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Түпнұсқа мақала

ИНСУЛЬТТАН КЕЙІНГІ ҚИМЫЛ БҰЗЫЛЫСТАРДЫ ҚАЛПЫНА КЕЛТІРУДЕГІ ЕРТЕ МОБИЛИЗАЦИЯ: РАНДОМИЗАЦИЯЛАНҒАН КЛИНИКАЛЫҚ ЗЕРТТЕУЛЕРДІҢ ОН ЖЫЛДЫҚ ШОЛУЫ

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ТҮЙІНДЕМЕ

Шолудың мақсаты - соңғы онжылдықта инсульттан кейін қимыл бұзылыстарды қалпына келтірудің басталу мерзіміне қатысты жоғары сапалы клиникалық зерттеулердің нәтижелерін синтездеу және ең жақсы тәжірибелерді анықтау, қайшылықтарды көрсету және терапиялық нәтижелерді оңтайландыру үшін болашақ зерттеу бағыттарын ұсыну.

Әдістері: 2014 жылдың қаңтары мен 2024 жылдың мамыры аралығында жарияланған зерттеулерге назар аудара отырып, PubMed/MEDLINE дерекқорлары арқылы жан-жақты әдебиетті іздеу жүргізілді. Іздеу терминдері инсультке, қимыл бұзылыстарды қалпына келтіруге және пациенттің нәтижелеріне қатысты MeSH тақырыптарына сәйкес болып, олар «ерте оңалту», «кешіктірілген оңалту» және «жеделден кейінгі оңалту» сияқты кілт сөздермен біріктірілген. Қосылу критерийлері ағылшын тілінде жарияланған және толық мәтінде қол жетімді ересектерге арналған клиникалық зерттеулер болды. Сапаны бағалау үшін Cochrane Risk of Bias құралы пайдаланылды.

Нәтижелер: Қаралған 54 мақаланың 6-ы инсульттан кейінгі оңалту уақытына тікелей қатысты. Бұл зерттеулер ерте оңалтудың артықшылықтарының аралас дәлелдерін берді, олардың кейбіреулері өте ерте мобилизациямен байланысты ықтимал тәуекелдерді ұсынды (24 сағат ішінде). AVERT сынағы өте ерте мобилизациямен нашар нәтижелер тапты, ал басқа зерттеулер оңалтудың ерте, бірақ мұқият басталуы қимыл бұзылыстарды қалпына келуін айтарлықтай жақсартуға әкелуі мүмкін екенін көрсетті. Нәтижелер оңалтуды бастаудың оңтайлы уақытын анықтаудың қиындығын көрсетеді. Инсульттан кейін 24-48 сағат ішінде басталған ерте оңалту, әдетте, егер пациенттер медициналық тұрғыдан тұрақты болса, пайдалы. Дегенмен, өте ерте және қарқынды жұмылдыру, әсіресе ауыр инсульт немесе тұрақсыз жағдайлары бар емделушілерде жағымсыз нәтижелердің қаупін арттыруы мүмкін. Әртүрлі оңалту кезеңдерінің пациенттердің нәтижелеріне ұзақ мерзімді әсерін түсіну үшін жеке оңалту жоспарлары және қосымша зерттеулер қажет.

Қорытынды: Инсульттан кейінгі моторлық оналту ерте бастау науқастың жеке қажеттіліктері мен медициналық мәртебесіне бейімделген жағдайда қалпына келтіруді және өмір сапасын жақсартады. Болашақ зерттеулер терапевтік пайданы барынша арттыру және тәуекелдерді азайту үшін оңалту шараларының уақыты мен қарқындылығын нақтылауға бағытталуы керек.

Түйін сөздер: инсульт, неврологиялық оңалту, физиотерапиялық әдістер, ерте реабилитация, кешіктірілген реабилитация, оңалту бойынша нұсқаулар

Оригинальная статья

РАННЯЯ МОБИЛИЗАЦИЯ В ПОСТИНСУЛЬТНОЙ ДВИГАТЕЛЬНОЙ РЕАБИЛИТАЦИИ: ДЕСЯТИЛЕТНИЙ ОБЗОР РАНДОМИЗИРОВАННЫХ КЛИНИЧЕСКИХ ИССЛЕДОВАНИЙ

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РЕЗЮМЕ

Целью обзора является синтез результатов высококачественных клинических исследований, проведенных за последнее десятилетие относительно сроков начала моторной реабилитации после инсульта для того, чтобы определить лучшие практики, выделить противоречия и предложить области для будущих исследований с целью оптимизации терапевтических результатов.

Методы: был проведен комплексный поиск литературы с использованием баз данных PubMed/MEDLINE, с упором на исследования, опубликованные в период с января 2014 года по май 2024 года. Поисковые термины включали заголовки MeSH, связанные с инсультом, двигательной реабилитацией и результатами для пациентов, в сочетании с такими ключевыми словами, как «ранняя реабилитация», «отсроченная реабилитация» и «пост-острая реабилитация». Критериями включения были клинические исследования на взрослых, опубликованные на английском языке и доступные в полном тексте. Для оценки качества использовался инструмент Cochrane Risk of Bias.

Результаты: Из 54 рассмотренных статей 6 имели непосредственное отношение к срокам реабилитации после инсульта. Эти исследования предоставили неоднозначные доказательства преимуществ ранней реабилитации, некоторые из которых предполагали потенциальные риски, связанные с очень ранней мобилизацией (в течение 24 часов). Испытание AVERT выявило неблагоприятные результаты очень ранней мобилизации, в то время как другие исследования продемонстрировали, что раннее, но осторожное начало реабилитации может привести к значительному улучшению восстановления моторики. Результаты подчеркивают сложность определения оптимальных сроков начала реабилитации. Ранняя реабилитация, начатая в течение 24-48 часов после инсульта, как правило, полезна, если пациенты стабильны с медицинской точки зрения. Однако очень ранняя и интенсивная мобилизация может увеличить риск неблагоприятных исходов, особенно у пациентов с тяжелыми инсультами или нестабильными состояниями. Необходимы персонализированные планы реабилитации и дальнейшие исследования для понимания долгосрочного влияния различных сроков реабилитации на результаты лечения пациентов.

Заключение: Раннее начало двигательной реабилитации после инсульта может улучшить восстановление и качество жизни, если оно адаптировано к индивидуальным потребностям и медицинскому статусу пациента. Будущие исследования должны быть сосредоточены на уточнении сроков и интенсивности реабилитационных вмешательств для максимизации терапевтических преимуществ и минимизации рисков.

Ключевые слова: *инсульт, неврологическая реабилитация, методы физиотерапии, ранняя реабилитация, отсроченная реабилитация, рекомендации по реабилитации.*

Original article

TIMING OF POST-STROKE MOTOR REHABILITATION: A DECADE-LONG REVIEW OF RANDOMIZED CLINICAL TRIALS

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ABSTRACT

Objective: This review aims to synthesize the findings from high-quality clinical trials conducted in the past decade regarding the timing of motor rehabilitation initiation after a stroke. The goal is to identify best practices, highlight controversies, and propose areas for future research to optimize therapeutic outcomes.

Methods: A comprehensive literature search was conducted using PubMed/MEDLINE databases, focusing on studies published between January 2014 and May 2024. Search terms included MeSH headings related to stroke, motor rehabilitation, and patient outcomes, combined with keywords such as "early rehabilitation," "delayed rehabilitation," and "post-acute rehabilitation." The inclusion criteria were clinical trials on adults, published in English, and available in full text. The Cochrane Risk of Bias tool was utilized for quality assessment.

Results: Out of 54 articles reviewed, 6 were directly relevant to the timing of post-stroke rehabilitation. These studies provided mixed evidence on the benefits of early rehabilitation, with some suggesting potential risks associated with very early mobilization (within 24 hours). The AVERT trial highlighted the adverse outcomes of very early mobilization, while other studies demonstrated that early but cautious rehabilitation initiation could lead to significant improvements in motor recovery. The findings underscore the complexity of determining the optimal timing for rehabilitation onset. Early rehabilitation, initiated within 24-48 hours post-stroke, is generally beneficial if patients are medically stable. However, very early and intensive mobilization may increase the risk of adverse outcomes, particularly in patients with severe strokes or unstable conditions. There is a need for personalized rehabilitation plans and further research to understand the long-term impacts of different rehabilitation timing on patient outcomes.

Conclusion: Early initiation of motor rehabilitation post-stroke can enhance recovery and improve the quality of life if tailored to the individual patient's needs and medical status. Future studies should focus on refining the timing and intensity of rehabilitation interventions to maximize therapeutic benefits and minimize risks.

Keywords: *stroke, neurological rehabilitation, physical therapy modalities, early rehabilitation, delayed rehabilitation, rehabilitation guidelines.*

Introduction. Stroke is a leading cause of long-term disability. Effective motor rehabilitation can significantly reduce motor impairments, improving patients' mobility and ability to perform daily activities independently. This is supported by the American Heart Association/American Stroke Association, which emphasizes the importance of rehabilitation in improving motor strength and limb mobility, particularly in the early stages post-stroke [1]. Motor deficits post-stroke can severely impact a patient's quality of life, limiting their participation in social and professional activities. Effective rehabilitation can help restore motor functions, thereby enhancing stroke survivors' overall quality of life [2].

The optimal timing for motor rehabilitation initiation after a stroke is a nuanced topic with varying recommendations based on the timing and intensity of the intervention.

The European Stroke Organisation (ESO) guidelines suggest that early initiation of rehabilitation is a key component of stroke unit care, although the exact definition of "early" remains debated. Trials have shown improved prognosis if therapy is started within 20-30 days post-stroke [3]. A systematic review by Lynch et al. highlighted that commencing physical rehabilitation within 24 hours of stroke onset showed a trend towards greater mortality, suggesting that mobilization within the first few days is generally well tolerated but should be approached with caution [4].

This review aims to analyze the results of high-quality clinical trials on the timing of motor rehabilitation initiation after a stroke published within the last decade. Additionally, it aims to discuss and identify areas where further research is needed to optimize the therapeutic effect of post-stroke motor rehabilitation and patients' well-being.

Methods. The literature search was limited to PubMed/MEDLINE. Articles in English published within the last decade from January 2014 to May 2024 were included. Three categories of Medical Subject Heading (MeSH) terms related to stroke, rehabilitation, and patient outcome were used on PubMed/MEDLINE for this search as presented in Table 1.

Table 1. Outline of search terms used for the review

Concept	MeSH terms	Other terms
Stroke	Stroke Brain Ischemia Intracranial Hemorrhages Cerebral Hemorrhage	
Rehabilitation	Neurological Rehabilitation Motor Activity Exercise Therapy Physical Therapy Modalities	
Timing		Immediate rehabilitation* early rehabilitation* delayed rehabilitation* late rehabilitation* post-acute rehabilitation*
Patient Outcomes	Patient Outcome Assessment Activities of Daily Living Quality of Life Health Status Indicators	

Note: MeSH is the U.S. National Library of Medicine's controlled vocabulary used for indexing articles for MEDLINE/PubMed. MeSH terminology provides a consistent way to retrieve information that may use different terminology for the same concepts.

*Denotes that the exact phrase as typed, including the specific order of words was searched.

MeSH - medical subject heading search terms.

These terms were combined with the following general keywords related to the time of the rehabilitation therapy onset: immediate rehabilitation, early rehabilitation, delayed rehabilitation, late rehabilitation, and post-acute rehabilitation. While MeSH terms are crucial, using keywords alongside MeSH terms can enhance search results. The full search strategy for the different elements for PubMed was:

(("Stroke"[Mesh] OR "Brain Ischemia"[Mesh] OR "Intracranial Hemorrhages"[Mesh] OR "Cerebral Hemorrhage"[Mesh]) AND ("Neurological Rehabilitation"[Mesh] OR "Motor Activity" [Mesh]

OR "Exercise Therapy"[Mesh] OR "Physical Therapy Modalities"[Mesh]) AND ("early initiation" OR timing OR "delayed rehabilitation" OR "immediate rehabilitation" OR "early rehabilitation" OR "late rehabilitation" OR "post-acute rehabilitation"))

The following inclusion criteria were adopted: clinical trials on adult patients (over 19 years); articles published in the English language; available full-text paper for analysis. As exclusion criteria: studies that used other types of non-conventional therapeutic approaches, and studies that did not aim to compare the timing of the onset of post-stroke motor rehabilitation.

The quality assessment of the selected studies was performed using the Cochrane Risk of Bias tool [5].

Results

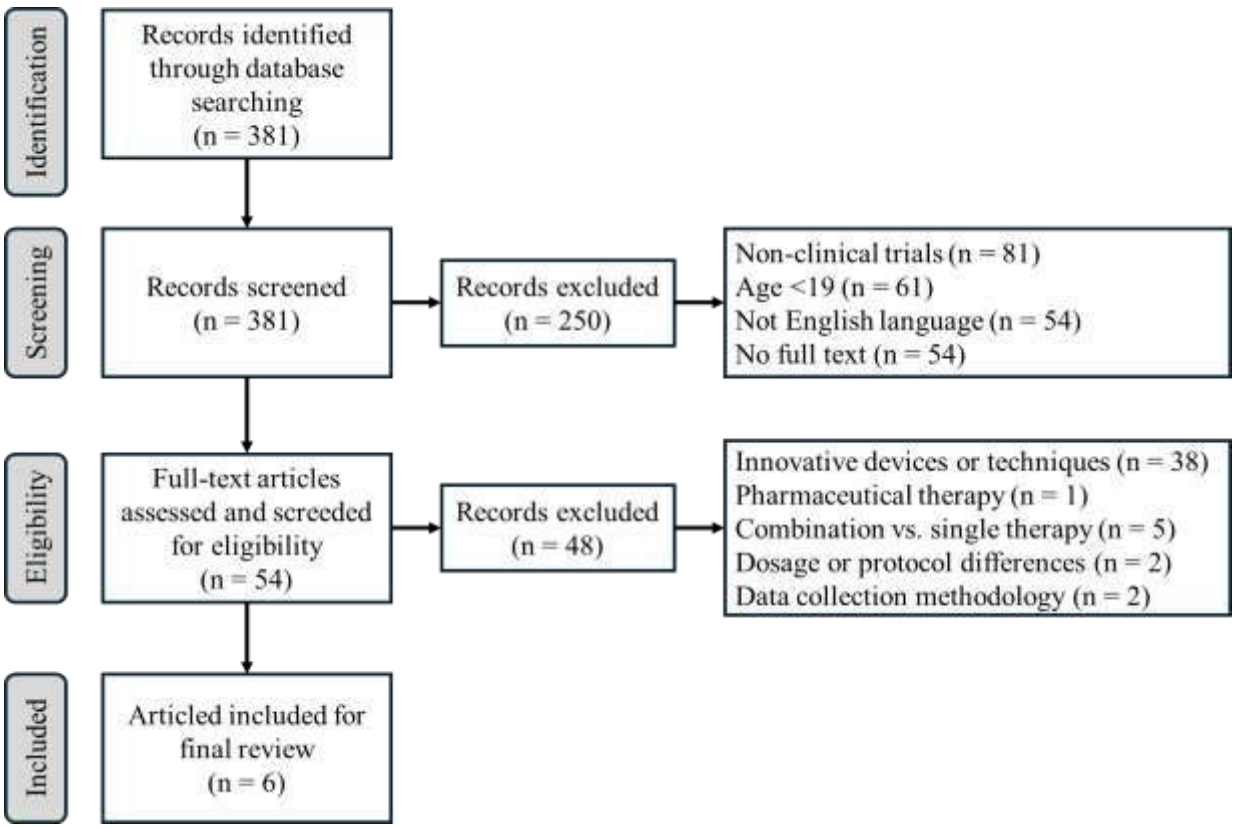

Figure 1. Flowchart of studies through the review

Figure 1 shows the study selection process. Finally, 54 studies were included in the full-text qualitative analysis, of which only 6 were found relevant to the subject of this review.

Six studies were included involving comparisons between different timing of motor rehabilitation onset after a stroke. A comprehensive summary of the characteristics of the studies can be found in **Table 2**. The findings reported in three papers by Bernhardt et al. [6], and Cumming et al. [7, 8], are part of the AVERT (A Very Early Rehabilitation Trial) study, a large-scale investigation focused on the effects of early mobilization after stroke. These three papers utilize data from the AVERT trial, which involved multiple centers and a significant number of participants, but the two papers focus on different outcomes. The publication by Cumming et al. (2019) [8] is generally more comprehensive and informative in terms of the broader impact of early mobilization. It covers a wider range of outcomes related to quality of life, which encompasses not only cognitive aspects but also physical and emotional well-being. Cumming et al. (2018) [7] provide detailed insights into cognitive outcomes, which are crucial for understanding specific neurological impacts. does not repeat the

Table 2. Overview of the included articles.

Author and year	Cochrane risk of bias conclusion	Trial groups (subjects per group)	Time of therapy onset after a stroke event	Intervention by study groups	Difference of the results of ther between the trial groups
Bernhardt et al., 2016 [6]	Physical activity correlated with better functional recovery in stroke patients.	Early Rehabilitation (1,054), Control (1,050)	Early: < 24 hours Control: > 24 hours	Early: very early mobilization that began within 24 hours of stroke onset, focused on out-of-bed activity, and resulted in at least 3 additional out-of-bed sessions compared to usual care. Control: standard stroke unit care.	Early mobilization was associate reduced odds of a good outcome increased odds of a favorable out months, after adjusting for age ar severity.
Cumming et al., 2018 [7]	Low risk of bias; well-conducted with sufficient blinding.	Early Mobilization (1,054), Control (1,050)	Early: < 24 hours Control: > 24 hours	Early: very early mobilization that began within 24 hours of stroke onset, focused on out-of-bed activity, and resulted in at least 3 additional out-of-bed sessions compared to usual care. Control: standard stroke unit care.	Early mobilization did not show improvements in cognitive outco compared to standard care.
Cumming et al., 2019 [8]	Low risk of bias; consistent findings and good control measures.	Early Mobilization (1,054), Control (1,050)	Early: < 24 hours Control: >24 hours	Early: very early mobilization that began within 24 hours of stroke onset, focused on out-of-bed activity, and resulted in at least 3 additional out-of-bed sessions compared to usual care. Control: standard stroke unit care.	Earlier and more frequent mobili not influence quality of life over year. No significant difference in funct outcomes compared to standard c
Liu et al., 2014 [9]	Low risk of bias; thorough randomization and blinding.	Early Rehab (20), Control (20)	Early: < 2 days. Control: 7 days.	Both groups: exercises of daily living, stretching exercises, neuromuscular electric stimulation, functional training (repetitive and systematic practice of tasks, such as stirring, grasping, and pointing)	The early intervention group had significantly better survival rates of life, functional independence, anxiety at 6 months compared to standard care group.
Liu et al., 2021 [10]	Low risk of bias; consistent outcomes and good control measures.	Early Rehab (42), Control (42)	Early: <3 days Control: 3-7 days.	Both groups: Bobath techniques, brain circulation therapy, and EMG biofeedback.	Early rehabilitation significantly neurological function, activities o living, and motor function compa control group. Same results after for confounding factors.
Manuela et al., 2016 [11]	Low risk of bias; well-structured and adequately controlled.	Early (120 – PNF, 120 – CTE, 240 in total), Control (60 – PNF, 60 – CTE, 120 in total)	Early: < 24 hours. Control: 4 days.	PNF: proximal joint passive/active mobilization and postural alignment and positioning, daily. CTE: guided passive/active movements during attention tasks and postural alignment and positioning, daily.	Early rehabilitation, whether thro or CTE, led to better long-term o at 12 months compared to delaye rehabilitation.

PNF - Proprioceptive Neuromuscular Facilitation [12]; CTE - and Cognitive Therapeutic Exercise [13].

results of the two Cumming et al. Papers [7, 8]. The paper by Bernhardt et al.[6] focuses on a dose-response analysis of early rehabilitation interventions in stroke patients, investigating the relationship between the intensity of early mobilization and patient outcomes. Therefore, we decided to include all these three papers in this review.

Discussion

Early studies have consistently demonstrated that the timing of post-stroke motor rehabilitation significantly influences recovery outcomes [14, 15, 16]. Consequently, the timing of rehabilitation initiation remains a pivotal factor in stroke recovery protocols.

The early onset of motor post-stroke rehabilitation remains a controversial issue due to a combination of medical, logistical, and patient-specific factors that complicate its universal application. The AVERT trial indicated potential harm from very early mobilization (<24 hours), suggesting a cautious approach is necessary immediately after stroke [17, 18]. Animal studies have shown that very early and intense training may lead to increased histological damage, further complicating the timing issue [19]. Additionally, the CPASS trial highlighted that while subacute phase rehabilitation (2-3 months post-stroke) showed the most significant improvements, acute phase rehabilitation (≤30 days) also provided benefits, albeit smaller [20].

We intended to review the randomized control trials performed and reported during the last decade.

Summary of Findings

Based on the analysis of the selected studies, the best timing for the onset of post-stroke rehabilitation is as early as possible, but with certain precautions. Nevertheless, in some trials earlier rehabilitation onset did not bring significantly better outcomes. Bernhardt et al. [6] suggest a dose-response relationship indicating the benefits of early rehabilitation, while Liu et al. [10] find that intervention in the very early phase (within 24 hours) can improve outcomes in patients with acute ischemic stroke, provided that they are medically stable.

Both papers by Cumming et al. [9, 10] investigated the impact of early mobilization following a stroke and found that initiating therapy early does not yield significant cognitive or quality-of-life benefits. One of the studies [7] study indicated that early mobilization did not improve cognitive outcomes, suggesting that starting therapy soon after a stroke does not affect memory, attention, or executive function recovery. Similarly, the other study [10] found that early mobilization had limited influence on overall quality of life, including physical, emotional, and social well-being. These findings suggest that while early mobilization is safe, it does not necessarily lead to better recovery outcomes in the immediate post-stroke phase. Therefore, the timing of therapy onset alone may not be a critical factor in determining the effectiveness of rehabilitation interventions post-stroke.

Morreale et al. [11] further emphasize that both early and delayed rehabilitation have their merits, but early treatment can lead to better functional recovery if tailored to the patient's cognitive and proprioceptive needs. Thus, early rehabilitation initiation, ideally within 24-48 hours, is recommended for optimal recovery, if it is adapted to each patient's medical and physical condition to ensure safety and effectiveness.

Protocols and guidance for rehabilitation onset timing

The standard of care for the timing of motor rehabilitation after stroke onset varies slightly across different regions, but there is a consensus on early initiation once the patient is medically stable.

The U.S. Department of Veterans Affairs and the U.S. Department of Defense recommend initiating rehabilitation as soon as the patient is medically stable, emphasizing the importance of early mobilization to improve outcomes [21]. This is supported by the American Heart Association and the American Stroke Association, which also advocate for early mobilization within 24-48 hours post-stroke, to reduce complications such as pneumonia, deep vein thrombosis, and pressure sores [22-24] In Europe, guidelines generally recommend starting motor rehabilitation early, typically within the first 24-48 hours post-stroke, provided the patient is medically stable. This approach is supported by the European Stroke Organization (ESO), which emphasizes early mobilization to improve functional outcomes and reduce complications [25], yet, the exact definition of "early" remains debated [26].

The Chinese Stroke Association guidelines suggest that early rehabilitation should generally be performed within the first month after stroke onset, with a recommendation to start within the first two weeks for optimal outcomes [27].

The recommendation that mobilization should start within the first 24 hours if the patient is hemodynamically stable is adopted in Brazil [28].

However, a cross-sectional survey among Indian physiotherapists involved in stroke rehabilitation offers some insights. According to the survey, most Indian physiotherapists (55%) reported initiating gait training within seven days after stroke onset [29].

In summary, the standard of care across various countries generally supports early initiation of stroke rehabilitation within 24-48 hours post-stroke, avoiding very early intensive mobilization within the first 24 hours.

Remaining controversies

The risks of initiating motor rehabilitation too early after a stroke, particularly within the first 24 hours, have been highlighted by several studies, most notably the AVERT trial. The AVERT trial

demonstrated that very early mobilization (VEM) within 24 hours post-stroke was associated with increased mortality and reduced odds of favorable outcomes at three months compared to usual care [30]. There was also a higher incidence of stroke progression and exacerbation of neurological deficits in patients who underwent very early mobilization [30]. Mobilizing patients too early can lead to significant drops in blood pressure upon achieving an upright position, which can be detrimental, especially in patients with unstable cardiovascular status [28].

The Brazilian Academy of Neurology guidelines also caution against early rehabilitation in patients with unstable medical conditions, such as unstable coronary conditions, severe hypertension, or significant drops in blood pressure upon mobilization [28].

Despite the widely accepted view that initiating motor rehabilitation within the first few days following stroke onset is preferable, there remain some contentious perspectives supported by clinical evidence.

Thus, Coleman et al. noted that for certain deficits, such as upper extremity function, interventions like constraint-induced movement therapy within two weeks can be beneficial [18].

The CPASS trial demonstrated that task-specific motor therapy initiated in the subacute phase (2-3 months post-stroke) resulted in significant improvements in upper extremity motor function compared to controls, suggesting a sensitive period for motor recovery [31]. This finding is supported by Edwardson et al., who argue for continuous and cumulative motor therapy during the acute and subacute phases [20]. Edwardson et al. did not propose to delay the rehabilitation onset, but emphasized the importance of continuous and cumulative motor therapy during both the acute and subacute phases, suggesting that the benefits observed in the subacute phase are likely due to the combined effects of early and ongoing rehabilitation efforts.

Additionally, a study by Duret et al. found that high-intensity robot-assisted training during the subacute phase led to significant improvements in motor performance, particularly in patients with severe impairments [32]. This indicates that even patients with more severe deficits can benefit from intensive rehabilitation during this period.

Motor rehabilitation initiated in the chronic phase of stroke, defined as beginning six months or more after the stroke event, can still be beneficial, although the degree of improvement may be less pronounced compared to earlier phases.

Several studies have demonstrated that significant motor recovery is possible even in the chronic phase. For instance, Teasell et al. conducted a comprehensive review of randomized controlled trials (RCTs) and found robust evidence supporting the efficacy of various rehabilitation interventions in chronic stroke patients. The majority of these RCTs demonstrated significant positive benefits in motor recovery, underscoring the potential for meaningful improvements even when therapy is initiated in the chronic phase [33]. Ballester et al. also highlighted that improvements in body function and structure are possible even at late chronic stages, extending beyond the traditionally accepted critical window of 3-6 months post-stroke. This study suggests a gradient of enhanced sensitivity to treatment that extends far beyond 12 months post-stroke [34]. While delayed rehabilitation can still yield benefits, the extent of recovery is generally less compared to early interventions.

Individual variability

The variability in patient responses and the complexity of stroke pathology add to the controversy, as not all patients may benefit equally from early intervention [18]. The variation in stroke severity and comorbid conditions among patients means that what is beneficial for one patient may not be appropriate for another, necessitating a more individualized approach to rehabilitation timing. The risk of increased fatigue and the possibility of overwhelming patients and their caregivers with early, intensive rehabilitation is a significant concern. Moreover, practical challenges in implementing high-intensity early rehabilitation and the need for individualized treatment plans

complicate the issue [35]. The mixed evidence for different rehabilitation strategies, such as constraint-induced movement therapy and non-invasive brain stimulation, further adds to the debate [18]. Finally, the need for standardized protocols and longer-term follow-up in clinical trials is emphasized to optimize recovery potential and address these controversies [17].

Age is another critical factor in the timing of rehabilitation. Huggins et al. demonstrated that younger adults (18-50 years) with stroke often present later to medical attention and have lower initial NIHSS scores compared to older adults (>50 years) [36]. This delay can impact the timing of rehabilitation initiation and subsequent outcomes.

In summary, the timing of post-stroke rehabilitation should be individualized for each patient due to the patient's individual characteristics and significant variability in stroke severity, comorbidities, and recovery rates. A tailored approach will help balance early intervention's potential benefits with the risks, ensuring more effective and safer rehabilitation outcomes.

Conclusions

The latest publications prove the safety and benefits of early onset of post-stroke motor rehabilitation, while immediate post-stroke rehabilitation does not necessarily lead to better recovery outcomes. The optimal timing and intensity remain subjects of ongoing research and debate. An individually tailored approach to the definition of the optimal timing of motor rehabilitation onset is essential for safe and efficient functional recovery and for providing long-term benefits for stroke survivors.

Conflict of Interest disclaimer

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author's contribution

The author (MB) solely contributed to this publication, including the concept, methodology, drafting, and writing.

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