

Early Comprehensive Physiotherapy for Functional Recovery Following Acute Non-Hemorrhagic Stroke: A Case Report

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Abstract

Background: Hemiparesis after stroke can impair mobility, balance, and independence. Detailed reports of integrated physiotherapy management during early inpatient rehabilitation remain limited.

Objective: To describe comprehensive physiotherapy management and short-term clinical outcomes in a patient with right hemiparesis following acute non-hemorrhagic stroke.

Methods: This case report involved a 47-year-old man admitted one day after stroke onset. He received two approximately 45-minute physiotherapy sessions comprising infrared radiation, manual therapy, sensory re-education, proprioceptive neuromuscular facilitation, range-of-motion and strengthening exercises, balance and transfer activities, breathing exercises, and functional task practice. Outcomes were assessed using pain, muscle strength, balance, functional independence, stroke severity, anxiety, coordination, and neurological examinations.

Results: Sensory function partially improved. Pain on pressure decreased from 7 to 4 and pain on movement from 5 to 3. Hamilton Anxiety Rating Scale scores decreased from 30 to 26, while Barthel Index scores increased from 20 to 50. Muscle strength, balance, coordination, neurological severity, and pathological reflexes remained unchanged.

Conclusion: Two sessions of comprehensive physiotherapy were associated with short-term improvements in sensory function, pain, anxiety, and functional independence. Causal effectiveness cannot be established from a single case.

Keywords

Stroke; Hemiparesis; Physical Therapy Modalities; Stroke Rehabilitation; Neuronal Plasticity

Introduction

Stroke remains a major cause of mortality and long term disability worldwide and places a substantial burden on patients, families, and health systems. Global estimates indicate that millions of people experience a first stroke each year and that a very large population lives with persistent stroke related disability. The burden is particularly substantial in low and middle income settings, where limitations in access to rehabilitation may further affect recovery.¹

Non hemorrhagic stroke, commonly referred to as ischemic stroke, results from interruption of cerebral blood flow and subsequent tissue injury. The resulting neurological deficits vary according to lesion location and severity. Motor impairment is particularly common and may involve weakness, impaired selective movement, altered muscle tone, sensory disturbance, reduced postural control, and limitations in upper and lower limb function.²

These impairments can reduce independence in activities of daily living and may be accompanied by secondary consequences of immobility, including pain, reduced physical conditioning, joint stiffness, and difficulty participating in rehabilitation. Early assessment is therefore important for identifying impairments that can be addressed through individualized rehabilitation while maintaining patient safety during the acute phase.^{3,4}

Recovery after stroke is influenced by the capacity of the nervous system to adapt following injury. Neuroplasticity involves changes in the organization and responsiveness of neural networks, while motor learning is supported by repetitive, task specific, and meaningful practice. Rehabilitation interventions are therefore designed not only to address individual impairments but also to provide appropriate sensory, motor, and functional stimulation.^{5,6}

Physiotherapy is an important component of multidisciplinary stroke rehabilitation. Current clinical guidance supports early rehabilitation when the patient's medical status is sufficiently stable and recommends individualized intervention based on impairments, activity limitations, participation needs, and tolerance. A comprehensive program may combine range of motion exercises, strengthening, proprioceptive neuromuscular facilitation, balance training, transfer practice, sensory stimulation, breathing exercises, and task oriented activities according to the patient's clinical presentation.^{3,4,7}

Although evidence supports several individual rehabilitation approaches, clinical practice frequently requires several interventions to be integrated around the needs of a single patient. Detailed case reports can provide clinically useful descriptions of assessment, treatment selection, dosage, monitoring, and short term outcomes that are not always apparent from controlled trials. Such reports may also illustrate how multiple impairment domains are addressed simultaneously in routine inpatient rehabilitation.⁷

The present case was clinically relevant because the patient demonstrated right hemiparesis accompanied by sensory impairment, shoulder region pain, impaired balance, reduced functional independence, dysarthria, and anxiety during the acute stage of stroke.^{2,4-6} A comprehensive physiotherapy program was selected to address these problems within the patient's tolerance and safety limitations. This case report therefore aimed to describe the clinical characteristics, physiotherapy assessment, intervention process, clinical reasoning, and short term functional outcomes of early comprehensive physiotherapy in a patient with acute non hemorrhagic stroke.

Methods

This report used a single patient case report design and was prepared in accordance with the CARE reporting framework. The purpose was to describe the clinical presentation, physiotherapy management, and short term outcomes of a patient with right hemiparesis following acute non hemorrhagic stroke during inpatient rehabilitation at Dadi Regional General Hospital, Makassar, Indonesia.

The patient was a 47 year old man who was admitted to Dadi Regional General Hospital, Makassar, with right sided weakness and dysarthria following non hemorrhagic stroke. According to the clinical timeline, the patient had a history of hypertension and high blood sugar, experienced vertigo requiring a three day hospitalization at Hikmah Hospital on March 28, 2026, developed weakness and unclear pronunciation on April 13, 2026, and was taken to Dadi Regional General Hospital on April 14, 2026, where computed tomography was performed. The initial physiotherapy assessment and first treatment occurred on April 15, 2026, followed by a second treatment and follow up assessment on April 17, 2026.

The physiotherapy assessment included subjective and objective examination. Subjective information concerned right sided weakness and difficulty speaking. Objective examination included static and dynamic observation, palpation, orientation, functional movement analysis, sensory examination, range of motion, muscle strength, coordination, balance, functional independence, neurological status, anxiety, and pathological reflexes. Baseline vital signs were also recorded. Because dysarthria limited verbal communication, information documented in the subjective component of routine SOAP documentation was supplemented by a close family member.

Pain intensity was assessed with the Visual Analog Scale (VAS) during palpation and active movement. Superficial sensory function was assessed by comparing the affected and unaffected sides for temperature, touch, and pain sensation. Joint mobility was examined through passive and active range of motion. Muscle strength was assessed using Manual Muscle Testing (MMT). Deep tendon and pathological reflexes were examined as part of the neurological assessment. Coordination was assessed using finger to finger testing for the upper extremity and heel to knee testing for the lower extremity.

Neurological impairment was assessed using the National Institutes of Health Stroke Scale (NIHSS). Balance and postural control were assessed using the Berg Balance Scale (BBS), while functional independence was evaluated with the Barthel Index (BI). Anxiety was assessed using the Hamilton Anxiety Rating Scale (HARS). The selected standardized measures have established clinical utility in stroke assessment, and the source manuscript cited evidence supporting the psychometric properties of the BBS and BI as well as the clinical use of stroke scales.⁸⁻¹¹

The physiotherapy program integrated electrotherapy, manual therapy, sensory re education, and exercise therapy. Infrared radiation was administered at the beginning of each session at approximately 30 cm from the skin for 5 minutes per region over the right upper and lower extremities. Manual therapy included muscle release to the anterior deltoid and pectoralis major using approximately 30 to 40% pressure for 10 minutes to address tenderness and soft tissue tension. Manual Muscle Belly Tone Stimulation was applied to the right biceps muscle belly, and shoulder approximation was used to provide proprioceptive input and support joint stability.

Sensory re education was provided through light touch and moderate pressure stimulation to the affected upper and lower extremities for approximately 8 to 10 repetitions in each area. Exercise therapy included deep breathing with 2 seconds of inhalation, 1 second of breath holding, and 4 seconds of exhalation. Passive range of motion was used for the upper extremity, while active assisted range of motion and strengthening exercises were used for the lower extremity. Bridging was included to address trunk and proximal control. Proprioceptive neuromuscular facilitation was applied to the upper and lower extremities. Rolling, grasp training, and heel to knee coordination activities were incorporated to address bed mobility, upper limb function, activities of daily living, and lower limb coordination. Most exercise components were performed using eight counts per repetition and three repetitions per set, with dosage adjusted according to clinical response and tolerance.

Each treatment session lasted approximately 45 minutes, and treatment was provided on April 15 and April 17, 2026. The patient's clinical response was monitored through routine SOAP documentation and direct observation during treatment. Exercise tolerance, fatigue, clinical response, and ability to participate in each scheduled activity were monitored throughout both sessions. The patient was described as cooperative and highly adherent, with active participation in both scheduled treatment sessions. Intervention intensity and progression were adjusted according to general condition, tolerance, and response, and no treatment related adverse events were reported.

The clinical timeline is presented in Table 1. Quantitative and qualitative pre intervention and post intervention findings are presented in Table 2. The intervention protocol and dosage parameters are presented in Table 3.

Because this was a single case report, outcomes were analyzed descriptively by comparing pre intervention and post intervention findings. No inferential statistical analysis, effect size calculation, or hypothesis testing was performed.

Written informed consent was obtained from the patient, including consent for publication of anonymized clinical information. The source manuscript states that formal ethical approval was not required for this case report and that the procedures were conducted in accordance with principles of confidentiality, anonymity, and ethical clinical practice.

Results

At the initial assessment, vital signs were within the recorded normal range: blood pressure 125/80 mmHg, respiratory rate 18 breaths/min, pulse 78 beats/min, body temperature 36.6°C, and peripheral oxygen saturation 98%. The patient was observed lying in bed with an infusion in the left hand. The right side appeared weak, the right leg tended to fall outward, and the patient appeared anxious. He was able to move the left upper and lower extremities but was unable to speak clearly. Transfers, including turning to either side and moving from sitting, required assistance. Palpation identified tenderness over the right pectoralis major and anterior deltoid, accompanied by pain during movement of the right shoulder. Range of motion was limited in the right upper and lower extremities.

The patient's clinical course and treatment sequence are summarized in Table 1. The timeline shows the progression from the documented history of hypertension and high blood sugar, through the preceding vertigo episode, acute symptom onset, hospital admission, initial assessment, and the two physiotherapy sessions.

Table 1. Clinical timeline of the patient.

Date	Clinical event
January 2025	History of hypertension and high blood sugar
March 28, 2026	Vertigo and three day hospitalization at Hikmah Hospital
April 13, 2026	Weakness developed after teaching with unclear pronunciation
April 14, 2026	Admission to Dadi Regional General Hospital, Makassar; CT scan performed
April 15, 2026	Initial assessment and first physiotherapy session
April 17, 2026	Second physiotherapy session and follow up evaluation

The principal pre intervention and post intervention findings are presented in Table 2. The clearest changes occurred in sensory perception, pain, anxiety, and functional independence, whereas the recorded measures of muscle strength, coordination, balance, neurological severity, and pathological reflexes remained unchanged.

Table 2. Clinical outcomes before and after two physiotherapy sessions.

Problem	Parameter	Pre intervention	Post intervention
Sensory	Temperature, sharp/blunt, rough/smooth sensation	Absent sensation	Partial return of sensation
Pain	VAS	Pressure 7; movement 5	Pressure 4; movement 3
Muscle weakness	MMT	Shoulder 0; elbow 0; wrist 0; hip 3; knee 3; ankle 3	Shoulder 0; elbow 0; wrist 0; hip 3; knee 3; ankle 3
Coordination	Finger to finger and heel to knee	Slow but accurate	Slow but accurate
Anxiety	HARS	30	26
Stroke severity	NIHSS	12	12
Balance	BBS	2	2
Reflexes	Babinski sign	Positive	Positive
Activity of daily living	Barthel Index	20	50

Abbreviations: BBS, Berg Balance Scale; HARS, Hamilton Anxiety Rating Scale; MMT, Manual Muscle Testing; NIHSS, National Institutes of Health Stroke Scale; VAS, Visual Analog Scale.

After two treatment sessions, superficial sensory function partially returned, with the patient able to perceive light touch that had been absent at baseline. Pain decreased from 7 to 4 during pressure and from 5 to 3 during movement. The HARS score decreased from 30 to 26, while the Barthel Index increased from 20 to 50. No change was observed in MMT grades, coordination, BBS score, NIHSS score, or the Babinski sign. No adverse events or treatment related complications were reported.

The physiotherapy protocol and dosage are detailed in Table 3. The program was individualized according to the patient's clinical condition, exercise tolerance, and response. Both scheduled treatment sessions were completed, and the patient remained cooperative throughout the intervention. The documented plan was to progress exercise dosage and modify functional training during subsequent rehabilitation according to recovery status; however, no additional treatment sessions were available within this case report.

Table 3. Comprehensive physiotherapy intervention protocol.

Problem	Modality	Dosage and technique
Pain	Infrared radiation	Moderate intensity; approximately 30 cm from skin; 5 minutes per region
Pain	Manual therapy	Approximately 30 to 40% pressure; muscle release to anterior deltoid and pectoralis major
Anxiety	Exercise therapy	Deep breathing: 2 seconds inhalation, 1 second hold, 4 seconds exhalation; 3 repetitions
Muscle weakness	Manual therapy	Manual Muscle Belly Tone Stimulation; 8 counts per repetition; 3 repetitions
Muscle weakness	Manual therapy	Shoulder approximation; 8 counts per repetition; 3 repetitions
Muscle weakness	Exercise therapy	Passive ROM for upper extremity; 8 counts per repetition; 3 repetitions
Muscle weakness	Exercise therapy	Active assisted exercise and strengthening for lower extremity; 8 counts per repetition; 3 repetitions
Balance	Exercise therapy	Bridging; 8 counts per repetition; 3 repetitions
Sensory impairment	Manual therapy	Light touch and moderate pressure stimulation; 8 to 10 repetitions per area
Activity of daily living	Exercise therapy	PNF; 8 counts per repetition; 3 repetitions
Activity of daily living	Exercise therapy	Rolling and grasp training; 8 counts per repetition; 3 repetitions
Coordination	Exercise therapy	Foot to target activity in supine position; 8 counts per repetition; 3 repetitions

Abbreviations: PNF, proprioceptive neuromuscular facilitation; ROM, range of motion.

Discussion

This case demonstrated that two sessions of comprehensive physiotherapy during the acute phase of non hemorrhagic stroke were followed by improvements in sensory function, pain intensity, anxiety, and functional independence, while muscle strength, balance, coordination, neurological severity, and pathological reflexes remained unchanged. These observations are consistent with the role of early rehabilitation in addressing impairments, reducing consequences of immobility, and supporting participation while the patient remains in the acute stage of recovery.^{12,13}

Pain was localized primarily to the right pectoralis major and anterior deltoid and was accompanied by pain during shoulder movement. Post-stroke shoulder problems may occur in association with motor impairment, altered muscle tone, abnormal positioning, and reduced use of the affected upper limb. These factors may contribute to impaired shoulder function and limitations in upper-limb activities during stroke rehabilitation.^{2,12} Infrared radiation and manual therapy were therefore placed early in the treatment sequence to address pain and soft tissue tension before exercise. The reduction in VAS scores after two sessions indicates a short term change in pain intensity, although the single case design does not allow the change to be attributed specifically to any one modality.^{2,12}

The patient initially demonstrated absent superficial sensation on the affected side and later demonstrated partial return of sensation. Sensory impairment after stroke can interfere with motor control, postural stability, upper limb function, and independence because effective movement depends partly on adequate sensory information. Repetitive peripheral sensory stimulation has been investigated as an adjunct to stroke rehabilitation, and the intervention in this case incorporated repetitive light touch and moderate pressure stimulation. Nevertheless, the mechanism responsible for the observed sensory change was not directly investigated, and spontaneous neurological recovery cannot be separated from the effect of physiotherapy in this case.¹⁴

Anxiety was also reduced, with the HARS score decreasing from 30 to 26. Anxiety during acute stroke may be related to sudden functional loss, communication difficulty, uncertainty, and dependence on others. Deep breathing was incorporated into the program as a simple intervention that could be delivered within the patient's tolerance. Evidence concerning breathing exercise in stroke rehabilitation suggests potential benefits across several functional domains, although the present case cannot establish that the observed reduction in anxiety was caused by breathing exercise alone.¹⁵

The Barthel Index increased from 20 to 50, indicating improved performance in activities of daily living over the observation period. The intervention included rolling, grasp training, proprioceptive neuromuscular facilitation, transfer related practice, and other functional activities. Task specific practice is commonly incorporated into stroke rehabilitation because repeated practice of meaningful activities can support functional learning. However, the improvement observed in this case may also reflect natural recovery, assistance from caregivers, changes in medical status, and repeated exposure to functional activities during hospitalization.¹⁶

No change occurred in MMT grades. The absence of an immediate strength gain is not unexpected in acute stroke, when voluntary activation can be substantially affected by disruption of corticospinal pathways. Strengthening, muscle stimulation, and shoulder approximation were nevertheless selected to support activation, proprioceptive input, and preparation for later functional training.¹⁷⁻²¹ Evidence on motor recovery indicates that clinically measurable gains generally require repeated practice and sufficient rehabilitation exposure, which was not available in this case.¹⁸⁻²¹

Balance remained unchanged, with a BBS score of 2. Bridging was selected to address trunk and proximal control before more demanding balance tasks. Balance recovery after stroke depends on the interaction of sensory, postural, and motor systems and generally requires repeated practice under progressively challenging conditions. The two session treatment period was too brief to determine whether the intervention would produce sustained balance improvement.²²

Coordination also remained unchanged. Finger to finger and heel to knee testing continued to show slow but accurate performance. Coordinated movement requires adequate sensory input, selective motor control, strength, and motor planning.^{23,24} Repeated task specific practice may be necessary before measurable changes become apparent. Similarly, the persistent Babinski sign and unchanged NIHSS score are not surprising over such a short observation period. Neurological severity is influenced by the underlying cerebral lesion and the broader course of acute medical recovery, and it should not be assumed that short term changes in these measures would result directly from physiotherapy.^{19,25,26}

Several strengths should be noted. The program was individualized to the patient's multiple impairments, treatment dosage was documented, clinical response was monitored during each session, and multiple standardized outcome measures were used to capture different domains of function. The report also provides a clinical timeline and a detailed intervention protocol, which may improve transparency and reproducibility of the clinical description.

The principal limitation is that this report concerns one patient who received only two treatment sessions. There was no comparison condition, no blinding, and no long term follow up. Consequently, the observed changes cannot be attributed causally to comprehensive physiotherapy, and the findings cannot be generalized to the broader stroke population. The case is better interpreted as a clinical description of short term change during early inpatient rehabilitation. Future studies should examine larger patient groups, longer intervention periods, and longitudinal outcomes to determine the effectiveness and sustainability of integrated physiotherapy programs.

Conclusion

In this single case of acute non hemorrhagic stroke with right hemiparesis, two sessions of comprehensive physiotherapy were associated with partial recovery of superficial sensation, reduced pain intensity, lower anxiety scores, and improved functional independence. No measurable change was observed in muscle strength, balance, coordination, neurological severity, or the pathological reflex assessed during the short observation period. The findings illustrate the feasibility of integrating electrotherapy, manual therapy, sensory re education, therapeutic exercise, proprioceptive neuromuscular facilitation, and functional activities according to the patient's clinical presentation and tolerance. However, the observed improvements cannot be interpreted as evidence of treatment efficacy because spontaneous neurological recovery, medical management, caregiver assistance, and other aspects of inpatient care may have contributed to the changes. The value of this case lies primarily in its detailed description of early physiotherapy assessment, individualized intervention, monitoring, and multidimensional short term outcomes. Larger studies with longer treatment exposure and follow up are needed to determine whether similar comprehensive rehabilitation strategies produce consistent and sustained benefits in patients with acute non hemorrhagic stroke.

Patient Perspective

A direct patient perspective could not be obtained because dysarthria limited verbal communication during the acute phase. A close family member provided the subjective information documented in routine SOAP records and reported that the patient appeared more comfortable, experienced less pain, participated more readily in rehabilitation activities, and that the family was satisfied with the care provided. This information is presented as proxy family feedback rather than as a direct patient statement.

Author Contribution

Nurul Maghfirah: Conceptualization; Methodology; Investigation; Data curation; Writing, original draft; Visualization; Project administration.

Meutiah Mutmainnah Abdullah: Methodology; Validation; Writing, review and editing; Supervision.

Sri Wahyuni N: Investigation; Data curation; Writing, review and editing; Visualization; Supervision.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

The source manuscript states that formal ethical approval was not required for this case report. Written informed consent was obtained from the patient, including consent for publication of anonymized clinical information. All procedures were conducted in accordance with principles of confidentiality, anonymity, and ethical clinical practice.

References

1. Feigin VL, Stark BA, Johnson CO, Roth GA, Bisignano C, Abady GG, et al. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol.* 2021;20(10):795-820.
2. Li X, He Y, Wang D, Rezaei MJ. Stroke rehabilitation: from diagnosis to therapy. *Front Neurol.* 2024;15:1402729.
3. O'Flaherty D, Ali K. Recommendations for upper limb motor recovery: an overview of the UK and European rehabilitation after stroke guidelines (2023). *Healthcare (Basel).* 2024;12(14):1433.
4. Tang E, Moran N, Cadman M, Hill S, Sloan C, Warburton E. Stroke rehabilitation in adults: summary of updated NICE guidance. *BMJ.* 2024;384:q498.
5. Karaganova I, Mindova S. Neuroplasticity after stroke: adaptive and maladaptive mechanisms in evidence-based rehabilitation. *J Stroke Cerebrovasc Dis.* 2026;35(6):108634.
6. Winterbottom L, Nilsen DM. Motor learning following stroke: mechanisms of learning and techniques to augment neuroplasticity. *Phys Med Rehabil Clin N Am.* 2024;35(2):277-291.
7. Klink ME, Hepworth LR, Charalambous M, Bismuth H, Boursin P, Rago C, et al. Mapping interdisciplinary teamwork in stroke across the care continuum: a rapid scoping review. *Br J Neurosci Nurs.* 2026;22(2).
8. Pise O, Kamble S, Ghorpade A. Assessment of multidimensional functional recovery post-stroke: a systematic review of outcome measures and their psychometric properties. *BMC Neurol.* 2026;26(1):376.
9. Siniscalchi A. Use of stroke scales in clinical practice. *Turk J Emerg Med.* 2022;22(3):119-124.
10. Önal B, Köse N, Önal ŞN, Zengin HY. Validity and reliability of the Berg Balance Scale in different tele-assessment methods in patients with stroke. *J Eval Clin Pract.* 2025;31(4).
11. Amini-roaya R, Mirzadeh FS, Heidari K, Alizadeh-Khoei M, Sharifi F, Effatpanah M, et al. The validation study of both the modified Barthel and Barthel Index, and their comparison based on Rasch analysis in the hospitalized acute stroke elderly. *Int J Aging Hum Dev.* 2021;93(3):864-880.
12. Wei X, Sun S, Zhang M, Zhao Z. A systematic review and meta-analysis of clinical efficacy of early and late rehabilitation interventions for ischemic stroke. *BMC Neurol.* 2024;24(1):91.
13. Roesner K, Scheffler B, Kaehler M, Schmidt-Maciejewski B, Boettger T, Saal S. Effects of physical therapy modalities for motor function, functional recovery, and post-stroke complications in patients with severe stroke: a systematic review update. *Syst Rev.* 2024;13(1):270.
14. Silva GF, Campos LF, de Aquino Miranda JM, Guirro Zuliani F, de Souza Fonseca BH, de Araújo AET, et al. Repetitive peripheral sensory stimulation for motor recovery after stroke: a scoping review. *Top Stroke Rehabil.* 2024;31(7):723-737.
15. Abdullahi A, Wong TW, Ng SS. Efficacy of diaphragmatic breathing exercise on respiratory, cognitive, and motor function outcomes in patients with stroke: a systematic review and meta-analysis. *Front Neurol.* 2024;14:1233408.
16. Siddiqi FA, Jahan S, Hassan MF, Rathore FA. Task-specific training and neuroplasticity for stroke recovery: mechanisms, interventions, and future directions. *J Pak Med Assoc.* 2026;76(3):470-474.
17. Noguchi KS, Moncion K, Wiley E, Morgan A, Huynh E, Balbim GM, et al. Prescribing strength training for stroke recovery: a systematic review and meta-analysis of randomised controlled trials. *Br J Sports Med.* 2025;59(3):185-197.
18. Urbin MA, Collinger JL, Wittenberg GF. Corticospinal recruitment of spinal motor neurons in human stroke survivors. *J Physiol.* 2021;599(18):4357-4373.

19. Kwakkel G, Stinear C, Essers B, Munoz-Novoa M, Branscheidt M, Cabanas-Valdés R, et al. Motor rehabilitation after stroke: European Stroke Organisation (ESO) consensus-based definition and guiding framework. *Eur Stroke J.* 2023;8(4):880-894.
20. Crow J, Smith A. National Clinical Guideline for Stroke for the United Kingdom and Ireland: part I - an overview of the updated recommendations. *Br J Occup Ther.* 2023;86(10):661-664.
21. Zheng K, Li L, Zhou Y, Gong X, Zheng G, Guo L. Optimal proprioceptive training combined with rehabilitation regimen for lower limb dysfunction in stroke patients: a systematic review and network meta-analysis. *Front Neurol.* 2024;15:1503585.
22. Zhou Y, Ren H, Hou X, Dong X, Zhang S, Lv Y, et al. The effect of exercise on balance function in stroke patients: a systematic review and meta-analysis of randomized controlled trials. *J Neurol.* 2024;271(8):4751-4768.
23. Hoh JE, Semrau JA. The role of sensory impairments on recovery and rehabilitation after stroke. *Curr Neurol Neurosci Rep.* 2025;25(1):22.
24. Sahrizan NSA, Yahya N, Law ZK, Wan Zaidi WA, Nabilah Ismail U, Afifah NH, et al. A systematic review of alterations in sensorimotor networks following stroke: implications for integration and functional outcomes across recovery stages. *Front Neurol.* 2025;16:1456146.
25. Alsubiheen AM, Choi W, Yu W, Lee H. The effect of task-oriented activities training on upper-limb function, daily activities, and quality of life in chronic stroke patients: a randomized controlled trial. *Int J Environ Res Public Health.* 2022;19(21):14125.
26. Lee HH, Kim YW, Kim HS, Yang SN, Im S, Yoo WK, et al. Clinical practice guideline for stroke rehabilitation in Korea - part 2: rehabilitation for motor and sensory function (2024). *Brain Neurorehabil.* 2025;18(3):e7.