are administered. The drug should retain its structure and biological activity, and its action is to be unidirectionally with ultrasound, ensuring their synergy effect on the organism. According to most researchers, UPP through ducts of the sweat and sebaceous glands. A certain role in the penetration of drugs in UPP play ion channels of the cell membrane and intercellular gap as one of the most important properties of ultrasound is its depolymerization and „loosening" effect.

In the dosage treatment modalities performed according to the energy flux density (intensity). Its threshold value when using various methods should not exceed 1 W/cm^2 (5 microns). It should be remembered that the lower limit of the thermal action of ultrasound is 0.8 W/cm^2 (4 microns) for pulse ultrasound fluctuations.

The duration of exposure of one field is usually 2-5 minutes, and in the area of a large joint – sometimes up to 6-10 minutes. Depending on the number of fields of duration, the procedure can be up to 10-15 minutes: in a stable manner, to 3 minutes per zone, with labile-5-10 minutes. Treatments are usually carried out every other day or every day. The average treatment course consists of 7-14 procedures. Because of the long and severe after-effect of treatment is recommended to repeat it no earlier than 3-5 months. The X-rays therapy and radium therapy should be avoided for 3-4 months prior to treatment with ultrasound and 3-4 months after treatment.

Babies' ultrasound can be administered in the preschool years. For persons under 20 years of age and older than 60 years, and the intensity of the procedure is reduced by 30%.

A prerequisite for the development UPP method was a significant increase in skin permeability and vascular cell membranes, increasing the number of functioning sweat and sebaceous glands, acceleration and transport of substances improving the functional activity of tissue under the influence of ultrasound.

Calling by ultrasound the increases the permeability of skin and histological-hematological barriers, creating favorable conditions for the penetration the molecules of drugs through them. With this method, the therapeutic effect of a ultrasonic waves are added to the therapeutic effects of a particular drug. Thanks to alternating pressure of ultrasonic waves, the molecule of drug gains greater agility and reactivity. This significantly increases the amount of drug entering the body and the efficiency of its therapeutic action. UPP Effectiveness also depends on the area of his holding.

The depth of penetration of drugs during UPP does not exceed the thickness of the epidermis of the skin. Proof of this is the fact that at UPP radioactive isotopes in the subcutaneous tissue are determined only after 1-2 hours after the procedure. Number of substances entering the body

varies from 1 to 5% of the dose taken for the procedure. This mucous membrane introduced more substance than through the skin. For substances that are poorly soluble in water and also to enhance the absorption of drugs through the epidermal barrier, DMSO-dimethyl sulfoxide (25% solution) is used as a solvent. Be aware that the phoretic capacity of ultrasound (amount injected them into the body medicine) depends on the frequency (frequency at 22 kHz greater than 2640 kHz) ultrasonic intensity (increasing 0.8 W/cm^2 (4 μm) increases, and then decreases), the mode (continuous mode is increased by 20% the amount of drug penetrating through the cell membrane, as compared with exposure to the pulsed mode (U. Smolenski et al, 1988) [36,37]. Also has the meaning the technique of the procedure (in labile procedure are injected drug more), solution concentration (5-10% of optimal solutions), duration of the procedure and site of administration (mucosal drug enters greater than through the skin). Accordingly, when introduced into the body phonophoresis from 1 to 5% of the procedures used for the drug, but its therapeutic efficacy is much higher than other options of administration.

UPP drugs have potentiated the effect of ultrasonic therapy and specific effect of the drug substance which is administered.

Ultrasonic vibrations significantly affect on the pharmacokinetics and pharmacodynamics of „sounding" drugs. As a result of the combined action, there are a lot of potentiated therapeutic effects: of vasodilator, anti-inflammatory and absorbable substances, antibiotics, immunosuppressants and anticoagulants and weaken their side effects. However, ultrasonic vibrations can several inactivate certain drugs (atropine, barbiturates, vitamins, codeine, caffeine, morphine, procaine, platifillina tartrate, polymyxin B sulfate, pyrazolone derivatives, quinine, ephedrine, etc.). Ultrasound waves do not substantially accelerate the diffusion of ascorbic acid and thiamine.

The following compositions are recommended for phonophoresis: hydrocortisone (5 g hydrocortisone suspension mixed with lanolin and vaseline, 25 g each), analgin (50% dipyrone solution of 5 ml mixed with vaseline and lanolin, 25 g), trilon B (trilon B 5 g, petrolatum and lanolin, 25 g), antibiotics (ampicillin emulsion, monomycin, tetracycline), lidase (64 units dissolved in 0.8 ml distilled water and add 0.8 ml of vaseline oil), aloe (liquid aloe extract 1:3, applied to the skin coat layer and vaseline oils), aminophylline (1.5 g aminophylline mixture, 20 g of distilled water, 15 g of petrolatum, lanolin, 15 g), prednisolone (0.5% ointment), baralginum (2-2.5 ml baralgina ampoule solution is rubbed into the skin and covered with glycerol), benzocaine (5-10% anestezinovaya ointment), gangleron (a mixture of 0.25% gangleron solution with vaseline and lanolin).

When penetrating into the human body, these drugs simultaneously with the biological effects of ultrasound increases the activity and adaptive defense mechanisms. The therapeutic effect of this influence is expressed in anti-inflammatory, analgesic, antispasmodic, absorbable, desensitizing influence.

The procedures are carried out in two ways: contact and distant (underwater). In the first case, the target area is applied by medicinal substance in the form of solutions, suspensions, ointments, and then fixedly mounted radiator (stable technique) or moved without departing from the skin surface (labile technique). When using solutions of medications that were applied with a pipette, or they were rubbed into the skin. Next, cover the place with vaseline oil and produce effects of ultrasound. The effectiveness of this UPP method increases after preliminary mechanical or chemical treatment of the skin surface in the area of exposure: dehydration of a mixture of ether and alcohol, heating or hot water, or diadynamic electricity treatment (DDT). In the second case, UPP conducted in the bath with the drug solution in degassed water at a temperature of 35-36 °C. The emitter move small circular motions

at a distance of 1-2 cm from the skin surface. This method is preferable for treating large, non-uniform surfaces. In ophthalmology and dentistry, various funnels and nozzles are used instead of baths.

ATTENTION!

When using liquid drugs, ultrasonic waves are supplied to the audio zone through the 2-3 mm thick cotton gauze.

N.A. Gavrikov et al. (1975) [36,39] proposed phonophoresis in combination with drugs under the provisional name „Kortan 1" (a mixture of 1% hydrocortisone solution and 10% dipyrone), „Biokortan" (a mixture of 0.5% hydrocortisone solution, 10% dipyrone and bio-stimulants such as drugs-gumizol, FIBS , pelloid of distillate), „Biofon" (preparations containing biostimulants „Biofon A" -aloe „Biofon G" -gumizol „Biofon P" -pelloid of distillate „Biofon F" -FIBS); „Singing" (10 g dipyrone, dissolved in 40 ml of mud filtrate and mixed with a solution of 40 g anhydrous lanolin and vaseline 10 g).

Phonophoresis with UPP drugs is combined with electrophoresis (ultraphonoelectrophoresis), diadynamic therapy (ultraphono diadinamophoresis), amplipuls therapy (ultraphonoamplipulsphoresis), magnetic (magnetoultraphonophoresis), vacuum treatment (vacuum ultraphonophoresis); it is conducted on acupuncture points in the form of microultraphonophoresis.

Ultrasound punctures (UP)

Impact on biologically active point and the Ah-Shi (pain points) by means of ultrasonic vibrations has been called the ultrasound puncture. This method is based on the same principles as in the general ultrasound therapy; the only difference is that the implementation of the therapeutic effect is not carried out due to local effects, but due to the effect of acupuncture-point acupuncture channel (meridian) organ. In this regard, expanding range of indications for ultrasonic therapy, because in cases where the local ultrasound therapy is contraindicated, it becomes possible to conduct at remote locations from the lesion. In this case, the body is not exposed to intense ultrasound, and therapeutic effect is achieved by biologically active points (BAP). It should be noted that the indications and contraindications for ultrasound puncture almost the same as for physiopuncture.

When using UP in practice, the doctor should have a clear idea what are the ultrasound parameters he will use for the treatment of certain diseases.

Optimal for medical specialists using in their practices of UP sedation which have low-frequency ultrasound (44 kHz). Preference should be given to low-frequency ultrasound when exposed to the signal, and, especially, on sympathetic points.

Here are the energetic parameters of the impact of ultrasonic influence on biologically active points:

- A slight degree of stimulation (arousal, toning) ultrasonic treatment corresponds to the intensity of 2-3 microns, with a duration of exposure of 5-20 with one point, the modulation frequency of 1-10 Hz;
- Moderate stimulation (harmonization) corresponds to the intensity of the ultrasound 3-4 microns, with exposure to 20-30 at one point, the modulation frequency 18 and 37 Hz;
- High degree of stimulation (brake, sedation method) are respectively 4-5 and 30-60 microns with a single point, the modulation frequency of 75 Hz.

Of particular, it should be noted that the doctor, guided by the patient's feelings must remember: the power of ultrasound stimulation with BAT should not exceed 1 W/cm^2. The total time for the ultrasound puncture is in the redistribution of 3-25 minutes. The procedures are conducted daily or

every other day, for a course of treatment is usually carried out 7-14 sessions. After the procedure, it necessary to rest for 30 minutes.

When selecting areas for UP should be favored classical approaches, which are detailed in many studies (D.M.Tabeeva, 1980; G.Luvsan, 1989; I.Z.Samosyuk, V.P.Lysenyuk, 1994) [1,2,3,4,5]. It should be noted that when doctor das ultrasound punctures h must clearly understand the functional significance of impacts, to be able to determine their location and use rules for choosing BAP and compatibility.

As with any medical process, an important task is the correct diagnosis of the disease, as well as the development of treatment strategies based on comorbidities. All this requires a doctor's thorough and comprehensive examination of the patient, establish the clinical diagnosis and acupuncture. The establishment of the last substantial assistance to the doctor can provide methods of electro-diagnostics by Nakatani or Voll. Choosing the optimal location for placement or a combination of them is a matter of creativity.

In recent years, the majority of doctors – specialists in acupuncture is used in formulating points of both traditional and modern principles. Of the modern principles, the most popular and effective is the segmental, in which affect metameres having a common segmental innervation to the affected organ.

These principles, as well as the use of signal points and sympathetic points, the action which allows purposefully to provide a therapeutic effect on specific organs.

Among other ways to select AT, widely used effect on pain points (Ah-Shi), or a combination of local and remote AT pain on the meridian, which belong to these pain points. Treatment of pain syndromes can be carried out also by stimulating and analgesic of signal points, as well as start and end points of the meridian. It is necessary to observe the following rules. In acute pain syndrome, first act on distant point from the hearth or on the opposite side of the point, then the treatment include local point. In chronic pain syndrome or a long-term course of the disease treatment should begin with action (2-3 sessions) on the so-called AT restorative action: P7 Les -Tsyue; GI4 Hae-Gu; GI11 Qu-Chi; E36 Tsu-San-Li; RP6 San- Yin- Jiao; R6 Chao-Hai; MS6 Nei-Guan; TR5 Wai-Guan; VG4 Min-men; VG14 Da-Chzhuy and auricular points AR55, AR82, AR22 and other, which can contribute to energy restoration and recovery of the patient.

In the following it is possible to make further work on the symptomatic AT points.

In the case of a long-term course of the disease, along with the stimulation of tonic AT, action is necessary to use the special power of the „sea", „pools" or „chakras" of energy.

For example, for diseases of the central nervous system the effects of encephalitis, cerebral palsy, and others.), it is recommended to stimulate the „medullary sea" AT points – VG16, VG20; in the asthenic conditions or diseases smoldering preference „sea power" -E9, the V10. The points „sea food" – E30, E36 recommended to use in cases of chronic diseases of the gastrointestinal tract, the points named „sea of blood" – V17, E31, E39, for anemia. Treatment of diseases, which takes place on the background of reducing immune reactivity of the organism, should begin with the impact on the „ocean of energy» -VC17. Immunomodulatory effect is inherent in some of the other points, the influence on which has a beneficial therapeutic effect. The most important effect is on the restorative action of AT and energy "reserves" in chronic diseases in the first 2-3 sessions, since this provides the necessary "energy pattern" for further treatment.

The points of restorative action (e.g., GV20 Baihui, ST36 Zusanli), immunomodulatory points (e.g., LI11 Quchi, SP6 Sanyinjiao), and so-called power pools (e.g., CV6 Qihai, KI3 Taixi) constitute the

basic therapeutic set, and it is recommended to include two to three of these points in each ultrasound procedure session.

Ultrasound therapy is successfully used different points AT: corporal (meridian points) out-meridian point and the point of the ear.

Taking into account the experience gained by the use of acupuncture treatment of chronic diseases, it is desirable to start with the use of distal points (restorative, immunomodulatory, energy seas, analgesic) and then reaching some improvement, it is necessary to switch to the impact on local points – the signaling points, sympathetic points and auricular points.

The number of treatment sessions in the course of ultrasound therapy, are determined mainly by the clinical effect is, but remains important not to overdose therapeutic dose as possible exacerbation of the process. For chronic diseases usually prescribe repeated courses of treatment.

The doctor who using ultrasound therapy, is obliged to pay attention to the following points:

1. During the treatment session, the patient should lie down if possible, which reduces the probability of occurrence of adverse reactions.
2. At the first session, the doctor is obliged to establish the patient's individual sensitivity to the therapeutic effects of the ultrasound, that is, to establish the required dosage to evaluate the effect on the patient's state of health, blood pressure changes, heart rate and other objective indicators. Throughout the course of treatment carried out monitoring of the patient, and in the event of adverse reactions in the treatment, it is necessary to make adjustments, until the abolition of ultrasound therapy.
3. In the selection of the dosage it should be taken into account the impact of the degree of weakening of the body, the type of nervous system of the patient, the degree of asthenia. For example, when treating children, the elderly, and debilitated patients, the radiation dose should be reduced by 30-50% compared to the usual dose for middle-aged people. With the same purpose – cutting session duration, or use much smaller device modes. Otherwise, undesirable effects may accompany treatment: vertigo, nausea, changes in heart rate, a fall or rise in blood pressure, etc. In any case, for the more successful adaptation of the patient to the ultrasound therapy sessions, it is desirable to reduce total exposure time by 20-30 % during the first exposure.
4. The points throughout the course of treatment necessary to alternate for the best effects, as permanent effect on the same point reduces the therapeutic effect in connection with the adaptation to the impact on the point. It is necessary to take into account the state of the meridians from the perspective of „redundancy – insufficiency" (a history of clinical manifestations or controlled trials by technic of acupuncture diagnosis).
5. When preparing the recipe of points it is necessary to consider the presence of concomitant diseases. For patients with a labile mental state, prone to alarming suspiciousness in the formulation is necessary to include the point with calming actions (E36 Tsu-San-Li, MS6 Nei-Guan, C7 Shen-Men, etc.).
6. It is necessary to carefully define the localization of the points, because points with different assignments can be placed close to one another.
7. In order to achieve maximum clinical effect of the treatment session, it is desirable to establish, taking into account the daily activity of the affected meridians.
8. Ultrasound should not be used to treat spots, nevi and angiomas, as it may cause biostimulation.

Furthermore, during the work of the doctor must act based on recommendations for the use of different modes of operation the apparatus, tochanges parameters according to the power frequency ultrasound, the frequency, type of modulation, etc.

For the introduction of drugs into the BAP (micro-ultraphoresis), an ointment base is applied to the working surface of the radiator, and then applied to a point on the skin. The duration of exposure to each point of not more than 1-2 minutes. In general, the recommendations for mikro-ultrafono-forez look the same as recommendations for ultrasound puncture.

A combination of other health factors with ultrasound punctures (USP)

As mentioned above, the ultrasonic puncture successfully combined with the simultaneous action of a magnetic field and, if necessary, followed acuncture (electropuncture) at the same point.

For example, sciatica. In this disease the most painful points is VB30, V36, V58. These points can be influenced by ultrasound and immediately, without a break to spend in them acuncture (electropuncture). The number of combinations of ultrasonic puncture with a variety of medical factors is practically unlimited. However, to obtain maximum efficiency, it is necessary to adhere to the general principle physiotherapy reflexology, using several methods of influence, try to „separate them on different levels." For example, if ultrasound puncture + magnetic action with irradiation of the posterior part of the stomach (V21, V20) is chosen for the treatment of gastric ulcer and duodenal ulcer, then at the same session can be influenced by the infrared laser on the abdominal organs (the projection bulbs of the duodenal ulcer, gallbladder, epigastrium).

The combination of the action of ultrasonic waves with other physical factors

Treatment with ultrasonic waves can be combined with virtually all types of electrotherapy, vacuum massage, and balneotherapy. An effective combination: ultrasound therapy with laser therapy, magnetotherapy and electrotherapy. In such cases, it is advisable to first use an ultrasound examination. It should be remembered that in the physiotherapy conditionally distinguish between two methods of influence, combined and united. Combined physiotherapy is considered to be consistent (at different times) the use of physical methods of treatment. Thus, combinable physical methods can be applied in a single day, on different days (interlace method) in the course of treatment or when some other alternate methods. The combined effect is a combination of two or more medical procedures either simultaneously or sequentially (one after another) on the same region. Increased use of two or more treatment methods may result from the effect of addition of acting in the same direction (on the same physiological system) methods or potentiating the action of another method.

The effect of combination therapy and physiotherapy based on the strengthening of the local reaction on the principle of contrast therapy and mechanism of sensitization. A properly selected physiotherapy complex greatly increases the effectiveness of treatment, has an impact on basic and associated diseases, various physiological systems of the body and the disease process, summarizes the positive effects of physical factors acting synergistically or weakens their adverse effects, as well as lengthen the period of aftereffect physiotherapy course.

The following procedures are compatible during the day:

- General and local action on the underlying disease (eg, ultrasound, and then shared bath or a common electrophoresis);
- Common action on the underlying disease and local action, for the treatment of concomitant diseases (eg, ultrasound in the region of the tonsils and gas bath);

- Two procedures of local action on the one disease (eg, ultrasound and electrotherapy);
- Two methods of local treatment, after which subsequent increases the effects of another (eg, phonophoresis and amplipulse);
- Permissible use in one day of three local procedures that do not cause a large load and fatigue of the patient (eg, microwave therapy, ultrasound and then electrophoresis);
- In the same session acceptable combination of three factors, for example the magneto solinoidy on the medulla zone and the corresponding segment of the spine, and the ultrasonic transducer on the on the projection of organ being in a pathological state).

3.9. Indications and contraindications to the use of ultrasound therapy

The main indications for ultrasound therapy

Diseases of the peripheral nervous system (radiculitis, neuritis, neuralgia, myalgia, peripheral nerve injury):

1. Diseases of the musculoskeletal system (degenerative-dystrophic and inflammatory diseases of joints and-deforming spine osteoarthritis, low back pain, spondylosis, ankylosing spondylitis, rheumatoid arthritis, bursitis, psoriatic polyarthritis, periarthrosis, epicondylitis, heel spurs, the effects of trauma and joint contractures, post-fracture bones, chronic tendovaginitah, Dupuytren's contracture and Liderhoza, meniscal lesion, sprains);
2. Internal diseases (chronic bronchitis, bronchial asthma, chronic pneumonia, initial forms of pneumoconiosis, peptic gastric ulcer and duodenal ulcer, chronic colitis, chronic cholecystitis without the presence of stones, biliary dyskinesia, chronic pyelonephritis, chronic pancreatitis);
3. Gynecological diseases (subacute and chronic inflammatory diseases of the uterus, secondary infertility, mastitis, etc.);
4. Urological diseases (prostatitis, epididymitis, orchitis, and others.);
5. Surgical disease (sluggish granulating wounds, scars, adhesions, hydro-adenitis, burns, chronic osteomyelitis, limb obliterating vascular disease);
6. Otolaryngological diseases (chronic tonsillitis, hypertrophic pharyngitis, subacute and chronic sinusitis, in the absence of pus in the sinuses, allergic rhinosinusopathy with moderate allergization, vasomotor rhinitis);
7. Dental disease (periodontal disease, glossalgia, scar adhesions cervical-facial region, arthritis and arthrosis of the temporo-mandibular joints, masticatory muscles contracture);
8. Eye disease (age scars, opacification of the vitreous, the prevention of corneal transplant clouding, residual manifestations of hemorrhage in vitreous, retinitis pigmentosa, diabetic eye disease, and others.);
9. Skin diseases (atopic dermatitis, chronic recurrent urticaria, limited scleroderma, arthropathic form of psoriasis, pruritus);
10. Diabetes and its complications, some embodiments,
11. Pulmonary tuberculosis when staunchly non-healing cavities.

The main contraindications for ultrasound therapy

Acute infectious diseases:

1. Fevers of unspecified origin;
2. Severe neurotic or personality disorders;
3. Circulatory (atherosclerotic et al.) encephalopathy grades III-IV;
4. Coronary heart disease with angina grades II-III or arrhythmia;
5. Cardiac aneurysm; stage III hypertension;
6. Circulatory failure, grades III;
7. Thrombophlebitis (the affected area);
8. Blood disease;
9. Bleeding tendency;
10. Pregnancy;
11. Severe exhaustion;
12. Systemic blood diseases.

Relative contraindications include: neoplasms (tumors) and mental diseases in the acute stage, syringomyelia.

Prohibited areas for ultrasonic therapy

Epiphysis of growing bones (up to approximately 17 years)

The use of ultrasound may be accompanied by the risk of damage to the bone growth zone. Since ultrasonic instruments of older types operate at low intensity (on display data does not match the actual number of attached energy), their use in most cases not result in damage to the growth zone. For this reason, many doctors do not agree with these contraindications. Modern devices are much more powerful and effective, but, in contrast to older devices, they can cause damage to the bone growth area, especially if insufficiently radiating head moves. Preventing this contraindication is the responsibility of the physician. It can be easily overcome by applying appropriate intensity ultrasound (0.4 W/cm^2 or 3 micrometers) and a labile (but not stable!) technique.

Sex glands in men (testicles) and in women (ovaries)

Small doses lead to temporary, while large doses lead to irreversible sperm or ovogenic failure.

Eyes

The use of ophthalmic ultrasound devices is allowed only in specialized centers.

Consequences of laminectomy

As a result of the operation after laminectomy, the spinal cord is not completely covered by the bone bed, and the intense effect of ultrasound on the spinal cord can lead to transient or permanent paraparesis.

Prevention: the impact on the post-operative area should only be conducted labile technique and low-intensity ultrasound.

It is not recommended to work with ultrasound directly on the heart, brain, bone prominent on the surface (the patella, the spinous processes of the vertebrae, etc.).

Features of ultrasound therapy

Many authors believe that ultrasound therapy is good treatment for epicondylar diseases. This can be taken if the ultrasound is performed only for the relevant muscles. Direct exposure of ultrasound to the painful space of bone can lead to increased pain and possibly a transition to a chronic phase of disease (the same effect as that in many cases, the massive use of corticosteroids). Similarly, the direction of the ultrasound directly „on the spine" often gives rise to pain in the periosteum around the protrusions of spine.

In the acute phase of the post-traumatic condition (up to 24-36 hours), the use of ultrasound to the area of torn injured tissue is contraindicated (it can increase swelling and "slow down" bleeding). The same applies to the classical inflammation (swelling, erythema, local temperature rise.

If the intensity of the ultrasound is too high, it can occur the deceleration in the corresponding nerve conduction, and then, followed by (reversible) blockage of blood flow impulses. However, this can follow irreversible disintegration of axons (myelin sheath is retained).

Prevention: use labile techniques and low-intensity ultrasound on nerve projection.

The ridges of bone just beneath the skin (ankle epicondyles, spinous processes, etc.) are also sensitive to ultrasound. In such cases, preference should be given to the method of underwater ultrasound therapy.

There are also other negative effects, mainly caused by overdose: hypoglycemia, fatigue, anxiety, change in appetite, and others.

Resumption of bleeding. For example, in the treatment of the knee joint by sonication, may occur resuming epistaxis.

Prevention: the use of low-intensity ultrasound in a patient with „usual" bleeding. Do not attempt to use ultrasound treatment during menstruation.

Nota bene for doctor and patient!

Do not allow the patient to conduct ultrasound therapy by himself!

Ultrasound therapy is often asymptomatic, but in the area to be treated, may feel a mild fever or heat.

If the skin feels intense heat, this indicates an insufficient contact substances. Pain during treatment session may indicate overdose or lack of movement of the radiating head. In case of overdose, the procedure should be discontinued!

Therapy can be resumed at a lower intensity, usually after a one-day break.

After the first procedure may be a temporary worsening of the disease.

Noticeable subjective or objective improvement occurs no later than after the third treatment session.

If improvement does not come (in the acute or under acute conditions) after five sessions, ultrasound therapy should not be continued.

If ultrasound is used to treat chronic processes or changes in the mechanical properties of tissue (such as Dupuytren's contracture or plantar aponeurosis associated with osteophytes calcaneus), the impressive results can occur only after a full (14-15 sessions) treatment or even several courses of ultrasound therapy.

3.10. Magnetic-laser therapy

The concomitant use of complex physical factors become one of the important directions in modern physical therapy. Currently, the combination of MP with low-energy laser radiation (LeL) is widely used.

The LeL impact on certain areas or human tissue, located in the permanent or pulsed magnetic field (MF) has been called magnetic-laser therapy (MLT). Such treatment option, as follows from the name itself, provides for simultaneous action on a specific area of two physical factors: LeL and MP, while the laser effect is enhanced in the magnetic field of therapeutic intensities (20-40 mT) by increasing the absorption of infrared (IR) radiation in the collinear arrangement of the molecular dipoles arising in MP. It seems appropriate to stop at the physical characteristics of these factors. For laser characterized by the following physical properties: monochromaticity, coherence, direction and polarization.

Monochromaticity radiation of electromagnetic waves (EMI) a specific frequency or a specific wavelength. For example, for a helium-neon laser (HNL), the characteristic radiation has a wavelength 632 nm, for Gallium arsenide laser – 890 nm, etc.

Coherence-order phase is the distribution of the laser radiation in both time and space.

The concept of orientation characterizes the small divergence LeL, the concept of polarization-ordering and orientation of the vectors of the electric and magnetic fields of the light waves in a plane perpendicular to the light beam. These physical properties of LeL determine the features of its biological action, and the intensity of the latter also depends on the wavelength: the longer the wavelength, the smaller the energy of the photon.

The incident on the surface of the biological tissue laser light is divided into three parts: reflection, absorption and diffuse.

The coefficients of reflection, absorption and scattering primarily depend on the laser wavelength. Thus, the penetration depth of ultraviolet LeL (=337 nm) is a fraction of a millimeter of the skin. The penetration depth of infrared LeL (=890 nm), without MP, is 40 mm, and with the impact on the tissue by irradiated with MP, the penetration depth growth up to 45 mm.

Biological factors affecting the change, the above coefficients are: skin pigmentation, nature of tissue damage, the degree of its blood supply, etc. Thus, it is known that the reflection coefficient of laser radiation from human skin varies from 20 to 43%, and the absorption coefficient from 57 to 80%. A liver, kidney, heart, spleen, large intestine has the high absorption coefficient (75 to 90%).

The degree of absorption of laser radiation defines the effectiveness of laser treatment and the duration of the of the subsequent pathological processes. This is reflected in the fundamental law of photobiology, the essence of which is to ensure that the biological effect can only cause a light wavelength that is absorbed by the molecules or components of the cell membrane. In the near-infrared region, the absorption of light quanta is probably due to overtones of oscillations of valence bonds of hydrogen atoms to carbon atoms of nitrogen and oxygen, and the increase in vibrational energy of the biomolecules. This may explain the uniformity of the electromagnetic radiation in a wide wavelength range. Infrared light is preferentially absorbed in the body of water molecules, oxygen, and some enzymes.

The main physical processes occurring in the skin, mucous membranes and other tissues during the absorption of light energy led to a decrease in the manifestation of the internal photoelectric effect and the electrolytic dissociation of molecules in various systems of the body.

In the internal photoelectric effect, under the influence of laser radiation, an electron, first associated with the atom absorbs a photon energy, breaks the connection with the nucleus of an atom and becomes free. Therefore, by irradiating laser light to the tissue it increases the concentration of free electrons and the conductivity increases.

More photons are absorbed at the surface of the tissue, which form more free electrons than at depth, which leads to the emergence of a potential difference between them, which, in turn, causes a photoelectromotive force (PEMF) and the appearance of photons. Moreover, the larger power of the radiation, the more pronounced the effect. Increasing the concentration of free charge carriers-electrons indirectly changes the dielectric constant (photodielectric effect), the magnetic susceptibility of tissue, etc.

Another result of the impact of a weakening LeL ionic bonds and ion-dipole interactions in molecules and tissues due to the absorbed energy. Thus, there a free ions and electrolytic dissociation is occurring. It is also known that laser radiation in the wavelength range 0,85-1,3 microns absorbed primarily oxygen, water, biological structures (primarily cell membranes) in resonance mechanism. This endogenous oxygen is virtually the only molecular target for MLT. This leads to the formation of two forms of high-energy singlet oxygen, the energy of which is realized as a non-selective photodynamic effect without photosensitizers. With regard to the problems of laser generation of singlet oxygen will result primarily to effects on cellular membranes, alteration of the antigenic properties of organs and tissues, as well as the peroxidation of cyclic compounds (purine and pyrimidine bases, cholesterol, steroids and hormones, bile pigments, porphyrins and others.) and aliphatic compounds (unsaturated fatty acids, phospholipids, sfignomielin, cerebrosides).

Consequently, the severity of LeL effect (gain or attenuation of the normalization of lipid peroxidation) depends on the concentration of singlet oxygen, that is, the dose of laser irradiation (V.A.Buylin et al., 1990) [3,39].

When combined (simultaneously) the impact of LeL and MP, in addition to a simple summation of the energies there, and other physical phenomena. The first effect is the Kikoin-Noskov effect: irradiation of tissue in the MP leads to the anomalous Zeeman effect and electron paramagnetic resonance, that is, observed selective absorption of EMR irradiated substance associated with its transitions between the energy levels of atomic electrons according to Zeeman. The frequency of the absorbed radiation (the resonance frequency) depends on the strength of a magnetic field.

The laser pulse energy is utilizing, after it was accumulation in the „dark stage" during the pulsed bio-stimulation (ie, in the intervals between laser pulses) only in high-speed and spectrally selective excitation transfer acts, cascades of biochemical reactions of the catalytic type, labile electronic states of the molecules in the cells of tissues and physiological substrates in the patient. Laser pulses can periodically renew, start (trigger principle) and „feed" the energy of such reactions in the case of local energy imbalance in certain diseases.

Thus, knowing the frequency of the laser light (the reciprocal of emission wavelength) and changing the force of magnetic field is possible to achieve equality of the resonant frequencies of electron paramagnetic resonance and laser radiation that leads to a sharp increase in the degree of absorption of the tissue which being irradiated, and consequently, an increase in photocurrent and effectiveness of the procedure.

The increase leads to a photocurrent due to the Hall effect, an additional potential difference between the irradiated layers located at different depths of tissue, which in turn leads to an

increase in photo-electromotive force, to several tens of volts (Kikoin-Noskova effect). It has also been shown that actively affects of MLT membrane processes in cells and tissues in a state of ions.

It is known that under the influence of LeL, tissues contain free ions (Na+, K+, Ca2+, etc.). Which increase metabolic processes through activation of membrane processes. For example, the ionic bond energy of NaCl is 97 kcal/mol, but upon dissociation in a liquid medium, these cage-like structures weaken, and the bond energy does not exceed 10 kcal/mol, which is a fraction of an electron volt. The energy of laser photons in the red and near-infrared ranges of the spectrum is approximately 1.9 eV, which is sufficient to break relatively weak electrolytic bonds. However, parallel with the process of recombination of ions, which slows down during metabolic reactions. Simultaneous exposure to biological tissues of MP and LeL inhibits ion recombination process. It is this combined effect promotes the separation of free charged particles by induced magnetic field proportional to the magnitude of the magnetic field (Hall effect). It should also be noted that the photon energy of the laser light in the focus of the the effect of magneto-laser able to break the energy ties between the water molecules and charged particles. When tissue is irradiated, LeL and MP ions become ordered, and the dipoles align along the MP power lines.

If power lines are directed deeper into the irradiated tissue, and the bulk of the ions and polarized molecules, too, is built deep into the tissue, which increases the penetration depth of the radiation. Irradiation of LeL in MF each unit volume of the tissue to digest more energy.

Naturally, the mechanism of the biological action of laser radiation, especially in combination with a magnetic field, cannot be limited to any single elementary event; it is determined not only by the totality of individual bioenergetic structures of a cell or tissue, but also by the reactions of the organism as a whole.

Therapeutic effects of magnetic laser therapy (MLT)

LeL has a complex and varied effect on the body, leading to a significant number of effects, the main manifestation of which is anti-inflammatory, analgesic effect and stimulation reparative processes pathophysiological sequence which may be the following:

Anti-inflammatory action:

- Activation of superoxide dismutase and catalase;
- Activation of microcirculation;
- Change the level of prostaglandins;
- Immuno-modulating action.

Reduction of lipid peroxidation when properly selected dose Lel:

- Alignment of the osmotic pressure;
- Reducing the swelling of tissues.

Analgesic effect:

- Activation of neurons metabolism;
- Increase the level of endorphins;
- Increase your sensitivity to pain.

Stimulation of reparative processes:

- The accumulation of ATP;
- Stimulation of cell metabolism;

- Increased fibroblast proliferation;
- Protein synthesis and collagen.

It is assumed that the specificity of LeL action depends on the radiation spectrum as specific wavelength absorbed by specific biological substrate (cells, molecules, and others.). For example, LeL in the ultraviolet range is absorbed mainly protein substrate (amino acids), and a specific acceptor emission (helium-neon laser) is the enzyme catalase, having a maximum absorption in the red region of the spectrum (628 nm), which practically coincides with the wavelength HNLradiation.

Increasing catalase activity within certain limits has a positive effect on the antioxidant system.

Under the influence of LeL in the red range, also in the tissues is activated enzyme superoxide dismutase, which, like catalase enzyme has a maximum absorption in the red region of the spectrum. All this leads to the normalization of lipid peroxidation (LPO), however, provided adequate doses selected magnetic field.

With high power loads and insufficient supply of the body with natural antioxidants, may increase lipid peroxidation processes that appear possible exacerbations of the disease to 7-9 sessions of laser therapy. It is assumed that the increase in oxidative processes in tissues is associated with the formation of active (singlet) forms of oxygen, since the latter have an absorption band near 640 nm (HNL = 632 nm) and, therefore, are activated, that is, it is formed form a singlet state.

Under the influence of radiation, HNL improves microcirculation, activation of collagen fibrillogenesis and with rapid epithelialization of the wound defect. Mitotic activation processes can be increased due to the energy metabolism in the cells of the wound edge epithelium and under the influence of HNL radiation.

In the near infrared range, the energy of LeL photons can initiate oscillatory processes in the molecules of a substance and activate the electronic excitation of atoms.

Therefore, the mechanism of action of biologically active IR is associated with photochemical transformations and a significant increase in the thermal vibrations of molecules of substances.

As a result of exposure to IR radiation, MF tissue come in a more excited state in which metabolic processes are amplified. This contributes the appearance of free forms substances, biologically active products of photolysis, pH-change medium. Ranges of energy activity of cell membranes, conformational changes occur in the liquid-crystal structures, primarily intracellular water. Strengthening of turbulent processes in flowing blood and lymph provides a more complete response to the plastic and energy components at the points of contact with the capillaries. These effects occur in the zones of irradiation launcher play a role for the development of zones generalized reactions at the tissue level, organ systems and whole organism.

Then, activation of the DNA-RNA-protein biosynthetic and oxidation-reduction processes in the main enzymatic systems occurs. Magnetic laser treatment causes an increase production of macroergs (ATP), the mitotic activity of the cells, oxygen absorption tissues, lowers the threshold of sensitivity of the receptor, reduces the duration of inflammation, interstitial edema and tissue tension, improves blood flow, increases the amount of collateral, has immunomodulatory effects *, activates transport of substances through the vascular wall. Thus, clinical observations and experimental studies show that the therapeutic effect of LeL and MP is more pronounced than in the separate or sequential use thereof. At the same time, it was possible to reduce the impact of exposure on the pathological center, compared to the duration of exposure when using only one factor and treat more deep-seated lesions.

Furthermore, now it is shown that the earth and the natural MP EMI actively affect many life processes, including endocrine glands, including – on the pineal gland.

The magnetic field of Earth and the natural electromagnetic fields affect:

- on the small groups of magnetite crystals which are inclusions in many cells of living organisms;
- on acupuncture points system, chakras and meridians;
- on the paramagnetic properties of water;

On the endocrine glands and, especially, to the pineal gland.

1. control, and biological rhythms, primarily „day and night mode", and hence of sleep and wakefulness, sleep or insomnia;
2. control of human immune status and, consequently, disease resistance and possibly to cancer (these data are now intensively studied by scientists in many research centers);
3. control of human mood, that is, from the base function of the pineal gland, in particular on the level of its hormones depends largely state of „depression", „euphoria" or balance. Interestingly, all the drugs-antidepressants act directly „through the pineal gland," or indirectly affecting its function;
4. control of the sexual activity and functional status of the prostate. For example, it turned out that southerners who moved to the place of residence in the Nordic countries, very often suffered from prostatitis and from treatment of it in an infinite variety of specialists. The reason – lack of solar isolation and, of course, from hypo functional condition of thyroid.
5. control of pain, that is, the dependence of human behavior from the pain, it has It depends on to the function of the pineal gland and its hormones level.

Important experimental studies investigating the combined effects of infrared radiation and constant and alternating magnetic fields on experimental atherosclerosis were conducted by S. M. Zubkova et al. (1998, 2000) [14].

An experimental model of hyperlipidemia was established in rats by transferring them to a vitamin-deficient diet enriched with cholesterol and mercazolil. The study population consisted of inbred male rats weighing 250–300 g, which were divided into the following experimental groups.

During the experimental period (24–28 days), all animals were maintained on a vitamin-deficient, cholesterol-enriched diet with the addition of mercazolil.

Group I (hyperlipidemia control group): rats with experimentally induced hyperlipidemia that did not receive any exposure to physical therapeutic factors.

Group II: rats with hyperlipidemia exposed to infrared radiation applied paravertebrally to the cervicothoracic spine (CIV–ThV level) for 3 minutes daily over 10 consecutive days, in combination with a constant magnetic field with a magnetic flux density of 30 ± 10 mT. The infrared radiation parameters were: wavelength 0.87 μm and output power 5 mW.

Group III: rats with hyperlipidemia exposed in the same anatomical region to infrared radiation combined with a full-wave pulsed magnetic field and an alternating magnetic field (frequency 50 Hz, magnetic flux density 30 ± 10 mT) for 3 minutes daily over 10 days.

Group IV: rats with hyperlipidemia exposed in the same region to infrared radiation combined with a constant magnetic field and a half-wave pulsed alternating magnetic field (frequency 50 Hz, magnetic flux density 15 ± 10 mT) for 3 minutes daily over 10 days.

In all experimental animals, adaptive changes were assessed in the primary target organs involved in this pathology, including the myocardium, liver, and cerebral cortex. The evaluation focused on protein and nucleic acid metabolism, levels of lipid peroxidation and antioxidant activity (AOA), indicators of the kallikrein–kinin system (KKS) and protease inhibitors, as well as serum concentrations of insulin and thyroid hormones.

Based on a comparative analysis of all investigated parameters, the authors concluded that the combined application of physical factors – infrared radiation (IR) together with a constant magnetic field (PMP) and a half-wave pulsed alternating magnetic field (AMF) – was the most effective among the three tested modes. This combination demonstrated superior efficacy in restoring vasomotor, metabolic, and immune disturbances associated with the development of atherosclerosis, as well as in ensuring adequate regulation of intravascular inflammatory responses.

When the exposure was localized to the cervicothoracic region (CIV–ThV), a reduction in sympathetic nervous system tone at the level of sympathetic ganglia was observed, accompanied by an increase in parasympathetic influences. These changes resulted in a pronounced vasodilatory effect and modulation of both systemic and regional hemodynamics, with active involvement of the kinin system.

In discussing the mechanisms underlying the initiation of biological effects, the authors emphasize the key role of water molecules as primary absorbers of infrared radiation, constant magnetic fields, and alternating magnetic fields, given that water is one of the most abundant components of the human body. In the infrared spectrum of water, the wavelength range of 0.7–0.9 μm corresponds to a major absorption band, with a maximum near 0.87 μm.

Absorption of infrared radiation by water molecules creates conditions for the interaction of electromagnetic energy with biological membranes, particularly at the level of the near-membrane layer (glycocalyx). Hydrated ions and polyelectrolyte cytoplasmic structures, which incorporate water molecules into their functional systems, also exhibit sensitivity to infrared radiation.

Under the influence of a constant magnetic field, orientation effects occur involving water molecules hydrating membranes and ions. Biological tissues can thus be regarded as optically heterogeneous and paramagnetic media, in which magnetic exposure induces a certain degree of structural ordering through these orientation effects. When such an ordered structure is subsequently subjected to infrared radiation, light scattering (the Tyndall effect) is reduced, and the resulting biological effects are predominantly associated with direct absorption of infrared electromagnetic energy.

When a third factor – a pulsed electromagnetic field (PeMF) – is added to infrared radiation and a constant magnetic field, the frequency characteristics of this field become critically important. Frequency serves as a key informational parameter in the interaction between electromagnetic fields and biological systems, as it enables synchronization of external physical stimuli with intrinsic biological rhythms.

One of the fundamental frequency characteristics relevant to this interaction is the cyclotron frequency, which determines the resonant behavior of ions in a magnetic field. The cyclotron frequency ($v_{(C_i)}$) is defined by the ratio of the ionic charge (q) to the product of the magnetic induction of the constant field (B_0) and the ion mass (m) (M. Ya. Azbel, 1966) [1,3,9].

1 = vts / 2qB0 / m.

When a match of the cyclotron frequency and multiplicity of the frequency of the external alternating magnetic field having the resonance effects of these ions and provides greater efficiency of its biological action (A.R.Liboff, 1985; A.R.Liboff et al, 1987). It was found that this combination PMP

and AMF can change the intra- and extracellular calcium concentration and the conditioned reflex activity of mammalian (C.F.Blackman et al, 1985;. J.R.Thomas et al, 1986) [36,40].

As shown by S.M.Zubkovoy et al. (1998) [37,41], as well as in other studies (V.V.Novikov, M.N.Zhadin, 1994;. G.N.Ponomarenko et al, 1998, increasing the biological activity of the combined effect of PHC and AMF with a decrease in the alternating magnetic field induction is evidence of the critical importance of information exchange with the AMF biosystems.

Thus, by proper selection of the complex physical factors can provide a more meaningful impact on the regulatory system of the body, reaching optimal adaptation reactions.

The results of experimental studies by S.M. Zubkov and co-authors (1998, 2000) [3,14,19] were performed using the „MUM-50", which provides for the possibility of simultaneous action of 2,36three factors mentioned above (laser light infrared, PMP and alternating magnetic field frequency of 50 Hz). The resulting the high biological effect in the IV group by experiment a combination of these factors no doubt. However, there are clinical studies (A.M.Gofeld et al., 1999) [39] in which a high therapeutic effect was achieved with much lower magnetic induction parameters (70 mT, which is comparable to Earth's magnetism). It received high therapeutic effect. Thus, the basic parameters in choosing the impact are not their capacity, and the selection of the resonance frequency.

To this end, by the scientific and methodological center „Medinteh" was made a special unit for magnetic resonance therapy („MIT-MR"), it passed the technical and clinical trials with high therapeutic effect of many diseases (hypertension I-II stages, angina pectoris, neuroses, etc.).

Technically, the device is made as a special mattress with built-in it 8 inductors and the control unit. Tensions MP on the surface of the inductor is less than 2 mT, and in the impact zone it is 50-200 mT. The device makes it possible to influence the following frequency variants: 1.2; 2.4; 3.3; 10.4; 12.5; 37.5; 50; 60; 75; 145; 700; 1500 Hz, which actually covers all the most commonly used frequency (heart rate, an alpha rhythm, the frequency of physical blocking of ion channels, frequency and analgesic al.).

In addition to the machine, there is one remote inductor with the same parameters as the MT in the above, and outrigger emitter inductor for MLT MP and pulsed IR laser or a pulsed laser and MP in the red range.

The procedure is as follows. The patient is placed after the required examination „on the mattress," that is, the inductors in special packaging (mattress) and then set the required parameters and enable the timer button is pressed the „start" and thus released the procedure, the duration of which is 10 to 30 minutes.

If necessary, in the presence of a specific disease (liver, stomach, and other fractures), an external inductor or inductor emitter connected to the control unit is applied to the desired organ.

Therefore, in medical practice today magnetic laser therapy has a place, and its application in the foreseeable future is even more promising. Of the manufactured equipment the most famous models are the devices MIT series („MIT-1 MLT", „MIT-LL", „MIT-1 Series 2", „MIT-1 IR" and others.).

General principles of magneto-laser therapy

Currently, magnetic laser therapy is used in two basic versions: zonal impact and transcutaneous laser irradiation of blood.

The selection of the exposure zone selection is made according to the principles set out in the relevant section of our book, and the time and other parameters are determined in the first place, the

laser energy (J/cm^2) and the tension of MT (mT).

It is known that the laser energy dose has the following effect (I.Z.Samosyuk et al., 2004) [1]:

- Preventive effect: 0.01-0.3 J/cm^2;
- Biostimulating effect: 0.2-0.9 J/cm^2;
- Therapeutic effect: 0.8-10 J/cm^2;
- Inhibitory effect: 10-25-30 J/cm^2;
- Damaging effect: more than 30-40 J/cm^2.

Based on the objectives of the treatment, the necessary dose is selected, and is calculated by the known formula:

t = ES / PK,

where: t – exposure time, s; E – required dosage of exposure energy, J/cm^2; S – exposure area, cm^2; P – laser radiation power, W; K – factor of the use of radiation.

When carrying out zonal MLT frequently used contacts, contact-compression or labile (scanning) methods and rarely – remote methods.

The pathological focus, after carrying out, if necessary, aseptic and antiseptic measures (wound, trophic ulcer, an area of bone fracture, inflammatory infiltrate, etc.) act with the help of special devices, such as MIT, which combine magnetic field and laser radiation emitters or impose a ring ferrite magnets (magnetic field strength of the order of 30-45 mT, but not more than 100 mT), and simultaneously irradiating by LeL which has performed at a power flux density of 4.5 to 20-30 mW/cm^2, depending on the severity and nature of the flow of pathological process. The duration of exposure to these physical factors on the one area, 3 -10 min., in one session are 20 minutes. Treatment typically consists of 3-10 treatments, less frequently -15 or 20. With the lack of clinical efficacy of the first course of therapy through a magnetic-10-15-20 days should undertake a second course of treatment.

Several MLT variants and their usage features

LN Budkar et al. (1996) [1,2,4] studied the effect of MLT in 112 patients with dysfunction of the pacemaker and conduction system of the heart (sinus node weakness syndrome or autonomic syndrome (parasympathetic) depressed sinus node and conduction system of the heart), which manifests itself in different variants arrhythmias (ventricular or suproventrikulyarnye arrhythmia).

The MLT course consisted of 15 daily treatments, which were carried out by the following procedure.

Exposure was carried out in the precordial area infrared laser (λ = 0.8-0.88 μm) at a power density of 4 mW/cm^2 and constant MP 10-40 mT with a total exposure of 12 minutes.

Kochetkov AV et al. (2000) [1] studied the effectiveness of various methods of magnetic and laser therapy in early rehabilitation of patients with cerebral stroke (CS) in 75 patients (ischemic CS was 57 people, hemorrhagic CS – at 18).

Treatment was started at 4-5 weeks after the acute cerebrovascular accident (ACVA). In one group of patients (61 pers.) has been used the method of combined MLT (CMLT) treatment procedure was as follows.

In the projection area of the lesion was performed trans-cerebral impact by low-frequency alternating magnetic field (LFAMF) in a continuous mode, a contact to cylindrical inductor (inductance 27-35 mT) with exposure of 10-15 min; a course of 15 treatments.

After 15-20 min. after applying LFAMF exposed to low-intensity infrared laser radiation (LIIRLR) (λ = 0,89 m) above the vessels. Parameters of the LIIRLR for one field: pulse mode (80-150 Hz), the power of 2-4 W/pulse at the contact stable method, exposure of 4-8 min. in the carotid sinus area and 4-10 min. on a projection of the vertebral artery in the suboccipital region; the total exposure when using single-channel devices, up to 20 min. (4 fields), two-channel – 10 min.; a course of 12 treatments.

For patients with lesions of the cerebral hemispheres, a combined version of MLT (CMLT). The essence of the method is as follows.

In one procedure, consistently, without interval worked LFAMF, without a break, to the brain (1st field, see above). In the projection area of cervical enlargement of the spinal cord (2nd field): a rectangular inductor, contact, intermittent (2-premise 2 with a break), the inductance of 18-25 mT, exposure of 10-12 min.; the total exposure of two fields – 25 min.; a course of 10-12 procedures. At the same time supraarterial laser, therapy on the projection area of both common carotid artery (CCA) was also carried out impact on your joints (no more than 2 joints).

Parameters, that influence on field 1: pulse mode (80 Hz and 1.5 kHz for 2-4 minutes each), power up to 5 W/pulse, the exposure of 4-8 min.; methods of contact – labile; total exposure to 4-field up to 20 min.; in the course of 10-12 procedures.

Patients in both groups received standard medical therapy.

As a result, the authors of the study noted that the clinical and neurological efficiency of complex rehabilitation, including methodology of CMLT, was 72% (in terms of „significant improvement" and „improvement") and of SKMLT („improvement") – 85%, which is significantly higher than the control groups ($P < 0.05$).

Percutaneous magnetic laser irradiation of blood

Until recently, the most common and well-studied method was effect on the blood predominantly by red laser as intravenous, percutaneous or irradiation of fluids and blood transfusion. These treatments are very popular among physicians and patients due to their relatively high efficiency. However, the practical application of magnetic laser therapy (MLT) allowed to use it in order to blood exposure. Thus, from the very beginning it was a variant of percutaneous exposure in mind the possibility of deeper penetration in the sharing of these factors.

The advantage of magnetic laser hemotherapy before the laser is as follows.

1. To achieve a stable controlled positive effect of hemolaser therapy, 1/3 of the circulating blood volume was required, and for a sufficient effect of hemomagnetic laser therapy, 1/4 was required. This is due to the more intense influence of magnetic laser therapy exposure on the blood. Red blood cells are known to contain iron, which is paramagnetic and thus able to „magnetized" and gain „new biological properties." The same applies to the enzyme „catalase" in the active center which also includes the iron atoms.
2. For the laser irradiation of a third of the blood volume in patient with a weight of 70 kg, for example via the cubital vein, it takes about 30 min. and in order to avoid a possible relapse during course of treatment optimal power LeL at the end of the optical fiber should be 1-2 mW.

The hemo-MLT procedure with equal effectiveness lasts 20-23 minutes with power up to 20 mW LeLand magnetic induction 30 mT. When MLT is not usually observed, this phenomenon leads to a secondary aggravation of to a pathology. According to modern concepts, the latter is associated with changes in the intensity of lipid peroxidation. In exchange of the application, such as laser ther-

apy, especially considerable intensity (50 mW), and the long duration of the procedure (30 minutes). After 6-7 treatments may experience an exacerbation of the disease. In physiotherapy and at resorts, these facts are well known and described in the form of so-called „balneo-reaction". The possibility of exacerbation of most FT options is related to the following factors:

- Depletion of natural antioxidants in the body in course of treatment;
- Increased metabolism and lipid peroxidation in response to „stress" (powerful) PT ;
- Changes in hormonal status (activation of the prostaglandin system in its thromboxane link, dopaminergic department and others).

In order to avoid exacerbation of the phenomenon it is recommended:

- Intake of antioxidants for the period FT (Vitamin E, A, C, aevitum and others);
- Short courses of treatment (up to 5 sessions) followed by a 3-4 day break;
- Selection an adequate capacity (dose) of physical factors and the factors themselves.

It turned out that MT is a kind of natural antioxidant, which is due to increased absorption of vitamins of this group from the intestine under the influence of MPs and their activation in the blood, regulation of lipid peroxidation (known MP parasimpatikotanii stimulation phenomenon), there may be other mechanisms.

Anyway, MLT, unlike pure laser therapy, in most cases, does not cause secondary exacerbations which is extremely important in the treatment of many disorders (e.g., angina, post-MI patients, hypertension etc.).

3. Percutaneous hemo-magnetic laser therapy allows to influence, due to significant penetration ability, not only the blood venous system, but also on arterial and on the filled with the blood the ventricles and atria of the heart.

Due to these advantages, percutaneous hemo-MLT is gradually replacing laser methods for blood irradiation.

The zone for exposure to magnetic percutaneous laser irradiation of the blood.

Selected for this purpose are usually vascular bundles in areas where they are positioned most surfactants: elbow and popliteal fossa, femoral and subclavian arteries, if necessary, the carotid arteries and the heart area. Less effect on smaller arteries or veins: radial, ulnar and others.

Before the procedure, if the effect on the artery defined by its pulsation and then magnetic-emitter mounted on the artery without much pressure (the blood must pass through the artery). Using a special attachment (cuffs), the transmitter is attached for the desired time. Next, turn on the device with the specified (required) parameters of magneto-laser impact.

Parameters of the hemomagnetic laser therapy procedure

For hemomagnetic laser therapy (hemo-MLT), red laser light (λ = 0.63 m) and infrared range (λ = 0.85-1 m) can be used. Preference is given to the latter. The optimal power of the red laser should be 10.5 mW, and the infrared laser – 10-20 mW. The magnetic-induction from 5 to 50 mT. With these parameters, the duration of exposure in a single session is 20-23 minutes. If other parameters require appropriate recalculation towards increase or decrease the duration of the procedure, as well as if the patient's weight is more than 70 kg or less than 70 kg. However, during hemo-MLT in adults, should generally not be less than 15 min., and for children 10 min. (the need for a specific irradiation volume of blood). It should also be remembered that in the same session is preferred to operate at 4 to 5 min on the area. For one zone (the bundle of vascular) – 20 min. In our work we prefer as fre-

quency modulation of these factors, determining in each patient of his basic rate by the number of heartbeats. For example, the number of heartbeats per minute is 75 beats, then 75:60 = 1,25 Hz. This is the base rate for a particular patient and the frequency of the modulation frequency or a multiple of it mounted on the apparatus.

The number of hemo-MLT procedures is defined individually and can range from 3 to 10-15 per course of treatment. If necessary hemo-MLT alternates or combined with other physical therapy (ultrasonic, electro-therapy, etc.) and to the zonal exposure of MLT.

The biophysical and biological effects of magnetic laser radiation described by B.S. Briskin et al. (1996) are formulated as follows [14,15,19].

1. At the atomic and molecular level:
   - The absorption of light by tissue photoacceptor.
   - Electrolytic dissociation of ions (the gap of weak links).
   - The formation of electron excitation.
   - The migration of electronic excitation energy.
   - Primary photosynthetic effect.
   - The emergence of primary photoproducts.
2. At the cellular level:
   - Changing the energetic activity of cell membranes.
   - Activation of the nuclear unit cells system DNA-RNA-protein.
   - Activation of redox, biosin¬teticheskih processes and key enzyme systems.
   - The increase in the mitotic activity of the cells, activation of the processes of reproduction.
   - Stimulation of ATP and the nucleic acid synthesis.
   - Reduced intensity of free-radical processes.
   - Immunostimulatory effects.
3. At the organ level:
   - Reduction of the sensitivity of the receptor.
   - Reduction of the duration of the phases of inflammation.
   - Reduction of interstitial edema.
   - Increased oxygen absorption fabrics.
   - Increased blood flow velocity.
   - Increasing the number of new vascular collaterals.
   - Activating the transport of substances through the vascular wall.
   - Improve the microcirculation.
   - Activation of metabolic processes.
4. At the level of the whole organism:
   - Anti-inflammatory.
   - Analgesic.
   - The regenerative, immunocorrective.
   - Decongestants, desensitizing.

- Improvement of the regional circulation.
- Bactericidal and bacteriostatic effects.

3.11. The combined use of physical factors

In the previous section we formed the basic principles of the zone selection exposure with multi-level rationale, systematic approach, as the most promising and giving the most significant therapeutic effect. In domestic PT to date is justified and has been successfully applied an integrated approach to the appointment of therapeutic physical factors (TPF), providing combined or combined their application. In our opinion,multi-level zones based on the principle of system selection, combined with complex application of TPF complement each other and extend the capabilities of physiotherapy and physio-puncture treatment. In this regard, let us more detail on these issues.

The combined use of TPF involves the simultaneous exposure to several factors in the same area carried out taking into account the laws of their mutual influence, which contributes to potentiation of the therapeutic effect. Clinical practice has proven the high efficiency and cost-effectiveness of simultaneous use of DC or pulse currents and mud applications (electro-mud), a high-frequency magnetic field and the drug electro-phoresis (inductive-thermoelectrophoresis), vacuum electrophoresis and vacuum-magnetic therapy, electro-ultraphonophoresis and magnetic-phonophoresis, magneto-laserphoresis and ultra-magneticlaserphoresis and others.

Such variants „phoresis" facilitate the administration of more drug increased pharmacological activity and extend its action in comparison with the individual application electro-phoresis or ultra-phonophoresis.

The combined use of TPF requires consistent (at different times) the use of LFF. In this case two or more impact factors can be carried out on one or different in one zone, and on different days or courses of the use of one method can be replaced by other procedures use rate.

In recent years, serial production of devices that allow simultaneous use of a magnetic field and laser radiation (magnetic-), ultrasound and laser radiation (laser-ultrasound therapy) – apparatus „MIT-11", as well as options for magneto-hydro-lazernoy- and magneto hydro-laser and vacuum therapy, hydro-bath, magnetic and others.

There is no doubt that further technical improvement of equipment will help to create new combinations of TPF.

The basic principles are the principles of a comprehensive physiotherapy synergy and potentiation implemented the inclusion of a set of physical factors of unidirectional action. For example, magnetic-, magneto-hydrodynamic laser-vacuum massage, laser, ultra-sound therapy and others.

The synergism principle is widely used in the combination methods, for example, when the preliminary application of ultrasound, magnetic fields or magnetic-laser facilitates the introduction of a large number of drugs by electrophoresis and lengthening their period of validity. To enhance the analgesic effect of ultrasound therapy combined with diadinamo- Amplipuls therapy or therapy, electro-phoresis of local anesthetic agents, while increasing anti-inflammatory and allergen ultrasound effect is achieved through an integrated application of high-frequency electromagnetic fields, UHF, SHF, and UFO, low-frequency magnetic therapy or magnetic laser therapy.

Much less frequently used the principle of antagonism in the complex physical therapy, which can reduce the unwanted or excessive effect of the actions of one of the factors. In particular, the use of infrared rays (infrared hydro shower) on the area exposed to ultraviolet radiation causes of

erythema attenuation. A similar procedure has already found application in a number of resorts in the Crimea.

The use of the electric field, UHF or infrared laser radiation in combination with mud applications greatly reduces the acute reaction to the mud.

Suffice it is widely used by combining of TPF for the principle of sensitization, based on the fact that the effect of one factor causes the body or some of its system in the state, more sensitive to the effects of another. Thus, prior to use techniques that cause active hyperemia (ULTRAFON therapy, heat treatments, massages) enhances the action of UV rays and more fully to carry out electrical stimulation as a result of reducing the electrical resistance.

An important element of physiotherapy is the principle of the local gain (focal) response, implemented through a combination of methods that have a beneficial effect on both the general and local condition (local intervention usually precedes total intervention).

The data accumulated by this time allow us to formulate the basic rules for the complex use of therapeutic physical factors as follows [17,39]:

1. In physiotherapy there are no absolutely incompatible procedures. Inappropriate use of individual actions on the exact same area on the same day does not exclude the possibility of their use in different areas or on different days.
2. The effectiveness of a therapeutic complex is not enhanced by inclusion of a large number of procedures, and depends on the doctor's ability to use multi-faceted properties of physiotherapy techniques for deliberate action on the pathological mechanisms and sanogenesis of disease, as well as the main clinical manifestations and comorbidities.
3. In most cases, the most effective is the inclusion of the complex in procedures general and local effect, thus, reasonable to administer local effect immediately prior to the common amplification reaction or 2-3 hours after the procedure, considering the generalized reactions and requiring a period of rest and recovery.
4. It is advisable to prescribe one general impact procedure on the same day, and only patients with high adaptive properties of the cardiovascular system, are in remission, it is permissible to use two procedures generalized influence provided enough (4-6 hours) period between them and maintaining the optimal number of procedures for the course.
5. The local area should act with one or two therapeutic factors, taking into account the possibility of their interaction and the optimal combination. In the presence of concomitant diseases, the number of local effects may be increased to 3-4, carried out on different zones, while it is advisable to use the methods which have different physical characteristics and nature, but do not have an antagonistic action with respect to each other.
6. Among the optimal combinations used for one zone and one day, the therapeutic effectiveness for which, has been proven, are a combination of IP and the laser electric field UHF, and FAL, electro-phoresis of drug and ultrasound, high frequency electromagnetic fields, UHF, SHF and iontophoresis. Equally feasible is a combination of inductothermy, UHF-therapy or micro-wave therapy with constant or variable pulse currents, and ultrasound. The effectiveness of the drug electro-phoresis increases significantly during the preceding exposure to infrared or visible rays or low-frequency magnetic field. More efficient functioning of the electrical neuromuscular system occurs after thermal procedures or, conversely, after exposure to cold (when hyperemia occurs).

7. The sequence of procedures and the interval between them are critically important for maximizing therapeutic effects. For example, the use of ultrasound immediately after iontophoretic drug administration enhances tissue penetration and increases local drug concentration. Conversely, performing the procedures in the opposite order may favor deeper drug distribution within the tissue rather than accumulation at the target site.

For iontophoresis following microwave therapy, an interval of no more than one hour between treatments is considered optimal. In contrast, when combining ultrasound with deep magnetic vibration (DMV) therapy, ultrasound should be applied immediately after DMV exposure for 10–15 minutes, and preferably just before the subsequent session of magnetic therapy, to ensure maximal synergistic effects.

8. The traditional rule is not appropriate combinations in a day of physical factors that are similar in nature. However, in recent years, thanks to the wide dissemination of short-pulse electroanalgesia apparatus, the use of relief of acute pain is widely used application on the same day or sinusoidal modulated diadynamic currents and short-pulse currents that combine to affect one area 4-6 times a day. A single, double application of DDT or CMT is performed, and all subsequent by short-pulse currents. In order to provide the analgesic effect of the application it is also acceptable in one day on one area of pulsed alternating sinusoidal current with frequency of 110 kHz (D'Arsonval current) and sinusoidal modulated currents.
9. In most cases impractical to effect one day per two factors reflexogenic zone except for using a combination of physical therapy techniques or special tasks.
10. As a rule, are not held on the same day multifaceted action procedure, in particular, heat and cold, due to possibility of surge of adaptive systems of the body and the development of an exacerbation of the pathological process. This combination of procedures is justified only in certain cases, to provide coaching or quenching influence (contrast baths and showers) or to attenuate excessive reaction to a previous procedure.
11. On the day of difficult and tiring diagnostic studies, it is advisable not to prescribe physical therapy, especially the overall impact.

To these must be added the following recommendations.

1. Combined use of LPF must take into account the multi-level, systemic principle in the choice of treatment zones. For example, in the treatment of optic nerve subatrophy, the following has proven to be optimal:

   a) magnetic stimulation of the occipital lobe of the brain;

   b) magnetic effects on the eyes;

   c) magnetic stimulation of the cervical region;

   d) low-frequency ultrasonic treatment on the liver area.

Thus, it is preferable to simultaneous influence on these factors listed above zone. Carrying out such procedures possible with the use of the machine „MIT-11."

2. To deliberate use of multi-level LPF, it is necessary to accurately determine of the status of functional systems of the body using acupuncture clinic data and diagnostic methods (methods Nakatani, Akabane, Voll et al.). In these cases, the systems are in state hyperfunctional preferably electromagnetic radiation-mm range, and in systems that are in hypofunction – laser radiation or ultrasonic waves.
3. When combining low-power physical factors (LPF) or applying them successively, it is generally preferable to start with the more energetically intense intervention and finish with the less

intense one. For example, a typical sequence may begin with ultrasound (sonication), followed by laser therapy, and conclude with extremely high frequency (EHF) therapy. This principle ensures that the informational component of each physical factor is effectively transmitted and preserved throughout the procedure. Performing the sequence in the reverse order – from weak to strong – can result in the weaker interventions "erasing" or diminishing the information content of stronger interventions.

Schematic options for the integrated, multi-level, systemic application of therapeutic physical factors are illustrated in Table 6.

The combined application of LPF, when implemented according to a multi-level system and the principle of zone selection, does not simply produce a cumulative effect of the individual factors. Instead, it generates novel quantitative and qualitative outcomes. Such outcomes may not only enhance or attenuate the effects of a single factor, but can also impart new therapeutic properties that are not present when each factor is applied in isolation.

Table 6. Integrated multi-level systemic application of therapeutic physical factors.

Step	Physical Factor	Relative Intensity	Target/Zone	Duration	Expected Effect
1	Ultrasound (sonication)	High	Deep tissues, musculoskeletal structures	10–15 min	Enhanced tissue permeability, neuromodulation, priming for subsequent therapies
2	Laser therapy (low-level / LLLT)	Medium	Superficial tissues, inflamed zones	5–10 min	Modulation of microcirculation, reduction of inflammation, stimulation of cellular metabolism
3	Extremely High Frequency (EHF) therapy	Low	Targeted local or systemic points	3–5 min	Immunomodulation, normalization of microvascular tone, informational effect at cellular level
Optional	Magnetic therapy (constant or pulsed)	Medium–High	Selected paravertebral zones / systemic	10–15 min	Regulation of autonomic balance, vasomotor normalization, coordination of multi-level response
Optional	Iontophoresis or drug delivery enhancement	Variable	Local affected tissue	5–10 min	Increased drug penetration, synergistic effect with physical factors

Notes for use:

1. *Sequence matters: Start with the most energetically intense factor (e.g., ultrasound) and finish with the least intense (e.g., EHF) to preserve the informational and modulatory effects of each factor.*
2. *Intervals: For combined procedures (e.g., microwave therapy followed by iontophoresis), maintain optimal intervals (≤1 hour) for maximal synergistic effect.*
3. *Customization: Factors and zones can be selected according to the patient's pathology, functional deficits, and tolerance.*
4. *Multi-level effect: Combined application produces qualitative effects beyond simple summation, potentially enhancing neuromodulation, microcirculation, and immune response.*

Integrated Multi-Level Application of Therapeutic Physical Factors

Effective rehabilitation using therapeutic physical factors depends not only on the choice of modality, but also on the sequence, intensity, and timing of their application. In a multimodal, multi-level system, each physical factor – such as ultrasound (sonication), low-level laser therapy (LLLT), extremely high frequency (EHF) therapy, magnetic therapy, or iontophoresis – produces both direct biological effects and informational signals that modulate cellular and systemic processes.

Key principles:

1. Sequential application: Start with the more energetically intense factor and progress to less intense factors to preserve the informational and modulatory effects of each modality.
2. Multi-level targeting: Address different tissues and structures (deep, superficial, systemic) in a coordinated manner.
3. Synergistic interaction: Combined application generates effects beyond the sum of individual therapies, providing enhanced neuromodulation, microcirculation, immune regulation, and tissue repair.
4. Timing and intervals: Proper intervals between treatments maximize the therapeutic outcome and optimize drug delivery when combined with iontophoresis or microwave therapy.

This approach is particularly relevant for post-war and veteran rehabilitation, where multimodal interventions address musculoskeletal, neurological, and immunological dysfunctions in a coordinated manner.

Sequential scheme: Integrated multi-level application

Step 1 ↔ Step 2 ↔ Step 3 (Optional Steps Included)

Step 1: Ultrasound (Sonication)

Intensity: High

Target/Zone: Deep tissues, musculoskeletal structures

Duration: 10–15 minutes

Effect: Enhances tissue permeability, primes neuromodulation, prepares tissue for subsequent therapies

↓ Next: Lower Intensity Factor

Step 2: Laser Therapy (Low-Level / LLLT)

Intensity: Medium

Target/Zone: Superficial tissues, inflamed zones

Duration: 5–10 minutes

Effect: Improves microcirculation, reduces inflammation, stimulates cellular metabolism

↓ Next: Weakest Factor

Step 3: Extremely High Frequency (EHF) Therapy

Intensity: Low

Target/Zone: Localized points or systemic zones

Duration: 3–5 minutes

Effect: Immunomodulation, normalization of microvascular tone, informational effect at the cellular level

Optional Step 4: Magnetic Therapy (Constant or Pulsed)

Intensity: Medium–High

Target/Zone: Paravertebral or systemic zones

Duration: 10–15 minutes

Effect: Regulation of autonomic balance, vasomotor normalization, coordination of multi-level systemic response

Optional Step 5: Iontophoresis / Drug Delivery Enhancement

Intensity: Variable

Target/Zone: Local affected tissue

Duration: 5–10 minutes

Effect: Increases local drug penetration, synergizes with physical factors

Methodological notes

Order matters: Always begin with the highest intensity factor and proceed to the weaker ones to maintain the informational and modulatory effects.

Intervals: For combined modalities (e.g., microwave therapy + iontophoresis), maintain an interval ≤1 hour for optimal synergistic effect.

Customization: Factor selection and zone targeting should be adapted to the patient's pathology, functional deficits, and tolerance.

Multi-level effect: The combination does not simply sum the effects of individual factors; it produces qualitative and quantitative effects, enhancing neuromodulation, microcirculation, and immune response.

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CHAPTER 4

PRACTICAL ADVICE FOR USING THE MIT-11 COMBINATION PHYSIOTHERAPY DEVICE

Lidiia V. Butska

4.1. Integration into multimodal rehabilitation

The MIT-11 combination physiotherapy device represents a multimodal tool designed to deliver integrated physical therapies in a single session, including ultrasound, low-level laser therapy, extremely high-frequency (EHF) radiation, magnetic fields, and optional iontophoretic drug delivery. Its design allows for precise modulation of intensity, frequency, and sequence, facilitating the synergistic application of multiple therapeutic factors in a systemic and multi-level approach.

This section provides practical guidance for clinicians and rehabilitation specialists on how to effectively use the MIT-11 device in post-war, veteran, and general rehabilitation contexts, where patients often present with musculoskeletal injuries, chronic pain, neurological deficits, and impaired microcirculation. Emphasis is placed on:

- Optimal sequencing of therapeutic modalities to maximize tissue response and informational effects.
- Selection of target zones and treatment parameters tailored to patient pathology.
- Timing and interval management to ensure synergistic interactions among physical factors.
- Integration into a multimodal rehabilitation program, including self-management, patient education, and community-based rehabilitation strategies.

The MIT-11 device is particularly suitable for veterans and post-war patients, where rehabilitation requires addressing complex chronic pain, impaired neuromuscular coordination, and autonomic dysregulation. In this population, therapy should be systemic, multi-level, and individualized, incorporating:

- Community-Based Rehabilitation (CBR): promoting participation, self-management, and peer support.
- Educational strategies: instructing patients on safe exercises, ergonomics, and symptom monitoring.
- Self-management techniques: combining physical therapy with relaxation, breathing exercises, and light physical activity to enhance neuroplasticity and reduce chronic pain.

The sequence, intensity, and combination of physical factors delivered by MIT-11 are critical. Starting with the most energetically intense modality (e.g., ultrasound) and progressing to lower-intensity interventions (e.g., EHF therapy) preserves the informational effect of each therapy, ensures synergistic interaction, and enhances systemic physiological responses.

The following sequential scheme illustrates a practical approach for integrating MIT-11 therapies into a multi-level rehabilitation session, showing order, intensity, target zones, and expected therapeutic effects for each modality. This approach allows clinicians to maximize efficacy while maintaining safety, and to adapt protocols to individual patient needs.

Sequential scheme for MIT-11 combination physiotherapy device

Step 1 → Step 2 → Step 3 (Optional Steps Included)

Step 1: Ultrasound (Sonication)

Intensity: High

Target/Zone: Deep tissues, musculoskeletal structures

Duration: 10–15 minutes

Effect: Enhances tissue permeability, primes neuromodulation, improves circulation, and prepares tissues for subsequent therapies

↓ Next: Lower Intensity Factor

Step 2: Laser Therapy (Low-Level / LLLT)

Intensity: Medium

Target/Zone: Superficial tissues, inflamed zones

Duration: 5–10 minutes

Effect: Stimulates microcirculation, reduces inflammation, promotes cellular metabolism, supports tissue regeneration

↓ Next: Weakest Factor

Step 3: Extremely High Frequency (EHF) Therapy

Intensity: Low

Target/Zone: Localized points or systemic zones

Duration: 3–5 minutes

Effect: Immunomodulation, normalization of microvascular tone, informational effect at the cellular and tissue level

Optional Step 4: Magnetic Therapy (Constant or Pulsed)

Intensity: Medium–High

Target/Zone: Paravertebral or systemic zones

Duration: 10–15 minutes

Effect: Regulates autonomic nervous system balance, normalizes vasomotor tone, coordinates multi-level systemic responses

Optional Step 5: Iontophoresis / Drug Delivery Enhancement

Intensity: Variable

Target/Zone: Local affected tissue

Duration: 5–10 minutes

Effect: Increases local drug penetration, synergizes with physical therapies, enhances overall therapeutic effect

Methodological notes for MIT-11 use

1. Sequence Matters: Start with the most energetically intense factor (ultrasound) and progress to weaker modalities to preserve the informational and modulatory effects.
2. Intervals: For combined therapies (e.g., microwave + iontophoresis), maintain intervals ≤1 hour for optimal synergistic effect.
3. Customization: Choose factors, intensity, and zones based on patient pathology, functional deficits, and tolerance.
4. Integration into Multimodal Rehabilitation: Combine MIT-11 sessions with CBR, self-management, education, and therapeutic exercise for veterans and post-war patients.
5. Multi-Level Effect: The combined application does not simply sum individual effects; it produces qualitative and quantitative outcomes, enhancing neuromodulation, microcirculation, tissue regeneration, and immune response.

Contraindications to the appointment of magnet laser ultrasound therapy:

- Malignancy (malignancy);
- Thrombophlebitis;
- Ulcer bleeding (especially recurrent) in history;
- Hypertension stage II-III;
- Coronary heart disease with angina and arrhythmia;
- Individual sensitivity to the factor;
- Acute ischemic stroke;
- Pronounced hypotension;
- The presence of cardiac pacemakers.

4.2. H81.0 Ménière's disease, sensorineural hearing loss

Etiopathogenesis

Hearing impairment can be either acquired or congenital. Among acquired causes, factors include infectious diseases, cardiovascular disorders, stress, exposure to ototoxic industrial and household chemicals, certain medications, trauma, and age-related hearing loss. Congenital sensorineural hearing impairments may result from isolated hereditary factors or perinatal pathology, such as hypoxia at birth.

The primary pathogenic mechanism in Ménière's disease is an increase in the volume of endolymph within the labyrinth, leading to elevated interlabyrinthine pressure.

In most patients, there is activation of lipid peroxidation and reduced antioxidant activity in the blood, often related to co-morbid conditions. Disruptions in brain and systemic microcirculation contribute to the pathogenesis of cochleovestibular dysfunction, further aggravating hearing and balance disturbances.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 1):

Table 1. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-4	75-99	5; 10; 50; 99	UST - 2 to zone, to 10 totally MLT -3 to zone, to 15 totally

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily.

Number of treatments: 21.

Re-treatment: after 6 months.

Possible combination with other treatments:

- Drug therapy;
- Laser-puncture.

Methods of exposure: labile and stable in the recommended areas.

Exposure to ultrasound is performed via the contact medium (vaseline, ultrasound gel, medication, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors set (stable) on a projection of pathological hearth, or in paravertebral reflex zones and the zone of the medulla oblongata (Table 2, Fig. 1).

UST:

- Zone 11 (paravertebrally projection of C2-C8 vertebral segments).

MLT R:

- Zone 27 (paravertebrally D11-L1, the projection of the segmental innervation of the kidney,
- Zone 37 (the big toes pads).

MLT IR:

- ZL Zone (locus zone – pathological changes – the area of the external auditory canal, mastoid).

Table 2. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
11	ZL	27; 37

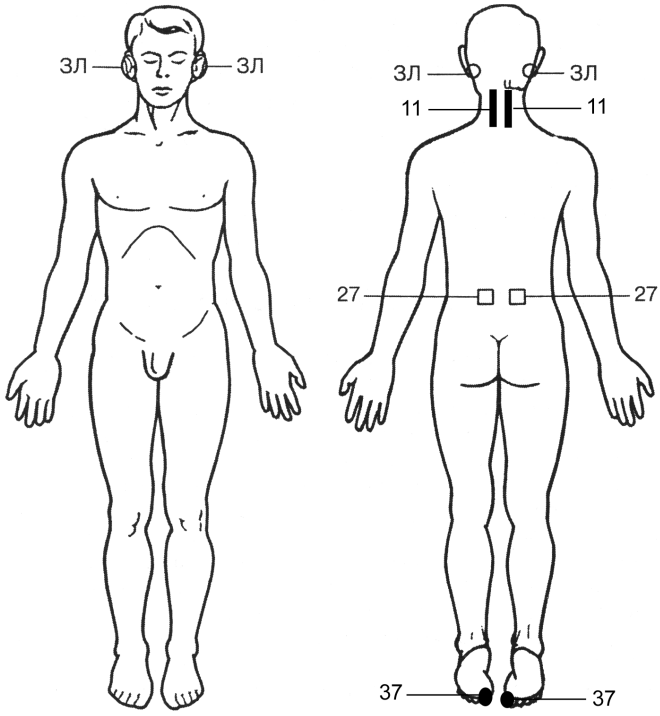

Figure 1. Zones for placing inductors.

4.3. G43 Migraine

Etiopathogenesis

Migraine is a disease characterized by paroxysmal re headache from 4 to 72 hours, often accompanied by visual and gastrointestinal symptoms.

Migraine attacks are accompanied by regional changes in cerebral blood flow due to the expansion of intracranial arteries. Vasomotor changes are caused by sporadic decrease systemic of concentration of serotonin. Prodromal symptoms may be due to intracranial vasoconstriction. One of the main factors of migraine is a constitutional predisposition to it, which is often hereditary According to the vascular theory of migraine is treated as suddenly develops generalized breakdown of the vasomotor regulation, which manifested by lability tone of cerebral and peripheral vascular disease.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 3):

Table 3. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	12-15	37; 75; 77	UST – to 10 totally MLT – to 15 totally

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily, during the acute (pain) period, a day in between attacks.

Number of treatments: up to 14-15.

Re-treatment: in case of need in two weeks.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Acupuncture.

Methods of exposure: labile and stable in the recommended areas.

Impact UST conducted directly or via a coupling medium (ultrasound gel, vaseline, medicament).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of the paravertebral or reflex zones and the zone of the medulla oblongata (Table 4, Fig. 2).

UST:

- Zone 17 (the projection of the liver)
- Zone 21 (the projection of the celiac plexus)
- Zone 25 (the projection of the liver and gall bladder).

MLT R:

- Zone 6 (projection of the carotid artery);
- Zone 10 (palmar surface of the right / left).

MLT IR:

- PPL (possible areas of pain localization – any pain sensible zone personal indicated)
- Zone 8 (C8 projection Th vertebral segments).

Additional area: UST (27); MLT IR (36).

ATTENTION!

For the impact of MLT and MLT R IR use 2-3 zone (of the proposed) in one session.

Table 4. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17; 21; 25; 27	PPL; 8; 36	6; 10

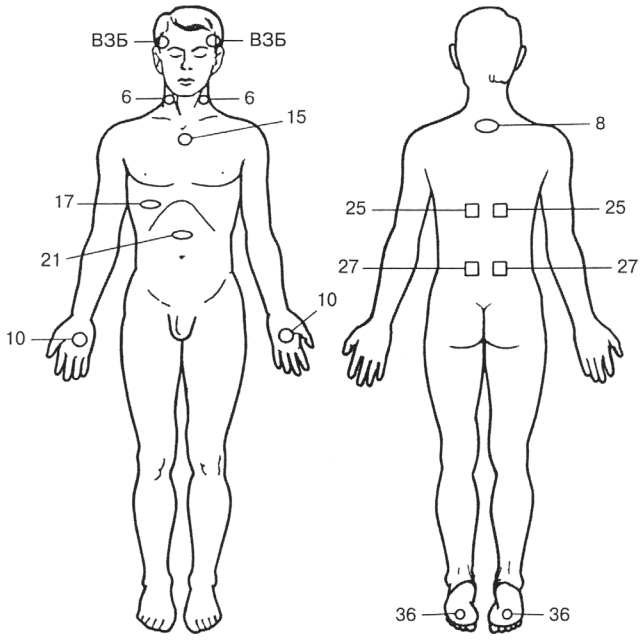

Figure 2. Zones for placing inductors.

4.4. N00-H59 Diseases of the eye and adnexa

H47.0 Subatrophy optic nerve

H35 Retinitis pigmentosa

Subatrophy of the optic nerve is a disease of the optic nerve and retina. It develops most often as a result of craniocerebral injury, cerebral vascular disease, or arachnoiditis. It is characterized by a decrease: the visual functions and pallor of the optic disc.

Etiopathogenesis

Causes: various pathological processes in the optic nerve and the retina (inflammation, degeneration, swelling, poor circulation, compression of the optic nerve damage), diseases of the central nervous system (brain tumors, abscesses, meningitis, syphilitic lesions), hypertension, atherosclerosis, profuse bleeding, intoxication, hereditary reasons.

Pathogenesis: the destruction of nerve fibers and their replacement by glial connective tissue, obliteration of capillaries that feed the optic nerve.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 5).

Table 5. Procedure parameters.

RANGE UST, mkm	**POWER MLT rel, %**	**MODULATION Hz**	**TIME, min**
3-5 growing with each session, a maximum the 5th session	50-75-99 growing with each session, maximum the 5th session	1-5th sessions - 1-10 (P 1) 6-7th sessions - 9.4 8-9th sessions - 18 10-11th sessions - 37 12-15th sessions - 75 16-21th sessions 10-100 sessions (P2)	UST – to 7 totally MLT – not more than 10 per zone.

Method of Treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily, first 5 sessions, the following 5 – in a day, then 3 sessions per week.

Number of treatments: 21.

Re-treatment: two or three months.

Possible combination with other treatments:

- Drug therapy;
- Superelectrophoresis (endonasal technique) hydrocortisone or vitamin E (in the solvent used kachastve 20% solution dimexidum.)

Methods of exposure: labile and stable in the recommended areas.

Impact UST conducted directly or via a contact medium (UST gel, Vaseline, medicament).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 6, Fig. 3).

UST:

- Zone 17 (the projection of the liver).

MLT R:

- Zone 3 (eye exposure through closed eyelids).

MLT IR:

- Zone 4a (the projection of the occipital lobe of the brain)
- Zone 8 (C8 projection Th2 vertebral segments).

Table 6. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17	8; 4a	3

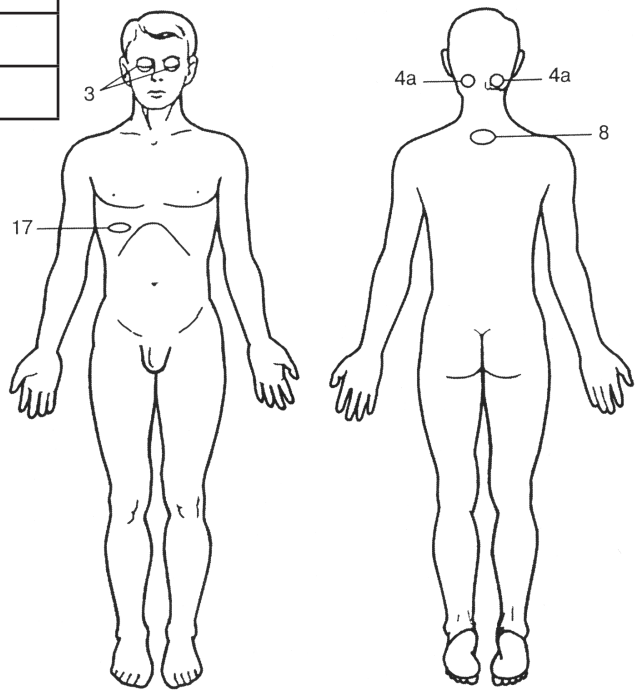

Figure 3. Zones for placing inductors.

4.5. L20-L30 Dermatitis and eczema

Dermatitis is a inflammation of the superficial layers of the skin neuro-allergic nature that occurs in response to external or internal stimuli, different polymorphic rash, itching and prolonged recurrent course.

Etiopathogenesis

It is considered eczema polyetiological disease. The weakness of the immune system in the presence of infectious antigenic stimuli is shown persistence of microbial and bacterial antigens to the formation of chronic recurrent inflammation in the epidermis and dermis. This gives rise to abnormal circulating immune complexes with the damaging formation of microstructures own series autoantigens autoaggressive initiating formation of antibodies.

Treatment regimens (acute stage)

The following procedure parameters are displayed on the front panel of the device (Table 7).

Table 7. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
2	75-99	Eczema, dermatitis - 0.7 Acne - 1.7 Pustular eczema, weakness, fatigue - 2.2 Diastolic hypertension - 9.2	UST - 5 on each side MLT - 3 zone, to 20 totally

Method of Treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: every other day.

Number of treatments: 10-12.

Retreatment: if necessary, after 30 days.

Exposure to ultrasound is performed via the contact medium – refined sunflower oil. As a medicament for ultraphonophoresis can use hydrocortisone.

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata.

UST:

- Zone 23, 25, 27 (paravertebrally, segmental lung area, liver, kidney);

MLT R:

- Zone 11 (ulnar fovea right / left);
- Zone 30 (popliteal fossa on the right / left);

- Zone 20 (the projection of the spleen);
- Zone 12 (over-and subclavian area).

Use 1-2 zone in one session.

MLT IR:

- Zone L (lesions)

Treatment regimen (chronic phase)

The following procedure parameters are displayed on the front panel of the device (Table 8).

Table 8. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3	75-99	Eczema, dermatitis – 0.7 Acne – 1.7 Pustular eczema, weakness, fatigue – 2.2 Diastolic hypertension – 9.2	UST – Zone 2, to 6-10 totally. MLT IR – 3 zone, to 20 totally. MLT R - 15

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily or every other day.

Number of treatments: 8-10.

Retreatment: if necessary, after 30 days.

Possible combination with other treatments:

- Drug therapy;
- EHF-puncture;
- Intravenous blood irradiation;
- Psychological correction;
- Diet therapy.

Methods of exposure: labile and stable in the recommended areas.

Impact UST is performed via the contact medium – refined sunflower oil.

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata.

Impact of Magnetic-Laser Therapy (MLT) Combined with Ultrasound (UST)

The combined application of MLT and contact ultrasound (UST) can enhance the therapeutic effect by simultaneously acting on pathological foci and reflexogenic zones. Inductors are positioned over the projection of the pathological focus, including paravertebral zones and the area of the medulla oblongata.

Ultrasound (UST)

- Applied to the OP area (lesions or pathological focus).

Magnetic-Laser Therapy (MLT) – Red Spectrum (R)

Recommended zones for application (choose 1–2 zones per session):

- Zone 11 – ulnar fovea (right or left)
- Zone 30 – popliteal fossa (right or left)
- Zone 20 – projection of the spleen
- Zone 12 – supra- and subclavian area

Magnetic-Laser Therapy (MLT) – Infrared Spectrum (IR)

Recommended paravertebral and segmental zones (select 1–2 zones per session):

- Zone 23 – paravertebral region
- Zone 25 – segmental lung area
- Zone 27 – liver and kidney projections

Clinical note: In each session, it is advisable to apply UST to the pathological focus while MLT targets 1–2 reflex or visceral zones. This combination allows for simultaneous local and systemic effects, enhancing microcirculation, tissue metabolism, and neuromodulation.

ACUTE PHASE (Table 9, Fig. 4)

Table 9. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
23; 25; 27	27	11; 30; 12; 20

CHRONIC STAGE (Table 10, Fig. 4)

Table 10. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
OP	23; 25; 27	11; 30; 12; 20

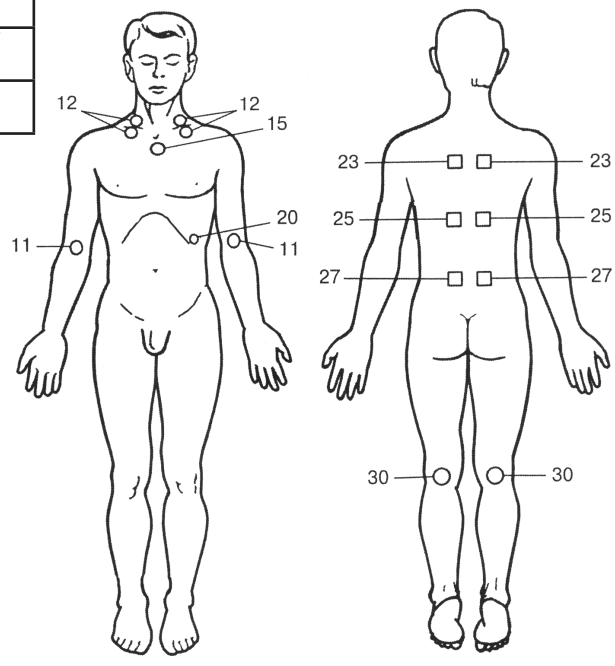

Figure 4. Zones for placing inductors.

4.6. K65 Peritonitis

Peritonitis is an inflammation of the peritoneum, accompanied by common symptoms of the disease organism from impaired function of vital organs and systems.

Etiopathogenesis

Peritonitis, regardless of the reason he was called is a bacterial inflammation, pathogens it is pathogenic cocci, Escherichia coli, is often the cause of peritonitis are anaerobes, Bacteroides, etc. In recent years, it found that up to 35% of peritonitis caused by several bacterial pathogens -. ,Associations of microbes.

In the pathogenesis of peritonitis main role belongs to intoxication. It is found that the area of the peritoneum is approximately equal to the skin surface. Evolving in a closed cavity suppurative process quickly leads to flood the body with toxins both bacterial and endogenous origin, especially serous cover contributes to the rapid involvement of it in the inflammatory process, which is usually accompanied by severe exudation. During the exudation on the parietal and visceral peritoneum formed fibrin overlay absorbing toxins.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 11).

Table 11. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
-	75-99	10	MLT - to 15 totally.

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily.

Number of treatments: 5-7.

Possible combination with other treatments: Drug therapy.

Methods of exposure: labile and stable in the recommended areas.

Impact MLT. The wires are in contact. The inductors are permanently installed on the projection of the pathological lesion or in the paravertebral reflex zones and the medulla oblongata (Table 12, Fig. 5).

MLT IR:

- Zone 13 (supravenous irradiation of blood vessels in the femoral area (on one side of the body) – 10 minutes;
- Zone 15 (the projection of the thymus gland) – 5 minutes.

After 4-6 hours of exposure carried out on the following 1.5 minutes zone:

MLT IR:

- Zone а, в, б (iliac area on the right / left);

- Zone B (left / right upper quadrant);
- Zone A (during the surgical wound in the two points).

MLT R:

- Zone 10 (palmar surface of hands).

Table 12. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
-	13, 15, а, б, в	10

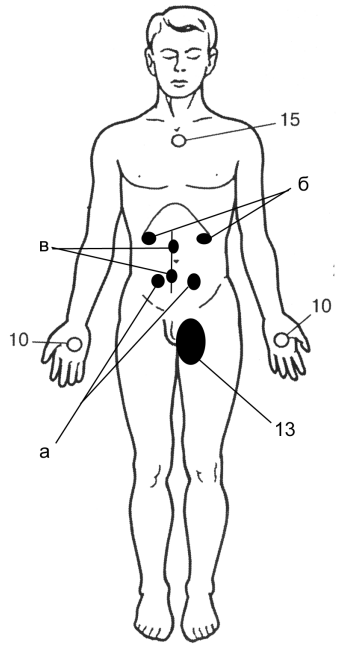

Figure 5. Zones for placing inductors.

4.7. L91.0 Keloids (prevention suppuration)

Etiopathogenesis

Scar formation is primarily driven by the extracellular matrix, including collagen. The extracellular matrix is a supramolecular complex that includes various types of chemical compounds (proteins, polysaccharides, proteoglycans, etc.). Of all collagens proteins constitute the main component of the extracellular matrix and are the most abundant proteins body occupying about 1/3 of all its proteins. Growth of excess extracellular matrix in the rumen occurs as a result of „wound" fibroblasts. In the intact (healthy) skin fibroblasts are responsible for the remodeling of components of the dermis, they destroy the old collagen and lay new. In wounds, injuries, burns, and post-surgical ulcers, myofibroblasts appear, attempting to „seal the gap" in the tissue by tightly adhering extracellular matrix components: collagen, glycosaminoglycans, elastin, and other proteins. This is due to the proliferation of fibroblasts and excessive production of extracellular matrix and growth scarring occurs.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 13).

Table 13. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
-	75-99	2-5 in the first three days, 37 and 77 in the following days.	MLT – 2.5-3 per zone, to 15 totally.

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily.

Number of treatments: 7-8.

Possible combination with other treatments: Drug therapy.

Methods of exposure: stable wound area of 10 cm^2 – 2 field irradiations.

Therapeutic terminal MLT IR placed over a wound and around the wound surface for a distance of 3-5 mm; therapeutic terminal MLT Red act directly on the method for the stable zone (contact).

MLT R:

- Zone 10 (palmar surface of hands).

MLT IR:

- wound area of the scar (Table 14, Fig. 6).

Table 14. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
-	Scar	10

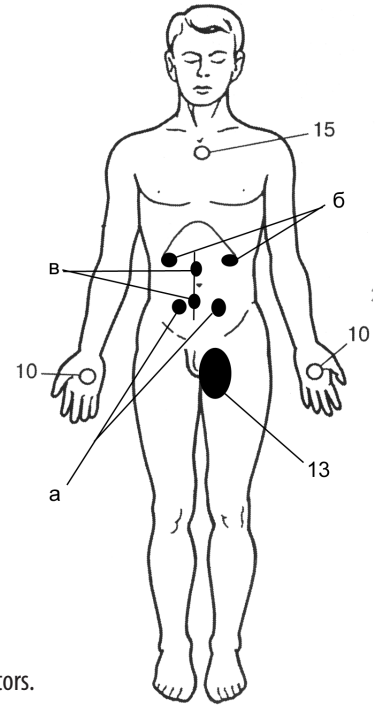

Figure 6. Zones for placing inductors.

4.8. T79.3 Post-traumatic wound infection, not elsewhere classified festering wounds

Damage to the skin and underlying tissues, in which there is pus, swelling, and tissue necrosis, as well as the absorption of toxins.

Etiopathogenesis

A purulent wound infection may occur when the wound is clean (chopped, sliced, chopped, torn, and so on.) or formed as a result of an abscess rupture. The pathogens of purulent process in random and surgical wounds often become so-called pyogenic bacteria (staphylococcus, streptococcus and etc.).

Currently, as in trauma and surgery is considered that any random wound is infected, that is, it contains a certain number of bacteria. However, bacterial contamination does not necessarily entail an abscess. For the development of infection, a combination of the following factors: sufficient tissue damage; presence in the wound cavity devitalized tissue, foreign bodies and blood streamed; sufficient concentration of pathogens. MLT spend on clean wound (purulent discharge absorbs up to 90% of the laser light).

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 15).

Table 15. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
-	12-15	37 the first three days, 75 in the following days.	MLT - 5 per zone, to 10 totally.

Method of treatment

Position of the patient: lying on his back.

Position transmitter: contact.

Frequency of treatments: daily.

Number of treatments: 13.

Possible combination with other treatments: Drug therapy.

Methods of exposure: a stable, a of 10 cm^2 area of the wound – 2 field exposure.

Therapeutic terminal MLT IR placed over a wound and around the wound surface for a distance of 3-5 mm; therapeutic terminal MLT Rvozdeystvuyut directly on the method for the stable zone (contact).

MLT R:

- Zone 10 (palmar surface of hands).

MLT IR:

- wound area of the scar (Table 16, Fig. 7).

Table 16. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
-	Scar	10

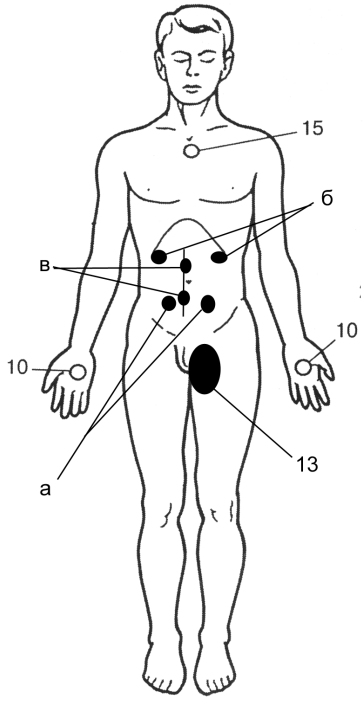

Figure 7. Zones for placing inductors.

4.9. L02 Abscesses, boils, carbuncles
L03 Phlegmon, felon

Etiopathogenesis

There are at penetration into the tissue of a homogeneous or mixed flora pyogenic bacteria (staphylococcus, streptococcus, E. coli and others.). May be formed and therefore without tissue necrobiosis microbial flora, such as when administered under the skin of certain chemical substances or drugs.

The development of acute purulent processes contributes to violations of trophism, circulatory disorders, tissue crush injury in trauma, bruises, weakening the body's resistance. abscess formation usually starts with an inflammatory infiltrate in the center which then decomposes with the formation of white blood cells proteolytic enzymes digest the latest necrotic tissue and products of cellular decay, forming a purulent exudate. At the periphery of the inflammatory focus demarcation shaft formed first by lymphocyte multiplication, and then through the development of granulation tissue and connective tissue sheath (pyogenic shell). Rapidly expanding, granulation tissue is moving to the center of the inflammatory focus, filling defect tissues. Before the formation of granulation shaft of the hearth there is increased absorption of toxic products and bacteria through the lymph and blood pathways, resulting in a total intoxication patient. Education granulating shaft prevents the absorption of toxins and microbes.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 17).

Table 17. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
-	75-99	5, 10, 20, 31, 50, 80 every day on a new frequency.	MLT – 2.5-3 per zone, to 15 totally.

Method of treatment

Position of the patient: lying on his back / sitting.

Position transmitter: contact.

Methods of exposure: a stable, 2-4 field around the hearth.

Frequency of treatments: daily.

Number of treatments: 5-7.

Possible combination with other treatments: -Drug therapy.

Medical terminal MLT IR placed around the inflammatory focus at a distance of 3-5 mm above the surface; therapeutic terminal MLT Red act directly on the method for the stable zone (contact).

MLT R:

- Zone 10 (palmar surface of hands).

MLT IR:

- around the hearth (Table 18, Fig. 8).

Table 18. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
-	Around the heart	10

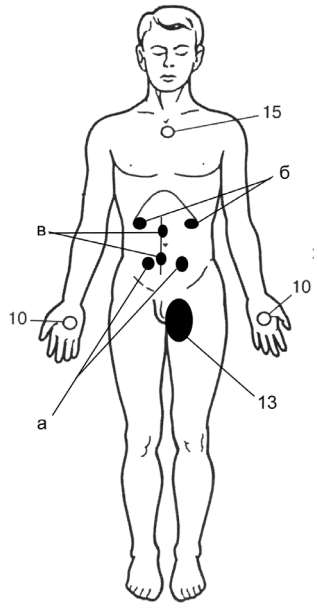

Figure 8. Zones for placing inductors.

4.10. I80 Phlebitis and thrombophlebitis

Thrombophlebitis is an inflammation of the vein walls to form a blood clot in the lumen of the vein. Most often, when it comes to thrombophlebitis of the lower limbs.

Etiopathogenesis

Thrombophlebitis. Factors contributing are slowing blood flow, changes in its composition, due to which the blood loses its normal rheological properties. Thrombophlebitis may develop on the background of violations of blood coagulation. Often the root cause of thrombophlebitis is an injury to the vascular wall, endocrine disorders, infections or allergic reactions. A number of diseases can be complicated by thrombophlebitis: varicose veins, purulent infections, hemorrhoids, cancer, blood diseases and heart.

Medical manipulation (long-term catheterization) and surgery on the blood vessels and increase the risk of thrombosis.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 19).

Table 19. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	1,2; 25; 8; 10; 89	UST – 3 to zone, to 10 totally. MLT – 3 to zone, to 10 totally.

Method of treatment

Position of the patient: lying on his back / sitting.

Position transmitter: contact.

Methods of exposure: a stable or labile without compression fabric.

Frequency of treatments: daily or every other day.

Number of treatments: 7-8.

Repeated treatment: two weeks 1 time per day.

Possible combination with other treatments: Drug therapy (detoxification, antibacterial).

Medical terminal MLT IR slowly (1 cm/sec) is moved along the affected vessel in the direction from the center to the periphery of the body, then transferred over the limb to the initial point of contact and then slowly move to the end of the affected area. 1-3 affect the zone depending on the length phlebothrombosis.

Therapeutic terminal MLT Cr act directly on the method for the stable zone (contact).

MLT R:

- Zone 15 (the projection of the thymus gland).

MLT IR:

- Zone L (the affected area);
- Zone GI1 (nail plate of the thumb on the right / left), starting with the 4th procedure for 2.5 minutes at the point, the modulation frequency of 75-80 Hz.

UST:

- Zone 27 (paravertebrally, Th1-L5) (Table 20, Fig. 9).

Table 20. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
-	L; GI1	15

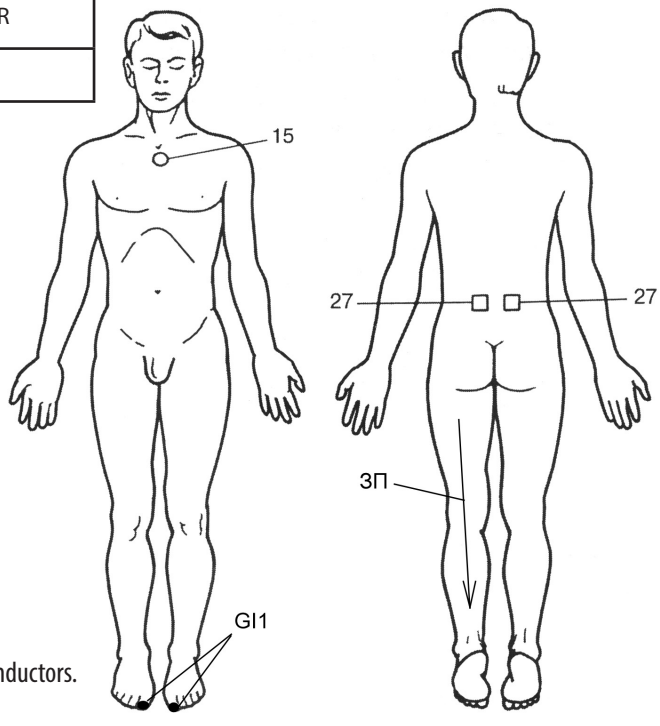

Figure 9. Zones for placing inductors.

4.11. T20-T32 Burns and corrosions

A burn is tissue damage caused by local exposure to high temperatures (more than 55-60 C), aggressive chemicals, electric current, light and ionizing radiation.

Etiopathogenesis

According to the depth of tissue damage are 4-degree burns. Extensive burns lead to the development of the so-called burn disease, dangerous fatal due to irregularities in the cardiovascular and respiratory systems, as well as the occurrence of infectious complications.

Therapy is indicated for the expressed syndrome of exudative inflammation in the case of superficial burns, for the prevention of complications and stimulation of reparative processes in wounds, with subdermal burns to improve blood and lymph circulation in paranecrotic area and stimulating the formation of high-grade granulation cover in the preoperative period with deep burns, and in the postoperative period – to stimulate the regenerative processes; for the prevention and treatment of pneumonia and edema secondary immunodeficiency.

Treatment regimns

The following procedure parameters are displayed on the front panel of the device (Table 21).

Table 21. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	75-80	UST – up to 6 totally. MLT IR – 2 to 3 affected area. MLT R – 15 totally.

Method of treatment

Position of the patient: lying on his back / sitting.

The position of the radiator: distantly at a distance of 5-6 mm from the surface of the wound.

Methods of exposure: labile.

Frequency of treatments: two times a day.

Number of treatments: 7-8.

Re-treatment: three weeks later the same course in a day.

Possible combination with other treatments: Drug therapy.

Magnetolaser effects, occurring shortly after injury, are visible on the surface of the open wound through the dressing. The exposure time is 8 seconds per point (during necrosis rejection), 4 seconds after necrotic tissue removal. Three to four treatments per point account for 1% of the area.

MLT R:

- Zone 6 (projection of the carotid artery);
- Zone 10 (palmar surface of the hand on the right / left);
- Zone 36 (the plantar surface of the foot).

MLT IR:

- OP area (lesions or pathological focus);
- Zone Zone 8 (C8 projection D2 vertebral segments).

UST:

- Zone 27 (paravertebrally, Th1-L1, the projection of the segmental innervation of the adrenal glands and kidneys);
- Zone 17 (the projection of the liver) (Table 22, Fig. 10).

Table 22. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17; 27	OP; 8	6; 10; 36

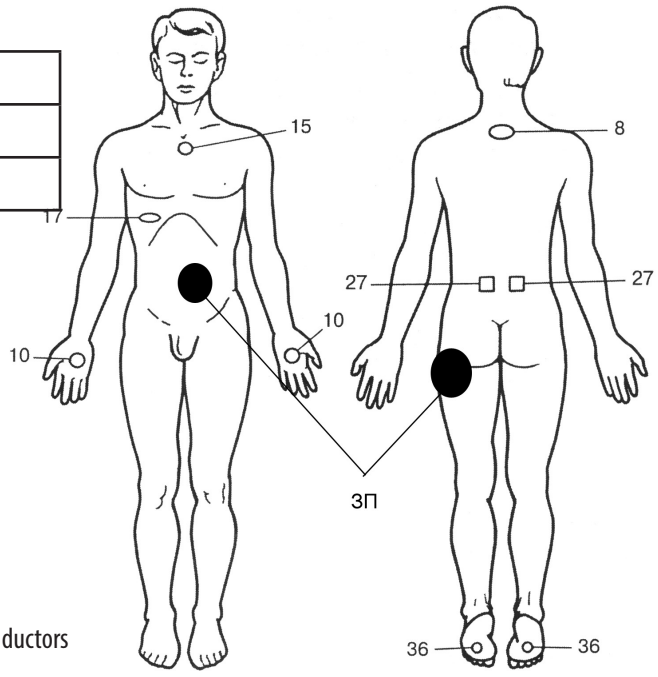

Figure 10. Zones for placing inductors

4.12. R52 Chronic pain syndrome (Pain, not elsewhere classified)

Feeling pain cause a variety of agents, but they share a common feature – a real or potential danger to damage the body. Therefore, pain signal mobilizes body to protect against pathogen restriction and protective function of the affected organ pain.

Etiopathogenesis

Causes of pain: physical (trauma, high or low temperature, high dose of UV, the electric current), chemical (contact with skin or mucous membranes of strong acids, alkalis, oxidizing agents, the accumulation of calcium salts fabric or potassium) and biological (high concentration of kinins, histamine, serotonin) factors.

Therapy is indicated for the prevalence of degenerative changes are accompanied by pain.

The procedure performed stimulates the antinociceptive system (formation of endogenous opiates, melatonin), changes the functional state of the cortex, stem, segmental and peripheral structures of the nervous system and reduces pathological changes directly to the damaged area.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 23).

Table 23. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	1,2; 25; 8; 10; 89	UST – 3-5 to zone, up to 15 totally. MLT - up to 25 totally.

Method of treatment

Position of the patient: lying on his stomach.

The position of the radiator: a contact.

Methods of exposure: labile, the recommended area.

Frequency of treatments: 1-2 days.

Number of treatments: 14-15

Re-treatment: 2-3 months.

Possible combination with other treatments:

- Drug therapy;
- Psychological correction;
- The central or electroanalgesia electrosleep.

Exposure to ultrasound is performed directly on the body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 24, Fig. 11).

UST: – Zone 17 (the projection of the liver);

- Zone 21 (the projection of the celiac plexus);
- Zone 25 (paravertebrally, Th7- L2, segmental innervation zone of the liver).

MLT R: – Zone 30 (popliteal fossa on the right / left);

- Zone 6 (projection of the carotid artery on the right / left);
- Zone 11 (ulnar fovea right / left);
- Zone 12 (over-and subclavian vein to the right / left);
- Zone 3 (the eye).

MLT IR: – Zone 1 (projection- reflex epiphysis area);

- Zone 8 (the projection of the C7 vertebral segments – Th2);
- Zone 4 (the projection of the brain stem).

During a session conducted nadvennoe (nadarterialnoe) irradiating the red blood magneto inductor zones 6, 11, 12 or 30, and act on two zones (zone 6 for instance – to the left and to the zone

30 – right) 5 – 7 min each. During the day, on the affected area 3 on both sides with 5-7-minute alternation with zones 1 and 4 (MIT IR device). Also, during each session produce ultrasonication for 5 – 7 minutes in one of the zones (17, 21, 25). The remaining area is used as an extra. This frequency modulation of all the factors must be changed one day apply frequency 75 – 77 Hz, and the next – scanning frequency 10 – 100 Hz. This principle is common, regardless of the localization of pain. However, for influencing pathologically altered hearth (zone of pain) used MP + IR radiation for 5 – 7 minutes with the above parameters.

Table 24. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17; 21; 25	1; 4; 8	3; 6; 11; 12; 10; 36

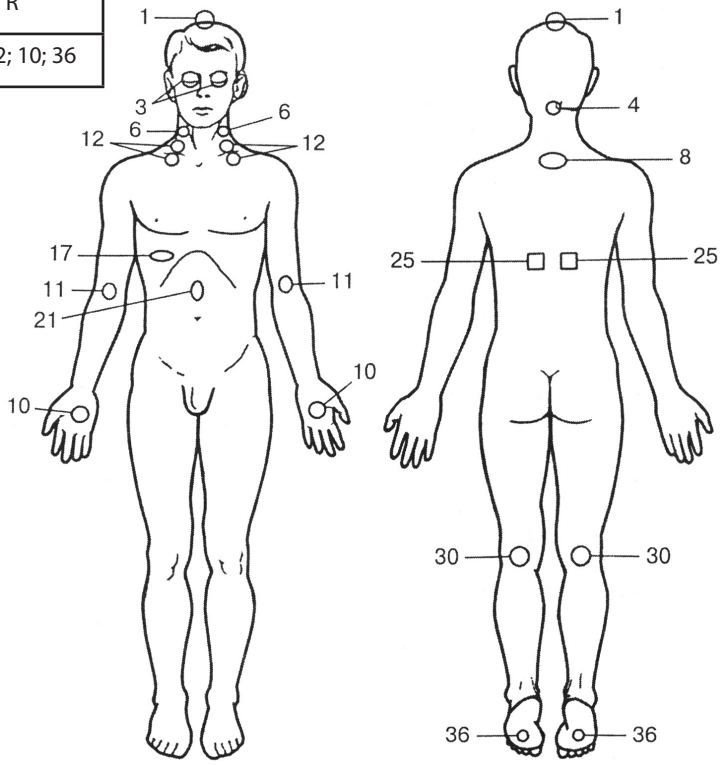

Figure 11. Zones for placing inductors.

4.13. Myofascial pain

M60.0 Myo fasciitis

M62.8 Miofibrozit

M79.0 Fibrosis; fibromyalgia

M72.5 Fasciitis

Myofascial pain is a non-generalized muscle non-specific pain caused by dysfunction and myofascial tissue in the muscles, irritability (trigger points – TP).

„Miogeloz" „fibrositis", „Myofasciitis" „myositis" „fibromyositis" „myalgia" – nonspecific painful muscle tissue seal, the source of muscle pain.

Etiopathogenesis

Causes: skeletal abnormalities (different length legs, flat feet), repetitive stereotyped movements, leading to fatigue individual muscles; prolonged immobilization of muscles; prolonged compression of the muscles; hypothermia; psycho-emotional stress; pathology of the internal organs. The mechanism of pain includes sensory, motor and autonomic components.

Traumatization of the muscle, leading to the formation of MB, associated primarily with the muscular overload. With continued prolonged muscle contraction suffers intramuscular capillary blood flow, reduced oxygen levels and glucose metabolism is impaired in cells, leading to their damage.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 25).

Table 25. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	12-15	37.5 alternated with 75-77	UST – 3-5 in the zone, up to 15 totally. MLT – up to 25 totally.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: a contact.

Methods of exposure: labile, the recommended area.

Frequency of treatments: 1-2 days.

Number of treatments: 14-15.

Re-treatment: 2-3 months.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Massage;
- Kinesitherapy.

Exposure to ultrasound is performed directly on the body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 26, Fig. 12).

UST:

- Zone ZP (zone of pain, CT);
- Zone 17 (the projection of the liver).

MLT R:

- Zone 30 (popliteal fossa on the right / left);
- Zone 11 (ulnar fovea right / left).

MLT IR:

- Zone SCA (zone referred pain).

Table 26. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
ZP; 17	ZP	11; 30

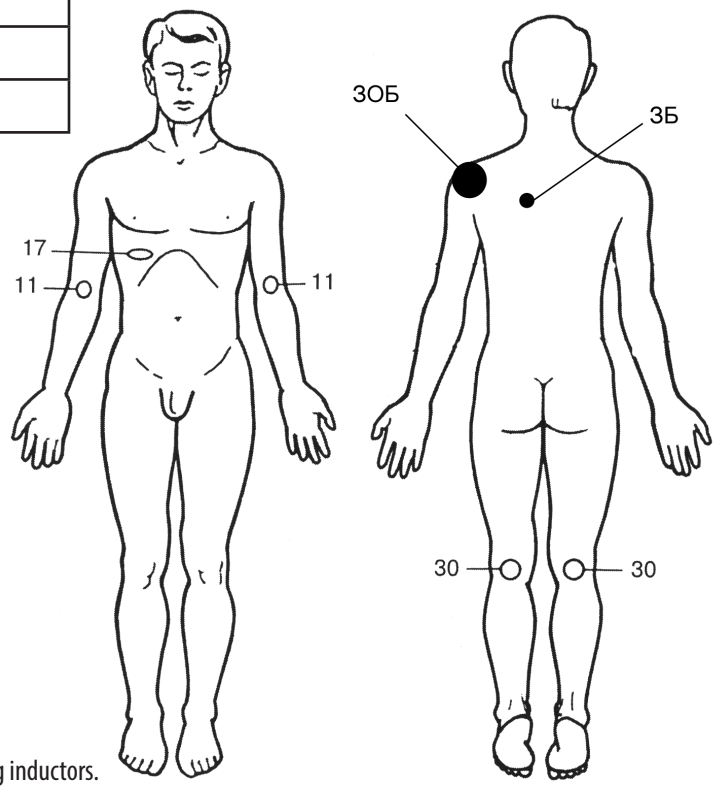

Figure 12. Zones for placing inductors.

4.14. M 00-M 03 Infectious arthropathies

The group of diseases that are characterized by the same type of lesions of the musculoskeletal system.

Etiopathogenesis

Reactive arthritis is most often associated with chlamydia (Chlamydia trachomatis) urogenital infection.

Pathogenetic mechanisms of reactive arthritis is unknown, although it is clear involvement of immune response to bacteria of the urogenital tract. It is believed that the development of immunocomplex synovitis due to excessive immune response to microbial antigens microorganism outside the joint cavity, with the formation of immune complexes which are deposited in the synovium.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 27).

Table 27. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
2-4	75-99	1.2 alternated with 77	UST – up to 5-7 totally MLT – 10 zone

Method of Treatment

Position of the patient: lying on his back / sitting.

The position of the radiator: contact.

Methods of exposure: labile, the recommended area.

Frequency of treatments: daily or every other day.

Number of treatments: 8-10.

Re-treatment: 2-3 months.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Massage.

Exposure to ultrasound is performed directly on the body or through a contact medium (ultrasound gel, cocoa butter or other plants, drug, etc.) around the affected joint.

ATTENTION!

When exposed to the knee scoring is carried out on all sides, except the patella.

When exposed to hip dubbing is performed on both sides – the front and rear.

When multiple lesions of joints influence on them is carried out alternately, and the total duration of the procedure is increased up to 8-10 minutes.

As contact protection when exposed to the small joints of the hands and feet can act gidrolinza.

Exposure is carried out simultaneously with the IFL UST kontaktno. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 28, Fig. 13).

UST:

- Zone 2 (the affected joint);
- Zone 28 (paravertebrally, segmental innervation of the affected joint area).

MLT R:

- Zone 30 (popliteal fossa on the right / left);
- Zone 11 (ulnar fovea right / left).

MLT IR:

- Zone 27 (paravertebrally, Th11- L1 segmental innervation of the kidney area).

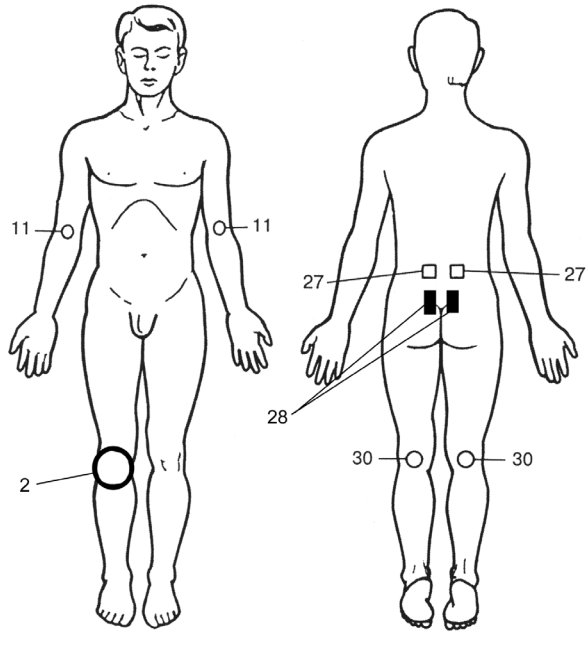

Figure 13. Zones for placing inductors.

Table 28. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
2; 28	27	11; 30

4.15. M79.2 Neuralgia cervical spine

Neuralgia (from the Greek words acute, aching, burning or dull pain in the course of the peripheral nerves arising episodic and periodic.

Attacks of pain may be accompanied by pallor or redness of the skin, sweating, muscle twitching. When no movement disorders neuralgia and sensitivity loss, and nerve damage are no structural changes.

Etiopathogenesis

The cause of the disease neuralgia can be very nerve, nerve plexus or the processes developing in the surrounding organs and tissues as a result of injury, infection (influenza, malaria, etc.), quenching, etc. Neuralgia develops mainly in the nerves, where the nerve passes through the narrow channels of the bone and can be easily crushed or infringed its surrounding tissues. The development of the infringement and the emergence of neuralgia may contribute to a variety of factors: hypothermia, inflammation, tumors, trauma, stress, intoxication, circulatory disorders, hernia of intervertebral disks, and so on.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 29).

Table 29. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	1,2; 25; 8; 10; 89	UST – 1-2 on the field, up to 6-8 totally. MLT – up to 15 totally.

Method of treatment

Position of the patient: lying on his back / sitting.

The position of the radiator: a contact.

Frequency of treatments: daily or every other day.

Number of treatments: 8-10.

Repeated treatment: two months if necessary.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Spa treatment.

Methods of exposure: a stable or labile recommended zone.

Impact UST conducted directly on a body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 30, Fig. 14).

UST:

- Zone 13 (paravertebrally C5-Th2).

MLT R:

- Zone 15 (the projection of the thymus gland).

MLT IR (after ultrasound exposure):

- Zone 8 (projection C5-Th2).

Table 30. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
13	8	15

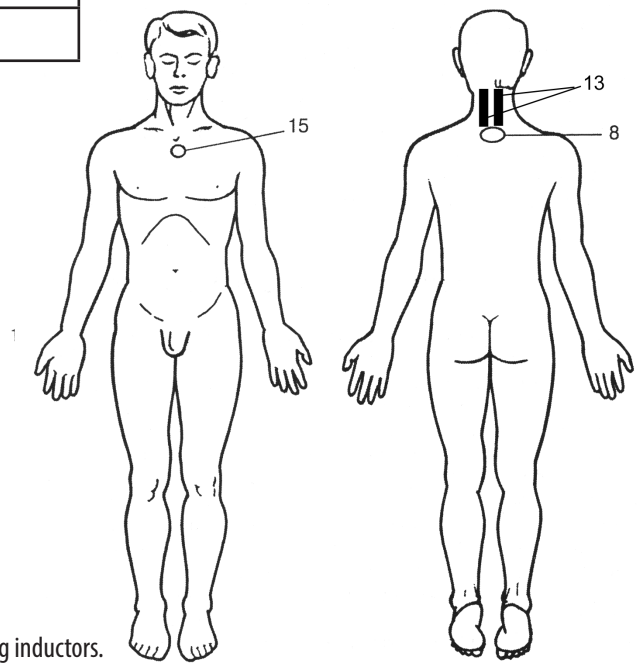

Figure 14. Zones for placing inductors.

4.16. M79.2 Neuralgia of the lumbar spine

Etiopathogenesis

Causes of neuralgia of the sciatic nerve (sciatica).

1. An osteochondrosis, intervertebral hernia, etc., When there is infringement of the roots with the development of sciatic neuralgia.
2. Injuries to the lumbar spine, hip fractures, pelvic tumor in the area of the passage of the sciatic nerve, infectious and inflammatory diseases of the pelvic organs, hypothermia, weight lifting, bad twist the torso.
3. Development of sciatica contributes to a sedentary lifestyle, sedentary work and pregnancy.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 31).

Table 31. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
2-5 5 at the end of the course	50-70	3,9; 99	UST – 3 on the field, per procedure voicing 2-3 field. MLT – 5 zone, 15 in total.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: a contact.

Frequency of treatments: daily or every other day.

Number of treatments: 8-10.

Repeated treatment: two months if necessary.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Spa treatment.

Methods of exposure: a stable or labile recommended zone.

Impact UST conducted directly on a body or through a contact medium (ultrasound gel, cocoa butter or other plants, drug, etc.).

Impact MLT UST is performed after a contact at point A-SHI (pain points).

UST:

- Zone 2, 3 (paravertebrally Th2-L5 and in the course of the sciatic nerve (thigh, calf, foot).

MLT R:

- Zone 15 (the projection of the thymus gland).

MLT IR (after ultrasound exposure):

- Zone A-SHI (pain points) (Table 32, Fig. 15).

Table 32. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
2; 3	A-SHI	15

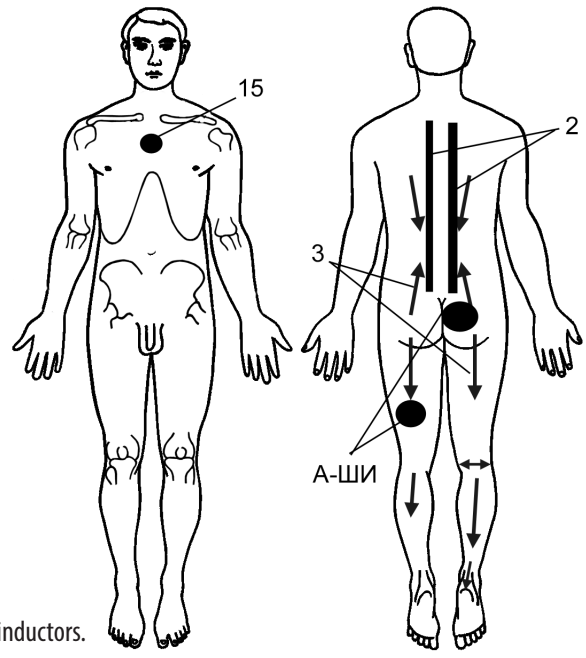

Figure 15. Zones for placing inductors.

4.17. F00-F99 Mental and behavioral disorders

F51.0 Insomnia

Insomnia is a dissatisfaction with sleep. Insomnia is the most common complaint of sleep disorders, and the patients have a sense of the quality or lack of restorative sleep function.

Etiopathogenesis

Main causes: stress, neurosis, mental illness, neurological disorders, physical illness, psychotropic drugs, alcohol, toxic factors, endocrine and metabolic diseases.

The pathogenesis of insomnia is not well studied. Insomnia is usually the result of the interaction of biological, physical, psychological and environmental factors. The areas of the brain involved in the regulation of wakefulness include tuberomamiliar posterior hypothalamic nucleus containing histamine neurons from which are stimulatory signals in the brain stem areas associated with wakefulness. Of these zones pulses diffusely projected onto the cerebral cortex and ensure the maintenance of wakefulness.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 33).

Table 33. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
4-5	75-99	2,4	UST – up to 5 totally. MLT – up to 20 totally.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: a contact.

Frequency of treatments: daily or every other day.

The number of procedures: the number of sessions is determined by the effectiveness of therapy.

Conversations with early awakening should be carried out in the morning and going to sleep in low – in the evening (for 1.5-2 hours before bedtime).

Possible combination with other treatments:

- Herbal medicine;
- Massage;
- Autogenous training;
- Psychological correction.

Methods of exposure: a stable or labile recommended zone.

Within one session exposure performed simultaneously on three zones of these factors.

Impact UST conducted directly on a body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 34, Fig. 16).

UST:

- Zone 17 (the projection of the liver).

MLT R:

- Zone 3 (the eye).

MLT IR:

- Zone 8 (C8-Th2 projection of the vertebral segments);
- Zone 4 (the projection of the brain stem);
- Zone 1 (embryological projection epiphysis).

Table 34. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17	1; 4; 8	3

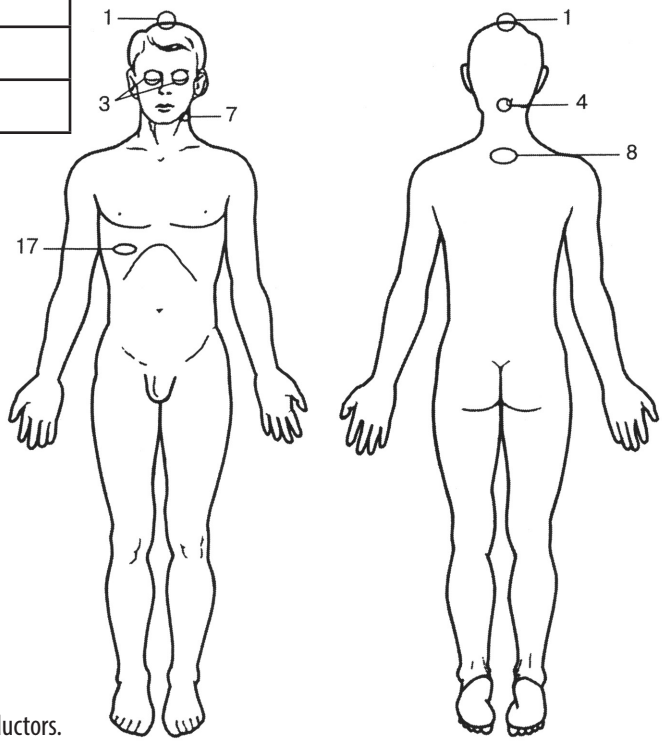

Figure 16. Zones for placing inductors.

4.18. F32 Depression

Depression is a mental disorder characterized by „depressive triad": depressed mood and loss of ability to experience pleasure, impaired thinking, motor retardation.

Etiopathogenesis

It is shown that the affective, motor and cognitive disorders with unipolar depression are similar with similar syndromes in lesions of the basal ganglia. Therefore, the hypothesis was suggested that the anatomical substrate of unipolar depression – loss of neural circuits involving the basal ganglia and the prefrontal area.

Physiotherapy treatment is prescribed as a preventive measure (3-5 sessions a day) on the eve of the expected state of deterioration.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 35).

Table 35. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	1-10	UST – 5 zone MLT – 10 zone, 30 in total

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: contact.

Frequency of treatments: daily or every other day.

Number of treatments: 3-5 sessions on the eve of the expected deterioration.

Possible combination with other treatments:

- Drug therapy;
- Physical therapy;
- Balneotherapy;
- Psychological correction.

Methods of exposure: a stable or labile recommended zone.

Within one session exposure performed simultaneously on three zones of these factors.

Impact UST conducted directly on a body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 36, Fig. 17).

UST:

- Zone 17 (the projection of the liver);
- Zone 25 (Th9-10 projection of the vertebral segments).

MLT R:

- Zone 3 (the eye);
- Zone 1 (embryological projection epiphysis);
- Zone 7 (projection VSHSG);
- Zone 10a (palmar surface of the right hand);
- Zone 11 (cubital fossa on the right / left).

MLT IR:

- Zone 8 (C8- Th2 projection of the vertebral segments);
- Zone 4 (the projection of the brain stem);
- Zone 10b (palmar surface of the hand from left);
- Zone 12 (over-and subclavian fossa).

Table 36. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17; 25	4; 8; 10b; 12	1; 3; 7; 10a; 11

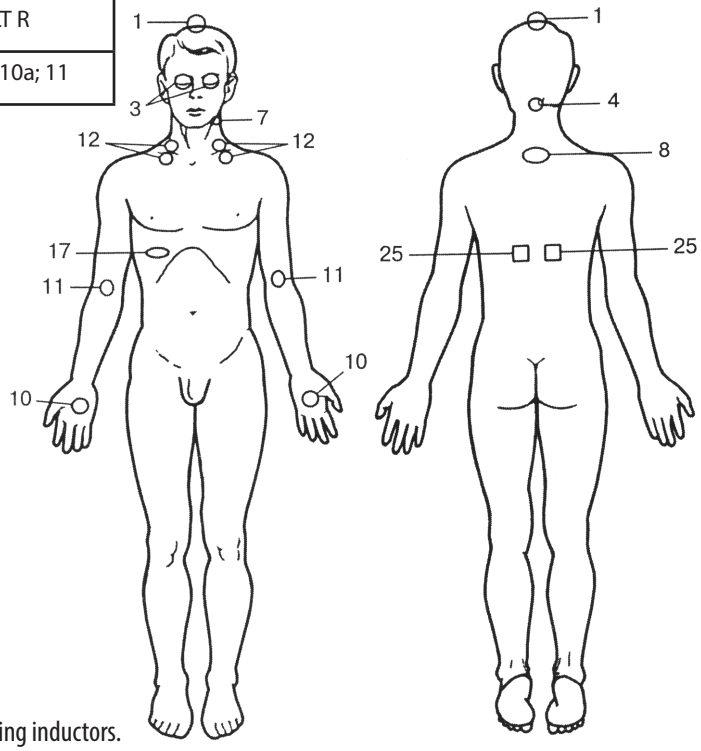

Figure 17. Zones for placing inductors.

4.19. F40-F48 Neurotic, stress-related and somatoform disorders

The main feature is repeated presentation of physical symptoms together with persistent demands of medical examinations, in spite of repeated negative findings and their assurances of doctors that the symptoms have no somatic nature. If the patient has any physical illness, they do not explain the nature and extent of symptoms, or suffering, or patient complaints.

Etiopathogenesis

Causes: stress factors, traumatic brain injuries, infections, intoxication, diseases of internal organs and endocrine glands, as well as the long-term lack of sleep, fatigue, malnutrition and prolonged emotional stress. Neurosis is the result of a collision of conflicting incentives that create a situation of uncertainty reflex response; clinic, so there is a conflict between the impulses. Somatoform disorders explain the activation of neuro-visceral connections that include somatization neurosis.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 37).

Table 37. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	2-5 (mode P1)	UST – 5 zone. MLT - 5 zone, 20 in total.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: contact.

Frequency of treatments: daily or every other day.

Number of treatments: 3-5 sessions on the eve of the expected deterioration.

Possible combination with other treatments:

- Balneotherapy;
- Psychological correction.
- Methods of exposure: a stable or labile recommended zone.

Impact UST conducted directly on a body or through a contact medium (UST ultrasonic gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 38, Fig. 18).

Methods:

Proper irradiation of blood in the carotid arteries (zone 11) with a frequency of 2-5 Hz, 5 minutes on each side, once every 2-3 days, 5-7 procedures.

For daily use:

- Zone 15 (frequency 75 Hz, 1 time min);
- Zone 8 (1 min); Zone 4 (8 sec);
- Zone 5 (20 sec);
- Zone 17 (2.5-3 minutes).

Course – 21 days.

UST:

- Zone 17 (the projection of the liver).

MLT R:

- Zone 15 (the projection of the thymus gland);
- Zone 11 (the projection of the carotid artery on the right / left).

MLT IR:

- Zone 8 (C8- Th2 projection of the vertebral segments);
- Zone 4 (temporal area to the right / left);
- Zone 5 (left pinna).

Table 38. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17	4; 8; 5	15; 11

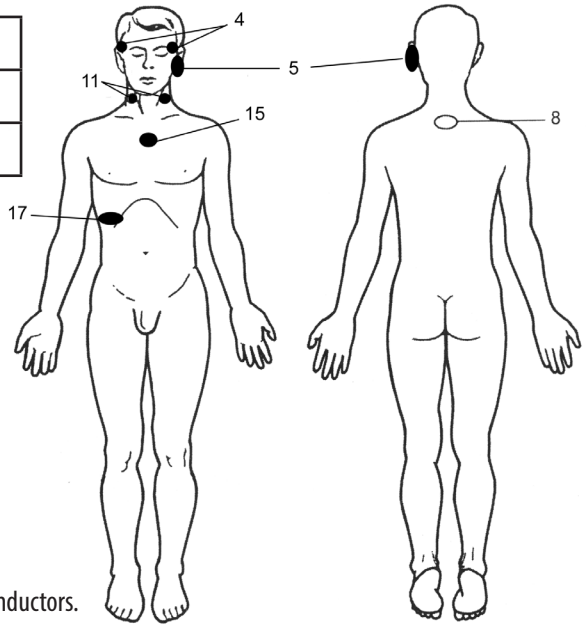

Figure 18. Zones for placing inductors.

4.20. F90 Dystonic hyperkinesia (tortikollis, oromandibular dyskinesia)

Abnormal involuntary movements suddenly occur in a variety of muscle groups.

Etiopathogenesis

Manifested in the organic and functional lesions of the nervous system: the cerebral cortex, subcortical motor centers or the brain stem. Usually caused by lesions of the basal ganglia and related structures forming extrapyramidal system (extrapyramidal hyperkinesis), rarely disorders of the peripheral nervous system (peripheral hyperkinesis). Can occur as a side effect of antipsychotic neuroleptic syndrome in the composition (medicinal hyperkinesis), due to their toxic effects on the extrapyramidal system.

Often arise against infectious diseases (encephalitis, rheumatism), vascular encephalopathy; after undergoing a traumatic brain injury, intoxication and others.

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 39).

Table 39. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	75-99	10-100 (mode P2)	UST – up to 7 totally. MLT – 10 zone, 30 in total.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: contact.

Frequency of treatments: 2-3 times a week, preferably in the morning.

Number of treatments: 14-15.

Number of courses per year: 3.

Possible combination with other treatments:

- Drug therapy;
- Autogenous training;
- Postisometric relaxation.

Methods of exposure: a stable or labile recommended zone.

Impact UST conducted directly on a body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 40, Fig. 19).

In one session, use the 3-4 zone with the following parameters.

UST:

- Zone 17 (the projection of the liver);
- Zone 25 (paravertebrally projection Th7-L2 segmental innervation zone of the liver and gall bladder).

MLT R:

- Zone 3 (the eye);
- Zone 10 (palmar surface of hands).

MLT IR:

- Zone 8 (projection C7 vertebrae segments – Th2);
- Zone 4 (the projection of the brain stem).

Table 40. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17; 25	4; 8	3; 10

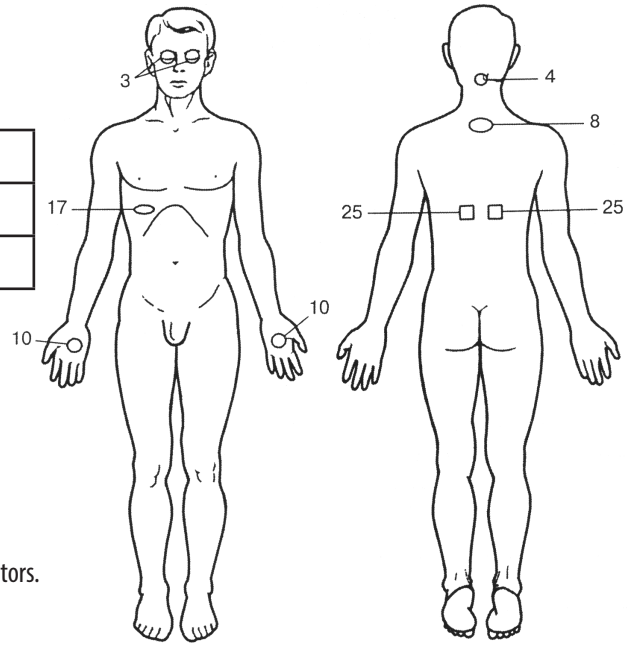

Figure 19. Zones for placing inductors.

4.21. Application magnitolazera ultrasound therapy for health purposes

Treatment regimens

The following procedure parameters are displayed on the front panel of the device (Table 41).

Table 41. Procedure parameters.

RANGE UST, mkm	POWER MLT rel, %	MODULATION Hz	TIME, min
3-5	50-75-99	9,4	UST – 5 per zone. MLT – 10 zone, 30 in total.

Method of treatment

Position of the patient: lying on his back.

The position of the radiator: a contact.

Frequency of treatments: 2 times a week.

Number of treatments: 5-7.

Number of courses per year: 2-3.

Possible combination with other treatments:

- Physical therapy;
- Hardening;
- Massage.

Methods of exposure: a stable or labile recommended zone.

Impact UST conducted directly on a body or through a contact medium (UST gel, cocoa butter or other plants, drug, etc.).

Impact MLT carried out simultaneously with a contact UST. Inductors mounted on the projection pathological focus in the area of paravertebral or reflex zones and the zone of the medulla oblongata (Table 42, Fig. 20).

In one session, use the 3-4 zone with the following parameters.

UST:

- Zone 17 (the projection of the liver).

MLT R:

- Zone 36 (the plantar surface of the foot);
- Zone 10 (palmar surface of hands).

MLT IR:

- Zone 8 (projection C7 vertebrae segments – Th2);
- Zone 27 (paravertebrally projection Th11-L1 segmental innervation of the kidney area).

Table 42. Zones for placing inductors.

Zones of impact		
UST	MLT IR	MLT R
17	27; 8	36; 10

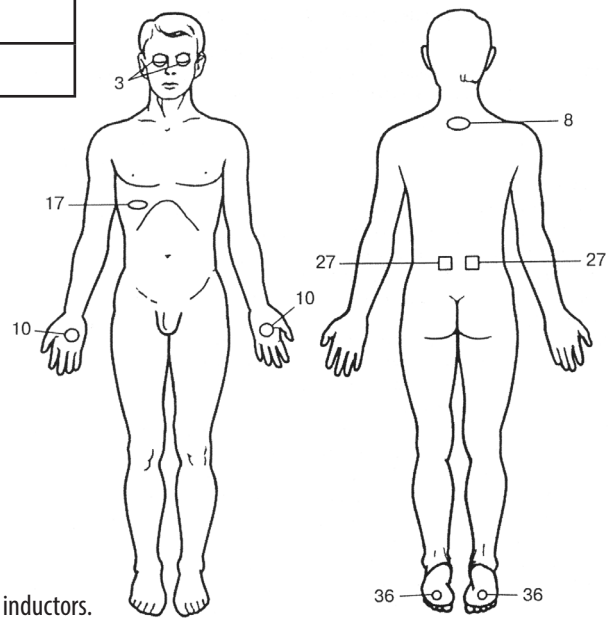

Figure 20. Zones for placing inductors.

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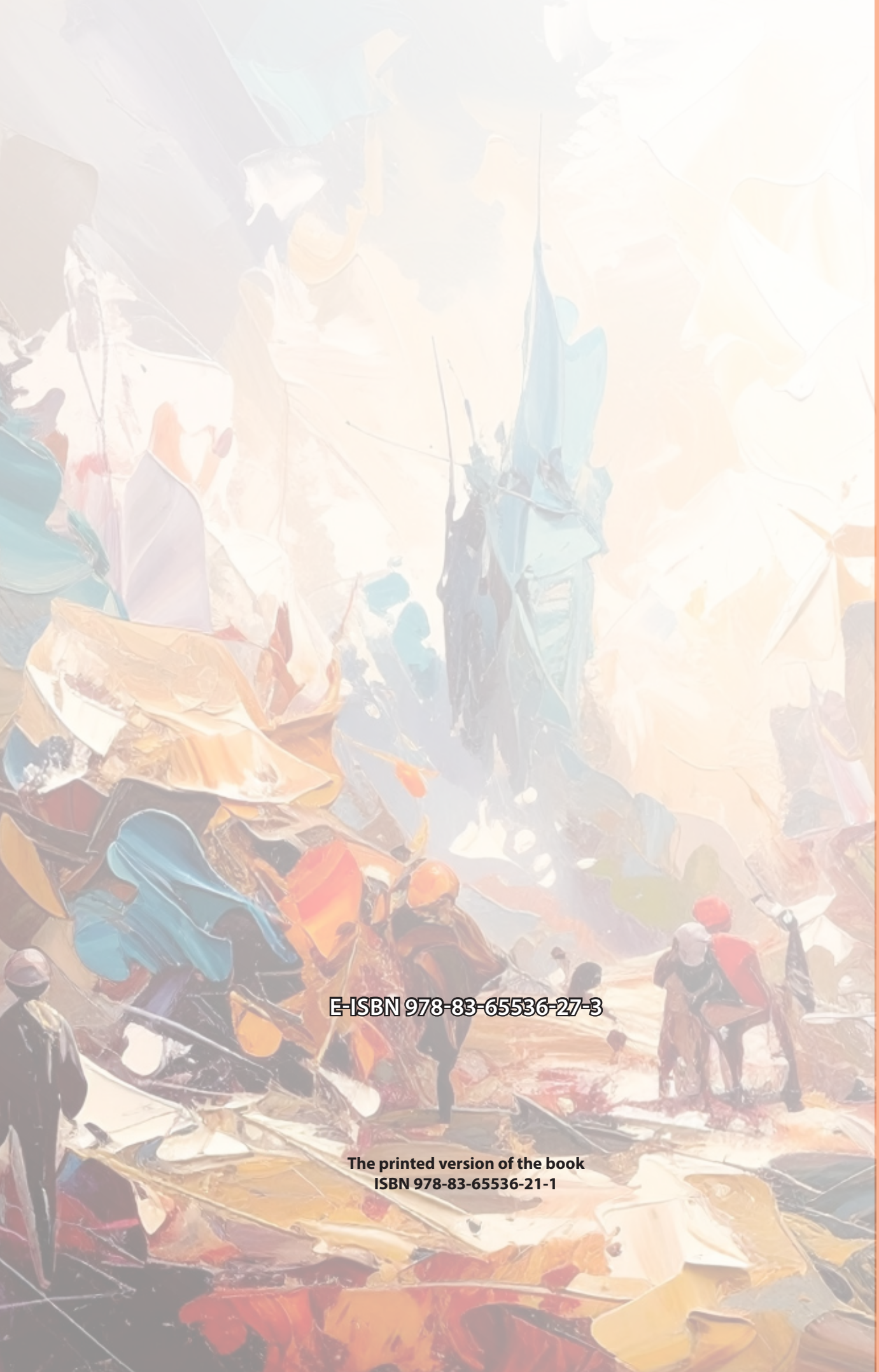

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