ASEAN Journal of Rehabilitation Medicine

e-ISSN 2673-0863

ASEAN J Rehabil Med
Volume 36, Number 2
May - August 2026
Formerly known as J Thai Rehabil Med

ASEAN Journal of Rehabilitation Medicine (ASEAN J Rehabil Med)

(Formerly Journal of Thai Rehabilitation Medicine)

Publication frequency

ASEAN J Rehabil Med published three issues a year: (1) January-April (2) May-August (3) September-December
Each issue contains 6-8 articles..

Open access policy

ASEAN J Rehabil Med provides an immediate open access to its content on the principle of making research freely available to the public and supporting a greater global exchange of knowledge.
The main access its content is https://www.tci-thaijo.org/index.php/aseanjrm/

ASEAN Journal of Rehabilitation Medicine (ASEAN J Rehabil Med)

(Formerly Journal of Thai Rehabilitation Medicine)

Ownership and publisher

ASEAN J Rehabil Med is owned by the Thai Rehabilitation Medicine Association, which oversees its publication and fully funds all associated management expenses. The association also facilitates operations and management to maintain high publication standards, implement strict peer review processes, and ensure open access for readers worldwide. However, this funding does not influence the editorial board's decision on reviewing or publishing articles

Office address:

11th Floor, Royal Golden Jubilee Buildings, 2 SoiSoonvijai, New Petchburi Road, Bangkok 10310, Thailand
Telephone/Facsimile: 66-(0)2716-6808 / 66-(0)2716-6809; E-mail address: asean.jrm@gmail.com

Content

Notes from the Editor-in-Chief

Welcome to this executive summary of the second issue of the ASEAN Journal of Rehabilitation Medicine (2026). This edition brings together a diverse array of clinical trials, longitudinal surveys, and innovative case reports that highlight the evolving landscape of physical medicine and rehabilitation across Southeast Asia, specifically within Thailand's leading medical institutions.

The first study, a randomized controlled trial (RCT) conducted at a general hospital, compared the effectiveness of acupuncture with electrical stimulation against ultrasound diathermy for treating myofascial neck pain in the upper trapezius. While both interventions led to improvements in disability scores (Thai-NDI), acupuncture was found to be statistically superior in reducing pain intensity on the numeric rating scale. The study concludes that acupuncture is a highly appropriate and effective method for managing trigger points and pain in the neck muscles.

Second, an ambispective cohort study on amyotrophic lateral sclerosis (ALS) in a Thai tertiary care center determined a median survival time of 37 months from the onset of symptoms. The research identified that a longer interval from symptom onset to diagnosis was a key predictor of improved survival, likely reflecting a slower biological disease velocity. Notably, in this specific cohort, neither Riluzole use nor comorbidities like hypertension showed a statistically significant impact on mortality, though major complications trended toward increased risk.

Regarding stroke rehabilitation, a retrospective study at tertiary care hospital examined whether functional outcomes differed between a patient's first admission and subsequent readmissions. Despite a limited 3-week stay per admission, the results showed no significant difference in rehabilitation efficiency or effectiveness between the two groups. This suggests that readmitting stroke patients for further intensive therapy is a valid clinical strategy for maximizing recovery, particularly in hospital settings where individual stays are capped.

The second International Spinal Cord Injury (InSCI) community survey in Thailand provided a comprehensive bio-psychosocial profile of 693 individuals living with SCI. The data revealed a predominantly male, traumatic paraplegic population facing significant socioeconomic hurdles, with over 64.0% reporting low household income. Secondary health conditions were remarkably prevalent—specifically spasticity (77.5%), pain (71.1%), and bowel issues (70.4%)—highlighting a critical need for integrated community-based rehabilitation services in Thailand.

A significant case report detailed the reversal of chronic genu recurvatum (knee hyperextension) in a stroke survivor two years post-injury. Using a year-long, systematically progressive robotic gait training program (SensibleSTEP®) combined with body weight-supported treadmill training, the patient eventually achieved independent ambulation without hyperextension. This case highlights that the "therapeutic window" for gait recovery remains open years after a stroke if structured robotic intervention and speed-challenge protocols are utilized.

In another post-stroke case, researchers evaluated the use of oral baclofen as a pharmacological adjunct to conventional speech-language therapy for severe spastic dysarthria and laryngeal tension dysphonia. While traditional therapy alone showed minimal results, the introduction of baclofen to address muscle hypertonicity led to noticeable improvements in lip seal, jaw function, and overall speech intelligibility. The study also emphasized the utility of the Frenchay Dysarthria Assessment (FDA) in capturing these subtle oromotor functional changes.

As we look toward the future of rehabilitation medicine in 2026, the research presented here underscores a vital shift toward personalized, technology-driven, and community-integrated care. Whether through the precision of robotic gait training or the broad-scale insights of the InSCI survey, our goal remains the same: to extend the therapeutic window and enhance the quality of life for every patient. We hope these findings inspire continued innovation and evidence-based practice across the ASEAN region.

Assoc. Prof. Kingkaew Pajareya
Editor-In-Chief
The ASEAN Journal of Rehabilitation Medicine

Original Article

A comparison of the Effectiveness of Acupuncture and Ultrasound Treatment in Patients with Neck Pain from Myofascial Pain of the Upper Trapezius: A Randomized Controlled Trial

Suwimon Sangiamsak
Rayong Hospital, Rayong, Thailand

ABSTRACT

Objectives: To compare the effectiveness of acupuncture and ultrasound treatment in patients with neck pain from myofascial pain of the upper trapezius

Study design: A randomized controlled trial

Setting: A general hosital, Thailand

Participant: Patients with myofascial pain syndrome of the upper trapezius muscle.

Methods: Sixty patients with myofascial pain syndrome of the upper trapezius muscle were enrolled. Thirty patients were randomly assigned to the experimental group which received acupuncture treatment at points GB20, SI11, DU14, SI15, GB21, and EX-HN15, along with electrical stimulation. The acupuncture points were stimulated in pairs: GB20 with EX-HN15 and GB21 with SI11. Continuous wave electrical stimulation was applied at a tolerable current level for 25 minutes. The thirty patients in the control group were treated with ultrasound diathermy using a Sonopuls 190 at a frequency of 1 MHz and an intensity of 0.8-1 watts/sq cm. Treatment duration was 5-10 minutes. Both groups received treatment twice a week for a total of four weeks. The outcome measures were the numeric rating scale (NRS) and the Thai version of the Neck Disability Index (Thai-NDI) scores, assessed before the intervention and at week 4 following treatment.

Results: There were no significant differences in demographic characteristics between the two groups. Following treatment, mean pain scores decreased from 7.13 (SD = 1.36) to 3.43 (SD = 1.72) in the acupuncture group and from 7.17 (SD = 1.42) to 4.50 (SD = 2.30) in the ultrasound therapy group. The between-group difference was statistically significant (p = 0.046). Both groups showed reductions in Thai-NDI mean scores after treatment, from 18.90 (SD = 7.19) to 10.10 (SD = 6.25) and from 21.70 (SD = 6.93) to 12.77 (SD = 6.40) in the experimental and control groups, respectively, with no statistically significant difference observed between the two groups.

Conclusions: Acupuncture treatment demonstrated positive effects as shown by lower post-treatment pain scores (NRS). Therefore, it can be considered an appropriate method for the management of myofascial pain of the upper trapezius muscle.

Keywords: acupuncture, ultrasound, neck pain, myofascial pain syndrome

ASEAN J Rehabil Med. 2026; 36(2): 57-64.

Introduction

Neck pain is one of the most common symptoms related to the musculoskeletal system, with the prevalence of neck pain reaching as high as 75.0%.[1] Besides being a personal issue, neck pain also negatively impacts quality of life, family, social interactions, healthcare expenses, and results in substantial work productivity loss.[2] Neck pain can stem from various causes. It is frequently associated with myofascial pain syndrome (MPS), a common clinical entity, especially in the upper trapezius muscle. The prevalence of MPS in patients presenting with pain ranges from 30.0% to 93.0%, with neck pain occurring in up to 55.0% of cases.[3] MPS is characterized by hyperirritable spots located within taut bands of skeletal muscle, known as trigger points, which elicit localized pain and exhibit referred pain patterns. Additionally, autonomic phenomena may also be present.[4]

Treatment options are classified into pharmacological and non-pharmacological approaches. Pharmacological treatments include nonsteroidal anti-inflammatory drugs (NSAIDs), tramadol, antidepressants, and anticonvulsants. Non-pharmacological treatments encompass interventions such as dry needling which has traditionally been used as one of the fastest and most effective methods to inactivate myofascial pain trigger points and help alleviate associated pain. Trigger point injections are similar to dry needling; however, they involve injecting various solutions, typically a local anesthetic. Studies suggest that trigger point injections have similar efficacy to dry needling but cause less discomfort.[5] Postural, mechanical, and ergonomic modifications are also options, but there is little direct data to support that approach in treating myofascial pain. Occupational muscle pain syndromes are theorized to occur as a result of repetitive microtrauma and myofascial

Correspondence to: Suwimon Sangiamsak, MD, FRCPhysiatrT; Rayong Hospital, 138 Sukhumvit Road, Thapradu, Muang, Rayong 21000, Thailand; E-mail:suwimonoko@hotmail.com

Received: August 31, 2025 Revised: October 17, 2025 Accepted: November 14, 2025

shortening. Correction of awkward postures is a standard part of treating these disorders, although long-term efficacy studies are lacking.[4] Other modalities include transcutaneous electrical nerve stimulation (TENS), which uses an electrical current to stimulate nerve fibers and provide pain relief. TENS can be used as an adjunct therapy to help alleviate MPS, but should not be considered a monotherapy. Laser therapy has also been used in the treatment of musculoskeletal pain, including MPS; however, its exact therapeutic mechanism remains unclear.[5]

Ultrasound diathermy (USD) is a therapeutic device that uses high-frequency sound waves to produce deep heating effects which is widely used in the treatment of patients with myofascial pain. It has been found to help reduce pain, increase pain thresholds, and improve joint range of motion.[5] More over, it has been shown to reduce pain more effectively than a placebo or no treatment, and is considered safe.[6] Ultrasound probes are composed of piezoelectric crystals that use high-frequency alternating currents to transform electrical energy into mechanical oscillation energy that is applied via a transducer or applicator placed in direct contact with the patient's skin. The waves are absorbed primarily by connective tissue, e.g., ligaments, tendons, fascia, scar tissue. The thermal and nonthermal effects of therapeutic ultrasound induce biological responses, including muscle relaxation, tissue regeneration, and a decrease in inflammation.[6] A study by Esenyel M, et al. reported that ultrasound treatment and trigger point injections were found to be equally effective.[7]

Acupuncture aims to restore bodily balance and is notable for its effectiveness in relieving pain.[8] The World Health Organization has recognized neck pain as a condition that can be treated with acupuncture, which is also considered safe. Acupuncture has been found to affect the autonomic nervous system, which controls the function of various organs and influences the secretion of several substances in the body, including endorphins and endogenous opioids. These substances help alleviate pain and reduce inflammation effectively.[9] For patients with neck pain, selected acupuncture points are often located along the gallbladder meridian, the small intestine meridian, and the governing vessel, since these meridians pass through the neck area. Additional extra-meridian points in the neck region may also be used. Therefore, acupuncture targeting points on these meridians can help alleviate neck pain in patients.[8] Nowadays, electroacupuncture is often used to enhance the effectiveness of acupuncture. Electroacupuncture is a technique that uses a device generating electrical currents through the acupuncture needle to stimulate blood and qi circulation, providing patients with continuous stimulation. One of the main indications for electroacupuncture is pain relief.[10] In a 2007 study, Trinh K, et al. conducted a systematic review on the effects of acupuncture for individuals with neck pain and found that acupuncture relieved pain more effectively than sham treatment.[11] Moreover, acupuncture has been shown to achieve therapeutic outcomes comparable to those of trigger point injection.[12]

In Thailand, USD is widely available and commonly used. There are also a large number of patients seeking services in rehabilitation departments, further intensifying the demand for treatment. Due to the high demand, rehabilitation department schedules are often tightly packed. This problem frequently leads to increased waiting times and to treatment sessions that are less frequent than clinically desirable, which may limit the continuity and effectiveness of patient care. Acupuncture, which is provided at acupuncture clinics within the Department of Thai Traditional Medicine, is considered an alternative medicine approach of interest, which may help treat patients with myofascial pain of the upper trapezius muscle. It can serve as a first-line option, allowing patients to receive treatment more quickly and effectively. This study aims to compare the effectiveness of acupuncture and ultrasound treatment in patients with neck pain from myofascial pain of the upper trapezius.

Method

Study design

This study was an open-label randomized controlled trial conducted at the Department of Rehabilitation Medicine, Rayong Hospital, Thailand. The Human Research Ethics Committee of Rayong Hospital approved it for human research (ethical approval number RYH REC No. E22/2567), and it was registered in the Thai Clinical Trials Registry on April 12, 2024 (Number TCTR20240412006). This study followed the recommendations of the Consolidated Standards of Reporting Trials (CONSORT) guidelines for reporting randomized controlled trials.

Participants

Participants in this study were patients with MPS of the upper trapezius muscle. Inclusion criteria were: (1) presence of trigger points, especially in the upper trapezius muscle diagnosed with MPS by a rehabilitation medicine physician, (2) pain intensity level of 5 or higher on a scale of 0-10, (3) age 18 and above, (4) no communication barriers, and (5) willingness to participate in the research. Exclusion criteria included (1) a history of cancer-related pain, (2) pain related to abnormalities in the nervous system, such as nerve compression in the neck or wrist, and brachial plexus injuries, (3) infection in the treatment area, (4) a history of easy bleeding, and (5) conditions affecting learning and memory. The number of participants included in this study was determined based on studies by Afniratri et al.[13] The sample size was calculated using the G Power program, with the numeric rating scale (NRS) as the primary outcome variable.[13] The required sample size was determined to be 27 participants per group, a total of 54, which is sufficient to detect a clinically meaningful difference with 80.0% power at a 5.0% significance level and to account for a potential combined dropout rate of 10.0%.

Therefore, the sample size obtained was 60 participants. All participants provided written informed consent.

Randomization

Eligible patients who consented to participate in the study were allocated into one of two groups using a simple randomization method, in which each participant randomly selected a sealed envelope containing the assigned treatment group.

Intervention

One group was treated by an acupuncture physician using acupuncture at points GB20, SI11, DU14, SI15, GB21, and EX-HN15, along with electrical stimulation using a Greatwall brand KWD-808 I Multipurpose health device. The acupuncture points were stimulated in pairs: GB20 with EX-HN15 and GB21 with SI11. Continuous wave electrical stimulation was applied at a tolerable current level for 25 minutes. The other group was treated by a physical therapist with USD using the Sonopuls 190 at a frequency of 1 MHz and an intensity of 0.8-1 watt/sq.cm. The treatment duration was 5-10 minutes per session. Both groups received treatment twice a week for a total of four weeks. Patients were also instructed to perform upper trapezius muscle stretching exercises 5-10 times, twice a day. During the four-week data collection period following this intervention, additional treatments such as other medications were not allowed, except for acetaminophen.

Outcome measurement

The primary outcome measures were the NRS and the Thai version of the Neck Disability Index (Thai-NDI) scores, both self-reported and assessed before the intervention and at week 4 after treatment. Participants documented the number of acetaminophen tablets consumed and the number of days on which stretching exercises were performed. Throughout the study, they were also monitored for any adverse effects related to the intervention.

Statistical methods

This study analyzed the demographic characteristics of both groups using the mean (standard deviation), percentage, and median (interquartile range). The paired t-test was used to measure NRS and Thai-NDI scores before and after treatment within each group. The independent t-test was used to compare NRS, Thai-NDI scores, and amounts of drug use between groups. The chi-square test was used to compare muscle stretching between groups. Statistical significance was set at $p < 0.05$.

Results

Figure 1 shows the study flowchart. Among the sample group of 60 patients, divided equally into acupuncture and USD treatment groups (30 participants each), the general characteristics were as follows. The majority were female (83.3%), with a mean age of 49.9 years (SD = 11.3). Half of the participants were between 41 and 60 years old (50.0%). The most common occupation was that of a government official or company employee (33.3%). The average BMI was 22.9 kg/m², with approximately 25.0% classified as overweight (BMI between 23.0 and 24.9 kg/m²). In terms of education, most participants held a bachelor's degree or higher (61.7%). The average duration of symptoms was 4.5 months, with most individuals (53.3%) reporting symptoms for three months or longer. The most common area of pain was bilateral at 58.3%. Comparison of general and clinical characteristics between the acupuncture and USD treatment groups revealed no statistically significant differences, as shown in Table 1.

Comparison of pre- and post-treatment results found that in the acupuncture group, the mean NRS before treatment was 7.13 (SD = 1.36), which decreased significantly to 3.43

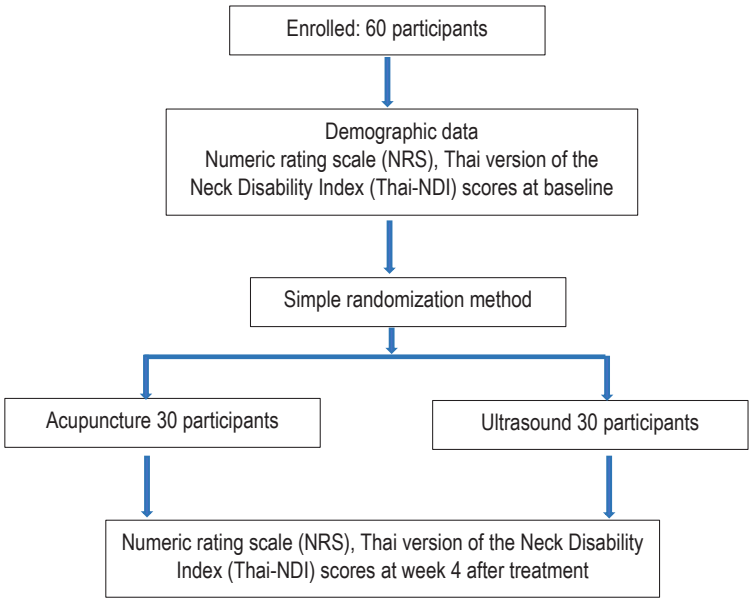


Figure 1. Flow diagram of the participants

(SD = 1.72) after treatment ($p < 0.001$). The mean score for the Thai-NDI scores before treatment was 18.90 (SD = 7.19), dropping to 10.10 (SD = 6.25) after treatment, also a statistically significant decrease ($p < 0.001$). In the USD group, the mean NRS before treatment was 7.17 (SD = 1.42) and decreased to 4.50 (SD = 2.30) after treatment, a statistically significant difference ($p < 0.001$). The mean Thai-NDI scores before treatment were 21.70 (SD = 6.93) and decreased to 12.77 (SD = 6.40) after treatment, also a statistically significant difference ($p < 0.001$), as shown in Tables 2 and 3.

Comparison between groups found that the NRS in the group receiving acupuncture averaged 7.13 (SD = 1.36) before treatment, while the group receiving USD had a pre-treatment mean score of 7.17 (SD = 1.42). There was no statistically significant difference between the two groups at baseline. After treatment, both groups showed reduced pain scores, with means of 3.43 (SD = 1.72) and 4.5 (SD = 2.3), respectively, a statistically significant difference (p = 0.046). Regarding the Thai-NDI scores, the acupuncture group had a mean pre-treatment NDI score of 18.9 (SD = 7.19), while

Table 1. Comparison of patient demographic data and baseline characteristics of the groups

Patient characteristic	Total (n = 60)	Acupuncture (n = 30)	Ultrasound (n = 30)	*p*-value
Sex[1]				1.00
Male	10 (16.7)	5 (16.7)	5 (16.7)	
Female	50 (83.3)	25 (83.3)	25 (83.3)	
Age, mean (SD)	49.9 (11.3)	50.3 (12.7)	49.4 (9.9)	0.761
18-40[1]	18 (30.0)	10 (33.3)	8 (26.7)	
41-60[1]	30 (50.0)	12 (40.0)	18 (60.0)	
> 60[1]	12 (20.0)	8 (26.7)	4 (13.3)	
Occupation[1]				0.460
Government official/company employee	20 (33.3)	11 (36.7)	9 (30.0)	
Housekeeping/retired	19 (31.7)	10 (33.3)	9 (30.0)	
Trade/manual labor	15 (25.0)	5 (16.7)	10 (33.3)	
Agriculture/gardening	6 (10.0)	4 (13.3)	2 (6.7)	
BMI, median (IQR)	22.9 (20.5-25.3)	22.5 (19.8-26.6)	23.1 (20.8-25.0)	0.882
< 18.5 underweight[1]	3 (5.0)	1 (3.3)	2 (6.7)	
18.5-22.9 optimum[1]	27 (45.0)	14 (46.7)	13 (43.3)	
23.0-24.9 overweight[1]	15 (25.0)	7 (23.3)	8 (26.7)	
25.0-29.9 class1 obesity[1]	12 (20.0)	5 (16.5)	7 (23.3)	
≥ 30.0 class 2 obesity[1]	3 (5.0)	3 (10.0)	0 (0.0)	
Education level[1]				0.717
Primary education/no schooling	5 (8.3)	3 (10.0)	2 (6.7)	
Secondary education/associate degree	18 (30.0)	10 (33.3)	8 (26.7)	
Bachelor's degree/higher than bachelor's degree	37 (61.7)	17 (56.7)	20 (66.7)	
Duration of symptoms, median (IQR)	4.5 (1-24)	4.5 (2-24)	4 (1-13.5)	0.457
≤ 3 months (acute)[1]	28 (46.7)	13 (43.3)	15 (50.0)	
> 3 months (chronic)[1]	32 (53.3)	17 (56.7)	15 (50.0)	
Position[1]				0.942
Right	14 (23.3)	7 (23.3)	7 (23.3)	
Left	11 (18.3)	5 (16.7)	6 (20.0)	
Bilateral	35 (58.3)	18 (60.0)	17 (56.7)	

[1], Number (%); IQR, interquartile range SD, standard deviation; BMI, body mass index;

Table 2. Comparison of the numeric rating scale (NRS) and the Thai version of the Neck Disability Index (Thai-NDI) scores at baseline and at week 4 after treatment

Scores	Baseline		Week 4		*p*-value[a]
	Mean	SD	Mean	SD	
Acupuncture (n = 30)					
NRS	7.13	1.36	3.43	1.72	< 0.001*
Thai-NDI	18.90	7.19	10.10	6.25	< 0.001*
Ultrasound (n = 30)					
NRS	7.17	1.42	4.50	2.30	< 0.001*
Thai-NDI	21.70	6.93	12.77	6.40	< 0.001*

*Statistically significant: $p < 0.05$, statistic used; [a], Paired t-test

Table 3. Scoring intervals of the Thai version of the Neck Disability Index (Thai-NDI) scores at baseline and at week 4 after treatment

Thai-NDI	Baseline		Week 4	
	n	%	n	%
Acupuncture (n = 30)				
0 -4 no disability	0	0.0	5	16.7
5-14 mild disability	11	36.7	19	63.3
15-24 moderate disability	11	36.7	5	16.7
25-34 severe disability	8	26.7	1	3.3
> 35 complete disability	0	0.0	0	0.0
Ultrasound (n = 30)				
0-4 no disability	0	0.0	2	6.7
5-14 mild disability	6	20.0	19	63.3
15-24 moderate disability	12	40.0	7	23.3
25-34 severe disability	10	33.3	1	3.3
> 35 complete disability	2	6.7	1	3.3

Table 4. Comparison of the numeric rating scale (NRS) and the Thai version of the Neck Disability Index (Thai-NDI) scores between the acupuncture group and the USD group

Scores	Acupuncture (n = 30)		Ultrasound (n = 30)		*p*-value[a]
	Mean	SD	Mean	SD	
NRS					
Baseline	7.13	1.36	7.17	1.42	0.926
Week 4	3.43	1.72	4.50	2.30	0.046*
NDI					
Baseline	18.90	7.19	21.70	6.93	0.130
Week 4	10.10	6.25	12.77	6.40	0.108

*Statistically significant at $p < 0.05$, statistical use; [a],Independent t-test

the USD group had a pre-treatment mean of 21.7 (SD = 6.93). The difference between groups was not statistically significant. After treatment, both groups had reduced NDI scores, with mean values of 10.10 (SD = 6.25) and 12.77 (SD = 6.40), respectively, but was not statistically significant as shown in Table 4.

Comparison of acetaminophen usage and muscle stretching between the acupuncture group and the USD group found no statistically significant differences between the two groups as shown in Table 5.

Discussion

Pre- and post-treatment results revealed significant declines in both NRS and Thai-NDI scores in the acupuncture group after treatment ($p < 0.001$). This finding is consistent with a study by Li et al., which found that acupuncture therapy was effective in decreasing pain and improving physical function.[14] Similarly, a meta-analysis study by Saraspuri, et.al. concluded that acupuncture therapy was effective in reducing pain in cases of upper trapezius myofascial pain syndrome, and that a significant improvement was observed in pain measured with the Visual Analogue Scale (VAS).[15]

Table 5. Comparison of the use of acetaminophen and muscle stretching between the acupuncture group and the ultrasound diathermy group

	Acupuncture (n = 30)	Ultrasound (n = 30)	*p*-value
Acetaminophen, mean (SD)	1.07 (3.2)	1.33 (2.4)	0.719[a]
0 tablet[1]	25 (83.3)	21 (70.0)	
≥ 1 tablet[1]	5 (16.7)	9 (30.0)	
Stretching exercise[1]			0.121[b]
Everyday	14 (46.7)	21 (70.0)	
5-6 days/week	3 (10.0)	3 (10.0)	
3-4 days/week	6 (20.0)	4 (13.3)	
1-2 days/week	7 (23.3)	1 (3.3)	
No	0 (0.0)	1 (3.3)	

[1]Number (%); [a]Independent t-test; [b]Chi-square test

Additionally, a growing body of evidence supports the efficacy of acupuncture in treating myofascial pain.[4] It was found that electroacupuncture is a reliable method for relieving myofascial pain. Electroacupuncture, which involves passing an electrical current through the needle, is believed to be more effective in alleviating pain than manual acupuncture. The mechanisms of action of electroacupuncture indicate that endogenous opioid peptides in the central nervous system mediate the analgesic effects produced by this treatment. Electroacupuncture applied at acupuncture points to stimulate muscle nociceptors in turn activate the body's endogenous antinociceptive system.[16]

Similarly, in the group treated with USD, both the NRS and the Thai-NDI scores showed a statistically significant reduction after treatment ($p < 0.001$). This finding is consistent with the results of a randomized, single-blind, placebo-controlled study on the effectiveness of ultrasound therapy for myofascial pain syndrome of the upper trapezius which also found that conventional ultrasound therapy is effective in treating this condition.[17] USD is a frequently used physical agent in soft tissue lesions, which increases blood flow in tissues through its thermal effect, enhances permeability in membranes, and promotes tissue healing. It also reduces muscle spasms and increases the ability of collagen fibers to grow. In addition to its physiological effects and segmental analgesia, which include nonthermal effects, it also has a micromassage effect that enables the movement of interstitial fluid in tissues.[17, 5]

When comparing treatment outcomes between acupuncture and ultrasound therapy, acupuncture was found to be more effective, as indicated by lower post-treatment pain scores on the NRS ($p = 0.046$). Mean pain scores declined from 7.13 (SD = 1.36) to 3.43 (SD = 1.72) in the acupuncture group and from 7.17 (SD = 1.42) to 4.50 (SD = 2.30) in the ultrasound therapy group, with the acupuncture group showing greater improvement. After treatment, the pain score in the acupuncture group decreased to a mild pain level, demonstrating significant improvement, whereas the post-treatment

pain score in the ultrasound therapy group remained at a moderate pain level, reflecting less improvement.[18, 19]

Acupuncture appears to effectively alleviate pain and reduce inflammation.[9] In addition, a meta-analysis indicated that patients receiving acupuncture had significantly lower pain scores compared to a placebo group.[15] Moreover, it was found that relevant acupuncture (over points relevant to myofascial neck pain) was superior to both NSAID treatment and irrelevant acupuncture (superficial needling over points not related to neck pain) in a group of 46 patients with chronic myofascial pain. Interestingly, a remarkably close correspondence has been found between acupuncture points and trigger points, with 71.0% of trigger points sharing location and pain distribution patterns with acupuncture points.[4] This may be attributed to the similarities between acupuncture and dry needling, where needles are inserted into myofascial trigger points. The insertion and movement of the needles can elicit localized twitch responses, which may interrupt motor end-plate noise and lead to pain reduction. The occurrence of a localized twitch response is similar to the "de qi" sensation experienced during acupuncture treatment.[20] USD is a technique that has been proposed to treat myofascial pain by converting electrical energy to sound waves in order to provide heat energy to muscles.[5] Multiple studies of ultrasound on MPS have been conducted; however, most have demonstrated mixed results. In one recent RCT study on the treatment of latent MPS of the trapezius, ultrasound decreased the basal level of electrical activity and reduced the sensitivity of the trigger points.[5] Another study compared the use of pressure release, hydrocortisone phonophoresis, ultrasound therapy, and a placebo for the treatment of upper trapezius myofascial trigger points. All three treatment groups demonstrated a statistically significant decrease in pain and an increase in pain threshold and range of motion ($p < 0.001$). Pressure release and phonophoresis had superior therapeutic effects compared to ultrasound.[21] Similarly, another study concluded no statistically significant difference in reduction of pain or analgesic usage between ultrasound plus massage, sham ultrasound plus massage, and exercise versus control.[22]

When comparing treatment outcomes between acupuncture and ultrasound treatment, Thai-NDI scores showed that both groups experienced a reduction in NDI scores after treatment, with no statistically significant difference observed between the groups. The Thai-NDI scores are used to measure the ability of the neck to manage daily life. A comprehensive approach, including maintaining good posture through stretching and relaxation exercises as well as lifestyle changes, is essential in addition to treatment for therapeutic efficiency.[4]

There are many theories that may explain how acupuncture works. The gate control theory of pain postulates that specific nerve fibers transmit a pain signal to the brain via the spinal cord, and that input from other nerve fibers can inhibit the pain signal transmission. Acupuncture is thought to stimulate inhibitory nerve fibers for a short period, thus reducing transmission of the pain signal to the brain. Endorphin Model clinical studies have reported that inserting acupuncture needles into specific acupuncture points triggered the production of endorphins in cerebrospinal fluid in patients who underwent acupuncture treatments.[9, 15] Recent research has found that traditional Chinese medicinal acupuncture therapy has a greater direct effect on the up-regulation of μ-opioid receptor binding availability in the central nervous system compared with a placebo (sham acupuncture). This finding may help explain some of the analgesic effects seen with acupuncture therapy.[9] Research in a neurotransmitter model in animals has shown that acupuncture can modulate the levels of serotonin, norepinephrine, and neurons that secrete γ-aminobutyric acid. It is postulated that through the neurotransmitter model, acupuncture can be efficacious for the treatment of depression, anxiety, and addiction.[9] Other theories postulate that acupuncture indirectly influences the autonomic nervous system. The current scientific theories provide a basis for stating that acupuncture affects the nervous system; however, its effects cannot be explained by a single mechanism.[9] Acupuncture analgesia involves the cerebral cortex, hypothalamus, thalamus, and limbic system.[9,15] Additionally, in reducing pain intensity, acupuncture operates through four domains: local inflammatory reaction, meridian intercellular transduction, cutaneous somatovisceral reflex, and neural transmission to the brain.[15]

Acupuncture is based on the idea that living beings have an inner energy, known as Qi (pronounced "chee"), and it is the flow of this inner energy that sustains them. According to traditional Chinese medical philosophy, balanced Qi is vital to optimal health and the imbalance or interruption in the flow of Qi causes illness and disease. Although acupuncture was developed for the prevention of illness, it also helps manage disease symptoms by reintroducing a balanced flow of Qi, its main focus.[9] Based on an ancient philosophy, acupuncture serves to circulate energy (Qi) through 12 meridians all over the body. Pain may occur when circulation in meridians is blocked; hence, it requires stimulation at several points to restore the fluency of energy circulation (Qi).[9,15] The overall effectiveness of acupuncture has been found to help reduce pain, promote muscle relaxation, improve psychological well-being, and especially facilitate the restoration of body balance (by restoring the balanced flow of Qi). Acupuncture treatment has demonstrated favorable outcomes and can be considered both an appropriate treatment option and a valuable alternative therapy.

Adverse events related to ultrasound therapy may include skin irritation, although this is a minor and rare side effect. Several studies suggest that therapeutic ultrasound is a safe treatment.[6] A study conducted in the United Kingdom examining more than 34,000 acupuncture treatments found no serious adverse events (e.g., hospitalization, permanent disability, or death) associated with acupuncture therapy. The

rate of minor adverse events (such as nausea, fainting, prolonged aggravation of existing symptoms, and psychological or emotional reactions) was reported to be between 0 and 1.1 per 10,000 treatments. Acupuncture involves puncturing the skin, so slight bruising, bleeding, or soreness at the acupuncture site may occur due to needle penetration through capillaries. However, these adverse effects are mild and self-limited. Modern acupuncture needles are thin, flexible, and made of solid surgical stainless steel. Unlike hypodermic needles, acupuncture needles are finely tapered, allowing them to slide smoothly into the skin. Some acupuncture needles are even thinner than an average strand of human hair. In developed countries, acupuncture uses single-use, disposable needles that are packaged and sealed by the manufacturer under sterile conditions. Patients are often surprised to learn that acupuncture is associated with minimal or no discomfort. Some experience a slight pinch as the needles are inserted, but many feel no pain at all.[9] In this study, no side effects or serious complications were observed in either group.

Limitations of this study include its open-label design, short-term follow-up period, and lack of a cost-effectiveness analysis.

Suggestions for future research projects include conducting large, randomized, blinded, controlled trials to confirm these results. A cost-effectiveness comparison between the two treatments could also be conducted to evaluate their relative value.

Conclusions

Compared to ultrasound, acupuncture twice weekly for 4 weeks can be a more effective treatment for pain relief in patients with neck pain from myofascial pain of the upper trapezius.

Conflict of interest declaration

The author confirms that there is no conflict of interest related to the manuscript.

Generative AI declaration

The author confirms that no large language models (LLMs) or artificial intelligence (AI) tools were used in the creation of this manuscript, including the writing, editing, or preparation of figures and tables, with the exception of using Copilot for assistance in checking and refining the English language.

Acknowledgments

I would like to express my gratitude to all the colleagues and participants at Rayong Hospital, Thailand.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability

The data that support the findings of this study are available from the corresponding author, Suwimon Sangiamsak, upon reasonable request.

Author contribution

Suwimon Sangiamsak: conceptualization, methodology, data curation, formal analysis, investigation, writing – original draft, and writing – review & editing.

References

1. Fejer R, Kyvik KO, Hartvigsen J. The prevalence of neck pain in the world population: a systematic critical review of the literature. Eur Spine J [Internet]. 2006 Jun [cited 2023 Sep 16];15(6):834-848. Available from: https://pubmed.ncbi.nlm.nih.gov/15999284/ doi: 10.1007/s00586-004-0864-4
2. Hoy DG, Protani M, De R, Buchbinder R. The epidemiology of neck pain. Best Pract Res Clin Rheumatol [Internet]. 2010 Dec [cited 2023 Sep 16];24(6):783-792. Available from: https://pubmed.ncbi.nlm.nih.gov/21665126/ doi: 10.1016/j.berh.2011.01.019
3. Simons DG. Clinical and etiological update of myofascial pain from trigger points. Journal of musculoskeletal pain [Internet].1996 Apr [cited 2023 Sep 16];4:93-122. Available from: https://www.tandfonline.com/doi/abs/10.1300/j094v04n01_07/ doi: abs/10.1300/j094v04n01_07
4. Borg-stein J, Simons DG. Myofascial pain. Arch Phys Med Rehabil [Internet]. 2002 Mar [cited 2023 Sep 16];83(3):S40-47. Available from: https://pubmed.ncbi.nlm.nih.gov/11973695/ doi: 10.1053/apmr.2002.32155
5. Desai MJ, Saini V, Saini S. Myofascial pain syndrome: a treatment review. Pain Ther [Internet]. 2013 Jun [cited 2023 Sep 17];2(1):21-36. Available from: https://pubmed.ncbi.nlm.nih.gov/25135034/ doi: 10.1007/s40122-013-0006-y
6. Qing W, Shi X, Zhang Q, Peng L, He C, Wei Q. Effect of therapeutic ultrasound for neck pain: a systematic review and meta-analysis. Arch Phys Med Rehabil [Internet]. 2021 Nov [cited 2023 Sep 17];102(11):2219-2230. Available from: https://pubmed.ncbi.nlm.nih.gov/33722564/ doi: 10.1016/j.apmr.2021.02.009
7. Esenyel M, Caglar N, Aldemir T. Treatment of myofascial pain. Am J Phys Med Rehabil [Internet]. 2000 Jan-Feb [cited 2023 Sep 17];79(1): 48-52 Available from: https://pubmed.ncbi.nlm.nih.gov/10678603/ doi: 10.1097/00002060-200001000-00011
8. Sinlamuth O, Satharanaporn S, Thirasakthana J, Sintuhsing J, Thammapongpan N, Sopasai K, et al. Research advances in treating cervical spondylosis with acupuncture and tuina massage. Thailand Journal of Traditional Chinese Medicine [Internet]. 2023 Jun [cited 2023 Sep 17];2(1):129-141 Available from: https://he01.tci-thaijo.org > article > download (In Thai)
9. Chon TY, Lee MC. Acupuncture. Mayo Clin Proc [Internet]. 2013 Oct [cited 2023 Oct 5];88(10):1141-1146 Available from: https://pubmed.ncbi.nlm.nih.gov/24079683/ doi: 10.1016/j.mayocp.2013.06.009

10. Buranathavornsak T, Piyaman S. Acupuncture in medical practice: 40 years of Professor Yan Li's experience. Bangkok: Phumthong; 2009. 144 p. (In Thai)
11. Trinh K, Graham N, Gross A, Goldsmith C, Wang E, Cameron I, et al. Acupuncture for neck disorders. Spine [Internet]. 2007 Jan [cited 2023 Sep 17];32(2): 236-243 Available from: https://pubmed.ncbi.nlm.nih.gov/17224820/ doi: 10.1097/01.brs.0000252100.61002.d4.
12. Ga H, Choi JH, Park CH, Yoon HJ. Acupuncture needling versus lidocaine injection of trigger points in myofascial pain syndrome in elderly patients – a randomised trial. Acupunct Med [Internet]. 2007 Dec [cited 2023 Sep 17];25(4): 130-136 Available from: https://pubmed.ncbi.nlm.nih.gov/18160923/ doi: 10.1136/aim.25.4.130
13. Afniratri A, Badri S, Wardoyo SH. Effect of combination therapy using ultrasound and local point acupuncture to reduce neck pain. The 9th International Conference on Public Health [Internet]. 2022 Nov [cited 2023 Sep 21];7(1):460-465 Available from: https://theicph.com/index.php/icph/article/view/2419 doi: 10.26911/FP.ICPH.09.2022.32
14. Li X, Wang R, Xing X, Shi X, Tian J, Zhang J, et al. Acupuncture for myofascial pain syndrome: a network meta-analysis of 33 randomized controlled trials. Pain Physician [Internet]. 2017 Sep [cited 2025 Jul 25];20(6):E883-E902 Available from: https://pubmed.ncbi.nlm.nih.gov/28934793/
15. Saraspuri NPK, Tamtomo D, Murti B. Effectiveness of acupuncture therapy to reduce pain in patients with upper trapezius myofascial pain syndrome: a meta-analysis. Indonesian Journal of Medicine [Internet]. 2022 Jul [cited 2025 Jul 14];07(3):326-336 Available from: https://theijmed.com/index.php/theijmed/article/view/561 doi: 10.26911/theijmed.2022.07.03.09
16. Aranha MFM, Alves MC, Bérzin F, Gavião MBD. Efficacy of electroacupuncture for myofascial pain in the upper trapezius muscle: a case series. Brazilian Journal of Physical Therapy [Internet]. 2011 Sept/Oct [cited 2025 Jul 14];15(5):371-379 Available from: https://pubmed.ncbi.nlm.nih.gov/22002184/. doi: 10.1590/s1413-35552011005000022
17. Yildirim MA, Ones K, Goksenoglu G. Effectiveness of ultrasound therapy on myofascial pain syndrome of the upper trapezius: randomized, single-blind, placebo-controlled study. Arch Rheumatol [Internet]. 2018 Mar [cited 2025 Jul 25];33(4):418-423 Available from: https://pubmed.ncbi.nlm.nih.gov/30874250/ doi: 10.5606/ArchRheumatol.2018.6538
18. Baranidharan G, Williams A, Wilson S, Cameron P, Tan T. Outcome Measures Guidance Document. [Internet]. London: Churchill House; 2019 [cited 2025 Oct 11]. Available from: https://www.britishpainsociety.org/static/uploads/resources/files/Outcome_Measures_January_2019.pdf
19. Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, et al. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. PAIN [Internet]. 2005 Jan [cited 2025 Oct 11];113(1-2):9-19. Available from: https://pubmed.ncbi.nlm.nih.gov/15621359/ doi:10.1016/j.pain.2004.09.012
20. Wang CC, Huang TH, Chiou KC, Chang ZY. Therapeutic effect of superficial acupuncture in treating myofascial pain of the upper trapezius muscle: a randomized controlled trial. Evid Based Complement Alternat Med [Internet]. 2018 Dec [cited 2025 Jul 14];2018:1-7 Available from: https://pubmed.ncbi.nlm.nih.gov/30622617/ doi: 10.1155/2018/9125746
21. Sarrafzadeh J, Ahmadi A, Yassin M. The effects of pressure release, phonophoresis of hydrocortisone, and ultrasound on upper trapezius latent myofascial trigger point. Arch Phys Med Rehabil [Internet]. 2012 Jan [cited 2025 Jul 14];93(1): 72-77 Available from: https://pubmed.ncbi.nlm.nih.gov/21982324/ doi: 10.1016/j.apmr.2011.08.001
22. Gam AN, Warming S, Larsen LH, Jensen B, Hoydalsmo O, Allon I, et al. Treatment of myofascial trigger-points with ultrasound combined with massage and exercise—a randomised controlled trial. Pain [Internet]. 1998 Jul [cited 2025 Jul 14];77(1): 73-79. Available from: https://pubmed.ncbi.nlm.nih.gov/9755021/ doi: 10.1016/S0304-3959(98)00084-0

Original Article

Survival Analysis of Amyotrophic Lateral Sclerosis: An Ambispective Cohort Study in a Thai Tertiary Care Center

Chinakit Idsaraphorn[1], Preeda Arayawichanon[1], Jukrapope Jitpimolmard[2], Pitchaya Wiratchotisatian[3] and Nantaporn Jitpimolmard[1]

[1]Department of Rehabilitation Medicine, Faculty of Medicine, [2]The National Phenome Institute, Office of the President, [3]Department of Statistics, Faculty of Science, Khon Kaen University, Thailand

ABSTRACT

Objectives: To determine the median survival time and identify independent prognostic factors for mortality in amyotrophic lateral sclerosis (ALS) patients at a tertiary-care hospital in Thailand.

Study design: Ambispective cohort study

Setting: Outpatient rehabilitation department of a tertiary care hospital in Thailand

Participant: Forty-four patients diagnosed with ALS according to the Awaji criteria

Methods: We analyzed clinical data from patients treated between January 2012 and July 2022. Survival time curves were generated using the Kaplan-Meier method. To identify predictors of mortality, a full multivariable Cox proportional hazards model was first constructed, followed by a parsimonious model retaining variables with $p < 0.20$.

Results: The cohort had a male-to-female ratio of 1.3:1 and a mean age at onset of the study of 56.6 years. The median overall survival time from symptom onset to death was 37.0 months (95%CI: 31.0, 44.0). In the final multivariable Cox model (C-index = 0.80), a longer interval from symptom onset to diagnosis was the only statistically significant independent predictor of improved survival time (HR = 0.11, 95%CI: 0.01, 0.90, $p = 0.04$). While the presence of major complications (HR = 3.05, $p = 0.06$), hypertension (HR = 2.98, $p = 0.08$), and male sex (HR = 2.24, $p = 0.17$) showed strong clinical trends toward increased mortality, none reached statistical significance in the refined model. Riluzole use was not associated with a survival benefit in this cohort (HR = 0.77, $p = 0.74$).

Conclusions: The median survival time of Thai ALS patients was 37 months. The time from symptom onset to diagnosis is a key indicator of survival time, likely reflecting the underlying biological speed of the disease. While complications and comorbidities such as hypertension influence the clinical course, larger multicenter studies are needed to validate these prognostic markers in the Southeast Asian population.

Keywords: amyotrophic lateral sclerosis, motor neuron disease, survival analysis, prognosis, tertiary-care hospital

ASEAN J Rehabil Med. 2026; 36(2): 65-70.

Introduction

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease with a global incidence of 1.7 per 100,000, primarily affecting males between ages 55-75.[1,2] Diagnosis relies on clinical and electrodiagnostic evidence of multi-regional denervation. While most cases present with asymmetric limb weakness, approximately 20.0% involve bulbar onset, which significantly increases mortality risk through early dysphagia and respiratory complications.[1,2]

Clinical phenotype and subsequent survival rates exhibited significant geographic and ethnic variability. A comprehensive meta-analysis by Marin et al. highlighted this heterogeneity, reporting median survival times from symptom onset ranging from 24 months in Northern Europe to 48 months in Central Asia.[3] These discrepancies suggest that a complex interplay of local demographic, genetic, and environmental factors influences disease progression. Supporting this, individual country studies have reported vastly different outcomes. For instance, an extensive Indian cohort (n = 1,153) demonstrated an overall median survival time of 114.8 months, with limb-onset patients surviving significantly longer (177.9 months) than those with bulbar onset (55.9 months).[4] Conversely, a Mexican series reported a much shorter mean survival time of 64.7 months.[5] Such regional variations underscore the necessity of robust local data, particularly in understudied populations.

Identifying reliable prognostic factors is essential for accurate clinical counseling and for optimizing multidisciplinary care. While bulbar-onset, advanced age, and rapid functional decline are established predictors of shorter survival time,[4,5] the relative impact of these factors appears to vary by population. Notably, while some Asian cohorts report exceptionally prolonged survival exceeding 100 months, data from Southeast Asia remains notably scarce.[4,6]

In Thailand, existing research is currently limited to small, retrospective samples that constrain the precision of survival time estimates.[6] Furthermore, Thai patients often face signifi-

Correspondence to: Nantaporn Jitpimolmard, MD, FRCPhysiatrT; Department of Rehabilitation Medicine, Faculty of Medicine, Khon Kaen University, Thailand Address: 123 Mittraphap Rd, Nai Mueang, Mueang, Khon Kaen 40002, Thailand; E-mail: nantano@kku.ac.th

Received: November 11, 2025 Revised: December 20, 2025 Accepted: February 1, 2026

cant diagnostic delays, which may obscure the relationship between disease velocity and outcomes. Consequently, this study aimed to evaluate median survival time and identify independent predictors of mortality in a cohort of Thai ALS patients treated at a university hospital over a period of 10 years. By analyzing variables such as onset site, sex, and the timing of major complications, we sought to provide locally relevant data to enhance clinical management in the region.

Methods

Study design

This ambispective cohort study included ALS patients who received care at Srinagarind Hospital, Faculty of Medicine, Khon Kaen University between January 2012 and July 2022. This study was conducted and reported in accordance with the STROBE guidelines. It was approved by the Khon Kaen University Human Research Ethics Committee (HE661049).

Inclusion criteria: 1) diagnosis of ALS confirmed by a neurologist according to the Awaji criteria[7] during the study period; 2) having undergone electrodiagnostic testing to ensure diagnostic certainty and exclude ALS mimics; 3) The absence of other chronic comorbidities likely to cause long-term complications affecting outcomes (e.g., stroke, spinal cord pathology, chronic obstructive pulmonary disease).

Exclusion criteria: Incomplete medical records that precluded the determination of the survival time or key baseline characteristics.

Data collection

Medical records including electronic medical records (EMR) were searched using ICD-10 code G12.2 for the study period. Data collected included sex, comorbidities, age at symptom onset, age at diagnosis, clinical onset region (spinal vs bulbar), clinical manifestations before diagnosis (spinal, bulbar, or both), interval from symptom onset to diagnosis, major complications (aspiration pneumonia, tracheostomy, bedridden status, enteral feeding via NG or PEG), death and time from onset to death, cause of death, and riluzole use. To ensure robust analysis, hospital records were cross-referenced to fill in missing information on complications, yielding a dataset with no missing values for the primary predictive variables.

If records were incomplete or patients were lost to follow-up, researchers mailed information and consent forms to the patients or their relatives. A telephone follow-up was conducted when consent was provided. If no response was received, the analysis used all available data up to the patient's most recent visit at University Hospital, resulting in censoring at that date.

Sample size calculation

The sample size for this descriptive study was determined based on the precision required for estimating the median survival time. Based on preliminary data suggesting a mean survival of approximately 65 months and a 5-year survival rate of 44.4%, we anticipated that a significant number of events would occur during follow-up.[5]

A sample size of 44 patients was chosen to achieve an acceptable level of precision for the median survival time estimate. With this sample size, it was projected that the 95% confidence interval (CI) for the median survival time would have a total width of approximately 35-40 months. Calculations were based on the method described by Machin et al.[8] for precision-based sample size estimation.

Statistical analysis

Analyses were performed using Python version 3.12.12 (CPython) on the Google Collaboratory platform. Descriptive statistics are reported as mean and standard deviation (SD) or median (interquartile range, IQR). Continuous variables, including the onset-to-diagnosis interval and age at onset, were included in the Cox proportional hazards model in their original units (months and years). The lifelines library (version 0.30.0) was used to fit Cox proportional hazards models.

Overall survival time was defined as the number of months from symptom onset to death; patients alive at last contact were censored at the date of last follow up. Survival time curves were estimated using the Kaplan-Meier method and compared using the Log-Rank test. The proportional hazards assumption was verified for all covariates using the Schoenfeld residuals test and visual inspection of log-minus-log plots before multivariable modeling. Given the limited sample size and number of observed events, this study was designed as an exploratory analysis. Consequently, the variable selection process and multivariable modeling were conducted with an exploratory strategy aimed at identifying potential prognostic factors and generating hypotheses rather than confirming definitive causal relationships.

To determine the independent predictors of survival time, we initially constructed a full multivariable Cox proportional hazards model incorporating clinically relevant covariates. Covariates were coded as follows: age at onset (continuous, per 1 year increase), sex (male vs female), onset region (spinal vs bulbar), time from symptom onset to diagnosis (continuous, per month), underlying diseases (hypertension, diabetes mellitus, dyslipidemia), riluzole use (yes vs no), and major complications (baseline binary: present vs absent). Variables were selected a priori on clinical grounds.

Subsequently, to derive a stable and parsimonious final model, variables were retained only if they exhibited a $p < 0.20$ in the full model adjustment. This selection criterion was adopted to balance the need to control for potential confounders while minimizing model complexity, given the limited number of events.[9] To ensure model stability, we formally assessed multicollinearity among predictors using Variance Inflation Factors (VIF). Furthermore, to address the potential for overfitting due to the low events-per-variable ratio, we performed a sensitivity analysis using Ridge-penalized Cox regression (L2 regularization), which shrinks coefficients to

provide more stable estimates in small-sample settings.[10] Hazard ratios (HR) and 95% CI were calculated for the final model, with statistical significance for the final independent predictors defined at $p < 0.05$.

Results

A total of 44 ALS patients diagnosed according to the Awaji criteria[7] were included in the study. The cohort consisted of 25 males (56.8%) and 19 females (43.2%), yielding a male-to-female ratio of 1.3:1. The mean age at symptom onset was 56.6 years (SD = 7.6), and the mean age at diagnosis was 57.8 years (SD = 7.6). The mean interval from symptom onset to diagnosis was 13.2 months (SD = 9.8).

Regarding clinical presentation, spinal onset occurred in 34 patients (77.3%) and bulbar onset in 10 patients (22.7%). At the time of diagnosis, the majority of patients presented with widespread involvement of the upper and lower extremities and the bulbar region (n = 23, 52.3%). The most common comorbidities were hypertension (25.0%) and diabetes mellitus (18.2%), although the majority of participants (63.6%) had no underlying disease.

Complications were observed in 22 of the cohort (50.0%). The most frequent complications included bedridden status (31.8%), aspiration pneumonia (18.2%), and the requirement for nutritional support via NG tube or PEG (18.2%). Only 13 patients (29.5%) received Riluzole therapy.

By the end of the study period, 18 patients (40.9%) had died, while 26 (59.1%) were censored (alive or lost to follow-up). The median follow-up time was 22.8 months (IQR: 6.4, 30.0). Causes of death among the 18 decedents included sudden cardiac arrest (n = 10, 55.6%), pneumonia (n = 7, 38.9%), and myocardial infarction (n = 1, 5.6%). Patients who died had a notably higher rate of complications compared to the censored group, particularly regarding bedridden status (72.2% vs. 3.8%) and aspiration pneumonia (44.4% vs. 0%). (Table 1)

The median overall survival time for the entire cohort of ALS patients was 37.0 months (95%CI: 31.0, 44.0). Estimated survival probabilities were 97.4% at 12 months, 85.9% at 24 months, 54.8% at 36 months, 27.7% at 48 months, and 13.8% at 60 months (Figure 1).

To identify independent predictors of survival time, we

Table 1. Demographic and clinical characteristics of ALS patients

Clinical characteristics	Total participants (n = 44)	Death (event) (n = 18)	Censored (Alive or lost to follow-up) (n = 26)
Male, n (%)	25 (56.8)	12 (66.7)	13 (50.0)
Region, n (%)			
Bulbar	10 (22.7)	5 (27.8)	5 (19.2)
Spinal	34 (77.3)	13 (72.2)	21 (80.8)
Comorbidities, n (%)			
No underlying disease	28 (65.1)	8 (44.4)	20 (76.9)
Diabetes Mellitus	8 (18.2)	6 (33.3)	2 (7.7)
Hypertension	11 (25.0)	6 (33.3)	5 (19.2)
Dyslipidemia	6 (13.9)	3 (16.7)	3 (11.5)
Age at onset (years); mean (SD)	56.6 (7.6)	57.3 (6.6)	56.0 (8.3)
Age at diagnosis (years); mean (SD)	57.8 (7.6)	58.6 (7.6)	57.2 (8.3)
Clinical involvement before diagnosis, n (%)			
Upper extremity only	2 (4.5)	2 (7.7)	0 (0.0)
Lower extremity only	1 (2.3)	1 (5.6)	0 (0.0)
Bulbar only	4 (9.1)	2 (11.1)	(7.7)
Upper and lower extremity	6 (13.6)	1 (5.6)	5 (19.2)
Upper extremity and bulbar	7 (15.9)	2 (11.1)	5 (19.2)
Lower extremity and bulbar	1 (2.3)	1 (5.6)	0 (0.0)
Upper extremity, lower extremity and bulbar	23 (52.3)	11 (61.1)	12 (46.2)
Onset to diagnosis interval (months); mean (SD)	13.2 (9.8)	13.4 (9.4)	13.1 (10.2)
Complications n (%)			
Yes	22 (50.0)	14 (77.8)	8 (30.8)
Aspiration pneumonia	8 (18.2)	8 (44.4)	0 (0.0)
Require NG or PEG feeding	8 (18.2)	7 (38.9)	1 (3.8)
Require tracheostomy	3 (6.8)	3 (16.7)	0 (0.0)
Bedridden status	14 (31.8)	13 (72.2)	(3.8)
No complications	22 (50.0)	4 (22.2)	18 (69.2)
Riluzole Use, n (%)	13 (29.5)	3 (16.7)	10 (38.5)

ALS, amyotrophic lateral sclerosis; NG, Nasogastric tube; PEG, percutaneous endoscopic gastrostomy

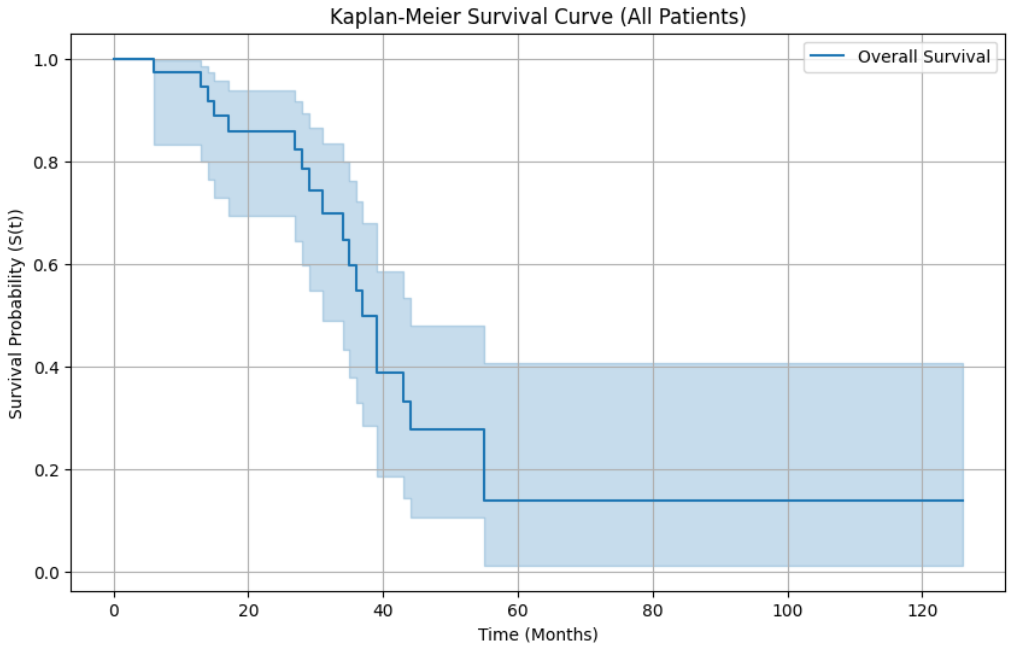


Figure 1. Kaplan–Meier overall survival time for the cohort (n = 44). Median survival time is 37.0 months (95% CI: 31–44); deaths = 18; censored = 26

Table 2. Full multivariable Cox proportional hazards model for predictors of mortality in ALS patients (n = 44).

Variable	Hazard ratio	95% CI	*p*, value
Spinal onset	0.75	0.17, 3.23	0.70
Male	2.71	0.68, 10.82	0.16*
Comorbidities			
Diabetes	0.89	0.19, 4.28	0.89
Hypertension	5.19	0.91, 29.61	0.06*
Dyslipidemia	0.30	0.05, 1.97	0.21
Age at onset	0.84	0.04, 17.51	0.91
Onset to diagnosis interval	0.20	0.02, 1.78	0.15*
Complications Present	4.56	1.09, 19.05	0.04*
Riluzole Use	0.77	0.15, 3.83	0.74

CI, confidence interval

*Indicates variables meeting the $p < 0.20$ criterion for inclusion in the final parsimonious model (male, comorbidity: hypertension, onset to diagnosis interval, and complication present)

initially constructed a full multivariable Cox proportional hazards model that incorporated all 9 clinical covariates (Table 2). This comprehensive model was used as a screening step to identify variables with a potential prognostic signal. Based on an a priori selection criterion of $p < 0.20$ within the full model, four variables—sex, hypertension, onset to diagnosis interval, and the presence of complications—were identified for inclusion in the final parsimonious model.

The final parsimonious model (Table 3) demonstrates high discriminative ability with a Concordance Index (C-index) of 0.80. In this refined analysis, a longer interval from onset to diagnosis was the only statistically significant independent predictor of improved survival time (HR = 0.11, 95% CI: 0.01, 0.90, $p = 0.04$). Although the presence of complications, male sex, and hypertension did not meet the traditional threshold

Table 3. Final parsimonious multivariable Cox model for predictors of survival time

Variable	Hazard ratio	95% CI	z-score	*p*-value
Complication present	3.05	0.96, 9.65	1.90	0.06
Hypertension	2.98	0.88, 10.09	1.76	0.08
Male	2.24	0.70, 7.17	1.36	0.17
Onset to diagnosis interval	0.11	0.01, 0.90	-2.06	0.04*

Concordance index = 0.80.

*Indicates statistical significance at $p < 0.05$.

for statistical significance, they demonstrated strong clinical trends toward increased mortality risk. They were retained to optimize the model's predictive power.

Discussion

In this ambispective cohort of 44 ALS patients in Northeast Thailand, the median overall survival time from symptom onset was 37.0 months. This result is consistent with the global range of 2-5 years,[3,5,11,12] but differs from the exceptionally long survival times reported in other Asian regions, such as India.[4] Our findings suggest that while the clinical phenotype of Thai ALS patients aligns with international patterns, the primary drivers of mortality risk in this population are clinical complications and the velocity of disease progression.

The most significant finding in our multivariable analysis was the independent association between the onset-to-diagnosis interval and survival time (HR = 0.11, $p = 0.04$). This inverse relationship—where a longer diagnostic delay correlates with a lower hazard of death—is a recognized phenomenon in ALS research often attributed to "reverse causation".[5]

Patients with aggressive, rapidly progressing phenotypes typically reach diagnostic criteria quickly but have poor outcomes.[13] Conversely, those with slower-progressing disease may experience longer delays due to the subtle nature of their symptoms but ultimately have a more favorable prognosis. In our cohort, this interval serves as a proxy for the disease's inherent biological velocity.

Regarding other clinical predictors, the refined model identified major complications (HR = 3.05, p = 0.06) and hypertension (HR = 2.98, p = 0.08) as factors with strong clinical trends toward reduced survival time, although they fell just outside the traditional threshold for statistical significance. The presence of complications—such as aspiration pneumonia or bedridden status—represents a critical turning point in the disease course. Similarly, the role of hypertension may reflect underlying vascular fragility that potentially accelerates neurodegenerative processes. Although the updated model provides more conservative hazard ratios than our initial analysis, the estimates remain clinically substantial. These results underscore the necessity of proactive, multidisciplinary interventions aimed at preventing respiratory and nutritional failure, which remain the primary drivers of mortality in ALS.[2,5]

Interestingly, male sex was retained in our final model (HR = 2.24, p = 0.17) but showed a much less pronounced effect than initially observed. While some literature suggests sex differences in ALS survival,[14] our data suggest that in the Thai population the impact of sex may be secondary to other factors like complication rates and diagnostic timing. Similarly, bulbar onset did not emerge as a significant independent predictor in the final multivariable model, despite being a well-established risk factor globally.[1,2] This may be due to the relatively small number of bulbar-onset cases in our Northeast Thai cohort, or it may suggest that once complications and progression velocity are accounted for, the site of onset carries less weight in this specific population.

The lack of a significant survival time benefit for riluzole (HR = 0.77, p = 0.74) remains consistent with our prior analysis. This is likely due to the study being underpowered to detect the modest survival time extension (typically 3-6 months) associated with the drug, combined with low utilization rates (29.5%) in our cohort, which may reflect barriers to access or cost in the Thai healthcare context.

Several limitations of this study warrant consideration. Primarily, the small sample size (n = 44) and the limited number of observed events (n = 18 deaths) restricted the statistical power for multivariable regression. With four predictors retained in the final model, the events-per-variable (EPV) ratio is approximately 4.5 which is below the traditional recommendation of at least 10 events per variable,[15] increasing the risk of overfitting where the model may capture statistical noise rather than true underlying patterns.

Furthermore, the lack of statistical significance for certain predictors should be interpreted with caution. Variables such as hypertension and sex demonstrated clinically large effect sizes (hazard ratios > 2) but failed to reach statistical significance. This discrepancy is likely attributable to limited statistical power due to an inadequate sample size, rather than a definitive absence of association. Therefore, these variables warrant further investigation in larger cohorts to confirm their prognostic value.

We did, however, take several steps to ensure the reliability of these results. Our final model demonstrated strong discrimination (C-index 0.80) and low multicollinearity, with Variance Inflation Factor (VIF) values below 2.0 for all variables.[10] Furthermore, a sensitivity analysis using Ridge-penalized Cox regression (L2 regularization) yielded hazard ratios that were consistent in direction and magnitude with those from our standard model. This consistency suggests that the estimates are stable and not severely inflated by the low EPV ratio. Nevertheless, the small event count resulted in wide 95% CI for some predictors—most notably for complications. Therefore, while the direction of these associations is clear, the absolute magnitude of the hazard ratios should be interpreted with caution.

It is important to state explicitly that this study is exploratory. Consequently, the associations identified should be viewed as hypothesis-generating signals rather than definitive causal relationships. The single-center design may have introduced referral bias toward more complex cases, and the median follow-up of 22.8 months suggests that survival time estimates beyond the 3-year point remain preliminary.

Despite these constraints, this study provides critical, locally relevant data from Northeast Thailand, where published ALS survival time evidence is sparse. By consolidating clinical outcomes over 10 years, these findings provide a baseline for prognostic counseling and a necessary foundation for the design of future, larger, multi-center regional studies.

Conclusions

In this single-center cohort from Northeast Thailand, the median survival time from symptom onset was 37 months. A longer interval from symptom onset to diagnosis was the only statistically significant independent predictor of improved survival time, likely reflecting the naturally slower progression of certain ALS phenotypes. While the presence of major complications, hypertension, and male sex showed strong clinical trends toward increased mortality risk, they did not reach independent statistical significance in our refined model.

These findings provide important baseline data for prognostic counseling in the Thai population and highlight the critical role of disease velocity in determining outcomes. Given the exploratory nature of this study and the limited sample size, further large-scale, multicenter research is necessary. Establishing a national ALS registry would provide the statistical power required to validate these prognostic markers and optimize standardized multidisciplinary care protocols for Thai patients.

Conflict of interest declaration

The authors declare that they have no conflicts of interest.

Generative AI declaration

The authors confirm that no large language models (LLMs) or artificial intelligence (AI) tools were used to create the content of this manuscript. Grammarly was used solely to check and refine grammar throughout the manuscript prior to submission. All content was critically reviewed and finalized by the research team.

Acknowledgements

The authors gratefully acknowledge the assistance of the Medical Records Department, Srinagarind Hospital, Khon Kaen University.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

Chinakit Idsaraphorn: conceptualization, data collection, formal analysis, writing - original draft,

Preeda Arayawichanon: supervision, methodology, validation, review & editing,

Jukrapope Jitpimolmard: methodology, investigation, data curation, visualization, review & editing,

Pitchaya Wiratchotisatian:data curation, visualization, data analysis, software, manuscript revision,

Nantaporn Jitpimolmard: conceptualization, methodology, supervision, investigation, validation, writing - review & editing.

References

1. Oskarsson B, Gendron TF, Staff NP. Amyotrophic Lateral Sclerosis: An Update for 2018. Mayo Clin Proc [Internet]. 2018 Nov [cited 2025 Feb 19];93(11):1617-28. Available from: https://pubmed.ncbi.nlm.nih.gov/30401437/. doi:10.1016/j.mayocp.2018.04.007
2. Benditt JO. Respiratory complications of amyotrophic lateral sclerosis. Semin Respir Crit Care Med [Internet]. 2002 June 23[cited 2025 Feb 19];(3):239-47. Available from: https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-2002-33032. doi:10.1055/s-2002-33032
3. Marin B, Logroscino G, Boumédiene F, Labrunie A, Couratier P, Babron MC, et al. Clinical and demographic factors and outcome of amyotrophic lateral sclerosis in relation to population ancestral origin. Eur J Epidemiol [Internet]. 2016 Mar [cited 2025 Feb 19];31(3):229-45. Available from: https://link.springer.com/article/10.1007/s10654-015-0090-x. doi:10.1007/s10654-015-0090-x
4. Nalini A, Thennarasu K, Gourie-Devi M, Shenoy S, Kulshreshtha D. Clinical characteristics and survival pattern of 1,153 patients with amyotrophic lateral sclerosis: experience over 30 years from India. J Neurol Sci [Internet]. 2008 Sept [cited 2025 Feb 19];272(1-2) :60-70. Available from: linkinghub.elsevier.com/retrieve/pii/S0022510X08002025. doi:10.1016/j.jns.2008.04.034
5. Sánchez-Martínez CM, Choreño-Parra JA, Nuñez-Orozco L, Placencia-Álvarez N, Alvis-Castaño LM, Guadarrama-Ortiz P. A retrospective study of the clinical phenotype and predictors of survival in non-Caucasian Hispanic patients with amyotrophic lateral sclerosis. BMC Neurol [Internet]. 2019 Oct [cited 2025 March 10];19(1):261. Available from: https://link.springer.com/article/10.1186/s12883-019-1459-3. doi:10.1186/s12883-019-1459-3
6. Kulkantrakorn K, Suksasunee D. Clinical, electrodiagnostic, and outcome correlation in ALS patients in Thailand. J Clin Neurosci [Internet]. 2017 Sept [cited 2025 Feb 1];43:165-9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0967586817305179. doi:10.1016/j.jocn.2017.05.034
7. Geevasinga N, Loy CT, Menon P, de Carvalho M, Swash M, Schrooten M, et al. Awaji criteria improves the diagnostic sensitivity in amyotrophic lateral sclerosis: A systematic review using individual patient data. Clin Neurophysiol [Internet]. 2016 July [cited 2025 March 25];127(7):2684-91. Available from: linkinghub.elsevier.com/retrieve/pii/S1388245716300232. doi:10.1016/j.clinph.2016.04.005
8. Bailey A, Crook A, Machin D. Statistical methods for clinical trials. Blood Rev [Internet]. 1994 June [cited 2025 Nov 9];8(2):105-12. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0268960X05800153?via%3Dihub. doi:10.1016/s0268-960x(05)80015-3
9. Hosmer D, Stanley L, Susanne M, Descriptive Methods for Survival Data. In: Applied Survival Analysis [Internet]. 2008 [cited 2026 Jan 20]:16-66. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470258019.ch2.doi:10.1002/9780470258019.ch2
10. Verweij PJ, Van Houwelingen HC. Penalized likelihood in Cox regression. Stat Med [Internet]. 1994 Dec 13 [cited 2026 Jan 6];(23-24):2427-36. Available from: https://pubmed.ncbi.nlm.nih.gov/7701144/. doi:10.1002/sim.4780132307
11. Cronin S, Hardiman O, Traynor BJ. Ethnic variation in the incidence of ALS: a systematic review. Neurology [Internet]. 2007 Mar [cited 2025 Feb 19];68(13):1002-7. Available from: https://www.neurology.org/doi/10.1212/01.wnl.0000258551.96893.6f. doi:10.1212/01.wnl.0000258551.96893.6f
12. Marin B, Boumédiene F, Logroscino G, Couratier P, Babron MC, Leutenegger AL, et al. Variation in worldwide incidence of amyotrophic lateral sclerosis: a meta-analysis. Int J Epidemiol [Internet]. 2017 Feb [cited 2025 Feb 19];46(1) :57-74. Available from: https://academic.oup.com/ije/article/46/1/57/2617177. doi:10.1093/ije/dyw061
13. Czaplinski A, Yen AA, Appel SH. Amyotrophic lateral sclerosis: early predictors of prolonged survival. J Neurol [Internet]. 2006 Nov [cited 2025 July 9];253(11):1428-36. Available from: https://link.springer.com/article/10.1007/s00415-006-0226-8. doi:10.1007/s00415-006-0226-8
14. Saha SP, Das SK, Gangopadhyay PK, Roy TN, Maiti B. Pattern of motor neurone disease in eastern India. Acta Neurol Scand [Internet]. 1997 July [cited 2025 Sep 15];96(1):14-21. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0404.1997.tb00232.x. doi:10.1111/j.1600-0404.1997.tb00232.x
15. Peduzzi P, Concato J, Feinstein AR, Holford TR. Importance of events per independent variable in proportional hazards regression analysis. II. Accuracy and precision of regression estimates. J Clin Epidemiol [Internet]. 1995 Dec [cited 2026 Jan 7];48(12):1503-10. Available from: https://pubmed.ncbi.nlm.nih.gov/8543964/. doi:10.1016/0895-4356(95)00048-8

Original Article

Comparative Analysis of Functional Outcomes in Stroke Patients: First Admission Versus Readmission to Inpatient Rehabilitation

Supitcha Tassatarn and Chayaporn Chotiyarnwong
Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand

ABSTRACT

Objectives: To explore potential differences in functional outcomes of stroke patients undergoing inpatient rehabilitation between their first admission and readmission to the rehabilitation ward.

Study design: Observational study design: retrospective chart review

Setting: A tertiary care hospital, Thailand. The inpatient ward (25 beds) of the Department of Rehabilitation Medicine, which has a limited admission period of up to 3 weeks.

Participant: Stroke patients over 18 years of age who were admitted between January 1, 2015, and December 31, 2020.

Methods: Using matched demographics, a comparison of functional outcomes between the first admission and readmission of stroke patients were conducted. Functional outcomes were evaluated based on changes in the Modified Barthel Index (MBI), rehabilitation efficiency (average increase in MBI scores per day), and rehabilitation effectiveness (potential improvement) comparing patients after their first admission and those following readmission.

Results: The demographic characteristics of patients at their first admission and readmitted patients showed no significant differences in age, sex, underlying disease, stroke classification, hemineglect, aphasia, dysphagia, motor power of the upper extremities, onset-to-admission interval, length of stay, or admission MBI score ($p > 0.05$). Functional outcomes were calculated and are presented as follows: The median of MBI changes were 2 (1, 5) for the first admission and 2 (1, 4) at readmission, with $r = 0.09$, $p = 0.19$; rehabilitation efficiency was 11 (6, 27) for the first admission and 10 (3, 18) at readmission, with $r = 0.14$, $p = 0.05$; and rehabilitation effectiveness was 25 (9, 50) for the first admission and 20 (5, 37) at readmission, with $r = 0.12$, $p = 0.10$.

Conclusions: The improvement in functional outcomes of stroke patients upon readmission to the rehabilitation ward showed no statistically significant difference compared to the improvement during their first admission when the length of stay was limited to 3 weeks. This suggests that in hospitals with a short length of stay, readmitting patients for further rehabilitation may be warranted. However, the results may not generalize to settings with a longer average length of stay. A study investigating the prognostic factors for functional outcome improvement in readmitted stroke patients is warranted.

Keywords: readmission, stroke, rehabilitation, length of stay, treatment outcome

ASEAN J Rehabil Med. 2026; 36(2): 71-79.

Introduction

Stroke is caused by inadequate vascular supply due to either blockage (ischemic stroke) or bleeding (hemorrhagic stroke), resulting in cell death from the disruption of oxygen and nutrients supplied by the blood. This leads to sudden weakness and numbness on one side of the body. The treatment consists of two phases. The first phase involves acute stroke therapies that aim to stop the progression of the disease, such as thrombolysis, mechanical thrombectomy, or surgery. However, patients still face many chronic or permanent disabilities after a stroke, despite rapid management.[1] As evidenced by statistical data in Thailand and around the world, stroke remains the leading cause of death and disability among patients over 60 years of age.[2] For that reason, the next phase of treatment, post-stroke rehabilitation, is crucial for reducing impairment and maximizing function as much as possible in stroke patients.[3]

Neurological recovery following a stroke involves two primary mechanisms. The first mechanism is natural recovery, which occurs as cerebral edema decreases and blood circulation is restored in the penumbra region. The second mechanism involves neural plasticity, where neurons undergo repair and reorganization; this process is enhanced through practice and learning during rehabilitation. Research indicates that the month following the onset of a stroke is the most critical period for neurological recovery. The typical duration of the recovery process is 3 to 6 months, beyond which there are few notable changes in neurological outcomes.[4-6]

Correspondence to: Chayaporn Chotiyarnwong, MD., FRCPhysiatrT, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Siriraj Hospital, Mahidol University, 2 Prannok Road, Bangkoknoi, Bangkok, 10700, Thailand; Email: hedhom2000@hotmail.com

Received: August 24, 2025 Revised: November 7, 2025 Accepted: November 15, 2025

Post-stroke rehabilitation is generally divided into three phases. The first phase is the acute phase, which begins 24 hours post-stroke, during which patients are encouraged to engage in early mobilization, such as bed mobility and sitting, to prevent immobilization syndrome. Once the medical conditions are stable, the rehabilitation phase begins. This period focuses on the restoration and compensation for diminished physical abilities. After the patients' functions are improved, the final phase, the community phase, begins. Patients need to be prepared before returning to their daily routines.[3, 7, 8]

Numerous studies demonstrate that rehabilitation initiated within the first month after a stroke yields the most favorable functional outcomes.[9, 10] However, at Siriraj Hospital, the number of patients exceeds the capacity of the medical staff, leading to long waiting times for patients to receive initial intensive rehabilitation.[11] As a result, the average time from stroke onset to rehabilitation in our rehabilitation ward has increased to 30 days. In addition to the delayed onset of rehabilitation, a longer length of stay is also associated with better outcomes.[12] According to Bindawas et al., the length of stay for stroke patients in inpatient rehabilitation facilities shows significant variation across countries. For instance, the average length of stay for stroke patients in the United States is approximately 16.5 days. In contrast, Canada's average length of stay ranges widely from 23 to 49 days, Australia averages 28 days, and New Zealand averages 30 days. The average length of stay in Saudi Arabia was notably higher at 45 days during the 2005-2008 period. Studies suggested that these differences in length of stay across settings and countries are largely attributable to systemic factors, including insurance models, healthcare coverage policies, and the quantity and quality of available inpatient rehabilitation facilities.[13, 14] The results of these studies are in line with the situation in Siriraj Hospital, where the length of stay in the rehabilitation ward is limited to under three weeks due to insufficient resources. Hospital staff at Siriraj additionally have to manage a large number of referral patients from secondary care hospitals. Due to limited beds and staff, the length of stay is restricted to 3 weeks to allow opportunities for other patients who are in the golden period of rehabilitation. This situation forces some patients to be discharged from the hospital before achieving their rehabilitation goals. As a consequence, these patients require readmission to the rehabilitation ward to reach their original goals. Additionally, several patients are initially admitted with severe neurological deficits, necessitating a wait for improved neurological status before they can be readmitted to begin rehabilitation programs again to achieve higher goals. In addition to patients being readmitted to reach previous or stepped-up goals, those with deconditioning can also be readmitted to restore function. According to the statistics from our hospital, we found that 1 in 5 stroke patients requires readmission.

It is evident that the issue of limited resources and strict length-of-stay policies is not unique to our facility, many healthcare systems worldwide encounter similar constraints. These challenges can significantly affect patient outcomes and underscore the need for effective rehabilitation strategies that optimize functional improvement within a limited timeframe.

Since no research studies have examined the outcomes following readmission, this study aims to evaluate the functional improvement in readmitted patients by comparing their pre- and post-admission functional scores with the outcomes of first-time admitted patients. The rationale for this comparison is to determine whether readmission provides significant benefits to patients. Understanding the implications of readmissions and rehabilitation efficacy in this context will contribute to the ongoing dialogue about resource allocation and patient care across various healthcare systems globally. We hypothesized that readmitted patients would demonstrate less functional improvement compared to those who were admitted for the first time, as these patients are likely to have already undergone substantial rehabilitation. If the outcomes following readmission are significantly inferior to those of first-time admission, outpatient rehabilitation should be considered instead. In contrast, if the study demonstrates that rehabilitation outcomes for our readmitted patients are not significantly different from those of first-time admitted patients, the length-of-stay limitation of three weeks should be reconsidered, and the importance of readmission should be emphasized.

Methods

Study design

The study design was single-center retrospective chart review and was reported following the STROBE 2025 guidelines for observational studies. The Siriraj Hospital Institutional Review Board approved this study, SIRB Protocol Number 274/2565, COA no.SI455/2022 (IRB4).

The study utilized a comparative analysis to assess differences in functional outcomes between stroke patients admitted for the first time and those who were readmitted. We hypothesized that patients in the first admission group would exhibit greater functional improvement compared to those who were readmitted. The reporting of this study adheres to the STROBE guideline for descriptive studies.

Participants

We conducted a single-center retrospective study on stroke patients who were admitted to the rehabilitation ward at Siriraj Hospital in Bangkok, Thailand, between 2015 and 2020. Siriraj Hospital has approximately 25 beds in the rehabilitation ward. The inpatient rehabilitation team comprises 30 rehabilitation residents, five physiatrists, 20 rehabilitation nurses, 20 physiotherapists, 20 occupational therapists, two speech therapists, three psychotherapists, and two social workers. During their admission, patients received physical therapy and occupational therapy for 1 hour per session,

once or twice a day throughout the week. If patients had language or psychiatric problems, speech therapy and psychotherapy were added as needed.

Intervention

We collected medical records of 923 stroke patients who were admitted to the rehabilitation ward between 2015 and 2020, all of whom were over 18 years old and diagnosed with stroke according to WHO criteria.[15] However, among these medical records, there may be instances of the same patients being admitted at different times. For example, if a patient was first admitted on February 3, 2016, and readmitted on May 18, 2016, there would be two separate medical records for that patient. Patient demographic data were recorded according to their status at the time of each admission. Medical records were excluded if the patients had: 1) unstable medical conditions during their hospital stay, 2) other neurologic complications (e.g., cervical myelopathy, meningioma), 3) admission Modified Barthel Index scores greater than 18 out of 20 (to avoid a ceiling effect), 4) disapproval of discharge (e.g., the patient declined to stay at the hospital), and 5) incomplete medical records regarding the Modified Barthel Index score. Patients with admission scores above 18 were excluded to prevent the ceiling effect, which occurs when a high initial score limits the ability to observe further improvements. This ensures that we analyzed individuals who still had potential for significant functional enhancement.[16, 17] Only one individual reviewed the medical records. A total of 842 medical records were included after exclusions. (Figure 1)

Outcome measurements

This study employed the modified version of the Barthel Index (MBI), introduced by Collin and Wade in 1988 as an outcome measurement tool. It consists of 10 items designed to assess the activities of daily living of patients with neuromuscular or musculoskeletal disorders. The MBI demonstrates good reliability and validity in post-stroke patients, with scores ranging from 0 to 20, where a score of 20 indicates full independence.[18-20] The scores also classify patients into four groups: 0-4 indicates total dependence, 5-12 indicates severe dependence, 13-18 indicates moderate dependence, and 19-20 indicates slight dependence.[17]

Patients' MBI scores were evaluated by physiatrists at both admission and discharge. Study outcomes were measured by 1) MBI change = discharge MBI score - admission MBI score, 2) Rehabilitation efficiency,[21] average increase in MBI scores per day = (discharge MBI score - admission MBI score) ÷ LOS, and 3) rehabilitation effectiveness,[21] potential improvement = [(discharge MBI score - admission MBI score) ÷ (20 - admission MBI score)] x 100.

To evaluate the functional outcomes of stroke readmissions in our rehabilitation ward, we compared data in the records of first admissions and readmissions to assess the significant improvements in readmitted patients, either due to continuing their rehabilitation to reach previous goals or stepping up to higher goals in subsequent admissions, or refreshing their programs for those who experienced deconditioning. However, established evidence indicates that age, upper limb motor power, and the interval from stroke onset to rehabilitation have significant effects on the outcomes of the Barthel Index score in post-stroke patients. Patients with a younger age and better upper limb motor power tend to have better outcomes on the Barthel Index Score.[9, 10, 22]

To control for these confounding factors, we matched the first admission and readmission groups by age (within a 2-year range),[23] upper limb motor power (MRC grade ≤ 2 and MRC grade > 2),[24] stroke onset to rehabilitation (≤ 30 days, 31-90 days, > 90 days) and admission MBI score (scores of 0-4, scores of 5-12 and scores of 13-18) before comparing the functional outcomes.[9, 10] (Figure 2)

We also identified the causes of readmission and deconditioning, which were recorded by rehabilitation residents in the medical records.

Statistical methods

All statistical analyses were performed using IBM SPSS Statistics for Windows version 26.0 (IBM Corp, Armonk, NY). A p-value of less than 0.05 was considered statistically significant. Quantitative data were represented as mean (SD) for normal distributions and the median with interquartile range (IQR) for non-normal distributions, while qualitative data were represented by frequency and percentage. Case-control matching was conducted using MedCalc Statistical Software version 19.2.6 (MedCalc Software bv, Ostend, Belgium; https://www.medcalc.org; 2020). Patients were matched based on age, upper limb motor power, time from stroke onset to rehabilitation, and the admission Barthel Index score.

Descriptive statistics in Table1 were compared using the independent t-test and chi-square test. For changes in MBI, rehabilitation efficiency, and rehabilitation effectiveness be-

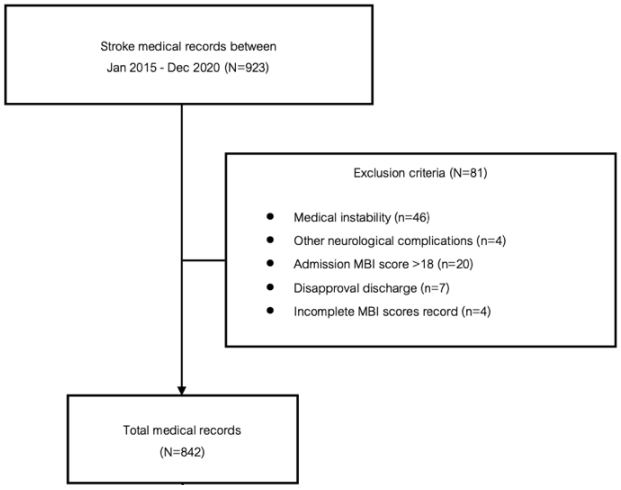


Figure1. Flow chart of participants in this study

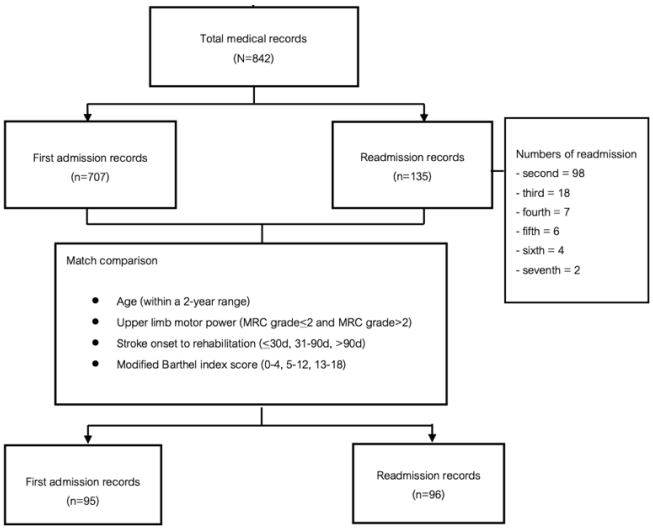


Figure 2. Flow of match comparison

Table 1. Demographic characteristics

	First admission n = 95	Readmission n = 96	[4]*p*-value
Age[1]	67.6 (11.3)	67.9 (11.2)	0.86
Female Gender[2]	36 (37.9)	43 (44.8)	0.33
Stroke classification[2]			
Ischemic	64 (67.4)	60 (62.5)	0.48
Hemorrhagic	31 (32.6)	36 (37.5)	0.48
Hemineglect[2]	12 (12.6)	15 (15.6)	0.55
Aphasia[2]	26 (27.4)	16 (16.7)	0.07
Dysphagia[2]	47 (49.5)	42 (43.8)	0.43
Motor power [2]			
UE3 proximal > [2]	35 (36.8)	36 (37.5)	0.93
UE3 distal > [2]	29 (30.5)	28 (29.2)	0.84
Onset to admission interval[2]			
< 30 days	2 (2.1)	2 (2.1)	0.99
31-90 days	17 (17.9)	17 (17.7)	0.99
> 90 days	76 (80.0)	77 (80.2)	0.99
Length of stay[1]	18.8 (6.4)	20.6 (6.8)	0.64
MBI score at admission[1]	7.78 (5.13)	8.02 (5.07)	0.74

[1]Mean (SD), [2]Number (percentage), [3]Upper extremities, [4]Statistical comparisons are shown for transparency; groups were matched on these variables by design

tween these two groups, the study employed the Mann-Whitney U-test. We hypothesized that readmitted patients would demonstrate less functional improvement compared to those who were admitted for the first time. If the *p*-value obtained for the functional outcomes between the two groups is not < 0.05, outpatient rehabilitation should be considered as an alternative to readmission.

We also calculated the 95% confidence intervals (CIs) for the descriptive data in Table 3. Effect size was calculated using the correlation effect size (*r*) derived from the z-value obtained through the Mann-Whitney U test. The interpretation of the effect size was referenced from Cohen, who categorized effect sizes as small (*r* = 0.1), medium (*r* = 0.3), and large (*r* = 0.5).[25] As no research on readmission outcomes has been published, we calculated the sample size based on the methodology of Wattanapan et al., who also collected data from rehabilitation wards in Thailand.[26] The sample size was estimated using n4Studies: an application for sample size calculation in health science research, version 2.2 (App Store; 2023).[27] Based on a statistical power of 0.8 and an alpha level of 0.05, the estimated sample size was determined to be at least 55 medical records per group.

Results

A total of 842 eligible stroke medical records (Figure 1) were divided into first admissions (n = 707) and readmissions (n = 135). After matching and comparison, only 191 records were included, comprising first admission charts (n = 95) and readmission charts (n = 96). In the readmission group, the timing of readmissions ranged from the second to the seventh admission. (Figure 2)

Table 2. Readmission characteristics

	Readmission N = 96
Numbers of readmissions[1]	
2	74 (77.1)
3	14 (14.6)
4	2 (2.1)
5	4 (4.2)
6	1 (1.0)
7	1 (1.0)
Cause of readmission[1]	
Improve function	57 (59.4)
Deconditioning	32 (33.3)
Others	7 (7.3)

[1]Number (percentage)

Table 1 presents the demographic characteristics of the patients. There were no significant differences in age, sex, underlying disease, stroke classification, hemineglect, aphasia, dysphagia, motor power of the upper extremities, onset-to-admission interval, length of stay, and admission MBI score. Because first-time admission patients had to match their waiting time with that of the readmission patients, the majority of participants in this study had a waiting time to admis-sion of more than 90 days, which contrasts with the average onset-to-admission interval mentioned above. These first-time admission patients experienced delays in admission due to a complicated patient referral system and issues related to medical rights.

In this study, the groups were matched based on relevant demographic and clinical characteristics to control for confounding variables. It is important to note that statistical comparisons of matched variables were intentionally designed to be equivalent on these parameters.

Table 2 provides details about readmission. The causes of readmission were classified based on a thorough review of resident notes. After matched comparison, the records indicate that readmissions occurred between two to seven times, with the highest percentage (77.1%) occurring during the second readmission. The majority of patients were readmitted to improve function (59.4%), continuing from their last admission. The second most common reason for readmission was deconditioning (33.3%). (Figure 3) The remaining patients (7.3%) were readmitted to relieve caregiver stress, which emerged as a leading cause of high readmission rates for patients with more than three readmissions, as shown in Table 2.

In patients with deconditioning (n = 32), the majority of cases were attributed to post-stroke complications (34.4%), such as pneumonia and urinary tract infections, followed by caregiver neglect and lack of social support (28.1%). Although these patients required caregivers to facilitate ambulation and exercise, some caregivers reported being too fatigued and lacking the time to engage in these activities. Additionally, some caregivers were too frail to assist patients with exercise, compounded by financial issues that made it difficult to involve therapists. All of these factors were identified as contributing to caregiver neglect and insufficient social support. Other issues included family-related difficulties (18.7%), such as fear of pain or falling during home exercises or avoiding community ambulation due to the COVID-19 pandemic, as well as a lack of motivation among patients (9.4%) and fall accidents (9.4%). (Figure 4)

Table 3 presents a comparison of outcomes between first admission and readmission. No significant differences were observed in MBI change (r = 0.09, p = 0.19) or rehabilitation effectiveness (r = 0.12, p = 0.10). For rehabilitation efficiency, the comparison yielded a p-value of 0.05, which is considered the borderline level of statistical significance. However, when interpreted in conjunction with the effect size (r = 0.14), we conclude that there is no clear evidence of a significant difference.

When examining the MBI change, it was observed that the median value was 2 for both first-admission and readmission patients. This value exceeds the minimal clinically important difference (MCID) of the MBI score, which is 1.85.[28] Therefore, this change can be interpreted as having clinical significance for the patients.

Discussion

In this study, the results do not align with the hypothesis we established. No significant differences were observed in MBI change, rehabilitation efficiency, or rehabilitation effec-

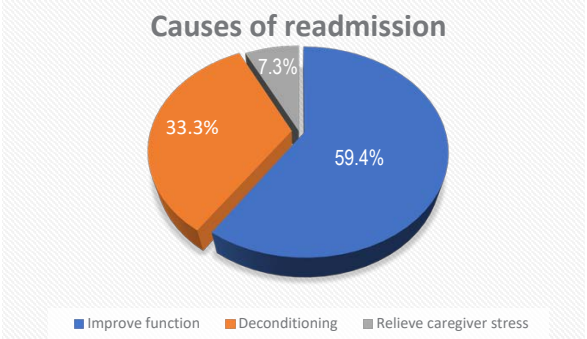


Figure 3. Causes of readmission

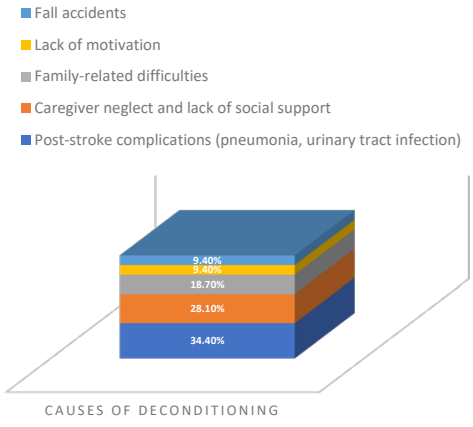


Figure 4. Causes of deconditioning

Table 3. Outcomes comparison

Outcome measures	First admission	Readmission	Effect size	*p*-value
MBI change	2 (1, 5)[1] 95%CI (2, 3)	2 (1, 4)[1] 95%CI (1, 3)	0.09	0.19[a]
Efficiency[2]	11 (6, 27)[1] 95%CI (10, 19)	10 (3, 18)[1] 95%CI (7, 14)	0.14	0.05[a]
Effectiveness[3]	25 (9, 50)[1] 95%CI (18, 33)	20 (5, 37)[1] 95%CI (13, 27)	0.12	0.10[a]

[1]Median (Q1, Q3), [a]Mann-Whitney U-test

$$^{2}\left(\frac{\text{discharge MBI score}-\text{admission MBI score}}{\text{length of stay}}\right)\times 100,\ ^{3}\left(\frac{\text{discharge MBI score}-\text{admission MBI score}}{20-\text{admission MBI score}}\right)\times 100$$

tiveness between first admissions and readmissions. Given these findings, it is essential to reassess the three-week length-of-stay limitation and to highlight the significance of readmission. Since there are no published studies on the functional outcomes of readmitted patients, the factors contributing to this equivalence in outcomes cannot be clearly determined. However, according to Table 2, most patients were readmitted to improve function, continuing from their previous admissions. It can be inferred that due to the limited three-week stay, some patients had not yet achieved their goals before discharge, leading to readmission for the continuation of their rehabilitation programs to reach their original targets. This finding aligns with the observations of O'Brien et al., who noted that a shorter length of stay correlated with a higher rate of failing to reach goals before discharge.[29] That study also demonstrated that a length of stay of 18 days, which is similar to ours, was associated with lower discharge Functional Independence Measure (FIM) scores than the predicted discharge FIM scores.[29] That is, readmitted patients were able to achieve greater functional improvement toward their original goals or to step up to higher goals in subsequent admissions.

According to Jørgensen et al., 80.0% of patients reached their best function within 3 weeks in mild strokes, within 7 weeks in moderate strokes, and within 12 weeks in severe strokes.[6] Therefore, some readmitted patients may have been initially admitted too early, resulting in only minimal functional improvement. In comparison, by the time of their readmission, their neurological and functional status had improved naturally, making them more suitable for rehabilitation than at the time of their first admission. Thus these patients still had the potential to improve their functional abilities, even after undergoing rehabilitation previously. This explanation is further supported by O'Brien et al., who stated that higher admission FIM scores are associated with greater functional improvement after inpatient rehabilitation.[29] Additionally, research supporting the idea that higher-dose repetitive task training yields significantly better rehabilitation outcomes compared to lower-dose training suggests that patients can continue to achieve improved functional outcomes during the readmission period.[30]

Some patients who were readmitted due to deconditioning from either post-stroke complications or caregiver neglect also had the capacity to restore their baseline functions and could still gain significant benefits from rehabilitation, which correlates with the findings of Kortebein and Suriyaarachchi et al.[31, 32]

This current study also examined the causes of deconditioning. We found that the majority of patients were affected by post-stroke complications such as urinary tract infections and pneumonia. Another significant cause to be aware of is caregiver neglect and low social support. Additionally, lack of motivation or depression was associated with deconditioning. These findings corroborate previous studies.[33, 34]

To address these complications, implementing proactive infection prevention strategies is essential. This action includes regular monitoring for signs of infection, early intervention, and education for both patients and caregivers about hygiene practices. Another significant cause to be aware of is caregiver neglect and low social support. To address this issue, structured caregiver support programs should be established, providing caregivers with training and resources; moreover, the lack of motivation or depression associated with deconditioning highlights the need for psychological support. Implementing routine mental health screenings and providing access to counseling and support groups can help address these emotional barriers. Furthermore, both extrinsic and intrinsic factors related to falling should be explored in greater detail.

Our study has two main strengths. The first is the use of matched comparison, which allowed us to eliminate most confounding factors that could affect the MBI score. Furthermore, there were no differences in other patient characteristics between the two groups. The second strength is that only one person was responsible for data collection, which helps reduce the risk of misclassification bias.

Regarding the limitations of the study, due to the small number of patients who were readmitted more than twice, we were unable to clarify and interpret the relationship between the number of readmissions and functional outcomes. Further studies should be conducted to understand these associations better. Additionally, because this was a retro-

spective chart review, MBI scores were evaluated by different assessors. However, the interobserver reliability of the Barthel Index is excellent, with a weighted kappa of 0.93.[35] It is also important to note that the results may not generalize to settings with a longer average length of stay, as our findings are particularly relevant to hospitals with limited bed capacity that typically necessitate a stay of three weeks or less. Moreover, the delayed admission group may negatively affect neural plasticity.[4-6] As a result, the rehabilitation outcomes for the first delayed admission may be lower than usual and may closely resemble those in the readmission group. Therefore, this study may not be applicable for interpreting results for patients in the early readmission group.

In hospitals where the rehabilitation length of stay is limited to three weeks, readmission is recommended to maximize functional outcomes and achieve rehabilitation goals. In that case, the hospital should establish a readmission policy to ensure that sufficient beds are available for both first-time patients and those who have been readmitted. Additionally, to enhance cost-effectiveness, the hospital should evaluate and implement a tiered reimbursement strategy that incentivizes outpatient rehabilitation and reduces the financial burden on the facility. Moreover, it is important to implement an outpatient rehabilitation program as an alternative option for readmitted patients in situations where bed availability is limited, ensuring they receive ongoing support that promotes further recovery and independence. Stroke patients with deconditioning should also be readmitted to restore function, provided that the causes of deconditioning can be addressed. Further investigations into the determinants of deconditioning should be conducted to reduce the rates of readmission in these patients. These implications should be viewed as preliminary evidence rather than practice-changing findings, underscoring the need for further validation and investigation.

Conclusions

The improvement in functional outcomes of stroke patients upon readmission to the rehabilitation ward showed no statistically significant difference compared to the improvement during their first admission, when the length of stay was limited to 3 weeks. This finding indicates that the limited three-week rehabilitation length of stay necessitates a reevaluation of current hospital policies regarding readmission.

The results suggest that some readmitted patients may benefit from the opportunity to continue their rehabilitation after not reaching their goals during their initial admission, particularly when their neurological status has improved. This finding underscores the importance of ongoing rehabilitation programs and suggests that readmission can be a valuable option for enhancing patient recovery.

The study further identifies common causes of deconditioning among patients, including post-stroke complications and caregiver neglect, underlining the need for proactive strategies in infection prevention and caregiver support.

In light of these findings, hospitals should establish comprehensive and flexible readmission policies to accommodate both first-time and readmitted patients. However, the findings may not be generalizable to settings with longer lengths of stay or to patients who are readmitted early.

Future research should focus on understanding the determinants of deconditioning to reduce readmission rates and to validate these preliminary findings, which are vital for informing better practices in the rehabilitation of stroke patients.

Conflict of interest disclosure

The authors declare that they have no potential conflicts of interest regarding the research, authorship, or publication of this article.

Generative AI declaration

The authors acknowledge the use of OpenAI's ChatGPT (version 4.0) to assist in language and grammar improvement throughout the manuscript. This tool was utilized solely for the purpose of enhancing clarity, coherence, and overall quality of the text, and no content generation or material alteration beyond linguistic refinement was conducted with the assistance of AI.

Acknowledgement

We would like to express our sincere gratitude to Aditya Rana for his invaluable assistance in refining the English language throughout the research. We are also grateful to Suthipol Udompunturak for help with the statistical analysis. Their contributions significantly improved the quality of this work.

Funding

This research project was supported by Siriraj Hospital Research Development Fund, Grant number (IO) R016531062.

Data availability

The data that support the findings of this study cannot be shared publicly and are available upon request from the corresponding author, Chayaporn Chotiyarnwong. The data are confidential and contain information that could compromise the privacy of the patients involved in the research.

Author contributions

Supitcha Tassatarn: data curation, formal analysis, funding acquisition, investigation and writing,

Chayaporn Chotiyarnwong: conceptualization, methodology, project administration, supervision and writing.

References

1. Caprio FZ, Sorond FA. Cerebrovascular Disease: Primary and Secondary Stroke Prevention. Med Clin North Am [Internet]. 2019 Mar [cited 2025 Nov 15];103(2):295-308. Available from: https://pubmed.ncbi.nlm.nih.gov/30704682/
2. Global, regional, and national burden of stroke, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol [Internet]. 2019 May [cited 2025 Nov 15];18(5):439-58. Available from: https://pubmed.ncbi.nlm.nih.gov/30871944/
3. Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC, et al. Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke [Internet]. 2016 Jun [cited 2025 Nov 15];47(6):e98-e169. Available from: https://pubmed.ncbi.nlm.nih.gov/27145936/
4. Cassidy JM, Cramer SC. Spontaneous and Therapeutic-Induced Mechanisms of Functional Recovery After Stroke. Transl Stroke Res [Internet]. 2017 Feb [cited 2025 Nov 15];8(1):33-46. Available from: https://pubmed.ncbi.nlm.nih.gov/27109642/
5. Krakauer JW, Carmichael ST, Corbett D, Wittenberg GF. Getting neurorehabilitation right: what can be learned from animal models? Neurorehabil Neural Repair [Internet]. 2012 Oct [cited 2025 Nov 15];26(8):923-31. Available from: https://pubmed.ncbi.nlm.nih.gov/22466792/
6. Jørgensen HS. The Copenhagen Stroke Study experience. J Stroke Cerebrovasc Dis [Internet]. 1996 Feb [cited 2025 Nov 15];6(1):5-16. Available from: https://pubmed.ncbi.nlm.nih.gov/17894959/
7. Krakauer JW. Motor learning: its relevance to stroke recovery and neurorehabilitation. Curr Opin Neurol [Internet]. 2006 Feb [cited 2025 Nov 15];19(1):84-90. Available from: https://pubmed.ncbi.nlm.nih.gov/16415682/
8. Ko SB, Yoon BW. Mechanisms of functional recovery after stroke. Front Neurol Neurosci [Internet]. 2013 [cited 2025 Nov 15];32:1-8. Available from: https://pubmed.ncbi.nlm.nih.gov/23859958/
9. Coleman ER, Moudgal R, Lang K, Hyacinth HI, Awosika OO, Kissela BM, et al. Early Rehabilitation After Stroke: a Narrative Review. Curr Atheroscler Rep [Internet]. 2017 Dec [cited 2025 Nov 15];19(12):59. Available from: https://pubmed.ncbi.nlm.nih.gov/29116473/
10. Salter K, Jutai J, Hartley M, Foley N, Bhogal S, Bayona N, et al. Impact of early vs delayed admission to rehabilitation on functional outcomes in persons with stroke. J Rehabil Med [Internet]. 2006 Mar [cited 2025 Nov 15];38(2):113-7. Available from: https://pubmed.ncbi.nlm.nih.gov/16546768/
11. Kumthornthip W, Chotiyarnwong C. Does Early Rehabilitation Admission Improve Functional Outcomes of Stroke Patients after a Short Hospital Stay? A Thai Retrospective Study on 596 Patients. J Med Assoc Thai [Internet]. 2024 [cited 2025 Nov 15];107:1013-20. Available from: http://www.jmatonline.com/PDF/1013-1020-PB-00664.pdf
12. O'Brien SR, Xue Y, Ingersoll G, Kelly A. Shorter length of stay is associated with worse functional outcomes for medicare beneficiaries with stroke. Phys Ther [Internet]. 2013 Dec [cited 2025 Nov 15];93(12):1592-602. Available from: https://pubmed.ncbi.nlm.nih.gov/23886846/
13. Bindawas SM, Vennu V, Mawajdeh H, Alhaidary HM, Moftah E. Length of Stay and Functional Outcomes Among Patients with Stroke Discharged from an Inpatient Rehabilitation Facility in Saudi Arabia. Med Sci Monit [Internet]. 2018 Mar [cited 2025 Nov 15];24:207-14. Available from: https://pubmed.ncbi.nlm.nih.gov/29321468/
14. Tran DT, Yan C, Dukelow SP, Round J. Length of Stay and Home Discharge for Patients with Inpatient Stroke Rehabilitation. Can J Neurol Sci [Internet]. 2023 Jan [cited 2025 Nov 15];50(1):28-36. Available from: https://pubmed.ncbi.nlm.nih.gov/34666861/
15. The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration. WHO MONICA Project Principal Investigators. J Clin Epidemiol [Internet]. 1988 [cited 2025 Nov 15];41(2):105-14. Available from: https://pubmed.ncbi.nlm.nih.gov/3335877/
16. López-Liria R, Vega-Ramírez FA, Rocamora-Pérez P, Aguilar-Parra JM, Padilla-Góngora D. Comparison of Two Post-Stroke Rehabilitation Programs: A Follow-Up Study among Primary versus Specialized Health Care. PLoS One [Internet]. 2016 Nov [cited 2025 Nov 15];11(11):e0166242. Available from: https://pubmed.ncbi.nlm.nih.gov/27835673/
17. Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. J Clin Epidemiol [Internet]. 1989 [cited 2025 Nov 15];42(8):703-9. Available from: https://pubmed.ncbi.nlm.nih.gov/2760661/
18. Collin C, Wade DT, Davies S, Horne V. The Barthel ADL Index: a reliability study. Int Disabil Stud [Internet]. 1988 [cited 2025 Nov 15];10(2):61-3. Available from: https://pubmed.ncbi.nlm.nih.gov/3403500/
19. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? Int Disabil Stud [Internet]. 1988 [cited 2025 Nov 15];10(2):64-7. Available from: https://pubmed.ncbi.nlm.nih.gov/3042746/
20. Mahoney FI, Barthel DW. FUNCTIONAL EVALUATION: THE BARTHEL INDEX. Md State Med J. 1965;14:61-5.
21. Shah S, Vanclay F, Cooper B. Efficiency, effectiveness, and duration of stroke rehabilitation. Stroke [Internet]. 1990 Feb [cited 2025 Nov 15];21(2):241-6. Available from: https://pubmed.ncbi.nlm.nih.gov/2305399/
22. Veerbeek JM, Kwakkel G, van Wegen EE, Ket JC, Heymans MW. Early prediction of outcome of activities of daily living after stroke: a systematic review. Stroke [Internet]. 2011 May [cited 2025 Nov 15];42(5):1482-8. Available from: https://pubmed.ncbi.nlm.nih.gov/21474812/
23. Yoo JW, Hong BY, Jo L, Kim JS, Park JG, Shin BK, et al. Effects of Age on Long-Term Functional Recovery in Patients with Stroke. Medicina (Kaunas) [Internet]. 2020 Sep [cited 2025 Nov 15];56(9). Available from: https://pubmed.ncbi.nlm.nih.gov/32906615/
24. Olsen TS. Arm and leg paresis as outcome predictors in stroke rehabilitation. Stroke [Internet]. 1990 Feb [cited 2025 Nov 15];21(2):247-51. Available from: https://pubmed.ncbi.nlm.nih.gov/2305400/
25. Cohen J. Statistical Power Analysis for the Behavioral Sciences Second Edition. Hillsdale, New Jersey: Lawrence Erlbaum Associates; 1988. 77 p.
26. Wattanapan P, Lukkanapichonchut P, Massakulpan P, Suethanapornkul S, Kuptniratsaikul V. Effectiveness of Stroke Rehabilitation Compared between Intensive and Nonintensive Rehabilitation Protocol: A Multicenter Study. J Stroke Cerebrovasc Dis [Internet]. 2020 Jun [cited 2025 Nov 15];29(6):104809. Available from: https://pubmed.ncbi.nlm.nih.gov/32312631/
27. Ngamjarus C, Chongsuvivatwong V, McNeil E. n4Studies: Sample Size Calculation for an Epidemiological Study on a Smart Device. Siriraj Med J [Internet]. 2016 [cited 2025 Nov 15];68:160-70. Available from: https://he02.tci-thaijo.org/index.php/sirirajmedj/article/view/58342
28. Hsieh YW, Wang CH, Wu SC, Chen PC, Sheu CF, Hsieh CL. Establishing the minimal clinically important difference of the Barthel

Index in stroke patients. Neurorehabil Neural Repair [Internet]. 2007 Jun [cited 2025 Nov 15];21(3):233-8. Available from: https://pubmed.ncbi.nlm.nih.gov/17351082/
29. O'Brien SR, Xue Y. Predicting goal achievement during stroke rehabilitation for Medicare beneficiaries. Disabil Rehabil [Internet]. 2014 [cited 2025 Nov 15];36(15):1273-8. Available from: https://pubmed.ncbi.nlm.nih.gov/24151817/
30. Veerbeek JM, van Wegen E, van Peppen R, van der Wees PJ, Hendriks E, Rietberg M, et al. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PLoS One [Internet]. 2014 Feb [cited 2025 Nov 15];9(2):e87987. Available from: https://pubmed.ncbi.nlm.nih.gov/24505342/
31. Kortebein P. Rehabilitation for hospital-associated deconditioning. Am J Phys Med Rehabil [Internet]. 2009 Jan [cited 2025 Nov 15];88(1):66-77. Available from: https://pubmed.ncbi.nlm.nih.gov/18688198/
32. Suriyaarachchi P, Chu L, Bishop A, Thew T, Matthews K, Cowan R, et al. Evaluating Effectiveness of an Acute Rehabilitation Program in Hospital-Associated Deconditioning. J Geriatr Phys Ther [Internet]. 2020 Oct [cited 2025 Nov 15];43(4):172-8. Available from: https://pubmed.ncbi.nlm.nih.gov/31389854/
33. Ottenbacher KJ, Graham JE, Ottenbacher AJ, Lee J, Al Snih S, Karmarkar A, et al. Hospital readmission in persons with stroke following postacute inpatient rehabilitation. J Gerontol A Biol Sci Med Sci [Internet]. 2012 Aug [cited 2025 Nov 15];67(8):875-81. Available from: https://pubmed.ncbi.nlm.nih.gov/22389457/
34. Bhattacharya P, Khanal D, Madhavan R, Chaturvedi S. Why do ischemic stroke and transient ischemic attack patients get readmitted? J Neurol Sci [Internet]. 2011 Aug [cited 2025 Nov 15];307(1-2):50-4. Available from: https://pubmed.ncbi.nlm.nih.gov/21636101/
35. Duffy L, Gajree S, Langhorne P, Stott DJ, Quinn TJ. Reliability (inter-rater agreement) of the Barthel Index for assessment of stroke survivors: systematic review and meta-analysis. Stroke [Internet]. 2013 Feb [cited 2025 Nov 15];44(2):462-8. Available from: https://pubmed.ncbi.nlm.nih.gov/23299497/

Original Article

The Second International Spinal Cord Injury (InSCI) Community Survey in Thailand: Overview of Bio-Psycho-Social Perspectives of Individuals with Spinal Cord Injury

Apichana Kovindha[1], Pratchayapon Kammuang-lue[1], Tulaya Dissaneewate[2], Chayaporn Chotiyarnwong[3], Napasakorn Komaratat[4], Surangkhana Insook[5] and Thai InSCI Research team[6]

[1]Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai; [2]Department of Rehabilitation Medicine, Faculty of Medicine, Prince of Songkla University, Songkhla; [3]Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok; [4]Sirindhorn National Medical Rehabilitation Institute, Nonthaburi; [5]Sunpasitthiprasong Hospital, Ubon Ratchathani; [6]Society of Physiatrists Specialized in Spinal Cord Injury, Thai Rehabilitation Medicine Association (TRMA), Bangkok, Thailand

ABSTRACT

Objectives: To describe the health status, socioeconomic characteristics, and spinal cord injury (SCI) profiles of individuals with SCI living in the community in Thailand

Study design: Descriptive cross-sectional study

Setting: Fourteen hospitals across Thailand

Participant: Thai individuals with SCI living in the community who had previously received rehabilitation at participating hospitals and who met the inclusion criteria were invited to participate in the second International Spinal Cord Injury (InSCI) community survey in Thailand.

Methods: Participants completed the Thai-translated version of the second InSCI questionnaire. After data cleaning, bio-psycho-social aspects were analyzed descriptively.

Results: A total of 693 respondents were included. Most participants were male (74.9%), paraplegic (65.4%), and had incomplete lesions (65.4%), with traumatic causes (79.2%). The median age at the time of the survey was 49 years (IQR: 38-62), and the median duration of SCI was 8 years (IQR: 5-14). Nearly half were married or cohabiting (46.9%), 64.1% needed assistance, and 55.7% lived in urban areas. Over half (51.4%) had completed secondary education, while 64.5% reported a household income below 17,200 baht per month. Most respondents were covered by the Thai universal health coverage scheme (68.4%), and 51.1% were satisfied with their general health. The three most prevalent secondary health conditions were spasticity (77.5%), pain (71.1%), and bowel problems (70.4%). The percentage of receiving treatment was lowest for sexual problems (12.8%).

Conclusions: The majority of Thais with SCI in the community had traumatic, incomplete paraplegics, experienced multiple secondary health conditions, reported low socioeconomic status, needed assistance, and only half were satisfied with their overall health

Keywords: spinal cord injury, secondary health conditions, rehabilitation, socioeconomic status, surveys and questionnaires

ASEAN J Rehabil Med. 2026; 36(2): 80-89.

Introduction

In 2013, the World Health Organization (WHO), in collaboration with the International Spinal Cord Society (ISCoS), published the International Perspective on Spinal Cord Injury

The members of the Thai InSCI Research team are Siam Tongprasert, Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai; Atcharee Kaewma, Nakornping Hospital, Chiang Mai; Chutimon Soonthornthum, Nakornping Hospital, Chiang Mai; Thiti Thoowadaratrakool, Phayao Hospital, Phayao; Phuricha Chaivirach, Nan Hospital, Nan; Punjama Tunwattanapong, Sunpasitthiprasong Hospital, Ubon Ratchathani; Lalita Panawattanawong, Udonthani Hospital, Udonthani; Thapanun Mahisanun, Thabo Crown Prince Hospital, Nong Khai; Suttipong Tipchatyotin, Department of Rehabilitation Medicine, Faculty of Medicine, Prince of Songkla University, Songkhla; Atcharee Kaewtong, Maharaj Nakhonsithammarat Hospital, Nakhonsithammarat; Donruedee Srisuppaphon, Sirindhorn National Medical Rehabilitation Institute, Nonthaburi; Titiya Potiart, Ratchaburi Hospital, Ratchaburi; Atchara Wangchumthong, Somdech Phra Nangchao Sirikit Hospital, Chon Buri; Jaruwan Kittiwarawut, Burapha University Hospital, Chon Buri, Thailand; Sintip Pattanakuhar, Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand and Department of Biomedical Engineering, Faculty of Engineering, University of Strathclyde, Glasgow, UK

Correspondence to: Pratchayapon Kammuang-lue, MD, FRCPhysiatrT; Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand; E-mail: pratchayapon.k@cmu.ac.th

Received: November 11, 2025 Revised: December 24, 2025 Accepted: January 3, 2025

(IPSCI) to raise awareness of the situation of individuals with spinal cord injury (SCI) living in the community. The report emphasized that SCI has profound impacts on health, functioning, and social participation, and that individuals with SCI require ongoing healthcare and supportive environments to maintain their quality of life (QoL).[1,2] Environmental barriers, inadequate policies, and insufficient services can further restrict participation and access to care.[2] Therefore, country-specific data are essential for informing effective healthcare systems and policies for people with SCI.[2]

To address this need, the International Spinal Cord Injury (InSCI) community survey, an initiative within the learning health system for spinal cord injury (LHS-SCI), was launched in 2017 by Swiss Paraplegic Research at Nottwil in collaboration with ISCoS and the International Society of Physical and Rehabilitation Medicine (ISPRM) aimed at understanding the lived experiences of people with SCI and monitoring the societal and health system responses across all WHO regions.[3] Researchers from 22 countries, including Thailand, participated in the first InSCI community survey (2017-2018), which generated important international, regional, and national evidence on body function impairments,[4] health status, socio-economic and work situation,[5] environmental barriers,[6] and QoL among individuals with SCI.[1]

Findings from the first Thai InSCI community survey revealed a high prevalence of secondary health conditions, such as spasticity (74.4%), pain (61.1%), and bowel problems (65.6%).[4] The employment rate (39.5%) was low compared with the general population (74.2%).[5] There were significant environmental barriers affecting QoL for individuals with SCI in Thailand.[6] In addition, individuals rehabilitated at SCI-specialized rehabilitation facilities (SSRFs) had better outcomes than those treated at non-SSRFs.[7] However, the first survey had limitations, including a relatively small sample size and limited national representativeness, which constrained its ability to provide robust evidence for service planning, system development, and policy decisions, particularly regarding equitable access to SCI-specialized rehabilitation services.

To address these gaps and to provide updated, nationally representative information, the Thai InSCI research team conducted the second InSCI survey. This second survey aimed to expand participant recruitment across regions and hospital levels and to update data on SCI characteristics, secondary health conditions, socioeconomic status, and QoL among individuals with SCI living in the community in Thailand. The objective of this first overview report was to update SCI characteristics, secondary health conditions, socioeconomic status, and QoL of Thais with SCI living in the community. This will further identify important issues for subsequent analyses of the second InSCI survey, which may inform improvements in rehabilitation services, healthcare systems, and policy development in Thailand.

Methods

This study was part of the InSCI community survey, a cross-sectional survey conducted in 31 countries worldwide.[8] This study also contributes data within the framework of the LHS-SCI to provide contextualization.[3,9,10]

Study design

This cross-sectional study is reported in accordance with the STROBE guidelines for cross-sectional studies (version 4).[11]

Setting

Physiatrists from 14 hospitals agreed to participate in the second InSCI survey in Thailand and conducted the survey after receiving ethical approval from the Institutional Review Board (IRB) or Research Ethical Committee (REC) of each hospital. These hospitals were purposively selected based on their capacity to provide rehabilitation services for individuals with SCI and to ensure geographic representation across the country. Among the 14 participating hospitals, the ratio of SSRFs to non-SSRF hospitals was 2:12.

The study included hospitals from various regions of Thailand to represent differences in healthcare systems and SCI rehabilitation settings across the country (Figure 1):

- North Region (4): Maharaj Nakorn Chiang Mai Hospital, Nakornping Hospital, Phayao Hospital, and Nan Hospital.
- Northeast Region (3): Sunpasitthiprasong Hospital, Udonthani Hospital, and Thabo Crown Prince Hospital.
- South Region (2): Songklanagarind Hospital and Maharaj Nakhonsithammarat Hospital.
- West-Central-East Region (5): Sirindorn National Medical Rehabilitation Institute, Siriraj Hospital, Ratchaburi Hospital, Somdech Phra Nangchao Sirikit Hospital, and Burapha University Hospital.

InSCI questionnaire Thai version

According to the InSCI standards for questionnaire translation, step 1 involved two translators from different backgrounds (a physiatrist and a nurse) independently translating the questionnaire. Step 2 had both translators discussing and developing a preliminary synthesis version. In step 3, an expert committee consisting of the translators, health professionals, a language expert, a methodologist, and 2-3 individuals with SCI who had different impairment levels reviewed, finalized, and submitted the Thai translation of the questionnaire to the study center for approval.

The second InSCI questionnaire consisted of personal information (excluding name and date of birth), SCI lesion characteristics, energy and feeling, health problems, activity and participation, independence of activities of daily living, work, environmental factors, health care services, COVID-19 vaccination status, personal factors, QoL and general health, physical activity, and health status. In addition to the original 76 questions in the second InSCI questionnaire, the Thai InSCI research team agreed to include 12 additional ques-

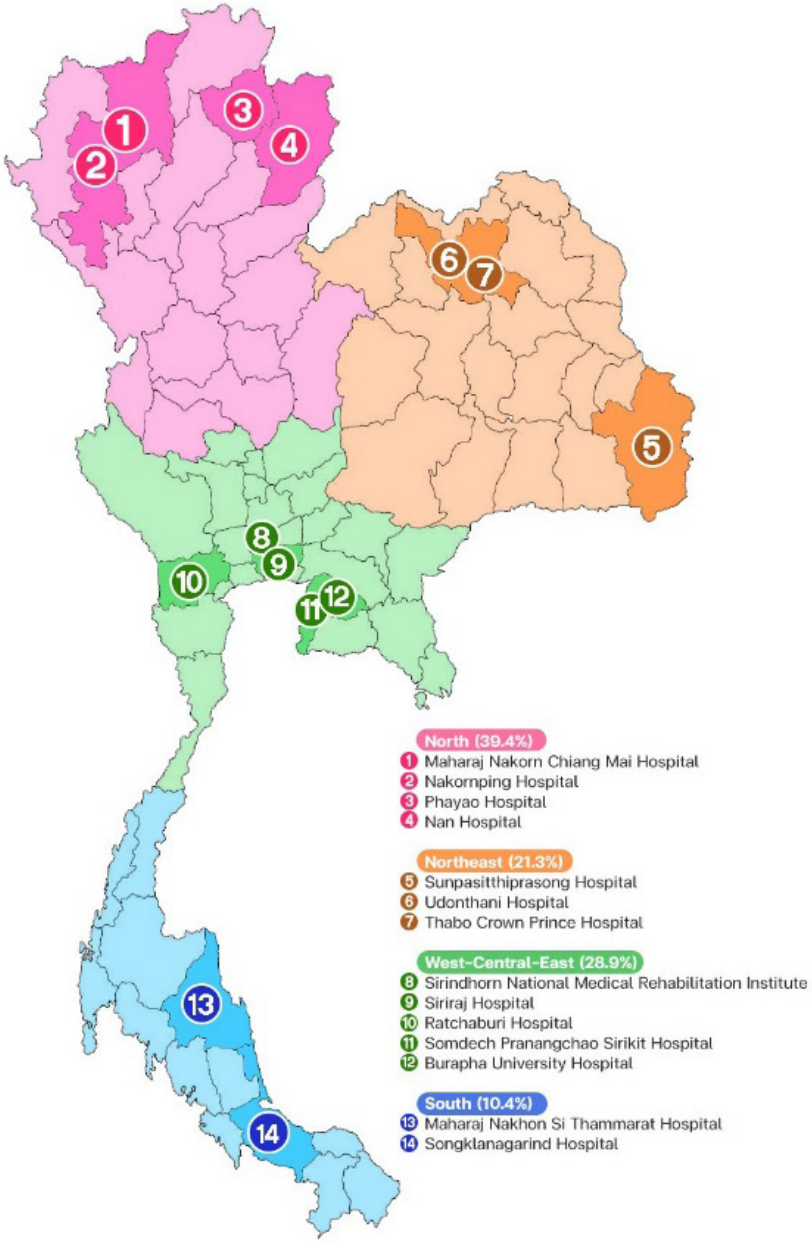


Figure 1. Regional distribution of respondents in the second International Spinal Cord Injury (InSCI) survey in Thailand

tions relevant to the Thai rehabilitation services and the Thai health system. After obtaining approval from the study center, the final Thai version of the questionnaire, comprising 88 questions, was completed by 10 individuals with SCI to test the electronic database system.

Participants

The inclusion criteria were Thai ethnicity, having either traumatic or non-traumatic SCI, being at least 18 years old, having experience living in the community after receiving medical rehabilitation, being capable of answering the questionnaire, and providing consent. Traumatic SCI included injuries such as cauda equina syndrome, while non-traumatic SCI included spinal cord lesions caused by vascular disease, infection, autoimmune diseases, cancer, toxins, or radiation. Exclusion criteria included congenital diseases such as spina bifida, neurodegenerative diseases like multiple sclerosis, amyotrophic lateral sclerosis, peripheral nerve damage, being currently in post-acute rehabilitation, being in the process of adjusting to antidepressant medication, having communication difficulties due to traumatic brain injury, or having fully recovered with minimal functional impairments.

Potential participants were identified from hospital rehabilitation records of the participating hospitals. The sampling frame included participants in the first Thai InSCI survey who were confirmed to be alive, plus newly identified individuals with SCI who had been rehabilitated at the participating hospitals. From this contact list, a weighted sampling approach by hospital was applied to ensure proportional representation. Contact details were verified, and the list was cleaned using RStudio to ensure following inclusion and exclusion criteria.

Sample size

The total number of potential participants in the contact list was 1,283, including 283 living individuals from the first InSCI survey cohort list and 1,000 from the new cohort list who were randomly selected using the dplyr package in RStudio and employing a weighted sampling approach for each hospital. The total expected number of respondents for data analysis was 1,000, comprising about 70.0% of those on the contact list.

Data collection

Data collection in Thailand began in January 2023 after Maharaj Nakorn Chiang Mai Hospital, the first hospital, received REC approval in September 2022. Notably, each hospital began data collection on different dates based on their REC/IRB approval dates.

The researchers and research assistants contacted each of the individuals on the contact list either by telephone or by mail. If telephone contact failed, they were invited to provide consent and complete the InSCI questionnaire either face-to-face on-site, by completing a paper questionnaire themselves, or by telephone interview. Standardized training for all researchers and research assistants was conducted to minimize interview bias, and a uniform interview guide and identical questionnaire were used across all data-collection modes. Afterwards, all questionnaires were checked for completeness and sent to one of the two research coordinators (PK or TD). One of the research assistants then uploaded the questionnaire data to the InSCI electronic database system at the study center in Switzerland. In accordance with the Personal Data Protection Act and the data transfer agreement, participants' names and personal identification numbers were not included in the questionnaires, and all data could only be retrieved upon approval from the study center.

The data collection ended in June 2024, which aligned with the timeline of the second InSCI survey. After receiving the data cleaning list from the InSCI study center, the two study coordinators contacted all researchers to verify any missing, incorrect, or questionable data. The confirmed correct data was then submitted to the study center. Data retrieval and analysis began after the study center finalized the data cleaning process.

Variables

In accordance with the study's objective, not all questionnaire items were reported; only those related to demographic and socioeconomic status, SCI characteristics, secondary health problems, QoL, and general health were selected for inclusion in this report. General health conditions were rated as excellent, very good, good, fair, and poor, and were compared to health in the previous year as much better, somewhat better, about the same, somewhat worse, and much worse. Secondary health problems in the last 3 months were rated by respondents as none, mild, moderate, severe, or extreme, along with whether they received treatment (e.g., taking medication). QoL in the last 14 days was rated as very poor, poor, neither poor nor good, good, and very good. Overall satisfaction with household income was rated on a visual analog scale from 1 (completely dissatisfied) to 10 (completely satisfied). Subjective social status was assessed using a 10-rung ladder, asking patients to place themselves on it relative to others in Thailand.

Statistical methods

Descriptive statistics were used to achieve the objectives of this report. Categorical data are presented as numbers and percentages, and continuous data are reported as mean and standard deviation (SD) or median and interquartile range (IQR), for data regarding demographic and SCI characteristics, living and socioeconomic situations, QoL, and health in general among individuals with SCI living in the community in Thailand. Based on InSCI variables, injury level was only categorized as either paraplegia or tetraplegia. Root-level lesions, such as cauda equina syndrome, were not analyzed or reported separately. The secondary health conditions rated as mild to extreme problems after SCI during the last 3 months were grouped into dichotomous (yes/no) variables for analysis to reduce recall and reporting bias and to avoid sparse data in low-prevalence severity categories. Missing data was reported, and no imputation was applied.

Results

When the data collection was closed, there were 725 respondents: 206 from the first survey of 283 and 519 from the new participant list of 1,000, and 555 non-respondents, of which 378 could not be contacted, 69 who died before or after the invitation, 62 who rejected the invitation, 25 with exclusion criteria, 5 having cognitive impairment, 2 having a language barrier, 2 moving abroad, 4 duplicate names, and 8 for unknown reasons. Three had not completed the questionnaire submission. After the data cleaning process, 32 respondents were excluded due to complete neurological recovery (26) or due to exclusion criteria (6). According to the study's objective, those who reported full recovery of sensation, motor function, as well as bladder and bowel control were excluded from the data analysis. Only those reported as having paraplegia or tetraplegia with complete or incomplete lesions were included in the report. As a result, data from 693 respondents, 202 (29.1%) from the first InSCI cohort and 491 (70.9%) from the newly recruited cohort, were included in the data analysis, as shown in Figure 2. In terms of the four main regions, 273 (39.4%) lived in the north, 200 (28.9%) in the west-central-east, 148 (21.3%) in the northeast, and 72 (10.4%) in the south.

Table 1 shows the demographic characteristics of the 693 respondents; 74.9% were males. The median age at SCI onset was 37 years (IQR: 25-52), and at the time of the survey was 49 years (IQR: 38-62). The median duration of

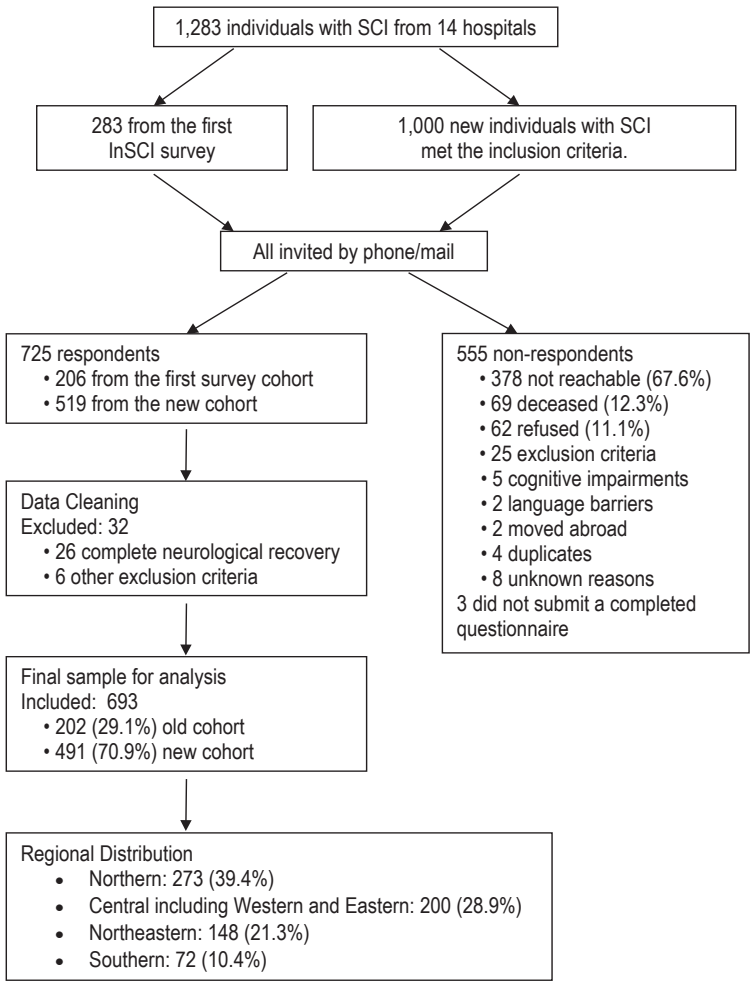


Figure 2. Recruitment process for the second International Spinal Cord Injury (InSCI) community survey in Thailand

Table 1. Basic sociodemographic characteristics of respondents

Variables	Results (n = 693)
Sex, male[1]	520 (75.0)
Marital status, married/cohabiting[1]	325 (46.9)
Highest educational level: higher secondary[1]	356 (51.4)
Living in urban area[1]	384 (55.7)
Living alone[1]	43 (6.2)
Assistance, yes[1*]	444 (64.1)
• Family	421 (60.8)
• Friend	34 (4.9)
• Paid assistant	45 (6.5)
Household income per month, < 17,200 Baht[1]	447 (64.5)
Age at the time of survey, years[2]	49 (38-62)
Age at SCI onset, years[2]	37 (25-52)
Duration of SCI, years[2]	8 (5-14)

*More than one choice could be chosen. SCI, spinal cord injury
[1]Number (%), [2]median (interquartile range, IQR)

SCI was 8 years (IQR: 5-14). Regarding education, 51.4% had completed higher secondary school. Of the respondents, 46.9% were married/cohabiting. A majority (64.1%) needed assistance, primarily from family members, and 55.7% lived in urban areas. Regarding socioeconomic status, 64.5% had household incomes below 17,200 baht per month. All respondents had health insurance, with 68.4% covered under the universal coverage scheme. The remainder were covered by the social security scheme (15.6%) or the civil servant benefit scheme (13.6%).

Table 2 shows that the majority of respondents were paraplegic (65.4%), had incomplete SCI lesions (65.4%), and suffered from traumatic causes (79.2%). Among the traumatic causes, traffic accidents were the most prevalent, followed by falls higher than one meter and accidents during work, whereas spinal degeneration was most prevalent among the non-traumatic causes, followed by infection.

Table 3 presents the general health status. Most respondents rated their health as good (42.1%). Compared with their health in the previous year, the majority reported that their health was about the same (34.3%).

Secondary health problems rated as mild to extreme within the last three months are shown in Table 4.

Missing data, where the individual did not report their health for each secondary health condition, was noted, and no imputation was performed. The percentage of secondary health problems was highest for spasm/spasticity (77.5%) and lowest for respiratory problems (21.2%), whereas the

Table 2. Spinal cord injury (SCI) level, severity, and causes

Variables	Results
Level of SCI, paraplegia	453 (65.4)
Severity of SCI, incomplete	453 (65.4)
Traumatic causes*	549 (79.2)
• Traffic accident	341 (49.2)
• Fall > 1 meter	102 (14.7)
• Accident during work	46 (6.6)
• Violence	37 (5.3)
• Fall < 1 meter	23 (3.3)
• Sports accident	5 (0.7)
• Leisure activity accident	7 (1.0)
• Iatrogenic	6 (0.9)
• Others	10 (1.4)
Non-traumatic causes*	144 (20.8)
• Spinal degeneration	54 (7.8)
• Infection	27 (3.9)
• Benign tumor	22 (3.2)
• Malignant tumor	13 (1.9)
• Vascular disease	13 (1.9)
• Others	16 (2.3)

N (%). *More than one cause was allowed to be chosen

Table 3. Current general health conditions compared with the previous year

Current general health condition	Results (n = 693)	Compared with the previous year's health condition	Results (n = 693)
Excellent	12 (1.7)	Much better	102 (14.7)
Very good	58 (8.4)	Somewhat better	219 (31.6)
Good	292 (42.1)	About the same	238 (34.3)
Fair	258 (37.2)	Somewhat worse	109 (15.7)
Bad	73 (10.5)	Much worse	25 (3.6)

N (%)

percentage of those who had received treatment was high for pressure injury (83.1%), UTI (82.4%) and bladder dysfunction (79.9%) and low for sexual dysfunction (12.8%) and sleep problems (32.6%). In addition, 13.2% reported current smoking and 31.8% mentioned having other health problems such as diabetes (8.2%), heart disease (2.6%), and cancer (1.8%). For Body Mass Index (BMI), 15.9% of respondents were classified as underweight (BMI < 18.5 kg/m²), 37.1% as normal weight (18.5-22.9 kg/m²), 24.4% as overweight (23.0-24.9 kg/m²), and 27.7% as obese (BMI ≥ 25.0 kg/m²) based on WHO BMI criteria for Asians.[12]

Satisfaction with household income, subjective social status, and QoL in the last 14 days is shown in Figure 3. Most respondents rated their satisfaction with household and subjective social status as 5 or below, indicating dissatisfaction, while QoL was rated as good.

Discussion

This second InSCI survey in Thailand recruited more participants from all regions of the country, unlike the first, which had two-thirds from one hospital in the north and the rest from three other hospitals in the central region.[13,14] This wider recruitment doubled the total number of respondents in the second survey compared to the first (693 vs. 320), representing the largest national database of individuals with SCI ever reported in Thailand and improving national representativeness.

Respondent characteristics and trends, overall demographics and injury details were similar to those in the first survey. Most were male, lived in urban areas, had completed secondary education, relied mainly on family caregivers, and reported low household income. Compared to earlier find-

Table 4. Prevalence of secondary health conditions rated as mild to extreme problems after SCI during the last 3 months, and the percentage receiving treatment for such conditions (N = 693)

Secondary health conditions	With problems (mild to extreme)			Receiving treatment		
	Missing data (n)	Results (n)	Percentage (%)	Missing data (n)	Results (n)	Percentage (%)
Spasm/spasticity		537	77.5	6	342	63.7
Pain		493	71.1	4	283	57.4
Bowel problems		488	70.4	5	289	59.2
Sleep problems		377	54.5	4	123	32.6
Sexual problems	1	357	51.5	4	46	12.8
Bladder problems		344	49.6	4	275	79.9
Joint contract		323	46.6	4	160	49.5
Urinary tract infection	1	244	35.3	5	201	82.4
Postural hypotension		238	34.4	4	63	26.5
Circulation problems		203	29.3	4	50	24.6
Injury caused by loss of sensation		193	27.9	4	80	41.5
Autonomic dysreflexia		180	26.0	4	79	43.9
Pressure ulcer		178	25.7	4	148	83.1
Respiratory problems		147	21.2	5	43	29.3

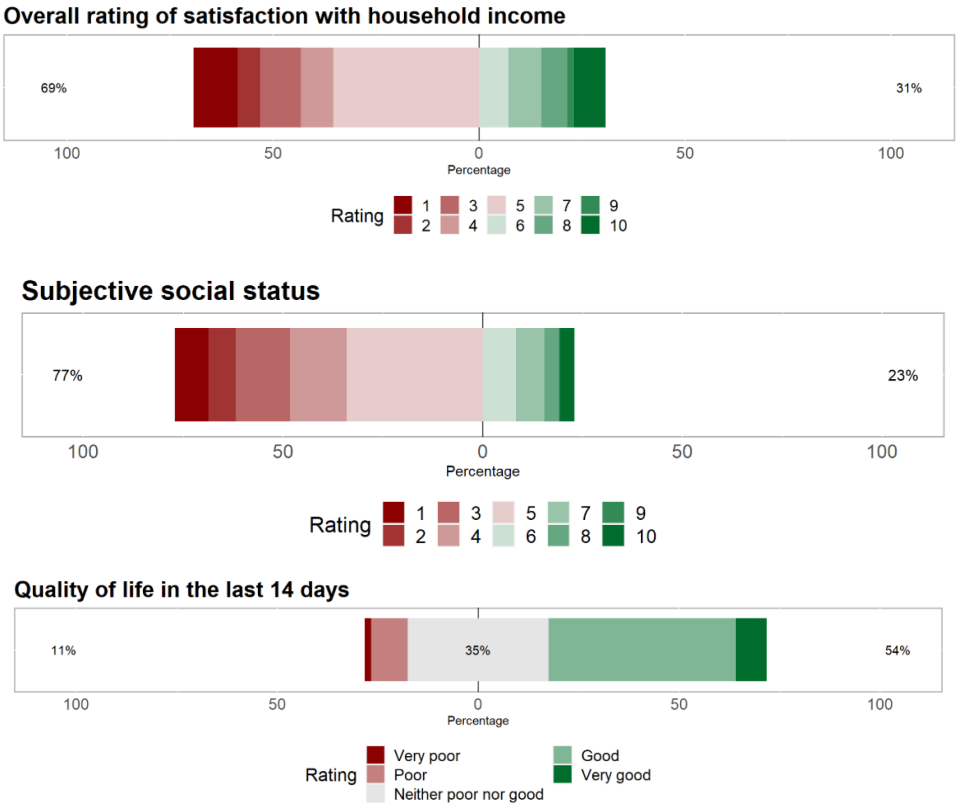


Figure 3. Satisfaction with household income, subjective social status, and quality of life

ings,[13,14] there was a slight increase in the age at injury onset, a higher percentage of males (from 71.2% to 74.9%), an increase in tetraplegia (from 26.0% to 35.0%), and a decrease in complete SCI rates (from 44.0% to 33.0%). Additionally, traumatic causes declined from 86.0% to 79.0%. The duration of SCI remained about the same at 8 years. These changes indicate a rise in non-traumatic causes, tetraplegics, and incomplete SCI. Traffic-related injuries continued to be the leading cause, making up nearly half of traumatic SCIs.[15] This highlights the ongoing need for stronger road safety measures, especially for the prevention of motorcycle-related injuries.

Regarding health insurance, the majority (68.4%) were enrolled in the universal health coverage scheme as expected, and 73.5% were registered as people with disabilities. These two figures are slightly increased from the previous reports[13, 14] and confirm that the majority of Thais are covered by one of the health insurance schemes, which can lessen personal and/or family financial burdens for healthcare. All respondents had physical disabilities due to SCI. However, registration as a person with disability (PWD) in Thailand is voluntary under national legislation, explaining why the registration rate was below 100%.

Some secondary health conditions showed improvement. The prevalence of urinary tract infection (UTI) declined from 44.9% in the first survey to 35.3% in the current study. This may reflect the quality of bladder care, bladder training, and access to appropriate healthcare services. A recent study across three countries in the Southeast Asia (SEA) region found that bladder management and UTIs affect the QoL of people with SCI.[16] QoL is influenced by multiple bio-psychosocial factors. Therefore, factors related to bladder management, such as bladder training and different methods of bladder emptying, and QoL should be further explored. However, bladder dysfunction itself remained common and comparable across surveys. Similarly, the prevalence of pressure injury remained relatively stable compared to the first survey (25.7% and 27.2%).[4] Still, it was slightly higher than the earlier cross-sectional study of pressure injury by one hospital with SSRFs in Thailand 20 years ago.[17] Our study of combined InSCI data from three SEA countries found that independence in toileting and independence in relieving weight were protective against pressure injury, whereas bowel, bladder, sexual dysfunction, spasticity, and impaired sensation were associated with a higher pressure injury risk. Rehabilitation by SSRFs may further reduce the risk of pressure injuries.[18]

Malnutrition is a known risk factor for pressure injury. Nutritional status was not addressed in the previous study.[18] In the second survey, 43.6% of respondents were classified as malnourished (underweight or obese) based on the WHO BMI cutoff for Asians.[12] In individuals with chronic SCI, it is recommended to lower the cutoff point for obesity to 22 kg/m² because they generally have up to 15% more body fat than BMI-matched able-bodied controls. When the cutoff point is lowered to 22 kg/m², the proportion of obese individuals

increases to about 50.0%.[19] Therefore, further analyses of nutritional inadequacy, body composition, and health consequences, including cardiometabolic complications and pressure injury risk, are essential for developing effective prevention strategies after SCI.

Despite generally positive self-rated health, conditions such as spasticity (77.5%), pain (71.1%), and bowel dysfunction (70.4%) remain prevalent or poorly managed. These rates were higher than in the first survey, where the figures were 74.4%, 61.6%, and 65.6%, respectively.[4] Fewer individuals with bowel dysfunction received treatment compared to those with bladder dysfunction, highlighting limited access to healthcare. Over 50.0% of respondents also reported sexual dysfunction and/or sleeping problems, with the latter remaining stable while reports of sexual problems increased.[4] Only 12.8% received treatment for sexual problems, with 75% of respondents being male and 46.9% married or cohabiting. This aligns with a study in Thailand showing that over half of 56 Thai men with SCI had sexual desire, but fewer than a third had sufficient erection, and only a third had received sex education.[20] Additionally, postural hypotension requires more attention, with its prevalence rising from 26.6% to 34.4% compared with the first survey.[4] Only one-fourth of those affected received treatment, making it a significant barrier to maintaining sitting in a wheelchair. Further investigation is needed to understand the long-term issues related to postural hypotension in Thais with SCI.

This overview report shows that although the majority rated their QoL as good/very good, secondary health problems are prevalent. Whether these are outcomes of the Intermediate Care (IMC) for patients with traumatic SCI, launched in 2018 and implemented in 2019 to increase access to medical rehabilitation services during the first 6 months from onset and achieve optimal functional independence,[21,22] cannot be confirmed yet, as functional outcomes were not included in this report, but are planned to be analyzed and reported in subsequent reports.

This study's strength lies in its large, representative sample from various hospitals. However, the proportion of respondents from the north (39.4%) was higher than the proportion in the general population (18.0%) as reported in 2023.[23] To reduce recall bias, individuals with cognitive impairment and depression were excluded. Standardized training minimized interview bias, and a uniform guide and questionnaire were used across all interview types. Completed questionnaires were checked for completeness before data entry. However, respondents needed at least 30 minutes to complete them and because the data were self-reported rather than obtained from medical records there was a risk of reporting bias.

Conclusions

The second InSCI community survey in Thailand provides national level evidence of the long-term bio-psycho-social status of individuals with SCI. Although most respondents rated their QoL as good or very good, many secondary health conditions remain prevalent and require greater clinical attention, highlighting the importance of continuous, comprehensive care and the critical role of the universal health coverage scheme in providing healthcare access, particularly for this vulnerable population. Future analyses using the existing InSCI database will focus on functional outcomes and their associations with secondary health conditions, as well as healthcare access, to better inform improvements in rehabilitation services and health policy for individuals with SCI in Thailand.

Ethical approval

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committees (RECs), Ethics Committees (ECs), or Institutional Review Boards (IRBs) of all participating hospitals. Approvals were granted by the Research Ethics Committee, Faculty of Medicine, Chiang Mai University (approved on September 27, 2022; EC No. REH-2565-09157); Research Ethics Committee, Thabo Crown Prince Hospital (approved on August 19, 2022; EC No. 65/2565); Research Ethics Committee, Nakornping Hospital (approved on September 12, 2022; EC No. 075/65); Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University (approved on September 26, 2022; EC No. COA No. Si 693/2022; Protocol No. 611/2565 [IRB3]); Research Ethics Committee, Somdech Phra Nangchao Sirikit Hospital (approved on October 4, 2022; EC No. Protocol RP 0030/65; COA-NMD-REC049/65); Research Ethics Committee, Phayao Hospital (approved on October 11, 2022; EC No. COA No. 179); Human Research Ethics Committee of Ratchaburi Hospital (approved on October 17, 2022; EC No. COA-RBHEC 033/2022); Research Ethics Committee, Sirindhorn National Medical Rehabilitation Institute (approved on October 26, 2022; EC No. 65033); Ethics Committee, Sunpasitthiprasong Hospital (approved on November 2, 2022; EC No. COA code 080/2565); Research Ethics Committee, Maharaj Nakhonsithammarat Hospital (approved on November 4, 2022; EC No. COA: B011/2565); Research Ethics Committee, Udonthani Hospital (approved on January 20, 2023; EC No. UDH REC No. 9/2566); Research Ethics Committee, Nan Hospital (approved in February 2023; EC No. COA No. 008; Nan Hospital REC No. 008/2566); Research Ethics Committee, Faculty of Medicine, Prince of Songkla University (approved on March 31, 2023; EC No. REC.65-323-11-1); and Institutional Review Board, Faculty of Medicine, Burapha University (approved on January 17, 2024; EC No. IRB1-004/2567).

Conflict of interest disclosure

The authors confirm that there is no conflict of interest related to the manuscript.

AI generative declaration

Generative AI was used only for language editing and clarity improvement. The authors retain full responsibility for all scientific content and conclusions.

Acknowledgments

The authors thank the research assistants for assistance with data collection and acknowledge the participating hospitals, study participants, the Thai Rehabilitation Medicine Association and the InSCI Study Center Nottwil for their supports.

Funding

This study was supported by the Medical Association of Thailand Research Grant; the Siriraj Research Development Fund, Faculty of Medicine Siriraj Hospital, Mahidol University (Grant No. (IO) R016632007); and the Research Fund, Faculty of Medicine, Prince of Songkla University (Grant No. 66-025-1).

Data availability

The data supporting the findings of this study are available upon request from the corresponding author [PK] but are not publicly available.

Author contributions

Apichana Kovindha: conceptualization, methodology, formal analysis, writing-original draft, review & editing, funding acquisition, supervision

Pratchayapon Kammuang-lue: conceptualization, data curation, formal analysis, investigation, writing-original draft, review & editing,

Tulaya Dissaneewate: conceptualization, data curation, formal analysis, investigation, writing-review & editing, funding acquisition,

Chayaporn Chotiyarnwong: conceptualization, investigation, writing-review & editing, funding acquisition,

Napasakorn Komaratat: conceptualization, investigation, writing-review & editing,

Surangkhana Insook: conceptualization, investigation, writing-review & editing,

Thai InSCI Research team: conceptualization, investigation, writing-review & editing.

References

1. Pacheco Barzallo D, Gross-Hemmi M, Bickenbach J, Juocevicius A, Popa D, Wahyuni LK, et al. Quality of life and the health system: A 22-country comparison of the situation of people with spinal cord injury. Arch Phys Med Rehabil [Internet]. 2020 [cited 2025 Jan 30];101(12):2167-76. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32533934 doi:10.1016/j.apmr.2020.04.030
2. World Health Organization. International perspectives on spinal cord injury: World Health Organization; 2013 [cited 2025 Jan 30]. Available from: https://www.who.int/publications/i/item/international-perspectives-on-spinal-cord-injury.
3. Stucki G, Bickenbach J. The international spinal cord injury survey and the learning health system for spinal cord injury. Am J Phys Med Rehabil [Internet]. 2017 Feb [cited 2025 Jan 30];96(2 Suppl 1):S2-S4. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28059873 doi:10.1097/PHM.0000000000000678
4. Ehrmann C, Reinhardt JD, Joseph C, Hasnan N, Perrouin-Verbe B, Tederko P, et al. Describing functioning in people living with spinal cord injury across 22 countries: A graphical modeling approach. Arch Phys Med Rehabil [Internet]. 2020 Dec [cited 2025 Jan 30];101(12):2112-43. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32980339 doi:10.1016/j.apmr.2020.09.374
5. Post MW, Reinhardt JD, Avellanet M, Escorpizo R, Engkasan JP, Schwegler U, et al. Employment among people with spinal cord injury in 22 countries across the world: Results from the international spinal cord injury community survey. Arch Phys Med Rehabil [Internet]. 2020 Dec [cited 2025 Dec 30];101(12):2157-66. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32673653 doi:10.1016/j.apmr.2020.05.027
6. Reinhardt JD, Middleton J, Bokel A, Kovindha A, Kyriakides A, Hajjioui A, et al. Environmental barriers experienced by people with spinal cord injury across 22 countries: Results from a cross-sectional survey. Arch Phys Med Rehabil [Internet]. 2020 Dec [cited 2025 Jan 30];101(12):2144-56. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32502565 doi:10.1016/j.apmr.2020.04.027
7. Pattanakuhar S, Kammuang-Lue P, Komaratat N, Chotiyarnwong C, Kovindha A, Gemperli A. Do individuals from an SCI-specialized rehabilitation facility have fewer secondary health conditions than those from a non-SCI-specialized rehabilitation facility? Analysis of the InSCI database from a middle-income country. J Spinal Cord Med [Internet]. 2025 Mar [cited 2025 Apr 25];48(2):290-9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/38251980 doi:10.1080/10790268.2023.2289690
8. Gross-Hemmi MH, Brach M, Popa D, Setiono S, Singhal B, Sunnerhagen KS, et al. Methodology and epidemiologic data of the second international spinal cord injury (InSCI) community survey. Arch Phys Med Rehabil [Internet]. 2025 [cited 2025 Nov 1]. Available from: https://doi.org/10.1016/j.apmr.2025.09.030 doi:10.1016/j.apmr.2025.09.030
9. Fekete C, Brach M, Ehrmann C, Post MWM, InSci, Stucki G. Cohort profile of the international spinal cord injury community survey implemented in 22 countries. Arch Phys Med Rehabil [Internet]. 2020 Dec [cited 2025 Apr 25];101(12):2103-11. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32533933 doi:10.1016/j.apmr.2020.01.022
10. Gross-Hemmi MH, Post MW, Ehrmann C, Fekete C, Hasnan N, Middleton JW, et al. Study protocol of the international spinal cord injury (InSCI) community survey. Am J Phys Med Rehabil [Internet]. 2017 Feb [cited 2025 Apr 25];96(2 Suppl 1):S23-S34. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28059876 doi:10.1097/PHM.0000000000000647
11. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. Epidemiology [Internet]. 2007 Nov [cited 2025 Apr 25];18(6):800-4. Available from: https://www.ncbi.nlm.nih.gov/pubmed/18049194 doi:10.1097/EDE.0b013e3181577654
12. World Health Organization, Regional office for the Western Pacific. The Asia-Pacific perspective : redefining obesity and its treatment.

Sydney: Health Communications Australia; 2000 [cited 2025 Dec 20]. Available from: http://iris.wpro.who.int/handle/10665.1/5379.
13. Pattanakuhar S, Kammuang-Lue P, Komaratat N, Chotiyarnwong C, Mahachai R, Kovindha A. Health care and rehabilitation services utilization, benefits and satisfaction: a community survey of individuals with spinal cord injury in Thailand. Spinal Cord [Internet]. 2022 Aug [cited 2025 Apr 25];60(8):739-45. Available from: https://www.ncbi.nlm.nih.gov/pubmed/35197575 doi:10.1038/s41393-022-00777-y
14. Pattanakuhar S, Kammuang-Lue P, Kovindha A, Komaratat N, Mahachai R, Chotiyarnwong C. Is admission to an SCI specialized rehabilitation facility associated with better functional outcomes? Analysis of data from the Thai spinal cord injury registry. Spinal Cord [Internet]. 2019 Aug [cited 2025 Apr 25];57(8):684-91. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30842632 doi:10.1038/s41393-019-0267-3
15. Kovindha A. People with spinal cord injury in Thailand. Am J Phys Med Rehabil [Internet]. 2017 Feb [cited 2025 Apr 25];96(2 Suppl 1):S120-S3. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28059897 doi:10.1097/PHM.0000000000000585
16. Pattanakuhar S, Ahmedy F, Setiono S, Engkasan JP, Strom V, Kovindha A. Impacts of bladder managements and urinary complications on quality of life: Cross-sectional perspectives of persons with spinal cord injury living in Malaysia, Indonesia, and Thailand. Am J Phys Med Rehabil [Internet]. 2023 Mar 1 [cited 2025 May 1];102(3):214-21. Available from: https://www.ncbi.nlm.nih.gov/pubmed/35700141 doi:10.1097/PHM.0000000000002066
17. Wilekha N, Kovindha A. A study of protective behaviors and risk factors of pressure ulcers in spinal cord injured patients. J Thai Rehabil [Internet]. 2005 [cited 2025 May 1];15(2):101 - 12. Available from: https://www.rehabmed.or.th/main/wp-content/uploads/2015/01/L-210.pdf
18. Kammuang-lue P, Pattanakuhar S, Engkasan JP, Wahyuni LK, Fauzi AA, Chotiyarnwong C, et al. Association between health service systems and pressure injury problems of individuals with chronic spinal cord injury in Malaysia, Indonesia, and Thailand: A cross-sectional study. Am J Phys Med Rehabil [Internet]. 2024 Oct 1 [cited 2025 May 1];103(10):867-74. Available from: https://www.ncbi.nlm.nih.gov/pubmed/38261764 doi:10.1097/PHM.0000000000002437
19. Laughton GE, Buchholz AC, Martin Ginis KA, Goy RE, Group SSR. Lowering body mass index cutoffs better identifies obese persons with spinal cord injury. Spinal Cord [Internet]. 2009 Oct [cited 2025 Dec 20];47(10):757-62. Available from: https://www.ncbi.nlm.nih.gov/pubmed/19350042 doi:10.1038/sc.2009.33
20. Moonla T, Tongprasert S, Kovindha A. Sexual functions and sexual relationships of Thai men with chronic spinal cord injury. Chiang Mai Med J [Internet]. 2010 [cited 2025 May 1];49(3):89 - 96. Available from: https://www.thaiscience.info/Journals/Article/CMMJ/10886632.pdf
21. Kaeowichian N, Suthamchai B, Chuenklin T, Rungnoei N, Girdwichai W, Pannarunothai S. Intermediate care policy in Thailand: What should be done? J Health Sci Thail [Internet]. 2021 [cited 2025 May 15];30(5):894 - 906. Available from: https://thaidj.org/index.php/JHS/article/view/11174
22. Thiengtham S, Chiang-Hanisko L, D'Avolio D, Sritanyarat W. Experience of transitional care among Thai-Isan older stroke survivors and their family caregivers. Qual Health Res [Internet]. 2024 Oct [cited 2025 May 15];34(12):1191-202. Available from: https://www.ncbi.nlm.nih.gov/pubmed/38482851 doi:10.1177/10497323241232937
23. National statistical office, Ministry of digital economy and society. Statistical Yearbook Thailand 2023 2023 [cited 2025 Dec 20]. Available from: https://www.nso.go.th/public/e-book/Statistical-Yearbook/SYB-2023/80/.

Case Report

Reversal of Chronic Post-Stroke Genu Recurvatum with Progressive Robotic Gait Training: A Case Report

Parit Wongphaet and Kittiphon Jitardhan
Department of Rehabilitation Medicine, Samrong General Hospital, Samutprakarn Province, Thailand

ABSTRACT

Objectives: Genu recurvatum is a common gait abnormality in ambulatory stroke survivors, often persisting into the chronic phase and causing problems such as knee pain or interfering with balance ability. While robotic gait training has shown benefits in subacute populations, its application in chronic stroke with longstanding knee hyperextension remains underreported. This study aim to report whether a systematically progressive robotic gait training program can reverse longstanding post-stroke genu recurvatum in a chronic stroke survivor

Case Presentation: We report the case of a middle-aged female, two years post-right middle cerebral artery infarction, who presented with persistent left knee hyperextension during the stance phase and fear of falling. She underwent a year-long outpatient-based robotic gait training program using the SensibleSTEP® end-effector device, followed by Body Weight Supported Treadmill Training (BWSTT). The training was based on the principle of "as much support as necessary, but as little as possible," with progressive adjustment of gait speed, step length, and body weight support. A speed challenge protocol was introduced after the patient achieved basic stance-phase control. Despite a mid-course setback due to spasticity, managed with a tibial nerve phenol block, the patient progressed to full prevention of knee hyperextension and achieved independent ambulation at low speed without the use of gait aids.

Conclusions: Carefully structured robotic gait training, incorporating progressive speed challenges, may help reverse chronic genu recurvatum even years after stroke. This case suggests that robotics can extend the therapeutic window for gait recovery in individuals with chronic stroke.

Keywords: case reports, stroke rehabilitation, knee, robotics, gait

ASEAN J Rehabil Med. 2026; 36(2): 90-99.

Introduction

Genu recurvatum, or knee hyperextension during the stance phase, is a common gait abnormality observed in individuals post-stroke, particularly among those with moderate to severe hemiparesis who retain ambulatory capacity. A large-scale observational study of 1,110 ambulatory stroke survivors reported a prevalence of genu recurvatum in approximately 19.5% of patients, with a subset experiencing knee pain and long-term joint stress, raising concerns over its biomechanical and functional implications.[1] Importantly, imaging studies of these patients reveal cartilage abnormalities not only in the paretic limb but also on the contralateral side, possibly due to compensatory overuse, underscoring the need for early biomechanical correction to prevent secondary joint damage.[2]

While some clinicians attribute recurvatum to spasticity of the quadriceps, particularly the rectus femoris, targeted nerve blocks have failed to improve knee extension control during stance, suggesting that isolated spasticity is not the sole driver of the abnormality.[3] Instead, appropriate proprioceptively guided co-contraction between hamstrings and quadriceps appears central to knee stabilization.

Several therapeutic approaches have been explored to mitigate genu recurvatum. Proprioceptive gait training, such as prowling exercises, has shown promising results in reducing hyperextension and improving swing-phase knee flexion.[4, 5] Orthotic interventions also play a significant role. For example, hinged soft knee orthoses[6] and articulated ankle-foot orthoses with calibrated plantarflexion resistance[7] can reduce hyperextension during stance. Robot-assisted gait training and treadmill-based therapies using pneumatic robotic knee-ankle-foot devices have demonstrated improvements in recurvatum angles, gait speed, and overall motor scores in patients with chronic stroke.[8]

Even though several of these methods show promising outcomes, it is generally believed that genu recurvatum in chronic stroke patients cannot be completely reversed. While the degree of hyperextension can be reduced, the abnormal gait pattern often persists to some extent.[8]

Robotic gait training devices are becoming increasingly prevalent in post-stroke rehabilitation programs. A systematic review and meta-analysis of randomized controlled trials concluded that electromechanical-assisted gait training

Correspondence to: Parit Wongphaet, MD, FRCPhysiatrT; Department of Rehabilitation Medicine, Samrong General Hospital, 1748 Soi Sukumvit 78, Samrong-Nuea, Muang, Samutprakarn 10270, Thailand; E-mail: spine.clinic@yahoo.com

Received: September 29, 2025 Revised: November 13, 2025 Accepted: November 14, 2025

combined with physiotherapy increases the likelihood of achieving independent walking after stroke, compared to gait training without such devices.[9] The number needed to treat (NNT) to achieve one additional case of independent walking is eight. The most significant benefit is observed in patients within the first three months post-stroke, particularly in those who are initially non-ambulatory. These technologies provide high-intensity, repetitive training with real-time feedback and reproducible motion guidance—essential elements for promoting neuroplasticity and gait retraining.[10]

"SensibleSTEP" is an end-effector-type robotic gait training device that has received approval from the Thai Food and Drug Administration (Thai FDA). It is engineered to provide safe, adjustable body weight-supported training, with customizable gait speed, step length, and both vertical and horizontal support, accommodating individual patient needs. Unique to its design, SensibleSTEP provides continuous visual feedback on the timing and magnitude of weight shift through its dual moving footplates. While this type of system has been successfully used for gait rehabilitation in subacute, non-ambulatory stroke patients[11], its utility in chronic stroke—specifically for cases with genu recurvatum—remains undocumented. This absence of literature suggests a novel opportunity to explore its application in improving knee kinematics and stance phase control in ambulatory chronic stroke patients with persistent recurvatum. This case report is written in accordance with the CARE guideline checklists.

We have been using SensibleSTEP at our hospital for more than five years. When a patient is in the machine, they stand on two moving footplates. The changing position of the footplates forces the patient to continuously adjust the co-contraction between the quadriceps and hamstrings to match the changing vector of the ground reaction force. This task can be made easier by slowing the walking speed, prescribing a shorter step length, providing more horizontal (side-to-side) hip support, increasing vertical trunk bodyweight support, or allowing greater hand support. As the patient's skill improves—specifically when they can maintain stable knee control throughout the stance phase without buckling or hyperextension—these parameters are progressively and systematically adjusted to increase training difficulty step by step, allowing further improvement.

Successful reversal of recurvatum had been consistently observed in many cases at our hospital, sometimes even within a single session; however, because neither video recording nor joint-angle-based gait analysis was routinely performed, these outcomes were not suitable for publication. It was during the subsequent initiation of systematic video documentation that the current patient presented for treatment.

To our knowledge, no previous report has documented the complete reversal of chronic post-stroke genu recurvatum using robotic gait training. Given these gaps in the literature and our clinical observations, we hypothesized that a systematically progressive robotic gait training program—designed to optimize stance-phase knee control through adjustable footplate dynamics, modulated support, and speed-dependent challenge—could meaningfully reverse longstanding genu recurvatum even in the chronic phase after stroke. The objective of this case report is to describe the clinical course, training parameters, and outcomes of a chronic stroke survivor with persistent knee hyperextension who underwent this structured robotic gait training approach, and to illustrate its potential role in restoring more physiological knee kinematics beyond the conventionally accepted therapeutic window.

Patient information

The patient is a middle-aged female who experienced a large right middle cerebral artery (MCA) infarction two years prior to enrollment in the robotic gait training program. The case was presented to the Rehabilitation Medicine Department, Samrong General Hospital. She had no known comorbidities and had initially undergone approximately four months of conventional inpatient rehabilitation, which was discontinued due to a plateau in progress. An unsupervised home exercise regimen followed this.

At the time of evaluation, she was independent in all basic activities of daily living (ADLs). However, she had not returned to her previous occupation as an accountant due to persistent reading difficulty and dizziness. She ambulated with a tripod cane and reported low walking confidence and fear of falling. Her primary rehabilitation goal was to regain confidence and independence in community ambulation.

Clinical findings

At the time of assessment, the patient exhibited consistent hyperextension of the left knee during the stance phase of gait, as well as shortened stance duration on the paretic side. There was no evidence of joint contracture, and passive range of motion at all major lower extremity joints was preserved. Lower extremity muscle tone of the knee extensors, knee flexors, and ankle plantar flexors was slightly increased, with a score of 1+ on the Modified Ashworth Scale.

The patient could extend the knee and flex the hip against gravity and strong manual resistance, but the movement was partially limited to synergistic patterns. Selective dorsiflexion at the ankle was absent, indicating impaired distal motor control. Sensory examination demonstrated intact light touch and proprioception in both lower limbs, with no abnormalities in joint mobility or tactile sensation.

Passive range of motion assessment demonstrated no contracture of the ankle or knee joints, and no shortening of the gastrocnemius-soleus complex; the ankle could be positioned in dorsiflexion beyond 90 degrees with the knee either flexed or fully extended. Knee stability tests, including varus and valgus stress tests and anterior and posterior drawer tests, revealed no joint laxity. The genu recurvatum observed in this patient was painless and occurred consistently throughout early, mid, and late stance phases without

any sudden snapping into hyperextension. The abnor-mal knee angle was clearly distinguishable from the contra-lateral limb on visual inspection, and joint-angle measurements were subsequently quantified using Kinovea software as described in the diagnostic methods section. Functionally, the patient was able to perform sit-to-stand and stand-to-sit transitions independently, ambulate on level ground with a gait aid, and ascend and descend stairs using a step-to pattern while holding the handrail. Gait speed was not recorded, as the primary interest in this case was the reversal of knee recurvatum, and it was anticipated that walking velocity might not necessarily improve. At the same time, the patient concentrated on preventing hyperextension during gait. Gait endurance tests, such as the 6-minute walk test (6MWT), were not conducted.

Examination of the upper extremity revealed the absence of voluntary hand function and minimal active movement at the shoulder and elbow, restricted to full flexor and partial extensor synergistic patterns. Despite profound motor impairment, the thumb-finding test was normal, indicating preserved proprioceptive function at the shoulder, elbow, wrist, and thumb joints.

Functionally, the patient ambulated with a tripod cane but demonstrated a slow gait, characterized by cautious steps and a pronounced fear of falling. Despite being independent in all basic activities of daily living, she had not returned to her profession due to reading difficulty and persistent dizziness.

Neuropsychological testing[12] revealed severe visuospatial neglect. On the Rey-Osterrieth Complex Figure Copy test[13], the patient omitted nearly the entire left half of the figure and significantly distorted the right-sided features. (see figure 2a) Other cognitive domains, including memory, language, reasoning, executive function, self-control, and praxis, remained intact. The patient was able to engage meaningfully in rehabilitation planning.

Interpretation of timeline and training progression

This case illustrates an individualized, structured, adaptive, and progressive robotic gait rehabilitation process, guided by the principle emphasized by the late Professor Stefan Hesse, a pioneer of the world's first end-effector-type gait robot, that rehabilitation should offer "as much support as necessary, but as little as possible."[14] Over the course of the program, five key parameters were systematically adjusted in each session: walking speed, step length, vertical trunk support (body weight unloading), horizontal trunk (hip) support, and reliance on upper limb support (handrails). These were modified dynamically, either independently or in combination, according to the patient's evolving neuromotor capacity, as detailed in the training log (Appendix 1) and summarized graphically in Figure 1.

Timeline

Date	Clinical event / intervention
Late Mar 2024	Initial doctor visit: pre-training assessment.
Early Apr 2024(A)	First training session: patient able to prevent knee hyperextension in some steps at low speed (1.1 km/h) on SensibleSTEP with continuous use of hand-rail support.
Late Apr 2024	Doctor visit: no observable change in overground gait.
Late May 2024	Training log: improved knee control on SensibleSTEP up to 1.7 km/h; no hip support required; started speed challenge protocol.
Early July 2024(B)	Training log: full knee control up to speed 2.0 km/h on SensibleSTEP, start using "speed challenge protocol" in gait training at the eighth session.
Mid Jul 2024	Doctor visit: partial prevention of recurvatum during ground walking.
Mid Aug 2024(C)	Training log: change of training strategy, prioritizing top speed at 34th ses-sion.
Late Aug 2024	Doctor visit: 80% of ground steps recurvatum-free using a single cane.
Mid Oct 2024(D)	Training log: reached best performance on SensibleSTEP at 49th session, af-ter which the training parameter regressed for the subsequent four sessions
Late Oct 2024	Doctor visit: Increased ankle spasticity identified; patient cannot prevent knee hyperextension in the stance phase, even with a tripod cane.
Late Nov 2024	Doctor visit: Underwent phenol neurolytic block to the left tibial nerve.
Early Dec 2024(D)	Training log: Switched to BWSTT at speeds up to 0.3 km/h; good knee con-trol, but ankle inversion spasticity required hands-on assistance.
Early Dec 2024	Doctor visit: acute right psoas myalgia resolved thoroughly after a hot pack and gentle passive stretching.
Mid Jan 2025	Doctor visit: complete absence of knee hyperextension while walking with a tripod cane.
Late Feb 2025	Doctor visit: full control of recurvatum at low speed using a single cane.
Early Mar 2025	Training log: Completed the last session of training, which required therapist assistance for ankle stability; afterward, the subject was able to manage foot placement independently.
Late Apr 2025	Doctor visit: able to largely prevent recurvatum at low speed without gait aid.

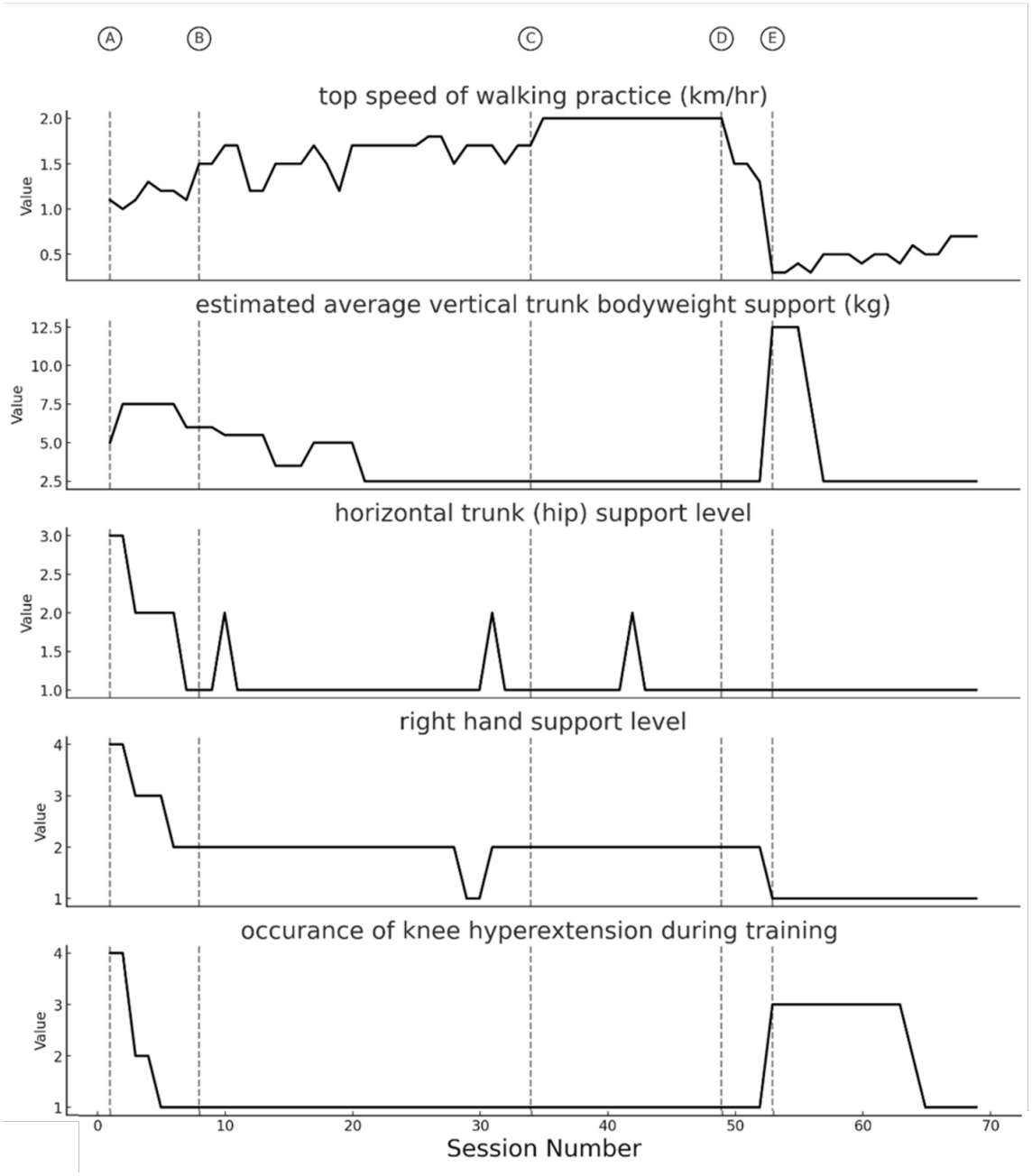


Figure 1. Display of Selected Training Parameters During the Course of Therapy

This graphic illustrates key training parameters recorded throughout the course of therapy, spanning 69 sessions. The first 52 sessions were conducted using the SensibleSTEP gait rehabilitation robot, while the remaining sessions, from session 53 to 69, transitioned to training with a body weight support treadmill training system (BWSTT).

During these sessions, various support and performance metrics were monitored. The horizontal trunk (hip) support level was rated on a scale where 3 indicates full mechanical support, 2 indicates partial support, and 1 indicates no support. The right hand support level was categorized as follows: 4 for constant hand holding, 3 for constant light touch, 2 for intermittent touch, and 1 for no hand support.

The occurrence of knee hyperextension during training was observed and rated with 4 indicating hyperextension occurred most of the time, 3 for about half of the time, 2 for less than half, and 1 indicating no hyperextension..

Several key milestones were annotated within the chart for reference:

(A) Session 1 marks the beginning of training with the SensibleSTEP gait robot.

(B) Session 8 represents the introduction of the speed challenge protocol.

(C) Session 34 highlights a shift in emphasis toward maximizing top walking speed.

(D) Session 49 indicates the peak of performance before a temporary decline due to ankle spasticity.

(E) Session 53 denotes the transition to body weight support treadmill training (BWSTT).

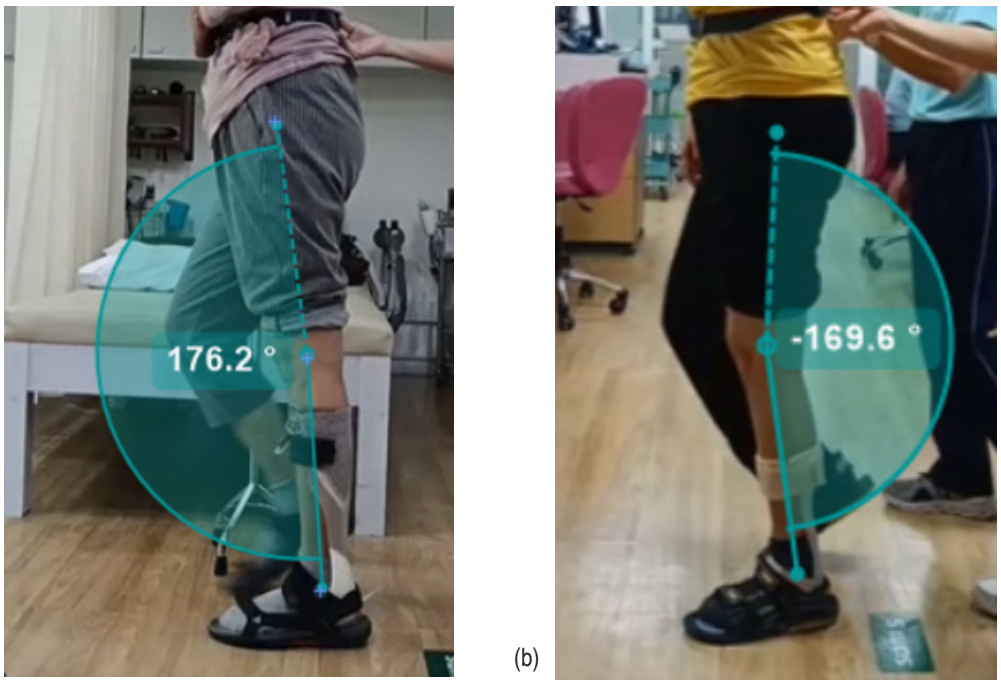


Figure 2. Side view of paretic knee during mid-stance pre- and post-treatment
Frames captured from overground gait video with minimal parallax. (a) Before treatment, using tripod cane, (b) After treatment, no gait aid

During the first eight sessions, the patient gradually developed the ability to stabilize the left knee and successfully prevent hyperextension during stance while practicing walking on the SensibleSTEP, though only at low walking speeds and with considerable support. Starting from the eighth session onward, the clinical team introduced the speed challenge protocol, a strategy developed to enhance motor adaptation and refine gait patterns. In each session, the therapist gently increased the speed of walking practice during 4-8 short bouts, pushing the speed up to the point where the patient could still maintain good knee control but required full concentration and perceived the task as challenging. Each high-speed bout lasted 10-15 seconds. After each bout, the speed was reduced to a "comfortable" pace, which was often higher than the patient's previous baseline speed. This method enabled the patient to adapt to higher walking speeds and greater biomechanical demands within a short time, thereby maximizing the session-to-session acquisition of balance and gait skills through dynamic and responsive challenge adjustments. Such a training strategy has shown immediate benefits in improving gait quality in both early Parkinson's disease[15] and ambulatory hemiparetic stroke patients.[16] Home exercises were neither prescribed nor recorded during this study.

Diagnostic assessment

No laboratory tests or imaging studies were used to assess this patient's gait and balance. The diagnosis of post-stroke genu recurvatum and stance-phase knee instability was based entirely on clinical gait observation and on the changing parameters of the training setup.

Short video recordings were taken using unspecified mobile phones of convenience at the first and last training sessions during therapy visits. These included side-view videos of overground walking at the patient's self-selected comfortable speed, with the patient intentionally attempting to control the knee and prevent hyperextension as much as possible. The videos clearly demonstrate progressive improvement in stance-phase knee control, starting from consistent hyperextension at every step—even while using a tripod cane—to complete prevention of hyperextension at every step without the use of any gait aid. A short video clip for this gait sequence is available online at https://archive.org/details/before-after-no-aid-compare.

Comprehensive training logs documenting these improvements are available in Appendix 1 and Appendix 2, respectively.

Figure 2 presents side-view images of the patient's paretic knee during the mid-stance phase of gait, captured before and after the rehabilitation intervention. These images were extracted from a continuous video recording of overground walking. For each condition, a representative frame was selected based on minimal parallax error—specifically, the moment when the camera view was most tangential to the patient's walking path and the knee joint was most clearly profiled. Image (a) shows the gait pattern prior to treatment, during which the patient relied on a tripod cane for support. Image (b) shows the same phase of gait following treatment, with the patient walking independently without any assistive device. These figures visually illustrate the changes in knee joint posture and stability during the stance phase resulting from the intervention.

Neuropsychological assessment revealed severe visuospatial neglect, confirmed by the Rey-Osterrieth Complex Figure Copy Test, which showed marked omission of elements on the left side and distortion of those on the right. However, despite this visual perceptual impairment, the patient did not exhibit any features of "pusher syndrome." There was no trunk inclination or postural bias in sitting, standing, transitions from sitting to standing, or during gait initiation[17] This suggests that the spatial perceptual difficulty was confined to external visual space, without involvement of the somesthetic sense or body schema.

At approximately five months into the training program, a marked improvement in visuospatial performance was observed. Although minor omissions and placement errors persisted, the severity of these deficits was greatly reduced. The patient's initial Rey-Osterrieth Complex Figure Copy performance is shown in Figure 3a, while the post-therapy performance is depicted in Figure 3b. For reference, the standard model figure provided for copying is shown in Figure 3c.

Furthermore, knee joint proprioception was intact, as was lower limb sensory function, reinforcing the conclusion that the genu recurvatum was not due to sensory loss. For these reasons, the gait abnormality was attributed primarily to impaired dynamic motor control of the paretic lower limb. Given the chronic stage of recovery and the clear clinical picture, no further diagnostic testing was deemed necessary.

Therapeutic intervention

The patient participated in a high-repetition, task-specific robotic gait training program, completing 69 sessions over a 12-month period. The primary rehabilitation objective was to restore stance-phase knee stability and reduce genu recurvatum. Training was delivered in two phases: initially with the SensibleSTEP end-effector robotic system, followed by Body Weight Supported Treadmill Training (BWSTT) once the maximum challenge level on SensibleSTEP was achieved.

Each session lasted 20 minutes. Initially, sessions included rest intervals; however, as endurance improved, the patient was able to achieve 20 minutes of continuous walking at a pace of 40-50 steps per minute, totaling approximately 800-1,000 steps per session. This volume exceeds typical step counts achieved in conventional therapy and meets criteria for intensive motor practice.

Training frequency was designed to promote skill acquisition and consolidation of stance-phase control, with the patient averaging 1.3 sessions per week over a 52-week period. A detailed overview of gait training progression is provided in Appendix 1.

Concurrently, the patient participated in an outpatient occupational therapy program focused on figure copying, constructional tasks, and graded visual field search activities, with a slow progression from simple to complex tasks. This program was discontinued after six months.

No additional rehabilitation interventions were administered beyond those described. Specifically, no tilt table training, passive stretching, or seated bench exercises were employed. Ground-based walking was occasionally included but limited to a few laps of approximately 10 meters per session, serving only as a minor adjunct to robotic gait training.

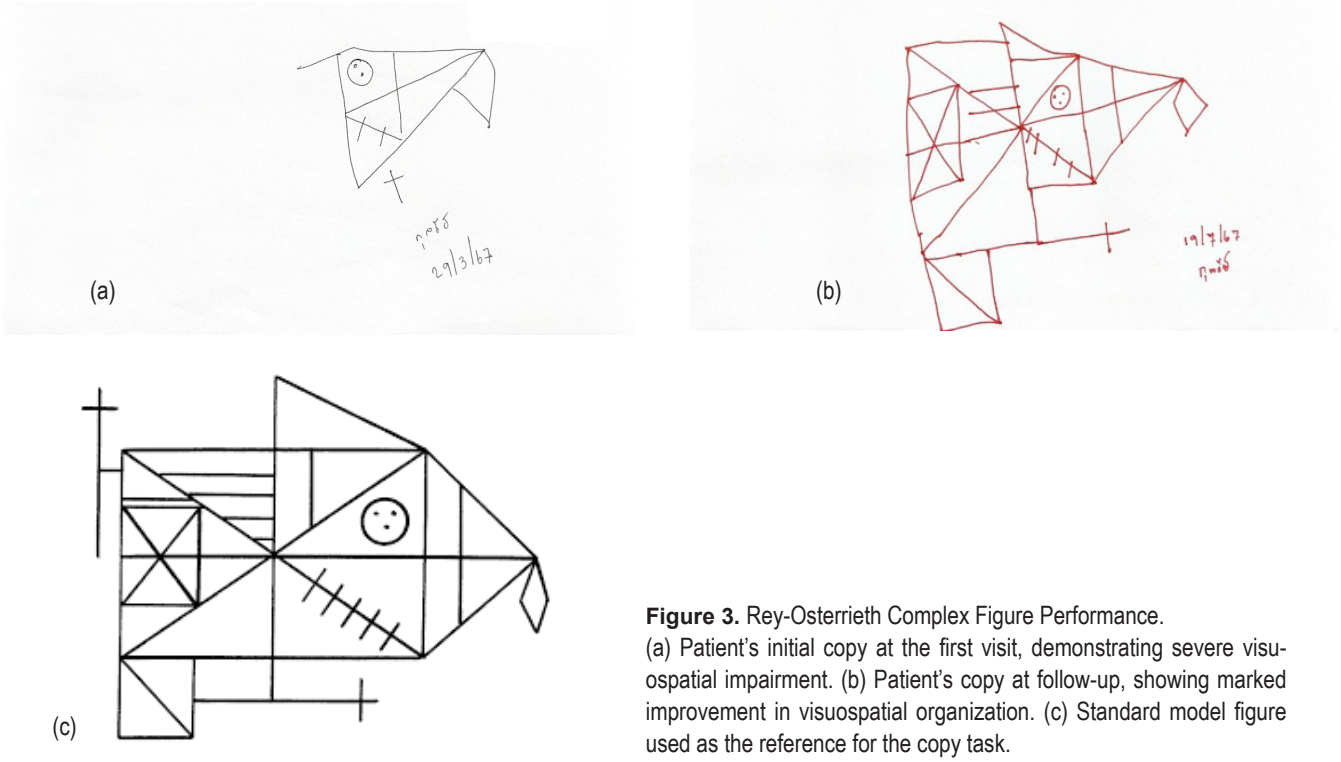


Figure 3. Rey-Osterrieth Complex Figure Performance.
(a) Patient's initial copy at the first visit, demonstrating severe visuospatial impairment. (b) Patient's copy at follow-up, showing marked improvement in visuospatial organization. (c) Standard model figure used as the reference for the copy task.

Follow-up and outcomes

A significant change in clinical status was noted during the October 2024 follow-up, approximately seven months into training: although resting tone was unchanged (Ashworth 1+), action-dependent ankle plantarflexion and inversion spasticity emerged, impairing knee control during overground walking. In response, a phenol neurolytic block was performed on the left tibial nerve in November. This intervention was supported by data from the training log, which showed a reduction in top walking speed from 2.0 km/h to 1.5 and 1.3 km/h in the sessions immediately preceding the block. This result underscores the sensitivity of robotic training metrics as indicators of gait and balance functional level.

The emergence of increased spasticity in this patient was most likely related to the heightened motor effort required during training to activate the knee-stabilizing musculature, particularly the quadriceps and hamstrings. Such sustained effort can increase excitability within central neuronal pools, especially at the spinal level. It is well recognized that high-effort motor tasks can provoke unintentional co-contractions in distant muscle groups, a phenomenon observed even in neurologically intact individuals and more prominently in those with prior central nervous system injury. In this case, years after the stroke, progressive training successfully enhanced knee control through improved agonist-antagonist co-activation; however, the same increase in descending drive and segmental excitability likely contributed to unintended overactivity of the calf muscles, resulting in action-dependent plantarflexion spasticity as a secondary complication.

By December 2024, approximately eight months into training, the patient had completed SensibleSTEP training close to its most challenging walking conditions—walking at 2.0 km/h with a 41 cm step length, no hip or hand support, and minimal vertical body weight support. It was evident that the patient was approaching a training ceiling within the SensibleSTEP system, where further increases in challenge were limited. Recognizing this, the clinical team made a deliberate decision to transition to Body Weight Supported Treadmill Training (BWSTT), which offered greater variability and higher levels of gait-specific demand beyond the capabilities of the end-effector robot.

Another brief minor setback occurred in early December 2024, when the patient developed acute psoas myalgia, likely due to the increased muscular demands of BWSTT. Moderate local tenderness over the muscle belly of the iliopsoas muscle at the proximal anterior thigh, just above the insertion point, was identified via manual palpation. Local treatment with a hot pack and stretching resolved the pain completely.

Following this, the patient continued to make steady progress. Notably, the gait training parameters had improved in parallel with the observed improvements in knee control during ground walking. She ultimately was able to walk without knee hyperextension and without gait aids at low speed. The treatment program was provided free of charge, as the research team believed the patient had potential for further recovery but remained uncertain about the extent of possible improvement. The patient expressed strong motivation to participate, willingly traveling for regular training sessions in the hope of enhancing her functional abilities. Verbal agreement to use her clinical information for a research case report was obtained at the outset, and written consent was secured upon completion of the training program.

The senior author (PW) serves as the hospital director and is also the director of the SensibleSTEP manufacturing company. This arrangement may introduce a potential conflict of interest; however, it also enabled the patient to undertake an extended course of therapy that would have been financially inaccessible otherwise. The outcome observed in this case may therefore be challenging to replicate in routine clinical practice—not because prolonged, progressive training is inherently ineffective, but because most chronic stroke survivors lack the financial means and logistical capacity to sustain long-term, high-frequency rehabilitation of this intensity.

Discussion

In our previous clinical experience, we have successfully reversed genu recurvatum gait in many stroke survivors, particularly among those with mild to moderate motor deficits. However, most patients with more severe deficits can participate in intensive training for only a limited duration—typically three to six months—due to financial or logistical constraints, regardless of whether they are still improving or have reached a plateau. This case is therefore relatively rare in that a highly chronic and severely affected patient was able to engage in consistent therapy over the span of an entire year. The outcome is particularly noteworthy given that the patient was more than two years post-stroke and had previously plateaued after conventional rehabilitation. In contrast to the typical trajectory of chronic stroke—where knee control abnormalities often persist, this case highlights the potential for targeted, parameter-driven robotic gait training to promote meaningful functional recovery even in the chronic phase, provided the intervention is sufficiently individualized and progressively scaled.

Although the outcomes in this case were not documented through laboratory-based gait measurements or formal clinical assessment scales, the magnitude of change was undeniable. The patient demonstrated a complete resolution of stance-phase knee hyperextension during overground walking, progressing from consistent recurvatum even with assistive devices to independent ambulation without gait aids. Improvements were corroborated by concurrent changes in robotic training parameters and observational video recordings, providing robust clinical evidence of genuine motor recovery.

Previous studies investigating interventions for genu recurvatum have generally shown reductions in hyperextension angles but rarely complete resolution of the abnormal gait pattern. A plausible explanation for the more favorable

outcome observed in this case lies in the longer duration, higher intensity, and individualized progression of training compared to most published protocols.

Beyond high repetition and task specificity, our program incorporated real-time, high-frequency biofeedback. Therapists provided continuous verbal cues during the stance phase, reinforcing correct knee stabilization patterns and correcting errors immediately. Moreover, training parameters were systematically titrated to maintain the patient within the "optimal challenge zone," demanding enough to drive adaptation without provoking compensatory patterns or failure. Such an adjustment depends on the therapist's decision. Thus, the effectiveness of training is influenced not only by the type of machine used but also by the therapist's knowledge and skill. Young physiotherapists or new graduates may take a considerable amount of time to master this process, or may struggle to learn if they do not have the opportunity to work alongside experienced colleagues. To address this gap, we are developing an artificial intelligence (AI) system designed to assist therapists by suggesting training adaptations and explaining the rationale behind each recommendation. These advancements aim to support clinical decision-making and enhance the consistency and quality of rehabilitation outcomes.

Motor rehabilitation fundamentally relies on experience-driven neuroplasticity[18], and the clinical effects of robotic gait training are heavily dependent on the specific design features of the device used. Not all robotic systems afford the same opportunity for active engagement and error-based learning. For instance, modified end-effector devices with a saddle between the thighs can inhibit normal lateral weight shifting, thereby limiting dynamic knee control training. Similarly, two-point swing harness systems that oscillate the trunk forward and backward may disrupt natural lateral weight shifts and interfere with the development of dynamic balance. Rigid exoskeletons that impose pre-set limb trajectories further constrain the patient's ability to generate and correct motor errors, an essential mechanism for retraining joint-specific dynamic knee stability. These design considerations underscore the importance of continuous, individualized adjustments to robotic training parameters—capabilities not uniformly available across all robotic systems.

In this study, the working definition of genu recurvatum relied on two clinically observable criteria: (1) apparent asymmetry visible to the naked eye when compared with the contralateral limb, and (2) apparent knee hyperextension, defined as any excursion beyond 180 degrees during any portion of the stance phase. Although this approach is less sensitive and less precise than gold-standard three-dimensional kinematic analysis, additional verification was performed using Kinovea, a freeware motion-analysis program. Anatomical markers were manually placed frame-by-frame, with the knee joint positioned at the visually estimated location of the lateral femoral epicondyle. Each sequence was reviewed to ensure that marker placement remained stable and did not drift or "bounce" relative to the underlying anatomical structures, and only sequences with minimal deviation were accepted for analysis. Despite the limitations inherent to two-dimensional video-based measurement, the convergence of clinical observation and training-performance data—illustrated in Figure 1 through the reduced frequency of hyperextension events, progressive increases in walking speed, and decreasing support requirements—strongly supports that the improvement in knee stabilization was genuine rather than an artifact of measurement constraints.

This case suggests that a complete reversal of chronic genu recurvatum is possible when rehabilitation integrates key motor learning principles, including prolonged duration, high repetition, task-specific practice, real-time therapist feedback, and dynamic modulation of task difficulty. Critically, the robotic system must permit active joint control and foster learning through trial and error. However, as a single-patient case report, these findings are not generalizable to the broader stroke population. To further validate these findings, future research should include prospective case series or randomized controlled trials incorporating quantitative gait analysis (e.g., marker-based or video-based systems), standardized functional outcome measures such as the Timed Up and Go (TUG), 6MWT, Fugl-Meyer Assessment, validated balance assessments, and spatiotemporal gait parameters. Including participants with varying levels of post-stroke severity will help delineate optimal patient selection criteria and protocol design.

It is important to acknowledge that the tibial nerve phenol block represented an unplanned co-intervention in this case. Although the injection contributed to a reduction in recurvatum by alleviating the newly emerged plantarflexor overactivity, its role should be interpreted within the broader clinical context. Prior to the intervention, training logs and video observations indicated that the patient was beginning to lose previously gained improvements in knee control, suggesting that the action-dependent increase in calf spasticity had become a disruptive factor in gait performance. Following the injection, stance-phase stability improved again, allowing training to resume its intended progression. Nevertheless, it is unlikely that the injection alone accounted for the overall restoration of knee stability; rather, the neurolytic block mitigated a secondary complication that had arisen during long-term training. The primary driver of recovery remained the structured, progressive motor retraining program, with the injection serving mainly to remove an interfering factor that hindered further gains.

Several noteworthy additional observations emerged from this case. First, changes in on-machine training parameters—such as walking speed, vertical unloading, and reliance on hand support—were detectable prior to observable improvements in overground gait through visual assessment. This result suggests that robotic training metrics may serve as earlier and more sensitive indicators of motor recovery than clinical gait observation. However, whether these pa-

rameters are more sensitive than instrumented temporal-spatial gait measures remains to be determined.

Second, progressive increases in training speed were systematically associated with reductions in vertical support, lateral trunk support, and handrail use, indicating coordinated improvement in dynamic balance and stance-phase control.

Third, the transition from Sensible STEP to BWSTT resulted in an immediate reduction in training speed, a marked increase in vertical support requirements (from 2.5 kg to 12 kg), and a transient reappearance of knee hyperextension during treadmill walking. These findings suggest that BWSTT imposes significantly greater biomechanical and motor control challenges compared to end-effector-based robotic systems.

Finally, the extent to which functional gains—such as improvements in gait speed and advanced balance performance—can be maximized and retained following the cessation of therapy remains an open question. Longitudinal follow-up at six- and twelve-months post-therapy will be critical to evaluating the durability of rehabilitation outcomes in this patient.

Patient perspective and informed consent

The patient reported that the therapy was highly beneficial, noting a marked increase in her confidence while walking and a reduction in her fear of falling. She also experienced improvements in her visual attention, which made daily activities more manageable. As a result, she felt able to resume work-related tasks and gradually regain a source of income, which further reinforced her sense of independence and quality of life. The patient provided written informed consent for the publication of this case report.

This case report was approved by the Medical Staff Organization of Samrong General Hospital, Samutprakarn Province, Thailand.

Conclusions

This case demonstrates that chronic post-stroke genu recurvatum, often considered irreversible, may be reversed entirely through individualized, progressive robotic gait training. The findings underscore the importance of long-duration, high-repetition, and parameter-driven therapy, which is supported by skilled clinical supervision. Future studies are warranted to confirm these results in larger cohorts and to establish clinical guidelines for patient selection and intervention protocols.

Conflict of interest declaration

The corresponding author (PW) is the director of Samrong General Hospital and of the company that manufactures the SensibleSTEP device. All other authors declare no conflicts of interest.

Generative AI declaration

Generative artificial intelligence tools were used in the preparation of this manuscript for grammar checking and for suggesting alternative sentence formulations. All original concepts, clinical interpretations, analytical reasoning, and the overall content structure were developed exclusively by the human authors.

Acknowledgements

The authors thank the patient for her participation and the rehabilitation staff of Samrong General Hospital for their dedication and support throughout the treatment and documentation process.

Funding

No external funding was received for this study.

Data availability

To protect patient privacy, no medical records or additional personal data are shared. All essential data supporting the findings of this study are included within the manuscript, and selected gait video clips are available through the provided URL.

Author contributions

Parit Wongphaet: conceptualization, formal analysis, methodology, project administration, supervision, writing

Kittiphon Jitardhan: data curation, supervision, validation, visualization, writing.

References

1. Tani Y, Otaka Y, Kudo M, Kurayama T, Kondo K. Prevalence of genu recurvatum during walking and associated knee pain in chronic hemiplegic stroke patients: a preliminary survey. J Stroke Cerebrovasc Dis [internet] 2016[cited 2025 Aug 02];25(5):1153-7. Available from : https://pubmed.ncbi.nlm.nih.gov/20153279/ doi:10.1016/j.jstrokecerebrovasdis.2016.01.028
2. Li W, Li Y, Gao Q, Li W, Liu J, Wen Q, Jia S, et al. Change in knee cartilage components in stroke patients with genu recurvatum analysed by zero TE MR imaging. Sci Rep [Internet]. 2022 [cited 2025 Aug 02] ;12(1):3751. Available from : https://pubmed.ncbi.nlm.nih.gov/35260668/ doi:10.1038/s41598-022-07817-w
3. Gross R, Delporte L, Arsenault L, Revol P, Letevre M, Clevenot D, et al. Does the rectus femoris nerve block improve knee recurvatum in adult stroke patients? A kinematic and electromyographic study. Gait Posture. [internet] 2014 [cited 2025 Aug 02] ;39(2):761-6. Available from : https://pubmed.ncbi.nlm.nih.gov/24286615/ doi:10.1016/j.gaitpost.2013.10.008
4. Geerars M, Minnaar-van der Feen N, Huisstede BMA. Treatment of knee hyperextension in post-stroke gait: a systematic review. Gait Posture. [internet] 2022 [cited 2025 Aug 02] ;91:137-48. Available from : https://pubmed.ncbi.nlm.nih.gov/34695721/ doi:10.1016/j.gaitpost.2021.08.016

5. Dalal KK, Joshua AM, Nayak A, Mithra P, Misri Z, Unnikrishnan B. Effectiveness of prowling with proprioceptive training on knee hyperextension among stroke subjects using videographic observation—a randomised controlled trial. Gait Posture. [internet] 2018 [cited 2025 Aug 02] ;61:232-7. Availble from https://pubmed.ncbi.nlm.nih.gov/34695721/ doi:10.1016/j.gaitpost.2018.01.018
6. Portnoy S, Frechtel A, Raveh E, Schwartz I. Prevention of genu recurvatum in poststroke patients using a hinged soft knee orthosis. PM R. [internet] 2015 [cited 2025 Aug 02] ;7(10):1042-51. Available from : https://pubmed.ncbi.nlm.nih.gov/27136122/ doi:10.1016/j.pmrj.2015.04.007
7. Kobayashi T, Orendurff MS, Singer ML, Gao F, Daly WK, Foreman KB. Reduction of genu recurvatum through adjustment of plantarflexion resistance of an articulated ankle-foot orthosis in individuals post-stroke. Clin Biomech (Bristol). [internet] 2016 [cited 2025 Aug 02] ;35:81-5. Available from : https://pubmed.ncbi.nlm.nih.gov/27136122/ doi:10.1016/j.clinbiomech.2016.04.011
8. Takahashi Y, Okada K, Noda T, Teramae T, Nakamura T, Haruyama K, et al. Robotized knee-ankle-foot orthosis-assisted gait training on genu recurvatum during gait in patients with chronic stroke: a feasibility study and case report. J Clin Med [Internet]. 2023 [cited 2025 Aug 02] ;12(2):415. Available from : https://pubmed.ncbi.nlm.nih.gov/36675345/ doi:10.3390/jcm12020415
9. Mehrholz J, Thomas S, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev [Internet]. 2020 [cited 2025 Aug 02] ;10(10):CD006185. Available from : https://pubmed.ncbi.nlm.nih.gov/36675345/ doi:10.1002/14651858.CD006185.pub5
10. Kwakkel G, Stinear C, Essers B, Munoz-Novoa M, Branscheidt M, Cabanas-Valdis R, et al. Motor rehabilitation after stroke: European Stroke Organisation (ESO) consensus-based definition and guiding framework. Eur Stroke J [Internet]. 2023 [cited 2025 Aug 02] ;8(4):880-94. Available from : https://pubmed.ncbi.nlm.nih.gov/37548025/ doi:10.1177/23969873231191304
11. Chanubol R, Wongphaet P, Panichareon L, Chavanich N. Gait rehabilitation in subacute hemiparetic stroke: robot-assisted gait training versus conventional physical therapy. ASEAN J Rehabil Med [internet]. 2015 Nov. 10 [cited 2025 Aug 02] ;22(2):42-50. available from: https://he01.tci-thaijo.org/index.php/aseanjrm/article/view/42331
12. Wongphaet P, Chanubol R, Phakdepiboon T, Vongpipatana S, Smithnaraseth D, Srisilpa K, et al. Mind matters: a practical bedside clinical neuropsychology handbook. 1st ed. Bangkok: Samrong General Hospital; 2025.
13. Vongpipatana S, Chokkhatiwat K, Wongphaet P. A comparison between Rey-Osterrieth Complex Figure Copying Test versus a combined battery of five tests in patients with right hemispheric stroke. J Thai Rehabil Med [Internet]. 2017[cited 2025 Aug 02] ;27(1):25-9. Available from : https://he01.tci-thaijo.org/index.php/aseanjrm/article/view/68275 DOI:10.14456/jtrm.2017.6
14. Hesse S. Lokomotionstherapie: ein praxisorientierter Überblick. 1st ed. München: Pflaum Verlag; 2008. 131p.
15. Pohl M, Rockstroh G, Rückriem S, Mrass G, Mehrholz J. Immediate effects of speed-dependent treadmill training on gait parameters in early Parkinson's disease. Arch Phys Med Rehabil .[internet] 2003[cited 2025 Aug 02] ;84(12):1760-6. Available from : : https://pubmed.ncbi.nlm.nih.gov/14669180/ doi:10.1016/s0003-9993(03)00433-7
16. Pohl M, Mehrholz J, Ritschel C, Rückriem S. Speed-dependent treadmill training in ambulatory hemiparetic stroke patients: a randomized controlled trial. Stroke. [internet] 2002 [cited 2025 Aug 02] ;33(2):553-8. Available from: https://pubmed.ncbi.nlm.nih.gov/11823669/ doi:10.1161/hs0202.102365
17. Karnath H-O, Broetz D. Understanding and treating "pusher syndrome". Phys Ther. [internet] 2003 [cited 2025 Aug 02] ;83(12):1119-25. Available from : https://pubmed.ncbi.nlm.nih.gov/14640870/ doi:10.1093/ptj/83.12.1119
18. Nudo RJ. Recovery after brain injury: mechanisms and principles. Front Hum Neurosci [Internet]. 2013 [cited 2025 Aug 02] ;7:887. Available from : https://pubmed.ncbi.nlm.nih.gov/24399951/ doi:10.3389/fnhum.2013.00887

Case Report

Evaluation of Baclofen on Speech Production in Post-Stroke Laryngeal Tension Dysphonia and Spastic Dysarthria: A Case Report

Lau Tsui Nam Trier[1], Joon Sin Ser[1] and San San Tay[2]
[1]Rehabilitation Medicine, SingHealth Residency; [2]Department of Rehabilitation Medicine, Changi General Hospital, Singapore

ABSTRACT

Objectives: Communication deficits following stroke are prevalent and often debilitating. While conventional speech rehabilitative strategies by speech-language pathologists remain the mainstay of therapy, pharmacological adjuncts that facilitate oromotor and phonatory function may further enhance recovery. This case report describes the use of oral baclofen as an adjunct to conventional speech therapy in a post-stroke patient with severe dysarthria. It also illustrates how the Frenchay Dysarthria Assessment (FDA) can sensitively capture functional changes beyond standard bedside evaluation.

Case description: A 64-year-old English-speaking male with no significant comorbidities presented with a right middle cerebral artery (MCA) infarct which occurred in the context of cerebral amyloid angiopathy for which he underwent successful thrombectomy. He suffered from severe motor speech impairment, including dysphonia and dysarthria. Nasoendoscopy revealed normal vocal cord structure and movement, suggesting laryngeal tension dysphonia. During the initial 10 days of conventional speech-language therapy without baclofen, there was minimal improvement in his speech production as assessed by the same speech-language pathologist using the Perceptual Dysarthria evaluation. Given the persistent oromotor and laryngeal muscle hypertonicity, oral baclofen was introduced to address suspected spastic contributions to the dysarthria and dysphonia.

Results: Over one month, the patient completed 22 structured speech therapy sessions. Following baclofen initiation, the FDA, administered before and after treatment, demonstrated noticeable improvements in multiple domains: lip seal function, lip spread in speech, jaw function in speech, palatal muscle function in speech, and tongue muscle function in protrusion, lateral movement, and speech. Speech intelligibility also improved.

Conclusions: This case highlights the potential of oral baclofen as an adjunctive agent in modestly improving speech production, articulation clarity, and intelligibility post-stroke, and underscores the clinical utility of the Frenchay Dysarthria Assessment in detecting oromotor improvements. Further studies are needed to determine the reproducibility and efficacy

Keywords: baclofen, dysarthria, tension, dysphonia, stroke
ASEAN J Rehabil Med. 2026; 36(2): 100-105.

Introduction

The ageing global population has driven an increased incidence of stroke, one of the leading causes of adult mortality and disability, often resulting in communication impairments include aphasia, cognitive-communication deficits, and motor speech disorders such as apraxia and dysarthria, with incidence reaching 60.0%.[1] According to the American Speech-Language-Hearing Association, up to 58.0% of acute stroke survivors experience dysarthria.[2] In a secondary UK analysis by Mitchell et al., 28.0% of patients with acute-phase stroke had dysarthria and aphasia.[3] A study from Bosnia and Herzegovina found that 57.7% of stroke patients had dysarthria, of which 82.4% had concomitant aphasia.[4]

Speech impairments significantly impact patients' quality of life by limiting communication, emotional expression, social participation, and increasing the risk of psychological complications.[5] Standard rehabilitation involves individualized speech-language therapy, focusing on articulation, phonation, and respiratory control.[6-8] However, the use of pharmacologic agents targeting muscle tone and spasticity remains limited in speech rehabilitation. Baclofen, a gamma-aminobutyric acid type B (GABA-B) receptor agonist, reduces spasticity by inhibiting excitatory neurotransmission at spinal and supraspinal levels. Its potential to modulate hypertonicity in oromotor and laryngeal musculature may facilitate improved phonation and articulation.

Despite the theoretical rationale, there are no published reports on the use of oral baclofen to enhance speech intelligibility post-stroke for patients with spastic dysarthria or laryngeal tension dysphonia. There is also a lack of medical treatments for post-stroke patients to improve speech function.

This case aims to demonstrate the potential adjunctive benefit of oral baclofen in post-stroke speech rehabilitation

Correspondence to: Lau Tsui Nam Trier, MBBS, MRCP(UK); Rehabilitation Medicine, Singhealth Residency, Singapore;
E-mail: trier.lau@mohh.com.sg

Received: September 10, 2025 Revised: November 19, 2025 Accepted: November 21, 2025

beyond conventional speech therapy, and the utility of the FDA in capturing functional oromotor changes that may not be evident on standard clinical examination.

This case report was prepared in accordance with the local legislation and institutional requirements. The participant provided written informed consent to participate in this report. Written informed consent was obtained from the individual for the publication of any potentially identifiable images or data included in this article. The reporting of this case adheres to the CARE guidelines.

Patient information

The patient was a 64-year-old English-speaking male with no significant medical history. He sustained a right middle cerebral artery infarct involving the right insular and opercular segments of the rolandic branch, in the context of cerebral amyloid angiopathy. He underwent mechanical thrombectomy with same-day intubation, followed by successful extubation. After stabilisation in the stroke unit, he was transferred to inpatient rehabilitation at a tertiary hospital.

Upon admission to rehabilitation, neurological examination revealed Medical Research Council (MRC) grade 4 motor power in the major muscle groups of the left upper and lower limbs, and mildly reduced sensation on the left side. Power and sensation on the right side remained intact. Notably, the patient exhibited severe speech motor disorders, including severe laryngeal tension dysphonia and spastic dysarthria, characterized by strained voice, slow rate of speaking, imprecise consonants, and apraxia of speech (AOS), characterized by inconsistent speech-sound errors across repeated attempts at the same word or phoneme, awareness of errors with unsuccessful attempts at self-correction due to impaired motor planning, groping behaviours, and markedly increased errors during multisyllabic sequences. Given the severity of the dysphonia and the recent intubation, an otolaryngological evaluation was obtained to exclude mechanical vocal cord trauma. Nasoendoscopy revealed intact vocal cords with normal appearance and mobility, suggesting laryngeal tension dysphonia rather than structural injury.

The FDA is the most commonly employed formal assessment tool among speech-language pathologists to evaluate the presence, type, and severity of dysarthria. It is known for its strong clinical utility and inter-rater reliability and can provide an objective assessment of the individual's progress.[9,10]

A baseline FDA revealed absent lip seal function, reduced lip and jaw function during speech, absent palatal muscle function, and impaired laryngeal muscle function affecting pitch and volume control. Tongue function was reduced in protrusion, elevation, lateral movement, and in speech. The patient exhibited significantly reduced speech intelligibility, with absent intelligibility at word, sentence, and conversational levels (Table 1). These findings supported a diagnosis of spastic dysarthria with co-existing AOS.

Timeline of inpatient rehabilitation

Day 1-10: Standard inpatient speech therapy began upon admission to inpatient rehabilitation.

Day 11: Oral baclofen 5 mg twice daily was initiated to address oromotor and laryngeal spasticity.

Day 34 (23 days after baclofen initiation): Repeat FDA was performed prior to inpatient discharge.

Pre-Baclofen, the patient's voice volume during vowel sound production was low and hoarse, as illustrated in Supplementary video 1. Spastic dysarthria features (strained voice, slow rate, imprecise consonants) remained severe.

Table 1. Frenchay Dysarthria Assessment prior to baclofen

		REFLEX			RESPIRATION		LIPS				
Normal Function	a										
	b										
	c										
	d										
No Function	e										
		Cough	Swallow	Dribble/Drool	At Rest	In Speech	At Rest	Spread	Seal	Alternate	In Speech

		JAW		SOFT PALATE			LARYNGEAL			
Normal Function	a									
	b									
	c									
	d									
No Function	e									
		At Rest	In Speech	Fluids	Maintenance	in Speech	Time	Pitch	Volume	In Speech

		TONGUE					INTELL		
Normal Function	a								
	b								
	c								
	d								
No Function	e								
		At Rest	Protrusion	Elevation	Lateral	Alternate	In Speech	Words/ Repetition	Sentences/ Description	Conversation

Intervention

The patient underwent 22 sessions of speech therapy during inpatient rehabilitation. Treatment methods were the same pre- and post-baclofen, incorporating voicing exercises and speech tasks, including /u/phonation with gentle phonation, counting exercises, production of simple words, and repetition of the patient's name. Key components of speech therapy interventions were as follows:

• Clear speech strategies involved producing "ah" with diaphragmatic breathing and over-articulating words.

• Devoiced vowel articulation practice focused on the production of vowel sounds. When the patient was unable to produce these sounds independently, the speech-language pathologist provided modelling for the correct articulation.

• Semi-occluded vocal tract exercises included humming of /m/ and /u/ sounds, bubble blowing through a straw, and exhalation through a party blower.

• Respiratory exercises with phonoarticulatory coordination involved repeating "oo", "ee", and "aa" five times, with speech-language pathologists modelling and prompting when the patient demonstrated inappropriate voicing during inhalation.

The patient underwent daily speech therapy for 10 days without baclofen, but functional improvement was minimal. AOS persisted with continued inconsistent errors on repeated productions, largely ineffective self-correction attempts, and disproportionate breakdown during multisyllabic word production.

Baclofen 5 mg twice daily was initiated on day 11 of the patient's inpatient rehabilitation admission to target spasticity affecting the oromotor and laryngeal muscles contributing to dysarthria. A reduced dose of 5 mg was administered to minimise sedation risk in this patient with cortical stroke, aiming to achieve mild neuromuscular relaxation while preserving participation in speech and physical therapy.

Baclofen is a GABA-B receptor agonist commonly utilised for post-stroke spasticity. Upon binding to GABA-B receptors, baclofen initiates a cascade of intracellular signalling events that inhibit presynaptic neurotransmitter release through multiple mechanisms. This effect decreases synaptic transmission and neuronal excitability, thereby ameliorating spasticity.

Results

An FDA was repeated 23 days after initiating baclofen and prior to inpatient discharge. The results revealed improvements in several areas: lip function in seal and speech; jaw function in speech; palatal muscle function in speech; and tongue muscle function in protrusion, lateral movement, and speech. Additionally, intelligibility improved in speech, in words, and in conversation. However, no improvement was observed in laryngeal muscles in pitch, volume, or in speech, nor in the elevation of the tongue. Intelligibility in sentences remained unchanged (Table 2).

A comparison of Tables 1 and 2 is shown in Table 3. The deterioration in lip movement at rest, laryngeal movement in time, tongue movement at rest, and elevation after baclofen initiation may be due to intra-rater subjectivity during the two assessments rather than actual clinical decline. Overall, the post-baclofen FDA improvements demonstrated convincing evidence of improvement in speech.

A video recorded after administration of one dose of baclofen demonstrated increased vowel loudness and improved tongue mobility: Supplementary video 2.

While speech apraxia and word-finding difficulties persisted, the patient's speech initiation improved, with increased volume,

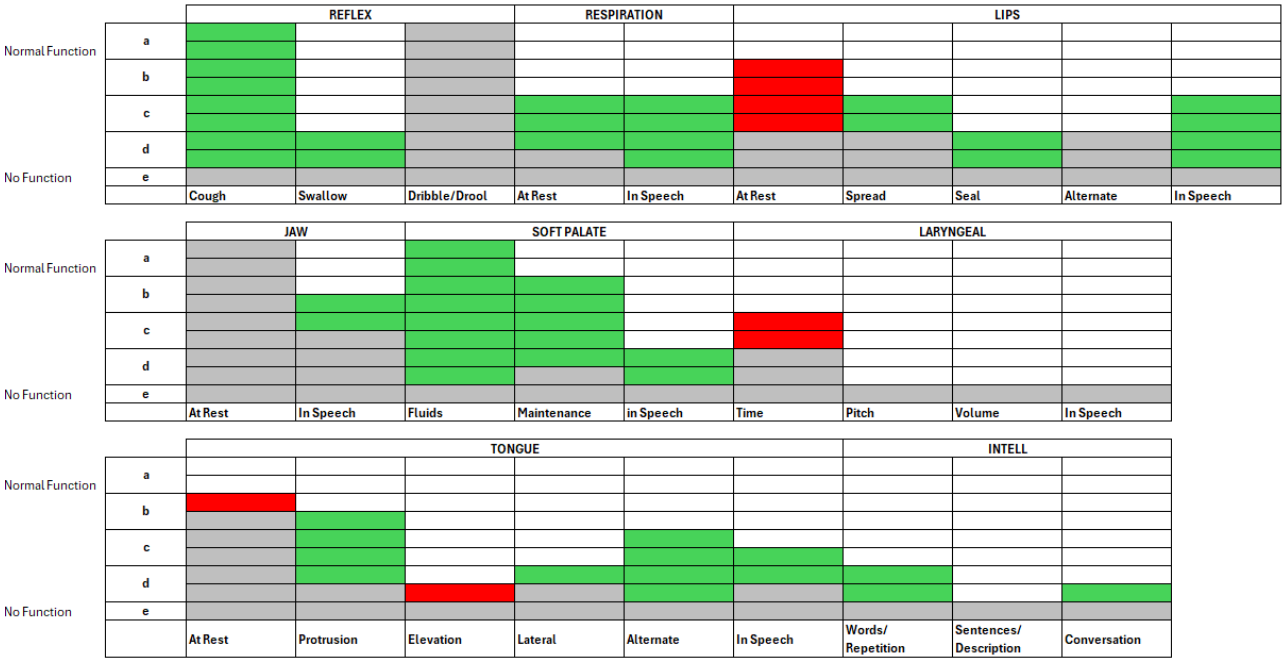
Table 2. Frenchay Dysarthria assessment 23 days after baclofen initiation, prior to discharge

		REFLEX			RESPIRATION		LIPS				
Normal Function	a										
	b										
	c										
	d										
No Function	e										
		Cough	Swallow	Dribble/Drool	At Rest	In Speech	At Rest	Spread	Seal	Alternate	In Speech

		JAW			SOFT PALATE		LARYNGEAL			
Normal Function	a									
	b									
	c									
	d									
No Function	e									
		At Rest	In Speech	Fluids	Maintenance	in Speech	Time	Pitch	Volume	In Speech

		TONGUE					INTELL			
Normal Function	a									
	b									
	c									
	d									
No Function	e									
		At Rest	Protrusion	Elevation	Lateral	Alternate	In Speech	Words/ Repetition	Sentences/ Description	Conversation

Table 3. Comparison of Frenchay Dysarthria Assessments pre- and post-baclofen; Green signifies improvement, Red signifies deterioration



greater articulatory movements, and enhanced intelligibility. Notably, voice strain was markedly reduced (Supplementary video 3), demonstrating reduced muscle rigidity. The patient did not demonstrate separate oral-motor apraxia, as non-speech oral movements (e.g., tongue protrusion) improved alongside speech functions. Post-baclofen, the patient demonstrated notable improvements in dysarthria and AOS. There was decreased strain and improved phonatory quality, and conversational intelligibility noticeably improved. There were also fewer inconsistent speech sound errors, fewer groping articulatory movements, and more effective attempts at self-correction. These improvements suggest that baclofen reduced hypertonicity of the laryngeal muscles, thereby improving conditions for apraxia training and facilitating more effective motor speech execution.

Discussion

This case highlights two key clinical insights:

1. The potential adjunctive role of oral baclofen in facilitating speech recovery post-stroke, and
2. The sensitivity of the FDA in quantifying incremental oromotor improvements during rehabilitation.

Conventional rehabilitation alone may not fully address hypertonicity within the laryngeal and articulatory musculature. Baclofen's enhancement of GABAergic inhibition can theoretically reduce excessive muscular tone, improving articulatory movements and phonation. The timing of improvement following baclofen initiation, captured by the FDA reassessment, suggests an additive benefit beyond spontaneous recovery and rehabilitative strategies.

The FDA provided a structured, quantifiable method for tracking changes across speech subsystems (lips, jaw, palate, tongue, and larynx). Compared with subjective bedside observation, the FDA allowed objective documentation of improvements in articulatory precision and range of movement, particularly in the orofacial musculature. In English-speaking patients, use of the original English version avoids confounding by linguistic translation. Nonetheless, clinicians should be cautious when generalizing results to non-English speakers whose phonetic demands differ.

Co-existing AOS complicates outcomes, as planning and sequencing deficits may mask improvements in muscle control. In this case, baclofen may have indirectly benefited apraxia rehabilitation by reducing laryngeal tension and enhancing phonatory feedback, enabling more precise articulation and facilitating motor learning. Importantly, no detrimental effect on motor planning was observed.

Currently, baclofen is primarily indicated for the management of spasticity post-stroke. In post-stroke patients with laryngeal tension dysphonia, spastic dysarthria, and reduced coordination within the laryngeal and articulatory subsystems, these impairments may compromise phonation and speech precision. Baclofen's capacity to modulate excessive neuromuscular excitability provides a theoretical basis for its consideration in residual oromotor spasticity which is unresponsive to conventional therapy. Thus, although not a standard post-stroke medication, its off-label use may be appropriate in carefully selected patients whose speech impairment has a dominant spastic component.

Post-stroke patients with dysphonia are typically managed as outpatients in the otolaryngology voice clinic. Standard practice involves a six-week trial of speech therapy before otolaryngologists consider botulinum toxin injection into the laryngeal muscles. Spasmodic dysphonia, characterized by involuntary spasms of the laryngeal muscles, is usually treated with botulinum toxin injection under laryngeal electromyography or flexible endoscopic guidance, coupled with

voice therapy. Management of spastic dysphonia follows a similar approach.

Baclofen was introduced during the pre-injection interval as a non-invasive pharmacologic alternative to reduce muscular hypertonia and optimize the patient's response to concurrent speech therapy. The decision to use baclofen rather than proceed directly to botulinum toxin was guided by the patient's potential for reversible neuroplastic changes and to avoid procedural risks during the early rehabilitation phase.

Evidence for baclofen in dysphonia and dysarthria remains limited. In a case study by Leary et al., a 40-year-old male with cerebral palsy (CP) and severe spastic dysarthria demonstrated measurable improvements in speech intelligibility following initiation of intrathecal baclofen (ITB). Improvement was observed in single-word production and complete sentence accuracy, as assessed by the Assessment of Intelligibility of Dysarthric Speech. These improvements were sustained six months after pump implantation.[11] Similarly, Mason et al. reported significant gains in speech intelligibility in a 28-year-old male with CP treated with ITB.[12]

Beyond individual case reports, a pilot study by Kristie et al. examined the effects of ITB on speech in children with cerebral palsy-related spasticity.[13] Outcomes were variable, with some children demonstrating improvement while others experienced deterioration in speech performance. A subsequent critical review by Anderson concluded that the overall evidence supporting ITB as a means of improving speech in CP remains weak and largely anecdotal.[14]

More recently, Madhav et al. conducted a cross-sectional study evaluating the use of oral baclofen as an adjunct to voice therapy in patients with primary muscle tension dysphonia. The study found no significant differences in voice-related psychometric outcomes between patients receiving baclofen and those managed with voice therapy alone.[15]

In this patient, results from the FDA demonstrated overall improvements in speech production, potentially attributable to relaxation of oromotor and laryngeal muscles. Nonetheless, multiple confounding factors must be considered when evaluating speech improvement, including natural post-stroke recovery, concurrent speech-language pathology interventions incorporating oromotor exercises, and communication training protocols.

Despite limited evidence in the stroke population, these studies collectively support baclofen's role in reducing oromotor hypertonicity, which may be extrapolated to post-stroke dysarthria characterized by similar pathophysiology. This case, therefore, provides preliminary clinical insight into a potential therapeutic avenue for addressing spastic dysarthria and laryngeal tension dysphonia in post-stroke patients.

Conclusions

This case report provides preliminary evidence that oral baclofen, when combined with standard speech-language therapy, may enhance articulatory and phonatory outcomes in post-stroke spastic dysarthria and AOS. This treatment could be beneficial in an acute inpatient setting, where early intervention is critical for optimizing functional recovery. The Frenchay Dysarthria Assessment is a sensitive tool for documenting subtle yet clinically meaningful improvements that are not readily captured by standard examination. Further controlled studies are needed to clarify baclofen's role, optimal timing, and patient selection in post-stroke speech rehabilitation.

Conflict of interest declaration

The authors declare that the case report was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI declaration

The authors confirm that no large language models (LLMs) or artificial intelligence (AI) tools were used in the creation of this manuscript, including the writing, editing, or preparation of figures and tables, with the exception of language and grammar improvement.

Acknowledgements

The authors would like to acknowledge the patient who agreed to participate in this case report without receiving any personal gain, for the benefit of future patients. We also express our gratitude to our inpatient speech-language pathologist team for working tirelessly to improve speech, communication, and the quality of life of patients under their care, and for assisting with the Frenchay dysarthria assessments.

Funding

The authors declare that no financial support was received for the research and/or publication of this article.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

Author contributions

Lau Tsui Nam Trier: writing - original draft, Information and data gathering, Video filming. Writing- review and editing,

Joon Sin Ser: writing - original draft, Information and data gathering, Writing- review and editing,

San San Tay: writing - original draft, Information and data gathering, writing- review and editing.

Supplementary materials

The following supporting information can be downloaded:

The supplement video_1 file (MP4 format) is available at: https://drive.google.com/file/d/1xBsuw-yGbsTGs7mM0UL-rt-fD7-_b3JN/view?usp=sharing

The supplement video_2 file (MP4 format) is available at: https://drive.google.com/file/d/1EYRyX_OsIRdQ2V8zSM-wHXoiYEOCgO57l/view?usp=sharing

The supplement video_3 file (MP4 format) is available at: https://drive.google.com/file/d/1BrnHEsCYEWfPNIsPciRm7VLGtotAsxAo/view?usp=sharing

References

1. Zahra G, Reza N, Narges B, Samaneh SN, Masoud M, Tabassom A. The Incidence of Aphasia, Cognitive Deficits, Apraxia, Dysarthria, and Dysphagia in Acute Post Stroke Persian Speaking Adults. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 3):5685-95.
2. Dysarthria in adults American Speech-Language-Hearing Association (ASHA) (2020). Available from: https://www.asha.org/practice-portal/clinical-topics/dysarthria-in-adults/#collapse_1
3. Mitchell C, Gittins M, Tyson S, Vail A, Conroy P, Paley L et al. Prevalence of aphasia and dysarthria among inpatient stroke survivors: describing the population, therapy provision and outcomes on discharge. Aphasiology 2021;7:950-96.
4. Vidović M, Sinanović O, Šabaškić L, Hatičić A, Brkić E. Incidence and types of speech disorders in stroke patients. Acta Clin Croatica. 2011;50(4):491-3.
5. João FO, Daniel ES, Pedro ES, Nuno M, Margarida A, Ana MF et al. Depression after stroke. Pract Neurol. 2021;21:384-91.
6. Nan H, Kang Z, Fang L, Zhen S, Long C, Yanbiao Z et al. Research trends and hotspots in post-stroke speech rehabilitation: A bibliometric analysis. Acta Psychol (Amst). 2025;254:104781.
7. Rita C, Michele V. Dysarthria and stroke. The effectiveness of speech rehabilitation. A systematic review and meta-analysis of the studies. Eur J Phys Rehabil Med. 2021;57:24-43.
8. Claire M, Sabrina EK, Martha DZ, Audrey B, Paul C, Brooke-Mai W et al. How do we measure dysarthria after stroke? A systematic review to guide the core outcome set for dysarthria. BMJ Open. [cited 2025 May 23];15(5):e099662. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC12104885/ doi: 10.1136/bmjopen-2025-099662
9. Pamela ME. Frenchay dysarthria assessment. International Journal of Language & Communication Disorders. 1980;3:165-173
10. Abeer MA, Shin YC, Rahayu BMK, Rogayah AR. A Report of Assessment Tools for Individuals with Dysarthria. The Open Public Health Journal. [cited 2019 Sep 30];12: 384. Available from: https://openpublichealthjournal.com/VOLUME/12/PAGE/384/ doi: 10.2174/1874944501912010384
11. Leary SM, Gilpin P, Lockley L, Rodriguez L, Jarrett L, Stevenson VL. Intrathecal baclofen therapy improves functional intelligibility of speech in cerebral palsy. Clin Rehabil. 2006;20(3):228-31.
12. Mason C, Gilpin P, McGowan S and Rossiter D. The effect of intrathecal baclofen on functional intelligibility of speech. Int. J. Language and communication disorders 1988;33(Suppl): 24-25
13. Kristie FB, John FM, John DL, Kim MNW, Mark R, Kathy AB et al. Oral motor, communication, and nutritional status of children during intrathecal baclofen therapy: A descriptive pilot study. Arch Phys Med Rehabil. 2003;84:500-6.
14. Anderson MA. Critical Review: The Effects of Intrathecal Baclofen Therapy on Speech in Individuals with Cerebral Palsy. School of Communication Sciences and Disorders, U.W.O; 2007
15. Madhav S, Ted G, Hadas G, Jessica P, Jacob PN. Evaluating the use of baclofen as adjunct treatment for muscle tension dysphonia. Am J Otolaryngol. 2022;43(2):103309.