OPTIMIZATION OF A COMPREHENSIVE REHABILITATION PROGRAM FOR ATHLETES WITH MOTOR DYSFUNCTION FOLLOWING STROKE

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Annotatsiya. *Insultdan keyingi motor disfunksiya mushak kuchi, muvozanat, koordinatsiya, yurish va jismoniy chidamlilikni cheklashi mumkin. Sportchilar reabilitatsiyasi umumiy funksional mustaqillikni tiklash bilan bir qatorda, xavfsiz jismoniy faollik va sportga bosqichma-bosqich qaytish imkoniyatini baholashni ham talab qiladi. Maqolada individual klinik baholash, vazifaga yo‘naltirilgan takroriy mashqlar, kuch va muvozanat treningi, yurish mashqlari, aerob tayyorgarlik, charchoqni boshqarish va psixologik yordamni birlashtiruvchi kompleks yondashuv tahlil qilinadi. Reabilitatsiya mazmuni insultning turi va og‘irligi, nevrologik holat, yurak-qon tomir xavflari, avvalgi sport tajribasi va bemorning maqsadlariga moslashtirilishi lozim. Sportga qaytish bo‘yicha qaror obyektiv funksional ko‘rsatkichlar va multidisiplinar baholashga asoslanishi kerak.*

Kalit so‘zlar: *insult, motor disfunksiya, sportchilar, kompleks reabilitatsiya, fizioterapiya, muvozanat, yurish, sportga qaytish.*

Аннотация. *Двигательные нарушения после инсульта могут ограничивать мышечную силу, равновесие, координацию, ходьбу и физическую выносливость. Реабилитация спортсменов направлена не только на восстановление функциональной самостоятельности, но и на оценку возможности безопасного возвращения к физической активности и спорту.*

В статье рассматривается комплексный подход, объединяющий индивидуальную клиническую оценку, повторную тренировку функционально значимых движений, упражнения на силу и равновесие, тренировку ходьбы, аэробную подготовку, управление утомляемостью и психологическую поддержку. Содержание программы следует адаптировать к типу и тяжести инсульта, неврологическому статусу, сердечно-сосудистым рискам, спортивному опыту и целям пациента. Решение о возвращении к спорту должно основываться на объективных функциональных показателях и междисциплинарной оценке.

Ключевые слова: *инсульт, двигательная дисфункция, спортсмены, комплексная реабилитация, физиотерапия, равновесие, ходьба, возвращение в спорт.*

ABSTRACT

Stroke-related motor dysfunction may impair strength, balance, coordination, gait, endurance, and participation in daily activities. For athletes, rehabilitation should restore functional independence while evaluating whether and how a safe, gradual return to physical activity or sport may be possible. This article synthesizes current guidance on an individualized, comprehensive framework combining baseline and repeated assessment, repetitive task-specific practice, progressive strengthening, balance and gait training, aerobic conditioning, fatigue management, psychological support, and staged sport-specific preparation. Programme content and intensity should be adapted to stroke severity, neurological status, cardiovascular risk, pre-stroke fitness, fatigue, comorbidities, and the athlete's goals. Return-to-sport decisions should be based on medical stability, objective functional performance, sport-specific risks, and multidisciplinary decision-making. Because evidence specifically involving competitive athletes after stroke is limited, recommendations for sport-specific progression must be cautious and should not be interpreted as a validated protocol.

Keywords: *stroke, motor dysfunction, athletes, comprehensive rehabilitation, task-specific training, balance, gait, return to sport.*

1. INTRODUCTION

Stroke is a major cause of acquired neurological disability and may produce persistent motor impairments that affect mobility, coordination, postural control, upper-limb use, and physical endurance. The consequences differ widely according to lesion characteristics, the severity of neurological deficits, age, comorbidities, access to rehabilitation, and the person's pre-stroke functional status. Motor rehabilitation is therefore not a uniform sequence of exercises but a structured

process intended to improve motor function, activity, independence, and participation through individually dosed and goal-oriented practice [1, 2].

Athletes who experience a stroke may have additional concerns related to their previous training load, sport identity, competitive goals, and expectations about returning to training. Nevertheless, a history of athletic performance does not guarantee adequate post-stroke balance, reaction time, coordination, judgment, or cardiovascular tolerance. Nor should the goal of returning to competitive sport override medical safety or the patient's own priorities. Rehabilitation planning should first address medical stability and functional needs, then consider the demands and risks of the intended sport.

The European Stroke Organisation (ESO) has emphasized repetitive, progressive, goal-oriented, task- and context-specific practice as a central principle of motor rehabilitation [1, 2]. The 2025 ESO guideline provides recommendations in selected areas, including additional upper-limb practice, gait training, sit-to-stand training, and approaches to therapy delivery [2]. The 2024 VA/DoD clinical practice guideline likewise provides a structured, evidence-based framework for stroke rehabilitation across inpatient and community settings [3]. These guidelines primarily concern stroke survivors generally rather than competitive athletes specifically, so their principles should be adapted carefully when applied to sports rehabilitation.

2. AIM AND OBJECTIVES

The aim of this article is to develop an evidence-informed conceptual framework for optimizing a comprehensive rehabilitation programme for athletes with motor dysfunction following stroke.

The objectives are: (1) to identify the key domains requiring assessment; (2) to describe the core components of motor rehabilitation; (3) to propose principles for individualizing and progressing training; (4) to outline safety considerations and staged return-to-sport decision-making; and (5) to identify evidence gaps requiring future clinical research.

3. MATERIALS AND METHODS

This article is a narrative review and practice-oriented synthesis of clinical guidelines and consensus literature on post-stroke motor rehabilitation. The principal sources include the ESO consensus framework for motor rehabilitation, the ESO guideline on motor rehabilitation, the VA/DoD Clinical Practice Guideline for Management of Stroke Rehabilitation, and the American Heart Association/American Stroke Association guideline literature [1–4]. The sources were selected for their relevance to rehabilitation principles, functional assessment, exercise progression, and multidisciplinary care. This is not a systematic review: no

formal database search protocol, duplicate screening, risk-of-bias assessment, or quantitative meta-analysis was undertaken. No original patient cohort or intervention dataset was analyzed, and therefore no original clinical outcomes or statistical effects are reported. The proposed framework should be considered a conceptual clinical planning model, not a validated treatment protocol.

4. RESULTS AND DISCUSSION

4.1. Comprehensive baseline assessment

An individualized programme begins with a multidimensional assessment. Medical evaluation should establish stroke type and stage, current neurological stability, relevant secondary-prevention measures, cardiovascular status, medications, and contraindications or precautions for exercise. Functional assessment should examine muscle strength, selective motor control, range of motion, sensation, spasticity, trunk control, sitting and standing balance, transfers, gait, upper-limb function, coordination, endurance, and fatigue. Cognition, communication, mood, motivation, sleep, pain, and the availability of caregiver support may also influence participation.

Standardized outcome measures should be selected according to the patient's impairments and goals. Depending on clinical context, tools may include the Fugl-Meyer Assessment for motor impairment, the Berg Balance Scale or Mini-BESTest for balance, the 10-Metre Walk Test for gait speed, the 6-Minute Walk Test for walking endurance, and the Functional Independence Measure or Barthel Index for activities of daily living. These instruments are examples rather than a mandatory battery; selection should account for validity, feasibility, safety, and local practice. Reassessment at planned intervals allows the team to document progress and adjust the training dose.

For an athlete, baseline assessment should additionally record pre-stroke sport, training volume, competition level, dominant limb, relevant sport-specific movement demands, and personal return-to-activity goals. The team should distinguish the ability to complete a task in a controlled clinic from the ability to perform it safely under fatigue, distraction, speed, contact, or unpredictable environmental conditions.

4.2. Task-specific motor training

Task-specific training involves repeated practice of meaningful movements in conditions that progressively resemble the activities the person needs to perform. Examples include reaching and grasping, sit-to-stand transitions, transfers, stepping, turning, stair climbing, and walking. Practice should be sufficiently repetitive, progressively challenging, and linked to clearly defined functional goals. The

therapist may modify task complexity, support, speed, distance, and environmental demands to maintain an appropriate balance between challenge and safety [1, 2].

The 2025 ESO guideline suggests that additional repetitive upper-limb practice may improve arm capacity and that additional walking practice may improve walking capacity, although certainty and the optimal dose vary across outcomes [2]. The guideline discusses a possible additional minimum of 20 hours of repetitive upper-limb practice and a similar additional dose of walking practice as evidence-informed considerations, not universal prescriptions. These doses should not be applied mechanically to every athlete; tolerance, impairment severity, medical stability, access to therapy, and total rehabilitation load must be considered.

Transfer of skills into daily life is essential. Exercises should be connected to meaningful tasks outside the therapy session, with clear instructions and a safe home-practice plan when appropriate. The team should monitor whether improvements in impairment translate into better activity performance and participation, rather than relying exclusively on changes in isolated muscle strength.

4.3. Strength, balance, coordination, and gait

Progressive strengthening may be used as an adjunct to functional practice when clinically appropriate. Exercises can target the lower limbs, trunk, and upper limbs according to the individual's impairment profile. Load, repetitions, rest periods, and movement complexity should be adapted to motor control, pain, fatigue, and cardiovascular response. Strengthening should not replace practice of the actual functional tasks the athlete needs to regain.

Balance rehabilitation may begin with supported sitting or standing, weight shifting, controlled reaching, and transfers, then progress to dynamic stepping, direction changes, and more complex tasks as safety permits. Gait training may address speed, step length, symmetry, turning, obstacle negotiation, and endurance. Assistive devices, orthoses, harness systems, or body-weight support may be useful for selected patients. The purpose is not to remove all compensatory strategies at any cost, but to maximize safe function and independence.

Coordination work should be introduced in accordance with demonstrated ability and risk. Ball handling, directional changes, dual-task exercises, or sport-related movement patterns may become relevant later in rehabilitation, but they should not be introduced solely because the person was previously an athlete. Complex drills require adequate foundational control and should be supervised when fall or collision risk is present.

4.4. Aerobic conditioning and fatigue management

After medical stabilization, appropriately prescribed aerobic exercise may help address deconditioning and reduced endurance. The mode of exercise—such as

walking, stationary cycling, or another accessible activity—should reflect motor ability, balance, cardiovascular status, and patient preference. Intensity and duration should be introduced progressively, with monitoring based on clinical risk and the person's response. A previous high level of fitness should not be used as the sole basis for prescribing vigorous exercise after stroke.

Fatigue can restrict training participation and may arise from multiple interacting factors, including neurological injury, poor sleep, mood symptoms, pain, medication effects, and excessive activity demands. Planning should include adequate recovery, pacing strategies, sleep and mood screening, and adjustment of session duration or complexity when necessary. New chest pain, unusual shortness of breath, faintness, sudden worsening of neurological symptoms, or other concerning changes require cessation of exercise and appropriate medical evaluation.

High-intensity gait training may be considered for selected patients with suitable medical stability and supervision, but it is not appropriate as a default starting point for all stroke survivors [2]. Decisions about intensity should follow clinical assessment and relevant guideline recommendations.

4.5. Psychological and social support

Stroke may alter an athlete's self-image, independence, social relationships, and sense of purpose. Frustration, fear of falling, anxiety about recurrence, or uncertainty about the future can affect engagement in rehabilitation. Psychological support, realistic goal setting, and communication among the athlete, family, and clinical team may help align expectations with the recovery process. Goals should include both measurable functional outcomes and outcomes that matter to the person, such as independent community mobility, recreation, or modified participation in sport.

A multidisciplinary team may include a stroke physician or neurologist, rehabilitation physician, physiotherapist, occupational therapist, nurse, psychologist, speech and language therapist when indicated, and sports medicine or exercise professionals when return to sport is being considered. Team roles depend on the person's needs and the resources available. Consistent communication helps avoid contradictory instructions and supports continuity between inpatient, outpatient, and community rehabilitation [3, 4].

4.6. Proposed stages for programme optimization

A practical framework may organize rehabilitation into overlapping stages. The stages are not fixed time periods and should be determined by function, medical status, and individual response.

Stage 1 — Medical stabilization and initial functional recovery. Establish safety, prevent secondary complications, identify impairments, and initiate appropriate positioning, mobility, and basic task practice under clinical guidance.

Stage 2 — Foundational motor retraining. Emphasize repeated functional tasks, transfers, strength, trunk control, balance, and gait according to the individual's priorities. Use objective measures to track change.

Stage 3 — Capacity and endurance development. Progress walking distance, exercise tolerance, dynamic balance, and coordinated movement when the person can perform the tasks safely. Address fatigue and recovery between sessions.

Stage 4 — Sport-related preparation. If clinically appropriate, introduce modified sport-related movements, controlled changes of direction, equipment-specific tasks, or low-risk technical drills. Progress only when the athlete demonstrates adequate control and tolerates the current level without concerning symptoms.

Stage 5 — Return-to-participation decision. Review neurological and cardiovascular stability, functional test results, fatigue, cognition, reaction demands, fall and collision risk, sport rules, and the availability of supervision or adaptations. The decision should be shared by the athlete and the relevant clinical team. Return to recreational participation may be a more appropriate goal than competitive sport for some individuals.

This staged model is a proposed organizational framework derived from general rehabilitation principles; it has not been validated as a specific protocol for athletes after stroke. Its value lies in making progression criteria explicit and preventing decisions based only on elapsed time or previous athletic status.

4.7. Limitations and research priorities

The principal limitation is the scarcity of research focused specifically on competitive or high-performance athletes following stroke. Much of the available guidance is based on the broader stroke population. Although the underlying principles of motor learning, task-specific practice, progressive exercise, and multidisciplinary care are relevant, sport-specific return criteria cannot be inferred confidently from general functional measures alone.

Future studies should describe stroke characteristics, previous athletic exposure, intervention dose, adverse events, standardized functional outcomes, and return-to-participation status. Prospective cohorts and pragmatic clinical studies could examine which assessment combinations best predict safe participation, how to adapt rehabilitation to different sports, and how to balance performance goals with secondary prevention and long-term health. Studies should distinguish return to

general physical activity, recreational sport, training, and competition because these outcomes have different risk profiles.

5. CONCLUSION

Optimization of a comprehensive rehabilitation programme for athletes with motor dysfunction following stroke requires an individualized, multidisciplinary, and outcome-oriented approach. The central components are repeated assessment, task-specific motor practice, progressive strengthening, balance and gait training, appropriately prescribed aerobic conditioning, fatigue management, psychological support, and carefully staged consideration of sport-related activities. Rehabilitation intensity and progression must be guided by medical stability, objective functional performance, tolerance, and the demands of the intended sport. Because athlete-specific evidence remains limited, return-to-sport decisions should be cautious, collaborative, and individualized. Further clinical research is required to validate sport-specific assessment pathways and progression criteria.

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