JUKEJ: Jurnal Kesehatan Jompa
https://doi.org/10.57218/jkj.Vol5.Iss2.2609

Vol. 5 No. 2 Juni 2026
e-ISSN:2830-5558 p- ISSN:2830-5744

Efficacy of Home-Based Electrotherapy for Chemotherapy-Induced Peripheral Neuropathy: A Systematic Review and Meta-Analysis

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Article Info

Article History
Received: 2026-02-08
Revised: 2026-06-05
Published: 2026-06-29

Keywords:
cancer rehabilitation; chemotherapy-induced peripheral neuropathy; neuromodulation; transcutaneous electrical nerve stimulation; wearable electrotherapy

Abstract

Chemotherapy-induced peripheral neuropathy (CIPN) remains a major survivorship challenge with limited therapeutic options. Neuromodulatory approaches such as transcutaneous electrical nerve stimulation (TENS) have emerged as non-pharmacologic alternatives, but the efficacy of home-based and wearable electrotherapy remains unclear. To evaluate the clinical effectiveness of home-based electrotherapy for improving neuropathic symptoms in patients with established CIPN. A systematic search of PubMed, Cochrane Library, and ScienceDirect (through November 2025) identified randomized controlled and comparative cohort trials evaluating home-based electrotherapy for CIPN. The primary outcomes were changes in neuropathic symptoms (EORTC-CIPN20) and safety. Data were pooled using a random-effects model, with heterogeneity assessed using the I^2 statistic. Four studies (n = 236) met the eligibility criteria. Home-based stimulation demonstrated high adherence (>80%) and a favorable safety profile with no serious adverse events. In the exploratory quantitative synthesis (n=3), the pooled standardized mean difference favored the intervention (SMD = −2.19; 95% CI −5.48 to 1.11), although this did not reach statistical significance (p=0.19). Substantial heterogeneity was observed (I2 =98%), likely attributable to variations in device parameters (conventional electrotherapy vs. high-tone) and study populations. Home-based electrotherapy is a feasible and safe adjunct intervention for CIPN with high patient acceptability. While the pooled analysis suggests a trend toward symptom reduction that may be clinically relevant, the high heterogeneity and lack of statistical significance preclude definitive conclusions regarding efficacy. Large-scale, standardized multicenter RCTs are required to confirm these preliminary findings and establish optimal stimulation protocols.

Artikel Info

Sejarah Artikel
Diterima: 2026-02-08
Direvisi: 2026-06-05
Dipublikasi: 2026-06-29

Kata kunci:
elektroterapi *wearable*; neuromodulasi; neuropati perifer akibat kemoterapi; rehabilitasi kanker; *transcutaneous electrical nerve stimulation* (TENS)

Abstrak

Neuropati perifer akibat kemoterapi (*chemotherapy-induced peripheral neuropathy* [CIPN]) merupakan komplikasi yang sering dialami penyintas kanker dengan pilihan terapi yang masih terbatas. Elektroterapi berbasis rumah, seperti *transcutaneous electrical nerve stimulation* (TENS), berkembang sebagai alternatif terapi nonfarmakologis, namun efektivitasnya masih belum pasti. Penelitian ini bertujuan mengevaluasi efektivitas klinis elektroterapi berbasis rumah pada pasien CIPN melalui tinjauan sistematis dan meta-analisis. Pencarian literatur dilakukan pada PubMed, Cochrane Library, dan ScienceDirect hingga November 2025. Luaran utama meliputi perubahan gejala neuropati (EORTC-CIPN20) dan keamanan. Sebanyak empat penelitian (n = 236) memenuhi kriteria inklusi. Hasil menunjukkan tingkat kepatuhan yang tinggi (>80%) dan tidak ditemukan efek samping serius. Analisis gabungan pada tiga penelitian menunjukkan kecenderungan perbaikan gejala pada kelompok intervensi (SMD = −2,19; IK95% = −5,48 hingga 1,11), namun tidak signifikan secara statistik (p = 0,19) dengan heterogenitas yang sangat tinggi (I^2 = 98%). Elektroterapi berbasis rumah merupakan intervensi tambahan yang aman dan layak diterapkan pada pasien CIPN, tetapi bukti efektivitasnya masih terbatas. Diperlukan uji acak terkontrol berskala besar dengan protokol yang terstandarisasi untuk mengonfirmasi manfaat klinisnya.

INTRODUCTION

Chemotherapy-induced peripheral neuropathy (CIPN) is a dose-limiting side effect of neurotoxic chemotherapy that significantly impairs quality of life (Park et al., 2013; Seretny et al., 2014). Affecting a

substantial proportion of cancer survivors, CIPN is driven by multifactorial mechanisms including axonal degeneration and neural sensitization (Staff et al., 2017). Current pharmacologic interventions often fail to provide adequate relief or are limited by systemic toxicity, highlighting an urgent unmet need for safe, non-pharmacologic alternatives (Boyette-Davis et al., 2018).

Transcutaneous electrical nerve stimulation (TENS) offers a potential solution by inhibiting pain signaling through spinal modulation (Patel et al., 2025). The evolution of TENS technology into home-based and wearable devices has transformed this modality from a clinic-bound therapy to a practical, self-administered option for chronic symptom management (Gewandter et al., 2024). Although individual studies suggest home-based TENS improves patient outcomes, the existing literature is characterized by methodological variability, and previous syntheses have failed to isolate the specific impact of home-based protocols (Gewandter et al., 2024).

To address this gap, this systematic review and meta-analysis evaluates the effectiveness of home-based electrotherapy and high-tone electrotherapy on CIPN severity. By synthesizing data specifically on self-administered interventions, this review aims to clarify the clinical utility of these devices in the supportive care of adult oncology patients.

METHOD

This systematic review adhered to the PRISMA 2020 guidelines. A comprehensive search was conducted in PubMed, Cochrane Library, and ScienceDirect from inception to November 2025, combining Medical Subject Headings (MeSH) with search keyword used were: ("chemotherapy-induced peripheral neuropathy" OR CIPN) AND ("transcutaneous electrical nerve stimulation" OR TENS OR "home-based TENS" OR "wearable TENS" OR "electrotherapy") AND (randomized OR trial OR cohort), augmented by backward citation tracking without language restrictions.

Eligibility criteria encompassed randomized controlled and comparative cohort trials evaluating home-based or wearable electrotherapy (including high-tone modalities) in adults with established CIPN against sham or standard care controls. Studies were required to report quantitative symptom severity outcomes (e.g., EORTC-CIPN20, pain intensity). Protocols involving exclusively clinic-based administration, prophylactic application, or confounded multimodal interventions were excluded.

Two independent reviewers screened all records and extracted data using a standardized form. Extracted information included first author, publication year, country, study design, sample size, chemotherapy regimen, intervention characteristics (device type, frequency, duration, pulse width, session length), comparator details, treatment duration, outcome measures, mean changes, and standard deviations. When necessary, corresponding authors were contacted to obtain missing data. For studies presenting results as medians or interquartile ranges,

data were converted into mean and standard deviation values using established statistical methods.

All data were cross-checked for accuracy before quantitative synthesis. Where multiple outcome timepoints were available, data from the final follow-up within 3–8 weeks of treatment were selected to ensure comparability across trials.

Risk of bias for randomized controlled trials was evaluated using the Cochrane Risk of Bias 2.0 (RoB 2) tool, which assesses randomization process, deviations from intended interventions, missing outcome data, measurement of outcome, and selective reporting. The single-arm feasibility study was appraised using the ROBINS-I framework for nonrandomized studies. Each domain was categorized as low, some concerns, or high risk of bias. Two reviewers independently rated each study, with discrepancies resolved by consensus discussion with a third reviewer. Visual summaries of bias domains were generated to support interpretation of study quality.

Figure 1. Risk of Bias Assessment with RoB-2 (above) and (ROBINS-I) tool of included studies

Quantitative pooling was performed for studies reporting mean changes in EORTC-CIPN20 total or sensory subscale scores, which represented the most consistently reported outcome across trials. A random-effects model (DerSimonian–Laird method) was used to account for expected clinical and methodological heterogeneity. For each study, standardized mean differences (SMDs) and 95% confidence intervals (CIs) were calculated. Heterogeneity was quantified using the I^2 statistic, with values of 25%, 50%, and 75% considered low, moderate, and high, respectively.

Sensitivity analyses were conducted by sequentially excluding each study to assess the robustness of pooled estimates. Publication bias was explored visually using funnel plots when three or more studies were available for a given outcome. All analyses were performed using Review Manager (RevMan) version 5.4. Statistical significance was defined as a two-sided p value < 0.05.

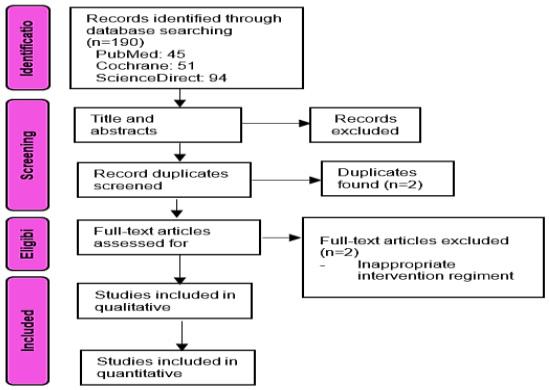

Figure 2. Diagram flow of literature search

Four studies met the inclusion criteria and were synthesized in this review, comprising one single-arm feasibility study, two randomized double-blind placebo-controlled trials, and one randomized single-blind controlled trial with a retrospective control group. Gewandter et

al. (2019) conducted a single-arm feasibility study involving 29 patients with chronic chemotherapy-induced peripheral neuropathy (CIPN) persisting for at least three months following neurotoxic chemotherapy, of whom 22 completed the intervention. Participants received a wireless home-based transcutaneous electrical nerve stimulation (TENS) device (Quell®) delivering 60–100 Hz stimulation with 200–400 μs pulse width for approximately five hours daily over six weeks. Significant improvements were observed in EORTC-CIPN20 scores (13% reduction, p = 0.004), accompanied by marked reductions in pain (38%) and cramping (53%), as well as a 52% improvement in SF-MPQ-2 scores (p = 0.002). Neurological function assessed using the Utah Early Neuropathy Scale (UENS) improved by 48% (p = 0.04), while adverse events were mild and transient, mainly consisting of contact dermatitis and temporary paresthesia, supporting the feasibility and tolerability of home-based TENS therapy.

Wakolbinger-Habel et al. (2024) performed a randomized, double-blind, placebo-controlled pilot trial in 14 colorectal cancer patients receiving platinum-based chemotherapy who presented with symptomatic CIPN. Participants were assigned to receive either active high-tone therapy (HiToP 191 PNP®) or an identical placebo device with no current output for 60 minutes daily, at least five days per week, over three weeks, followed by a two-week observation period. The active treatment group demonstrated significant reductions in paresthesia intensity (−1.71 ± SE, p = 0.034) and mental stress related to paresthesias (−2.43 ± SE, p = 0.006) compared with placebo, whereas no significant differences were observed in other neuropathic symptoms or overall quality of life. No adverse events were reported, indicating that home-based high-tone therapy is safe and well tolerated.

In a larger randomized, double-blind, placebo-controlled trial across six National Cancer Institute Community Oncology Research Program (NCORP) sites, Gewandter et al. (2024) randomized 142 patients with chronic CIPN following taxane-, platinum-, or vinca-based chemotherapy, of whom 130 completed the study. Participants received either active wireless home-based TENS (Quell®), delivering 60–100 Hz stimulation for approximately three hours daily over six weeks, or sham stimulation. Although the between-group difference in EORTC-CIPN20 total score did not reach statistical significance (Δ = 1.05; 95% CI −0.56 to 2.67; p = 0.199), clinically meaningful reductions in pain and cramping intensity, ranging from 1.2 to 1.4 points on the numerical rating scale, were observed in favor of the active TENS group. Moreover, a higher proportion of participants in the active group reported overall symptom improvement compared with controls (61% vs. 42%; OR 2.18, p = 0.03). No significant changes were noted in numbness or tingling, and reported adverse events were mild and reversible, mainly involving transient paresthesia and minor skin irritation.

Sassmann et al. (2024) conducted a randomized, single-blind controlled trial involving 51 patients with CIPN following taxane- or platinum-based chemotherapy, supplemented by 17 retrospective controls. Participants were allocated to receive either high-tone external muscle stimulation (HTEMS) or conventional TENS for 30 minutes daily, at least five days per week, over eight weeks, with all interventions performed at home. Both active treatment groups demonstrated significant improvements in sensory and motor subscales of the EORTC-QLQ-CIPN20 compared with controls, with mean sensory score reductions of −12.3 ± 17.7 in the TENS group and −14.7 ± 16.5 in the HTEMS group versus −3.3 ± 12.4 in controls ($p = 0.048$). Improvements in CIPN severity grade were also observed based on CTCAE v4 criteria ($p < 0.05$). HTEMS produced the strongest effect on sensory symptoms ($p = 0.039$), and both interventions were associated with high adherence rates and minimal adverse events, supporting the feasibility of home-based electrotherapy.

RESULTS AND DISCUSSION

Study Selection

A total of 190 records were identified through database searching 45 from PubMed, 51 from the Cochrane Library, and 94 from ScienceDirect. After title and abstract screening, 182 records were excluded for being nonrelevant, noninterventional, or non-CIPN specific. Eight duplicates were screened and two removed, leaving six full-text articles for eligibility assessment. Of these, two were excluded due to inappropriate intervention regimens (clinic-based rather than home-administered electrotherapy), resulting in four studies included in the qualitative synthesis and three in the quantitative meta-analysis (**Figure 3**).

Study Characteristics

The four included studies encompassed a combined total of 236 participants with established chemotherapy-induced peripheral neuropathy (CIPN) following exposure to neurotoxic agents such as taxanes, platinum compounds, and vinca alkaloids. Three studies were randomized controlled trials, while one (Gewandter et al., 2019) was an open-label feasibility study. All trials explored home-based or wearable forms of transcutaneous electrical nerve stimulation (TENS) or related high-tone electrotherapy as an adjunctive, non-pharmacologic intervention for symptomatic CIPN.

Interventions varied across trials but shared the same therapeutic intent: to deliver low- to mid-frequency electrical stimulation at home to modulate neuropathic pain and sensory disturbances. Two studies by Gewandter et al. (2019; 2024) used a wireless, app-controlled Quell® device, delivering stimulation at 60–100 Hz and 200–400 µs pulse width for 3–5 hours per day. Sassmann et al. (2024) compared high-tone electrical muscle stimulation (HTEMS) and conventional TENS, both self-administered for 30 minutes daily, five days per week, over eight weeks. Wakolbinger-Habel et al. (2024) used the HiToP 191 PNP® high-tone system, also applied daily for three weeks,

with sham control units identical in appearance but without current output.

All studies assessed outcomes using the EORTC-CIPN20 questionnaire, particularly its sensory subscale, as the primary indicator of neuropathy burden. Additional measures included symptom-specific Numeric Rating Scales (NRS) for pain, tingling, and cramping, and EORTC-QLQ-C30 for quality of life. Reported adverse effects were minimal and reversible, primarily mild skin irritation or transient paresthesia. These characteristics are detailed in after figure 2**.**

Qualitative Synthesis

Overall, the qualitative review indicates consistent symptomatic benefit and high feasibility of home-based electrotherapy devices in reducing CIPN-associated sensory symptoms (details in after figue 2). Gewandter et al. (2019, 2024) established the foundational evidence for wireless electrotherapy, demonstrating that unsupervised daily use is feasible and clinically meaningful. While their multicenter RCT showed mixed statistical significance regarding total EORTC-CIPN20 scores, the active group reported significantly higher subjective global relief and reduced cramping compared to sham. Parallel findings were observed in high-tone electrotherapy (HiToP/HTEMS) studies. Wakolbinger-Habel et al. (2024) and Sassmann et al. (2024) reported that home-based stimulation significantly reduced paresthesia intensity, mental stress, and sensory deficits compared to controls. Notably, Sassmann et al. highlighted concurrent improvements in motor subscales and functional stability. Collectively, these studies support the utility of home-based electrical stimulation as a practical, effective strategy for mitigating sensory neuropathy burden and facilitating self-management in cancer survivors.

Quantitative Synthesis

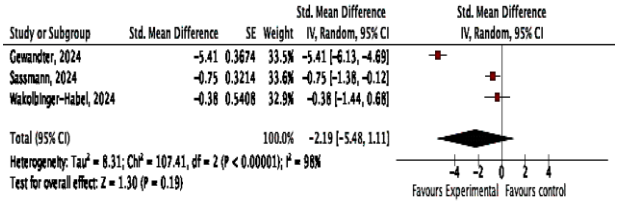

Figure 3. Forest Plot Of Home-Based Electrotherapy Versus Control For Chemotherapy-Induced Peripheral Neuropathy. Forest Plot Depicting The Pooled Standardized Mean Difference (SMD) And 95% Confidence Intervals For Change In EORTC-CIPN20 Total And Sensory Subscale Scores Across Included Studies. Negative Values Favor The Intervention (Home-Based Electrotherapy). Analysis Performed Using A Random-Effects Model.

Quantitative pooling of three studies (n=207) revealed a large effect size favoring home-based electrotherapy (SMD = −2.19; 95% CI −5.48 to 1.11), though this did not reach statistical significance (p = 0.19) due to substantial heterogeneity (I^2 = 98%). This heterogeneity likely reflects variations in device parameters (conventional electrotherapy vs. high-tone) and treatment durations (3–8 weeks). Nevertheless, all individual point estimates consistently favored the intervention, suggesting clinically relevant improvements in sensory symptoms despite the statistical variance. The intervention profile was highly

favorable, with no serious adverse events reported and high adherence across all trials, confirming the feasibility of long-term home application.

This systematic review provides the first focused synthesis of home-based electrotherapy and high-tone electrotherapy for CIPN. The pooled analysis revealed a consistent trend toward symptom reduction across all included studies, particularly in sensory domains of the EORTC-CIPN20. Although the aggregate effect size did not reach statistical significance (SMD = −2.19, p = 0.19)—likely due to high heterogeneity in device parameters and patient populations—the magnitude of individual improvements (often exceeding 10 points on sensory subscales) suggests clinical relevance. Crucially, the intervention demonstrated an excellent safety profile and high adherence (>80%), distinguishing home-based electrotherapy as a feasible, patient-empowered strategy for survivorship care.

Unlike previous meta-analyses that aggregated diverse modalities (e.g., scrambler therapy, acupuncture), this review isolates the specific contribution of self-administered stimulation. Our findings align with evidence in diabetic neuropathy, suggesting a class effect of peripheral neuromodulation in restoring afferent balance via gate-control mechanisms and descending inhibition. Clinically, the observed symptom relief is comparable to pharmacologic agents like duloxetine but without the systemic toxicity, positioning home-based electrotherapy as a rational non-pharmacologic alternative. The efficacy of high-tone modalities (HTEMS/HiToP) in improving motor deficits further suggests that higher-frequency stimulation may offer broader neuromuscular benefits beyond simple pain modulation.

Interpretation of Findings

This systematic review and meta-analysis comprehensively synthesized the existing evidence on home-based transcutaneous electrical nerve stimulation (TENS) and related electrotherapy for chemotherapy-induced peripheral neuropathy (CIPN). The pooled findings indicate a consistent trend toward improvement in neuropathic symptom burden as assessed by the EORTC-CIPN20 instrument. Although the combined standardized mean difference (SMD = −2.19; 95% CI −5.48 to 1.11) did not reach statistical significance, all individual studies demonstrated symptom reduction favoring the electrotherapy group, supporting a clinically meaningful benefit in the management of CIPN.

The magnitude and direction of improvement observed across trials, particularly the 10–15 point decreases in EORTC-CIPN20 sensory subscales, are notable given the chronic, refractory nature of CIPN and the limited efficacy of pharmacologic treatments (Seretny et al., 2014; Loprinzi et al., 2020; Smith et al., 2013). Such improvements exceed the threshold generally considered clinically relevant for neuropathic symptom reduction. The large heterogeneity (I^2 = 98%) likely reflects differences in device technology (Quell®, HTEMS, HiToP 191), stimulation frequency (60 Hz vs. kilohertz

high-tone), treatment duration (3–8 weeks), and patient population (chronic vs. subacute CIPN). Despite this variability, the directional consistency of symptom improvement across trials suggests that neuromodulation through peripheral electrical stimulation may provide a reproducible therapeutic effect.

From a patient-centered perspective, the reported outcomes align with real-world acceptability: adherence exceeded 80%, adverse events were minimal, and none of the participants discontinued due to safety concerns. Collectively, these findings reinforce the viability of home-based electrotherapy as a safe, feasible, and potentially effective adjunctive strategy for managing CIPN, particularly when pharmacologic options are limited or poorly tolerated.

Comparison with Previous Studies

While prior meta-analyses have evaluated diverse neuromodulatory interventions in CIPN, including scrambler therapy, electroacupuncture, or peripheral field stimulation, none have specifically focused on home-based electrotherapy, which differs in mechanism, cost, and accessibility (Johnson et al., 2022; Majithia et al., 2016). Earlier syntheses pooled heterogeneous modalities, obscuring the isolated efficacy of portable or wearable stimulation systems. This review addresses that gap by focusing exclusively on self-administered, home-based electrotherapy, offering a clearer understanding of its clinical potential.

Our results align with previous findings showing that peripheral electrical stimulation can modulate neuropathic pain and enhance sensory recovery by restoring afferent balance (Moseley & Flor, 2012; Yang et al., 2022). Compared with pharmacologic agents such as duloxetine, which yields modest mean pain score reductions of 0.7–1.0 points (Smith et al., 2013), the symptom changes achieved through electrotherapy are comparable or greater, with a superior safety profile. This parity in effect size underscores the therapeutic relevance of neuromodulation, particularly for cancer survivors in whom systemic drug exposure poses additional risks.

Furthermore, studies in diabetic and post-surgical neuropathy populations have demonstrated similar patterns of benefit with prolonged electrotherapy application, suggesting a potential class effect of peripheral electrical stimulation across neuropathic etiologies (Patel et al., 2025; DeJesus et al., 2023; Moseley & Flor, 2012). The present findings therefore extend the known utility of electrotherapy into the domain of chemotherapy-induced neurotoxicity, where conventional interventions have historically underperformed.

Clinical Implications

Clinically, home-based electrotherapy offers a safe, cost-effective, and patient-empowered alternative to pharmacologic agents, particularly for older adults or those with polypharmacy burdens. Its potential integration into digital health platforms and multidisciplinary rehabilitation programs could further optimize symptom monitoring and quality of life. Moving forward, the

standardization of stimulation parameters is essential to ensure reproducible outcomes and facilitate evidence-based clinical implementation.

Limitations

Despite encouraging results, several limitations warrant discussion. The total sample size across included studies was modest, and treatment durations were short, typically under eight weeks. These constraints limit statistical power and the ability to assess long-term durability of benefit. Device heterogeneity, ranging from conventional low-frequency electrotherapy to high-tone stimulation, introduces methodological variability that may contribute to the high I^2 observed in the pooled analysis. Differences in patient population, chemotherapy type, and disease chronicity further complicate direct comparisons.

Moreover, most studies relied on self-reported symptom questionnaires, which, while clinically relevant, are subject to response bias and placebo effects. Objective measures such as nerve conduction studies or quantitative sensory testing were seldom incorporated. Lastly, publication bias could not be fully excluded given the small number of available trials, though the direction of findings across studies appears consistent. Future meta-analyses incorporating more homogeneous data sets will be essential to validate these findings and refine effect size estimates.

Future Directions

The combined evidence from qualitative and quantitative syntheses highlights a promising therapeutic potential of home-based electrotherapy and high-tone electrotherapy for the management of CIPN. While statistical heterogeneity limits firm conclusions, the consistency of direction across all studies, the magnitude of symptomatic improvement, and the low risk of adverse effects collectively strengthen the rationale for further large-scale, standardized RCTs. Future research should investigate optimal frequency, intensity, and session duration for maximal therapeutic efficacy. Incorporating objective electrophysiologic outcomes and biomarkers of neural recovery, such as intraepidermal nerve fiber density or somatosensory evoked potentials, could help elucidate the biological basis of electrotherapy-induced improvements.

Integration with wearable digital platforms represents the next frontier, enabling real-time remote monitoring, adaptive feedback algorithms, and personalized dosing schedules. Comparative effectiveness studies contrasting electrotherapy with pharmacologic agents like duloxetine or gabapentinoids would also help position home-based electrotherapy within multimodal management frameworks. Finally, exploring the preventive potential of electrotherapy initiated early during chemotherapy may provide insights into its role not only in treatment but also in neuroprotection against chemotherapy-induced injury.

CONCLUSION

This meta-analysis highlights home-based electrotherapy as a safe, feasible, and potentially effective self-management

strategy for CIPN. While pooled results did not reach statistical significance, the consistent trend toward symptom reduction and excellent safety profile supports its clinical utility as a non-pharmacologic adjunct. To definitively establish efficacy, future research must prioritize the standardization of stimulation protocols and the conduct of large-scale multicenter RCTs utilizing objective neurophysiological endpoints.

REFERENCES

Bennett, G. J., Liu, G. K., Xiao, W. H., Jin, H. W., & Siau, C. (2011). Terminal arbor degeneration A novel lesion produced by the antineoplastic agent paclitaxel. *European Journal of Neuroscience, 33*(9), 1667–1676. https://doi.org/10.1111/j.1460-9568.2011.07671.x

Boyette-Davis, J. A., Hou, S., Abdi, S., & Dougherty, P. M. (2018). An updated understanding of the mechanisms involved in chemotherapy-induced neuropathy. *Pain Management, 8*(5), 363–375. https://doi.org/10.2217/pmt-2018-0020

DeJesus, B. M., Rodrigues, I. K. L., Azevedo-Santos, I. F., & DeSantana, J. M. (2023). Effect of transcutaneous electrical nerve stimulation on pain-related quantitative sensory tests in chronic musculoskeletal pain and acute experimental pain: Systematic review and meta-analysis. *The Journal of Pain, 24*(8), 1337–1382. https://doi.org/10.1016/j.jpain.2023.02.011

Fukuda, Y., Li, Y., & Segal, R. A. (2017). A mechanistic understanding of axon degeneration in chemotherapy-induced peripheral neuropathy. *Frontiers in Neuroscience, 11*, 481. https://doi.org/10.3389/fnins.2017.00481

Gewandter, J. S., Culakova, E., Davis, J. N., Gada, U., Guido, J. J., Bearden, J. D., et al. (2024). Wireless transcutaneous electrical nerve stimulation (TENS) for chronic chemotherapy-induced peripheral neuropathy (CIPN): A proof-of-concept randomized clinical trial. *The Journal of Pain, 25*(5), 104431. https://doi.org/10.1016/j.jpain.2024.104431

Johnson, M. I., Paley, C. A., Jones, G., Mulvey, M. R., & Wittkopf, P. G. (2022). Efficacy and safety of transcutaneous electrical nerve stimulation (TENS) for acute and chronic pain in adults: A systematic review and meta-analysis of 381 studies (the meta-TENS study). *BMJ Open, 12*(2), e051073. https://doi.org/10.1136/bmjopen-2021-051073

Loprinzi, C. L., Lacchetti, C., Bleeker, J., Cavaletti, G., Chauhan, C., Hertz, D. L., et al. (2020). Prevention and management of chemotherapy-induced peripheral neuropathy in survivors of adult cancers: ASCO guideline update. *Journal of Clinical Oncology, 38*(28), 3325–3348. https://doi.org/10.1200/JCO.20.01399

Majithia, N., Smith, T. J., Coyne, P. J., Abdi, S., Pachman, D. R., Lachance, D., et al. (2016). Scrambler therapy for the management of chronic pain. *Supportive Care in Cancer, 24*(6), 2807–2814. https://doi.org/10.1007/s00520-016-3177-3

Moseley, G. L., & Flor, H. (2012). Targeting cortical representations in the treatment of chronic pain: A review. *Neurorehabilitation and Neural Repair, 26*(6), 646–652. https://doi.org/10.1177/1545968311433209

Park, S. B., Goldstein, D., Krishnan, A. V., Lin, C. S. Y., Friedlander, M. L., Cassidy, J., et al. (2013). Chemotherapy-induced peripheral neurotoxicity: A critical analysis. *CA: A Cancer Journal for Clinicians, 63*(6), 419–437. https://doi.org/10.3322/caac.21111

Patel, P., Green, M., Tram, J., Wang, E., Murphy, M., Abd-Elsayed, A. A., et al. (2025). Latest advancements in transcutaneous electrical nerve stimulation (TENS) and electronic muscle stimulation (EMS): Revisiting an established therapy with new possibilities. *Journal of Pain Research, 18*, 137–153. https://doi.org/10.2147/JPR.S489450

Seretny, M., Currie, G. L., Sena, E. S., Ramnarine, S., Grant, R., MacLeod, M. R., et al. (2014). Incidence, prevalence, and predictors of chemotherapy-induced peripheral neuropathy: A systematic review and meta-analysis. *Pain, 155*(12), 2461–2470. https://doi.org/10.1016/j.pain.2014.09.020

Smith, E. M. L., Pang, H., Cirrincione, C., Fleishman, S., Paskett, E. D., Ahles, T., et al. (2013). Effect of duloxetine on pain, function, and quality of life among patients with chemotherapy-induced painful peripheral neuropathy: A randomized clinical trial. *JAMA, 309*(13), 1359–1367. https://doi.org/10.1001/jama.2013.2813

Staff, N. P., Grisold, A., Grisold, W., & Windebank, A. J. (2017). Chemotherapy-induced peripheral neuropathy: A current review. *Annals of Neurology, 81*(6), 772–781. https://doi.org/10.1002/ana.24951

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