Received: 28 February 2023 | Revised: 18 January 2024 | Accepted: 31 January 2024
DOI: 10.1111/ijun.12389

REVIEW ARTICLE

Clarifying practical aspects of posterior tibial nerve stimulation for neurogenic overactive bladder: A scoping review

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Abstract

Patients with neurological diseases often suffer from overactive bladder. Posterior tibial nerve stimulation is mentioned in guidelines as a treatment when antimuscarinics fail or cannot be tolerated by patients, but the evidence is scant. This article summarizes the evidence on the practical aspects of tibial nerve stimulation for neurogenic overactive bladder (NOAB), such as electrical parameters and treatment duration, and identifies areas requiring further investigation. Scoping review. Literature search on PubMed, CINAHL, and Cochrane Library, including studies from 2010 to 2024 regarding tibial nerve stimulation for NOAB. Sixteen papers were considered: seven on transcutaneous tibial nerve stimulation (TTNS), seven on percutaneous tibial nerve stimulation (PTNS) and two protocols. Most studies enrolled neurological and non-neurological patients or studied non-randomized samples of a few patients. Clinical outcomes, treatment duration, number of sessions, and follow-up times showed considerable heterogeneity, but some practical recommendations could be drawn. For PTNS, most authors suggest using 20 Hz and 200 µs, but the amplitude is highly variable among studies. For TTNS, 10 Hz and 200 µs are suggested, with considerable variability in the number of sessions and overall treatment duration. Most papers propose similar criteria regarding the frequency and duration of the stimulation, and all of them support the efficacy of tibial nerve stimulation, except for one. The areas requiring research include long-term results, allowing for shaping adequate maintenance programmes to avoid losing the results achieved.

KEYWORDS
lower urinary tract symptoms, neurogenic overactive bladder, posterior tibial nerve stimulation, transcutaneous electric nerve stimulation

What is known about this topic

Posterior tibial nerve stimulation is a possible treatment for neurogenic overactive bladder when antimuscarinics fail or cannot be tolerated by patients. The posterior tibial nerve is a convenient way to provide electrical stimulation to bladder innervation, as bladder reflexes are mediated by bladder afferent fibres that run through the greater pelvic ganglion. The literature often reports data from small, non-randomized studies, which must be properly summarized.

What this paper adds

Clinical outcomes, treatment duration, number of sessions, and follow-up times show considerable heterogeneity in the literature. Most authors suggest using 20 Hz and 200 µs for percutaneous tibial nerve stimulation, but the amplitude is highly variable among studies. For transcutaneous stimulation, 10 Hz and 200 µs are suggested, with considerable variability in the number of sessions and overall treatment duration.

1 | INTRODUCTION

Neurogenic bladder is a condition that occurs in patients with diseases affecting the central nervous system (CNS) or peripheral nervous system (PNS), resulting in bladder sphincter dysfunction such as alterations in urination or urinary incontinence.[1] Among the symptoms reported by patients, overactive bladder (OAB) is one of the most common. OAB is defined by the International Continence Society as a sense of urgency, frequently accompanied by increased frequency and nocturia, but not necessarily by urinary incontinence. This symptomatic diagnosis differs from detrusor overactivity, which requires a specific urodynamic finding; therefore, OAB can be related to detrusor overactivity or other causes.[2]

The epidemiology of neurogenic overactive bladder (NOAB) is related to the incidence and prevalence of neurological diseases, thus making the resulting symptoms widespread and troublesome. Any neurological condition can alter bladder function because of the strong integration between the nervous centres and the urinary tract.[3] It is estimated that the worldwide population comprises more than 2.5 million people with spinal cord injury (SCI), more than 1.5 million with multiple sclerosis (MS), and approximately 3 million with Parkinson's disease (PD).[4] In Italy, there are currently 913 000 people who have suffered a stroke with disabling consequences, 80% of which are of first onset and 20% of recurrence.[5] Over the years, the epidemiology of dementia, another high-prevalence neurological condition, has also been dramatically increasing, with this condition expected to affect approximately 48 million people worldwide in 2020.[6] All these diseases can result in OAB or its determinants; other conditions to be considered include cerebral palsy, hereditary spastic paraplegia, MS, and peripheral neuropathy related to diabetes.[7]

Several interventions have been studied in the existing literature to treat NOAB, although international guidelines still need to work on low-quality studies that produce inconclusive evidence.[7] Conservative methods (treatments not involving drugs or surgery) are particularly interesting to nurses for mitigating neurogenic LUTS. Examples of such methods include pelvic floor muscle training (PFMT), functional electrical stimulation (both also commonly used for non-neurogenic urinary storage symptoms),[8,9] sacral neuromodulation, and posterior tibial nerve stimulation (TNS).

The latter is a neuromodulation technique, the electrical stimulation of nerves instead of muscles, first described by Stoller (1983) with a percutaneous approach using fine needles like those used for acupuncture; it can also be administered transcutaneously using adhesive electrodes placed on the skin. Both methods allow electrical current to be delivered to the posterior tibial nerve, which originates from the sciatic nerve; the roots are located near S3-S4, from which the detrusor and pelvic floor innervation also originate. For this reason, TNS is a convenient way to root electrical stimulation to bladder innervation. This characteristic makes it suitable for NOAB since bladder reflexes are mediated by afferent fibres that run through the greater pelvic ganglion. It has long been known that these fibres originate at the level of L4-S3 and innervate the detrusor muscle; the sciatic nerve originates at the same level. The pathophysiology of NOAB is based on the unbalance between afferent and efferent signals related to excessive sensitivity of afferent C fibres. This leads to lower urinary tract symptoms (LUTS) like urgency and frequency, which characterize NOAB.[10]

Many studies in the literature regarding TNS in neurogenic patients present conflicting evidence on the expected effects and the clinical criteria (e.g., electrical parameters) to be adopted during treatments. For this reason, after the publication of the most recent European guidelines, some authors have conducted in-depth systematic reviews on the transcutaneous approach,[11] highlighting the limited quality of the available evidence. In recent years, pre-clinical studies on animals have been conducted to clarify further some details of the therapeutic mechanisms.[12] In some countries, nurses can manage TNS with the transcutaneous approach[13]; given the considerable variability in the evidence regarding the practical information needed to apply the treatment successfully, it is appropriate to conduct a scoping review to identify areas that still exist and require investigation.

2 | AIMS OF THE STUDY

To summarize the evidence regarding the practical indications and management of TNS for NOAB, identify areas of this topic that still require attention from researchers.

3 | MATERIALS AND METHODS

A scoping review was conducted, following the method of Arksey and O'Malley described by Daudt et al.[14] This method includes five steps, '(1) identification of the research question; (2) identification of relevant studies; (3) selection of studies; (4) recording of data; and (5) collation, synthesis, and reporting of results'. The research questions were, 'What evidence currently supports posterior tibial nerve stimulation as a conservative rehabilitation method for neurogenic overactive bladder?' 'What information is contained in the available papers on the practical application and reproducibility of the treatment sessions proposed by the researchers?' and 'What areas of TNS still require research?' The first research question was prompted by the possibility of finding new literature to update the most recent available systematic review published in 2018.[11] Regarding the second question, we sought to clarify the practical information needed to apply TNS safely and effectively (duration of sessions, electrical parameters, overall treatment duration).

3.1 | Search strategy

PubMed, CINAHL, and Scopus were searched for studies compliant with the criteria outlined in Table 1. Pubmed was chosen because it is the largest biomedical database worldwide, CINAHL because of its focus on nursing literature, and Scopus because it also indexes preprint papers and journals not included in the other databases.

TABLE 1 Inclusion and exclusion criteria.

Inclusion	Exclusion
• Primary literature (any study design)	• Secondary literature (reviews)
• Published in English or Italian	• Languages other than English or Italian
• Published from 2010 to Jan 2024	• Published before 2010
• Adult patients (age 18+) undergoing TNS for neurogenic LUTS	• Paediatric patients
	• Patients undergoing TNS for non-neurogenic LUTS

Often, the available reviews reported only the overall results of primary articles (sometimes quite old) without providing detailed information on treatment protocols. Therefore, reference lists of review papers were screened, and primary sources were retrieved to provide details on the practical aspects of TNS studied by the original authors. The keywords were used: posterior tibial nerve stimulation, transcutaneous, percutaneous, neurological incontinence, neurogenic overactive bladder, neurogenic LUTS, neurogenic detrusor overactivity, combined using Boolean operators and MeSH to construct the search strings. Reference lists of scientific books available in our university's medical library were also analysed for potential additional articles to be included in this work. Studies enrolling paediatric patients or persons with non-neurogenic LUTS were excluded. The authors of this paper and the university librarian searched independently to check for additional sources. The keywords used in all databases were *lower urinary tract symptoms*, *tibial nerve stimulation*, and *neurogenic overactive*.

Two nurses with more than 10 years of urology and research background reviewed the documents. They analysed the full text, supported by two other nurses with expertise in research methodology and academic publication. Disagreements were resolved through discussion and consensus. Characteristics of the included papers were assessed according to CONSORT[15] and STROBE[16] statements for interventional and observational studies, respectively.

4 | FINDINGS

Fifteen studies were retrieved, nine on PTNS and six on TTNS; Figure 1 summarizes the results of this literature search.

Eligibility criteria for patients were clearly stated in all articles; no double-blind studies were found. In all reports, patients in the treatment and control groups showed comparable demographic and clinical characteristics, for example, diagnosis, number of years with their neurological conditions, or LUTS. All retrieved studies provided statistical measures of the magnitude and variability of clinical outcomes. Because two approaches are available, this article will discuss percutaneous and transcutaneous stimulation separately.

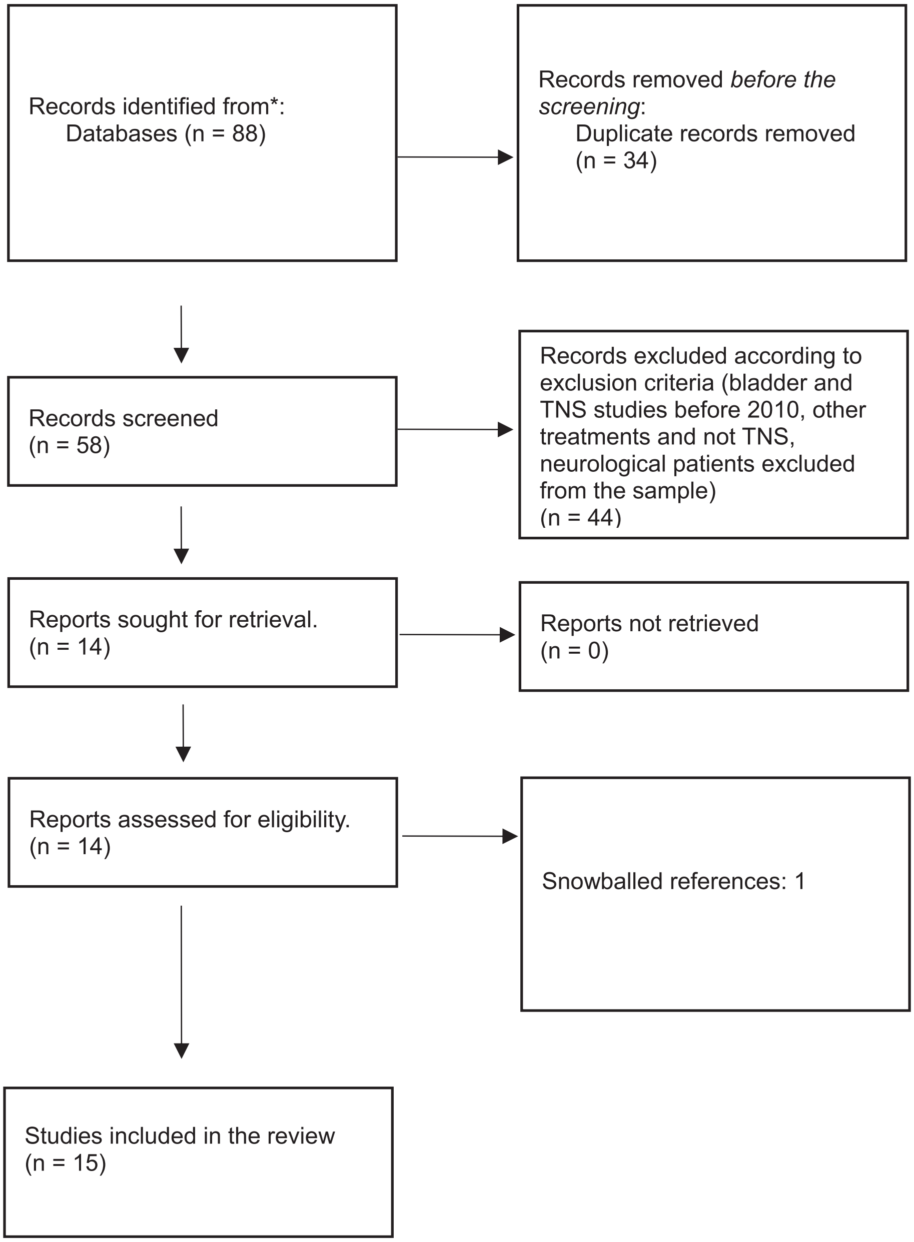

FIGURE 1 Flowchart of the literature search.

4.1 | Percutaneous TNS

Nine studies were retrieved, including a retrospective study,[17] four non-randomized, non-controlled studies[18–21] and four randomized controlled trials.[22–24] The sample size ranged from 17 to 100 patients.

In a study on 47 persons with PD without any control group,[17] improved cystometric parameters were found, such as urgency and nocturia. In the retrospective study by Tudor et al.,[18] 49 patients had neurologic conditions (19 MS, 7 PD, four adrenomyeloneuropathy, 4 Fowler's disease, 4 neurodegenerative ataxia, 2 epilepsy, 1 autonomic failure, 1 familial dysautonomia; 7 had other conditions) among the 74 consecutively enrolled. Frequency, incontinence severity, NOAB symptoms, and quality of life significantly improved; several studies have found similar benefits on more homogeneous samples based on voiding diaries[19–21,24,25] or questionnaires.[22,23] However, in one case, the inventory used by the authors had yet to be validated.[22] Table 2 summarizes the treatment characteristics in the studies.

Table 3 briefly presents the measures and main outcomes of the studies.

4.2 | Transcutaneous TNS

Six papers were retrieved,[26–31] one of which was a crossover trial,[26] three were randomized controlled trials,[27–29] and one was a non-randomized, non-controlled interventional study.[30]

Girtner et al.[26] conducted a placebo-controlled study of 51 patients undergoing simultaneous bilateral TTNS (including only 35% of cases), finding significant improvement in maximum cystometric capacity and NOAB symptoms. In their randomized, controlled

TABLE 2 Characteristics of percutaneous tibial nerve stimulation.

Study	Intervention
Canbaz-Kabay 2016[17]	Weekly sessions for 3 months, then every 14 days for 3 months, then every 3 weeks for 3 months, finally every 4 weeks for 3 months. 200 µs, 20 Hz, unknown session length, intensity just below the threshold of motor contraction.
Tudor et al. 2020[18]	12 weekly sessions of 30 min, 200 µs, 20 Hz, amplitude 0.5–9 mA.
Canbaz-Cabay et al. 2017[19]	Protocol of 6, 9, and 12 months of therapy. After 12 weeks of therapy, PTNS was applied at 14 day intervals for 3 months, 21 day intervals for 3 months, and 28 day intervals for 3 months. 200 µs, 20 Hz, unknown session length, intensity just below the threshold of motor contraction.
Eftekhar et al. 2014[22]	Daily sessions of 30 min for 12 weeks. Electric parameters: unknown.
Zecca et al. 2014[20]	Weekly sessions of 30 min for 12 weeks, then maintenance (see Table 2). 200 µs, 20 Hz, amplitude 0.5–9 mA.
Kabay et al. 2021[21]	14-day intervals for 3 months, 21-day intervals for 3 months and 28-day intervals through 24 months, 200 µs, 20 Hz.
Marzouk et al. 2022[23]	Sessions of 45–50 min, 3 days weekly for a month, 200 µs, 20 Hz.
Chen et al. 2012[24]	Biweekly sessions of 30 min for 4 weeks, 200 µs, 20 Hz, amplitude 1–50 mA.
Gobbi et al. 2011[25]	Weekly sessions of 30 min for 12 weeks, 200 µs, 20 Hz, amplitude 0.5–9 mA.

trial of 60 patients, Welk et al.[27] found no significant differences between patients undergoing TTNS and sham treatment (26 and 24 people, respectively). However, their treatment used a different frequency of electric current than other studies (Table 3). The other studies found significant benefits among TTNS patients regarding urgency episodes and urine leakages.[28–30] A study by Stampas et al.[31] considered the possibility to self-administer PTNS at home. The authors described a daily 30-min procedure, beginning with the ascertainment of the correct electrode position by toe flexion when the stimulation began. Baseline and 4-week surveys were performed, and the participants filled out a voiding diary for 4 weeks. During the first week, TTNS was self-administered with the prescribed antimuscarinic medications without any changes to posology; from the second week of TTNS, medication weaning was introduced weekly, as tolerated by the patients. All 16 patients reported high satisfaction, ease of use, and no adverse events. Twelve out of the 14 who used antimuscarinic drugs reduced dosage (mean reduction 3.2 mg) thus experiencing statistically and clinically relevant decrease in side effects such as dry mouth and drowsiness.

Table 4 summarizes the treatment characteristics reported in the studies.

Table 5 briefly presents the results of the studies.

The study by Booth et al.[32] was excluded from this review after discussion: it was a randomized controlled study on 30 nursing home residents over 65 years of age, unspecified diagnosis, with N or bowel dysfunction, divided into two equally divided groups (TTNS vs. sham stimulation). The exclusion criteria did not include neurological patients. Therefore, it was impossible to be certain that the subjects had a neurological condition.

5 | SUMMARY OF EVIDENCE

As stated by some authors,[17] the efficacy of TTNS may be limited by the greater stimulation required to activate the tibial nerve compared with PTNS. The patient's pain threshold limits the ability to achieve this greater stimulation. The sample size was generally limited, leading to the enrolment of consecutive groups of patients in several papers. Considerable heterogeneity was found in patient's baseline characteristics, treatment outcomes, follow-up timeline, and outcome measures: for example, in some studies, general results are provided with percentages of patients who did or did not benefit from treatment; in others, data are provided regarding the number of daily urinations and in still others the percentage indicating a reduction in other symptoms. Not all papers mentioned explicitly any baseline urodynamic finding, although urodynamic assessment is supported by strong recommendations in the European guidelines.[7]

Several papers have studied neurologic and non-neurologic patients. Electrical parameters show discrepancies between studies for both PTNS and TTNS; there is no agreement among authors of retrieved papers on the duration and weekly frequency of sessions. For PTNS, most authors suggest using 20 Hz and 200 µs, but the amplitude is highly variable among studies. For TTNS, 10 Hz and 200 µs are suggested, with considerable variability in the number of sessions and overall treatment duration. As a result, some authors found significant differences in the efficacy levels of PTNS. Because this scoping review aimed to identify areas needing further investigation, good-quality studies are urgently needed to clarify all these issues.

5.1 | Implications for nursing

In treating NOAB, the results regarding the efficacy of TNS are, on average, good and encouraging. However, only Welk and McKibbon[27] found no benefit from TNS in their sample, which was investigated by administering subjective questions and included both neurologic and non-neurologic patients. Although published more recently than the guidelines, all studies indicate TNS as the third-choice treatment for NOAB after antimuscarinic drugs (supported by 1A evidence) and

TABLE 3 Details of the included studies (PTNS).

Paper	Sample size and treatments	Clinical characteristics of the patients	Measures and main outcomes
Kabay 2016[17]	47 patients with Parkinson's disease with symptoms of detrusor overactivity underwent PTNS	Patients with PD and NOAB. Of the total 47 patients, 26 patients were men and 21 were women.	• Urodynamic studies before and after 12-week PTNS treatment: improved urinary volume by 92.6 mL (average value) • International Consultation on Incontinence Questionnaire Short Form (ICIQ-SF), Overactive Bladder Questionnaire (OAB-V8), Overactive Bladder Questionnaire Short Form (OAB-q SF): decreased micturition frequency by 5.6 micturitions per day, urgency episodes decreased by 3.1 episodes, nocturia decreased by 2.7 urinations.
Tudor et al. 2020[18]	74 patients (52 women, 22 men).	66.2% of the sample had neurological disorders (MS 25.7%, 40.5% unspecified).	• Bladder diary: 24-h frequency and urgency • ICIQ-OAB and ICIQ-LUTSqol questionnaires: 24-h frequency on bladder diary—1.67 (−3.0, 0.33) ($p = 0.002$), number of incontinent episodes on bladder diary—0.0 (−1, 0) ($p = 0.01$), incontinence severity on bladder diary 0 (−0.33, 0) ($p = 0.007$), OAB symptoms—3 (−11.5, 5) ($p = 0.01$), and quality of life—16 (−57, 6.5) ($p = 0.004$).
Canbaz-Kabay et al. 2017[19]	34 patients enrolled to the PTNS treatment, 21 of which completed the 1 year PTNS treatment with a tapering protocol of 6, 9, and 12 months of therapy, respectively.	All patients had NOAB secondary to multiple sclerosis.	• 3-day voiding diary at 3rd, 6th, 9th, and 12th month. • Validated questionnaires (ICIQ-SF, OAB-V8, OAB-q SF) within 3-month intervals thereafter during their enrolment in the study. • Daytime frequency decreased by 5.4 voids daily, urge incontinence decreased by 3.4 episodes daily, urgency episodes decreased by 7.4 episodes daily, nocturia decreased by 2.6 voids, and voided volume improved by a mean of 72.1 cc. The improvements for all voiding diary parameters were significant in the 6th, 9th, and 12th months when compared with baseline.
Eftekhar et al. 2014[22]	40 women treated with tolterodine alone (4 mg daily for 3 months) or tolterodine plus percutaneous posterior tibial nerve stimulation (30 min while a 34-gauge needle placed 5 cm near internal malleolus).	The neurological disease of the patients causing NOAB was not specified, nor was the stage.	• Ad hoc, non-validated questionnaire investigating pelvic problems: decrease in urine leakages and urinary urgency. The authors investigated sexual function (Female Sexual Function Inventory questionnaire) which did not show improvements at the end of the treatment.
Zecca et al. 2014[20]	83 patients with multiple sclerosis. Patients who responded positively to the initial treatment: percutaneous tibial nerve stimulation, 30 min, once a week for 12 weeks. 1st maintenance step: PTNS every 28 days for 3 months, then every 21 days for	83 patients, 21 men, 62 women with MS and NOAB (of whom 74 moved to the maintenance step).	• 3-day bladder diary: daily urination frequency decreased 10 to 7 times, nocturia decreased from 4 to 2 times. • Patient perception of bladder condition (PPBC) questionnaire, patient perception of intensity of urgency scale (PPIUS), Kings Health

TABLE 3 (Continued)

Paper	Sample size and treatments	Clinical characteristics of the patients	Measures and main outcomes
	3 months, then every 14 days for 3 months. Intensity 0.5–9 mA, pulse duration 200 µs, frequency 20 Hz, based on sensory and motor response of individual patients.		QOL questionnaire (KHQ) and Overactive Bladder Questionnaire (OAB-q): statistically significant improvements in all scores. • Treatment satisfaction with TSVAS (Treatment Satisfaction-Visual Analog Scale): 70% of patients (mean value).
Kabay et al. 2021[21]	76 patients (44 men, 32 woman) PTNS was applied through a 24-month period.		• The patients completed a 3-day voiding diary • ICIQ-SF, OAB-V8, OAB-q SF questionnaires at 3rd, 6th, 9th, 12th, and 24th month • Daytime frequency decreased by 4.6 voids daily, urge incontinence decreased by 4.2 episodes daily, urgency episodes decreased by 6.2 episodes daily, nocturia decreased by 2.4 voids and voided volume improved by a mean of 71.4 cc. When compared with baseline significant improvements were seen in the volume at the first involuntary detrusor contraction, maximum cystometric capacity, maximal detrusor pressure at first involuntary detrusor contraction, maximal detrusor pressure at MCC, detrusor pressure at maximal flow and post-void residual volume after PTNS treatment at 3, 12, 24 months except maximal flow rate (Qmax) value ($p > 0.05$).
Marzouk et al. 2022[23]	40 male patients undergoing pelvic floor muscle training (PFMT) or PFMT+PTNS	Multiple sclerosis patients with NOAB.	• Overactive bladder symptoms score (OVBS) score: improvement in median scores. • Urodynamic parameters (uroflow, filling and voiding cystometry), and post voiding residual volume by abdominal ultrasound: A significant decrease was detected in posttreatment mean episodes (number of nighttime frequency, urgency, incontinence)
Chen et al. 2012[24]	100 patients (of which 98 completed the study) divided into two groups. Comparison of the effectiveness of percutaneous tibial nerve stimulation with solifenacin.	Spinal trauma patients with NOAB.	• Bladder diary: significant improvement of NOAB symptoms in the first group is significant ($p < 0.05$).
Gobbi C et al. 2011[25]	21 consecutive patients (of whom 18 completed the study, 16 male and 2 female) with multiple sclerosis (MS).	Patients with MS and NOAB not responsive to pharmacological treatment with antimuscarinics. 10 patients with relapsing remitting MS, 7 with secondary progressive form, 1 with primary progressive form.	• Bladder diary: daily urination frequency (n°): 9 to 6 times. Mean volume of urine per urination: 182–225 mL. Nocturia: 3 to 1 episodes. • Bladder ultrasound: mean post-voiding residual 98 mL to 43 mL.

Abbreviations: MS, multiple sclerosis; NDO, neurogenic detrusor overactivity; NOAB, neurogenic overactive bladder; PD, Parkinson's disease; PTNS, percutaneous tibial nerve stimulation.

TABLE 4 Electrical parameters of transcutaneous tibial nerve stimulation (TTNS).

Study	Intervention
Girtner et al. 2021[26]	Weekly sessions, median length 19 min, for 12 weeks. Biphasic rectangular current, 10 Hz, 230 µs, amplitude up to 180 mA (minimum amplitude unknown).
Welk et al. 2020[27]	3 sessions per week for 12 weeks, bipolar current, 10 Hz, 200 µs, 30 min.
Perissinotto et al. 2015[28]	Biweekly sessions of 30 min, 10 Hz, 200 µs for 5 weeks, amplitude unknown.
Monteiro et al. 2014[29]	Biweekly sessions of 30 min for 45 days; 10 Hz, 200 µs, amplitude slightly below the motor threshold.
De Sèze et al. 2011[30]	Daily sessions of 20 min for 3 months; 10 Hz, 200 µs, intensity below the patient's threshold.
Stampas et al. 2019[31]	No electrical parameters were retrieved in the paper.

TABLE 5 Details of the studies on transcutaneous tibial nerve stimulation (TTNS).

Paper	Sample size and treatments	Clinical characteristics of the patients	Measures and main outcomes
Girtner et al. 2021[26]	51 patients receiving simultaneous bilateral TTNS and then placebo.	35% of the sample had neurogenic OAB (unspecified origin).	• Urodynamic assessment: filling volume at the first desire to void (FDV) increased significantly by 54 mL. Simultaneous-bilateral TTNS showed significant improvements of bladder functioning like delayed FDV, increased maximum cystometric capacity and reduced urinary retention.
Welk et al. 2020[27]	50 patients (30 for the purposes of this review) receiving TTNS or sham treatment.	30 had neurogenic OAV, 20 idiopathic OAB	• PPBC questionnaire (bothersome level of the bladder symptoms) did not improve significantly in any of the two groups.
Perissinotto et al. 2015[28]	13 patients divided into 2 groups. Comparison of TTNS and sham stimulation.	Patients with NOAB.	• Voiding diary: after 10 weeks of treatment, mean daily voidings decreased from 6 to 2. Mean daily episodes of urgency decreased from 8 to 1.
Monteiro et al. 2014[29]	24 patients receiving TTNS ($n = 12$) or sham stimulation ($n = 12$).	The patients had with stroke outcomes and NOAB.	Voiding diary: urgency syndrome before and after treatment (45 days): 90% to 50%. Findings at baseline, after treatment, and after 12 month follow-up: • Urge incontinence: 92% to 67% to 58%. • Nocturnal enuresis: 8% to 0% to 0%. • Nocturia: 83% to 42% to 8%. • Frequency of urination: 83% to 25% to 0%. • Subjective improvement of symptoms (at the end of *follow-up*) 100%.
De Sèze et al. 2011[30]	70 patients receiving daily sessions of 20 min of TTNS	Multiple sclerosis patients (mean age 48 years) with NOAB symptoms who had no disease relapses in the last 3 months, not wheelchair-bound, able to walk at least 20 metres.	• Voiding diary: results before treatment and 90 days after treatment. • Patients with severe urgency: 51.4% to 24.2%. • Daily micturitions (n°) 11.3 to 8.9. • Urine leaks per week (n°) 5.8% to 3.1%. • Continent patients: increased from 25.7% to 47%.

TABLE 5 (Continued)

Paper	Sample size and treatments	Clinical characteristics of the patients	Measures and main outcomes
Stampas et al. 2019[31]	16 patients with NOAB, self-administering TTNS at home daily for 30 min across 4 weeks. Those taking antimuscarinic drugs received a weaning schedule from week 2.	All patients had spinal cord injury and a mixture of retention (requiring intermittent self-catheterization) and incontinence.	• Drug dosage: reduced by approximately 3.2 mg weekly (95% confidence interval, −5.9 to −0.4) and anticholinergic side effects of dry mouth and drowsiness decreased more than 1 level of severity from baseline. • I-QoL quality of life questionnaire: At 4 weeks, total I-QoL score improved by an average of 3.2 points compared to baseline in all domains.

bladder training. The nurse also manages bladder training independently and involves trying to 'train' the bladder through urination at scheduled times and using specific measures. For example, a feeling of urgency arises. In that case, the patient may attempt to inhibit it with submaximal contractions of the pelvic muscles (anus elevator muscle) while sitting on a hard surface (to maximize proprioception) and with the spine firmly supported on a backrest. The contraction should be submaximal to prevent the patient from recruiting the abdominal wall muscles, which would increase pressure on the bladder with a paradoxical effect and increase the desire to urinate. These contractions should be repeated until the stimulus is inhibited.[30] Contraction techniques must be taught, taking care to eliminate any antagonistic synergies in the patient (e.g., simultaneous contraction of the *levator ani* muscle and the abdominal wall), other synergies that are unnecessary for the purpose (e.g., recruitment of the lower extremity adductors or gluteals), and counterproductive behaviours (e.g., command reversal, which consists of performing an abdominal push instead of a proper contraction of the anus elevator, with increased pressure on the bladder). Nurses can usefully teach the patient to palpate the tendon centre of the perineum for feedback on whether the contraction was performed correctly during the learning period. As mentioned above, for neurogenic OAB, the first-choice treatment is not conservative but pharmacologic with anticholinergic medications (evidence 1A). Finally, the nurse should take a thorough medical and surgical history, investigate eating and elimination habits, and ascertain the obstetrical-gynaecologic history in women. The nurse should conduct a physical assessment related to metameric-radicular topography to check which radicular levels are involved in the patient's problems. Since the sensory and motor nerve systems interact for the lower urinary tract to function physiologically normally, diagnosing neuro-urological symptoms aims to characterize the dysfunction. Before scheduling any additional diagnostic tests, a complete medical history, physical examination, and bladder diary are required. Neuro-urological diseases, whether inherited or acquired, require prompt diagnosis and treatment: even in normal reflexes, this prevents irreversible alterations within the lower urinary tract.[7]

6 | CONCLUSION

TNS can be considered among the possible treatments for neurogenic bladder, where pharmacological treatment with anticholinergic drugs or conservative treatment with functional electrical stimulation combined with biofeedback has not given the desired results (bladder disorders). This is a minimally invasive treatment for percutaneous stimulation and harmless for transcutaneous stimulation. In several countries, nurses can independently administer this treatment, similar to other conservative interventions requiring technical equipment, hence the importance of this scoping review for nurses and other professionals involved in neurogenic bladder rehabilitation. Future research should focus on comparing different electrical parameters on patients with similar neurological conditions to establish evidence-based indications for practice definitively. Long-term studies, possibly on large cohorts of patients with comparable conditions, are also needed to define criteria for maintaining outcomes achieved through TNS. As an adjunct to this review, it will be interesting to evaluate the results of the study proposed by a Swiss team[33] on SCI, which is currently underway. This randomized controlled trial has completed the preparatory phase,[33] but the final results could not be retrieved in the literature. Of note, this study emphasizes the need to assess motor response before applying TTNS, as suggested by other authors for PTNS.[34] Another protocol for a randomized controlled trial was found.[35] This study proposal is very recent, and the study is still ongoing.

FUNDING INFORMATION

None.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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How to cite this article: Terzoni S, Ferrara P, Di Schiena M, et al. Clarifying practical aspects of posterior tibial nerve stimulation for neurogenic overactive bladder: A scoping review. *Int J Urol Nurs*. 2024;18(1):e12389. doi:10.1111/ijun.12389