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Effect of Proprioceptive Neuromuscular Facilitation on Pain, Fatigue, Severity, and Functional Independence In Acute Guillain-Barré Syndrome: An Interventional Study

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Abstract

Introduction: Guillain-Barré syndrome (GBS) is an acute immune-mediated neuropathy causing weakness, pain, fatigue, and functional decline. Evidence comparing structured physiotherapy approaches during acute hospitalization remains limited. This study compared the effects of Proprioceptive Neuromuscular Facilitation (PNF) with conventional physiotherapy on pain, fatigue, disease severity, and functional independence in acute GBS.

Materials and Methods: A randomized controlled trial was conducted in a tertiary care hospital. Thirty-two patients with acute GBS were randomized to PNF (n = 16) or conventional physiotherapy (n = 16). Outcomes including pain, fatigue, disease severity, and functional independence were assessed using the Numeric Pain Rating Scale, Fatigue Severity Scale, Hughes Functional Grading Scale, and Barthel Index at admission, two weeks, and discharge. The Friedman test, Wilcoxon signed-rank test with Bonferroni correction, and Mann-Whitney U test were applied for within-group, post-hoc pairwise, and between-group comparisons, respectively.

Results: Both groups demonstrated significant improvement across all outcome measures over time ($p < 0.001$). Fatigue at discharge was significantly lower in the PNF group ($p = 0.004$). Change-score analysis favored PNF for pain and fatigue reduction, though between-group differences were not statistically significant for most outcomes.

Conclusions: Early structured physiotherapy during acute hospitalization improves pain, fatigue, disease severity, and functional independence in GBS. PNF is comparable to conventional physiotherapy and may offer additional benefit in reducing fatigue during early recovery.

Keywords: Guillain-Barré Syndrome, early physiotherapy, proprioceptive neuromuscular facilitation

Introduction

GBS is an acute, immune-mediated polyradiculoneuropathy and remains one of the leading causes of acute flaccid paralysis worldwide. The estimated incidence is 1–2 cases per 100,000 person-years, with a higher occurrence in males.[1] GBS is commonly preceded by infections such as Campylobacter jejuni, cytomegalovirus, Epstein–Barr virus, Zika virus, and, more recently, SARS-CoV-2, resulting in immune-mediated demyelination or axonal injury of peripheral nerves.[2-4] Clinically, the condition presents with rapidly progressive, symmetrical limb weakness, often associated with cranial nerve involvement, sensory symptoms, autonomic dysfunction, and, in severe cases, respiratory compromise requiring intensive care support.[5]

Advances in acute medical management, particularly intravenous immunoglobulin and plasma exchange, have improved survival and reduced severe long-term disability.[6] Despite this, many patients continue to experience pain, fatigue, weakness, and limitations in daily activities during the acute hospitalization period and beyond.[7] Rehabilitation therefore plays an essential role in multidisciplinary care, not to modify immune pathology, but to prevent secondary complications, maintain respiratory and musculoskeletal function, manage pain and fatigability, and facilitate safe early functional activity.[8]

Most rehabilitation literature in acute GBS has focused on respiratory care and prevention of complications. However, there is limited evidence scientifically evaluating structured therapeutic exercise programs aimed at promoting early functional recovery during hospitalization.[9] With improvements in multidisciplinary care and safety monitoring, there is a growing need to explore rehabilitation strategies beyond basic maintenance exercises, while ensuring patient safety during the acute phase.

Conventional physiotherapy and PNF share the goal of preventing secondary complications and supporting recovery in acute GBS. However, their therapeutic approaches differ. Conventional physiotherapy primarily focuses on maintenance and protection, whereas PNF emphasizes neuro-motor facilitation through proprioceptive input and functional movement patterns[10] This approach may influence pain modulation and functional severity without imposing excessive physiological stress.

PNF was originally described by Kabat and later developed by Knott and Voss. It aims to enhance neuromuscular performance using diagonal movement patterns, proximal stabilization, and coordinated functional activity. PNF has shown benefit in several neurological and musculoskeletal conditions.[10] Despite its theoretical suitability for improving motor control, reducing fatigue, and supporting function in acute neuromuscular conditions, its role in GBS has not been systematically studied, and existing evidence remains limited.

The present study compares a PNF-based physiotherapy program with conventional physiotherapy in patients hospitalized with acute GBS. The study evaluates the effects of both approaches on pain, fatigue, disease severity, and functional independence during the acute admission period using valid and reliable outcome measures. The aim is to generate clinically relevant evidence to inform rehabilitation practice during early GBS recovery.

Materials and Methods

Study Design

A randomized, parallel-group, open-labeled, controlled trial with a pretest–posttest design was conducted in the Department of Neurology of a tertiary care hospital from July 2024- until June 2025. The clinical protocol was conducted, recorded, and reported according to Good Clinical Practice guidelines and the Declaration of Helsinki. The study got approval from the Biomedical Research Ethics Committee (BREC/24/710). The study was prospectively registered with the Clinical Trials Registry of India (CTRI/2024/09/073341). Participants were recruited between July 2024 and June 2025 using a total enumeration method. Written informed consent was obtained from all participants or their legally authorized representatives

Inclusion and Exclusion Criteria

Adults aged 18 years or older with a clinical and electrophysiological diagnosis of GBS, including Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP), Acute Motor Axonal Neuropathy (AMAN), Acute Motor and Sensory Axonal Neuropathy (AMSAN), and rhombencephalitis overlap, were included if patients were hemodynamically stable at admission. Patients with altered consciousness, multi-organ failure, psychiatric illness, recent fractures or surgeries, joint instability, limb amputations, or communication difficulties interfering with assessment or therapy were excluded.

Randomization

After baseline assessment, participants were allocated to either the PNF group or the conventional physiotherapy group using a pre-generated random allocation sequence. Allocation concealment was ensured using sequentially numbered case-record numbers.

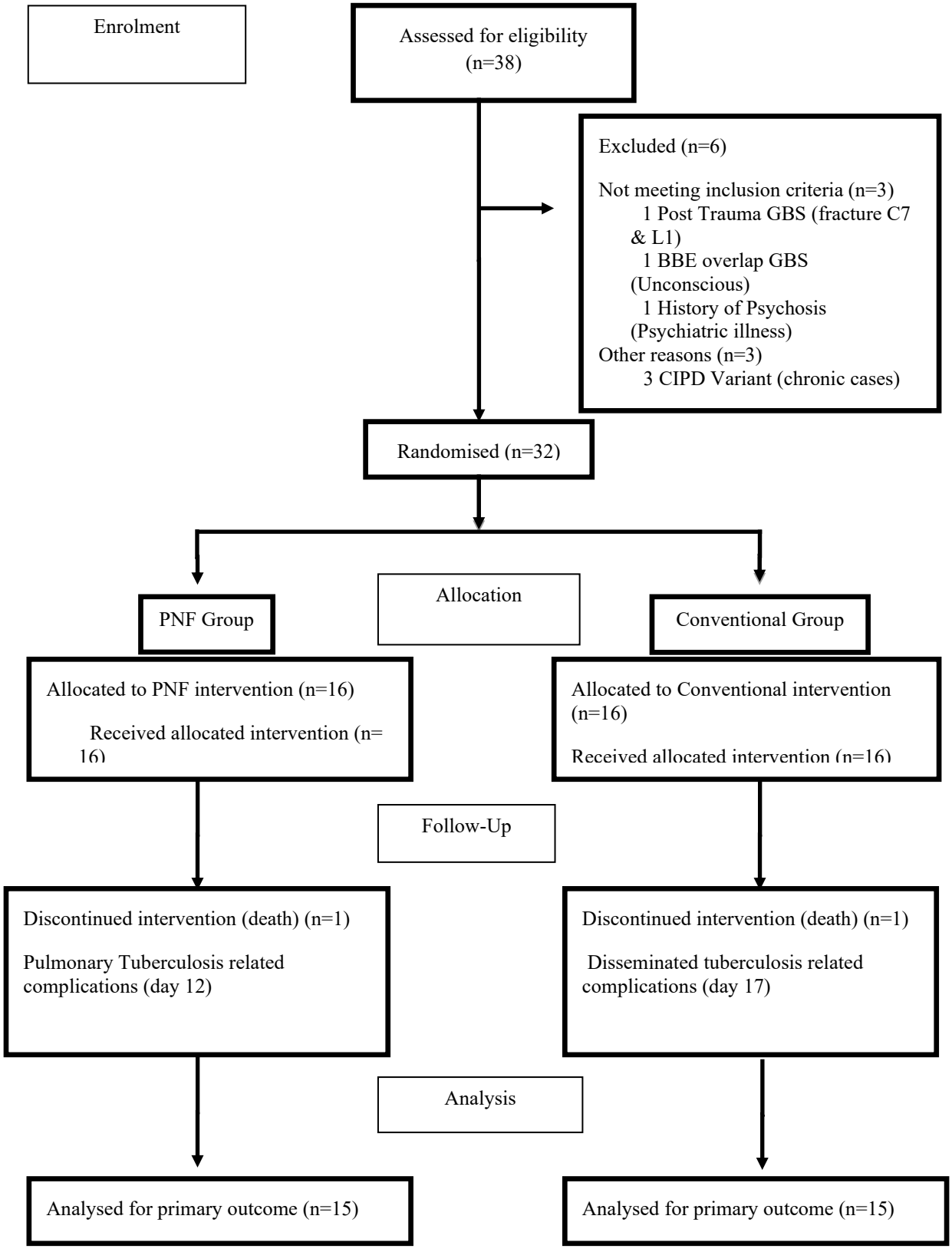
Interventions

All participants received standard acute neurological physiotherapy, including positioning, chest physiotherapy, and measures to promote early mobility, as clinically indicated throughout hospitalization. The PNF group received a structured facilitation-based program targeting the neck, trunk, pelvis, and limbs, incorporating rhythmic initiation, slow reversals, alternating isometrics, rhythmic stabilization, and D1/D2 diagonal movement patterns. Sessions were approximately 30 minutes in duration. The conventional physiotherapy group followed a graded exercise program progressing from passive and active-assisted movements to active and resistive exercises. Both groups were given sessions twice daily, seven days per week from admission till discharge. Exercise intensity and progression were individualized according to patient tolerance. All participants were monitored during therapy for vitals, pain, fatigue, autonomic stability, and respiratory status to ensure safety.

Outcome Measures

Pain intensity, fatigue severity, disease severity, and functional independence were assessed using the Numeric Pain Rating Scale, Fatigue Severity Scale, Hughes Functional Grading Scale, and Barthel Index, respectively, at admission (T1), two weeks (T2), and discharge (T3).

Figure 1 Flowchart of study



Statistical Analysis

Statistical analysis was performed using IBM SPSS version 20. As most variables were non-normally distributed, data were presented as medians with interquartile ranges. Within-group changes across time points were analyzed using the Friedman test with Kendall's coefficient of concordance as effect size. Post-hoc pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni correction. Between-group comparisons were analyzed using the Mann–Whitney U test, with effect size reported as rank-biserial correlation. A two-sided p value ≤0.05 was considered statistically significant.

Results

Participants

A total of 38 patients were assessed for eligibility. Six were excluded, and 32 were randomized equally into the PNF group (n = 16) and conventional physiotherapy group (n = 16). One participant in each group died due to pulmonary tuberculosis related complications. Thirty participants completed follow-up and were analyzed. The participant flow is shown in Figure 1.

Baseline demographic and clinical characteristics of enrolled participants are summarized in Table 1. Within-group changes are presented in Table 2, with post hoc pairwise comparisons shown in Table 3. Between-group comparisons are summarized in Table 4.

Table 1: Baseline Demographic and clinical characteristics of participants

Variable	PNF Group (n=16)	Conventional Group (n=16)
Age (years), median (IQR)	33 (31)	41.5 (28)
Sex, n (%)		
Male	11(68.8)	12 (75.0)
Female	5(31.25)	4 (25.0)
GBS variants, n (%)		
AIDP	8 (50.0)	10 (62.5)
AMAN	4 (25.0)	3 (18.8)
AMSAN	3 (18.8)	3 (18.8)
Rhombencephalitis- Overlap	1 (6.3)	0 (0.0)
Cranial nerve involvement, n (%)	7 (43.8)	5(31.3)
Bulbar involvement, n (%)	6(37.5)	6(37.5)
Dysautonomia, n (%)	4(25)	6(37.5)

Values are presented as median (interquartile range) or number (%). Baseline characteristics are shown for all enrolled participants (n = 32). Outcome analyses were performed on participants who completed follow-up (n = 30)

Table 2 Friedman test for within-group changes in outcome measures across three time points in the PNF and Conventional Group

Outcome Measure	Group	χ^2 (df=2)	p-value	ES-Kendall's W
Numeric Pain Rating Scale	PNF	24.03	0.000	0.801
	Conventional	20.945	0.000	0.698
Fatigue Severity Scale	PNF	25.2	0.000	0.840
	Conventional	20.800	0.000	0.693
Hughes Functional Grading	PNF	18.5	0.000	0.617
	Conventional	19.922	0.000	0.664
The Barthel Index	PNF	25.2	0.000	0.840
	Conventional	24.133	0.000	0.804

Values represent Friedman chi-square statistics (χ^2, df = 2), corresponding p values, and effect size expressed as Kendall's coefficient of concordance (W). Higher W values indicate greater within-group change across time. All analyses were performed on participants who completed follow-up (n = 15 per group). A p value ≤0.05 was considered statistically significant.

Table 3 Wilcoxon signed-rank post hoc comparisons of outcome measures across time points in the PNF and Conventional group

Outcome Measure	Group	Comparison	Z value	p (raw)	p (Bonferroni)
Numeric Pain Rating	PNF	T1 vs T2	-3.032[a]	0.002	0.006
		T2 vs T3	-3.308[a]	0.001	0.003
		T1 vs T3	-3.438[a]	0.001	0.003
	Conventional	T1 vs T2	-2.804[a]	0.005	0.015
		T2 vs T3	-2.863[a]	0.004	0.012
		T1 vs T3	-3.330[a]	0.001	0.003
Fatigue Severity Scale	PNF	T1 vs T2	-2.558[a]	0.11	0.33
		T2 vs T3	-3.414[a]	0.001	0.003
		T1 vs T3	-3.408[a]	0.001	0.003
	Conventional	T1 vs T2	-1.829[a]	0.067	0.201
		T2 vs T3	-3.412[a]	0.001	0.003
		T1 vs T3	-3.270[a]	0.001	0.003
Hughes Functional Grading Scale	PNF	T1 vs T2	-1.428[a]	0.153	0.459
		T2 vs T3	-3.314[a]	0.001	0.003
		T1 vs T3	-3.100[a]	0.002	0.006
	Conventional	T1 vs T2	-6.32[a]	0.572	1.716
		T2 vs T3	-3.638[a]	0.000	0.000
		T1 vs T3	-3.15[a]	0.002	0.006
The Barthel Index	PNF	T1 vs T2	-2.225[b]	0.001	0.003
		T2 vs T3	-3.425[b]	0.001	0.003
		T1 vs T3	-3.412[b]	0.001	0.003
	Conventional	T1 vs T2	-2.220[b]	0.026	0.078
		T2 vs T3	-3.422[b]	0.001	0.003
		T1 vs T3	-3.411[b]	0.001	0.003

Values represent Wilcoxon signed-rank test statistics (Z) with corresponding unadjusted and Bonferroni-adjusted p values for pairwise comparisons (T1–T2, T2–T3, and T1–T3). Superscripts indicate direction of ranks. Analyses were performed on participants who completed follow-up (n = 15 per group). A Bonferroni-adjusted p value ≤0.05 was considered statistically significant.

Table 4 Between group comparison of outcome measures at baseline (T1), change over time (ΔT), and discharge (T3) using Mann- Whitney U test

Outcome Measure	Time point	PNF Group {Median(IQR)}	Conventional Group {Median(IQR)}	U Value	Z Value	p-value	Effect Size r
Numeric Pain Rating Scale	T1	5(3)	4(4)	103.0	-0.398	0.691	-
	ΔT (T3-T1)	4(2)	2(2)	68.5	-1.864	0.062	0.481
	T3	2(1)	2(3)	75.5	-1.578	0.115	-
Fatigue Severity Scale	T1	51(8)	52(16)	110.0	-0.104	0.917	-
	ΔT (T3-T1)	25(29)	9(10)	66.0	-1.933	0.053	0.499
	T3	30(19)	40(16)	43.5	-2.869	0.004	-
Hughes Functional Grading	T1	4(0)	4(1)	100.5	-0.568	0.570	-
	ΔT (T3-T1)	2(1)	1(1)	87.0	-1.111	0.66	0.287
	T3	2(1)	3(2)	79.5	-1.424	0.154	-
The Barthel Index	T1	20(20)	15(35)	101.5	-0.460	0.645	-
	ΔT (T3-T1)	55(55)	35(40)	83.0	-1.277	0.220	0.329
	T3	80(20)	55(40)	75.5	-1.545	0.122	-

Values are presented as median (interquartile range). Between-group comparisons were performed using the Mann–Whitney U test. Change scores (ΔT) were calculated as discharge minus admission values (T3–T1). Effect size (r) was calculated for change scores. Analyses were conducted on participants who completed follow-up (n = 15 per group). A p value ≤0.05 was considered statistically significant.

Pain Intensity

Friedman test analysis demonstrated a significant effect of time on pain intensity in the both group across baseline, two weeks, and discharge ($p < 0.001$), with strong to very strong effect size. Post-hoc Wilcoxon analysis showed significant reductions across all pairwise time-point comparisons in both groups. Baseline pain scores were comparable between groups. Although change-score analysis (ΔT3–T1) favored the PNF group with a moderate effect size, this difference did not reach statistical significance. No significant between-group difference was observed at discharge.

Fatigue Severity

A significant time effect was observed for fatigue severity in both groups on Friedman analysis ($p < 0.001$), with strong effect sizes. Post-hoc analysis indicated that improvement occurred predominantly between two weeks and discharge. Baseline fatigue severity did not differ between groups. Change-score analysis demonstrated a greater magnitude of fatigue reduction in the PNF group with a large effect size, though not statistically significant. At discharge, fatigue severity scores were significantly lower in the PNF group compared to the conventional group.

Disease Severity

Friedman test revealed significant within-group changes over time for Hughes Functional Grading Scale scores in both groups ($p < 0.001$), with moderate to strong effect sizes. Post-hoc analysis showed that functional improvement occurred mainly during the later phase of hospitalization. No significant between-group differences were observed at baseline, for change scores, or at discharge.

Functional Independence

Barthel Index scores demonstrated a significant time effect in both groups ($p < 0.001$), with very strong effect sizes. Post-hoc analysis revealed earlier improvement in the PNF group, whereas improvement in the conventional group occurred predominantly between two weeks and discharge. Between-group comparisons showed no significant differences at baseline, for change scores, or at discharge.

Discussion

This study demonstrates that both PNF-based and conventional physiotherapy initiated during acute hospitalization are associated with meaningful short-term improvement in pain, fatigue, functional independence, and neurological severity in patients with GBS. These findings are consistent with foundational neurorehabilitation principles described by Orsini et al. which support the applicability of both interventions used in this study.[11] The lack of statistically significant differences between groups for most outcomes suggests that early structured physiotherapy itself plays a central role in recovery during the acute phase, irrespective of the specific technique used.

Evidence guiding active physiotherapy during acute hospitalization in GBS remains limited. Most published work has focused on respiratory care and prevention of complications.[12,13] With only case-based reports describing structured therapeutic exercise during this phase. Case reports by Nagore et al. described improvement in functional ability with time during hospitalization, while Vishnuram et al. reported improvement in Hughes Functional Grading Scale scores over the acute course.[14, 15] More recently, Gawande et al. in a case study, applied the contract-relax technique of PNF to the upper and lower limbs along with other physiotherapy interventions and reported improvements in pain, functional ability, and neurological recovery during acute hospitalization.[16] The present findings are consistent with all of these observations and extend them by demonstrating similar time-dependent improvement within a prospective, comparative framework.

Fatigue emerged as the most responsive outcome in the present study. Fatigue is a common and disabling symptom in GBS and has been predominantly studied in post hospitalization or chronic phases of rehabilitation. Previous studies by Garssen et al., Khan et al., and Shah et al. have reported fatigue reduction following supervised exercise programs in later stages of recovery.[17-19] In contrast the present findings suggest that fatigue severity can improve even during acute hospitalization. Although both groups showed improvement over time, fatigue severity at discharge was significantly lower in the PNF group, with change-score analysis indicating a larger magnitude of improvement favoring PNF.

Differences in intervention delivery may be relevant in interpreting these findings. PNF required direct therapist facilitation, whereas the simpler structure of conventional physiotherapy may have allowed easier execution and better compliance during acute hospitalization, potentially contributing to the overall improvements observed in both groups.

Study Limitations

The study has several limitations. The modest sample size and single-center design limit generalizability, and the lack of blinding may have introduced performance bias. Standardization of intervention dosage was challenging in the acute care setting due to variability in disease course, patient tolerance, and daily clinical status during hospitalization. Fatigue was assessed using a subjective

patient- reported measure, which may have influenced sensitivity to change. Additionally, concurrent medical treatments and variability in hospitalization duration were not controlled. Future multicenter studies with larger samples, objective fatigue measures, and hybrid rehabilitation models integrating therapist-led and caregiver-assisted interventions are needed to define scalable and phase-specific rehabilitation strategies for early-stage GBS.

Conclusions

Early structured physiotherapy initiated during acute hospitalization is associated with significant improvements in pain, fatigue, disease severity, and functional independence in patients with GBS. Both PNF-based and conventional physiotherapy demonstrated comparable effectiveness during the acute phase, emphasizing the importance of early rehabilitation rather than technique-specific differences. However, patients receiving PNF showed greater reduction in fatigue severity at discharge, suggesting a possible advantage of facilitation-based strategies in reducing fatigue severity. These findings add to the limited randomized controlled evidence on active rehabilitation during the acute stage of GBS and suggest the safety and clinical value of early structured therapeutic exercise.

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