

Long-Term Transcutaneous Electrical Nerve Stimulation (TENS) Use: Impact on Medication Utilization and Physical Therapy Costs

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Abstract:

Objective: A study was conducted to assess a variety of treatment outcomes in long-term users of transcutaneous electrical nerve stimulation (TENS) who suffer from chronic pain. Key components of the study examined the effects of long-term TENS therapy on pain-related medications and physical/occupational therapy (PT/OT) use.

Design: From a population of 2,003 chronic pain patients (CPPs) who acquired a TENS device (Epix XL[®], Empi, Inc., St. Paul, MN, U.S.A.) for pain management, a randomly selected sample of 376 patients who used TENS were interviewed by telephone by an independent research firm. The survey assessed a variety of outcome variables including changes in medication use, number of pain-related medications, and use of PT/OT prior to TENS and after a minimum 6 months of TENS treatment. The data were subjected to a paired *t* test analysis. A cost simulation model was then applied to the medication and PT/OT data.

Results: The mean duration of pain, for which TENS was prescribed, was 40 ± 60 months. As compared with the period prior to TENS use, this long-term TENS user group reported a statistically significant reduction in the following types of pain medications: opiate analgesics, tranquilizers, muscle relaxants, nonsteroidal anti-inflammatory drugs (NSAIDs), and steroids. PT/OT use was also significantly reduced. Cost simulations of pain medications and PT/OT are presented.

Conclusions: Long-term use of TENS is associated with a significant reduction in the utilization of pain medication and PT/OT. In this study population, cost simulations of medication and PT/OT indicate that with long-term TENS use, costs can be reduced up to 55% for medications and up to 69% for PT/OT. The potential for TENS associated improvement, combined with reduced medication-related complications and costs, are important points that clinicians should consider when constructing a treatment plan for chronic pain patients. Finally, cost simulation techniques provide a useful tool for assessing outcomes in pain treatment and research.

Key Words: TENS—Pain treatment—Cost effectiveness—Physical therapy.

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In 1965 Melzack and Wall described the gate control theory.¹ This theory suggested that activation of large diameter myelinated sensory fibers could reduce the transmission of nociceptive input carried by small myelinated and nonmyelinated pain fibers. One clinical application of the

gate control theory, transcutaneous electrical nerve stimulation (TENS), uses low voltage electrical current applied through skin electrodes to activate populations of large diameter sensory fibers in an attempt to "gate" or reduce nociceptive input. Since development in the 1970s, TENS has been used to treat a wide variety of both acute and chronic pain conditions. In fact, there have been more than 600 publications describing a variety of applications and outcomes of TENS therapy.² The diverse body of literature encompassing TENS therapy also includes a number of clinical reviews. In one review of TENS, Long concluded the following: TENS has a beneficial effect on patients suffering from pain of diverse origins; in chronic pain syndromes, TENS has a short-term benefit in approximately 50% of patients; and for about 25% of TENS users, TENS is the only therapy needed for years after treatment begins.³ In addition, Long concluded that the effect of TENS stimulation is beyond that which can be explained by placebo, but there are few long-term follow-up studies of TENS use.³ A more recent literature review by Fishbain and associates⁴ indicates that 58% to 72% of chronic pain patients (CPPs) report an initial positive effect from TENS; at 6 months 13% to 74% continue to report a positive effect; and at 1 year 27% to 66% of users still report a reduction in pain. Most of these types of TENS studies rely solely on subjects' pain reports to establish efficacy and rarely on other outcome measures such as activity, socialization, or medication use.⁵

A recent study presented data obtained from a survey of 506 TENS users.⁴ These data focused on a variety of long-term outcome measures in addition to pain relief. These measures included the percentage of CPPs who use TENS over a long-term basis, as well as outcome measures to assess user activity, quality of life, impact of pain on activities, and utilization of other pain treatments. In this study, more than 74% of patients prescribed TENS were reported still using their units at 6-month follow-up. Additionally, TENS use was associated with a statistically significant improvement in a number of long-term outcome measures including less pain interference with work, home, and social activities and a general report of decreased pain. Users also indicated that TENS treatment helped them return to work and reported a high level of overall satisfaction with TENS treatment. Finally, long-term TENS users reported a statistically significant reduction in pain-related medications and adjunctive therapies. This recent study provides some of the most comprehensive information to date on outcome measures other than pain relief for long-term users (LTUs) of TENS.

Based on the available body of literature, Fishbain and colleagues summarized two general groups of long-term TENS studies: those that examined the long-term effects of TENS on reported pain levels, and those studies that

examined outcome measures apart from pain report.⁴ The first category of studies, numbering 20 in total,⁶⁻²⁵ encompassing more than 7,600 subjects, reported a positive effect from TENS treatment over study periods ranging from 6 months to 4 years. The second category of studies, numbering five in total,^{19,20,23,24,26} examined the effects of TENS on outcome measures such as sleep, socialization, and medication consumption. Freid and associates, in a review of Canadian Compensation Board records and patient questionnaires, indicated that 58.8% of 637 patients reported improved sleep and 57.2% of TENS users reported a need for less pain medications.²³ Most of the study patients (70%) suffered from intractable back pain. Erickson and colleagues, in a study of 123 patients treated with TENS, demonstrated that long-term TENS use was associated with an increase in social activities, and 84% of patients reported a reduction in analgesic medication consumption.¹⁹ Of the patients who reported a reduction in medication use, nearly half (46%) decreased medication consumption by more than 50%. Nathan and Wall, in a long-term study of TENS in patients with postherpetic neuralgia, reported an unspecified reduction in analgesics, tranquilizers, and antidepressants associated with TENS use.²⁶ Finally, two studies encompassing a total of 224 subjects reported that 72% of subjects with unspecified chronic pain problems²⁰ and 79% of subjects with facial pain²⁴ reduced pain medications.

This review of the literature, which focuses on outcome measures apart from pain report, indicates the following: (a) in studies that examined TENS and pain medication use, there was a reduction in medication use associated with TENS treatment; (b) little is known about the effect of TENS on the specific types or patterns of pain medication use; and (c) no cost projections have been published that examine the impact of TENS on the costs of medications or physical therapy used for the management of chronic pain. In a previous publication, we examined the effect of long-term TENS use on outcome measures associated with pain, activity, quality of life, medication reduction, and treatment satisfaction.⁴ We have chosen to examine the relationship surrounding TENS and concurrent pain medication and physical therapy use in detail in a separate publication for the following reasons: there is a paucity of data that addresses this critical subject in the chronic pain literature; medication and physical therapy cost projections are complex issues requiring specialized statistical techniques and assistance from healthcare economists; and the initial study focused on outcome measures of long-term TENS use and quality of life measures such as reported pain ratings, patient satisfaction with treatment, and pain effects on activity levels. Therefore, we elected to publish this cost simulation study as a separate manuscript. The following study closely examines the specific classes, types, and amounts of pain

medications consumed by a population of patients with a variety of long-standing chronic pain problems treated with TENS over a 6-month period. A simulation is performed that provides estimates of specific medication and physical therapy costs within this study population. Finally, the authors discuss the study implications in the clinical management of patients with chronic pain.

METHODS

In 1994 the Clinical Department of Empi, Inc. contracted an independent research firm, Winona MRB, Inc., to conduct a scientific telephone survey of long-term TENS users. Winona MRB specializes in quantitative large-scale data collection and analysis and was utilized to control for potential industry bias. We have previously reported in detail the survey design, data collection methodology, and sampling methods in a previous study.⁴ In summary, Empi provided Winona with the names and telephone numbers from a population of pain patients who had bought an Epix XL (Model 989, Empi Inc., St. Paul, MN, U.S.A.) TENS device during October 1993 ($n = 2,003$). From this pool, Winona research personnel telephoned and interviewed randomly selected patients in May 1994. This time frame allowed for at least 6 months of TENS use. Winona collected telephone data from patients until a minimum quota was met of 400 TENS patients who were using their device in the last 2 months and 100 TENS patients who reported not using their TENS in the last 2 months. To meet this quota, 506 patients completed the full study questionnaire. For purposes of statistical analysis, the LTU patient group was defined as patients who used TENS for 6 or more months. Of the 405 patients who reported TENS use in the past 2 months, 29 were removed because of a self-report of less than 6 months of TENS use, thus leaving 376 patients who have been defined as the LTU group.

The interview included a variety of questions designed to measure the specific types of treatments and medications used to treat pain when TENS was initially prescribed and again after at least 6 months of TENS therapy. Details of the assessment questions are contained in the Appendix. In addition, each TENS user was asked a variety of questions pertaining to demographics, pain history, and other treatment outcome measures.⁴ The data analyses were conducted using the SAS® System (SAS Institute, Cary, NC, U.S.A.).²⁷ Descriptive statistics (mean, standard deviation, and frequency distribution) were calculated for both the medication and physical/occupational therapy (PT/OT) variables. A paired t test and a correlated z test were used to evaluate the quantitative and proportional pre/post scores, respectively.^{28,29} A paired t test was used to compare total medication use between pre/post scores, and the correlated z test was used to compare pre/post PT/OT/OT use.

The collected data were tabulated by Winona MRB, Inc., and a report was sent to Empi, Inc. Empi provided the report and data on computer disk to the senior authors in an effort to collaborate on publication.

SIMULATION

Simulations were performed to estimate a range of costs associated with pain medication and physical therapy use in the study subjects. A list was compiled of the name of the pain medications used and the number of patients who were using each medication at the time of TENS prescription and 6 months after device purchase. A dosage range for each medication was determined using the manufacturer's recommended dose. For each medication, dosing calculation ranges included the lowest recommended dose and the highest manufacturer's recommended dose. The number of patients using each medication times the cost of the medication over the recommended dosing ranges was used to determine medication costs. The simulations assumed that those patients who stated that they were not taking a particular medication were, in fact, not using any of that medication, and that patients who reported use of a medication were using doses of medication in a range recommended by the drug's manufacturer.

A survey was taken from a pool of Puget Sound area pharmacies to determine the monthly cost of each medication at both the high and low dosing schedule. The pharmacies were picked at random, and each pharmacy was used to calculate cost for a maximum of three different medications. The monthly cost for each individual medication included the average cost calculated from the prices obtained from three different pharmacies. Pricing was obtained for both the generic and brand name formulations of the medications. In addition, pricing information was obtained from an industry standard publication, *Drug Topics Red Book*.³⁰ Therefore, for each individual medication, there were six potential categories used to simulate costs: the lowest recommended dose of the generic brand of medication; the highest recommended dose of the generic brand of medication; the lowest recommended dose of the proprietary brand of medication; the highest recommended dose of the proprietary brand of medication, and the *Red Book* costs for low and high dosages of medication. For some medications [i.e., Relafen (nabumetone) and Toradol (ketorolac)], only one brand of medication was available. In these cases, the sole available preparation was used for calculation in each group (generic high/low and brand high/low). The monthly cost for each medication included the number of patients taking the particular medication and the cost range for that individual medication. In addition, only patients actually taking medications were used for the simulation, hence $n = 255$, not 376.

Utilization review guidelines for physical therapy, current procedural terminology (CPT) codes, and fee schedules were obtained from the Washington State Department of Labor and Industries (L&I). L&I "standard" clinical guidelines call for a series of six physical therapy sessions prior to a utilization review. CPT codes used for cost projections included: 97530, kinetic activation (\$27.91/15 minute unit); 97110, therapeutic exercise (\$26.56/15 minute unit); 97265, mobilization (\$36.92/15 minute unit); and 97250, soft tissue massage (\$36.92/15 minute unit), for an average hourly cost of \$128. These guidelines and fee schedules were used for the simulations. The simulation model calculated PT/OT costs for 6, 9, and 12 PT/OT visits prior to TENS purchase for all LTU patients ($n = 327$) who were active in PT/OT. The same calculations were performed at 6 months of TENS use for LTU patients active in PT/OT ($n = 103$). Costs are reported both as aggregate and per patient costs.

RESULTS

A total of 74.3% ($n = 376$) of the patients prescribed TENS ($n = 506$) were still using their units 6 months after TENS purchase. This LTU group had a mean age of 47.9 ± 14.7 years, 62.7% were females, and 49.7% were worker's compensation patients. A total of 39% had pain conditions located in their back, and the mean duration of pain for the LTU group was 40.4 ± 62 months.

Table 1 shows the types of medication and the number of medications taken by the LTU group at the initiation of TENS treatment and after at least 6 months of TENS treatment. These changes represent a statistically significant reduction in the use of opiates ($p < .0001$), nonsteroidal anti-inflammatory drugs (NSAIDs) ($p < .003$), sedatives ($p < .05$), muscle relaxants ($p < .01$), and steroids ($p = .014$) in the LTU group. The mean number of pain-related medications taken at TENS initiation was 1.19 ± 1.14

TABLE 1. Types and numbers of medications taken by long-term users prior to TENS initiation and after at least 6 months of TENS use ($n = 376$)

Medication class ^a	No. of medications at TENS initiation	No. of medications after 6 mo of TENS use	<i>t</i> value	<i>p</i> value
NSAIDs	115	82	-3.03	$p < .003$
Opiates	206	101	-7.35	$p < .0001$
Steroids	6	0	-2.47	$p = .014$
Sedatives, hypnotics	17	9	-2.01	$p < .05$
Muscle relaxants	44	28	-2.49	$p < .01$

Multiple responses possible. TENS, transcutaneous electrical nerve stimulation; NSAID, nonsteroidal anti-inflammatory drug.

^aSpecific drug names and numbers of users are available upon request from the first author.

medication per patient. At 6-month follow-up, 0.69 ± 0.86 pain medications were used per patient ($p < .0001$, $t = -8.25$). The number of different pain medications used per patient are displayed in Table 2. At TENS purchase, 125 patients were using two or more types of pain medication. This was reduced to 62 patients 6 months after TENS purchase. The reduction in the number of pain medications used was statistically significant ($p < .0001$).

The results of the medication simulation are shown in Table 3. The LTU group displayed reductions in simulated costs across all classes of medications. Table 4 shows the cost simulations summary for medication use. A total of 327 patients were using PT/OT prior to TENS purchase, and 108 were active in PT/OT 6 months after TENS purchase ($p < .001$, $t = -19.563$). There was no difference in PT/OT use between worker's and non-worker's compensation covered patients. Table 5 shows the cost simulation for PT/OT use.

DISCUSSION

As previously discussed, there are five other studies that have demonstrated a reduction in medication consumption associated with TENS use.^{19,20,23-25} Most studies did not report on the specific classes of medication studied,^{19,20,23,24} whereas a single study reported only that analgesics, tranquilizers, and antidepressants were reduced after TENS use.²⁵ No study examining long-term TENS use has reported in any detail the changes in the classes of medications, the specific types of medications, or the actual number of patients who are consuming these medications. Nor has any study previous to Fishbain et al.,⁴ examined the association between long-term TENS use and adjunctive pain therapies. The present paper indicates that in patients who are using TENS for at least 6 months, there is a statistically significant reduction in the use of a variety of pain-related medications including NSAIDs, opiates, sedatives, muscle relaxants, and steroids.

TABLE 2. Number and percentage of patients taking pain-related medications at the time of TENS purchase and at 6-month follow-up ($n = 376$)

No. of different pain medications	TENS initiation: <i>n</i> (%)	6-mo follow-up: <i>n</i> (%)
0	121 (32)	195 (52)
1	130 (35)	119 (32)
2	80 (21)	48 (13)
3	26 (7)	10 (3)
4	15 (4)	4 (1)
5	4 (1)	0

$p < .001$ for number of medications at TENS purchase versus at 6-month follow-up. TENS, transcutaneous electrical nerve stimulation.

TABLE 3. Cost simulation of medications used at TENS initiation and at 6-month follow-up for the long-term users group who were using pain medications (n = 255)

Medications	(A)	(B)	(C)	Percentage of cost reduction (low/high)
	Cost (\$) per month when TENS initiated (low/high)	Cost (\$) per month at 6-mo follow-up (low/high)	Cost (\$) difference: column A - B (low/high)	
Opiates	n = 204	n = 100		
Generic low/high	8,490/14,983	4,295/7,179	4,195/7,804	49/52
Brand low/high	15,032/22,991	6,891/10,328	8,141/12,663	54/55
Red Book low/high ²⁷	7,600/14,002	3,920/6,920	3,680/7,082	
NSAIDS	n = 112	n = 82		
Generic low/high	3,848/8,170	3,090/6,166	758/2004	20/25
Brand low/high	4,643/9,622	3,659/7,320	984/2,302	21/24
Red Book low/high ²⁷	3,603/7,806	2,903/5,891	700/1915	
Sedatives, relaxants, and steroids	n = 77	n = 37		
Generic low/high	2,220/3,924	1,590/2,737	630/1,198	28/30
Red Book low/high ²⁷	2,200/3,695	1,488/2,630	712/1,065	

Multiple responses possible. TENS, transcutaneous electrical nerve stimulation.

The study methodology relied on a telephone survey of patients prescribed TENS at least 6 months previous to the follow-up. This study design, which surveyed hundreds of patients, had no control group of users who received either a nonfunctioning TENS unit or other control interventions; therefore, one cannot infer a direct cause-and-effect relationship between TENS use and a reduction in pain medication consumption. Several factors could confound this correlation including a spontaneous resolution or improvement of the existing pain condition; a change in medication consumption unrelated to TENS use, or extrinsic factors such as changes in insurance status affecting medication usage. It is relatively unlikely that the patients in this study had spontaneous improvements in their conditions given the chronicity of the condition. The mean duration of symptoms prior to TENS use was 40.4 ± 62 months. This long duration of symptoms prior to TENS prescription makes it less likely that reduction in medication use was due to spontaneous improvement or regression to the mean.³¹ In addition, the LTU of TENS also showed a reduction in adjunctive pain treatments over the

6-month period.⁴ This would also support an active role of TENS in affecting the outcome measures.

Finally, as noted, the study design asked TENS users to remember their pain, medication use, and functional status at a time when they had already been using TENS for at least 6 months. The literature suggests that the passage of time can influence patients ratings of historical pain.^{32,33} A recent study that evaluated the effect of present pain on the recall of distant pain levels and medication use found that prior pain is recalled as less severe when present pain is at relatively low levels, and as more severe when present pain is at relatively high levels.³⁴ Recall of pain medication use followed the same trends: prior medication use was underestimated when present pain was at lower levels, and prior medication use was overestimated when present pain was at elevated levels. These data indicate that in our present study of long-term TENS users who were experiencing reduced pain and greater satisfaction at time of assessment, the effects of pain treatment (TENS) may have biased the patients to actually underreport baseline pain and medication use. These limitations and considerations inherent

TABLE 4. Summaries of all pain-related medications for 1, 6, and 12 months (n = 255)

	(D)	(E)	(F)
	Sum (\$) of Column C, Table 3	Simulated medication cost savings (\$) over 6 mo (Column C \times 6)	Simulated medication cost savings (\$) over 12 mo (Column C \times 12)
All classes of medication			
Generic low	5,583	33,498 (131)	66,996 (262)
Generic high	11,006	66,036 (259)	132,072 (518)
Brand low	9,755	58,530 (230)	117,060 (460)
Brand high	20,385	122,310 (480)	244,620 (560)
Red Book low ²⁷	5,092	30,552 (120)	61,104 (240)
Red Book high ²⁷	10,062	60,372 (237)	120,744 (474)

Figures in parentheses in Columns E and F are cost per individual patient (dollar sum \div 255).

TABLE 5. Cost simulations for physical therapy/occupational therapy prior to TENS purchase ($n = 327$) and after 6 months ($n = 103$)

	(G)	(H)	(I)
No. of PT/OT sessions	Sum of costs (\$) for all patients at TENS purchase	Sum of costs (\$) for all patients after 6 mo of TENS	Simulated cost savings (\$) per patient over 6 mo (Column G - H)
6 visits/6 mo	251,136 (768)	79,104 (242)	526
9 visits/6 mo	376,704 (1,152)	118,656 (363)	789
12 visits/6 mo	502,272 (1,536)	158,208 (484)	1,052

Figures in parentheses in Columns G and H are cost per individual patient (dollar sum \div no. of patients). TENS, transcutaneous electrical nerve stimulation; PT/OT, physical therapy/occupational therapy.

in our study are not unique to pain research, but are found in all healthcare research using retrospective reporting of healthcare status.

A review of the literature was done to determine what happens to medication use over time in groups of untreated patients with chronic pain. Perhaps the best data come from studies that examine such measures in evaluating other pain treatment interventions. Deardorff and associates³⁵ studied a number of outcome variables including pain medication use in patients who were treated in a comprehensive pain program ($n = 42$) versus an identical group of patients ($n = 15$) evaluated for treatment but denied treatment due to insurance coverage. At follow-up of an average of 11 months, treated patients showed improvements in a variety of outcome measures used to assess function such as activity level, return to work, and reduced pain medication consumption. The "nontreated" control group showed a significant increase in the amount and number of pain medications used. Tollison and colleagues³⁶ in a study similar to Deardorff's,³⁵ reported that the percentage of nontreated patients using opiate and nonopiate pain medications changed little, even at 18 months of follow-up. Others have also reported similar findings.³⁷⁻⁴⁰ Compensation status had no effect on consumption of pain medications.³⁸ Similarly in our study, the status of compensation (worker's compensation vs. nonworker's compensation) did not affect whether a LTU of TENS was using pain medications. Thus, although the present study did not specifically use a nontreatment control group, the chronicity of the study patients and experiences contained in the literature would indicate that the consumption of pain medications would not be expected to decrease solely with time.

The changes in physical therapy use over time could be from a number of causes. Changes in insurance status could impact the use of PT/OT; however, the use of PT/OT at time of purchase or after 6 months was not different between worker's compensation and nonworker's compensation users of TENS. Similarly, the reduction in TENS use could be due to a spontaneous improvement of pain symptoms. The chronicity of the conditions (mean duration >40 months) makes this possibility less likely. What-

ever the cause, there was a significant reduction in PT/OT use and costs that correlated with long-term TENS use.

From the data available in this study, it was not possible to perform a formal cost-benefit analysis of TENS therapy. Weinstein and Statson⁴¹ note that such analyses require all inclusive data on the cost of the interventions (e.g., TENS); any reoccurring costs (e.g., TENS electrodes); reductions in current therapies (e.g., PT/OT, chiropractic care, and medications); changes in morbidity associated with therapy (medication side effects); changes in physician visits and diagnostic procedures, and the financial impact from patients returning to work. In other instances, while national averages of costs are available, costs specific for a given study patient were not. For instance, while the average nationwide cost of the TENS units used in this study (Epix XL, Empi, Inc., St. Paul, MN, U.S.A.) was \$442 per unit, the actual costs for any given study patient can be greatly influenced by factors such as contractual pricing agreements.⁴² Such comprehensive and subject-specific data do not exist in this survey. Nevertheless, most clinical decisions are guided not by a strict cost-benefit analysis, but by a variation of this model that also accounts for differences in outcome measures.⁴³ In many instances, these outcomes are not always easily qualified or assigned a dollar value (e.g., pain relief, patient satisfaction, or improved quality of life). Specifically, in the case of TENS treatment, clinicians consider not only the initial costs of the units but also any likely changes that may occur in the quality of the patient's life or improvement in activity levels.

The cost simulations done on the pain medications and physical therapy used by the LTU of TENS are important for several reasons. They provide the clinician with at least one limited measure of the financial impact that a therapy such as TENS has on existing pain-related expenditures. Previous to the present paper, little information existed. Determining the financial implications of any intervention can be quite complex. For instance, few clinicians consider that when a medication such as an NSAID is prescribed over the long term, a balanced analysis must be made between benefits, risks, and costs of the inter-

vention.⁴⁰ For instance, de Pourvoirville has developed a model for the NSAIDs.⁴⁴ This model, based on actual cost analyses data, determines that the real economic burden of an NSAID to a healthcare system must include the cost of treating the complications. These complications often range from common and inexpensive to treat, to less common but relatively expensive to treat, and include peptic ulcer disease,⁴⁵ liver failure,⁴⁶ and acute and chronic renal insufficiency.⁴⁷ De Pourvoirville has calculated that the costs of NSAID drugs need to be multiplied by a coefficient that ranges from 1.36 to 3 to account for the treatment of iatrogenic gastrointestinal complications alone. Similar coefficients have been reported by others.⁴⁸ This cost analysis is made even more complicated if one considers that nearly 25% of patients prescribed NSAIDs also receive an expensive gastric-sparing medication.⁴⁹ Similar cost considerations due to iatrogenic complications exist for drugs such as steroids, opiates, and sedatives. Conversely, TENS treatment is relatively free of side effects.³

In the present study, the long-term TENS user group showed both a reduction in the number of patients who were using multiple combinations of different pain medications and in the amount of pain medication consumed. Recent data indicate that certain patients consuming opiate pain medications on a chronic basis display cerebral dysfunction likely related to their opiate use.^{50,51} These changes included both cognitive and psychomotor impairment. The decrease in overall medication consumption would likely contribute to a reduction in medication-related complications and possibly an improvement in the quality of life.

In the present study, we did not have access to actual medication, TENS, or PT/OT costs because the patients were in many different healthcare systems, hence the cost simulations. In addition, while the LTU of TENS showed a significant reduction in the utilization of other modalities such as PT/OT, OT, and chiropractic therapies, it could not be determined if the reduction in these therapies were solely due to TENS use. Therefore, the results of this study must be interpreted with the previous caveats. Nevertheless, these data have important clinical considerations.

CONCLUSIONS

There exists a population of patients treated with TENS who use TENS successfully over long periods of time. These users demonstrate improvement in a number of outcome variables that include reduced therapy and medication use, increased activities, and improved treatment satisfaction, all that contribute to an improved quality of life.^{52,53} These improvements, combined with a generalized reduction of pain medications and the accompanying cost and complication considerations, are important points that clinicians

must weigh when constructing a treatment plan for patients with chronic pain.

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APPENDIX

Questions used to assess prescription medications and therapies for pain treatment

7a. What treatment or therapies were you using to manage your pain *prior* to using the TENS device? (READ LIST—RECORD ALL MENTIONS) (PROBE) Anything else?

Physical or occupational therapy
Chiropractic treatment
Prescription pain medication
No other treatment
Other

7b. In addition to your TENS device, what other treatments or therapies are you currently receiving for the pain for which your TENS device was prescribed? (READ LIST—RECORD ALL MENTIONS) (PROBE) Anything else?

Physical or occupational therapy
Chiropractic treatment
Prescription pain medication
No other treatment
Other

8a. Which prescription pain medication(s) did you take *before* you received your TENS device?

8b. Which prescription pain medication(s) are you *still* taking? (DO NOT READ LIST—RECORD ALL MENTIONS)

Codeine	Motrin
Darvocet	Naprosyn
Darvon	Nembutal
Demerol	Percodan
Deprol	Prozac
Diazepam	Relafen
Feldine	Talwin
Flexeril	Toradol
Librium	Zoloft
Methadone	Other (specify)
Morphine	

9. Since you have been using the TENS device, has your reliance on prescription pain medication . . . ? (READ LIST—RECORD ONE RESPONSE ONLY)

Increased
Stayed the same, or
Decreased
Don't know