

PHYSICAL THERAPY FOR MILITARY PERSONNEL WITH TRANSRADIAL AMPUTATION AND PROSTHETICS WITHIN THE MEDICAL REHABILITATION SYSTEM DURING THE WAR IN UKRAINE

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INTRODUCTION

The full-scale war in Ukraine has significantly increased the number of severe combat injuries. Among them, a significant part is injuries to the upper extremities. Mine-explosive, gunshot and shrapnel wounds can lead to complex injuries to bones, muscles, blood vessels and nerves. In the most severe cases, this may require amputation.

As noted in the literature, transradial amputation is one of the common levels of upper limb amputation. Despite the preservation of the elbow joint, such an amputation can significantly limit a person's functional capabilities. This makes it difficult to perform daily tasks, self-care and professional activities and can affect social activity^{1,2}.

The publications emphasize that physical therapy plays an important role in the rehabilitation of military personnel after transradial amputation. It helps prepare the stump for prosthetics and prevent postoperative complications. Physical therapy restores motor functions and develops skills in using the prosthesis. Its main goal is to achieve the maximum possible level of functional independence of the patient³. In war conditions, the organization of such assistance in accordance with international standards and principles of the International Classification of Functioning, Disability and Health (ICF) becomes especially important.

A summary of scientific publications showed that despite the development of modern rehabilitation medicine, the issues of rehabilitation of military personnel with transradial amputation require further study. This especially applies to physical therapy and medical rehabilitation, taking into account the specifics of modern combat injuries. It is also important to consider the conditions and features of the organization of rehabilitation care in Ukraine.

The aim of the work is to generalize modern scientific approaches to medical rehabilitation and physical therapy of military personnel with transradial amputation in the conditions of war in Ukraine. A separate direction of work is to determine the main approaches to training military personnel for prosthetics and the features of physical therapy at different stages of recovery. An important task is also to determine approaches to restoring

¹ Guryev S. O., Kushnir V. A., Solovyov O. S., Panasenko S. I. Substantiation of indications for limb amputation in civilian victims with multisystem injuries as a result of modern warfare. *The Ukrainian Journal of Clinical Surgery*. 2025. № 1. C. 49–56. DOI: 10.26779/2786-832X.2025.1.49.

² Tennent D.J., Wenke J.C., Rivera J.C., Krueger C.A. Characterisation and outcomes of upper extremity amputations. *Injury*. 2014 Jun;45(6):965-9. doi: 10.1016/j.injury.2014.02.009. Epub 2014 Feb 15. PMID: 24657058.

³ Esquenazi A. Amputation rehabilitation and prosthetic restoration: From surgery to community reintegration. *Disability and Rehabilitation*. 2004. Vol. 26(14–15). P. 831–836. DOI: 10.1080/09638280410001708850.

functional activity and facilitating the return of military personnel to everyday and professional life.

To achieve this goal, relevant domestic and foreign scientific sources were analyzed. Modern approaches to organizing the rehabilitation process, physical therapy and prosthetics of military personnel after transradial amputation were summarized. The role of physical therapy in the prevention of secondary complications, restoration of functional capabilities and improvement of the quality of life of patients was considered. The work used methods of analysis and generalization of scientific literature, bibliographic, comparative and systematic analysis.

1. Basic principles of medical rehabilitation and physical therapy after transradial amputation

Modern approaches to medical rehabilitation after transradial amputation. Combat injuries of servicemen of the Armed Forces of Ukraine are particularly severe. As a result of serious wounds received in battle, in many cases there is a need for transradial amputation. Such amputation is quite common.

A study of published works shows a significant number of mine and explosive injuries as a result of the full-scale war in Ukraine. The number of shrapnel injuries and gunshot injuries has also increased. As a result of such injuries, muscle tissue and bones are destroyed. There is a rupture of blood vessels and nerve fibers. Such lesions often require amputation.

The results of studies indicate that with amputation of the upper limb, patients experience phantom pain and psychoemotional disorders. Secondary disorders of the musculoskeletal system are noted, and the effectiveness of self-care is impaired. The functions of grasping and manipulating certain essential items are significantly limited. This reduces the patient's ability to self-serve. This is also associated with a decrease in the social activity of patients, disruption of their professional, specialist and labor activities^{4, 5, 6, 7}.

Research in scientific publications indicates the importance of the biopsychosocial model in modern medical rehabilitation. At the same time, the emphasis is on the importance of taking into account biological factors, psychological and social aspects. Thus, the process of recovery of patients and their return to social activity is complex. At the same time, scientific works emphasize that for the patient, not only compensation for one or another activity is especially important, but also the formation of his functional independence. His optimal psycho-emotional state and psycho-emotional well-being are important. The patient's social

⁴ Tennent D.J., Wenke J.C., Rivera J.C., Krueger C.A. Characterisation and outcomes of upper extremity amputations. *Injury*. 2014 Jun;45(6):965-9. doi: 10.1016/j.injury.2014.02.009. Epub 2014 Feb 15. PMID: 24657058.

⁵ Tintle S.M., Baechler M.F., Nanos G.P., Forsberg J.A., Potter B.K. Reoperations following combat-related upper-extremity amputations. *The Journal of Bone and Joint Surgery. American Volume*. 2012. Vol. 94, No. 16. Art. e119(1–6). DOI: 10.2106/JBJS.K.00197.

⁶ Швець А.В., Горішна О.В., Депутат Ю.М., Ричка О.В., Жалдак А.Ю., Кіх А.Ю. Прогностична оцінка потреби у медичній реабілітації військовослужбовців Збройних Сил України на основі даних структури їх бойової травми. *Український журнал військової медицини*. 2022. Т. 3, № 3. С. 110–117. DOI: 10.46847/ujmm.2022.3(3)110.

⁷ Cancio J.M., Eskridge S., Shannon K., Orr A., Mazzone B., Farrokhi S. Development of overuse musculoskeletal conditions after combat-related upper limb amputation: a retrospective cohort study. *Journal of Hand Therapy*. 2023. Vol. 36, No. 1. P. 66–73. DOI: 10.1016/j.jht.2021.05.003.

activity and his professional realization are also noted as an important component of rehabilitation.

In general, scientists emphasize that the process of rehabilitation of patients should be continuous. The emphasis is on its patient-orientedness and compliance with the principles of the International Classification of Functioning, Disability and Health (ICF).

The literature indicates that for the successful recovery of the patient, his early involvement in rehabilitation interventions is important. In the early stages of rehabilitation, after the patient is stabilized, first of all, rehabilitation measures are carried out that are preventive in nature and prevent complications. Such complications can occur after surgery. Measures that protect the patient from contractures and swelling of the stump are also important. Maintaining the mobility of the shoulder and elbow joints is also very important. The patient also needs to be taught to hold the limb correctly and perform therapeutic exercises properly.

At this stage, it is necessary to pay primary attention to the formation of the stump. Scientific articles emphasize that such indicators as the shape of the stump, its sensitivity, the condition of soft tissues, as well as scars are important factors. These factors determine, to a large extent, the possibility of successful prosthetics. In the future, they ensure the patient's effective use of the prosthesis^{8,9}.

As the conducted studies show, an important place in the rehabilitation process is occupied by the prevention and treatment of pain syndrome. It is noted that postoperative pain, as well as neuropathic and phantom pains, are the most common. It is emphasized that such forms of pain significantly limit the effectiveness of rehabilitation and the functional characteristics of the patient.

The analyzed literature notes the features of the modern approach to the rehabilitation process. It is emphasized that the rehabilitation approach should be comprehensive. It should include, in particular, medication, mirror and physical therapy. The process of stump desensitization is important, which increases the effectiveness of rehabilitation interventions. Psychological support of the patient and the use of cognitive-behavioral therapy methods are also essential. Studies have shown that the combination of interventions of this nature provides pain relief, reduces its intensity, and, in general, improves the results of subsequent prosthetics. Rehabilitation of military personnel after transradial amputation requires coordinated work of specialists from different fields. The combination of medical care and physical therapy allows to simultaneously take into account the health status of the military personnel, their functional capabilities and individual needs for rehabilitation. Interdisciplinary interaction plays an important role in this process. Such interaction ensures the consistency of rehabilitation measures and contributes to the comprehensive recovery of patients. This approach is especially important for military personnel with the combined

⁸ Smith D.G., Ehde D.M., Legro M.W., Reiber G.E., del Aguila M.A., Boone D.A. Phantom limb, residual limb, and back pain after lower extremity amputations. *Clinical Orthopaedics and Related Research*. 1999. No. 361. P. 29–38. DOI: 10.1097/00003086-199904000-00005.

⁹ Highsmith M.J., Kahle J.T., Miro R.M., Mengelkoch L.J., Orriola J.J., Lewandowski A.L. Interventions to manage residual limb ulceration due to prosthetic use in individuals with lower extremity amputation: a systematic review. *Technology and Innovation*. 2016. Vol. 18, No. 2–3. P. 115–124. DOI: 10.21300/18.2-3.2016.115.

consequences of severe combat trauma, when physical recovery must be carried out simultaneously with medical, psychological and social support^{10, 11}.

The purpose, tasks and principles of physical therapy. Physical therapy is the main component of comprehensive medical rehabilitation of military personnel after transradial amputation.

Its main goal is multifaceted and includes the following aspects:

- restoration of the maximum possible level of functional independence of the patient,
- preparation of the patient for effective prosthetics,
- formation of skills in using the prosthesis,
- return of the patient to professional activity and active life.

The literature indicates the differences between the features of the treatment of acute trauma and physical therapy. It is emphasized that physical therapy is aimed both at eliminating the consequences of surgical intervention and at adapting the patient to new conditions determined by transradial amputation. In particular, first of all, we are talking about changing the anatomical and functional characteristics of the patient and developing new motor stereotypes. Prevention of secondary disorders is also important.

Analysis of literary sources shows certain characteristics of the rehabilitation process that ensure its effectiveness. Emphasis is placed on the implementation of an individual approach to rehabilitation interventions.

The physical therapy program should take into account the following indicators:

- the patient's functional status,
- the level of amputation,
- the presence of phantom pain,
- the presence of concomitant injuries,
- the patient's physical fitness
- the patient's motivation for recovery.

It is also necessary to take into account the fact that mine and blast injuries and shrapnel wounds are often accompanied by significant damage to soft tissues, blood vessels, nerves and bones. Such injuries are often combined with other injuries and psycho-emotional disorders that may be observed in the patient^{12, 13}.

Scientists in their publications indicate that modern physical therapy is based on the following principles:

¹⁰ Chan B.L., Witt R., Charrow A.P., Magee A., Howard R., Pasquina P.F., Heilman K.M., Tsao J.W. Mirror therapy for phantom limb pain. *The New England Journal of Medicine*. 2007. Vol. 357, No. 21. P. 2206–2207. DOI: 10.1056/NEJMc071927.

¹¹ Іванець О.Р., Макар О.Р. Синергія внутрішньої медицини та фізичної терапії у відновленні здоров'я постраждалих внаслідок водних забруднень бойового походження. *Внутрішня медицина XXI століття: інтеграція знань та практики : зб. наук. праць наук.-практ. конф. з міжнар. участю, 12 червня 2025 р., Львів*. Львів : ДНТ «ЛНМУ ім. Д. Галицького», 2025. С. 21–24.

¹² Stinner D.J., Burns T.C., Kirk K.L., Ficke J.R. Return to duty rate of amputee soldiers in the current conflicts in Afghanistan and Iraq. *The Journal of Trauma*. 2010. Vol. 68, No. 6. P. 1476–1479. DOI: 10.1097/TA.0b013e3181bb9a6c.

¹³ Швець А.В., Горішна О.В., Депутат Ю.М., Ричка О.В., Жалдак А.Ю., Кіх А.Ю. Прогностична оцінка потреби у медичній реабілітації військовослужбовців Збройних Сил України на основі даних структури їх бойової травми. *Український журнал військової медицини*. 2022. Т. 3, № 3. С. 110–117. DOI: 10.46847/ujmm.2022.3(3)-110.

- early start of rehabilitation interventions,
- continuity of rehabilitation,
- individual approach to patients,
- functional orientation of rehabilitation,
- gradual increase in load,
- active participation of the patient in the rehabilitation process.

A very important condition for the successful conduct of the rehabilitation process is the coordinated work and interaction of specialists in an interdisciplinary team.

A physical therapist must closely cooperate with a doctor of physical and rehabilitation medicine, an occupational therapist, a prosthetist, a psychologist and other members of the professional team that conducts the rehabilitation and recovery of the patient.

The following main tasks of physical therapy are highlighted in literary sources:

- prevention of postoperative complications, contractures and swelling of the stump;
- formation of a functionally suitable stump,
- reduction of the patient's pain syndrome,
- restoration of joint mobility and muscle strength,
- preparation of the patient for prosthetics,
- teaching the patient to use the prosthesis,
- restoration of household, professional and social skills,
- prevention of overload of the healthy upper limb and spine¹⁴.

Physical therapy in the early postoperative period. As emphasized in the publications, one of the most important stages of rehabilitation is the early postoperative period. This pattern is determined, in particular, by the fact that it is at this time that the prerequisites for successful prosthetics and further functional recovery are laid.

Rehabilitation measures are started with the permission of the attending physician after stabilization of the patient's general condition.

Scientific articles define the main tasks of this period. They are as follows:

- prevention of postoperative complications,
- reduction of pain and edema,
- maintenance of mobility of the shoulder and elbow joints,
- formation of the correct stump,
- prevention of contractures.

To perform these tasks, the following methodological approaches are used:

- breathing exercises,
- early activation,
- exercises for a healthy upper limb and lower limbs,
- active and isometric exercises for the shoulder girdle,
- exercises for patient relaxation

Scientists emphasize that the amputated limb must be in the correct positioning. It is noted that prolonged stay of the shoulder joint in the adduction position, as a rule, leads to the formation of contractures. This, in turn, in the future, significantly complicates the patient's use of the prosthesis. To avoid such a situation, the patient must be taught the correct position

¹⁴ Østlie K., Franklin R.J., Skjeldal O.H., Skrondal A., Magnus P. Musculoskeletal pain and overuse syndromes in adult acquired major upper-limb amputees. *Archives of Physical Medicine and Rehabilitation*. 2011. Vol. 92, No. 12. P. 1967–1973. DOI: 10.1016/j.apmr.2011.06.026.

of the limb during rest and sleep. The position of the patient's limb during his daily activities is also important¹⁵.

The results of numerous studies confirm that stump care is of great importance.

Analysis of literary sources allows us to highlight the following rehabilitation actions that are used after the healing of the postoperative wound:

- compression therapy,
- light massage,
- desensitization,
- exercises to form the optimal shape of the stump,
- exercises to prepare the stump for using the prosthesis receiving sleeve.

At the same time, prevention of skin hypersensitivity and cicatricial changes is carried out.

Generalization of research results also allows us to highlight a set of measures aimed at preventing phantom pain. In this case, the following are used:

- drug treatment,
- mirror therapy,
- exercises for imaginary movements,
- desensitization,
- muscle relaxation methods,
- psychological support.

It is noted that the combination of these methods helps reduce the intensity of the pain syndrome and improves the patient's readiness for the next stages of rehabilitation¹⁶.

The completion of the early postoperative period is also important. At that time, according to literature sources, the following parameters are assessed:

- the condition of the stump,
- the volume of movements,
- the patient's muscle strength,
- the severity of pain,
- the patient's general physical fitness.

The results obtained are used in the future to develop an individual approach in conducting a further physical therapy program. These results also allow us to determine the patient's level of readiness for the stage of pre-prosthetic preparation.

Pre-prosthetic preparation. A significant amount of data has accumulated in the scientific literature, which indicates that the decisive stage of rehabilitation is pre-prosthetic preparation. The effectiveness of the patient's further use of the prosthesis largely depends on this stage.

The purpose of pre-prosthetic preparation includes the following options:

- achieving the optimal functional state of the stump,
- restoring the patient's physical performance,
- preparing the patient for learning to control the prosthesis.

¹⁵ Esquenazi A. Amputation rehabilitation and prosthetic restoration: From surgery to community reintegration. *Disability and Rehabilitation*. 2004. Vol. 26(14–15). P. 831–836. DOI: 10.1080/09638280410001708850.

¹⁶ Chan B.L., Witt R., Charrow A.P., Magee A., Howard R., Pasquina P.F., Heilman K.M., Tsao J.W. Mirror therapy for phantom limb pain. *The New England Journal of Medicine*. 2007. Vol. 357, No. 21. P. 2206–2207. DOI: 10.1056/NEJMc071927.

The main tasks of this stage, as evidenced by the study of published works, are as follows:

- final formation of the stump,
- reduction of stump edema,
- increase in scar tissue mobility,
- development of strength and endurance of the muscles of the shoulder girdle
- development of strength and endurance of the residual limb segment,
- maintenance of the full range of motion in the shoulder and elbow joints,
- prevention of contractures,
- correction of posture disorders.

An important component is the desensitization of the stump. In this case, according to the literature, the following are used:

- massage,
- compression therapy,
- tactile training,
- gradual increase in tolerance to mechanical stress¹⁷.

According to the generalization of the results of studies published in scientific works, physical therapy at the stage of pre-prosthetic preparation includes the following components:

- active resistance exercises,
- exercises to stabilize the scapula,
- exercises to strengthen the muscles of the trunk,
- exercises to develop coordination and balance.

When performing exercises, special attention is paid to the symmetry of the movements performed by the patient. Prevention of compensatory mechanisms also plays an important role. Such compensatory mechanisms can lead to overloading of the healthy upper limb, cervical and thoracic spine.

An important place at this stage is also occupied by the psychological preparation of the patient for prosthetics.

The generalization of the materials of the publications allows, in this case, to highlight the following components of joint interactions, members of the multidisciplinary team. The key role, in this case, is played by the physical therapist, as well as the psychologist and the prosthetist. These scales, each from their own perspective, explain the features of the future use of the prosthesis, as well as form realistic expectations of the patient regarding its functional capabilities. They provide motivation for the patient to actively participate in the rehabilitation^{18, 19}.

¹⁷ Esquenazi A. Amputation rehabilitation and prosthetic restoration: From surgery to community reintegration. *Disability and Rehabilitation*. 2004. Vol. 26(14–15). P. 831–836. DOI: 10.1080/09638280410001708850.

¹⁸ Østlie K., Franklin R.J., Skjeldal O.H., Skrondal A., Magnus P. Musculoskeletal pain and overuse syndromes in adult acquired major upper-limb amputees. *Archives of Physical Medicine and Rehabilitation*. 2011. Vol. 92, No. 12. P. 1967–1973. DOI: 10.1016/j.apmr.2011.06.026.

¹⁹ Resnik L., Klinger S.L., Etter K. The DEKA Arm: Its features, functionality, and evolution during the Veterans Affairs Study to optimize the DEKA Arm. *Prosthetics and Orthotics International*. 2013. Vol. 38, No. 6. P. 492–504. DOI: 10.1177/0309364613506913.

2. Physical therapy during the stages of preparation for prosthetics and use of the prosthesis

Physical preparation for using the prosthesis. Physical preparation of the patient for primary prosthetics begins after the stump is ready.

Its main goal, as noted in the publications, is to create the necessary physical prerequisites for effective control of the prosthesis and the performance of functional movements.

An analysis of literary sources has shown that such a program includes the following elements:

- development of muscle strength (shoulder girdle, torso, residual limb segment),
- training of the patient's endurance and coordination,
- working out the speed of motor reactions,
- development of proprioception.

As noted, exercises that ensure the stability of the shoulder girdle are of particular importance. It is the shoulder girdle that takes an active part in controlling most mechanical and myoelectric prostheses. Therefore, such exercises are very important for the development of the patient's further ability to control the prosthesis²⁰.

Physical therapy during the initial use of the prosthesis. Physical therapy after prosthetics is aimed at developing stable skills in the patient regarding its use. It is important to integrate the patient into everyday activities.

An analysis of the literature allows us to identify several main stages of rehabilitation interventions to achieve such tasks.

At the initial stage, the patient is taught the following skills:

- correct putting on and taking off the prosthesis,
- rules for caring for the stump,
- monitoring the condition of the skin,
- safe operation of the prosthesis.

Next, the patient must acquire the following skills in controlling the prosthesis:

- mastering the skills of opening and closing the gripping mechanism,
- holding objects of different shapes and masses,
- performing simple actions using the prosthesis,
- performing more complex household and professional manipulations.

As noted in the publications, when using myoelectric prostheses, special attention is paid to training isolated muscle contractions. It is these muscle contractions that provide precise control of the prosthesis' electronic system^{21, 22}.

It is emphasized that at this stage the patient is functionally trained. Such training simulates his future everyday and professional actions.

²⁰ Kesler M.S., Heckman J.T., Kaufman G.E., Morgenroth D.C. Advances in prosthetics and rehabilitation of individuals with limb loss. *Physical Medicine and Rehabilitation Clinics of North America*. 2019. Vol. 30, No. 2. P. 423–437. DOI: 10.1016/j.pmr.2018.12.013.

²¹ Biddiss E., Chau T. Upper-limb prosthetics: Critical factors in device abandonment. *American Journal of Physical Medicine & Rehabilitation*. 2007. Vol. 86, No. 12. P. 977–987. DOI: 10.1097/PHM.0b013e3181587f6c.

²² Resnik L., Klinger S.L., Etter K. The DEKA Arm: Its features, functionality, and evolution during the Veterans Affairs Study to optimize the DEKA Arm. *Prosthetics and Orthotics International*. 2013. Vol. 38, No. 6. P. 492–504. DOI: 10.1177/0309364613506913.

The literature provides options that the patient is trained in. These are the following positions:

- coordination of movements of the trunk and upper limbs,
- maintenance of correct posture,
- control of the position of the shoulder girdle,
- avoidance of irrational compensatory movements.

It is noted that for military personnel, the needs associated with the performance of professional tasks, physical training and a high level of functional activity are additionally taken into account^{23, 24}.

An important principle of functional training, as noted in the scientific literature, is the principle of gradual complication of tasks. Tasks are complicated from simple movements in controlled conditions to the performance of complex actions in a real everyday environment.

Exercises performed by the patient should be aimed at the development and improvement of the following functions in terms of motor activity:

- coordination of movements,
- accuracy, speed and smoothness of movements,
- development of bilateral interaction of the upper limbs
- formation of economical motor stereotypes.

At the same time, the scientific literature emphasizes that along with such exercises, correction of compensatory movements should be carried out. Such movements may occur in the patient as a result of excessive use of the trunk or a healthy upper limb.

In general, as indicated, such work allows preventing the development of chronic pain in the neck, shoulder girdle and spine, as well as increasing the efficiency of using the prostheses²⁵.

Scientists in their publications note the close interaction and combination of physical therapy and occupational therapy, which is observed at this stage of the patient's rehabilitation.

The complex work of a physical therapist and occupational therapist is aimed at developing a number of important skills in the patient, among which the following are the most important:

- restoration of self-service,
- performance of various activities in everyday life,
- use of communication means,
- writing skills,
- work with tools.

In general, the development of various functional skills that are necessary for the patient's independent life and professional activity is important.

²³ Metzger A.J., Dromerick A.W., Holley R.J., Lum P.S. Characterization of compensatory trunk movements during prosthetic upper limb reaching tasks. *Archives of Physical Medicine and Rehabilitation*. 2012. Vol. 93, No. 11. P. 2029–2034. DOI: 10.1016/j.apmr.2012.03.011.

²⁴ Cancio J.M., Orr A., Eskridge S., Shannon K., Mazzone B., Farrokhi S. Occupational therapy practice patterns for military service members with upper limb amputation. *Military Medicine*. 2020. Vol. 185, No. 3–4. P. 444–450. DOI: 10.1093/milmed/usz341.

²⁵ Metzger A.J., Dromerick A.W., Holley R.J., Lum P.S. Characterization of compensatory trunk movements during prosthetic upper limb reaching tasks. *Archives of Physical Medicine and Rehabilitation*. 2012. Vol. 93, No. 11. P. 2029–2034. DOI: 10.1016/j.apmr.2012.03.011.

Long-term physical therapy after prosthetics. As scientists indicate in their works, after the patient has completed the initial adaptation to the prosthesis, the rehabilitation stage begins, which is designed to ensure his long-term functional recovery.

A generalization of the literature data showed that the main goal of this stage includes several components, namely:

- improving the patient's skills in using the prosthesis,
- increasing the patient's physical performance,
- preventing secondary complications that may arise,
- ensuring the patient's maximum independence in everyday life and professional activities.

In accordance with the set goal, as emphasized in the publications, exercises are selected to form an individual physical therapy rehabilitation program, the implementation of which should ensure the solution of a number of tasks. This program includes, in particular, exercises for:

- developing muscle strength,
- patient endurance,
- coordination of movements,
- patient balance,
- aerobic performance.

Special attention, as emphasized in the publications, is paid to training bilateral coordination of movements, accuracy of manipulations and speed of performing functional tasks set for the patient^{26, 27}.

Analysis of scientific sources shows that one of the priority areas is the prevention of secondary disorders of the patient's musculoskeletal system. This is due to the fact that after amputation, the load on the patient's healthy upper limb, as well as on his shoulder girdle and spine, increases significantly. Such changes can lead to the development of pain syndromes, posture disorders and various degenerative processes in the patient.

To prevent such phenomena, it is recommended to use a set of exercises aimed at:

- strengthening the muscles of the trunk,
- maintaining symmetry of movements,
- correcting the patient's posture,
- forming economical motor stereotypes.

It is especially emphasized that continuous care for the stump occupies an important place in the rehabilitation process.

Patient care for the stump, as indicated in literary sources, includes the following items:

- daily monitoring of the skin condition,
- prevention of abrasions,
- correct use of compression devices,

²⁶ Resnik L., Klinger S.L., Etter K. The DEKA Arm: Its features, functionality, and evolution during the Veterans Affairs Study to optimize the DEKA Arm. *Prosthetics and Orthotics International*. 2013. Vol. 38, No. 6. P. 492–504. DOI: 10.1177/0309364613506913.

²⁷ Biddiss E., Chau T. Upper-limb prosthetics: Critical factors in device abandonment. *American Journal of Physical Medicine & Rehabilitation*. 2007. Vol. 86, No. 12. P. 977–987. DOI: 10.1097/PHM.0b013e3181587f6c.

– timely detection of signs of inflammation or excessive pressure of the receiving sleeve^{28, 29}.

Analysis of modern scientific sources shows the importance of the patient's physical activity and his return to professional activity. This approach is an integral part of the lifestyle of a serviceman after completing the basic rehabilitation course. The patient's physical activity, as is recognized, plays a very important role.

The publications draw attention to the fact that regular training of patients performs a number of very important functions. In particular, the following trainings:

- support the patient's functional capabilities,
- improve his endurance,
- contribute to the prevention of cardiovascular diseases
- have a positive effect on the patient's psycho-emotional state.

Published works indicate that an important direction of modern rehabilitation is adaptive sports. It contributes to the restoration of physical fitness, the development of coordination and strength. Adaptive sports form confidence in the patient's own abilities and are also an important element of social integration. The patient's participation in certain types of physical activity depends on the level of his functional capabilities.

In general, playing sports and participating in various types of physical activity help maintain a high level of motivation in the patient and improve their quality of life^{30, 31}.

The current state of research suggests that for military personnel, the ultimate goal of rehabilitation is to achieve a high level of functional readiness. The achieved level of rehabilitation should allow the patient to return to professional duties and successfully adapt to civilian life.

After prosthetics, the rehabilitation process does not end, since the military personnel must gradually adapt to the prosthesis and restore the skills of using it in everyday and professional activities. At this stage, physical therapy should be aimed not only at maintaining the achieved results, but also at further developing strength, coordination, endurance and functional independence. It is also important to regularly assess the functional capabilities of the military personnel and, if necessary, adjust the rehabilitation program in accordance with their individual needs and life goals. This approach allows us to consider physical therapy as

²⁸ Resnik L., Borgia M., Clark M.A., Ni P. Measuring residual limb health in persons with upper limb amputation: Modifications of the Prosthetic Evaluation Questionnaire residual limb health scale. *PM&R*. 2023. Vol. 15, No. 10. P. 1208–1217. DOI: 10.1097/PXR.0000000000000227.

²⁹ Cancio J.M., Ikeda A.J., Barnicott S.L., Childers W.L., Alderete J.F., Goff B. Upper Extremity Amputation and Prosthetics Care Across the Active Duty Military and Veteran Populations. *Physical Medicine and Rehabilitation Clinics of North America*. 2019. Vol. 30, No. 1. P. 73–87. DOI: 10.1016/j.pmr.2018.08.011.

³⁰ Resnik L., Borgia M., Clark M.A. Function and quality of life of unilateral major upper limb amputees: Effect of prosthesis use and type. *Archives of Physical Medicine and Rehabilitation*. 2020. Vol. 101, No. 8. P. 1396–1406. DOI: 10.1016/j.apmr.2020.04.003.

³¹ Burger H., Franchignoni F., Heinemann A.W., Kotnik S., Giordano A. Validation of the Orthotics and Prosthetics Users' Survey Upper Extremity Functional Status Module in people with unilateral upper limb amputation. *Journal of Rehabilitation Medicine*. 2008. Vol. 40, No. 5. P. 393–399. DOI: 10.2340/16501977-0183.

a continuous component of recovery – from pre-prosthetic preparation to long-term post-prosthetic support³².

Telerehabilitation can be an important addition to physical therapy. Its use allows you to continue rehabilitation support at home, monitor the implementation of recommended exercises, timely adjust the program and maintain the patient's motivation. This form of work may be especially relevant for military personnel who have limited access to rehabilitation services due to distance from the institution, relocation or other organizational circumstances. At the same time, telerehabilitation should be considered as a supplement to in-person care, and its use should be determined taking into account the functional state and individual needs of the patient. The scientific literature emphasizes that the decision to return to military service is made individually for each patient. In this case, his functional capabilities, type of prosthesis, nature of professional tasks and medical indications are taken into account^{33, 34, 35, 36, 37}.

Assessment of the effectiveness of physical therapy. Assessment of the effectiveness of physical therapy is an important component of the rehabilitation process.

Analysis of the literature shows that the effectiveness of physical therapy is assessed at all stages of rehabilitation. It is noted that a comprehensive examination of the patient includes the determination of the following parameters:

- muscle strength,
- range of motion in the joints,
- patient endurance,
- coordination,
- functional capabilities of the upper limb,
- intensity of pain syndrome,
- level of independence in daily activities.

³² Ivanets O.R. Physical rehabilitation as a component of innovative solutions for management of hydroecological threats during the war in Ukraine: from pre-prosthetic preparation to post-prosthetic recovery // Сталий розвиток охорони здоров'я: національний та глобальний вимір. Колективна монографія. Рига: Izdevniecība "Baltija Publishing. 2026. (В друці).

³³ Stinner D.J., Burns T.C., Kirk K.L., Ficke J.R. Return to duty rate of amputee soldiers in the current conflicts in Afghanistan and Iraq. *The Journal of Trauma*. 2010. Vol. 68, No. 6. P. 1476–1479. DOI: 10.1097/TA.0b013e3181bb9a6c

³⁴ Dharm-Datta S., Etherington J., Mistlin A., Rees J., Clasper J. The outcome of British combat amputees in relation to military service. *Injury*. 2011. Vol. 42, No. 11. P. 1362–1367. DOI: 10.1016/j.injury.2011.06.028.

³⁵ Швець А.В., Мальцев О.В., Кисельов С.М., Каплук О.Б. Особливості процесу реабілітаційного менеджменту серед комбатантів: світовий досвід. *Український журнал військової медицини*. 2024. Т. 5, № 3. С. 39–49. DOI: 10.46847/ujmm.2024.3(5)-039.

³⁶ Tkachuk A.V., Yesselbaieva A.K., Aravitska M.H. Dolzhykova O.V., Morozenko D.V., Babkina O.P., Danylenko S.I. Social aspects of post-amputation rehabilitation of military personnel. *Actual Problems of Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy*. 2025. Vol. 25, No. 4 (92). P. 267–272. DOI: 10.31718/2077-1096.25.267.

³⁷ Іванець О.Р., Макар О.Р. Телереабілітація у фізичній терапії після перелому діафіза плечової кістки: перспективи впровадження. *У Національний конгрес фізичної та реабілітаційної медицини 14–15 листопада 2025 року*, м. Львів. С. 22–24.

At the same time, as evidenced by the generalization of literature sources, along with clinical examination, standardized functional tests and assessment scales are used. This approach allows you to objectively determine the following parameters:

- dynamics of patient recovery,
- effectiveness of prosthetics
- timely adjustment of the individual physical therapy program.

The emphasis is also on the appropriateness of taking into account the patient's quality of life indicators, satisfaction with the use of the prosthesis and the achievement of individually defined functional goals in accordance with the principles of the ICF. When assessing the results of physical therapy, it is important to take into account not only changes in the physical and functional state of the serviceman, but also his psycho-emotional well-being. Psycho-emotional distress can affect the patient's involvement in the rehabilitation process, his motivation and ability to consistently follow the recommendations of specialists. Therefore, it is advisable to evaluate the effectiveness of physical therapy after transradial amputation in a comprehensive manner, combining the analysis of functional results with the assessment of the psychological state, quality of life and level of social activity of the serviceman^{38, 39, 40, 41, 42}.

In general, the literature review showed that physical therapy is a key component of medical rehabilitation of military personnel after transradial amputation. It ensures consistent restoration of functional capabilities at all stages of treatment, starting from the early postoperative period to the patient's full adaptation to the use of the prosthesis.

The effectiveness of physiotherapeutic interventions depends on the following factors:

- early start of rehabilitation,
- individualization of the rehabilitation program,
- productive interaction of specialists in an interdisciplinary team,
- active participation of the patient in the physiotherapeutic process
- application of modern methods of physical therapy and prosthetics.

³⁸ Іванець О.Р., Макар О.Р. Психоемоційний дистрес як предиктор результатів фізичної терапії у онкопациєнтів із переломами діафіза плечової кістки в умовах війни. *Матеріали Всеукраїнської науково-практичної конференції з міжнародною участю «Перспективи розвитку медичної реабілітації на різних рівнях надання медичної допомоги»* – Тернопіль : ТНМУ. 2026. С. 59 – 63.

³⁹ Resnik L., Borgia M. Reliability of outcome measures for people with upper-limb amputations: a systematic review. *Archives of Physical Medicine and Rehabilitation*. 2012. Vol. 93, No. 6. P. 1038–1048. DOI: 10.1016/j.apmr.2011.11.001.

⁴⁰ Burger H., Franchignoni F., Heinemann A.W., Kotnik S., Giordano A. Validation of the Orthotics and Prosthetics Users' Survey Upper Extremity Functional Status Module in people with unilateral upper limb amputation. *Journal of Rehabilitation Medicine*. 2008. Vol. 40, No. 5. P. 393–399. DOI: 10.2340/16501977-0183. .

⁴¹ Волянський О.М., Кіх А.Ю. Застосування Міжнародної класифікації функціонування, обмеження життєдіяльності та здоров'я для оцінки ефективності реабілітації військовослужбовців. *Український журнал військової медицини*. 2024. Т. 5, № 3. С. 75–84. DOI: 10.46847/ujmm.2024.3(5)-075.

⁴² Shostak S.M., Andriichuk O.Ya., Ulianytska N.Ya., Sakharuk L.Yu. Psycho-emotional state of patients: assessment of anxiety during the early stage of post-traumatic physical therapy and occupational therapy. *International Medical Herald*. 2025. Vol. 1, No. 3–4. P. 49–56. DOI: 10.64108/imh.2025.3.4.49

Ensuring the restoration of the patient's functional independence and improving the quality of his life is ensured by such criteria as:

- a comprehensive combination of physiotherapeutic exercises,
- functional training,
- preparation of the patient for prosthetics,
- teaching the patient to use the prosthesis,
- prevention of secondary complications
- maintenance of the patient's physical activity.

These factors create conditions for the successful professional and social reintegration of military personnel.

CONCLUSIONS

Transradial amputation of the upper limb is one of the most common consequences of severe combat injuries of military personnel during the war in Ukraine. It leads to significant impairment of the functional capabilities of patients, limitation of their daily activities and decrease in professional performance. In general, the quality of life of people significantly deteriorates. These negative factors determine the need for a comprehensive, continuous and patient-oriented system of medical rehabilitation.

Medical rehabilitation of military personnel with transradial amputation is based on the following principles:

- early onset,
- staged implementation,
- individualization of the rehabilitation program,
- continuity of rehabilitation interventions,
- effective interaction of specialists in a multidisciplinary team.

Important components of the rehabilitation process are such measures as preparation of a functionally suitable stump and prevention of postoperative complications. A significant place in this process is occupied by such areas as the treatment of pain syndrome and psychological support of the patient. Great attention should also be paid to the preparation of the patient for prosthetics and his social adaptation.

Physical therapy is a defining component of comprehensive rehabilitation. It performs a number of important tasks, in particular, such as:

- ensuring the restoration of the patient's motor functions,
- maintaining the full range of movements in adjacent joints,
- developing strength, endurance and coordination,
- preventing contractures and secondary disorders of the musculoskeletal system.

Physical therapy measures should be consistent with the rehabilitation stage and the functional needs of the patient. For the full return of military personnel with transradial amputation to everyday life, it is important to ensure proper preparation for prosthetics. It is no less important to gradually teach them to use a mechanical or myoelectric prosthesis to restore self-service skills, professional activity and social activity. Further functional training of patients also plays an important role, helping them to confidently use the prosthesis in real life situations.

In this case, it is necessary to use functionally oriented methods of physical therapy, which should be as close as possible to the real living conditions and professional activities of patients.

Effective recovery of military personnel after transradial amputation requires a comprehensive approach. This approach involves a combination of medical rehabilitation, physical therapy, occupational therapy, psychological support of the patient, as well as modern prosthetics and social reintegration measures. This interaction helps restore the functional independence of the patient, improve the quality of his life and create conditions for returning to professional activity and active participation in social relations.

Further development of the rehabilitation system for military personnel in Ukraine requires orientation on modern and scientifically based approaches. Important areas are the introduction of evidence-based methods of physical therapy, strengthening cooperation between specialists of different specialties and wider use of modern prosthetic technologies.

Improving rehabilitation approaches will contribute to better organization of care and more complete consideration of the individual needs of each patient. This will create more favorable conditions for restoring functional independence of patients and their return to daily and professional activities.

SUMMARY

The paper summarizes modern scientific approaches to medical rehabilitation and physical therapy of military personnel with transradial amputation in the conditions of war in Ukraine. Special attention is paid to preparation for prosthetics and gradual training in the use of the prosthesis. Modern approaches to the restoration of functional activity and the return of military personnel to everyday and professional life after upper limb amputation are also considered.

The effectiveness of rehabilitation of military personnel after transradial amputation largely depends on how early the recovery is started and how consistently it is carried out. An important role is played by the coordinated work of a multidisciplinary team and an individual approach to the needs of each serviceman. Medical rehabilitation involves the preparation of a functionally suitable stump, prevention of postoperative complications and control of pain syndrome. At the same time, important components are psychological support, social adaptation and preparation for prosthetics.

Physical therapy plays an important role in restoring motor abilities after upper limb amputation. It is aimed at developing strength, endurance and coordination, preventing contractures, as well as developing skills in using mechanical and myoelectric prostheses.

Comprehensive medical rehabilitation and physical therapy are an important part of the recovery of military personnel with transradial amputation. Their implementation should be based on evidence-based approaches, coordinated work of a multidisciplinary team and taking into account the individual needs of the patient.

Key words: transradial amputation, military personnel, medical rehabilitation, physical therapy, prosthetics, war in Ukraine.

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