

Special Review



Clinical Practice Guideline for Stroke Rehabilitation in Korea—Part 2: Rehabilitation for Motor and Sensory Function (2024)

Hyun Haeng Lee, Yong Wook Kim, Hyoung Seop Kim, Seung Nam Yang, Sun Im, Woo-Kyoung Yoo, Joon-Ho Shin, Min-Kyun Oh, Won-Seok Kim, Da-Sol Kim, Won Kee Chang, Seyoung Shin, Sekwang Lee, Doo Young Kim, Sung-Hwa Ko, Yeo Jun Yun, Yookyung Lee, Miyoung Choi, Suk Hoon Ohn, KSNR Stroke CPG Writing Group



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HIGHLIGHTS

- GRADE methodology adopted for evidence-based stroke motor and sensory rehabilitation guidelines.
- Assistive devices including robotics conditionally recommended for upper limb function.
- Botulinum toxin and taping conditionally recommended for shoulder pain and subluxation.

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Hyun Haeng Lee ,¹ Yong Wook Kim ,² Hyoung Seop Kim ,³ Seung Nam Yang ,⁴ Sun Im ,⁵ Woo-Kyoung Yoo ,⁶ Joon-Ho Shin ,⁷ Min-Kyun Oh ,⁸ Won-Seok Kim ,⁹ Da-Sol Kim ,¹⁰ Won Kee Chang ,⁹ Seyoung Shin ,¹¹ Sekwang Lee ,⁴ Doo Young Kim ,¹² Sung-Hwa Ko ,¹³ Yeo Jun Yun ,¹⁴ Yookyung Lee ,¹⁵ Miyoung Choi ,¹⁶ Suk Hoon Ohn ,¹⁷
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ABSTRACT

This clinical practice guideline (CPG) is the second part of the fourth edition of the Korean Stroke Rehabilitation Guidelines, following the first part published in 2023. While, the first part addressed rehabilitation for motor function, while this second part focuses on both motor and sensory rehabilitation. Beginning with the fourth edition, significant methodological advancements have been introduced, transitioning from a consensus-based approach to an evidence-based framework using the Grading of Recommendations Assessment, Development, and Evaluation methodology. The target population encompasses adult stroke patients, both male and female, with ischemic and hemorrhagic stroke types included, while pediatric stroke cases are excluded from consideration. This guideline is primarily intended for physiatrists and specialized therapists who provide rehabilitation services to patients with stroke-related motor impairments and activities of daily living limitations across primary, secondary, and tertiary healthcare facilities. The development team consisted of eighteen stroke rehabilitation specialists and one expert in CPG development methodology. Key questions were formulated based on target population

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Conflict of Interest

The development of this CPG, 'Clinical Practice Guideline for Stroke Rehabilitation in Korea—Part 2: Rehabilitation for Motor and Sensory Function (2024),' received no financial or non-financial support from any interest groups, including specific societies, institutions, or related industries. All members of the guideline development committee were required to submit a conflict of interest (COI) form to thoroughly check for potential conflicts. All participating members declared no COI (e.g., financial relationships with related companies, consulting, lectures, research grants, intellectual property ownership) related to the study content during their participation period, ensuring the objectivity and fairness of this guideline.

preferences and international stroke rehabilitation guidelines, with subsequent refinement by specialists responsible for each respective topic. Draft recommendations underwent a formal consensus process using the RAND-UCLA Appropriateness Method, followed by further refinement through public hearings and external expert evaluation.

Keywords: Clinical Practice Guideline; Biofeedback; Robotics; Shoulder Pain; Telerehabilitation

INTRODUCTION

Stroke is one of the three leading causes of death in Korea, along with cancer and heart disease, and is a condition that can lead to severe neurological and functional impairments in survivors. According to the analysis using data of the National Health Insurance Services from 2011 to 2020, the incidence of new stroke cases has remained steady or slightly increased, with approximately 100,000 new cases annually [1]. Consequently, multidisciplinary rehabilitation therapy, initiated from the acute phase and continued thereafter, is recommended as a core strategy to maximize functional recovery and minimize long-term disability [2,3].

Many advanced countries have developed clinical practice guidelines (CPGs) for stroke rehabilitation tailored to their healthcare systems, systemizing the latest evidence to support clinicians' decision-making [4]. In Korea, the Korean Society for NeuroRehabilitation (KSNR) first published its CPG for stroke rehabilitation in 2009 and has continuously revised and supplemented it since [5-8].

This CPG is the second part of the fourth edition, following Part 1, which was published in 2023. While Part 1 addressed rehabilitation for motor function, this second part expands the scope to include rehabilitation for both motor and sensory functions not covered previously. This guideline is designed to assist clinicians in making optimal treatment decisions by integrating the latest research findings and scientific evidence. It is not intended to be uniformly applied to all patients; the final treatment decisions rest with the attending physician, considering each patient's medical condition, preferences, and circumstances. Therefore, this guideline cannot replace the professional judgment of a physician or be used for the purpose of restricting, evaluating, or auditing clinical practice.

AIM OF CPG

The primary purpose of this CPG is to support the clinical decision-making of healthcare professionals involved in the rehabilitation of stroke patients by presenting evidence-based treatment recommendations for the entire rehabilitation process, from the acute to the chronic phase. This guideline particularly focuses on rehabilitation methods for recovering motor and sensory functions. By promoting the systematic use of this guideline, we aim to reduce the gap between evidence-based medicine and actual clinical practice, minimize variations in treatment approaches among institutions and physicians, and ultimately enhance the quality of medical care. This guideline comprehensively covers rehabilitation therapies that can affect the health benefits and potential risks for individual stroke patients. Its ultimate goal is to contribute to maximizing patients' functional recovery, preventing

complications, facilitating their return to daily life, and improving their quality of life. Furthermore, this guideline provides valuable information not only for medical professionals but also for patients and their caregivers to better understand the principles and processes of rehabilitation therapy.

TARGET POPULATION AND SCOPE

This CPG is a revision of the ‘Clinical Practice Guideline for Stroke Rehabilitation in Korea 2016’ [7] and follows the ‘Clinical Practice Guideline for Stroke Rehabilitation in Korea—Part 1: Rehabilitation for Motor Function (2022)’ [8]. It focuses on rehabilitation for motor and sensory functions. This guideline targets adults with ischemic and hemorrhagic stroke, excluding pediatric stroke.

TARGET USERS AND SETTINGS

The primary target users of this CPG are physicians and specialized therapists who provide rehabilitation for patients experiencing difficulties in activities of daily living due to motor and sensory deficits after stroke in primary, secondary, and tertiary medical institutions.

METHOD OF CPG DEVELOPMENT

Building of CPG development group

The guideline development team was composed of an operating committee, a working committee, and an advisory committee. The operating committee, selected by the board of KSNR for expertise and representativeness, included a chairperson, a general secretary, and a methodology expert. The working committee, responsible for the practical development, consisted of 16 psychiatrists from 12 universities and 2 hospitals. The advisory committee, comprising the president and board members of the KSNR, provided overall supervision and review.

Decision of CPG development method

This CPG was newly developed (‘De novo’) using the evidence-based Grading of Recommendations Assessment, Development, and Evaluation (GRADE) methodology, marking a transition from the prior consensus-based approach [9]. The key questions were determined through a multi-stage process. An initial pool of candidate questions was identified from previous Korean guidelines and recent international CPGs. The operating committee for the Part 1 guideline compiled 39 key questions (KQs) relevant to the guideline’s scope from previous and international CPGs. Following a preference survey of patients, caregivers, and experts, the operating committee for the Part 1 (2022) guideline selected and addressed the highest-priority 24 topics [8]. For this guideline (Part 2), the current operating committee then selected the topics from the remaining pool of topics.

Evaluation of foreign stroke clinical guidelines

The operating and working committees for the Part 1 guideline selected topics within the guideline’s scope, using stroke rehabilitation guidelines from Canada (2019) [10,11], the United States (2019) [12], and Australia (Living CPG, available at <https://app.magicapp>).

org/#/guideline/6659). Two researchers evaluated each CPG using the Korean Appraisal of Guidelines for Research and Evaluation II tool. Based on the results, the operating and working committees for the Part 1 guideline decided to utilize all three CPGs for the selection of KQs.

Perspectives and preferences of the target population

A survey was conducted among 11 stroke patients and their caregivers, as well as medical staff at the Part 1 guideline operating committee members' affiliated hospitals, to assess the importance and preference for each KQ using an 11-point Likert scale (0–10).

Decision of CPG scope

The revision of the 'Clinical Practice Guideline for Stroke Rehabilitation in Korea' was planned to be conducted sequentially in parts due to its broad scope, adopting the GRADE methodology. Accordingly, the operating and advisory committees for the current guideline defined its scope and, after discussion, confirmed the title as 'Part 2: Rehabilitation for Motor and Sensory Function.'

Selection of key questions

From the 39 initial questions, 24 were addressed in Part 1 (2022). The remaining topics were used to formulate 13 KQs for this guideline, 'Part 2: Rehabilitation for Motor and Sensory Function.' Each KQ was structured in the Patient, Intervention, Comparison, Outcome format and finalized after consultation with search specialists, methodology experts, and the assigned committee members.

Literature search and selection

The literature search was conducted by information specialists using four databases: Ovid MEDLINE®, Ovid Embase, Cochrane Library, and KoreaMed. The search period ranged from 1946 to August 22, 2024. The search terms, selected by the committee members responsible for each KQ, were composed of MeSH terms, Emtree terms, and natural language, used alone or in combination, to ensure a highly sensitive search. To prevent the omission of major studies, a manual search strategy was used to supplement the search results. The search terms for each KQ are attached in **Supplementary Data 1**. Based on the search results, two clinical experts (working committee members) for each KQ conducted the final selection of literature related to the KQs according to the selection criteria and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram. The first screening was conducted by reviewing titles and abstracts, and the second screening was conducted by reviewing the full text of the literature. When disagreements arose during the literature selection process, a consensus was reached through discussion between the 2 working committee members. If a consensus could not be reached through discussion, the operating committee intervened and mediated to make the final selection. The PRISMA flow diagram for each KQ is included in the recommendation statement for each KQ.

Risk of bias

Two clinical experts for each KQ assessed the finally selected literature using validated risk-of-bias tools. To ensure consistency, a workshop for the working committee was held on September 23, 2024, with a methodology expert. The tools used were AMSTAR 2.0 for systematic reviews, RoB 2.0 for randomized controlled trials, and ROBANS 2.0 for non-randomized studies. Consensus on assessments was reached through discussion, with the operating committee mediating unresolved disagreements.

Analysis of evidence

The working committee members for each key question extracted and summarized research findings from the selected literature. Meta-analyses were conducted when feasible, and a workshop with a methodology expert was held on November 11, 2024, to ensure their accuracy. The general process for meta-analysis was as follows: A random-effects model was used to secure the generalizability of the derived effect sizes. Subgroup analyses were recommended to investigate the cause of heterogeneity when it exceeded 50% ($I^2 > 50\%$), and sensitivity analyses were permitted to confirm the robustness of the estimates. The standardized mean difference was used as the principal measure, but the mean difference was also allowed if the same tool was used to assess a specific outcome. The entire meta-analysis was performed using the R language with the 'meta,' 'metafor,' and 'robvis' packages.

Certainty of the evidence and level of recommendation

The working committee members determined the certainty of the evidence and the strength of recommendations based on the GRADE method. A workshop with a methodology expert was held on December 16, 2024, to ensure the validity and accuracy of this process. Decisions were made by consensus among the assigned working members, with the operating committee mediating any disagreements.

Formal consensus and conflict of interests

A formal consensus process was conducted with all members of the operating, working, and advisory committees. Members with any minor conflicts of interest were excluded from the development and consensus process for the relevant clinical questions. After an informal consensus meeting, the revised recommendations underwent a formal consensus process using the RAND-UCLA Appropriateness Method via several rounds of surveys from March 5 to March 17, 2025. The appropriateness and consensus for the 13 KQs were evaluated on a 9-point Likert scale.

Appraisal from outside expert

The consensus-driven recommendations were presented at a public hearing during the 2025 KSNR Spring Conference on March 22, 2025. The development process and final results were shared with all KSNR member physicians, occupational therapists, and physical therapists to gather their opinions.

Opinion of the persons concerned

After drafting, the guideline was evaluated by a panel of 10 external experts (including specialists from related societies not involved in the development) from May 25 to June 6, 2025. The completed guideline will be submitted to the Clinical Practice Guideline Committee of the Korean Medical Association for further external evaluation, and any feedback will be considered for the next revision.

Distribution and implement

This CPG will be published on the KSNR website, making it accessible to physicians and other professionals treating stroke patients. It is expected to be utilized for continuing medical education, healthcare professional training, patient and caregiver counseling, and as a reference for clinical decision-making. Feedback from users will be continuously collected for future improvements.

Plan of revision and update

The update of this CPG will proceed according to the scheduled sequential updates of the existing guidelines using the GRADE method.

RESULTS

As a result of the development process described above, an evidence-based CPG was developed, including recommendations for a total of 13 KQs. The summary of recommendations is presented in **Table 1**. The detailed development process, rationale, and a Korean version of the recommendation are available as **Supplementary Data 1** and **2**.

Table 1. Summary of recommendations for motor and sensory function rehabilitation

KQ	Division	Recommendation	LoE	LoR*
KQ1. Biofeedback (upper extremity)	Update	For patients with upper limb dysfunction after stroke, biofeedback therapy using electromyography, when added to conventional therapy, does not show a significantly superior effect in improving upper limb motor impairment and function compared to conventional therapy alone. However, as consistent, albeit limited, functional improvement is observed, it can be selectively added depending on the patient's condition.	Low	B
KQ2. Biofeedback (lower extremity)	Update	For patients with lower limb dysfunction after stroke, biofeedback therapy using electromyography does not show a significantly superior effect in improving lower limb motor function and function compared to conventional therapy alone. However, as limited functional improvement in lower limb motor function is observed, it can be selectively added depending on the patient's condition.	Low	B
KQ3. Assistive device	Update	For patients with upper limb dysfunction after stroke, task-oriented upper limb rehabilitation using assistive devices is superior to task-oriented rehabilitation without devices in improving upper limb function and ADL, but can be implemented selectively considering resource availability, feasibility, and patient acceptance.	Moderate	B
KQ4. Intra-articular injections for post-stroke shoulder pain	Update	For patients with post-stroke shoulder pain, intra-articular injections have a short-term (within 3 weeks) effect on improving shoulder joint pain and can be selectively implemented depending on the patient's underlying disease and condition.	Low	B
KQ5. Botulinum toxin for post-stroke shoulder pain	Update	For patients with post-stroke shoulder pain, botulinum toxin injections into the shoulder-girdle muscles are effective for long-term improvement of shoulder joint pain and can be selectively implemented by evaluating the patient's upper limb muscle spasticity.	Low	B
KQ6. Suprascapular nerve block for post-stroke shoulder pain	Update	For patients with post-stroke shoulder pain, suprascapular nerve block may be effective for short-term improvement of shoulder joint pain (within 2 weeks post-intervention) and is implemented selectively considering the pros and cons of other treatments.	Low	B
KQ7. Orthosis for post-stroke shoulder subluxation and pain	Update	For patients with post-stroke hemiplegia, the use of shoulder orthoses may have a limited effect on preventing shoulder subluxation and improving pain, and can be selectively implemented depending on the patient's condition.	Low	B
KQ8. Taping for post-stroke shoulder subluxation and pain	New	For patients with post-stroke hemiplegia, the use of shoulder taping can be effective in preventing shoulder subluxation and improving pain, and can be selectively implemented depending on the patient's condition.	Moderate	B
KQ9. Muscle strengthening exercise for post-stroke shoulder subluxation	New	For patients with post-stroke hemiplegia, shoulder muscle strengthening exercises can have some beneficial effects on preventing shoulder subluxation and can be selectively implemented depending on the patient's condition.	Moderate	B
KQ10. Bilateral arm training	Update	For patients with upper limb dysfunction after stroke, bilateral arm training is effective in improving upper limb motor function when implemented selectively according to the patient's condition.	Low	B
KQ11. Sensory stimulation training	Update	For patients with somatosensory deficits after stroke, rehabilitation including sensory stimulation training is effective in improving sensory function and can be selectively implemented depending on the patient's condition.	Low	B
KQ12. Whole-body vibration	Update	Rehabilitation including whole-body vibration has been shown to have limited effects on improving balance and motor function in stroke patients compared to rehabilitation without it, and can be added to conventional rehabilitation depending on the patient's condition.	Moderate	B
KQ13. Telerehabilitation	Update	For patients with upper limb dysfunction after stroke, telerehabilitation is non-inferior to conventional rehabilitation in improving upper limb motor impairment, so telerehabilitation can be considered when providing sufficient conventional rehabilitation is difficult.	Moderate	B

KQ, key question; LoE, level of evidence; LoR, level of recommendation; ADL, activities of daily living.

*LoR A: Strong for recommend; LoR B: Conditional for recommend; LoR C: Conditional against recommend; LoR D: Strong against recommend; LoR I: Inconclusive.

DISCUSSION

This CPG, the second part of the 4th edition of the Korean Stroke Rehabilitation Guidelines, provides updated, evidence-based recommendations for motor and sensory rehabilitation, areas not covered in Part 1. By employing the GRADE methodology, this guideline shifts from a traditional consensus-based approach to a more rigorous, evidence-based framework, reflecting a global trend in CPG development [9,13]. This ensures that the recommendations are based on the best available evidence, enhancing their reliability and applicability in clinical settings.

A key finding of this CPG is the growing evidence for technology-supported interventions. The conditional recommendation for telerehabilitation (KQ13) as a non-inferior alternative for upper limb therapy offers a notable option for improving access to care, particularly when in-person treatment is challenging [14,15]. This, along with the conditional recommendation for using assistive devices like robotics and virtual reality (KQ3), highlights the evolving landscape of neurorehabilitation, where technology is increasingly integrated to enhance therapy intensity and engagement [16].

In the management of post-stroke shoulder complications, this guideline presents a series of nuanced conditional recommendations. Interventions for preventing subluxation, such as orthoses (KQ7), taping (KQ8), and shoulder muscle strengthening (KQ9) are suggested to have some effects and should be applied selectively. For shoulder pain, various options are presented with specific conditions: intra-articular injections for short-term relief (KQ4), suprascapular nerve block for possible short-term benefit (KQ6), and botulinum toxin injections for long-term improvement, particularly concerning spasticity and regulatory considerations for off-label use (KQ5). This detailed, conditional approach guides clinicians in tailoring treatment for this common and reducing post-stroke complication [17].

Biofeedback (KQ1, KQ2) and whole-body vibration (KQ12) received conditional recommendations, suggesting they are not universally superior to conventional therapy but may offer benefits for certain patients. This highlights a critical area for future research. The limited, low-quality evidence for these modalities necessitates larger, well-designed randomized controlled trials to clarify their specific roles, optimal parameters, and target patient populations.

Compared to the previous edition and other international guidelines, this CPG provides more specific recommendations on sensory rehabilitation (KQ11). The conditional recommendation for sensory stimulation training, though based on low-certainty evidence, is an important step in addressing this often-neglected aspect of stroke recovery. Future research should focus on identifying the most effective sensory training protocols and integrating them with motor rehabilitation to optimizing overall functional recovery [18].

A limitation of this CPG is that the development committee was composed solely of physiatrists. Although opinions from other healthcare professionals were gathered through public hearings and external reviews, a multidisciplinary development committee from the outset could have provided a broader perspective. Future revisions should aim to include a more diverse group of experts, including therapists, nurses, and patient representatives, to further strengthen the guideline's comprehensiveness and applicability. Additionally, some KQs were based on a small number of studies, leading to low or moderate certainty of

evidence. This underscores the need for continued high-quality randomized controlled trials in stroke rehabilitation in Korea.

CONCLUSION

This CPG provides up-to-date, evidence-based recommendations for motor and sensory rehabilitation after stroke. It serves as a valuable resource for clinicians and aims to standardize and improve the quality of stroke care in Korea. Continuous updates and further research are essential to refine these recommendations as new evidence emerges.

SUPPLEMENTARY MATERIALS

Supplementary Data 1

Detailed development process and rationale for the recommendation

Supplementary Data 2

Korean version of Clinical Practice Guideline for Stroke Rehabilitation in Korea—Part 2: Rehabilitation for Motor and Sensory Function (2024)

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