Kazakh Journal of Clinical Neuroscience
ISSN 1813-3908

Review

Recovery of Lower Limb Function after Stroke: The Role of Self-Management and Modern Rehabilitation Technologies

Tokzhan Kispayeva [1], Inna Bolshakova [2*], Albina Zhexenbayeva [3], Tomiris Zhunussova [4]

[1] Professor at the School of «Nursing Education», Karaganda Medical University, Karaganda, Kazakhstan. E-mail: Kispaeva@qmu.kz
[2] PhD student, Assistant Professor at the School of Nursing Education, Karaganda Medical University, Karaganda, Kazakhstan. E-mail: I.Malysheva@qmu.kz
[3] Master's student, Karaganda Medical University, Karaganda, Kazakhstan. E-mail: albinazheksenbaeva03@mail.ru
[4] Bachelor's degree student, Karaganda Medical University, Karaganda, Kazakhstan. E-mail: shigurikentoki@gmail.com

*** Corresponding author:** I.Malysheva@qmu.kz

Received: May 19, 2026
Revised: May 27, 2026
Accepted: June 11, 2026
Published: June 30, 2026

Citation: Tokzhan Kispayeva, Inna Bolshakova, Albina Zhexenbayeva, Tomiris Zhunussova. Recovery of lower limb function after stroke: the role of self-management and modern rehabilitation technologies.
Kaz J Clin NeuSci. 2026, 79 (2), kjcn050.
https://doi.org/10.53498/pznz1y60

Abstract

Stroke remains one of the leading causes of long-term disability worldwide. Impairments of lower limb function and gait substantially reduce functional independence, limit social participation, and negatively affect patients' quality of life. Despite significant advances in rehabilitation technologies, restoring motor function after stroke remains a major clinical challenge. In recent years, increasing attention has been paid to self-management strategies aimed at promoting active patient participation and improving long-term rehabilitation outcomes.

Objective. To analyze current scientific evidence regarding the use of self-management strategies in the recovery of gait and lower limb function after stroke and to evaluate the role of modern rehabilitation technologies and multidisciplinary support in improving rehabilitation outcomes.

Methods. A narrative literature review was conducted using publications published primarily between 2015 and 2025. Literature searches were performed in PubMed, Scopus, Web of Science, Google Scholar, and the Cochrane Library using keywords related to stroke rehabilitation, gait recovery, lower limb function, self-management, and rehabilitation technologies. Systematic reviews, meta-analyses, randomized controlled trials, clinical guidelines, and studies evaluating technological rehabilitation approaches and self-management interventions were included.

Results. The reviewed evidence demonstrated that post-stroke gait impairment results from a combination of neurophysiological, biomechanical, and behavioral factors. Robotic-assisted gait training, virtual reality, telerehabilitation, wearable monitoring systems, and other technology-assisted interventions improve motor performance, gait quality, functional mobility, and rehabilitation intensity. Furthermore, integrating self-management strategies enhances patient adherence to rehabilitation, increases physical activity, improves self-efficacy, and facilitates long-term maintenance of functional gains. Nursing support plays a crucial role by providing patient education, motivational counseling, continuous monitoring, and ensuring continuity of rehabilitation care.

Conclusions. Integrating modern rehabilitation technologies with self-management strategies represents a promising approach to restoring lower limb function after stroke. A comprehensive rehabilitation model combining technological, educational, behavioral, and nursing interventions may improve functional independence, enhance long-term rehabilitation outcomes, and ultimately improve the quality of life of stroke survivors.

Keywords: stroke, stroke rehabilitation, walking, lower extremity, self-management, robotics, nursing care.

1. Introduction

Stroke remains one of the leading causes of mortality and long-term disability worldwide, representing a major medical and socioeconomic challenge for healthcare systems. According to international studies, a substantial proportion of stroke survivors experience persistent functional impairments, among which motor deficits are among the most common and disabling consequences [1–3].

Lower limb dysfunction and gait impairment are among the most prevalent sequelae of stroke, significantly affecting patients' functional independence, social participation, and quality of life [5,6]. Independent ambulation is considered a key indicator of successful rehabilitation because restoration of walking ability is closely associated with functional autonomy and return to activities of daily living [5,7]. However, despite conventional rehabilitation programs, many patients continue to experience residual gait impairments several months after stroke, highlighting the need for more effective rehabilitation strategies [8,9].

Contemporary neurorehabilitation has evolved rapidly through the implementation of innovative technologies, including robotic gait training systems, virtual and augmented reality, telerehabilitation, neuromodulation techniques, and biofeedback systems [10–16]. These approaches increase training intensity, provide objective monitoring of motor performance, and enable individualized rehabilitation programs. Nevertheless, technological interventions alone may not achieve sustainable long-term outcomes without the patient's active engagement in the rehabilitation process [12,17].

In recent years, increasing attention has been paid to the concept of self-management, which emphasizes patients' active participation in managing their health condition through adherence to rehabilitation recommendations, independent exercise performance, and continuous monitoring of functional changes [18]. The integration of self-management strategies into post-stroke rehabilitation has been shown to improve motivation, treatment adherence, and functional recovery [17,19–21]. Members of the multidisciplinary rehabilitation team, particularly nurses, play a pivotal role in developing self-management skills by providing patient education, motivational support, and ongoing monitoring of rehabilitation adherence [22,23].

Therefore, integrating advanced rehabilitation technologies with self-management strategies represents a promising approach to improving lower limb recovery after stroke. Despite growing interest in technology-assisted rehabilitation and self-management interventions, evidence regarding their combined impact on gait recovery remains fragmented and requires further synthesis.

The aim of this narrative review was to analyze current scientific evidence on the application of self-management strategies in the recovery of gait and lower limb function after stroke and to evaluate the role of innovative rehabilitation technologies and multidisciplinary support in improving rehabilitation outcomes.

2. Materials and Methods

A narrative review of the scientific literature was conducted to examine contemporary approaches to gait restoration and lower limb functional recovery following stroke. A comprehensive literature search was performed using the international electronic databases PubMed, Scopus, Web of Science, Google Scholar, and the Cochrane Library.

The search strategy included the following English-language keywords and their combinations: stroke rehabilitation, gait recovery, lower limb function, self-management, robot-assisted rehabilitation, virtual reality, telerehabilitation, multidisciplinary rehabilitation, and stroke survivors.

Publications written in English and published primarily between 2015 and 2025 were considered for inclusion. The review included systematic reviews, meta-analyses, randomized controlled trials, clinical practice guidelines, and original studies investigating gait recovery, lower limb rehabilitation, technology-assisted rehabilitation, self-management interventions, and multidisciplinary approaches for individuals after stroke.

Studies were excluded if they provided insufficient methodological information, represented duplicate publications, were conference abstracts, or

https://doi.org/10.53498/pznz1y60

were not directly related to lower limb functional recovery after stroke.

The retrieved publications were screened for relevance based on their titles, abstracts, and full texts where appropriate. The final selection comprised studies that were directly related to lower limb rehabilitation after stroke, technology-assisted rehabilitation, self-management strategies, and multidisciplinary rehabilitation. The selected evidence was synthesized narratively to summarize current knowledge and identify emerging trends in post-stroke rehabilitation.

3. Results

3.1. Gait and Lower Limb Impairments After Stroke

Lower limb motor impairment is one of the most common consequences of stroke and results from complex neurophysiological and biomechanical mechanisms associated with damage to the central nervous system. Following stroke, patients frequently develop muscle weakness, spasticity, impaired proprioception, reduced postural control, and impaired motor coordination, leading to altered gait kinematics and reduced functional mobility [24,25]. The severity of these impairments depends on the location and extent of brain injury as well as the degree of neuroplastic recovery.

One of the characteristic features of post-stroke gait is gait asymmetry, which is manifested by reduced stance time on the paretic limb, shorter step length, and impaired weight transfer [7]. Patients often adopt compensatory gait strategies to maintain stability, resulting in increased energy expenditure and reduced walking efficiency [7,24]. Uneven weight distribution between the lower limbs is considered an important contributor to falls and functional limitations [25].

Another common pathological characteristic of post-stroke gait is knee hyperextension (genu recurvatum), which may develop as a consequence of muscle weakness, extensor spasticity, or impaired ankle control. This condition compromises lower limb stability during the stance phase, decreases walking speed, and may be accompanied by pain, further limiting functional mobility [26]. In addition, impaired ankle function and reduced shock absorption adversely affect gait biomechanics and walking efficiency.

Altered lower limb kinematics also play an important role in gait dysfunction after stroke. Rather than focusing on isolated joint movements, assessment of overall limb kinematics provides a more comprehensive understanding of intersegmental coordination and motor control. Previous studies have demonstrated that improvements in lower limb kinematics are associated with enhanced walking speed and functional mobility in stroke survivors [24].

Balance impairment and deficits in postural control are additional factors limiting gait recovery. Reduced stability is associated with insufficient loading of the paretic limb and impaired sensorimotor integration, contributing to an increased risk of falls and reduced confidence during ambulation [24,25]. Improving weight transfer between the lower limbs is considered one of the key mechanisms underlying gait recovery and restoration of functional independence [25].

In addition to biomechanical impairments, cognitive, emotional, and motivational factors substantially influence motor recovery. Depression, fear of falling, reduced self-confidence, and low motivation may delay rehabilitation progress and diminish the effectiveness of therapeutic interventions [17,21]. These findings emphasize the importance of a comprehensive rehabilitation approach that addresses not only physical impairments but also behavioral and psychosocial aspects of recovery.

Despite considerable advances in stroke rehabilitation, persistent gait impairment remains common several months after stroke. Evidence suggests that approximately half of stroke survivors continue to experience walking limitations six months after stroke, negatively affecting functional independence and quality of life [5,6]. These findings highlight the need for more effective rehabilitation strategies aimed at optimizing lower limb recovery while actively engaging patients throughout the rehabilitation process.

3.2. Contemporary Technologies for Lower Limb Rehabilitation After Stroke

Contemporary neurorehabilitation has increasingly incorporated technology-assisted interventions designed to enhance training intensity, improve motor control, and promote neuroplasticity. These innovative approaches have expanded the possibilities of conventional rehabilitation by enabling more individualized and intensive interventions for restoring lower limb function after stroke [11,12].

Robot-assisted gait training has emerged as one of the most rapidly evolving rehabilitation strategies. The use of robotic devices, including exoskeletons and body weight-supported gait trainers, enables repetitive practice of physiological gait patterns with high movement precision and adjustable levels of assistance, thereby facilitating motor relearning and improving functional mobility [13]. Robotic gait training is particularly beneficial during the early stages of rehabilitation, when independent ambulation is limited, as it allows patients to perform intensive task-specific training while reducing the physical demands placed on rehabilitation staff [11]. Evidence suggests that combining robotic gait training with conventional rehabilitation results in greater improvements in motor function and balance than conventional therapy alone [12,13]. Additional evidence supporting the effectiveness of robotic rehabilitation has been provided by recent systematic reviews and meta-analyses [27].

Virtual and augmented reality have also become important components of contemporary stroke rehabilitation. Immersive virtual environments provide interactive training scenarios, real-time visual and auditory feedback, and gamified exercises that enhance patient motivation and engagement [14]. Virtual reality-based interventions have been associated with improvements in motor coordination, balance, walking speed, and overall participation in rehabilitation programs [14]. Furthermore, these technologies allow rehabilitation programs to be tailored to individual functional abilities.

Telerehabilitation represents another promising approach for extending rehabilitation beyond inpatient settings. Remote rehabilitation platforms, mobile applications, and wearable sensors facilitate continuous monitoring of physical activity, supervision of exercise performance, and communication between patients and healthcare professionals, thereby improving adherence to rehabilitation programs [15,16]. Such interventions are particularly valuable for individuals with limited access to specialized rehabilitation services and support the continuation of therapy following hospital discharge.

Neuromodulation techniques and biofeedback interventions have also demonstrated considerable potential for improving lower limb motor recovery. Functional electrical stimulation is widely used to activate paretic muscles, improve motor control, and normalize gait patterns, leading to increased walking speed and greater gait symmetry [12]. In addition, biofeedback enables patients to better recognize limb position and movement, facilitating motor learning and movement correction during rehabilitation.

Wearable sensor technologies provide objective assessment of gait characteristics, weight distribution, and exercise performance. These systems support individualized rehabilitation planning, continuous monitoring of functional recovery, and data-driven adjustment of therapeutic interventions [16]. Moreover, digital health technologies encourage self-monitoring and promote greater patient engagement throughout the rehabilitation process.

Despite the substantial advantages of technology-assisted rehabilitation, their long-term effectiveness largely depends on patient motivation, adherence to prescribed exercise programs, and sustained participation in rehabilitation. Without active patient engagement, even advanced technological interventions may have limited long-term benefits [17,21]. Therefore, integrating technology-assisted rehabilitation with self-management strategies has become an important direction for optimizing rehabilitation outcomes and promoting long-term patient independence.

3.3. Self-Management in Post-Stroke Rehabilitation

In recent years, self-management has become recognized as a fundamental component of effective stroke rehabilitation. Self-management refers to the active involvement of patients in managing their health condition through adherence to rehabilitation recommendations, independent performance of therapeutic exercises, symptom monitoring, and informed decision-making aimed at maintaining functional independence [18]. This patient-centered approach promotes individual responsibility for recovery and contributes to improved long-term rehabilitation outcomes.

Following stroke, individuals experience not only motor impairments but also cognitive, emotional, and behavioral changes that may limit their ability to participate effectively in rehabilitation. Within this context, self-management is viewed as a comprehensive behavioral process that enables patients to adapt to chronic health conditions while maintaining functional independence [18,21]. Core components of self-management include goal setting, self-monitoring, activity planning, symptom management, and enhancement of self-efficacy.

Evidence indicates that self-management programs improve functional outcomes, increase physical activity, and enhance health-related quality of life among stroke survivors.

Patients who actively engage in their rehabilitation demonstrate greater motor recovery and better adherence to therapy than those receiving conventional rehabilitation alone [17,19,20]. One of the principal mechanisms underlying these benefits is increased patient motivation and engagement, which promote consistent exercise participation and long-term maintenance of rehabilitation gains.

Self-management is particularly important for the recovery of lower limb function and gait, as successful rehabilitation largely depends on the frequency and intensity of training. Rehabilitation delivered exclusively within healthcare facilities is often insufficient to achieve optimal functional recovery. The incorporation of home-based exercise programs, independent practice, and activity monitoring increases overall training volume and facilitates the development of stable motor skills [15,16].

Restoration of independent walking requires prolonged and continuous practice that extends beyond supervised rehabilitation sessions. Therefore, patients' active participation in home exercise programs, self-monitoring of physical activity, and achievement of individualized rehabilitation goals are considered essential components of successful gait recovery after stroke. The development of self-management skills helps maintain adequate training intensity and supports the long-term preservation of functional improvements.

Digital health technologies have become an important component of self-management interventions. Mobile health applications, wearable activity sensors, and telerehabilitation platforms enable patients to monitor their recovery progress, receive timely feedback, and maintain communication with healthcare professionals [15,16]. The integration of these technologies into rehabilitation programs has been associated with improved treatment adherence and better functional outcomes.

Psychological factors also play a crucial role in the effectiveness of self-management. Confidence in recovery, reduced fear of falling, and positive attitudes toward rehabilitation are closely associated with improved motor performance and greater functional independence [17,21]. Support provided by healthcare professionals and family members further facilitates sustainable behavioral changes and enhances the effectiveness of self-management interventions.

Despite the growing body of evidence supporting self-management, its implementation in routine clinical practice remains limited. One of the major challenges is the insufficient integration of behavioral interventions into conventional rehabilitation models, which continue to focus primarily on physical recovery [17,20]. This highlights the need for comprehensive rehabilitation programs that combine physical therapy with educational and behavioral support.

Overall, self-management represents an essential component of contemporary stroke rehabilitation. By promoting active patient participation, improving adherence to rehabilitation, and supporting long-term behavioral change, self-management contributes to enhanced lower limb recovery, greater functional independence, and improved quality of life. Integrating self-management strategies with technology-assisted rehabilitation may therefore represent a promising direction for the future development of neurorehabilitation.

3.4. The Role of Nursing Support in Promoting Self-Management After Stroke

The effectiveness of post-stroke rehabilitation largely depends on multidisciplinary collaboration, in which nurses play a pivotal role. Contemporary models of stroke rehabilitation recognize nursing support not only as an essential component of patient care but also as a key contributor to patient education and behavioral interventions aimed at developing self-management skills [22]. Owing to their continuous interaction with patients throughout the rehabilitation continuum, nurses are uniquely positioned to facilitate recovery and support patients' adaptation to functional limitations.

One of the primary responsibilities of nurses is to educate patients and their families about stroke, rehabilitation principles, and strategies for self-monitoring and long-term disease management. Educational interventions improve patients' understanding of the importance of regular physical activity, adherence to prescribed exercise programs, and compliance with rehabilitation recommendations, thereby enhancing treatment adherence and long-term rehabilitation outcomes [17,22]. By promoting self-monitoring skills, nurses encourage patients to take an active role in their recovery and maintain functional gains after discharge from inpatient rehabilitation.

Nurses also play an important role in providing motivational support throughout the rehabilitation process. Depression, anxiety, fear of falling, and reduced confidence are common psychological consequences of stroke that may limit patients' participation in rehabilitation activities [17,21]. Through motivational interviewing, individualized goal setting, and continuous encouragement, nurses help strengthen patients' self-efficacy and facilitate successful recovery of motor function.

Another important aspect of nursing care is ensuring continuity of rehabilitation during the transition from hospital to outpatient or home-based care. Following hospital discharge, rehabilitation intensity often decreases, and professional supervision becomes less frequent, potentially leading to deterioration in functional outcomes. Nurses involved in follow-up care and remote monitoring programs help maintain patient engagement, supervise adherence to home exercise programs, and identify potential complications at an early stage [22,23].

The integration of digital health technologies has further expanded the role of nurses in post-stroke

https://doi.org/10.53498/pznz1y60

rehabilitation. Telehealth services, mobile health applications, wearable activity monitors, and electronic rehabilitation diaries enable nurses to monitor patients' recovery remotely, provide timely feedback, and adjust rehabilitation recommendations according to individual needs [15,16]. These technology-assisted nursing interventions strengthen self-management skills, promote sustained physical activity, and improve long-term rehabilitation adherence.

Overall, nursing support represents an essential component of comprehensive stroke rehabilitation and plays a central role in fostering self-management among stroke survivors. Patient education, motivational counseling, continuity of care, and technology-supported follow-up collectively contribute to greater adherence to rehabilitation, improved recovery of lower limb function, and enhanced functional independence.

3.5 Integration of Technology-Assisted Rehabilitation and Self-Management for Lower Limb Recovery After Stroke

Contemporary stroke rehabilitation increasingly recognizes motor recovery as a multidimensional process that requires not only physical interventions but also behavioral strategies promoting active patient participation. In this context, integrating technology-assisted rehabilitation with self-management represents a promising approach to improving lower limb recovery and sustaining rehabilitation outcomes [12,17,20].

Technological innovations, including robotic gait training systems, virtual reality, wearable activity sensors, and telerehabilitation platforms, provide objective monitoring of motor performance while delivering real-time feedback to patients. Visual, auditory, and sensory feedback enhance patients' awareness of movement and facilitate the development of self-monitoring skills, which constitute one of the core components of self-management [14,16]. Consequently, these technologies not only promote physiological recovery but also support behavioral changes that encourage patients to take an active role in managing their rehabilitation.

Remote rehabilitation and digital health technologies further extend rehabilitation beyond clinical settings, allowing therapeutic interventions to continue in the home environment. Home-based exercise programs supported by remote monitoring and regular feedback from healthcare professionals increase training duration and intensity while improving adherence to rehabilitation programs and maintaining physical activity following hospital discharge [15,16]. This is particularly important because rehabilitation intensity often declines after discharge, potentially compromising long-term functional recovery.

The integration of technology-assisted rehabilitation with self-management also contributes to the development of patient self-efficacy. Opportunities to monitor personal progress, receive objective feedback on functional improvement, and participate in individualized goal setting increase patients' confidence in their ability to recover and strengthen their motivation to continue rehabilitation [17,21]. Enhanced self-efficacy has consistently been identified as a key determinant of successful motor recovery and long-term maintenance of functional gains.

Another important advantage of integrating digital technologies into rehabilitation is the possibility of delivering personalized interventions. Data collected from wearable monitoring devices allow continuous assessment of movement patterns, physical activity, and functional performance, enabling clinicians to tailor rehabilitation programs according to individual patient needs while reducing the risk of complications [16]. Such personalized rehabilitation strategies are consistent with current trends toward precision rehabilitation and patient-centered care.

Despite the considerable potential of integrating technology-assisted rehabilitation with self-management, several challenges remain. Limited digital literacy, restricted access to technological resources, and the need for healthcare professionals to acquire competencies in the use of digital rehabilitation tools may hinder implementation in routine clinical practice [15,16]. Furthermore, the effectiveness of these interventions depends largely on patient motivation as well as continuous support from healthcare professionals and family members [17,21].

Overall, the integration of technology-assisted rehabilitation and self-management represents a promising model for enhancing lower limb recovery after stroke. By combining technological innovations with behavioral strategies, this approach increases rehabilitation intensity, improves treatment adherence, promotes self-management skills, and supports more sustainable functional recovery.

4. Discussion

https://doi.org/10.53498/pznz1y60

The findings of this narrative review suggest that recovery of lower limb function after stroke is a complex, multifactorial process influenced by neurophysiological, biomechanical, and behavioral mechanisms. Although substantial progress has been achieved in the development of technology-assisted rehabilitation, including robotic gait training, virtual reality, telerehabilitation, and neuromodulation techniques, the effectiveness of these interventions depends largely on patients' active engagement in rehabilitation and adherence to prescribed therapeutic programs. These findings support the growing recognition that behavioral self-management strategies should be integrated into contemporary neurorehabilitation programs [12,17].

The evidence reviewed highlights the considerable potential of technology-assisted rehabilitation to increase training intensity, improve motor control, and promote neuroplasticity. Nevertheless, technological interventions alone may not ensure sustained functional recovery if patients remain passive participants in the rehabilitation process. Long-term rehabilitation success requires active patient involvement and the development of self-management skills that encourage continued participation beyond supervised therapy [11–14,17].

Self-management has emerged as an essential component of contemporary stroke rehabilitation because it improves treatment adherence, increases physical activity, and supports the maintenance of functional gains over time. Incorporating self-management strategies into rehabilitation programs encourages patients to assume an active role in their recovery, enhances self-monitoring, and strengthens self-efficacy. Confidence in one's ability to recover has consistently been identified as an important determinant of successful motor recovery following stroke [17–21].

An important finding of this review is the complementary relationship between technology-assisted rehabilitation and self-management. Digital rehabilitation technologies provide continuous monitoring, objective feedback, and opportunities for individualized rehabilitation, whereas self-management strategies enhance patient engagement and long-term adherence. Together, these approaches facilitate the extension of rehabilitation into the home environment through telerehabilitation, wearable technologies, and remote monitoring systems, thereby supporting sustained functional recovery and long-term independence [15,16].

Another key finding concerns the contribution of nursing care to the development of self-management skills. Through patient education, motivational support, and continuity of care across rehabilitation settings, nurses facilitate adherence to rehabilitation programs and improve functional outcomes. Their role becomes particularly important during the transition from inpatient rehabilitation to community- or home-based care, when professional supervision decreases and the risk of reduced physical activity increases [22,23].

Despite the promising evidence supporting the integration of technology-assisted rehabilitation and self-management, several limitations remain. Considerable heterogeneity exists among published studies with respect to study design, intervention protocols, outcome measures, and patient populations. Many studies also include relatively small sample sizes and limited long-term follow-up, making it difficult to draw definitive conclusions regarding the sustained effectiveness of combined interventions. Furthermore, successful implementation of self-management programs may depend on patients' cognitive function, social support, digital literacy, and access to rehabilitation technologies.

Future research should focus on the development and evaluation of personalized rehabilitation models that combine digital health technologies, telerehabilitation, and structured self-management interventions. Additional high-quality prospective studies are also needed to clarify the long-term effectiveness of these integrated approaches and to further define the role of nurses and multidisciplinary rehabilitation teams in supporting self-management among stroke survivors [15–17,22,23].

5. Conclusions

Stroke rehabilitation is a complex and multidimensional process aimed at restoring motor function, improving functional independence, and enhancing patients' quality of life. Lower limb dysfunction and gait impairment remain among the major contributors to long-term disability after stroke and therefore require effective rehabilitation strategies. Contemporary rehabilitation technologies, including robotic systems, virtual reality, telerehabilitation, neuromodulation techniques, and digital monitoring tools, have demonstrated considerable potential for improving motor control and functional mobility.

The findings of this review indicate that successful rehabilitation depends not only on technological innovations but also on patients' active participation throughout the recovery process. The integration of self-management strategies enhances motivation, treatment adherence, and self-monitoring while supporting more sustainable functional improvements. Multidisciplinary rehabilitation teams, particularly nurses, play a crucial role in developing self-management skills through patient education, motivational support, and continuity of care.

Integrating technology-assisted rehabilitation with self-management represents a promising direction for contemporary neurorehabilitation. Combining technological, educational, and behavioral interventions may increase rehabilitation intensity, improve patient engagement, and promote long-term maintenance of functional recovery. Furthermore, the development of personalized rehabilitation programs supported by digital health technologies and remote monitoring has the potential to further optimize lower limb recovery after stroke.

Although the available evidence is encouraging, additional high-quality longitudinal studies are needed to establish the long-term effectiveness of integrated rehabilitation models and to determine the optimal strategies for incorporating self-management into routine clinical practice. Future research should also further clarify the contribution of nurses and multidisciplinary rehabilitation teams to promoting self-management and improving long-term rehabilitation outcomes.

In conclusion, comprehensive rehabilitation models that integrate advanced rehabilitation technologies with structured self-management strategies represent a promising approach to improving lower limb function, functional independence, and quality of life among stroke survivors.

Author Contributions. Conceptualization: I.A.B., T.T.K.; Methodology: I.A.B., T.T.K.; Literature search: I.A.B., T.T.K.; Formal analysis: I.A.B., T.T.K., A.S.Z., T.S.Z.; Writing – original draft: I.A.B.; Writing – review & editing: T.T.K., A.S.Z., T.S.Z.; Supervision: T.T.K.

All authors have made substantial contributions to this work, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the manuscript.

Funding. This research received no external funding.

Conflict of Interest. The authors declare no conflict of interest.

AI Declaration. AI–based tools were used exclusively for language editing and stylistic improvement of the manuscript. All scientific content, interpretation of the literature, conclusions, and final editorial decisions were made solely by the authors. The authors take full responsibility for the accuracy and integrity of the manuscript.

References

1. Feigin, V. L., Stark, B. A., Johnson, C. O., Roth, G. A., Bisignano, C., Abady, G. G., & GBD 2019 Stroke Collaborators. (2021). Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis. The Lancet Neurology, 20(10), 795–820. https://doi.org/10.1016/S1474-4422(21)00252-0
2. Owolabi, M. O., Thrift, A. G., Martins, S., Johnson, W. D., Pandian, J., Abd-Allah, F., Yaria, J., Phan, H. T., Roth, G. A., Gall, S. L., Beare, R., Phan, T. G., Mikulík, R., Akinyemi, R. O., Norrving, B., Brainin, M., Feigin, V. L., Abanto, C., Abera, S. F., … GBD Stroke Collaborators. (2022). The global burden of stroke: A continuing challenge. The Lancet Neurology, 21(10), 939–951. https://doi.org/10.1016/S1474-4422(22)00291-8
3. Feigin, V. L., Brainin, M., Norrving, B., Martins, S., Sacco, R. L., Hacke, W., Fisher, M., Pandian, J., Lindsay, P., Uchino, K., Kim, J. S., Hachinski, V., Skvortsova, V., Iadecola, C., Wang, Y., Bath, P. M., Hankey, G. J., Caso, V., Roth, G. A., … World Stroke Organization. (2022). World Stroke Organization global stroke fact sheet 2022. The Lancet Neurology, 21(10), 895–906. https://doi.org/10.1016/S1474-4422(22)00238-4
4. Langhorne, P., Bernhardt, J., & Kwakkel, G. (2011). Stroke rehabilitation. The Lancet, 377(9778), 1693–1702. https://doi.org/10.1016/S0140-6736(11)60325-5
5. Moore, S. A., Boyne, P., Fulk, G., Verheyden, G., & Fini, N. A. (2022). Walk the talk: Current evidence for walking recovery after stroke. Stroke, 53(11), 3494–3505. https://doi.org/10.1161/STROKEAHA.122.038953
6. de Rooij, I. J. M., van de Port, I. G. L., Visser-Meily, J. M. A., van Heugten, C. M., & Post, M. W. M. (2021). Gait-related participation after stroke. Physiotherapy Theory and Practice, 37(12), 1337–1345. https://doi.org/10.1080/09593985.2019.1683894
7. Patterson, K. K., Mansfield, A., Biasin, L., Brunton, K., Inness, E. L., & McIlroy, W. E. (2020). Longitudinal changes in poststroke gait asymmetry. Neurorehabilitation and Neural Repair, 34(5), 421–432. https://doi.org/10.1177/1545968319900998

8. Winstein, C. J., Stein, J., Arena, R., Bates, B., Cherney, L. R., Cramer, S. C., DeRyter, F., Eng, J. J., Fisher, B., Harvey, R. L., Lang, C. E., MacKay-Lyons, M., Ottenbacher, K. J., Pugh, S., Reeves, M. J., Richards, L. G., Stiers, W., Zorowitz, R. D., & American Heart Association Stroke Council. (2016). Guidelines for adult stroke rehabilitation and recovery: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke, 47(6), e98–e169. https://doi.org/10.1161/STR.0000000000000098

9. Kwakkel, G., Stinear, C., Essers, B., Davidson, I., English, C., Gebruers, N., Ali, M., Bernhardt, J., Burridge, J., Feys, H., Gethin, C., Langhorne, P., Lennon, S., McCabe, J., Mehrholz, J., Meskers, C., Platz, T., Pollock, A., Winstein, C., … European Stroke Organisation. (2023). Motor rehabilitation after stroke: European Stroke Organisation guideline. European Stroke Journal, 8(4), 880–894. https://doi.org/10.1177/23969873231190009

10. Pollock, A., Baer, G., Campbell, P., Choo, P. L., Forster, A., Morris, J., Pomeroy, V. M., & Langhorne, P. (2025). Physical rehabilitation approaches for the recovery of function and mobility following stroke. Cochrane Database of Systematic Reviews, 2025(2), Article CD001920. https://doi.org/10.1002/14651858.CD001920.pub4

11. Mehrholz, J., Thomas, S., Kugler, J., Pohl, M., & Elsner, B. (2025). Electromechanical-assisted training for walking after stroke. Cochrane Database of Systematic Reviews, 2025(5), Article CD006185. https://doi.org/10.1002/14651858.CD006185.pub6

12. Kwakkel, G., van Wegen, E. E. H., Burridge, J. H., Winstein, C. J., van Dokkum, L. E. H., Alt Murphy, M., Levin, M. F., Krakauer, J. W., Langhorne, P., Mehrholz, J., Meskers, C. G. M., Ward, N. S., Daffertshofer, A., Carey, L., Luft, A. R., Nudo, R. J., Holden, M. K., Cramer, S. C., Bernhardt, J., … European Stroke Organisation. (2022). Technology-assisted training for stroke rehabilitation. The Lancet Neurology, 21(1), 84–96. https://doi.org/10.1016/S1474-4422(21)00366-6

13. Bruni, M. F., Melegari, C., De Cola, M. C., Bramanti, A., Bramanti, P., & Calabrò, R. S. (2021). Robotic gait rehabilitation after stroke: Current evidence and future perspectives. Journal of Clinical Medicine, 10(17), 3762. https://doi.org/10.3390/jcm10173762

14. Winter, C., Kern, F., Gall, D., Latoschik, M. E., Pauli, P., & Käthner, I. (2021). Immersive virtual reality during gait rehabilitation increases walking speed and motivation after stroke. Journal of NeuroEngineering and Rehabilitation, 18, 68. https://doi.org/10.1186/s12984-021-00853-1

15. Chen, J., Jin, W., Zhang, X. X., Xu, W., Liu, X. N., & Ren, C. C. (2015). Telerehabilitation approaches for stroke patients: A systematic review and meta-analysis of randomized controlled trials. Journal of Stroke and Cerebrovascular Diseases, 24(12), 2660–2668. https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.09.014

16. Chen, Y., Abel, K. T., Janecek, J. T., Chen, Y., Zheng, K., & Cramer, S. C. (2019). Home-based technologies for stroke rehabilitation: A systematic review. International Journal of Medical Informatics, 123, 11–22. https://doi.org/10.1016/j.ijmedinf.2018.12.001

17. Lynch, E. A., Nesbitt, K., Gulyani, A., Chan, R. J., Bidargaddi, N., Cadilhac, D. A., Bonevski, B., Jones, F., Allan, L. P., Godecke, E., Barnden, R., Brogan, E., Kandasamy, T., Larcombe, S., Bulto, L. N., & English, C. (2025). Do self-management interventions improve self-efficacy and health-related quality of life after stroke? A systematic review. International Journal of Stroke, 20(7), 786–800. https://doi.org/10.1177/17474930251340286

18. Lorig, K. R., & Holman, H. R. (2003). Self-management education: History, definition, outcomes, and mechanisms. Annals of Behavioral Medicine, 26(1), 1–7. https://doi.org/10.1207/S15324796ABM2601_01

19. Sahely, A., Giles, D., Sintler, C., Soundy, A., & Rosewilliam, S. (2023). Self-management interventions to improve mobility after stroke: An integrative review. Disability and Rehabilitation, 45(1), 9–26. https://doi.org/10.1080/09638288.2022.2028019

20. Hwang, N. K., Park, J. S., & Chang, M. Y. (2021). Telehealth interventions to support self-management in stroke survivors: A systematic review. Healthcare, 9(4), Article 472. https://doi.org/10.3390/healthcare9040472

21. Jones, F., & Riazi, A. (2011). Self-efficacy and self-management after stroke: A systematic review. Disability and Rehabilitation, 33(10), 797–810. https://doi.org/10.3109/09638288.2010.511415

22. Camicia, M., Lutz, B. J., Summers, D. V., Klassman, L., & Vaughn, S. (2021). Nursing's role in successful stroke care transitions across the continuum: From acute care into the community. Stroke, 52(12), e794–e805. https://doi.org/10.1161/STROKEAHA.121.033938

23. Prvu Bettger, J., Alexander, K. P., Dolor, R. J., Olson, D. M., Kendrick, A. S., Wing, L., Coeytaux, R. R., Graffagnino, C., & Duncan, P. W. (2012). Transitional care after hospitalization for acute stroke or myocardial infarction: A systematic review. Annals of Internal Medicine, 157(6), 407–416. https://doi.org/10.7326/0003-4819-157-6-201209180-00004

24. Mizuta, N., Hasui, N., Kai, T., Kuroda, Y., Kinoshita, H., Kiyama, R., Tanaka, S., Yamamoto, Y., Nakamura, M., & Suzuki, T. (2024). Limb kinematics in gait disorders of post-stroke patients. Scientific Reports, 14, 1123. https://doi.org/10.1038/s41598-024-51542-5

25. Shen, K. H., Prajapati, S. K., Borrelli, J., Bulea, T. C., & Damiano, D. L. (2022). Neuromechanical control during limb loading post-stroke. Scientific Reports, 12, 11352. https://doi.org/10.1038/s41598-022-15073-0

26. Geerars, M., Minnaar-van der Feen, N., & Huisstede, B. M. A. (2022). Treatment of knee hyperextension in post-stroke gait: A systematic review. Gait & Posture, 94, 1–8. https://doi.org/10.1016/j.gaitpost.2022.02.012

27. Amirbekova, M., Kispayeva, T., Adomaviciene, A., Eszhanova, L., Bolshakova, I., & Ospanova, Z. (2025). Effectiveness of robotic therapy in motor recovery after stroke: Systematic review and meta-analysis. Frontiers in Human Neuroscience, 19, 1622661. https://doi.org/10.3389/fnhum.2025.1622661

Инсульттен кейінгі төменгі аяқ-қол қызметін қалпына келтіру: Өзін-өзі басқару және заманауи оңалту технологияларының рөлі

Киспаева Т.Т. [1], Большакова И.А. [2*], Жексенбаева А.С. [3], Жунусова Т.С. [4]

[1] «Мейіргерлік білім беру» мектебінің профессоры, Қарағанды медицина университеті, Қарағанды, Қазақстан. E-mail: Kispaeva@qmu.kz

[2] PhD-докторант, мейіргерлік білім беру мектебінің ассистент профессоры, Қарағанды медицина университеті, Қарағанды, Қазақстан. E-mail: I.Malysheva@qmu.kz

[3] Магистрант, Қарағанды медицина университеті, Қарағанды, Қазақстан. E-mail: albinazheksenbaeva03@mail.ru

[4] Бакалавр студенті, Қарағанды медицина университеті, Қарағанды, Қазақстан. E-mail: shigurikentoki@gmail.com

Түйіндеме

Инсульт бүкіл әлемде ересек тұрғындардың мүгедектікке ұшырауының негізгі себептерінің бірі болып табылады. Төменгі аяқ-қол қызметінің және жүрудің бұзылыстары науқастардың функционалдық тәуелсіздігін төмендетіп, өмір сүру сапасын нашарлатады және әлеуметтік бейімделуін қиындатады. Оңалтудың заманауи технологияларының қарқынды дамуына қарамастан, инсульттен кейін қозғалыс қызметін қалпына келтіру өзекті клиникалық мәселе болып қала береді. Соңғы жылдары науқастың оңалту үдерісіне белсенді қатысуын қамтамасыз ететін өзін-өзі басқару стратегияларына ерекше көңіл бөлінуде.

Шолудың мақсаты: инсульттен кейінгі жүру және төменгі аяқ-қол қызметін қалпына келтіру кезінде өзін-өзі басқару элементтерін қолдану жөніндегі заманауи ғылыми жарияланымдарды талдау, сондай-ақ, заманауи оңалту технологиялары мен мультидисциплинарлық қолдаудың оңалту тиімділігін арттырудағы рөлін бағалау.

Әдістері. 2015–2025 жылдары жарияланған ғылыми еңбектерге нарративтік әдебиетке шолу жүргізілді. Іздеу PubMed, Scopus, Web of Science, Google Scholar және Cochrane Library деректер базаларында орындалды. Талдауға инсульттен кейінгі төменгі аяқ-қол қызметін қалпына келтіруге, технологиялық оңалту әдістеріне және өзін-өзі басқару бағдарламаларына арналған жүйелі шолулар, мета-талдаулар, клиникалық ұсынымдар, рандомизацияланған бақыланатын зерттеулер және басқа да ғылыми жарияланымдар енгізілді.

Нәтижелері. Әдебиеттерді талдау инсульттен кейінгі жүру бұзылыстарының нейрофизиологиялық, биомеханикалық және мінез-құлықтық факторлардың үйлесуімен байланысты екенін көрсетті. Роботтандырылған терапияны, виртуалды шынайылықты, телеоңалтуды, цифрлық бақылау жүйелерін және басқа технологиялық тәсілдерді қолдану қозғалыс қызметін, жүру сапасын және функционалдық мобильділікті жақсартып, жаттығулардың қарқындылығын арттыратыны анықталды. Сонымен қатар, өзін-өзі басқару стратегияларын енгізу науқастардың оңалтуға бейімділігін арттырып, физикалық белсенділігін, өзіндік тиімділігін және қол жеткізілген нәтижелердің ұзақ мерзімді сақталуын қамтамасыз етеді. Науқастарды оқыту, мотивациялық қолдау көрсету, оңалту ұсынымдарының орындалуын бақылау және медициналық көмектің сабақтастығын қамтамасыз етуде мейіргерлік сүйемелдеудің маңызды рөлі анықталды.

Қорытынды. Заманауи оңалту технологияларын өзін-өзі басқару стратегияларымен біріктіру инсульттен кейінгі төменгі аяқ-қол қызметін қалпына келтірудің келешегі зор бағыты болып табылады. Технологиялық, білім беру, мінез-құлықтық және мейіргерлік компоненттерді біріктіретін кешенді тәсіл оңалтудың тиімділігін арттыруға, функционалдық тәуелсіздікті жақсартуға және науқастардың өмір сүру сапасын жоғарылатуға мүмкіндік береді.

Түйін сөздер: инсульт, инсульттен кейінгі оңалту, жүруді қалпына келтіру, төменгі аяқ-қол, өзін-өзі басқару, роботтандырылған оңалту, мейіргерлік күтім.

Восстановление функции нижних конечностей после инсульта: Роль самоменеджмента и современных реабилитационных технологий

Киспаева Т.Т. [1], Большакова И.А. [2*], Жексенбаева А.С. [3], Жунусова Т.С. [4]

[1] Профессор школы «Сестринского образования», Карагандинский медицинский университет, Караганда, Казахстан. E-mail: Kispaeva@qmu.kz

[2] PhD докторант, ассистент профессор школы сестринского образования, Карагандинский медицинский университет, Караганда, Казахстан. E-mail: I.Malysheva@qmu.kz

[3] Магистрант, Карагандинский медицинский университет, Караганда, Казахстан. E-mail: albinazheksenbaeva03@mail.ru

[4] Студент бакалавриата, Карагандинский медицинский университет, Караганда, Казахстан. E-mail: shigurikentoki@gmail.com

Резюме

Несмотря на развитие современных технологий реабилитации, восстановление двигательных функций после инсульта остается актуальной клинической задачей. В последние годы все большее внимание уделяется стратегиям самоменеджмента, направленным на повышение активности пациента и его участия в процессе реабилитации.

Цель обзора: провести анализ современных научных публикаций, посвященных применению элементов самоменеджмента при восстановлении функции ходьбы у пациентов после инсульта, а также оценить роль инновационных технологий и междисциплинарного сопровождения в повышении эффективности реабилитации.

Методы. Выполнен нарративный обзор научной литературы, опубликованной преимущественно в 2015–2025 гг. Поиск проводился в базах данных PubMed, Scopus, Web of Science, Google Scholar и Cochrane Library с использованием ключевых слов, отражающих восстановление функции нижних конечностей после инсульта, самоменеджмент и современные технологии реабилитации. В анализ включались систематические обзоры, метаанализы, клинические рекомендации, рандомизированные контролируемые исследования и публикации, посвященные технологическим методам восстановления двигательных функций и программам самоменеджмента.

Результаты. Анализ литературы показал, что нарушения походки после инсульта обусловлены сочетанием нейрофизиологических, биомеханических и поведенческих факторов. Установлено, что применение роботизированной терапии, виртуальной реальности, телереабилитации, цифровых систем мониторинга и других технологических решений способствует повышению интенсивности тренировок, улучшению моторного контроля, функциональной мобильности и качества ходьбы. Выявлено, что интеграция элементов самоменеджмента способствует повышению приверженности пациентов реабилитации, увеличению двигательной активности, развитию самоэффективности и сохранению достигнутых функциональных результатов. Существенное значение имеет сестринское сопровождение, обеспечивающее обучение пациентов, мотивационную поддержку, мониторинг выполнения рекомендаций и преемственность реабилитационной помощи.

Выводы. Интеграция современных технологий реабилитации с элементами самоменеджмента является перспективным направлением восстановления функции нижних конечностей после инсульта. Комплексный подход, сочетающий технологические, образовательные и поведенческие компоненты, способствует повышению эффективности реабилитации, улучшению функциональной независимости, долгосрочному сохранению достигнутых результатов и повышению качества жизни пациентов.

Ключевые слова: инсульт, реабилитация после инсульта, восстановление походки, нижние конечности, самоменеджмент, роботизированная реабилитация, сестринское сопровождение.

https://doi.org/10.53498/pznz1y60