

UDC 615.8:616.831-001.3-085

## **Oliha KOVALOVA**

Candidate of Medical Sciences, Associate Professor, Head of the Physical Therapy and Ergotherapy Department, National University "Zaporizhzhia Polytechnic", Zhukovsky str., 64, Zaporizhzhia, Ukraine, 69063 (kovaleva221562@gmail.com)

**ORCID:** 0009-0007-6468-106X

## **Olena BURKA**

Ph.D. in Pedagogy, Associate Professor, Associate Professor of the Physical Therapy and Ergotherapy Department, National University "Zaporizhzhia Polytechnic", Zhukovsky str., 64, Zaporizhzhia, Ukraine, 69063 (ob777388@gmail.com)

**ORCID:** 0000-0003-2642-2431

## **Liudmyla SHUBA**

Ph.D. in Pedagogy, Associate Professor, Associate Professor of the Physical Culture and Sport Management Department, National University "Zaporizhzhia Polytechnic", Zhukovsky str., 64, Zaporizhzhia, Ukraine, 69063 (mila.shuba@gmail.com)

**ORCID:** 0000-0002-8037-4218

**SCOPUS:** 57202819507

## **Alla KOVALEVA**

Senior Lecturer of the Physical Therapy and Ergotherapy Department, National University "Zaporizhzhia Polytechnic", Zhukovsky str., 64, Zaporizhzhia, Ukraine, 69063 (kovaleva\_alusik@ukr.net)

**ORCID:** 0000-0001-8072-1374

## **Kristina YANITSKAYA**

student, specialty 227.1 Physical Therapy Department, National University "Zaporizhzhia Polytechnic", Zhukovsky str., 64, Zaporizhzhia, Ukraine, 69063 (yanitskaya2002@gmail.com)

**ORCID:** 0009-0002-2009-0413

**To cite this article:** Kovalova O., Burka O., Shuba L., Kovaleva A., Yanitskaya K. (2023). Kompleksna reabilitacijna programa vidnovlennya osib z kontuziyeyu [Comprehensive rehabilitation program for persons with post-concussion syndrome]. *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 4, 41–47, doi: 10.32782/2522-9680-2023-4-41

## COMPREHENSIVE REHABILITATION PROGRAM FOR PERSONS WITH POST-CONCUSSION SYNDROME

**Abstract.** The use of high-energy weapons, such as artillery, leads to an increase in the number of brain injuries. The escalation of the Russian-Ukrainian war, outbreak in February 2022, contributed to the fact that 80 % of military personnel who have been in the war zones suffered concussions. Diagnosing this pathology is challenging. This condition is quite dangerous, even though the clinical manifestations may be vague at the initial stage. As a result, this can lead to a stroke with a full spectrum of clinical symptoms. Every third concussion sufferer experiences long-term effects in the form of heaviness in the head, throbbing headache, sleep disturbance, cognitive impairment, "cogwheel" sign, sensorineural hearing loss, optic nerve atrophy, and dental problems. Also, concussion often features mental disorders, making it harder to provide care and rehabilitation. The implications of a severe concussion include rapid fatigue that persists for a long time, poor health, and increased irritability.

**The purpose of the study** is to develop a comprehensive rehabilitation program that will help prevent irreversible damage to the central nervous system and the fastest possible recovery for persons with concussions received during the performance of combat missions.

**Materials and method.** The resulting rehabilitation program is based on two tasks: the selection of effective rehabilitation methods for persons with post-concussion syndrome (modulated electric current (MEC), rational psychotherapy, kinesiotherapy, and therapeutic massage); the selection of reliable, validated tools for assessing effectiveness (VAS pain assessment), mental state was assessed according to the Spielberger's State-Trait Anxiety Inventory (STAI) and the Pallium Index (IMP). Signs of intracranial hypertension were evaluated using the clinical and cerebral cortex index (CCI) analysis methods.

**Outcomes and discussion.** The obtained outcomes showed the effectiveness of the rehabilitation program: the results under the VAS pain assessment method for the main group have improved by 23.84 %, the ones of the control group – by 14.23 %; the mental state, assessed by the Spielberger anxiety scale (STAI), has improved by 42.85 % for the experimental group, and by 8.67 % for the control group; and the cerebral cortex index of the main group has improved by 35.16 %, and the one of the control group – by 22.58 % which certainly indicates the positive impact of the applied methods.

# Фізична терапія. Ерготерапія. Дискусії

---

**Conclusions.** Application of the apparatus allows for significant reduction or total elimination of painful myofascial syndrome. Also, the application of MEC contributed to the restoration of physical capabilities and the increase in tolerance to physical exertion. Based on the obtained data, the effectiveness of the developed complex rehabilitation program for persons with post-concussion syndrome has been proven.

Also, MEC therapy helps increase tolerance to physical stress due to increased oxygenation of tissues. The study has confirmed the hypothesis regarding the effectiveness of the comprehensive rehabilitation program for persons with post-concussion syndrome.

**Key words:** rehabilitation, rehabilitation program, kinesiotherapy, therapeutic massage, concussion, technical means of rehabilitation, quality of life.

## **Ольга КОВАЛЬОВА**

кандидат медичних наук, доцент, завідувач кафедри фізичної терапії та ерготерапії, Національний університет «Запорізька політехніка», вул. Жуковського, 64, м. Запоріжжя, Україна, 69063 (kovaleva221562@gmail.com)

**ORCID:** 0009-0007-6468-106X

## **Олена БУРКА**

кандидат педагогічних наук, доцент, доцент кафедри фізичної терапії та ерготерапії, Національний університет «Запорізька політехніка», вул. Жуковського, 64, м. Запоріжжя, Україна, 69063 (ob777388@gmail.com)

**ORCID:** 0000-0003-2642-2431

## **Людмила ШУБА**

кандидат педагогічних наук, доцент, доцент кафедри управління фізичною культурою та спортом, Національний університет «Запорізька політехніка», вул. Жуковського, 64, м. Запоріжжя, Україна, 69063 (mila.shuba@gmail.com)

**ORCID:** 0000-0002-8037-4218

**SCOPUS:** 57202819507

## **Алла КОВАЛЬОВА**

старший викладач, кафедра фізичної терапії та ерготерапії, Національний університет «Запорізька політехніка», вул. Жуковського, 64, м. Запоріжжя, Україна, 69063 (kovaleva\_alusik@ukr.net)

**ORCID:** 0000-0001-8072-1374

## **Кристина ЯНИЦЬКА**

студентка спеціальності 227.1 «Фізична терапія», Національний університет «Запорізька політехніка», вул. Жуковського, 64, м. Запоріжжя, Україна, 69063 (yanitskaya2002@gmail.com)

**ORCID:** 0009-0002-2009-0413

**Бібліографічний опис статті:** Ковальова О., Бурка О., Шуба Л., Ковальова А., Яницька К. (2023). Комплексна реабілітаційна програма відновлення осіб із контузією. *Фітотерапія. Часопис*, 4, 41–47, doi: 10.32782/2522-9680-2023-4-41

## **КОМПЛЕКСНА РЕАБІЛІТАЦІЙНА ПРОГРАМА ВІДНОВЛЕННЯ ОСІБ ІЗ КОНТУЗІЄЮ**

**Актуальність.** Застосування високоенергетичної зброї, переважно артилерійської, призводить до збільшення кількості травм головного мозку, що є основним наслідком. Ескалація російсько-української війни, яка розпочалася в лютому 2022 року, сприяла тому, що 80 % військовослужбовців, які були в зоні бойових дій, отримали контузії. Діагностування цієї патології є дуже складним завданням. Цей стан є досить небезпечним, навіть якщо на початковій стадії клінічні прояви можуть бути невідчужливими. У кінцевому підсумку це може призвести до розвитку інсультів з усім спектром клінічних проявів. У третини осіб, що зазнали контузії, спостерігаються віддалені наслідки у вигляді важкості в голові, головного болю розпирального характеру, порушення сну, порушення когнітивних функцій, «зубчастого колеса», розвитку сенсорної приглухуватості, атрофії зорового нерва та проблем стоматологічного характеру. Також важливим аспектом є наявність психічних розладів як характерної риси контузії, що становлять серйозну проблему під час надання допомоги та реабілітації. Наслідками тяжкої контузії є швидка втомлюваність, що довго зберігається, погане самопочуття, підвищена дратівливість.

**Метою дослідження** є розробка комплексної реабілітаційної програми, яка сприятиме запобіганню незворотнім порушенням центральної нервової системи та максимальному швидкому відновленню для осіб із контузією, отриманою під час виконання бойових завдань.

**Матеріали та методи.** Створена реабілітаційна програма базувалася на виконанні двох завдань: підбір ефективних методів реабілітації для осіб із контузійми (модульований електричний струм (МЕС), раціональна психотерапія, кінезіотерапія та лікувальний масаж) і підбір достовірних, валідизованих засобів оцінки ефективності (оцінювання болю за ВАШ (VAS). Психічний стан оцінювався за шкалою тривожності Спілбергера (STAI). Ознаки внутрішньочерепної гіпертензії оцінювалися клінічно та методом аналізу індексу мозкового плаща (ІМП).

**Результати та обговорення.** Отримані результати показали ефективність розробленої реабілітаційної програми: результати за методом оцінювання болю ВАШ (VAS) основної групи покращилися на 23,84 %, контрольної групи – на 14,23 %; психічний стан за шкалою тривожності Спілберґера (STAI) для основної групи покращився на 42,85 %, для контрольної – на 8,67 %. Індекс мозкового плаща (ІМП) основної групи покращився на 35,16 %, контрольної – на 22,58 %, що, безумовно, свідчить про позитивний вплив застосованої методики.

**Висновки.** Застосування апарату дає змогу суттєво зменшити й усунути больовий міофасціальний синдром. Також застосування МЕС сприяло відновленню фізичних можливостей і підвищенню толерантності до фізичних навантажень. На підставі отриманих даних доведено ефективність розробленої комплексної реабілітаційної програми для відновлення осіб із наслідками контузій.

**Ключові слова:** фізична терапія, реабілітаційна програма, кінезіотерапія, контузія, технічні засоби реабілітації, якість життя.

**Introduction.** The war, which began in 2014, takes many lives. The humanitarian catastrophe in our country affects, foremost, the best, patriotic, motivated representatives of the Ukrainian community. The soldiers who have managed to survive have many health issues. One would think that relatively healthy combatants face the problem of adaptation in modern society. They have both physical and mental issues. Disorders associated with concussions (acoustic brain injury) are often observed in visually intact people (Badiuk, 2007; Gaida, Badyuk, Sushko, 2018; Loskutov, Kondrashov, Naumenko, Gulaj, 2003). Relatively young people have signs of aggression, irritability, sleep disorder, avoiding social obligations, conflicts with family or an excessive need to be with their family, reduced work capacity, anxiety, alcohol abuse, drug addiction, and crime. According to statistics, the divorce rate among military men is 75 %. The family is not always able to accept the person changed by the war (Pronoza-Stebliuk, 2019; Women's and Men's Health Physiotherapy, 2019).

Timely qualified help avoids many problems, promotes adequate adaptation, allows socializing, supports mental and physical health, and helps to find a place in society and preserve family ties (Krylyuk, Guryev, Gudyma, 2017; Mysula et al., 2005).

Traumatic injuries of the skull and brain account for 30–40 % of all injuries and rank first in terms of mortality and disability among people of active working age (Denysiuk et al., 2022; Pronoza-Stebliuk, 2019; Ramona et al., 2021; Stoyanov et al., 2022).

Of course, this ratio changes significantly during military operations. At the beginning of the study, it was assumed that due to the effect of modulated electrical current (MEC) on certain zones, it is possible to eliminate pathological conditioned reflex connections, eliminate muscle spasm, improve hemodynamics, reduce intracranial pressure, and, as a result, improve cerebral blood circulation, and oxygen supply in vital centers.

Against the backdrop of the therapy, the oxygen saturation of the brain structures improved, which became the basis for the effective use of rational psychotherapy.

The technique we developed made it possible to positively affect the human psyche. During the study, we used rational psychotherapy – a psychotherapy method based on the explanation and logical conviction of the patient. Under conditions of brain structures' active oxygen supply, the mechanism of oxygen euphoria is activated, and a person is able to respond more adequately to the measures of rational therapy, which contributes to the formation of positive thinking. Against the therapy background, a quality rapport between the physical therapist and the patient is established. We applied the method of displacing the negative through positive memories and impressions. The war will not go away from the patient's mind, but with our recovery method, a positive dominant is formed in real time.

Active communication with the patient took place during the procedure. Taking into account the patient's psychotype, social status, habits, and wishes, the procedures gradually led the patient out of the acquired negative experience, forming positive narratives of modern life. In this way, a person was brought back to reality, which, in turn, contributed to the socialization of persons traumatized by the war. The formation of both short-term and long-term tasks took place. Apathy and depression were replaced by psychological attitudes that motivate and contribute to a full recovery, the return of working capacity, and the desire to live and be a useful member of society (Moskalenko, Bulax, Puzanova, 2014; Muxin, 2015). Therefore, considering the above material, we believe that the topic is extremely relevant.

**The purpose of the study** is to develop a comprehensive rehabilitation program that will help prevent irreversible damage to the central nervous system and the fastest possible recovery for persons with concussions received during the performance of combat missions.

**Materials and method.** The resulting rehabilitation program was based on two tasks:

1. The selection of effective rehabilitation methods for persons with post-concussion syndrome.
2. The selection of reliable, validated tools for assessing the effectiveness of the developed rehabilitation program.

The first component of our program was the application of MEC using a physiotherapeutic device. Its action, firstly, consisted in the elimination of conditioned-reflex connections, improvement of microcirculation, and elimination of muscle spasm, which contributed to adequate lymphatic drainage and indirectly reduced intracranial pressure or brought it to a normal level. The result of the therapy was the elimination or reduction of the pain syndrome. The grounds for using this device were its proven effectiveness, domestic design certified in Ukraine, which has been tested in many clinics in our country (Kharkiv, Kyiv, Mykolaiv, Kherson, Berdyansk). A scientific study on the use of neuroadaptive therapy was conducted at the Zaporizhzhia Medical Academy of Postgraduate Education. In traumatology, neuroadaptive therapy was used in the 9th Zaporizhzhia City Hospital. There, the main methods of applying physiotherapy for the injuries sequela treatment were developed.

When working with the device, a local reaction occurs, and the flow of impulses is transmitted by somatic and autonomic afferent pathways to the segments of the spinal cord and to the higher divisions of the central nervous system. The device application allows you to reduce the dose of analgesics.

When working with the device, there is no direct harmful effect on the skin, toxicity, or allergic reactions, which gives grounds for its long-term use

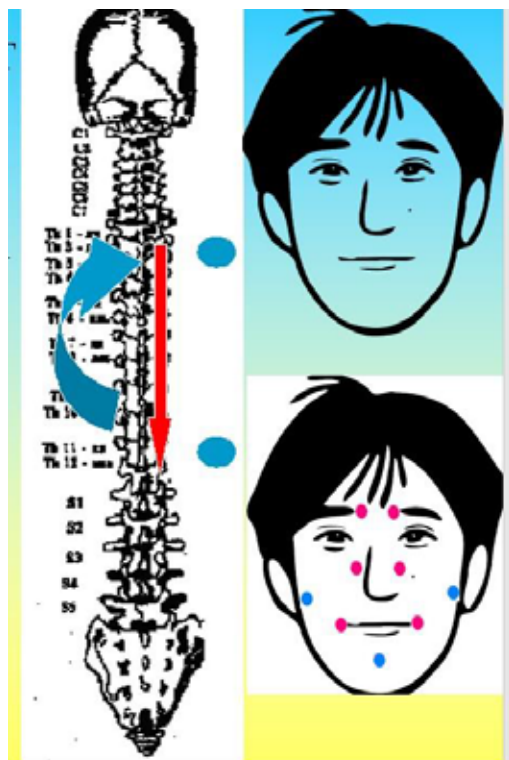


Fig. 1. “Three tracks, six points” method

to reduce pain and swelling of any origin (injuries, diseases, inflammation), and reliably reduce symptoms of anxiety.

The MEC application was carried out according to the “three tracks, six points” method, reflexes, zones, on the affected body parts for 20–30 min. with an operating frequency of 77 Hz. (Fig. 1).

Working according to the “three tracks, six points” system contributed to eliminating conditional-reflex connections and indirectly influenced the decrease of intracranial pressure.

The program’s second component is rational psychotherapy – a method based on explanations and logical persuasion of the patient. It was used situationally, according to the patient’s needs.

The complex included kinesiotherapy and therapeutic massage.

Kinesiotherapy, i.e. movement therapy, is a method of physical therapy that uses movement to improve body functions, particularly the musculoskeletal system. Kinesiotherapy improves the function of muscles and joints, strengthens the body, and relieves pain (Moskalenko, Bulax, Puzanova, 2014; Pashko et al., 2019). In our rehabilitation program, we relied on the medical history and applied an individualized approach that took into account the patient’s specific needs, and his mental and physical state at the time of examination and treatment. Against the background of eliminating conditional-reflex connections, to achieve the most positive result, we used kinesio tapes, various balls, resistance bands, and other equipment to provide support during exercises and movements (Popadyuxa, 2018).

Therapeutic massage is a method of physical therapy that we applied to improve the function of muscles and tissues, reduce pain, and improve blood circulation (Gryniv, Kuceryb, Kras, Mayevska, Muzyka, 2019; Kuceryb, Muzyka, 2019). The main features of therapeutic massage in our rehabilitation program:

1. An individual approach, which takes into account individual needs and the patient’s condition.
2. Targeted work with specific problem areas or affected body parts to improve their condition.
3. Using special techniques to improve blood circulation, reduce pain, and achieve certain therapeutic goals: hatching, rubbing, light pressure, vibration, etc. This contributed to faster tissue recovery and reduced inflammation.

Visual Analog Scale for Pain (VAS) pain assessment is a commonly used tool for measuring and evaluating pain intensity. This scale allows the patient to determine the degree of his pain by indicating on the line a percentage display of its intensity from “no pain” to “the greatest pain

possible”) (Golky, Buryanova, Klymovyczkogo, 2013; Moskalenko, Bulax, Puzanova, 2014; Muxin, 2015).

Following the rules allows for obtaining more accurate and reliable outcomes for pain intensity assessment:

1. Definition. The patient should understand that the scale shows a range from “no pain” to “the greatest pain possible”. The patient should be instructed that they should choose the point on the scale that best represents their feeling of pain.

2. Instruction. Give the patient clear instructions so they understand how to use the VAS scale correctly. For example, ask them to mark an “X” on the scale according to their pain level.

3. Thoughtfulness Your patient should carefully consider the choice and mark the point on the scale that best reflects the feeling. Note that there is no “right” or “wrong” answer.

4. Polling. Ask the patient which point on the scale they chose and offer them to explain their choice if necessary.

5. Marking. After the patient has selected a point on the ruler, measure the distance from the “no pain” point to the point marked. It will be helpful to convert the subjective feeling of pain into a numerical value.

6. Recording. Record the measured distance or a numerical value corresponding to the pain intensity. It can be helpful for further monitoring and comparison purposes.

Following these rules will help ensure accurate and reliable outcomes when using the VAS scale (Moskalenko, Bulax, Puzanova, 2014; Muxin, 2015).

Mental status assessment was held using Spielberger’s State-Trait Anxiety Inventory (STAI). It is a psychological tool for measuring the level of anxiety in a person. American psychologist Charles Spielberger has developed it, and it is commonly accepted in clinical practice and research for the assessment of anxiety symptoms.

STAI consists of two parts:

1. «T» (Trait Anxiety) scale: this part measures long-term, consistent anxiety, which is typical for the person. It considers how prone a person to a feeling of anxiety in general is.

2. “S” (State Anxiety) scale: this part assesses temporary anxiety state, that can arise in a particular situation or the course of some events. It describes anxiety observed at the moment or in a certain moment.

Each part includes individual questions, answering which the respondent assesses their feelings using a “barely ever” to “often” scale.

The Spielberger’s Anxiety Scale is a reliable tool for assessing anxiety and allows specialists to obtain objective data on the psychological state of patients. It

helps to detect anxiety, assess the level and dynamics of its manifestation, and develop an individualized treatment or support plan.

The total final score for each of the subscales can range from 20 to 80 points. The higher the final score, the higher the level of anxiety (situational or personal).

The electroencephalography and neuropsychological research methods are crucial for differential diagnosis, and that’s why we used them in the study.

Today, echoencephalography is the only method that can diagnose and confirm the presence of intracranial hypertension with a high degree of probability. Further, clinical signs and tests of the patient’s mental state are to be considered. Standard research methods, such as Dopplerography and MRI, are not informative enough. Neurotransmitter connections are disturbed due to concussion, so routine methods cannot help in measuring them.

Intracranial hypertension and its dynamics are evaluated using the Pallium Index. This Index is considered as an indicator hydrocephalus of the lateral ventricles.

The Pallium Index reference values (indicators of intracranial hypertension): the upper normal limit is 2.2; slightly expressed – 2.3; moderately expressed – 2.4; moderately expressed with a tendency – 2.5; 2.6 and 2.7 – expressed; 2.8 – expressed with a tendency to acute; 2.9–3.2 – acutely expressed.

Electrical potentials of the brain were studied using electroencephalography (EEG) based on an electroencephalographic diagnostic system (echoencephalographic unit “ANGIODIN-ECHO/U”), which allows for assessment of the width of the third ventricle and the location of the lateral walls of the temporal horns of the lateral ventricles.

**Study outcomes and discussion of them.** The study population: 30 wounded persons (main group), aged 19 to 39 years (average age  $29.53 \pm 1.08$  years). As a control group, 20 people (average age  $29.1 \pm 1.4$  years) with identical injuries were assessed.

The selection criteria were determined based on modern classification – according to clinical forms of concussion. A mild concussion and concussion were investigated. The presence of pain syndrome, heaviness in the head, and neurological manifestations were mandatory criteria for the screening of patients. 36.7 % of the wounded had combined injuries (in addition to TBI, injuries to two or more organs or parts of the body).

The general outcomes of the study are shown (Table 1) to 3 ( $p < 0.005$ ).

The outcomes received using Spielberger’s State-Trait Anxiety Inventory (STAI) underwent comparison with reference values to assess whether the patient was

within the normal range or in the zone of increased anxiety compared to the normal for the selected age group. After analyzing the obtained data, we observed more positive dynamics in the main group, where a comprehensive rehabilitation program was applied, affecting the reduction of the level of anxiety. One can also note that the variation rate shows that the groups are homogeneous both at the beginning (V to 8.71) and at the end (V to 8.05) of the study.

The use of the VAS method provided a quantitative assessment of pain, which is crucial for making treatment decisions and monitoring the effectiveness of pain control measures. This scale is highly sensitive to changes in the level of pain. This facilitates obtaining an objective assessment of pain intensity, facilitating monitoring and comparison of pain levels at different times (Table 2). Also, from the coefficient of variation, a conclusion can be made that the groups are homogeneous both at the beginning (V up to 7.89) and at the end (V up to 7.16) of the study.

Pallium index is a measure used to assess hydrocephalus, which is an enlargement of lateral ventricles of the brain. Hydrocephalus is an excessive

accumulation of cerebrospinal fluid (CSF) in the brain ventricles. This condition can increase the volume of the cerebral cavities and decrease the volume of the brain. The pallium index is measured by ultrasound of the brain, namely ultrasound scanning. To determine the pallium index, special formulas, that take into account the size of the lateral ventricles of the brain and the width of the head, are used. An increase in the pallium index may indicate the presence of hydrocephalus, especially if the value exceeds the established norms for a certain age group. Considering the research's peculiarities, using this index is essential for a deep understanding of the positive/negative dynamics of the proposed rehabilitation program. The obtained figures are shown (Table 3). Also, based on the coefficient of variation, it was found out that the groups were homogeneous at the beginning (V to 9.23) and at the end (V to 8.56) of the study.

Based on the obtained results, we can evaluate the effectiveness of our proposed comprehensive rehabilitation program for people with post-concussion syndrome. The data show statistically significant positive changes in pain, anxiety, and cerebral mantle index values in the main group. Considering the abovementioned, we conclude that the developed comprehensive rehabilitation program is viable and can be used in further practice.

**Conclusions.** The study confirms our hypothesis regarding the effectiveness of the developed comprehensive rehabilitation program for persons with post-concussion syndrome.

Using MEC for the rehabilitation of veterans suffering from intracranial hypertension caused by concussion allows for decreasing intracranial hypertension, normalizing the autonomic nervous system, reducing the level of anxiety, and normalizing the sleep pattern.

The device allows for significantly reducing or eliminating painful myofascial syndrome and increasing the level of tissue oxygenation, which contributes to increasing tolerance to physical stress.

The application of MEC allows for increasing tolerance to physical stress.

It has been proven that the developed comprehensive rehabilitation program for patients in a state of anxiety and depression contributes to the improvement of sleep, the emergence of a stable positive motivation for life, and short-term and long-term goals. Taking into account the above, we conclude that the developed complex rehabilitation program is fully justified and can be successfully used in the further practical activities of military recovery after concussions.

Table 1

**Anxiety rate before and after application of the comprehensive rehabilitation program**

Group	Main group (n = 30)		Control group (n = 20)	
	Beginning	End	Beginning	End
Study				
$\bar{x} \pm m$	42.41 ± 0.70	33.90 ± 0.32	41.90 ± 1.22	35.78 ± 0.94
•	0.68	0.39	0.98	0.86
V	8.53	7.29	8.71	8.05

Table 2

**Pain indicator before and after application of the comprehensive rehabilitation program**

Group	Main group (n = 30)		Control group (n = 20)	
	Beginning	End	Beginning	End
Study				
$\bar{x} \pm m$	7.00 ± 0.62	4.00 ± 0.31	7.15 ± 0.61	6.53 ± 0.52
•	0.58	0.43	0.54	0.49
V	7.13	6.22	7.89	7.16

Table 3

**The pallium index before and after the application of the comprehensive rehabilitation program**

Group	Main group (n = 30)		Control group (n = 20)	
	Beginning	End	Beginning	End
Study				
$\bar{x} \pm m$	3.10 ± 0.70	2.01 ± 0.31	3.10 ± 0.91	2.40 ± 0.81
•	0.93	0.56	0.84	0.77
V	9.15	7.05	9.23	8.56

**Perspectives of further research.** As the results of the study confirm the effectiveness of the developed comprehensive rehabilitation program for improving the condition of people with post-concussion syndrome, we believe that the obtained results are the basis for the use of the comprehensive rehabilitation program in hospitals and sanatoriums. Using a comprehensive rehabilitation

program can help reduce recovery time and improve the quality of life for military personnel. In addition, the use of the MEC technique can be recommended in field conditions (sanitary instructor's first aid kit), because the device has proven the possibility of obtaining high-quality results in the shortest possible time. We plan to devote further research to this topic.

## REFERENCES

- Badiuk, M. I. (Red.). (2007). *Vijskovo-medychna pidgotovka* [Military medical training]. Kyiv : MP Lesya. (Ukr).
- Denysiuk, M. V., Dubrov, S. O., Cherniaiev, S. V., Sereda, S. O., Zaikin, Y. M. (2022). Structure of traumatic injuries and experience in the treatment of the wounded patients, as a result of hostilities in the first days of russia's attack on Ukraine. *Pain, Anaesthesia & Intensive Care*, 1 (98), 7–12. [https://doi.org/10.25284/2519-2078.1\(98\).2022.256092](https://doi.org/10.25284/2519-2078.1(98).2022.256092) (Ukr).
- Gaida, I. M., Badyuk, M. I., Sushko Yu. I. (2018). Peculiarities of structure and current of modern combat trauma among servicemen of the Armed Forces of Ukraine. *Pathologia*, 15 (1), 73–76. <https://doi.org/10.14739/2310-1237.2018.1.129329> (Ukr).
- Golky, G. G., Buryanova, O. A., Klymovyyczkogo, V. G. (2013). *Travmatologiya ta ortopediya : pidruchnyk dlya stud. vyshhyx med. navch. Zakladiv* [Traumatology and orthopedics: textbook for students. higher med. education institutions]. Vynnyca : Nova Knyga. (Ukr).
- Grynkiv, M., Kuceryb, T., Kras, S., Mayevska, S., Muzyka, F. (2019). *Medyko-biologichni osnovy fizychnoyi terapiyi, ergoterapiyi («Normalna anatomiya» ta «Normalna fiziologiya») : navch. posib.* [Medical and biological bases of physical therapy, occupational therapy («Normal Anatomy» and «Normal Physiology») : Textbook]. Lviv : LDUFK. (Ukr).
- Krylyuk, V. O., Guryev, C. O., Gudyma, A. A. (2017). *Ekstrena medychna dopomoga travmovanym na dogospitalnomu etapi: navchalnyj posibnyk* [Emergency medical care for the injured at the pre-hospital stage : Textbook]. Kyiv. (Ukr).
- Kuceryb, T., Muzyka, F. (2019). *Anatomiya lyudyny z osnovamy morfologiyi : navch. Posib* [Anatomy with the basics of morphology : Textbook]. Lviv : LDUFK. [in Ukrainian].
- Loskutov, O. E., Kondrashov, A. M., Naumenko, L. Yu., Gulaj, A. M. (2003). *Posibnyk do praktychnyx zanyat z vijskovo-polovoyi xirurgiyi* [Guide to practical training for military surgeon]. Ternopil: Ukrmedknyga. (Ukr).
- Moskalenko, V. F., Bulax, I. Ye., Puzanova, O. G. (2014). *Metodologiya dokazovoyi medycyny : pidruchnyk* [Methodology of evidence-based medicine: a textbook] Kyiv : Medycyna. (Ukr).
- Muxin, V. M. (2015). *Fizychna reabilitaciya v travmatologiyi : monografiya* [Physical rehabilitation in traumatology : monograph]. Lviv : LDUFK. (Ukr).
- Mysula, I. R., Vakulenko, L. O., Shved, M. I., Levyczka, L. V., Loboda, V. F., Vakulenko, D. V., Pryluczka, G. V. (2005). *Medychna ta socialna reabilitaciya: Navchalnyj posibnyk* [Medical and social rehabilitation : Instructional medium]. Ternopil : TDMU. (Ukr).
- Pashko, K. O., Popovych, D. V., Lotoczka O. V. ta in. (2019). *Gigiyena u fizychnij reabilitaciyi: pidruchnyk dlya st-iv ZVO* [Hygiene in physical rehabilitation: a textbook for higher educational establishment]. Ternopil : Ukrmedknyga. (Ukr).
- Popadyuxa, Yu. A. (2018). *Suchasni komplekxy, systemy ta prystroji u reabilitacijnyx tehnologiyax* [Modern complexes, systems and devices in rehabilitation technologies]. Kyiv : Centr uchbovoyi literatury. (Ukr).
- Pronoza-Stebliuk K.V. (2019). Features of medical and psychological rehabilitation of combatants with post-concussion syndrome. Особливості медико-психологічної реабілітації учасників бойових дій із постконтузійним синдромом. *Medical psychology*, 14, 2. 32–35. Retrieved from [http://nbuv.gov.ua/UJRN/Mpsl\\_2019\\_14\\_2\\_8](http://nbuv.gov.ua/UJRN/Mpsl_2019_14_2_8)
- Ramona, DAmico et al. (2021). *Hericium erinaceus and Coriolus versicolor. Modulate Molecular and Biochemical Changes after Traumatic Brain Injury* (Модулируйте молекулярные и биохимические изменения после черепно-мозговой травмы), *Antioxidants (Basel)*. 10 (6), 898. <https://doi.org/10.3390/antiox10060898>
- Stoyanov, O., Kalashnikov, V., Vastyanov, R., Son, A., Kolesnik, O., Oleinik, S. (2022). Vegetative disregulation in the pathogenesis of cerebral angiodystonia and chronic brain ischemia. *International neurological journal*, 18 (3), 19–24. <https://doi.org/10.22141/2224-0713.18.3.2022.941>
- Womens and Mens Health Physiotherapy. (2019). Retrieved from: <http://www.wmhp.com.au/>

Стаття надійшла до редакції 25.10.2023

Стаття прийнята до друку 04.12.2023

**Conflict of interests:** none.

**Contributions of authors:**

**Kovalova O.** – developing the study concept and design, editing, data analysis;

**Burka O.** – material collection, text preparation, data analysis;

**Shuba L.** – material collection, data analysis, text preparation;

**Kovaleva A.** – analysis of domestic and foreign publications;

**Yanitskaya K.** – text preparation.

**Email address for corresponding with the authors:**

[kovaleva\\_alusik@ukr.net](mailto:kovaleva_alusik@ukr.net)