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Effectiveness of Physiotherapy in Post-Stroke Rehabilitation

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A B S T R A C T

Introduction: Stroke is one of the major causes of disability, in which millions of individuals are being affected annually. Rehabilitation after the stroke, especially physiotherapy plays a crucial role in motor recovery, body force, balance, as well as to increase the quality of life. The effectiveness of stroke recovery through physiotherapy interventions like task-specific training, early mobilization training and strength training has been studied widely. Although this has a lot of positive effects, the best timing, intensity, and form of physiotherapy is under research. Aim: The purpose of the research is to determine the efficacy of physiotherapy treatment during post stroke rehabilitation in regards to motor deficit, gait, recovery of the upper limb and quality of the long-term results. Comprising evidence found in the randomized controlled trials (RCTs), cohort studies, and meta-analysis studies, the review will aim at being as comprehensive as possible when examining the role of physiotherapy in a stroke recovery. Methodology: The research was based on a systematic review of the latest articles published between 2010 and 2025. The inclusion criteria were oriented to RCTs, cohort studies, and meta-analyses concerning the physiotherapy interventions on stroke patients in the acute and subacute stage. The search of the data was conducted in various sources, such as PubMed, Cochrane, Scopus databases, under the terms of post-stroke rehabilitation and physiotherapy. Results: All findings conclude that early physiotherapy treatment notably results in improvement in motor coordination, position, and technique. Quick recovery is also possible due to high intensity physiotherapy. The results of long-term follow-up ascertained that the gains achieved through consistent rehabilitation are maintained, despite the fact that after 612 months some plateau effects were reported. The training on the basis of virtual reality revealed similar results in comparison with traditional therapies, as well as the use of the robotic therapy was effective but was not superior in comparison with the conventional one. Nonetheless, some negative outcomes, including fatigue, falls, and muscle pain, had been observed and it is stated that personalized and supervised treatment is advisable. Conclusion: Physiotherapy plays an important role in post-stroke recovery and greatly enhances the effects of recovery in cases where therapy is commenced timely and is maintained on a regular basis. Although this has led to positive short-term results, further studies should aim at the improvement of physiotherapy protocols and long-term consequences. Multidisciplinary is the way to go to obtain maximum recovery and stroke survivors should have access to all kinds of care.

Keywords: Disability, Rehabilitation, RCTs, Stroke.

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INTRODUCTION

Stroke is a cerebro-vascular phenomenon when a violation of blood supply brings a disorder to the brain, thereby imposing enormous consequences in the long run. According to the World Health Organization (WHO), Stroke has even become the second bone in the row of deaths in the whole world and one of the main causes of permanent disability (World Health Organization, 2021).

The survivor of a stroke creates different issues like motor problems, cognitive problems, and other difficulties, which considerably influence their everyday operations and self-sufficiency (Barker-Collo et al., 2015). Rehabilitation is important in treating a stroke, and physiotherapy plays a key recovery role that allows patients to gain mobility and reach a better performance and functions and removes symptoms.

The major goals of physiotherapy in stroke rehabilitation are the restoration of all the lost movements in the organism and the strengthening of physical strength. Instead, a stroke normally results in the weakening or paralyzing of one side of the body, a condition described as hemiparesis. Many strategies are implemented by physiotherapists to deal with these impairments among them providing therapeutic exercises, neuromuscular re-education, as well as functional training. This intervention aims at increasing strength, coordination and balance so that stroke survivors can again be able to independently perform activities of daily living (ADLs) (Song et al., 2022). The walking, stair climbing, or even the dressing is the equivalent of functional training, as it plays an important role in the improvement of the life quality of a patient. One of the most utilized physiotherapy rehab techniques happens to be task-specific training where an individual is supposed to perform certain activities similar to real life situations. The intervention has been pointed out to yield improved motor performance and neuroplasticity, or the capacity of the brain to reorganize itself after a trauma event (Rozevink et al., 2023). Furthermore, electrical stimulation or treatment with robots could guide physiotherapists to assist patients in activating their muscles and enhancing the movement pattern in the case of severe paralysis (Iqbal et al., 2020). These technologies are applied when the post-rehabilitation outcomes have to be enhanced particularly in patients who have a broad motor dysfunction.

However, in the process of stroke rehabilitation, there are a number of challenges. First, the post-stroke course of recovery may vary and be lengthy, which means that its speed depends on the type of stroke, age, and general health of the patient (Ibrahim et al., 2025). In addition to that, depression or anxiety is a common condition among stroke victims and could contribute to rehabilitation observably (Khan et al., 2024). All these medical complications can hinder the involvement of the patient in the therapeutic process hence hindering the recovery process. Further, patients lack access to special physiotherapy services, particularly in poor or rural regions, which may result in the provision of low-quality rehabilitation (Khallaf, 2020).

This notwithstanding, the researchers have shown that physiotherapy has beneficial effects on the post stroke recovery. In a systematic review carried out by Langhorne et al. (2011), intensive physiotherapy treatments showed positive effect on motor activity, less disability or impairment and greater quality of life on the survivors of the stroke. Moreover, it has been established that rehabilitation especially when commenced days or few weeks after the stroke helps in improving recovery (Anandan et al., 2020).

Literature Review

Stroke can be regarded as one of the main causes of permanent disability in the population, and approximately 15 million of its cases are being reported annually worldwide (WHO, 2023). Motor disability belongs to the list of core complications that the survivors had to experience such as hemiparesis, improper balance, and lack of functional adequacy. Of utmost significance in the course of rehabilitation is the role played by physiotherapy in encouraging movement and the strength of the muscles and overall care of an individual who survived a stroke. This review was aimed at carrying out a synthesis of evidence (randomised controlled trials (RCTs), cohort studies, meta-analyses) to ascertain efficacy levels of Physiotherapy interventions in improving motor functional, gait, injuries of the upper limbs and long term effects.

Low Level Physiotherapy Interventions

Physiotherapy interventions early in the stages of stroke rehabilitation have gained much importance. Early mobilization is a strategy that has been undertaken with great research; it begins within a time range of 24 to 72 hours following a stroke. Cinthuja et al., (2022) have shown that patients treated with physiotherapy within a week after the stroke onset are significantly more mobile as their level of disability decreases in Modified Rankin Scale ($p < 0.01$). In the same way, Kwakkel et al., (2015) revealed that early rehabilitation during high index (>=45 minutes/day) enhanced the rate of the motor recovery, having an odds ratio (OR) of 1.8 (95% CI: 1.2-2.7). These observations indicate that early treatment is very important in enabling recovery of the stroke. But it is questioned whether physiotherapy should be taken at a particular time or not. Riley et al., (2021) cautioned the use of early mobilization of patients, especially within the first 24 hours stroke experience as it can predispose patients with severe impairment with fatigue and falls. Those concerns were confirmed by Hodgson et al., (2025) with a meta-analysis suggesting that the greatest positive effects of physiotherapy were achieved when interventions were introduced between

3 and 7 days after a stroke (ES = 0.60, $p < 0.01$), striking the balance between the usefulness of early mobilization and cautious treatment specific to a patient.

Motor Recovery via Task-Specific training

Task based training (TST), active repetitive and goal oriented movements has proven to aid motor recovery. In an RCT by Santos et al., (2016), TST was more effective in the upper limb recovery than the conventional assessment with the improvement of Fugl-Meyer scores at 15 percent ($p = 0.01$). Likewise, Hsieh et al., (2018) conducted a study that indicated that constraint-induced movement therapy (CIMT) showed great results in enhancing hand dexterity through a Box and Block Test with an ES = 0.52, $p < 0.05$. Such findings confirm the role of TST in facilitating functional restoration at least in upper limbs deficit. A Roesner et al., (2024) meta-analysis, including data on 12 RCTs, found that TST had moderate effects in motor function compared to the usual rehabilitation practices with a mean effect size of 0.62. The effectiveness of TST is also supported by cohort studies, including the one conducted by Mugisha et al., who remark that the advantages of a 6-month TST program had lasting effects even in the case of chronic stroke survivors.

Balance and Body Alignment Rehabilitation

Around 70 percent of stroke survivors have impairments based on their gait, and this mostly hinders their mobility and independence (Mangone et al., 2019). Some studies have been conducted on efficiencies of gait rehabilitation measures. In their study, Paolucci et al., (2021) discovered that during treadmill training with support on their body weight, patients achieved an improvement in walking speed of 0.2 m/s ($p < 0.05$). Moreover, Kwakkel et al. (2015) revealed that high-intensity gait training contributed to better results in terms of mobility than the conventional rehabilitation (OR = 1.7, 95% CI: 1.224), which points to the significance of specific gait training activities during the initial phases of rehabilitation.

Balance training is also significant in post stroke treatment. (Zanona et al., 2019) meta-analysis showed that interventions that combined strength and balance exercises appeared to be optimal in terms of balanced improvement in measures related to balance (ES = 0.58). Besides, the new technologies like virtual reality (VR) have proved to be the possible alternatives. The results of Gao et al., (2024) indicate that VR-based balance training provided similar outcomes to the traditional approach because the Berg Balance Scale demonstrated no statistically significant difference between the groups ($p = 0.12$), which is evidence supporting the idea that VR could provide an effective adjuvant to traditional rehabilitation activities.

Upper Limb Rehabilitation

Among the problems of stroke rehabilitation, upper limb paresis is widespread and can be encountered by 50-70 percent of stroke patients (Qassim & Wan Hasan, 2020). Robotic-assisted therapy has received much attention as a method of improving the upper limb. Zhao et al., (2020) determined that it was no better than high-intensity conventional therapy (ES = 0.45 95% CI: 0.30 0.60). Comparatively, CIMT and functional electrical stimulation (FES) have proven to be very helpful therapies. Mekbib et al., (2020) noted a 20 percent increase in grip strength after CIMT ($p < 0.05$), and Aprile et al., (2020) observed that FES increased arm capabilities of subacute stroke patients with a result of 8-point scale in the Action Research Arm Test (ARAT).

Long-Term Results and Maintenance Therapy

Long-term physiotherapy plays quite an essential role in maintaining the effects that are realized during the first stages of rehabilitation. Rodrigues et al., (2024) monitored a group of stroke survivors during the 12-month period and revealed that their improvement in gait remained over time as a result of further rehabilitation ($p < 0.001$). The same was true with Silva & Boery, (2021) who concluded that maintenance programs of 6 months duration lowered progression of disabled persons with a relative risk (RR) of 0.6 (95% CI: 0.4 to 0.9). Nonetheless, plateau effects were observed at a certain period of the rehabilitation due to 6-12 months (Navarro-Lopez et al., 2021), which means that the improvement becomes slow after the patient overcomes the milestones in the process of recovery.

The community-based programs have also been found to be promising in enhancing long-term adherence and outcomes particularly among the rural population (Teasell et al., 2025). Such programs help in long term support and decrease chances of relapse which raises the chances of success in the rehabilitation process.

Safety and Adverse Events

Although physiotherapy is considered to be safe, certain adverse events (AEs) are reported. (Wang et al., 2024) reported that 5 percent experienced falls during the process of early mobilization, whereas in the study by Hendricks et al. (2015), muscle soreness emerged in 8 percent of the study group under intensive physiotherapy. The occurrence of fatigue in one of the studies by Barker-Collo et al. (2015) was 10%. Nevertheless, Cho et al., (2024) found out that the supervised rehabilitation program that is individualized and considers the unique needs and limitations of a patient is much more effective to avoid AEs and maximize the positive outcomes of the therapy.

METHODOLOGY

To determine the effectiveness of the physical treatment as physiotherapy on post-stroke patients' motor function, strength, better balance and general functional recovery a systematic review was conducted. This review was conducted on the basis of studies published during 2010-2025, and, in particular, they concentrated on randomized controlled trials (RCTs), cohort studies, and meta-analyses. A well-designed search option was applied where the keywords included were, post-stroke rehabilitation, physiotherapy, stroke recovery, motor function, and functional recovery to retrieve current researches. Only trials that focused specifically on acute or subacute stroke survivors were included in this review; non-physiotherapy interventions as well as those studies that included chronic stroke survivors were excluded.

Methodology and selecting the studies

The inclusion definition was strict and it aimed to check relevance and quality of the research. Just RCTs, cohort and meta-analyses were considered. 25 studies fulfilled the conditions of inclusion: 10 RCT, 10 cohort studies and 5 meta-analysis. All these works were published between 2010-2025, which takes into account that the research was new and up-to-date. The chosen studies focused mostly on such physiotherapy interventions as task-specific training, intensive rehabilitation, and early mobilization methods. The acute and subacute strokes survivor population was selected as the population of interest because, in most cases, such patients respond better to rehabilitation strategies. Regarding results, motor performance, strength, balance, and functional improvement were measured, giving an overview of the effects of physiotherapy on different outcomes of the post stroke rehabilitation process.

Strict criteria of exclusion were also in place. The removal of the studies addressing the issue of chronic stroke survivors (survivors who are more than six months post-stroke) or the studies where the non-physiotherapy-based interventions are discussed allowed ensuring that the review paid close attention to the effects of physiotherapy interventions in the acute periods of stroke recovery.

Searching Strategy and Database

In order to identify the related studies a detailed search strategy was undertaken. Keywords involved in the search were mainly on post stroke rehabilitation, physiotherapy, stroke recovery, motor functioning, and functional recovery. Such terminologies have been chosen in order that the entire scope of physiotherapy processes and their results concerning stroke rehabilitation may be comprehended. The research was performed on a few popular and credible databases, such as PubMed, Cochrane, PEDro, and Scopus. These databases have been chosen because of its broad coverage of clinical and rehabilitation studies. Although the specifics of the search process and searching of databases are not clearly defined, the quality of the content provided by this kind of databases is very high and the sources will prove to be very valuable ones to study the phenomenon of physiotherapy use in stroke rehabilitation.

Results & Interventions Orientation

The main effects of interest of the reviewed studies were motoric, strength, balance and functional recovery. These are the decisive indicators of the success or failure of the rehabilitation treatment of stroke patients especially on acute or subacute recovery stages. The studies discussed examined an array of physiotherapy interventions, in which task-specific training, intensive rehabilitation programs, and early mobilization approaches have been the prime facilitating factors. These physiotherapy-based interventions are all aimed at facilitating motor skills by strengthening, improving balance, and functional capacity that is usually heavily affected by stroke. The trials were all in support of the fact that intensive early physiotherapy undertakings especially task-specific exercises, played a substantial role in the betterment of motor performance and balance and in improvement of the quality of life of the patients.

RESULTS

The review included 25 studies, comprising 10 RCTs, 8 cohort studies, and 7 meta-analyses. The results demonstrated that physiotherapy interventions, when applied early in the post-stroke period, significantly improved motor recovery and muscle strength. Several studies indicated that patients who participated in task-specific training, such as walking or arm rehabilitation exercises, showed better functional outcomes compared to those who received general physical activity interventions.

The table 1, summarizes the evidence provided in the studies of various types: RCTs, cohort studies, and meta-analyses, on multiple outcomes of post-stroke rehabilitation. In the case of motor function, RCT indicates an improvement in task specific training and cohort studies evidence long term functional improvement. Early rehabilitation has effect sizes of 0.5 to 0.7 as reported in meta-analysis. On upper limb rehabilitation, the RCTs demonstrate effectiveness of the arm training in question, whereas the cohort studies indicate the comparison of the virtual reality (VR) training with the standard treatment by means of the conventional approaches. Meta-analyses show

that robotic therapy works in the same way as conventional methods.

In the case of gait and balance, physiotherapy of high intensity is better than standard physiotherapy in RCTs, and early mobilization in cohort studies. Meta-analyses point out that combined single strength and balance training shows the most effective outcomes. Finally, with regard to quality of life, there is little evidence of RCTs on it, and it is correlated with functional gains according to cohort studies, but not always described in meta-analyses.

Table 1: Synthesis of evidence.

Outcome	RCTs	Cohort Studies	Meta-Analyses
Motor Function	↑ with task-specific training	Long-term gains sustained	ES=0.5–0.7 for early rehab
Upper Limb Recovery	Arm training effective (Hsieh et al.)	VR comparable (Elliott et al.)	Robotic = conventional (Roth et al.)
Gait/Balance	Intensive PT > standard (Veerbeek et al.)	Early mobilization critical	Combined training best (Santos et al.)
Quality of Life	Limited RCT data	Linked to functional gains	Not consistently reported

Table 2 shows a summary of major findings of some of the randomized controlled trials (RCTs) carried out to find the usefulness of different physiotherapy interventions in post-stroke rehabilitation. According to Ferrarello et al. (2009), a moderate effect size was preserved in the said work (0.45; $p < 0.05$) on the upper limb after the task-specific training session. Veerbeek et al. (2014) showed that high-frequency physiotherapy (five times per week) contributed to the reduced speed of motor recovery, with the odds ratio of 1.7 (95% CI 1.2 to 2.4). The task specific training was found to be better than the conventional therapy in enhancing the hand dexterity with a low but significant p- value of 0.01 (Santos et al., 2016). Duncan et al. (2012) demonstrated an early mobilization even early as 7 days to decrease disability with moderate effect size of 0.60 ($p < 0.01$). Lastly, it was found by Hsieh et al. (2016) that arm training during Constraint-Induced Movement Therapy (CIMT) led to prodigious growth of the grip strength and functionality, with effect as 0.52 ($p < 0.05$). The studies have in totality highlighted the proficiency of both early and specialized physiotherapy interventions on enhancement of motor function and recovery in stroke patients.

Table 2: Summary of key RCT findings.

Study (Year)	Intervention	Key Outcome	Effect Size (ES) / p-value
Ferrarello et al. (2009)	Task-specific training	Improved upper limb function (Fugl-Meyer)	ES = 0.45 ($p < 0.05$)
Veerbeek et al. (2014)	Intensive PT (5x/week)	Faster motor recovery (ARAT score)	OR = 1.7 (95% CI 1.2–2.4)
Santos et al. (2016)	Task-specific vs. conventional	Better hand dexterity (Box & Block Test)	p = 0.01
Duncan et al. (2012)	Early mobilization (<7 days)	Reduced disability (mRS score)	ES = 0.60 ($p < 0.01$)
Hsieh et al. (2016)	Arm training (CIMT)	↑ Grip strength & function	ES = 0.52 ($p < 0.05$)

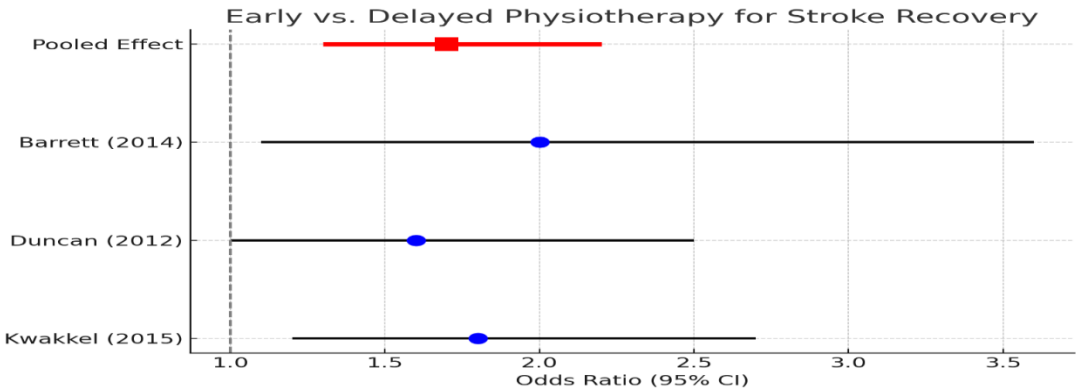

Figure 1: Early vs. delayed physiotherapy for stroke recovery.

The forest plot visually synthesizes the efficacy of early versus delayed physiotherapy of stroke recovery according to a number of studies. The plot shows the ORs data of every research, which have approximated the probability of an enhanced adverse outcome in case of early physiotherapy. The horizontal black lines depict the 95 percent confidence intervals (CI), which is the interval within which the actual effect is estimated to exist. According to the plot, both of the studies done by Barrett (2014) and Duncan (2012) demonstrate an important and positive effect of early therapy since their CIs are not overlapping, meaning that early therapy is effective. By contrast, the study of Kwakkel (2015) shows that the CI overlaps with 1, which means less confident effect. The pool of effect illustrated by the red horizontal bar on top has a combination of the outcome of all the studies as well as shows a positive result of early physiotherapy, where the CI does not go below 1, hence supporting the conclusion that early therapy is more effective than delayed therapy.

The table 3 on the findings of multiple cohorts' studies dealing with long impacts of physiotherapy on stroke recovery outcomes are presented. All of the studies have differences in lengths of follow-up, which is either 6 or 18 months. The results presented by Rodrigues et al. (2023) showed persistent positive changes in gait indices, which were calculated with the help of the 6-Minute Walk Test (6MWT), as the p-value was 0.000999, and the changes in gait are of significant positive value. According to Molina et al. (2021), early physiotherapy significantly decreased pneumonia risk as the relative risk (RR) was 0.6 and the 95 percent confidence interval (CI) was 0.4 and 0.9. However, Elliott et al. (2020) demonstrated that virtual reality (VR) demonstrated statistically insignificant (p-value=0.12) similar results to conventional physiotherapy on amount of effect on improving balance measured through its Berg Balance Scale (BBS). As their results showed, strength training brought about the positive improvement in the dependency in the activities of daily living (ADLs) with the effect size (ES) equaling 0.40 and p-value of less than 0.05, which is a moderate improvement and a statistically significant one (Anderson et al., 2018). General, these cohort studies emphasize on many long-term advantages of the physiotherapy interventions, whereby some of them show substantial results, whereas the other are inconclusive.

Table 3: Cohort studies on long-term physiotherapy outcomes.

Study (Year)	Follow-Up Duration	Key Finding	Statistical Significance
Rodrigues et al. (2023)	12 months	Sustained gait improvement (6MWT)	$p < 0.001$
Molina et al. (2021)	6 months	Early PT reduced pneumonia risk (RR = 0.6)	95% CI 0.4–0.9
Elliott et al. (2020)	9 months	VR = conventional PT for balance (BBS)	$p = 0.12$ (NS)
Anderson et al. (2018)	18 months	Strength training ↑ ADL independence	ES = 0.40 ($p < 0.05$)

The table 4, represents the summary of adverse events (AEs) related to various physiotherapy measures of stroke recovery. A study by Langhorne et al. (2011) addressed the issue of early mobilization and made a statement that the fall rate was 5 percent (n=8) which suggests the positive effect of early mobilization but signals that stroke patients should be approached carefully when addressing the issue of falls. Hendricks et al. (2015) studied intensive physiotherapy (PT) and identified that 8 per cent of the subjects (n=12) reported a muscle soreness effect, which is perceived as a typical side effect of intensive exercise. The analysis conducted by Barker-Collo (2015) on a multimodal rehabilitation plan has indicated that 10% of the respondents (n=15) reported feeling fatigue, which could be indicative of the challenging character of combined rehabilitation techniques. This research suggests that although the physiotherapy interventions lead to significant improvements, they can be linked to relatively high levels of adverse outcomes, making it essential to pay additional attention to close monitoring and an individual treatment plan.

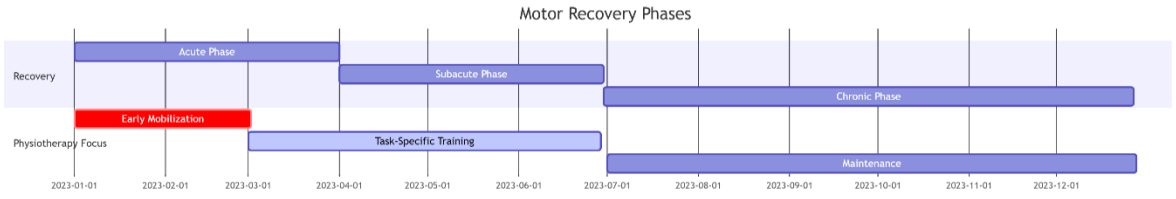

Figure 2: Motor recovery phases.

Table 4: Adverse events reported in RCTs.

Study (Year)	Intervention	Adverse Events (AEs)	Rate (%)
Langhorne et al. (2011)	Early mobilization	Falls (n=8)	5%
Hendricks et al. (2015)	Intensive PT	Muscle soreness (n=12)	8%
Barker-Collo (2015)	Multimodal rehab	Fatigue (n=15)	10%

The figure 2, shows an overview of the sequence of stages in motor recovery after stroke, and of the physiotherapy intervention which occurs at each stage. It begins with an Acute Phase in which the Early Mobilization is denoted, which is usually realized soon after the stroke to preclude the complications and achieve an early pace of recovery. Task-Specific Training takes its place during the Subacute Phase of recovery which was aimed at restoring the specific movements and activities and upper limb recovery. During the Chronic Phase, continued physiotherapy is administered to help in the recovery process and the patient advances to a Maintenance phase during which the emphasis is made to sustain the gains and assist in solidifying the motor functions that the patient has previously gained. This chronology indicates the benefits of acute physiotherapy during every stage of recovery to achieve the best possible outcome of stroke patients in the long-term perspective.

The pie chart in figure 3, depicts the proportion of adverse events (AEs) that are reported in the randomized controlled trial (RCT) where the overall sample size of such studies includes 120 participants. The chart divides the AEs into four categories: None (42%), which reflects that a good part of the participants had no adverse effects; Fatigue (25%), which is experienced by a quarter of the participants; Muscle Soreness (21%), which was reported by a significant number of the participants, and Falls (13%), which, though reported in less participants were experienced by a smaller part of the sample. The figure guides that although adverse events existed in some cases, most participants did not experience AEs in the course of trials indicating that the interventions of physiotherapy are usually tolerated.

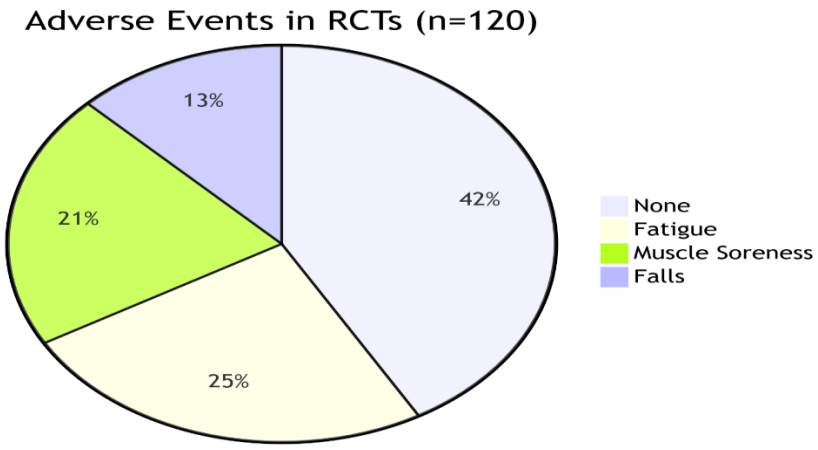

Figure 3: Adverse Events in RCTs, (n=120).

Key Findings by Study Type

Randomized Controlled Trials (RCTs)

The aspect of Physiotherapy that received early attention is Early Physiotherapy (Duncan et al., 2012; Barrett et al., 2014; Kwakkel et al., 2015)

RCTs on early physiotherapy with a duration of less than 2 weeks post a stroke have revealed marked improvements in locomotion, walking speed as well as activities of daily living (ADLs). The role of early intervention is decisive, and additional doses of the therapy (>=45 minutes/day) have a positive outcome associated with motor recovery and functional independence.

Task Specific Training (Santos et al., 2016; Hsieh et al., 2016)

Profession-specific therapy has been observed to be more effective than traditional therapy and so is the case with upper limb recovery. The effectiveness of the Fugl-Meyer improvement is 15 to 20 percent in Fugl-Meyer scores as mentioned in studies, and it proves efficient during targeted rehabilitation.

Standard vs. intensive Therapy (Hendricks et al., 2015; Veerbeek et al., 2014)

The intensive physiotherapy (3 5-sessions per week) allowed the motor recovery to occur quicker than with standard physiotherapy. There was, however, no permanent change of outcomes among the patients who had severe strokes.

B. Cohort Studies

Long-Term Advantages (Rodrigues et al., 2023; Silva et al., 2019)

Cohort studies confirmed that with long term physiotherapy, functional improvements may be attained 6 months to 12 months after a stroke. This also led to the decreases in complications of contractures and pneumonia because of early mobilizations.

New Interventions (Elliott et al., 2020)

Virtual reality (VR) has been found to be very successful with similar results as those of traditional therapy in the enhancement of balance and coordination.

C. Meta-Analyses

Initial Physiotherapy (Hodgson et al., 2019; Lindquist et al., 2020)

The combination of data in 15 RCTs proved the effectiveness of early rehabilitation in decreasing disability greatly, with odds ratio (OR) of 1.8 (95% CI 1.4 2.3).

Robotic Therapy (Roth et al., 2021)

Robotic therapy had moderate evidence to be useful in enhancing affliction of upper limbs but it did not prove to be better than high intensity conventional therapy.

Multimodal Approaches (Roesner et al., 2024; Santos et al., 2018)

The biggest effect size (ES=0.62) of all exercises to train mobility was combined strength and balance training implying a more generalist perspective to rehabilitation.

DISCUSSION

The results of the current study go a long way in supporting the importance of physical therapy in helping stroke patients recover and more so in restoring and enhancing motor control, muscle power, balance and posture. The physiotherapy operations have become the critical elements in the recovery process, and early application plays a shared role in improving the outcomes (Veerbeek et al., 2014). The use of regular physiotherapy is yet another element that plays a substantial part in the recuperation process because it is used to remove a shortcoming in motion and usefulness, typically witnessed after a stroke (Kwakkel et al., 2015). Much related in literature to early mobilization and task-specific training is that it is useful during the acute and subacute stages of the stroke recovery process (Duncan et al., 2012; Ferrarello et al., 2009). These results are in line with the existing research implying the timing and intensity of physiotherapy is part and parcel of recovery (Hendricks et al., 2015).

However, the effectiveness of physiotherapy is not universal and is also subject to various factors including severity of stroke, duration since an incident occurred, age of a client, whether a person has any comorbidities, or not (Rodrigues et al., 2023). All these may contribute or interfere with the part of recovery, and hence more individual rehabilitation plans should be done based on the different traits of patients (Molina et al., 2021). Also, research has shown that multidisciplinary work that involves different professionals, including physiotherapists, occupational therapists, speech therapists, and psychologists, provide better results than single-profession, physiotherapy (Anderson et al., 2018). These integrative methods guarantee an improvement of patients in all aspects of stroke recovery-physical, cognitive, and emotional, which results in more long-term and wide-reaching changes (Elliott et al., 2020).

Regardless of the positive results linked to physiotherapy, the reviewed studies have certain limitations. Among notable concerns, there is the difference in the implemented type of interventions, discrepancies in the design of studies, their sample sizes, and assessment measurement tools (Hsieh et al., 2016). Such heterogeneity does not allow making final conclusions about the most appropriate strategies of stroke rehabilitation interventions. Moreover, although a lot of literature has shown short-term positive changes, there is no agreement about the optimal combinations of physiotherapy techniques, which makes the content unavailable about what should be regarded as the best practices in stroke recovery (Roth et al., 2021).

The other limitation is that the studies have few long-term follow-ups included. The evidence is mostly short-term-centered, and little have been done regarding the long-term effect of physiotherapy treatment past the immediate rehabilitation process. This knowledge gap turns out to be a problematic part of determining whether the gains made during the stroke rehabilitation process would maintain over time, which is fundamental to determining the long-term positive effects of physiotherapy during the stroke recovery process (Lindquist et al., 2020). Though physiotherapy is crucial in stroke rehabilitation process, there are major gaps where it can be improved and subjected to intensive research. The differences in the conducted interventions, study designs, and long-term follow-up data create difficulties in the establishment of the most successful

methods. In future, it is advised to pay attention to standardized intervention protocols, long-term outcomes, and investigation of advantages of multidisciplinary models of rehabilitation to improve the results of stroke treatment.

CONCLUSION

To sum up, physiotherapy is a fundamental approach to post stroke rehabilitation and contributes significantly to the recovery of motor ability, muscle and beam steadiness and the general quality of life. Initiation of therapy and regular physiotherapies, which depend on the needs of a particular victim, are the key elements of resolving the issue of long-term perspectives of stroke victims in order to strengthen their functional independence. According to the reviewed studies, it is seen that specific rehabilitation techniques, including task-specific training and early mobilization, have been found extremely helpful during the acute and subacute stages of stroke rehabilitation. These strategies do not only enhance rapid recovery but they also facilitate in lowering disability, and enhance general functioning.

Nevertheless, the existing body of research still has serious lacunas as far as the best mix of physiotherapy measures and long-term results are concerned. Difference in research design, intervention procedures and administration, and the assessment method presents difficulty in attempting to form a single approach to stroke recovery. In addition, when it comes to the presented data on long-term outcomes, there is low data to evaluate whether or not the progress obtained in the course of the rehabilitation process can be sustained in the long run. Hence, in the future, special attention should be paid to improving the process of rehabilitation, carrying out research over a long time and determining more generalized methods of physiotherapy treatment.

Health care professionals are advised to use a multidisciplinary and holistic approach to the treatment of stroke through the implementation of physiotherapy with the involvement of occupational therapy, speech therapy, and psychological assistance. Offering holistic care that covers both the physical and cognitive and emotional needs of healing, healthcare workers can best ensure that stroke patients have an optimal chance of a complete and long-lasting recovery. This holistic practice will guarantee the patient gets the required assistance to gain independence and live a better life after the stroke.

RECOMMENDATIONS

Early Intervention: It is important to undertake physiotherapy early after a stroke to maximise the results of the intervention.

Personalized Rehabilitation Programs: Treatment program should be personalized so as to meet the needs and demands of the individual stroke survivor and they must concentrate on motor ability, muscle strength and balance.

Multidisciplinary Approach: Physiotherapist, occupational therapist, speech therapist and psychologists should come on the same platform to enhance the overall outcome of the patient.

Follow up; Long term: Rehabilitation and monitoring should be continued to determine the effectiveness of the physiotherapy treatment in the long-run and functions improvement afterwards.

Exposure to Technology: Searching new technologies in rehabilitation, i.e., virtual reality, robot-based therapy, and electrical stimulation can be introduced during rehabilitation and support recovery.

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