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Reclaiming Movement: Recent Advances in Physiotherapy Management of Stroke Patients-A Review

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Abstract:

Stroke is a leading cause of long-term disability worldwide, often resulting in impaired motor function, balance, gait, and reduced independence. Physiotherapy plays a crucial role in promoting functional recovery through evidence-based rehabilitation strategies. This review summarizes recent advances in stroke physiotherapy, focusing on task-oriented training, robotic-assisted rehabilitation, virtual reality (VR), constraint-induced movement therapy, motor imagery, artificial intelligence, and telerehabilitation. Recent evidence indicates that high-intensity, repetitive, and task-specific training remains the foundation of effective stroke rehabilitation, while emerging technologies improve patient engagement, treatment precision, and access to rehabilitation services. Artificial intelligence and digital health tools further support personalized rehabilitation and remote monitoring. Although these innovations show promising outcomes, challenges such as high costs, limited long-term evidence, and unequal access continue to affect their widespread implementation. Overall, modern stroke rehabilitation is moving toward personalized, technology-assisted approaches that enhance functional recovery and quality of life. Further high-quality research is needed to establish standardized protocols and improve the clinical adoption of emerging rehabilitation technologies.

Keywords: Stroke rehabilitation; Physiotherapy; Neuroplasticity; Robotic-assisted therapy; Virtual reality; Task-oriented training; Gait retraining.

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1. INTRODUCTION

A stroke represents a disruption of the blood flow to the brain resulting in irreversible motor, sensory, coordination, and balance impairments and loss of independence in performing everyday tasks[1]. To date, it remains one of the leading causes of disabilities in adults across the world, where the majority of stroke survivors require rehabilitation aimed at helping them recover walking, hand function, and arm mobility. Physiotherapy is the cornerstone of stroke recovery because it applies concepts such as motor learning and activity-dependent neuroplasticity, enabling the nervous system to restructure after stroke.

Over the past two decades, stroke physiotherapy has shifted from passive exercise and purely compensatory strategies to interventions based on knowledge of the brain's adaptation after stroke. In addition, an increasing body of research investigates which types and doses of physiotherapy produce the best functional outcomes[2]. The development of robotic devices, sensors, VR and AR technologies and telehealth solutions have created new ways for physiotherapists to provide patients with high-intensity, repetitive and motivating exercises.

Figure 1: Physiotherapy for Stroke Patients[3]

These advances have produced a substantial and varied body of literature. Yet, in some instances, developments have occurred faster than the accumulation of evidence and its systematic translation into practical guidelines, meaning clinicians must consider a diverse array of interventions with very different supporting evidence bases[4].

The demands for rehabilitation posed by stroke victims are themselves very heterogeneous, depending on the nature and severity of the brain damage sustained, the existence of other impairments such as cognition or language, pre-existing medical conditions, and the patient's personal and social situation. No one treatment fits all patients, and much of the recent work done within the field has been dedicated precisely to identifying which treatments fit which patients, at which stage of their recovery process, and in what amounts of intensity[5]. This review tries to summarize these elements of evidence.

1.1 Background and Context

Traditionally, stroke physiotherapy has been dominated by neurofacilitation techniques from the mid-twentieth century, which focused on handling techniques designed to inhibit spastic tone and promote "normal" movement patterns. Despite their significant influence on clinical practices for several decades, these techniques have been grounded mostly in the clinical rationale and theoretical frameworks of neurological recovery rather than in outcomes-based trials.

Since the 1990s, however, accumulating evidence from the fields of motor learning and neuroplasticity has challenged this approach and revealed that recovery is significantly impacted by the number, intensity, specificity and salience of movement practised rather than by the type of handling used for eliciting movements. This evidence has led to the development of task-oriented training, constraint-induced movement therapy and high-intensity gait training that place greater emphasis on active, repetitive and purposeful training of practical skills rather than on facilitative handling[6].

Technological advances in the recent years have taken this evolution even further. Now robotic equipment, body-weight supported treadmill training, wearable technology and VR make it possible to increase the dose and quality of training, provide immediate feedback and monitor progress beyond the boundaries of conventional treatment setting.

1.2 Objectives of the Review

- To synthesise recent research on physiotherapy interventions used in the management of stroke, including task-oriented training, robotic and exoskeleton-based therapy, VR and gamified rehabilitation, constraint-induced movement therapy, and gait and balance retraining.
- To examine the methodological approaches used to generate this evidence, including systematic reviews, RCTs, pilot and comparative studies, and qualitative research.
- To critically evaluate the strengths and limitations of these interventions in terms of clinical effectiveness, feasibility, accessibility, and patient experience.

1.3 Importance of the Topic

Stroke creates a significant burden for the affected persons and families as well as for health services because many people develop permanent functional disabilities in mobility, upper limb function, and activities of daily living after their condition[7]. The aging population and growing survival rate of stroke increase the need for adequate rehabilitation services and put an emphasis on the necessity for delivering effective physiotherapy treatments.

A systematic review of the latest studies on the physiotherapy options could thus become useful for physiotherapists who need to apply evidence-based practices and understand what innovations should be introduced in their practices. Moreover, such a paper can give the directions for further studies and innovations in the field of physiotherapy.

The economic impact of functional disability caused by stroke is also substantial for patients and health services because it includes healthcare costs as well as indirect costs due to the reduced ability of a person to work. Thus, the interventions that help to increase the functional independence even partially can be valuable not only for the patients but also for their relatives and for the whole health services[8].

1.4 Scope and Structure of the Review

In particular, this review will concentrate on the role of physiotherapists in the treatment of adults who have had a stroke, including during the acute and sub-acute inpatient phase of rehabilitation and the outpatient and community phase of rehabilitation that follows. This review is not intended to comprehensively describe the stroke management literature generally – including aspects such as acute thrombolysis or surgical procedures – and also not intended to comprehensively address issues of occupational therapy, speech and language therapy or psychological interventions, apart from in relation to physiotherapy[9].

The rest of the review is then structured into four additional sections. The second section gives a brief overview of the key research themes and intervention types within the current stroke physiotherapy literature, alongside the scope of evidence that exists for these. The third section then addresses separately the methodological approach used in developing this evidence, as the quality of the research used to develop a clinical recommendation is just as important as the results of the research itself[10].

2. ADVANCES IN PHYSIOTHERAPY MANAGEMENT OF STROKE: KEY RESEARCH THEMES

Physiotherapy research in stroke rehabilitation involves various levels of technology ranging from simple task-based interventions to complex robotic and VR systems. The evidence base for such research is presented in Table 1 to show the variety of designs and outcome measures used in the literature reviewed here[11].

Table 1. Indicative Scope of the Stroke Physiotherapy Evidence Base, by Intervention Category[12]

Intervention Category	Typical Study Focus	Common Outcome Measures
Task-oriented / repetitive practice	Upper- and lower-limb functional retraining	Fugl-Meyer Assessment, Action Research Arm Test, Timed Up and Go
Robotic-assisted therapy	Adjunct or substitute for manual therapist-led practice	Motor impairment scores, active range of motion, therapy dose delivered
VR / gamified rehabilitation	Engagement-driven repetitive practice	Balance and reach measures, adherence, patient-reported engagement
Constraint-induced movement therapy	Intensive, forced use of the more-affected upper limb	Motor Activity Log, Wolf Motor Function Test
Technology-enabled gait and balance training	Treadmill, body-weight support, sensor feedback	Gait speed, cadence, symmetry, Berg Balance Scale

As shown in Table 1 below, the body of evidence covers a variety of intervention types which are quite diverse from one another and each of which contribute in their own way to the overall picture of physiotherapy's role in stroke recovery[13]. Each of these types of intervention will be discussed below in the following sections, before moving on to consider the method by which this evidence was created.

2.1 Task-Oriented and Repetitive Task-Specific Training

In task-oriented training, there is a repetition of functionally useful, goal-directed behaviors, such as reaching, grasping, getting up from sitting positions and walking. Task-oriented training is based on the premise that the nervous system adapts best to activities that mimic activities required by the individual in his/her everyday life[14].

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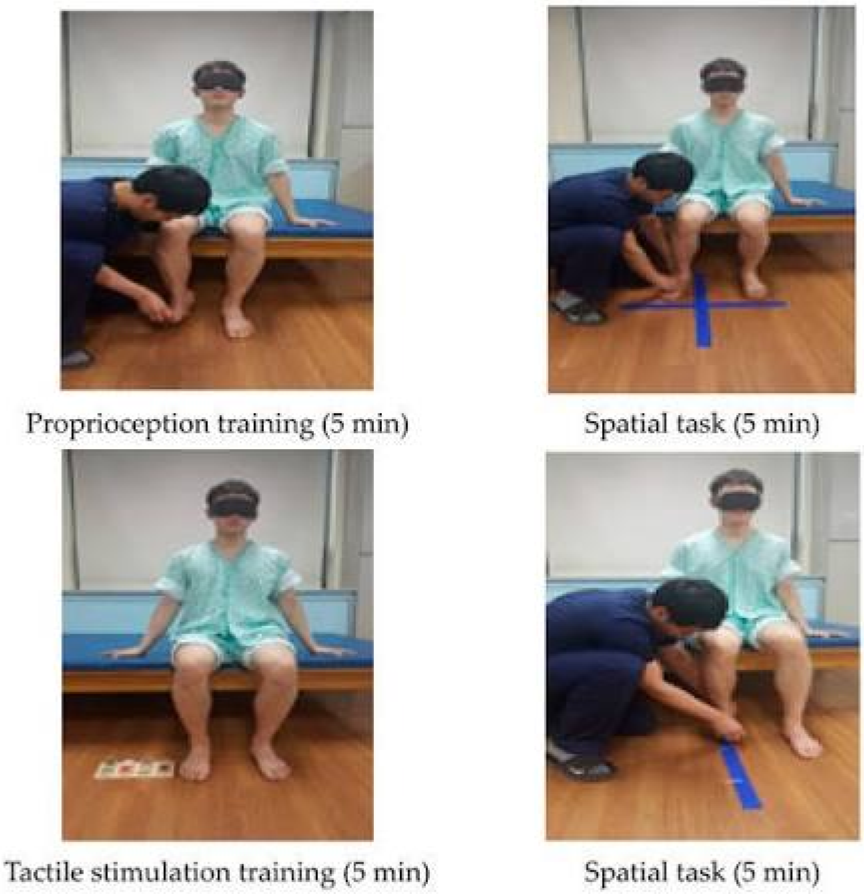

Figure 2: Task Specific Training[15]

There is substantial evidence demonstrating that task-oriented training is an effective way of enhancing upper-limb function, gait, and balance post-stroke, with the magnitude of improvement being linked to the number of repetitions performed during training and its intensity.

- The repetition and dose of exercise seem to be of more importance compared to the type of handling applied, thus shifting the focus away from facilitation-based techniques.
- Task-specific circuit training involving a number of functional stations has been linked with better walking speed, endurance, and balance confidence[16].
- Group task-oriented training can allow a greater number of repetitions during a limited therapy session, provided proper supervision is maintained.

While there is broad support from many studies, there are significant differences between trials regarding how task-oriented training is conceptualized and administered, making the comparison of results between studies difficult and impeding the formulation of dosing recommendations.

There is a further consideration about the timing of such therapy. Several studies indicate that task-oriented practice carried out soon after the stroke, when the patient stabilizes, leads to better functional outcome than later rehabilitation, but very early, intensive mobilization protocols in days after stroke have yielded conflicting results – there are indications that very early, intensive practice may not be beneficial for all patients[17]. This led to increasing interest in finding the optimal "window" and dose of task-oriented practice.

Table 2. Recent Literature on Advances in Stroke Physiotherapy Rehabilitation

Author(s) & Year	**Study Type**	**Major Findings**
Chen et al. (2025) [18]	Update Review	Reviewed the pathophysiology and management strategies of post-stroke spasticity. Highlighted the importance of individualized physiotherapy, pharmacological management, and multidisciplinary rehabilitation to improve motor recovery and reduce disability.
Senadheera et al. (2024) [19]	Scoping Review	Examined artificial intelligence applications in adult stroke rehabilitation. Reported that AI supports personalized rehabilitation, movement assessment, remote monitoring, predictive analytics, and clinical decision-making while emphasizing the need for standardized validation and ethical implementation.
Shen et al. (2025) [20]	Narrative Review	Summarized recent evidence on motor imagery therapy for upper-limb rehabilitation after stroke. Found that motor imagery combined with conventional physiotherapy enhances upper-limb motor recovery, cortical reorganization, and functional independence.
Hatem et al. (2016) [21]	Multiple Systematic Review	Evaluated rehabilitation techniques for upper-extremity recovery after stroke. Concluded that task-oriented training, constraint-induced movement therapy, mirror therapy, robotics, and repetitive practice have the strongest evidence for improving upper-limb motor function.
Díaz-Arribas et al. (2020) [22]	Systematic Review	Assessed the effectiveness of the Bobath concept in stroke rehabilitation. Reported insufficient evidence that Bobath therapy is superior to other physiotherapy interventions, supporting the

		adoption of evidence-based task-oriented rehabilitation approaches.

Recent important studies related to the current state of physiotherapy in the management of stroke patients have been reviewed in Table 2. These papers give evidence about modern techniques used in rehabilitation, motor recovery treatment, spasticity treatment, artificial intelligence usage, and evidence-based physiotherapy.

2.2 Robotic-Assisted and Exoskeleton-Based Rehabilitation

Robot-assisted technologies, including both end-effector arm devices and exoskeletons for gait training, have gained popularity as methods of delivering highly repetitive and highly controlled practice which is difficult to provide manually by a therapist alone[23]. Robot-assisted technologies include devices that guide, assist and resist movement and often have a feedback mechanism incorporated into their use.

Upper limb robot-assisted therapy has been found to improve motor impairment scores with small, yet statistically significant results when delivered in addition to standard therapy, and the greatest effect seen in subjects who were further away from complete recovery in the baseline assessment. Robotic exoskeletons and end-effector gait devices enable patients with weak lower limbs to practice walking in a safe manner and repetitively, even before they would be able to do so with manual assistance alone.

- Robotic systems are able to standardize and objectively measure the dosage of therapy given, solving an age-old problem of manual administration of rehabilitation therapy.
- There is relatively lesser amount of data showing benefits at functional and practical level as compared to impairment level[24].
- The cost factor, requirement of physical space, and specialized training of staff continue to restrict the use of robotic systems to the rehabilitation facilities that have ample resources.

Another emerging field, although quite different, involves the use of powered lower limb exoskeletons for overground gait training, which differ from robot systems in the sense that exoskeletons help people walk in a more practical environment. Some preliminary findings show that overground exoskeleton training can help improve the ability to walk independently among severely gait-impaired patients who cannot walk on their own, but due to the weight of the equipment, time required to put them on, and need for strict supervision by therapists, a lot of training is yet to be done.

Table 3. Summary of Key Intervention Approaches and Reported Findings in Stroke Physiotherapy[25]

Intervention Approach	Typical Population / Setting	Key Reported Findings
Task-oriented circuit training	Sub-acute and chronic stroke, inpatient/outpatient	Improved gait speed, balance confidence, and functional independence with higher-intensity practice
Robotic-assisted upper-limb therapy	Moderate-to-severe upper-limb impairment	Modest gains in motor impairment scores; less consistent evidence for functional task performance
VR gaming systems	Sub-acute stroke, balance and upper-limb retraining	Comparable or superior engagement and adherence versus conventional exercise, with mixed functional outcome evidence
Constraint-induced movement therapy	Chronic stroke with some voluntary hand/wrist movement	Sustained improvements in real-world arm use, particularly with high-intensity protocols
Body-weight-supported treadmill training	Early-to-moderate gait impairment	Improved walking speed and endurance, though comparable to overground task-specific gait training in several trials

2.3 Virtual Reality, Gamification and Immersive Rehabilitation Technologies

Both (VR) and gamified rehabilitation devices offer the possibility of providing therapeutic exercise in an interactive, even gamified environment by translating the patient's movements into screen activity via motion sensing technology[26]. Such applications are used in the field of balance training, upper limb reaching and grasping, and cognitive-motor dual task rehabilitation.

One of the main appeals of using VR is its ability to make the repetition of exercises more engaging and motivating for the patient. Both immersive and semi-immersive systems have been shown to lead to better adherence to prescribed exercises, with some trials demonstrating improvements in balance and upper limb function which are as good as those provided by standard therapy[27].

- The commercial gaming devices provide an affordable way into VR-based rehabilitation, even though they are not always tailored to the specific needs of the motor tasks in rehabilitation.

- The clinical VR devices provide the therapists with an opportunity to grade the task difficulty and evaluate their performance, although they are more costly and need more technical expertise[28].
- VR-based rehabilitation seems to be at least as effective as conventional training, not better, and thus can be considered an adjunct to rather than a substitute for conventional therapies.

In addition to improving motor functioning, a relatively new topic in rehabilitation science is using the VR and gaming platform to overcome cognitive-motor dual task deficit, where the patients practice either walking or reaching while engaging in some cognitive task[29]. Early results seem to show that the dual task training in VR can help with safe walking and cognitive-motor coordination, although this research field is far less matured than the other ones where single task training is practiced on balance or upper limb rehabilitation.

2.4 Constraint-Induced Movement Therapy and Upper-Limb-Focused Interventions

The CIMT approach involves restricting the use of the unaffected limb through the use of a mitt or a sling, along with intensive training of the affected arm and hand through repetitive tasks. CIMT is one of the best-researched upper limb therapies in the field of stroke rehabilitation, as it is based on the idea of "learned non-use," where the patients use their unaffected limbs during the early stage of recovery[30].

Clinical evidence supports the efficacy of CIMT and its low-intensity modifications in enhancing the functional use of the affected limb in cases where the patients have enough voluntary movements in their arms. The effect of CIMT seems to be sustained in some studies. The original protocol of CIMT, which involves the use of several hours of restricted training daily over weeks, can be difficult for the patients. This makes service delivery costly. Modified protocols over a long period at low daily intensity have been devised.

- CIMT works best with those patients who have at least some abilities to extend their wrist and fingers. This reduces the number of stroke victims it can be used with.
- Modes of CIMT seem to maintain many functional advantages of the former but make the procedure easier to do and more tolerable for patients.
- Having the patient comply with the requirement of constraining the non-affected limb during the unsupervised periods remains practically difficult.

In addition to the original method of CIMT, another technique known as bilateral arm training has been studied where both arms simultaneously perform the same or complementary movements. This training may serve as an alternative treatment for those patients who cannot benefit from constraint-induced training because of the poor voluntary movement of the affected limb. The latter training seems to be less effective than CIMT according to many studies despite the fact that some research results show similar positive effects from both techniques.

2.5 Gait and Balance Rehabilitation: Treadmill Training, Body-Weight Support and Sensor-Guided Feedback

The goal of walking is one of the most common objectives sought out after in stroke patients, and much of the physical therapy research on this topic has become more concerned with the use of high-intensity and task-specific gait training, which is achieved using body weight support systems, treadmills, and biofeedback sensors. This strategy aims to facilitate patients with safe repetition of the stepping pattern while compensating for their lower limb weakness.

In body weight-supported treadmill training, the patients can walk without falling, and there is robotic or manual help for guiding limb movement. There is sufficient evidence about the benefits of such treatment in improving walking speed and endurance, but from the available clinical trials, it was concluded that overground, task-specific walking practice at high intensities provides similar results, indicating that the main factor is the intensity and repetition of the exercise and not the method.

- Wearable sensors and biofeedback systems are becoming popular in addressing gait asymmetries, weight-bearing asymmetries, and conducting practice at home between monitored sessions.
- The use of dynamic, reactive, and dual-task balance training has been shown to be more effective than static balance training to reduce falls.
- High-intensity gait training protocols that do not require any equipment are becoming popular and have been proven to provide results similar to those of technology-enabled gait training.

2.6 Telerehabilitation and Technology-Supported Home-Based Practice

Apart from clinic-based physiotherapy technologies, there has also been significant development of telerehabilitation options which allow expanding physiotherapy support outside the clinic by means of video consultations, mobile apps, and wearable sensors for home exercise programmes. It is especially applicable to stroke survivors, as they might experience problems with transportation or mobility, or feel fatigued due to their conditions, thus being unable to visit the clinic frequently[31].

It is believed that telerehabilitation allows obtaining results that can be compared to those of in-person physiotherapy for patients that can use such treatment. It is also reported that telerehabilitation helps patients that live far away from clinics to receive help, reduce the necessity to travel and provide continuous observation of patient activity and adherence to programme thanks to connected technologies.

- Telerehabilitation can be considered most appropriate for those patients who have enough cognitive abilities, home assistance, and familiarity with technology.
- Ablended approach of in-person visits combined with remote monitoring of patients becomes more popular than either fully remote or in-person physiotherapy treatment.
- Information about comparative cost-effectiveness of telerehabilitation is still scarce despite obvious advantages of this approach.

3. METHODOLOGIES AND FINDINGS

Unlike the description of the methods of interventions above, this part analyzes the way the evidence behind the research is developed, such as the nature of research designs, their strengths and limitations, which determine how applicable their results are in practice[32]. The literature under review includes systematic and scoping reviews, randomized controlled trials, intervention studies, comparative studies and qualitative studies, each of which provides a different kind of evidence.

3.1 Systematic and Scoping Review Methodologies

A lot of the combined evidence relating to physiotherapy for stroke is derived from systematic and scoping reviews that combine results from several primary researches[33]. Reviews that have been done in an appropriate way usually adopt a certain reporting format, pre-plan their search process and then use more than one database to reduce selection bias.

- Systematic reviews enable synthesis of results from studies employing various sample sizes, settings and measures of outcomes, offering a more comprehensive overview of the intervention than any individual study.
- Meta-analyses, when possible, offer the pooled estimates of the effects, although the considerable heterogeneity in terms of intervention protocols and measures of outcomes among stroke rehabilitation studies often makes this approach less productive.
- Scoping reviews are especially helpful in the cases when an area of research is still emerging and the body of evidence is not ready for meta-analysis, e.g. the case of robotic and VR-based interventions[34].

The problem of heterogeneity between the studies with regard to definition and operationalisation of stroke severity, stroke onset and intervention "dose" is a frequent feature of systematic reviews on this topic and hampers both pooling of results and general understanding of which patients benefit the most from each particular approach. The reviewers quite often state that this heterogeneity makes drawing strong conclusions difficult, even when the general trend is positive.

3.2 Randomised Controlled Trial Designs

Randomised controlled trials (RCTs) continue to provide the principal evidence for interventions effectiveness in stroke physiotherapy, which test a new or more intensive intervention against standard treatment or another comparator. RCT design varies significantly, with well-designed studies featuring concealed randomisation, blinding of the outcome assessors where possible, and a priori stated outcome criteria[35].

- Most RCTs carried out in this area are small-sized single-centre studies, thereby raising the possibility of effect sizes being overestimated or missed altogether due to low power of such trials.
- The definition of comparator varies greatly among studies, with "usual care" differing considerably depending on the healthcare system in question.
- Usually, follow-up periods are relatively short, i.e. measured in weeks or months following the intervention, which makes it hard to judge how long the observed gains will be sustained[36].

Another issue relevant to physiotherapy studies is a rather challenging blinding of participants and their treatment providers, as the latter are usually aware of the type of therapy being provided by a particular technology. Although blinding of the assessors is feasible, the risk of performance and detection biases should be taken into account when reading the findings of such studies.

3.3 Pilot and Comparative Intervention Studies

In light of the difficulty of conducting trials of robotic/VR rehabilitation therapies on a large scale due to the technological nature of the interventions, the evidence supporting the use of robotic and virtual-reality therapy is mainly based on small-scale feasibility/pilot trials. These studies normally focus on the safety, feasibility, and acceptability of the interventions before moving on to larger effectiveness trials[37].

- Pilot studies are used to perfect the protocols and outcome measurements for the intervention before the larger trial is conducted, but these studies cannot provide evidence of effectiveness.
- Comparative trials that compare two different treatments are useful for determining if new technologies have an advantage over traditional techniques[38].
- Published studies in this literature base are known to emphasize positive results.

4. DISCUSSION

The review of evidence suggests that stroke physiotherapy is experiencing a slow but steady evolution from conventional facilitation methods to an approach characterized by high-intensity, repetitive, task-specific and technologically-supported rehabilitation. This development is further backed up by emerging evidence related to motor learning and brain plasticity, indicating that the practice of repeated exercises can facilitate better recovery results[39]. Technologies like robot-assisted physiotherapy, VR training, AI-assisted therapy, wearables and tele-rehabilitation have contributed to the effectiveness of rehabilitation by making treatment more intense, engaging and allowing for objective monitoring of patients. Nevertheless, despite all technological developments, the effectiveness of stroke rehabilitation still heavily relies on personalized, patient-centered interventions alongside physiotherapy skills[40].

4.1 Interpretation of Findings

Across intervention types, one of the most striking findings is the consistent importance of dosage over the actual type of training technique being utilized. Task-oriented training, robotics-assisted treatment, VR, constraint induced movement therapy, and intensive gait training are shown to have comparable results when the dosage is controlled for, implying that technology can have most utility in providing for better practice dose and consistency, rather than creating superior movement results.

That said, there may be some techniques that have more benefits for a particular group of patients: constraint induced movement therapy may be more effective for those patients who still have some voluntary movement left while robotics-assisted therapy may prove more helpful for those with greater disability levels unable to perform higher repetition training without additional help.

The importance of this "dose over device" concept for such different kinds of treatment interventions can arguably be considered as one of the most valuable lessons learned recently. It shows that the key point of stroke physiotherapy should not be searching for the best technique but for the most efficient way to provide the adequate amount and dose of practice.

4.2 Implications and Significance for Clinical Practice

- For rehabilitating stroke patients, intensive practice, repetitiveness, and task specificity are more beneficial to functional recovery than the application of advanced technology.
- The application of robotic devices and VR should be applied to supplement conventional physiotherapy in order to make therapies more intensive, engaging, and to monitor the patient's progress.
- In healthcare environments characterized by limited resources, effective conventional physiotherapy can produce significant functional recovery results, whereas advanced technologies should be introduced selectively.

- Physiotherapists should have adequate training to operate emerging technologies, engage in evidence-based decision making, select suitable candidates for treatment, and integrate technology into the individual rehabilitation program.

- Healthcare organizations should assess the clinical and cost-effectiveness, maintenance requirements, training requirements, and patient group of interest before acquiring robotic and VR rehabilitation systems.

- A holistic approach to rehabilitation, which integrates conventional physiotherapy with technological assistance, should be adopted in order to maximize functional recovery, promote independence, and improve the quality of life of stroke patients.

4.3 Gaps and Future Research Directions

In spite of a substantial number of research activities conducted, however, some essential gaps still exist. For instance, many studies face challenges associated with their small size, limited duration, and heterogeneity of outcome measures. Comparative effectiveness research comparing various technology-based approaches to one another instead of comparing them to conventional care is also scarce.

- The use of standardized outcome measures in future research will be particularly useful. They should include not only changes at the level of impairment, but also at the levels of functioning and participation.
- Longer-term follow-up is required to determine whether the benefits gained through structured rehabilitation are sustained after the end of formal therapy.
- The need for cost-effectiveness and implementation studies in standard, resource-limited clinical environments is essential in directing the equitable use of new technologies.
- The examination of methods by which specific rehabilitation interventions can be better tailored to the needs of individual patients based on factors such as level of disability and cognitive functioning can potentially take the field towards more personalized rehabilitation planning.

The question of equity of access is also important. Much of the scientific literature demonstrating the advantages of robotic, VR, and tele-rehabilitation approaches has been produced in well-equipped research facilities, and the question remains as to how often these findings generalize to other, less well-equipped environments where the costs of equipment, technology, and staffing levels may be different. Without focused effort towards implementation in varied environments, it is likely that the advances made in stroke rehabilitation using technology will only benefit those who already have the most access to specialized care.

5. CONCLUSION

The current literature review has been focused on analyzing contemporary approaches to the physiotherapy treatment of stroke patients using various techniques such as task-specific training, robot-assisted and exoskeletal physical therapy, VR, gamified therapy, constraint-induced movement training, motor imagery, artificial intelligence, telerehabilitation, and technology-enabled gait and balance training. According to the analyzed information, effective stroke rehabilitation is based on high-intensity and task-specific therapies which are associated with the principles of neuroplasticity and motor learning. Technological advancements have facilitated the process of rehabilitation by increasing the precision of treatment and improving patient engagement and access to treatment options while traditional physiotherapy remains an integral part of the functional recovery of stroke patients.

5.1 Summary of Main Insights and Conclusions

It has become clear from the review of evidence that factors related to intensity, repetition, and specificity of training are invariably linked with positive outcomes in all intervention types, and that novel technologies primarily enhance recovery by allowing higher dose and monitoring of training as well as increased level of engagement with the task, rather than through introduction of a new mode of recovery. Constraint-induced movement therapy and structured, high-intensity task training are currently the most evidenced techniques, while robotic and VR interventions are promising as supplementary methods for impaired and less engaged patients.

One of the consistent themes of the entire review is that recovery following stroke is best facilitated by a rehabilitative process that is appropriately intense, specific to the task, and tailored to the individual patient's recovery phase and abilities, not by any particular method or equipment mentioned separately.

5.2 Importance of the Review

In light of the large number of people living with disabilities resulting from stroke, as well as the rapid rate of emergence of rehabilitation technologies within the health care system, the development of an evidence base is necessary to make informed choices regarding whether to invest in technology or to stick with traditional forms of treatment where these are well-executed. This review will provide a contribution to this process by reviewing the evidence in a number of different types of interventions and identifying the methodological strengths and weaknesses that need to be considered.

5.3 Recommendations

- While providing clinical services, it is essential that task-specific practice intensity and repetition are prioritised with selective technology use where it adds to the quality and quantity of such training.

- Constraint-induced movement therapy and the modifications that have been developed should be considered when treating individuals with residual voluntary movement especially in the chronic stages.
- The development of robotic and VR technologies should be based on evidence for the practical benefits of the technologies and be complemented by appropriate training for staff members.
- Future research should include large scale and long-term studies comparing various forms of technology with each other and implementation research to assess their cost-effectiveness and accessibility.

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