

PHYSICAL THERAPY AND OCCUPATIONAL THERAPY FOR MILITARY PERSONNEL AFTER BLAST-RELATED THORACIC TRAUMA

ФІЗИЧНА ТЕРАПІЯ, ЕРГОТЕРАПІЯ ВІЙСЬКОВОСЛУЖБОВЦІВ ПІСЛЯ ЗАБРОНЬОВОЇ ТРАВМИ ГРУДНОЇ КЛІТКИ

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DOI <https://doi.org/10.32782/2522-1795.2025.19.3.2>

Abstracts

Chest injury in military personnel is one of the most common combat injuries among military personnel. This is the result of explosive waves, falls, contusion or compression with heavy objects without penetration into the chest cavity. The most typical clinical manifestations include the contusion of the chest wall, fractures of the ribs, lung damage, ventilation disorders and respiratory failure. These conditions can lead to a decrease in physical activity, impaired respiratory function and reduce the quality of life in the affected persons. **The aim** is to analyze current scientific evidence and clinical guidelines regarding physical therapy for military personnel after blast-related thoracic trauma. **Materials and methods.** Storing, analysis and systematization of scientific literature published between 2019 and 2024 based on search in PubMed, Scopus and Web of Science Databases. **Results.** Clinical recommendations, protocols, systematic examinations and results of original physical therapy studies after a blast-related thoracic trauma of chest in military personnel illuminate the need to supplement traditional methods of physical therapy such as early mobilization, breathing gymnastics, posture drainage daily activities. Individualized physical therapy programs are developed and implemented to address the specific needs of patients during the pre-operative, in-hospital, and post-hospital periods, focusing on the prevention of long-term complications. This systematic approach effectively contributes to the restoration of respiratory function, improved physical capacity, and reduced risk of complications.

Conclusions. Physical therapy – including breathing exercises, positional treatment, occupational therapy and motor rehabilitation – is a key component in the recovery process after breastfeeding. Despite its prevalence, the rehabilitation management of the military after breast trauma remains a lot of investigated, especially in the context of constant military conflict.

Key words: physical therapy, chest trauma, therapeutic exercises, motor activity, quality of life, ergo-therapy, military personnel, ICF.

Заброньова травма грудної клітки у військовослужбовців є одним із найпоширеніших бойових поранень серед військовослужбовців. Вона виникає унаслідок ударної хвилі, падіння, контузії чи тиску важких предметів без проникнення в грудну порожнину. Найтипівішими клінічними проявами є забій грудної клітки, переломи ребер, ушкодження легень, порушення вентиляції та дихальна недостатність. Такі стани можуть призводити до обмеження фізичної активності, порушення дихальної функції та зниження якості життя військовослужбовців.

Мета дослідження – проаналізувати сучасні наукові дані та клінічні рекомендації щодо фізичної терапії військовослужбовців після заброньової травми грудної клітки.

Методи дослідження. Огляд, аналіз, систематизація даних наукової літератури за 2019–2024 рр. шляхом пошуку в базах PubMed, Scopus, Web of Science.

Результати дослідження. Клінічні рекомендації, протоколи, систематичні огляди та результати оригінальних досліджень фізичної терапії після закритої травми грудної клітки у військовослужбовців висвітлюють необхідність доповнення традиційних методів фізичної терапії (рання мобілі-

зація, дихальна гімнастика, постуральний дренаж) силовими вправами з низьким навантаженням на грудну клітку, ерготерапією із фокусом на виконання щоденних активностей. Індивідуальні програми фізичної терапії розробляються та впроваджуються з урахуванням конкретних потреб пацієнтів у передопераційний, стаціонарний та післястаціонарний періоди, з акцентом на профілактиці довгострокових ускладнень. Такий системний підхід ефективно сприяє відновленню дихальної функції, поліпшенню фізичної працездатності та зниженню ризику ускладнень.

Висновки. Фізична терапія, зокрема дихальна гімнастика, позиційне лікування, ерготерапія та відновлення рухових функцій є ключовим компонентом у процесі реабілітації після ушкоджень грудної клітки. Незважаючи на значну поширеність, реабілітаційний менеджмент військовослужбовців після ураження грудної клітки залишається не досить дослідженим, особливо в умовах військових дій.

Ключові слова: фізична терапія, бойова травма грудної клітки, терапевтичні вправи, рухова активність, якість життя, ерготерапія, військовослужбовці, МКФ.

Introduction. In the context of the ongoing military conflict in Ukraine, there has been a significant increase in the number of service members sustaining blast-related (non-penetrating) thoracic injuries resulting from explosive shock waves, barotrauma, contusion, or traumatic compression. These injuries are frequently accompanied by pulmonary contusion, hemothorax, pneumothorax, impaired respiratory function, and the development of secondary complications such as atelectasis, pneumonia, and respiratory failure [2; 5]. Although blast-related thoracic trauma shares morphofunctional characteristics with closed chest injuries, it is often associated with a more severe clinical course [1].

Physical therapy during the stabilization phase plays a critical role in maintaining pulmonary ventilation, preventing complications, and accelerating functional recovery. However, to date, Ukraine lacks unified clinical guidelines regulating the rehabilitation of service members with blast-related chest trauma, underscoring the need to analyze current physical therapy approaches based on recent evidence.

Combat-related chest trauma (CRCT) remains one of the most common causes of hospitalization among military personnel in active combat zones. According to recent clinical reviews, blast-related chest trauma – resulting from the impact of an explosive wave, blunt injury, or contusion – accounts for approximately 20–30% of all non-penetrating battlefield injuries. While these injuries do not involve open wounds, they may cause significant functional impairments, including hemothorax, pneumothorax, respiratory dysfunction, decreased physical tolerance, and a high risk of post-traumatic complications

such as respiratory failure, pneumonia, and chronic pain [5].

The aim is to analyze current scientific evidence and clinical guidelines regarding physical therapy for military personnel after blast-related thoracic trauma.

Materials and methods. A narrative review and synthesis of scientific literature were conducted using the PubMed, Scopus, and Web of Science databases. Inclusion criteria were as follows: articles describing physical therapy approaches in military personnel after blast or combat-related thoracic trauma, including respiratory therapy, mobilization, occupational therapy protocols, clinical guidelines, systematic reviews, and findings from original research studies.

Research Results. In Ukraine, there is a substantial body of research addressing the physical, psychological, and social rehabilitation of military personnel. The topics range from theoretical models to practical recommendations, reflecting the need for a comprehensive approach, the improvement of state programs, and the adaptation of effective foreign rehabilitation practices to the Ukrainian context. Much of the work is conducted within the framework of scientific studies, analysis of practical experience, and discussions at specialized conferences, underscoring the considerable attention devoted to the systemic aspects of rehabilitation for military personnel.

There is active clinical and research work in Ukraine focused on surgical stabilization of the thoracic cage, particularly in the context of combat-related injuries, as well as the rehabilitation of the respiratory system. Analysis of national

literature revealed that various physical rehabilitation interventions are applied – such as breathing exercises, mobilization techniques, and endurance training – yet there remains a lack of a comprehensive, fully adapted system tailored to Ukrainian realities (sources: ujmm.org.ua, journals.uzhnu.uz.ua, ojs.tdmu.edu.ua) (Table 1).

Blunt (non-penetrating) combat chest trauma refers to injuries caused by the impact of blast waves, blunt force, or kinetic energy without disruption of the integrity of the thoracic wall. This type of trauma is characteristic of modern warfare scenarios, particularly in the context of body armor use, which protects against penetrating injuries but cannot fully absorb or neutralize the kinetic force of an impact or explosion [5; 9]. The core classification categories include the mechanism of injury, clinical forms, key symptoms, typical complications, and physical therapy strategies for military personnel with this type of injury (Table 2).

Therefore, taking into account multifaceted clinical syndromocomplex, patients with chest trauma (for example, chest slaughter, fractures of ribs, pulmonary contusion) require interdisciplinary rehabilitation evaluation. The assessment tools should be sufficiently sensitive to the effectiveness of the rehabilitation process and many dangerous effects of chest injuries. Therefore, it is important to include clinical, functional, psychosocial and contextual evaluation, according to the biopsychosocial model and ICF principles. Medical and clinical assessment should

include the identification of the type of injury (contusion, rib fractures, hemothorax, pneumothorax, pulmonary contusion); pain assessment and intensity (VAS/NRS scales); localization and duration; evaluation of respiratory compromise: dyspnea at rest or on exertion (mMRC scale), monitoring of oxygen saturation (SpO₂), and heart rate (HR).

Pulmonary function assessment may include evaluation of inspiratory volume, forced ventilation, cough (its effectiveness and strength), thoracic mobility (chest wall excursion during breathing), and pain during movement.

Assessment of activity and participation, including self-care abilities (e.g., dressing, hygiene, bed mobility), can be performed using the Barthel Index. Mobility level can be evaluated with the 6-Minute Walk Test (6MWT), while physical exertion tolerance may be assessed with the Borg Rating of Perceived Exertion (RPE) scale.

Considering the psycho-emotional state of the service member, it is advisable to assess anxiety or fear of pain/suffocation using tools such as the Hospital Anxiety and Depression Scale (HADS) and the Pain Catastrophizing Scale. Assessment should also include motivation for recovery, level of social support, and awareness of available social protection mechanisms. Given the severity and duration of the pathological condition, quality-of-life assessment should serve not only as a measure of rehabilitation effectiveness but also as a feedback mechanism between the patient and their environment. Environmental

Table 1

Main Areas of Thoracic Rehabilitation Research in Ukraine

Direction	Interventions	The main results
Physical rehabilitation after thoracic surgery	Breathing exercises, physiotherapy, mobilization	Partial adaptation of the world models to realities in Ukraine, identification of lack of a comprehensive system of rehabilitation of military after the torus of kale injuries [8].
Pulmonary rehabilitation after chest injuries	Breathing simulators, 6mwt, physiotherapy	The clinic shows the importance of early pulmonary rehabilitation (breathing simulators, 6MWT minute walking, chest physical therapy), secretion drainage (Flutter, mechanical aspiration), increased oxygenation, prevention of complications [2; 3]
Flail Chest stabilization in military	Surgery, Hospital Logistics	Reduction of IVL, better pain control; Specificity of use of surgical treatment in military hospitals: improvement of respiratory function, reduction of pain, reduction of the duration of the IVL/bed regime [1; 6].
Unstable costal frame	Innovative stabilization techniques	The development of the thoracic surgical techniques in 2023–2024 is highlighted [7].

Table 2

Clinical Forms of Blunt Combat Chest Trauma and Their Characteristics

Clinical form	The mechanism of occurrence	Key symptoms	Complications are possible	Approaches to physical therapy
Lung slaughter (contusion): accompanied by swelling, microcrovoys, disorders of gas exchange	Explosive wave, chest compression, secondary blows with fragments of armor or structures	Shortness of breath, hemoptysis, reduction of saturation	Lung swelling	Respiratory gymnastics, positional drainage, stimulating inhalation, prevention of complications from the cardiopulmonary system
Fractures of ribs: often multiple	Direct stroke, fall, compression, secondary strokes with fragments of armor or structures	Acute pain, shortness of breath, decrease in mobility	Ventilation restriction, pneumonia, atelectasis	Anesthesia, therapeutic exercises, breathing exercises, breathing techniques, torso and muscle stabilization.
Pneumothorax (closed)	Pleura's damage without breakthrough outside	Sudden shortness of breath, pain, asymmetry of respiratory noise	Lung collapse, respiratory failure	After stabilization – gradual load therapeutic exercises, controlled activation
Hemothorax	Hemorrhage into the pleural cavity	Pain, hypoventilation, chest lag in breathing	Lung tamponade, fibrothorax	After drainage – breathing exercises, therapeutic exercises, postural therapy
Chest polytrauma, chest compression syndrome and lung ventilation	Combined injuries during explosion/accident	Combination of symptoms by lungs, heart, muscle	Multiple organ failure	Individual Plan of Physical Therapy, Ergotherapy, Multidisciplinary Approach

and personal factor evaluation should cover the availability and use of assistive devices, assistance from family or healthcare staff, living conditions (elevator access, bathroom facilities, stairs), and personal factors such as willpower, pain perception, and comorbidities. The clinical course of thoracic injury in military personnel is often complicated by a high risk of polytrauma (e.g., traumatic brain injury, limb fractures, burns), the development of complications due to delayed evacuation or treatment, and a predisposition to acute respiratory distress syndrome (ARDS), pneumonia, or pleurisy [2]. It is important to note that blast injuries, characterized by heterogeneous mechanisms of damage, can simultaneously cause pulmonary rupture (due to blast overpressure) and penetrating trauma (from high-velocity fragments), resulting in a combined injury mechanism. Affected anatomical structures may include the thoracic wall, heart, lungs, thoracic spine, aorta, venae cavae, pulmonary vessels, and esophagus [5; 9].

The most common consequences of blast-related thoracic injuries include pulmonary contusion, partial laceration of lung parenchyma, respiratory dysfunction, reduced chest wall mobility, decreased physical endurance, limitations in self-care and activities of daily living (ADLs) and persistent pain (Table 3).

Blunt chest trauma is frequently associated with pulmonary contusion, the development of pneumonitis, and restricted respiration. Atelectasis in the injured area is a common occurrence and significantly increases the risk of post-traumatic pneumonia [7; 15]. Even with successful treatment, most patients continue to experience pain and functional impairment: studies report that 57–67% of patients still experience dysfunction and chronic pain three months post-injury [5]. Long-term complications (chronic pain syndrome, limited physical activity) may persist for up to two years or more [14]. At the same time, a number of authors emphasize that following blunt thoracic trauma (BTT), it is often possible to

detect foreign bodies in injured military personnel, such as bullets, mine fragments, or other foreign objects [9]. Accordingly, surgical intervention and preoperative preparation of the servicemember are clearly indicated. Taking such prognostic considerations into account, the goal of rehabilitation management involves patient assessment and implementation of targeted interventions during both the preoperative and postoperative periods.

Table 3

Consequences of Blast-Related Thoracic Injuries

System	Complications are possible
Respiratory system	– hypoventilation – Atelectasis – Pneumonia – hemothorax / pneumothorax
Cardiovascular system	– myocardial damage (contusion) – rhythm violation – Orthostatic hypotension
Neurological and psycho-emotional	– Post-traumatic pain syndrome – anxiety/depressive disorders
The musculoskeletal system	– restraint of breast mobility – Severe sarcopeny – Osteopenia
Other complications	– bedsores – a decrease in physical endurance – a decrease in the vital capacity of the lungs

Without timely rehabilitation, adverse outcomes may include prolonged respiratory dysfunction, recurrent pulmonary infections, chronic thoracic pain, established respiratory distress or failure, reduced physical endurance, and psycho-emotional disorders (such as PTSD and depression linked to pain and impaired mobility) [11].

Therefore, the primary goals of physical therapy following chest trauma are pain control, restoration of respiratory function, and early patient mobilization. Effective analgesia is essential for enabling active exercises and movement. Insufficient pain management restricts deep breathing and mobility, which in turn impairs lung ventilation and increases the risk of complications. Research supports the early implementation of respiratory exercises – such as controlled breathing and positive expiratory pressure (PEP) train-

ing – as these reduce the risk of hypostatic pneumonia and improve oxygen saturation [15].

The UK's NICE guidelines (2022) support a similar approach, emphasizing the need for early stimulation of deep breathing and physical activity [13]. Patients are encouraged to mobilize and cough with chest support, while additional methods (e.g., active cycle of breathing techniques, inhalation trainers, IPPB) are used to prevent atelectasis.

Pulmonary rehabilitation is recommended within the first 24–48 hours post-injury to optimize gas exchange and prevent systemic deconditioning. NICE (2022) highlights that chest trauma rehabilitation should begin as early as possible to improve respiratory function and prevent muscle atrophy. Early mobilization, when clinically feasible, stimulates deep breathing and improves the overall condition. Special attention is given to the prevention of contractures: early restoration of shoulder mobility on the affected side is essential, especially in cases involving lateral rib fractures, where limitation is common [13].

Clinical protocols emphasize the importance of a multidisciplinary approach – involving physical therapists, occupational therapists, pain specialists, surgeons, and psychologists – to achieve both physical recovery and psycho-emotional adaptation [8; 12].

Thus, physical therapy for military personnel with blunt chest trauma should be based on three core principles: Respiratory support, Physical activation, Functional independence (see Table 4).

Recent clinical guidelines recommend a comprehensive approach to rehabilitation in cases of rib fractures and blunt thoracic trauma. The 2023 International Consensus on Respiratory Health outlines the following key principles: early intervention (within <24 hours) aimed at improving lung volumes and clearing secretions (including supported coughing, resistance breathing, incentive spirometry, etc.), as well as very early mobilization – such as sitting and walking – depending on patient capability [10]. These guidelines also advise against rigid chest binding, as it restricts breathing. Daily monitoring using objective measures (oxygen saturation, forced vital capacity) is recommended to assess progress.

Table 4

Key Physical Therapy Methods for Chest Trauma

Method of physical therapy	Description	Expected effect / goal
Breathing exercises	Deep breathing, active breathing cycle, cough technique, vibration	Increasing pulmonary volumes, improving ventilation, prevention of atelectasis and stagnation
Respiratory simulators	Spirometry, Flatters of Positive Pressure	Stimulation of deep breath, relief of sputum drainage, improvement of oxygenation
Position therapy and mobilization	Early sitting, change of body position, turns, getting up, early gait	Prevention of complications of lying regime, improvement of respiratory function, reduction of decondium
Functional and strength exercises	Exercises on the mobility of the chest, shoulder girdle, imitation of household actions (gait, dressing)	Restoration of amplitude of movements, muscle strength, daily activity, reduction of duration of treatment
Energy-saving strategies	Training efficient use of energy in self-service	Increased endurance, adaptation to loading, prevention of fatigue

In Ukraine, pulmonary rehabilitation is considered essential and should begin immediately after the patient's condition stabilizes, using all available tools – from breathing trainers to oxygen support in cases of respiratory failure [2–4; 7].

Review and experimental studies confirm the benefits of physical therapy for chest injuries: respiratory training significantly reduces the risk of atelectasis and pulmonary infections, shortens the duration of hospitalization and chest drainage, and improves oxygenation (PaO_2 , SaO_2) and lung function indicators [11; 14; 15]. Training that includes deep and diaphragmatic breathing, inhalation therapy, and forced coughing has been shown to improve patients' final vital capacity compared to conservative treatment, facilitating faster recovery of respiratory function [1; 3; 7]. Importantly, such interventions do not increase the risk of pleural complications. These findings confirm that active pulmonary exercise is an effective non-pharmacological component of treatment for patients with blunt chest trauma.

Alongside respiratory exercises, mobilization and functional training also yield positive outcomes. Studies indicate that patients who engage in more physical activity and begin walking earlier demonstrate better functional outcomes and spend less time in inpatient care [11]. Retrospective reviews emphasize that interventions such as supported coughing, thoracic stabilization, and early activation improve clinical outcomes

by reducing complications and enhancing functional status. Moreover, rehabilitation programs combining therapeutic exercises with elements of occupational therapy promote the recovery of patient independence [14; 15].

Pilot controlled studies are also being conducted using virtual reality and traditional breathing exercises for patients with blunt thoracic trauma. However, analysis of the results has shown no significant differences between the two approaches. The findings highlight the need for methodological guidance emphasizing very early intervention with breathing exercises, mobilization, avoidance of chest binding, and daily monitoring of clinical condition and functional status [16].

Currently, standardized clinical approaches to closed thoracic injuries are used in military rehabilitation, but their adaptation to the realities of combat conditions remains insufficient. In Ukraine, further development is needed in the retraining system for physical therapists in accordance with NATO standards and current clinical guidelines.

Conclusions. In Ukraine, there is a considerable amount of research on the physical, psychological and social rehabilitation of servicemen. The topic covers both theoretical models and practical recommendations that reflects the need for a comprehensive approach, improvement of government programs and adaptation of effective foreign rehabilitation practices to the Ukrainian realities

of rehabilitation of servicemen. In Ukraine, clinical and research work in the field of surgical stabilization of the chest is actively conducted, especially in the context of combat injuries, as well as in the direction of rehabilitation of the respiratory system. Over the past few years, a considerable amount of data on the role of physical therapy after breastfeeding in the military has been accumulated. The technique of providing immediate medical care, complications of injury, technique of surgery, rehabilitation management are analyzed. The most modern approaches emphasize the immediate negative effects of injury and distant complications. It is a complex of pathological conditions that are related to the dysfunction of the cardiorespiratory system, a decrease in physical activity, post-traumatic stress disorders, and a decrease in quality of life. Scientific achievements emphasize the need to initiate early pulmonary rehabilitation. Physical therapy after an explosion that does not penetrate the chest injury is a critical component in the restoration of the military. Physical therapy should include systematic breathing exercises, early mobilization and restoration of daily movements. It is recommended to start rehabbing for the first 24 hours, combining breathing exercises with active physical activity (such as sitting and walking). Empirical studies confirm that such interventions improve pulmonary ventilation, reduce the duration of hospitalization and reduce the incidence of respiratory complications. The integrated approach includes both physical therapists and labor therapists. Due to purposeful exercises to restore control, limb function and basic activity of daily life, the independence of the patient can be effectively restored and improved quality of life.

At the same time, there is an urgent need for the implementation of clinical protocols on the basis of evidence in the system of military rehabilitation of Ukraine. It is also necessary to develop a national clinical standard for rehabilitation after thoracic injury with clearly defined algorithms and time frames for initiating therapy. Equally important is the integration of multidisciplinary approaches that combine thoracic surgeons, pulmonologists, physical therapists and other medical workers.

Bibliography

1. Беденюк А.Д., Мальований В.В., Війтович Л.Є., Довга І.І. Травма грудної клітки: особливості перебігу, ускладнення та лікувальна тактика. Шпитальна хірургія ім. Л.Я. Ковальчука, 2020. 2: 120–122. doi: 10.11603/2414-4533.2020.2.10779.
2. Грубич О.С., Чернякова І.О. Фізична терапія та реабілітація в умовах повномасштабної війни в Україні. *Медицина в умовах воєнного стану* : матеріали наук.-практ. конф. Харків. 2024. С. 61–63. URL: <https://hero.knmu.edu.ua/handle/123456789/33545>.
3. Григус І.М. Фізична реабілітація при захворюваннях дихальної системи : навчальний посібник. Львів : Новий світ. 2020. 170 с.
4. Єжова О.О., Тимрук-Скоропад К.А., Ціж Л.М. Терапевтичні вправи : навчальний посібник. Львів : ЛДУФК, 2023. 158 с.
5. Лікування поранених з бойовими ушкодженнями грудей : монографія / упоряд.: Лурін І.А., Хорошун Е.А., Гуменюк К.В. та ін. ; за заг. ред. В.І. Цимбалюка. Тернопіль : ТНМУ, 2023. 236 с.
6. Мельниченко О.О. Особливості хірургічного лікування нестабільності грудинно-реберного каркасу при бойовій хірургічній травмі. *Український журнал військової медицини*. 2023. 4(3): 192–198. URL: [https://doi.org/10.46847/ujmm.2023.3\(4\)-192](https://doi.org/10.46847/ujmm.2023.3(4)-192).
7. Співак А.П. Аналіз існуючих підходів до фізичної реабілітації пацієнтів після хірургічного лікування захворювань грудної клітки: аналітичний огляд. Україна. Здоров'я нації, 2019. 2: 113–118. URL: http://nbuv.gov.ua/UJRN/Uzn_2019_2_20.
8. Уніфікований клінічний протокол екстреної медичної допомоги. Травма органів грудної клітки – пневмоторакс. URL: <https://urgent.com.ua/ua/archive/2017/2/%2865%29/pages-48-59/travma-organiv-grudnoyi-klitki-pnevmotoraks>.
9. Яковенко О.К., Ходош Е.М. Бойова травма грудної клітки та її наслідки. 2023. URL: <https://health-ua.com/terapiya-i-semeynaya-meditsina/boiova-travma/74187>.
10. European Respiratory Society ERS International Congress 2023. URL: <https://europeanlung.org/en/get-involved/events/ers-congress-2023/>.
11. Mistry R.N., Moore J.E. Management of blunt thoracic trauma. *BJA Educ*. 2022. 22(11): 432–439. doi: 10.1016/j.bjae.2022.08.002. Epub 2022 Oct 1.
12. NATO Standard AJP-4.10. URL: <https://tccc.org.ua/files/downloads/ajp410-allied-joint-doctrine-for-medical-support-en.pdf>.
13. National Institute for Health and Care Excellence (NICE). Major trauma: service

delivery (NG40). NICE Guideline. 2019. URL: <https://www.nice.org.uk/>.

14. Jain A., Waseem M. Chest Trauma. Treasure Island (FL): StatPearls Publishing; 2025. URL: <https://www.ncbi.nlm.nih.gov/books/NBK482194/>.

15. Mistry R.N., Moore J.E. Management of blunt thoracic trauma. *BJA Education*. 2022. 22(11): 432–439. <https://doi.org/10.1016/j.bjae.2022.08.002>.

16. Tjitske D. Groenveld, Smits Indy G.M., Scholten N., Marjan de Vries, Harry van Goor, Vincent S. Pulmonary and Physical Virtual Reality Exercises for Patients with Blunt Chest Trauma: Randomized Clinical Trial. *JMIR Serious Games*. 2024. <https://doi.org/10.2196/54389>.

References

1. Bedenyuk, A.D., Mal'ovanyy, V.V., Viytyvych, L.Ye., Dovha, I.I. (2020). Travma hruudnoyi klitky: osoblyvosti perebihu, uskladnennya ta likuval'na taktyka [Chest trauma: characteristics of the course, complications, and treatment tactics]. *Shpytal'na khirurhiya im. L.Ya. Koval'chuka*. 2:120–122. DOI: 10.11603/24144533.2020.2.10779 [in Ukrainian].

2. Hrubych, O.S., Chernyakova, I.O. (2024). Fizychna terapiya ta reabilitatsiya v umovakh povnomasshtabnoyi viyny v Ukrayini [Physical therapy and rehabilitation amid full-scale war in Ukraine]. *Medytsyna v umovakh voyennoho stanu: materialy nauk.-prakt. konf. Kharkiv*. 61–63. Retrieved from: <https://repo.knmu.edu.ua/handle/123456789/33545> [in Ukrainian].

3. Grygus, I.M. (2024). Fizychna reabilitatsiya pry zakhvoryuvannyakh dykhal'noyi systemy [Physical rehabilitation for respiratory diseases]: navchalnyi posibnyk. L'viv: Novyy svit. 170 s. [in Ukrainian].

4. Yezhova, O.O., Tymruk-Skoropad, K.A., Tsih, L.M. Terapevtychni vpravy [Therapeutic exercises]: navchalnyi posibnyk. L'viv: LDUFK. 2023. 158 s. [in Ukrainian].

5. Likuvannya poranenykh z boyovymy ushkozhenyamy hrudey [Treatment of wounded soldiers with combat chest injuries]: monohrafiya / uporyad.: Lurin I.A., Khoroshun E.A., Humenyuk K.V. ta in.; za zah. red. V.I. Tsymbalyuka. Ternopil': TNMU. 2023. 236 s. [in Ukrainian].

6. Mel'nychenko O.O. (2023). Osoblyvosti khirurhichnoho likuvannya nestabil'nosti hruudynno-rebernoho karkasu pry boyoviy khirurhichniy travmi [Features of surgical treatment of instability of the sternocostal cage in combat surgical trauma]. *Ukrayins'kyi zhurnal viys'kovoyi medytsyny*. 4 (3):192–198. [https://doi.org/10.46847/ujmm.2023.3\(4\)-192](https://doi.org/10.46847/ujmm.2023.3(4)-192) [in Ukrainian].

7. Spivak, A.P. (2019). Analiz isnuuyuchykh pidkhodiv do fizychnoyi reabilitatsiyi patsiyentiv pislya khirurhichnoho likuvannya zakhvoryuvan' hruudnoyi klitky: analitychnyy ohlyad [Analysis of existing approaches to physical rehabilitation of patients after surgical treatment of chest diseases: an analytical review]. *Ukrayina. Zdorov'ya natsiyi*. 2: 113–118. Retrieved from: http://nbuv.gov.ua/UJRN/Uzn_2019_2_20 [in Ukrainian].

8. Unifikovanyy klinichnyy protokol ekstrenoyi medychnoyi dopomohy. Travma orhaniv hruudnoyi klitky – pnevmotoraks [Unified clinical protocol for emergency medical care. Chest trauma – pneumothorax]. Retrieved from: <https://urgent.com.ua/ua/archive/2017/2%2865%29/pages-48-59/travma-organiv-grudnoyi-klitki-pnevmotoraks> [in Ukrainian].

9. Yakovenko, O.K., Khodosh, E.M. (2023). Boyova travma hruudnoyi klitky ta yiyi naslidky [Combat chest injury and its consequences]. Retrieved from: <https://health-ua.com/terapiya-i-semeynaya-meditsina/boiova-travma/74187> [in Ukrainian].

10. European Respiratory Society ERS International Congress. 2023. Retrieved from: <https://europeanlung.org/en/get-involved/events/ers-congress-2023/>.

11. Mistry R.N., Moore J.E. (2022). Management of blunt thoracic trauma. *BJA Educ*. 22(11):432–439. DOI: 10.1016/j.bjae.2022.08.002.

12. NATO Standard AJP-4.10. Retrieved from: <https://tccc.org.ua/files/downloads/ajp410-allied-joint-doctrine-for-medical-support-en.pdf>.

13. National Institute for Health and Care Excellence (NICE). Major trauma: service delivery (NG40). NICE Guideline. 2019. Retrieved from: <https://www.nice.org.uk/>.

14. Jain, A., Waseem, M. Chest Trauma. (2025). Treasure Island (FL): StatPearls Publishing. Retrieved from: <https://www.ncbi.nlm.nih.gov/books/NBK482194/>.

15. Mistry, R.N., Moore, J.E. (2022). Management of blunt thoracic trauma. *BJA Education*. 22(11): 432–439. <https://doi.org/10.1016/j.bjae.2022.08.002>

16. Tjitske D. Groenveld, Smits Indy G.M., Scholten N., Marjan de Vries, Harry van Goor, Vincent S. (2024). Pulmonary and Physical Virtual Reality Exercises for Patients with Blunt Chest Trauma: Randomized Clinical Trial. *JMIR Serious Games*. <https://doi.org/10.2196/54389>.

Прийнято до публікації: 23.09.2025

Опубліковано: 30.10.2025

Accepted for publication on: 23.09.2025

Published on: 30.10.2025