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Home-Based Use of Functional Electrical Stimulation for Foot Drop: Feasibility, Perceived Effectiveness in Daily Mobility Tasks, and Organizational Implications

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Abstract

Background: Foot drop significantly impairs mobility and limits participation in daily activities in patients with neurological disorders. Functional electrical stimulation (FES) is an established treatment; however, its use in home-based settings and its organizational implications remain insufficiently explored.

Methods: Seven patients with neurological foot drop participated in this feasibility study conducted in a clinical rehabilitation setting. Following initial supervised training, participants used the FES device at home according to their individual routines. Outcome measures included patient-specific functional limitations, feasibility parameters (adherence, independence, adverse events), and patient-reported effectiveness across predefined mobility tasks. An exploratory organizational model was used to estimate potential therapist time savings.

Results: All participants were able to use the device in a home environment. No serious adverse events were observed. High perceived effectiveness was reported across daily mobility tasks (>80%), including those identified as most limiting. All participants also noted a positive impact on mobility. The exploratory organizational model indicated that a home-based approach may reduce therapist time by approximately 21–22 hours per patient, which, when applied across a larger patient population, may translate into substantial cumulative savings in therapist workload.

Conclusion: Home-based FES within a clinic-based loan model appears feasible, safe, and clinically relevant. It may represent an efficient complement to outpatient rehabilitation by improving patient mobility while reducing therapist workload and logistical burden.

Keywords: Functional electrical stimulation; Foot drop; Neurorehabilitation; Home-based rehabilitation; Feasibility study; Patient-reported outcomes; Assistive technology; Cost analysis

Introduction

Foot drop is a common consequence of various neurological conditions, including stroke, traumatic brain injury, and cerebral palsy. It results from weakness or impaired activation of the ankle dorsiflexor muscles, leading to insufficient dorsiflexion during the swing phase of gait [1,2]. This deficit produces characteristic gait abnormalities, such as toe dragging or compensatory steppage gait, and significantly impairs walking ability [2]. As a consequence, foot drop compromises safety and increases the risk of

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falls, thereby limiting independence and participation in daily activities [3,4].

In real-world settings, patients with foot drop are particularly restricted in mobility-related tasks such as walking on uneven terrain, stair ambulation, and transfers, which require adequate dorsiflexion control and dynamic balance [5,6]. These limitations extend beyond basic locomotion and directly affect the ability to perform everyday activities, including community mobility and social participation, which are frequently reduced in individuals with neurological impairments [6,7]. Consequently, improving functional mobility in these contexts remains a key goal of rehabilitation, with particular emphasis on restoring safe and efficient ambulation in real-world environments.

The management of foot drop depends on the underlying etiology and typically involves conservative approaches, including physical therapy combined with ankle–foot orthoses (AFOs) or functional electrical stimulation (FES) [1,3]. In cases of insufficient response, surgical interventions such as nerve decompression or tendon transfer procedures may be considered [3]. While AFOs provide passive mechanical support to maintain ankle position during gait, FES actively stimulates peripheral nerves and muscles to produce functional movement, thereby promoting a more physiological gait pattern and potentially facilitating long-term functional improvement [8-10]. By delivering timed electrical stimulation to the peroneal nerve, FES has been shown to improve gait speed, walking efficiency, and patient-reported outcomes [10-12], with effects often comparable to those of AFOs in clinical settings [11].

In addition to its immediate orthotic effect, FES may also provide therapeutic benefits through repeated activation of neuromuscular pathways, potentially contributing to motor relearning and sustained functional improvements over time [12,13]. FES aligns with key principles of motor learning, particularly task-specific repetitive practice. However, the intensity of rehabilitation in outpatient settings is often insufficient to achieve optimal training volume. Home-based FES programs have therefore been introduced to enable more frequent and ecologically valid practice within daily life [14-16].

Most existing evidence has been derived from controlled clinical settings and relies predominantly on standardized outcome measures, which may not fully reflect real-world functional performance [11,17]. There is limited information regarding the feasibility and effectiveness of FES when used in a home environment under real-life conditions, despite increasing interest in home-based rehabilitation models [18]. In particular, patient-reported outcomes related to specific daily mobility tasks remain underexplored, even though they are highly relevant for evaluating meaningful functional improvement and participation in everyday life [7].

Furthermore, the broader organizational implications of home-based FES use have not been sufficiently addressed. The potential to shift part of rehabilitation from outpatient care to a home-based model may reduce the demand for therapist time and repeated clinic visits, thereby improving the efficiency of rehabilitation services. At the same time, such an approach requires careful consideration of device availability, usability, and integration into routine clinical practice [17,18].

The aim of this study was therefore to evaluate the feasibility of home-based FES use in patients with foot drop, to assess patient-reported effectiveness across a range of daily mobility tasks, and to explore its potential organizational implications within a clinic-based loan model of care.

Materials and Methods

Study Design

This feasibility study was conducted as part of routine rehabilitation care at the Center for Mental Balance (CEDR), Pardubice, Czechia, between May and October 2025. The aim of the study was to evaluate the feasibility of a home-based FES program implemented within a clinic-based loan model of care in patients with varying levels of neurological impairment.

Prior to enrollment, all participants received detailed verbal and written information regarding the study procedures, as well as the expected benefits and potential risks associated with participation. They were also informed that anonymized data collected during the study could be used for research and publication purposes. Participation was voluntary, and all individuals provided written informed consent before inclusion. The study protocol adhered to established ethical standards for research involving human participants and was conducted in accordance with the Declaration of Helsinki.

Participants

Eligible participants were individuals with neurological disorders associated with gait impairment characterized by foot drop. All participants were required to be in a stable medical condition and capable of understanding and following the study procedures.

Participants were not included if they presented with acute or uncontrolled systemic conditions, such as fever or active infection, including tuberculosis, or if malignancy or severe cachexia was suspected. Additional exclusion criteria comprised bleeding disorders, inflammatory conditions in the area of stimulation, and clinically significant cardiovascular disease. Further exclusion criteria included impaired sensation in the lower limbs, recent fractures or joint dislocations, or any condition in which movement could exacerbate symptoms. Patients experiencing unexplained pain without a

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clear diagnosis were also excluded. Individuals with severe psychiatric disorders, pregnancy-related conditions, or local skin contraindications (e.g., inflammation, irritation, trophic changes, or damaged skin at the electrode placement site) were not eligible. The presence of implanted electronic devices or metal implants in the treatment area also led to exclusion.

Treatment Protocol

At baseline, participants completed a questionnaire aimed at identifying five daily activities that were most affected by their mobility limitations. The initial session was conducted at the rehabilitation center, where patients and, when appropriate, their caregivers received detailed instruction on the application and use of the FES device (BTL Walk Easy, BTL Industries Ltd.) During this session, patients were trained in proper device setup and operation. The stimulation cuff was positioned on the lower leg while the patient was seated in a standardized position, typically with the hip, knee, and ankle flexed to approximately 90°, or with the foot supported in a relaxed position. Stimulation intensity was gradually increased until a visible and functional dorsiflexion response was achieved. Electrode placement and stimulation parameters were individually adjusted to ensure a neutral foot position during activation while minimizing unwanted movements such as inversion or eversion. Final optimization was performed during walking, allowing fine-tuning based on gait pattern and patient comfort.

Following the initial supervised session, the device was provided to participants for home use within a loan-based model of care. Patients were encouraged to incorporate FES into their daily routines according to their individual schedules and preferences. Follow-up visits at the rehabilitation center were limited to periodic clinical assessments and technical support as needed. The overall duration and intensity of the intervention were not fixed but were adapted to each participant's functional status, daily routine, and rehabilitation goals.

Throughout the study period, patient-reported feedback was systematically collected during scheduled outpatient visits, with a primary focus on adherence to the home-based FES program. This included information on the frequency of device use, duration of individual training sessions, and the modes of device application. Participants were also asked to report any adverse events or technical difficulties encountered during device setup or operation.

Outcome Measures

Outcome measures were designed to capture patient-specific functional limitations, feasibility of home-based device use, and patient-reported effectiveness in real-world conditions. At baseline, patients were asked to identify the most limiting activities in their daily life using a patient-specific functional approach. These activities were subsequently categorized into broader domains (e.g. walking, stair ambulation, transfers, and complex mobility tasks) for analysis. During the study period, patient-reported feedback was collected with a focus on feasibility parameters, including adherence to device use, difficulties encountered during application, and the occurrence of adverse events. After the testing period, participants completed a structured questionnaire to evaluate their overall experience with the device. This questionnaire included patient satisfaction, perceived effectiveness of the device during predefined daily mobility tasks, and practical aspects of device use. Patients were asked to estimate the effectiveness of the device as a percentage reflecting perceived functionality in each task.

The predefined mobility tasks included level walking, stair ambulation, walking uphill and downhill, treadmill walking, and public transport use. These tasks were not standardized but reflected real-world conditions encountered by the participants. For reference, typical conditions included stair heights of approximately 15–19 cm, slopes up to 15°, and predominantly low-floor public transport with minimal step height. In addition, information regarding the individual scenario of device use was collected, including the use of walking aids, and the integration of the device into daily activities. Patients were also asked to subjectively describe perceived changes in walking ability and to report any technical limitations or usability issues associated with the device.

Data Processing and Analysis

Data were primarily analyzed at the individual patient level due to the exploratory nature of the study and the small sample size. Patient characteristics and feasibility outcomes are presented descriptively for each participant without aggregation. Patient-reported effectiveness of FES in predefined mobility tasks was expressed as a percentage and averaged across participants for graphical presentation. Only tasks performed by the patient were included in the analysis; tasks not performed were treated as missing data and excluded from calculations. Patient-specific functional limitations identified at baseline were grouped into broader thematic domains (e.g. walking, stair ambulation, transfers, and complex mobility tasks) to facilitate interpretation. Given the exploratory design of the study, no inferential statistical analysis was performed.

Results

Seven patients with neurological conditions associated with foot drop were included in the study. The cohort was heterogeneous in terms of diagnosis, age, and mobility status. Detailed patient characteristics are presented in Table 1.

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Table 1: Patient characteristics.

Patient	Age	Sex	Diagnosis	Mobility aids
P1	51	M	Stroke	1 crutch (outdoor)
P2	55	M	Stroke + femur fracture	quad cane
P3	36	M	Stroke	none
P4	41	M	CP + TBI	none
P5	43	M	TBI	none
P6	44	F	TBI	none
P7	45	F	TBI	occasional support

TBI = traumatic brain injury; CP = cerebral palsy

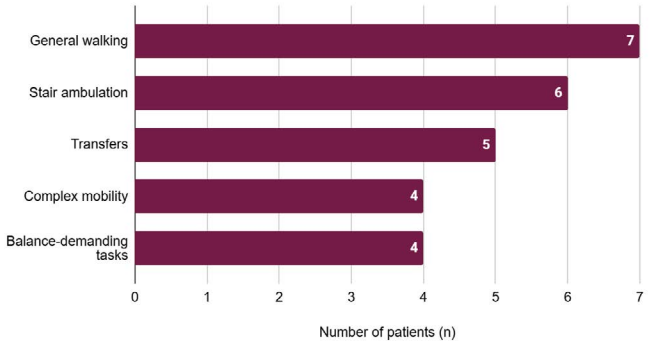

Figure 1: Frequency of patient-reported most limiting daily activities.

Patients most frequently identified mobility-related activities as limiting, particularly walking and stair ambulation. Transfer-related activities and more complex or balance-demanding tasks were also reported, although less consistently. The distribution of patient-reported limitations is shown in Figure 1.

All participants were able to use the FES device in a home environment following initial training. Daily use was variable, reflecting individual routines and preferences, but all patients incorporated the device into their regular daily activities. In one participant with the longest duration of device use, the frequency of stimulation was gradually reduced from daily use to every other day, as the patient began to incorporate independent walking without stimulation, reporting noticeable improvement in gait quality. No serious adverse events were reported. Feasibility outcomes are summarized in Table 2.

FES was perceived as highly effective across a range of daily mobility tasks, with particularly strong effects reported in basic locomotor activities. Slightly lower, but still substantial, effectiveness was observed in more demanding conditions such as stair ambulation and slope walking. Notably, the activities in which FES demonstrated the greatest perceived effectiveness corresponded to those most frequently identified as limiting by the patients (Figure 1). Detailed task-specific effectiveness data are presented in Figure 2.

Table 2: Feasibility of home-based FES use.

Patient	Duration of use	Daily use
P1	3 months	60 min/day
P2	1 month	60 min/day
P3	1 month	30–60 min (3× daily)
P4	1 month	≥30 min/day
P5	3 months	60 min/day
P6	3 months	15 min/day
P7	5 months	up to 2 h (every other day)

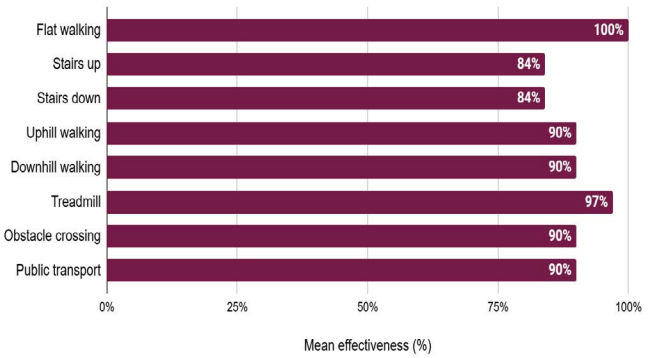

Figure 2: Patient-reported mean effectiveness of FES across different mobility tasks.

All patients reported a positive subjective effect of FES on their mobility. The most commonly described benefits included improved foot lifting, reduced tripping, increased walking speed, and enhanced confidence during walking. Several patients also reported a general perception of easier and more natural walking.

To estimate the organizational implications of a clinic-based loan model, a simplified comparison with standard outpatient rehabilitation was performed (Table 3).

Table 3: Estimated organizational impact of a loan-based home FES model.

Parameter	Standard outpatient care	Loan-based home FES
Therapy frequency	2 visits/week	initial fitting + occasional follow-up visits
Duration of care model	12 weeks	12 weeks
Therapist time per visit	60 min	60–90 min initial, 2x30 min follow-up
Total therapist time per patient	24 h	2–3 h
Estimated therapist time saved	-	21–22 h

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The home-based FES approach was associated with a reduction of approximately 21–22 therapist hours per patient. At the level of a fully utilized rehabilitation service involving multiple patients, this reduction may translate into a substantial cumulative saving of therapist time.

Discussion

This study demonstrated that home-based use of FES within a clinic-based loan model is feasible in neurological patients with foot drop. All participants were able to use the device in a home environment following initial training. Patients reported high perceived effectiveness across a range of daily mobility tasks, with effectiveness exceeding 80% in all evaluated activities. In addition, the findings suggest that this approach may reduce therapist workload, allowing more efficient allocation of clinical resources to patients who require direct supervision within a loan-based model.

Patient-reported functional limitations indicated that the most relevant impairments in daily life were related to walking, stair ambulation, and transfers. These corresponded to the tasks in which FES demonstrated high effectiveness, suggesting that the device addresses clinically meaningful aspects of mobility. This was further supported by subjective patient feedback, with all participants reporting improvements in gait quality, particularly in foot clearance and overall mobility. Together, these findings support the ecological validity of FES in real-world conditions. The absence of adverse events and only minor technical issues further supports the safety and usability of the device in a home setting.

Beyond its immediate orthotic effect, FES has been described to provide a therapeutic effect through repeated activation of neuromuscular pathways, in accordance with principles of motor learning. Achieving such effects requires a high volume of task-specific practice with near-physiological movement patterns, which may be difficult to attain in standard outpatient rehabilitation due to time constraints [14]. In contrast, a home-based approach enables patients to increase training frequency and integrate FES into everyday activities, thereby supporting activity-dependent neuroplasticity [16]. In the present study, this was illustrated in one participant with the longest duration of device use, who gradually reduced the frequency of FES-assisted training and increased independent walking without stimulation, reporting noticeable improvement in gait quality.

From an organizational perspective, the results suggest that a home-based FES loan model may represent an efficient use of rehabilitation resources. In addition to reducing therapist time, home-based therapy may decrease the need for repeated outpatient visits. Outpatient rehabilitation would also involve logistical demands such as transportation and caregiver involvement. Transportation itself may represent a relevant barrier, increasing the overall burden on both patients and their families and potentially affecting long-term adherence to rehabilitation. Home-based therapy may therefore not only improve accessibility but also support adherence by reducing these external barriers.

This study has several limitations. It was designed as a feasibility study with a small sample size and does not aim to evaluate clinical effectiveness. Larger studies with appropriate control groups and standardized, ideally objective, outcome measures are required to confirm these findings. Furthermore, the organizational model presented in this study is simplified and does not account for device maintenance, consumables, or administrative costs associated with a loan-based system.

Despite these limitations, this study represents one of the first attempts to evaluate both the feasibility and organizational implications of a home-based FES loan model. The findings suggest that FES may provide a clinically meaningful benefit for patients with neurological gait impairment while offering a potentially cost-efficient and logistically less demanding approach for both healthcare providers and patients.

Conclusion

This study demonstrated the feasibility and practical effectiveness of a home-based FES program implemented within a clinic-based loan model and suggested its potential for organizational cost savings in healthcare settings. All evaluated mobility tasks were rated by patients as highly effective, with perceived effectiveness exceeding 80%, including those identified as the most limiting in daily life, such as general walking, stair ambulation, and transfers. All participants also reported a positive subjective impact of the intervention on their mobility.

The exploratory organizational model indicated that a home-based approach may reduce therapist time by approximately 21–22 hours per patient, which, when applied across a larger patient population, may translate into substantial cumulative savings in therapist workload. In addition, this model may substantially reduce the logistical burden for patients, particularly in activities such as transfers, which were frequently reported as highly limiting and often required caregiver assistance.

Overall, these findings support the potential of home-based FES as a clinically relevant and organizationally efficient complement to conventional outpatient rehabilitation.

References

1. Alnajjar F, Zaier R, Khalid S, et al. Trends and Technologies in Rehabilitation of Foot Drop: A Systematic Review. Expert Rev Med Devices 18.1 (2021): 31-46.
2. El-Osta B, Wilson R. Concepts in Foot Drop Management-Review of the Current Literature. Acta Scientific Orthopaedics 2.10 (2019): 37-45.

Citation: Dominika Kúrová, Lukáš Sajdl. Home-Based Use of Functional Electrical Stimulation for Foot Drop: Feasibility, Perceived Effectiveness in Daily Mobility Tasks, and Organizational Implications. Journal of Biotechnology and Biomedicine. 9 (2026): 140-145.

3. Carolus AE, Becker M, Cuny J, et al. The Interdisciplinary Management of Foot Drop. Dtsch Arztebl Int 116.20 (2019): 347-354.

4. Poppler LH, Groves AP, Sacks G, et al. Subclinical Peroneal Neuropathy: A Common, Unrecognized, and Preventable Finding Associated With a Recent History of Falling in Hospitalized Patients. Ann Fam Med 14.6 (2016): 526-533.

5. Cho JE, Seo KJ, Ha S, et al. Effects of community ambulation training with 3D-printed ankle-foot orthosis on gait and functional improvements: a case series of three stroke survivors. Front Neurol 14 (2023): 1138807.

6. Akulwar IS, Shahane NC. An ICF Perspective on Impact of Environmental Barriers on Community Participation in Stroke Patients: A Qualitative Approach. Arch Neurol & Neurosci 4.4 (2019).

7. Wesselhoff S, Hanke TA, Evans CC. Community mobility after stroke: a systematic review. Top Stroke Rehabil 25.3 (2018): 224-238.

8. Karniel N, Raveh E, Schwartz I, et al. Functional electrical stimulation compared with ankle-foot orthosis in subacute post stroke patients with foot drop: A pilot study. Assist Technol 33.1 (2021): 9-16.

9. David R, Billot M, Ojardias E, et al. A 6-Month Home-Based Functional Electrical Stimulation Program for Foot Drop in a Post-Stroke Patient: Considerations on a Time Course Analysis of Walking Performance. Int J Environ Res Public Health 19.15 (2022): 9204.

10. Tache-Codreanu DL, Rotaru IA, Butum-Cristea MA, et al. Short-Term Facility-Based Functional Electrical Stimulation for Chronic Post-Stroke Foot Drop: A Pilot Study. Bioengineering (Basel) 13.2 (2026): 238.

11. Prenton S, Hollands KL, Kenney LP. Functional electrical stimulation versus ankle foot orthoses for foot-drop: A meta-analysis of orthotic effects. J Rehabil Med 48.8 (2016): 646-656.

12. Sabut SK, Sikdar C, Kumar R, et al. Functional electrical stimulation of dorsiflexor muscle: Effects on dorsiflexor strength, plantarflexor spasticity, and motor recovery in stroke patients. NeuroRehabilitation 29 (2011): 393-400.

13. Stein RB, Everaert DG, Thompson AK, et al. Long-term therapeutic and orthotic effects of a foot drop stimulator on walking performance in progressive and nonprogressive neurological disorders. Neurorehabilit Neural Repair 24 (2010): 152-167.

14. Daly JJ, Ruff RL. Functional interventions based on brain plasticity evidence for stroke patients. ScientificWorldJournal 7 (2007): 2031-2045.

15. Lang CE, Macdonald JR, Reisman DS, et al. Movement practice during stroke rehabilitation. Arch Phys Med Rehabil 90 (2009): 1692-1698.

16. Kúrová D, Sajdl L. Home-Based Functional Electrical Stimulation Across Different Levels of Mobility in Neurological Patients: A Case Series. J Clin Psychol Neurol 4.1 (2026): 1-6.

17. Cardoso LRL, Bochkezanian V, Forner-Cordero A, et al. Soft robotics and functional electrical stimulation advances for restoring hand function in people with SCI: a narrative review, clinical guidelines and future directions. J Neuroeng Rehabil 19.1 (2022): 66.

18. Covarrubias-Escudero F, Balbontín-Miranda F, Urzúa-Soler B, et al. Home-based functional electrical stimulation protocol for people with chronic stroke. Efficacy and usability of a single-center cohort. Artif Organs 49.7 (2025): 1141-1152.

Citation: Dominika Kúrová, Lukáš Sajdl. Home-Based Use of Functional Electrical Stimulation for Foot Drop: Feasibility, Perceived Effectiveness in Daily Mobility Tasks, and Organizational Implications. Journal of Biotechnology and Biomedicine. 9 (2026): 140-145.