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Mini Review

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Rehabilitation outcomes in elderly stroke patients aged 85 and above

Abstract

Background: Intensive inpatient rehabilitation is well known to have positive impacts on functional recovery of patients who sustained stroke. However, there is limited understanding of its effectiveness in elderly patients, particularly those over 85. This entity faces unique challenges due to age-related factors and potential exclusion from intensive rehabilitation. Therefore, a comprehensive understanding of how rehabilitation impacts elderly patients is required.

Methods: In order to consolidate current understanding regarding the effectiveness of stroke rehabilitation in the oldest-old (85+) patients, a literature search was conducted to gather all available evidence studying rehabilitation outcome measures in the over-85 age group.

Results: A limited number of literatures addressed the impact of stroke rehabilitation on the oldest-old group of patients. Outcome measures used to assess the effectiveness of inpatient rehabilitation included Functional Independence Measure (FIM), Barthel Index (BI), Rivermead Mobility Index (RMI) and Dysphagia Outcome and Severity Score (DOSS). These measures collectively showed significant improvement in function at discharge compared to admission across all age group. A general trend of reduced functional gain in the older age group was observed, although the statistical significance of the difference between younger and older patients varied.

Conclusion: Although the effectiveness of stroke rehabilitation is reduced in patients aged over 85, the functional gains achieved by these patients remains invaluable across all age groups. Therefore, stroke rehabilitation should be provided to the oldest-old patients without discrimination.

Keywords: stroke, cerebrovascular accident, inpatient rehabilitation, oldest old patients, over 85 years

Volume 8 Issue 2 - 2025

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Received: June 20, 2025 | **Published:** July 14, 2025

Introduction

Stroke is a debilitating disease affecting many patients globally, often leaving profound functional impairments in its wake. Over the years, extensive research and development have been dedicated to understanding and improving the rehabilitation of those patients who have suffered stroke, which have led to advancements in various rehabilitation approaches involving multidisciplinary inputs. Despite these strides, there remains a significant gap in our knowledge on the impact of stroke rehabilitation on elderly patients, particularly those over the age of 85.[1] The oldest-old stroke patients are significant stakeholders in stroke care, representing 33.9% of all stroke cases.[2] Additionally, 30% of those stroke patients over the age of 85 require long-term institutional care.[2] This demographic presents unique challenges due to age-related physiological changes, comorbidities, and potential cognitive decline.[1] Due to the perceived minimal improvement post stroke rehabilitation, there have been concerns raised about whether the oldest-old patients face risk of exclusion from intensive stroke rehabilitation care due to age discrimination.[3] There has been an association of oldest-old age with high probability of not accessing post-acute rehabilitation, and it was also found that oldest-old age is an independent predictor of exclusion from early mobilization.[3] However, only scarce data exist on the effectiveness of rehabilitation interventions specifically tailored to this population, making it challenging to determine if rehabilitation is comparably ineffective for them. Addressing this gap in knowledge is crucial to explore the effectiveness of rehabilitation for this age group, which will help optimize stroke rehabilitation care and preserve the quality of life for elderly stroke survivors.

This literature review aims to collate the current understanding of intensive inpatient stroke rehabilitation outcomes for patients over the age of 85. The review will focus on studies examining functional gains in aspects of motor skills, cognition, activities of daily living (ADL), and swallowing. Each of these areas plays a crucial role in the overall well-being and quality of life for stroke survivors. By exploring these specific domains, we aim to understand the effectiveness of rehabilitation interventions in addressing the diverse needs of elderly stroke patients, and provide recommendations on how stroke rehabilitation should be approached in this age group.

Methods

Inclusion and exclusion criteria

Stroke

This review includes strokes of all types, whether ischemic or haemorrhagic, and considers both first-time and recurrent events. Moreover, strokes of all locations are included.

Rehabilitation

This review focuses on conventional stroke rehabilitation care provided in hospitals, specifically intensive inpatient rehabilitation involving a multidisciplinary team. It excludes virtual rehabilitation, robotic rehabilitation, home-based rehabilitation and telerehabilitation.

Research papers that focus on stroke treatment or medication trials during rehabilitation were not included.

Patient population

Studies focusing on elderly patients, particularly those over the age of 85, were initially targeted. However, due to the limited availability of relevant journals, the inclusion age was adjusted to 80 years old. Journals that included a mixed population of adults as well as elderly patients were also included, provided they offered specific distinctions in the data among the different age groups.

Outcome measures

Articles that provided distinctive outcome measures of rehabilitation program at both admission and discharge were included. Outcomes of stroke rehabilitation were searched with lenses of all functional changes, including mobility, cognition, independence in ADL, and swallowing ability. Outcome measures of all types were studied, including Functional Independence Measure (FIM), Barthel Index (BI), Rivermead Mobility Index (RMI) and Dysphagia Outcome and Severity Score (DOSS).

Search strategy and review procedure

A literature review of journals written in English and published up to May 2024 was conducted. All types of journal articles were considered, including observational cohort studies (both prospective and retrospective), randomized controlled trials, and cross-sectional studies. The databases of PubMed, CINAHL, and Medline were searched using combinations of keywords, synonyms, and closely related terms including "rehabilitation," "stroke," and "oldest old OR over 85." Broad search terms encompassing all aspects of rehabilitation outcomes were used for the database search due to the limited amount of literature available with stricter search terms. The electronic search strategy yielded 506 journals from PubMed, 270 from CINAHL and 693 from Medline, comprising a total of 1469 articles. 44 duplicate articles were removed from the total, resulting in 1,425 articles. The first step in the selection was based on the title and the abstract, yielding 162 papers. The second step was on the full text screening according to the selection criteria. 124 articles were excluded since they provided inpatient rehabilitation outcomes but either did not study the specific age group of participants or did not include patients over the age of 80. Total of 27 papers were excluded as they studied the targeted elderly groups however did not provide outcome measures from inpatient rehabilitation programs. Full texts were not available for 2 articles. This process of exclusion yielded a final selection of 10 journals for review (Figure 1).

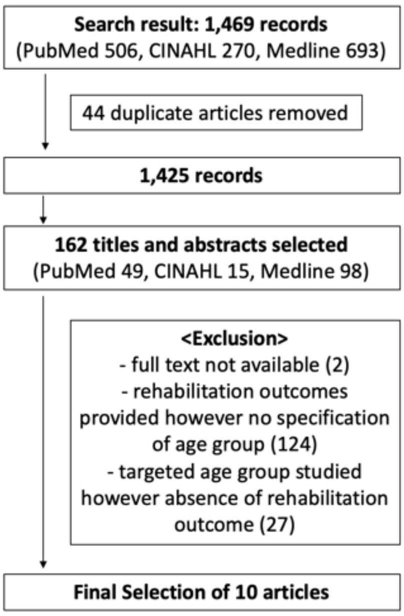

Figure 1 Review procedure.

Results

Functional Independence Measure (FIM)

The Functional Independence Measure (FIM) is one of the most commonly used methods for evaluating function recovery after stroke. The FIM includes both motor and cognition components, providing a comprehensive assessment of overall function. A number of papers have used FIM as a marker of functional gain following stroke rehabilitation. Table 1 demonstrates the various ways FIM scores were used to study rehabilitation outcomes across different age groups. The efficacy of FIM in stroke rehabilitation has been investigated in studies such as Zucchella et al.[6] and Lieberman et al.[7] These studies calculated efficacy by dividing the change in FIM score by the number of rehabilitation days. Montebello Rehabilitation Factor Score (MRFS), explored in Mutai et al.,[8] is calculated by (Discharge FIM – Admission FIM) ÷ (maximum FIM – Admission FIM). Absolute efficacy of rehabilitation is derived by converting the MRFS to a percentage. The use of MRFS and absolute efficacy values address the ceiling effect, since they account for the limited gain capacity of patients with initially high FIM scores compared to those with low admission FIM scores. Consequently, they provide a fairer comparison of recovery rates across different patient groups. The five journals collectively found that total FIM scores increase significantly after rehabilitation, across all age groups. However, there is a notable decrease in both FIM gain and the absolute efficacy of rehabilitation as the age of the group increases. Statistically significant decreases were reported in the studies by Zucchella et al.[6] and Mutai et al.[8] whereas

Citation: Yoo J, Lan L. Rehabilitation outcomes in elderly stroke patients aged 85 and above. *Hos Pal Med Int Jnl.* 2025;8(2):44‒49.
DOI: 10.15406/hpmij.2025.08.00270

Lieberman et al.[7] showed statistically insignificant result. Statistical comparisons across age groups were not provided by Kimura et al.[4] and O'Brien et al.[5] These findings suggest that patients over the age of 85 indifferently benefit from rehabilitation and show increased FIM scores post-rehabilitation. However, the efficacy of functional recovery in older patients shows varying statistical difference compared to younger age groups.

Table 1 Literatures that used Functional Independence Measure (FIM) as an outcome measure of inpatient rehabilitation

	Age groups (n)	FIM on admission			FIM at discharge	FIM gain	FIM efficacy*	Absolute efficacy of rehabilitation**/ MRFS***
		Total	Motor	Cognition				
Kimura et al.,[4] (n= 1,186)	≤ 59 (297)	72.3	49.3	23	116	38.6	-	-
	60-69 (273)	68.1	45.4	23	111	32.8	-	-
	70-79 (343)	69.1	45.7	25	107	29.7	-	-
	≥ 80 (273)	61.4	40.4	21	95	25.4	-	-
O'Brien et al.,[5] (n= 71,652)	85-89 (51,876)	-	-	-	-	20.8	-	-
	90-94 (16,838)	-	-	-	-	20.3	-	-
	95-99 (2,722)	-	-	-	-	17.9	-	-
	≥ 100 (216)	-	-	-	-	17.2	-	-
Zucchella et al.,[6] (n= 402)	65-74.9 (145)	36.3	-	-	70.8	34.5	0.7	40.9**
	75-84.9 (206)	30.5	-	-	59.1	27.9	0.5	30.7**
	> 85 (51)	25.3	-	-	42.2	16.4	0.3	17.7**
Lieberman et al.,[7] (n= 265)	75-84 (220)	66	-	-	77	11	0.59	20.8**
	85+ (45)	64	-	-	72	8	0.44	15.5**
Mutai et al.,[8] (n= 461)	65-74 (136)	79 +	47.5+	29+	103.5 +	-	-	0.44+,***
	75-84 (174)	48.5 +	28.5+	21.5+	74 +	-	-	0.21+,***
	≥ 85 (151)	34 +	18+	14+	45 +	-	-	0.08+,***

* FIM efficacy = (Discharge FIM – Admission FIM) ÷ number of days of rehabilitation

** Absolute Efficacy of rehabilitation (Discharge FIM – Admission FIM) ÷ (maximum FIM – Admission FIM) × 100)

*** MRFS = Montebello Rehabilitation Factor Score, (Change in FIM ÷ (maximum FIM – Admission FIM))

\+ Median values

"-" represents N/A

When comparing the older adult group (75-84) and the oldest-old group (85+) in Lieberman et al.,[7] a consistent trend was observed where the oldest-old group had lower values in FIM gain, FIM efficacy, and absolute efficacy of rehabilitation compared to the younger elderly group. However, these differences were not statistically significant. The Lieberman et al.[7] interpreted this result that stroke patients over the age of 85, when carefully selected for rehabilitation, can achieve improvements comparable to those aged 75-84. In addition to studying FIM score changes, Mutai et al.[8] studied factors associated with the rehabilitation efficiency in different age groups. They found that for patients over 85, non-paretic limb function and cognitive FIM were key factors influencing rehabilitation efficiency. O'Brien et al.[5] also identified factors associated with increased discharge FIM scores, including longer length of stay (LOS), higher admission FIM scores and being aged 85-89 or 90-94. Conversely, an increasing number of comorbidities and complications were associated with decreased discharge FIM scores.[5] In consideration of possible alteration in rehabilitation design for older groups of patients, Kimura et al.[4] conducted a retrospective multicenter study on how rehabilitation therapy duration affects functional recovery in patients with sub-acute stroke stratified by age group. Participants in the study received an average of approximately 140 minutes of daily multidisciplinary rehabilitation therapy. Pearson's correlation coefficients indicated moderate correlation for age groups 70-79 ($r=0.328$) and over 80 ($r=0.378$), but no correlation for the 60-69 and under 59 groups. Multivariate regression analysis also showed that Beta (β) coefficients representing FIM gain per 10-minute increase in rehabilitation therapy were statistically significant ($p < 0.001$) for the 70-79 and over 80 groups, further indicating a positive relationship between therapy duration and functional improvement in these age groups. This suggested that increasing the duration of rehabilitation sessions for patients over 70 may lead to improved functional outcomes.

However, this study also noted that, despite the correlation between therapy duration and FIM gain, the percentage of FIM gain achieved through extended rehabilitation is limited in older patients compared to younger ones. This was attributed to age-related factors such as decreased physiological reserves, lower physical activity levels, cognitive decline, and reduced neuroplasticity, which collectively lead to slower functional recovery. As a result, older patients inherently require more rehabilitation to restore basic motor functions and improve daily activities. The lack of statistical impact in younger age groups could be explained by the ceiling effect, where younger patients with better physiological reserves and neuroplasticity may achieve spontaneous recovery independently of rehabilitation duration. The 140-minutes of therapy may already be sufficient for younger patients, with additional therapy not showing measurable FIM improvements, though the extra rehabilitation might enhance advanced functional performance not captured by the FIM.

Barthel Index (BI) and Rivermead Mobility Index (RMI)

Other studies have assessed the effectiveness of rehabilitation on functional recovery using the Barthel Index (BI) (Table 2). BI serves as a tool for assessing patient's ability to independently complete activities of daily living, with higher value representing

DOI: 10.15406/hpmij.2025.08.00270

increased independency. Kugler et al.[9] observed that age is a poor predictor of functional recovery, since despite of BI gains decreasing with increasing age, the clinical relevance was minor. Instead, initial disability was identified to be a more significant factor. This suggests that age should not be considered a limiting factor in stroke rehabilitation. In Paolucci et al.,[10] similar trend was found with study of BI across five age groups, showing decreasing BI efficiency and effectiveness as age group increases. They equally confirmed that age has unfavorable influence on functional outcome, however suggested that inpatient rehabilitation remains substantially effective for the very old patients although at lesser degree. In Paolucci et al.,[10] mobility at both admission and discharge was also evaluated, using the Rivermead Mobility Index (RMI) (Table 3). The RMI assesses functional mobility in stroke patients, focusing on gait, balance and transfers. The data were matched for severity of stroke measured by Canadian Neurological Scale (CNS) and onset-admission interval. It was found that the increasing age was associated with poorer rehabilitative results, evidenced by significantly lower RMI efficiency and effectiveness. Logistic regression analysis further showed that, >85 years group had nearly six times risk of a poor therapeutic response on mobility.

Table 2 Literatures that used Barthel Index (BI) as an outcome measure of inpatient rehabilitation

	Age groups (n)	Pre-stroke BI	BI within 24h after admission	BI after one week	BI at discharge	BI gain since admission to discharge	BI efficiency*	BI Effectiveness*
Kugler et al.,[9] (n= 3,102)	< 45 (163)	-	67	81	88	72	-	-
	45-54 (269)	-	66	81	85	63	-	-
	55-64 (689)	-	65	76	81	59	-	-
	65-74 (928)	-	65	74	79	53	-	-
	75-84 (827)	-	57	68	73	47	-	-
	> 84 (226)	-	49	60	65	42	-	-
Paolucci et al.,[10] (n= 150)	≤ 50	100.00	46.17	-	87.41	-	0.51	73.72
	51-64	100.00	42.00	-	77.50	-	0.45	68.39
	65-74	99.83	33.83	-	62.93	-	0.28	47.57
	75-84	99.50	25.67	-	55.58	-	0.38	46.79
	≥ 85	99.33	19.67	-	38.08	-	0.23	27.96

BI = Barthel Index

* BI efficiency = (Discharge BI – Admission BI) ÷ number of days of rehabilitation

** BI Effectiveness = (Discharge BI – Admission BI) ÷ (maximum BI – initial BI) × 100

“-“ represents N/A

Dysphagia outcome and severity score

Dysphagia is a common consequence of stroke, affecting up to two-thirds of stroke patients.[11] It is an important marker of stroke rehabilitation, since untreated dysphagia can significantly increase the risk of dehydration, malnutrition and aspiration pneumonia, posing a risk to overall recovery from stroke.[11,12] Given that older patients already have a baseline disadvantage with dysphagia prior to stroke rehabilitation, the rehabilitative outcomes of post-stroke dysphagia in the oldest-old patients are particularly important. In Castagna et al.[13] stroke patients with dysphagia were divided into two age groups: old (≥ 65 years and < 85 years) and oldest-old (≥ 85 years). The study evaluated the improvement in the Dysphagia Outcome and Severity Score (DOSS) from admission to discharge. The DOSS quantifies the severity of dysphagia on a scale from 1 to 7, with 1 representing severe dysphagia and 7 representing no dysphagia. Scores of 5 or below are considered indicative of dysphagia. Overall, both groups showed significant benefit from rehabilitation (P=0.002). However, the oldest-old patients (≥ 85 years) had a smaller degree of recovery (0.4 ± 1.3) compared to the old group (≥ 65 and < 85 years), with an improvement of 1.0 ± 1.5. Furthermore, a multiple regression model fitting DOSS improvement at discharge with functional measurements (FIM, Norton scores, and Modified Barthel Index) revealed that there was greater functional variation in the oldest-old group compared to the old group. Overall, this study demonstrated significant dysphagia improvement in both old and oldest-old age group, while the degree of improvement was smaller in patients over 85 years old.

Table 3 Literature that used Rivermead Mobility Index (RMI) as an outcome measure of inpatient rehabilitation

	Age groups	Pre-stroke RMI	Admission RMI	Discharge RMI	RMI efficiency	RMI Effectiveness
Paolucci et al.,[10] (n= 150)	≤ 50	15.00	4.17	11.62	0.10	64.85
	51-64	15.00	3.90	9.53	0.08	56.06
	65-74	14.93	2.87	7.45	0.05	40.76
	75-84	14.90	1.97	5.96	0.06	32.26
	≥ 85	14.03	1.93	4.19	0.03	18.64

RMI= Rivermead Mobility Index

* RMI efficiency = (Discharge RMI – Admission RMI) ÷ number of days of rehabilitation

** RMI Effectiveness = (Discharge RMI – Admission RMI) ÷ (maximum RMI – initial RMI) × 100

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DOI: 10.15406/hpmij.2025.08.00270

Discussion

Previous evidence points to the advancing age-related challenges in rehabilitation, such as reduced neuroplasticity affecting motor and cognitive relearning,[14] higher comorbidities and frailty impacting tolerance and response to therapy[15] and decreased physical endurance and recovery due to diminished cardiorespiratory competence and musculoskeletal durability.[16] Although these challenges can attenuate the rate of rehabilitation, emerging evidence demonstrates that rehabilitation remains effective in older populations, especially when interventions are tailored adequately. Previous study on neuroplasticity in older adults suggests that the brain retains some capacity for relearning and functional adaptation even in later life.[17] Rehabilitation efficacy remains sturdy even in individuals aged 80 years, particularly in structured programs.[18] Cognitive and motor training can lead to meaningful improvement in post-stroke elderly.[19] Therefore, increasing age may reduce but does not eliminate the potential for rehabilitation. This is supported by the growing emphasis on personalized rehabilitation approaches and evidence-based strategies, such as graded exercise, cognitive-motor integration, and person-centred care planning, which consider age as one of many factors but not a barrier.[20,21]

Across the reviewed journals, a consistent finding emerges that stroke patients undergoing intensive inpatient rehabilitation experience notable improvements in various aspects of function, including mobility, cognition, activities of daily living (ADL), and swallowing function, regardless of age. However, a recurring trend observed in all studies is the association between increasing age and decreased rehabilitation efficiency. This result seems inevitable, since the recovery in older adults is unavoidably restricted by age-related comorbidities, complications, and neuropsychological impairments.[4] Although this association may not always reach statistical significance in every study, some researchers interpret the lack of statistical difference across age as evidence to suggest that age does not necessarily dictate less effective rehabilitation outcomes. Nonetheless, the overarching conclusion remains clear that intensive inpatient rehabilitation can lead to meaningful enhancements in functional abilities for stroke patients, underscoring the importance of tailored rehabilitation strategies regardless of age. Furthermore, Kimura et al.[4] found that providing longer duration of daily rehabilitation therapy was associated with better functional recovery in individuals aged 70-79 and those over 80, while that association was not observed in the younger age groups below 70. This suggested that increasing the length of stroke rehabilitation session in aged group of population may lead to improved function outcomes among older stroke patients. While providing extra rehabilitation duration for elderly patients to account for baseline physical regression could strain the sustainability of rehabilitation programs; balancing the benefits of extended rehabilitation with the natural ageing process and limited life expectancy remains a significant challenge.

Limitations of the study

The most significant limitation in the literature review was the limited number of publications available specifically examining the effectiveness of stroke rehabilitation across difference age groups, which hindered comprehensive comparisons and detailed analysis. Other consequences of stroke, such as aphasia, require rehabilitation as well, however there is a lack of specific research on the rehabilitation outcomes for stroke patients over 85 years old with these conditions. Additionally, studies often fail to provide detailed specifications on outcomes, such as separately exploring motor and cognitive improvements instead of merging them in FIM studies. Within motor improvement studies, more precise specifications, such as examining balance or upper and lower limb mobility, would be beneficial. Additionally, the lack of distinction in the type and severity of stroke limits the specificity of our understanding of rehabilitation outcomes.

Conclusion

Elderly stroke often face complex rehabilitation needs thus tailored rehabilitation is essential for achieving functional gains. While increasing age leads to certain rehabilitation challenges and may reduce the potential for rehabilitation, it does not negate the capacity for functional recovery entirely. As the discussed studies highlighted, oldest-old patients over the age of 85 can still achieve significant improvements in functional outcomes with appropriate rehabilitation interventions. The evidence also suggests that tailored rehabilitation programs can lead to meaningful recovery, emphasising the importance of not limiting rehabilitation efforts based solely on a patient's age. While further large-scale research is needed to examine the capacity and sustainability of rehabilitation in elderly stoke patients, health professionals should embrace an individualized, evidence-informed approach to maximize outcomes in older stroke patients, recognizing that meaningful rehabilitation gains are achievable well into advanced age.

Acknowledgments

None.

Conflicts of interest

The authors declared that there are no conflicts of interest.

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DOI: 10.15406/hpmij.2025.08.00270

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