

Physical Therapists' Use of Functional Electrical Stimulation for Clients With Stroke: Frequency, Barriers, and Facilitators

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Background. Best practice guidelines for stroke rehabilitation recommend functional electrical stimulation (FES) to improve gait and upper extremity function. Whether these guidelines have been implemented in practice is unknown.

Objective. The purposes of this study were: (1) to determine the frequency with which physical therapists use FES to address common therapeutic goals poststroke and (2) to identify the barriers to and facilitators of FES use.

Design. This was a cross-sectional, survey study.

Methods. A valid and reliable online survey was sent to Canadian physical therapists. Questions about demographic characteristics, FES use, knowledge of FES literature, and barriers and facilitators were posed. Closed-ended questions were analyzed with descriptive statistics and index scoring to produce summary scores. Pearson or point-biserial correlation coefficients correlated FES use with demographic variables. Open-ended questions about barriers and facilitators were analyzed by 3 researchers using a conventional content analysis.

Results. Two hundred ninety-eight physical therapists responded. Use of FES for clients with stroke was low for all therapeutic goals queried (improve walking, arm function, muscle strength and endurance, and sensation; prevent shoulder subluxation; and decrease spasticity). However, 52.6% of the respondents stated that they would like to increase their use of FES. More than 40% of the respondents were unsure of the strength of the evidence supporting FES for stroke care. Physical therapists with postgraduate FES training were more likely to use FES ($r=.471$, $P<.001$). A lack of access to resources, such as time, equipment, and training, was the most frequently cited barrier to FES use.

Limitations. As an observational study, cause-and-effect relationships for FES use cannot be identified.

Conclusions. Functional electrical stimulation is not widely used by physical therapists in stroke rehabilitation. Improving access to resources—in particular, continuing education—may facilitate the implementation of FES into clinical practice.

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Following a stroke, individuals are often left with sensorimotor impairments, such as paresis and abnormal muscle tone, which significantly limit their ability to mobilize and participate in activities of daily living. Physical rehabilitation aims to resolve these impairments, enabling recovery of movement and function. One intervention that is recommended for stroke rehabilitation by numerous best practice guidelines is functional electrical stimulation (FES).¹⁻³ Functional electrical stimulation can produce appropriately sequenced and timed muscle contractions for functional tasks. This stimulation is accomplished by delivering a low-level, electrical current through electrodes on the skin to activate motoneurons, causing muscle contraction. Functional electrical stimulation has been used in individuals with stroke to improve strength,⁴ upper extremity function,⁵ and gait⁶ and to prevent hemiplegic shoulder subluxation.⁷ Moreover, FES therapy is associated with neuroplasticity poststroke⁸⁻¹⁰ and thus can contribute to neural recovery.

The most recent guidelines from the American Stroke Association recommend FES for gait and upper extremity training, including shoulder subluxation, in clients with impaired muscle contraction.² Two Canadian best practice guidelines also recommend FES for stroke care.^{1,3} These recommendations are based on the strength of the scientific literature for FES in stroke. For example, the Stroke Rehabilitation Evidence-Based Review states there is level 1A evidence (ie, findings supported by a meta-analysis or at least 2 randomized controlled trials) that FES improves upper extremity function, prevents the development of shoulder subluxation, and decreases spasticity and, when combined with gait retraining, can improve gait performance.³ Although the evidence for the therapeutic benefits of FES is strong, this evidence does not imply that FES is superior to other treatment approaches that physical therapists may use.^{11,12}

Even though FES has been recommended for stroke rehabilitation, physical therapists may not use it regularly in practice. Functional electrical stimulation devices are not available in every

clinical environment, and not all physical therapy programs include FES in their curriculum. Thus, FES may be underutilized by physical therapists. To determine the usage of FES to address common therapeutic goals in stroke rehabilitation, we undertook an FES survey involving physical therapists across Canada. The aims of our study were: (1) to determine how frequently physical therapists use FES to address common therapeutic goals for their clients with stroke (eg, improve walking), (2) to assess how knowledgeable physical therapists are of the scientific evidence supporting the use of FES poststroke, and (3) to identify the barriers and facilitators influencing the use of FES. We hypothesized that the majority of physical therapists do not use FES as a means to achieve therapeutic goals for clients with stroke. We also hypothesized that a lack of education and access to FES equipment would be identified as barriers to the use of FES in clinical practice, whereas the substantial scientific evidence and access to continuing education courses in FES would be facilitators.

Method

Study Design

This cross-sectional study involved 2 phases. First, a valid and reliable online survey was developed. Second, the survey was distributed to physical therapists across Canada.

Survey Development

The survey was developed by a focus group consisting of 3 physical therapists and the study authors. Of the 3 physical therapists, 2 used FES routinely in their practice, and 1 did not use FES but worked with the stroke population. The focus group developed an ordinal-level survey (ie, mostly closed-ended questions) (Appendix). The survey consisted of 4 parts: (1) demographic information (eg, practice setting, number of years practicing), (2) frequency of FES use for various therapeutic goals relevant to stroke, (3) facilitators of and barriers to FES use, and (4) knowledge of the FES literature for stroke rehabilitation. Response options consisted of Likert scales with both numeric and descriptive anchors. To explore barriers and facilitators, closed-ended questions were modified from a previous study.¹³

Two open-ended questions also were included in this section (Appendix). After several iterations of refining the questions, the survey was translated into French by a bilingual physical therapist, and both English and French versions were created in electronic form (FluidSurveys version 3.0, SurveyMonkey Canada, Ottawa, Ontario, Canada).

Assessment of Content Validity

To evaluate the content validity of the survey, 10 experts were recruited from Canada, the United States, and the United Kingdom. All experts were clinical researchers in the area of FES for neurological populations. The experts were given the study objectives, as written above, to review and asked to rate how relevant each question was to the objectives on an ordinal scale (ie, not relevant, relevant, very relevant). Eight of the 10 experts provided feedback. If ≥ 6 experts (ie, $\geq 75\%$) rated the question as relevant or very relevant, the question was retained. Five questions about the use of FES for different therapeutic goals did not meet this criterion and were deleted (improving transfers, standing posture, and sitting posture and to reducing/preventing contractures and muscle atrophy).

Assessment of Test-Retest Reliability

After establishing content validity, we evaluated the survey's test-retest reliability. Eight physical therapists who live in 3 provinces and who work with clients with stroke were recruited to participate. Therapists were invited to complete the online survey on 2 occasions spaced 2 weeks apart. A researcher sent a reminder to the therapists to complete the survey at the second time point.

Survey Respondents

To attract a large number of respondents and produce generalizable findings, we had broad inclusion criteria for the survey. As the survey was completed anonymously, potential respondents self-screened for the following inclusion criteria: (1) they were licensed to practice physical therapy in Canada, (2) their typical caseload included adults or children with stroke in any care setting (eg,

acute care, rehabilitation, private practice), and (3) they could understand written instructions in English or French. Physical therapists across Canada were invited to participate in the survey through electronic or print newsletters of the Canadian Physiotherapy Association, each provincial or territorial physical therapy association, and the provincial colleges of physical therapy (ie, licensing bodies). Membership in a college is mandatory; thus, advertising through the colleges reduced sampling bias, as it ensured that the study information reached all practicing physical therapists in Canada. Survey data were automatically collected through FluidSurveys version 3.0 over 3 months in late 2014. Respondents could request a paper copy of the survey, if preferred. In this case, data were manually entered into FluidSurveys version 3.0 by a researcher.

Data Analysis

Test-retest reliability. Test-retest reliability of the survey was evaluated by calculating the agreement across the 2 survey administrations for each therapist. Agreement, expressed as a percentage, was calculated by totaling the number of survey items for which the same response was chosen, divided by the total number of items on the survey. The average agreement across therapists was calculated for 3 sections of the survey (frequency of FES use, facilitators and barriers, and knowledge of FES evidence). To gauge the strength of the reported agreement, weighted kappa coefficients using quadratic weights were calculated.¹⁴ Kappa coefficients ranged from 0 to 1, with 1 suggesting perfect agreement.¹⁴

Analysis of survey responses. Survey responses were exported from FluidSurveys version 3.0 to Microsoft Excel (Microsoft Corp, Redmond, Washington). Data were checked for incomplete responses; surveys with only the demographic section completed were excluded. Frequency tables were created to report the percentage of the sample with a certain characteristic.¹⁵ Index scoring was used to convert descriptive responses about the use of FES for various goals (eg, never [0%], rarely [1%–20%], occasionally [21%–40%], and so

on) to numerical values.¹⁵ Specifically, for these questions (question 14, Appendix), index scores were assigned as follows: 0=never, 1=rarely, 2=occasionally, 3=sometimes, 4=frequently, 5=most of the time. Index scores also were applied to obtain summary scores for questions that queried the same concept.¹⁵ In this case, index scoring was used to create a summary score for knowledge of FES evidence (question 16, Appendix). For the questions related to arm function, shoulder subluxation, and walking performance, the scores were assigned as follows: –2=strongly disagree, –1=disagree, 0=neither agree nor disagree, 1=agree, 2=strongly agree. Index scores were assigned in the reverse order (ie, from –2=strongly agree to 2=strongly disagree) for the question about hemiplegic shoulder pain to correspond with the most recent evidenced-base practice guideline.³ Thus, a total index score of 8 (4 questions × correct score of 2) reflected excellent knowledge of stroke-related FES evidence, whereas a score of –8 reflected incorrect knowledge.

To identify the factors associated with the use of FES, Pearson or point-biserial correlation coefficients were used to correlate the index score for FES use to improve walking with several demographic variables. The therapeutic goal of improving walking was chosen for this analysis for 2 reasons: (1) of the 6 therapeutic goals queried in the survey, improving walking function is a goal that is more commonly addressed by physical therapists than by other health care professionals, and (2) the mean index score for this goal was higher than the mean scores for the other goals queried (see Results section). The index score for FES use for walking was correlated with the following variables: respondent age, sex, years working as a physical therapist, presence of continuing education in FES, presence of entry-level training in FES, total index score for FES knowledge, and percentage of respondent caseload that is stroke. The choice of variables was based on previous literature; for example, a younger age, shorter time since graduation from university, and being male are all linked with greater use of technology in health care settings.¹⁶ The

variables representing education, knowledge, and experience with clients with stroke were chosen to address our hypothesis concerning the facilitators of FES use. Alpha was set to .05. Continuous variables are reported with the mean ± 1 standard deviation.

Data in the form of text were collected through 2 open-ended questions. A conventional content analysis was performed on the responses to these questions by 3 researchers. The researchers independently reviewed the responses and identified common themes for the barriers to and facilitators of FES. The researchers then discussed the identified themes as a group to reach consensus.

Results

Survey Test-Retest Reliability

Five of the 8 therapists completed the survey on 2 occasions. The average agreement of survey responses for these 5 therapists was good to excellent: 73.3%±25.3% for the section on FES use, 60%±21.5% for the section on barriers and facilitators, and 85%±22.4% for the section on knowledge of FES evidence. When respondents chose different responses for a question, the responses differed by only one category (eg, strongly agree and agree) most of the time. This difference was reflected in the weighted kappa coefficients, which suggested excellent test-retest reliability: .97 for section on FES use, .90 for the section on barriers and facilitators, and .93 for the section on knowledge of FES evidence.

Survey Data: Demographics

A total of 305 surveys were collected (Fig. 1). Seven surveys were excluded because either only the demographic information was completed or the respondents indicated they were not involved in direct patient care. Therefore, 298 surveys were included. We received surveys from 8/10 provinces and 2/3 territories.

The mean respondent age was 41.5±11.3 years, and 84.2% were female. Most respondents (65.4%) lived in a community where the population was greater than 100,000. The highest degree obtained by 79.2% of respon-

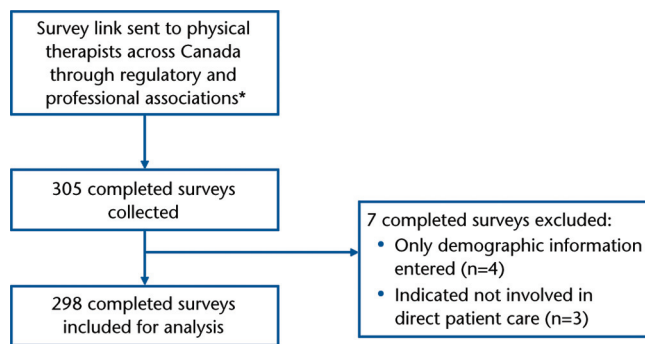


Figure 1.

STROBE flow diagram outlining collection and screening of completed surveys. *Total number of physical therapists who saw the survey information and link is unknown.

dents was an entry-level degree in physical therapy (BScPT/MPT/MScPT). Other levels of education included thesis-based MSc (8.7%), PhD (1.7%), diploma in physical therapy (6.7%), and “other” (3.7%), which included MBA, master of public health, and postgraduate certifications. Sixty-nine percent of the respondents received FES education in their entry-level program. Approximately a third of respondents (31.5%) had completed continuing education in FES.

The majority (62.1%) of the respondents had been working as a physical therapist for >10 years. The proportions working as physical therapists for 5 to 10 years and <5 years were roughly equal (19.5% versus 18.5%, respectively). Respondents worked in a variety of health care settings: inpatient rehabilitation (22.9%), acute care (20.2%), outpatient rehabilitation (20.2%), private practice (14.1%), home care or community setting (10%), long-term care (7.3%), research (1%), and “other” (4.1%). Under “other,” respon-

dents reported the following settings: military, complex chronic care, subacute care, and teaching. Roughly half of the respondents (51.3%) identified neurology as their primary area of practice. Other areas of practice included orthopedics (22.5%), cardiorespiratory (1.3%), and “other” (24.8%), which included geriatrics, pediatrics, and mixed/all areas. Most respondents worked with adult clients (65.8%), whereas 7% worked exclusively with pediatric clients, and 27.2% reported working with clients of all ages. Forty-nine percent had been working with individuals with stroke for >10 years. Clients with stroke represented 40% or less of the caseload for 57.4% of the respondents.

Use of FES

The majority of respondents reported “never” or “rarely” using FES for the 6 therapeutic goals queried (Tab. 1). The mean total index score for FES use was 6.7 ± 7.0 on a scale of 0 to 30. Figure 2

shows the mean index score for each therapeutic goal (on a scale of 0–5). The highest mean index score (1.53 ± 1.63) was calculated for the goal of improving walking function, and the lowest mean index score (0.54 ± 1.01) was calculated for improving sensation.

Knowledge of FES Evidence

Overall, some respondents were aware of the strong evidence to support the use of FES in stroke rehabilitation, and roughly an equal proportion were unsure (Tab. 2). The mean index score for overall level of knowledge was 1.2 ± 1.7 on a scale from –8 to 8. The mean index score was positive for 3 therapeutic goals (improve arm function, improve gait performance, and prevent shoulder subluxation), indicating that some respondents were aware of the evidence and best practice guidelines. On average, respondents were incorrect about the evidence supporting the use of FES for hemiplegic shoulder pain. The most recent update of the Stroke Rehabilitation Evidence-Based Review⁷ states there is strong evidence that FES does not reduce hemiplegic shoulder pain.

Correlates of FES Use

The index score for FES use to improve walking showed a moderately strong relationship with participation in a continuing education course in FES ($r = .471$, $P < .001$). Weaker correlations were found between FES use and index scores for knowledge of the evidence ($r = .279$, $P < .001$), entry-level physical therapy education in FES ($r = .15$, $P = .013$), and percentage of the respondent caseload that is stroke ($r = .14$, $P = .014$). The fol-

Table 1.

Use of Functional Electrical Stimulation by Physical Therapists to Address Specific Therapeutic Goals^a

Goal	Never	Rarely	Occasionally	Sometimes	Frequently	Most of the Time
Prevent/↓ shoulder subluxation	48.47%	20.68%	10.51%	9.15%	5.76%	5.42%
↑ arm function	48.81%	16.72%	9.90%	9.56%	8.87%	6.14%
↑ walking function	38.85%	18.24%	16.89%	10.47%	8.11%	7.43%
↑ muscle strength, endurance	39.66%	20.34%	14.58%	12.54%	9.15%	3.73%
↓ hypertonia/spasticity	59.93%	17.47%	8.56%	7.19%	4.79%	2.05%
↑ sensation	70.21%	16.10%	7.19%	3.08%	3.08%	0.34%

^a Never=0% of the time, rarely=1%–20% of the time, occasionally=21%–40% of the time, sometimes=41%–59% of the time, frequently=60%–79% of the time, most of the time= $\geq 80\%$ of the time.

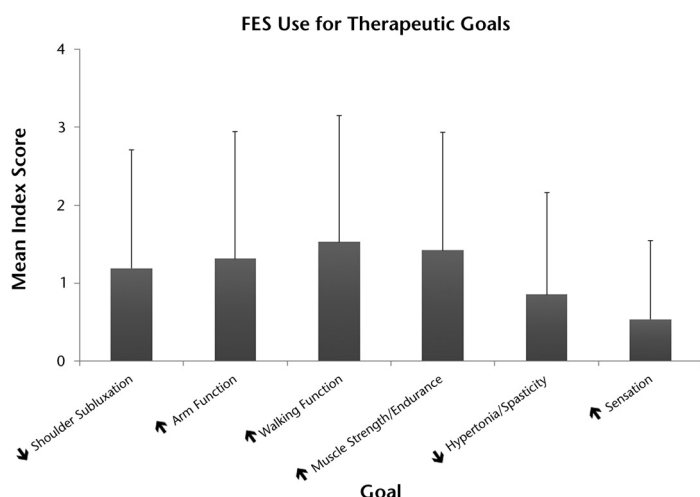


Figure 2.

Mean index score for each therapeutic goal queried in the survey. For each goal, the index score can range from 0 (ie, never uses FES for that goal) to 5 (ie, uses FES most of the time (ie, $\geq 80\%$ of the time for that goal)). FES=functional electrical stimulation.

lowing variables did not show a significant correlation with index scores of FES use to improve walking: age ($r = -.083$, $P = .154$), years practicing as a physical therapist ($r = -.02$, $P = .731$), sex ($r = -.029$, $P = .619$), and size of the population that the therapist serves ($r = .102$, $P = .079$).

Barriers and Facilitators

The closed-ended survey questions identified few barriers or facilitators that were common to the majority of respondents. For most questions, there was not a noteworthy difference between the proportion of respondents who agreed or strongly agreed and disagreed or strongly disagreed (Fig. 3). Issues that could be identified as potential barriers included: a preference to use other treatment options (50.2%), lack of training in FES (40.2%), and patients not having

access to devices in their home (68.1%). The majority of respondents (64.9%) stated that hands-on training would increase their use of FES (ie, a facilitator), and, interestingly, 52.7% stated they would like to increase their use of FES in clinical practice.

The open-ended questions allowed respondents to report what they perceive prevents or facilitates their use of FES. For these 2 optional questions, 244 responses were received for facilitators and 221 responses were received for barriers. For facilitators, 5 main themes were identified: (1) access to resources that enable the application of FES, (2) therapists being comfortable and confident in applying FES, (3) existence of high-quality evidence for the efficacy of FES, (4) client characteristics that increase the likelihood of adherence and

transition to the home environment, and (5) identifying therapeutic goals that can be appropriately addressed with FES.

The most frequently cited facilitator of FES use was access to resources. A variety of different resources were mentioned, such as time, equipment, funds, and support from colleagues and supervisors. Specifically, having adequate time to apply FES was a facilitator, as was having access to appropriate equipment (eg, equipment in working order, simple setup). Receiving support from colleagues in leadership positions was identified as facilitatory, and several respondents gave examples of creative methods that their places of work have supported (eg, regular FES group sessions). Other resources that facilitate FES use included: working with colleagues, both physical therapists and assistants, who have experience with FES; having access to FES suppliers who are responsive to questions; and, lastly, patient access to funding for FES devices through provincial or third-party health benefits.

Another frequently mentioned facilitator was the therapist feeling comfortable and confident in applying FES. Respondents acknowledged the importance of hands-on experience and understanding FES parameters. They reported that these skills and knowledge were gained through continuing education courses, hands-on training, peer teaching, and "train the trainer" programs. Another facilitator that falls within this theme is having had positive outcomes with FES in the past, whether observed over time or observed immediately (eg, applying FES for foot drop, seeing an immediate improvement in gait quality).

Table 2.

Knowledge of Evidence of Functional Electrical Stimulation (FES)^a

There Is Strong Evidence That FES Can . . .	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Index Score $\bar{X}$ (SD)
Improve arm function poststroke	9.2%	42%	43.5%	4.6%	0.7%	0.54 (0.75)
Prevent shoulder subluxation poststroke	8.1%	34.6%	48.8%	7.8%	0.7%	0.42 (0.78)
Improve walking performance poststroke	10.3%	43.6%	40.4%	5.3%	0.4%	0.58 (0.76)
Reduce hemiplegic shoulder pain	7.8%	30.5%	51.8%	9.2%	0.7%	-0.35 (0.78)

^a Mean index score for each question can vary from -2 (incorrect knowledge of the evidence) to 2 (correct knowledge of the evidence).

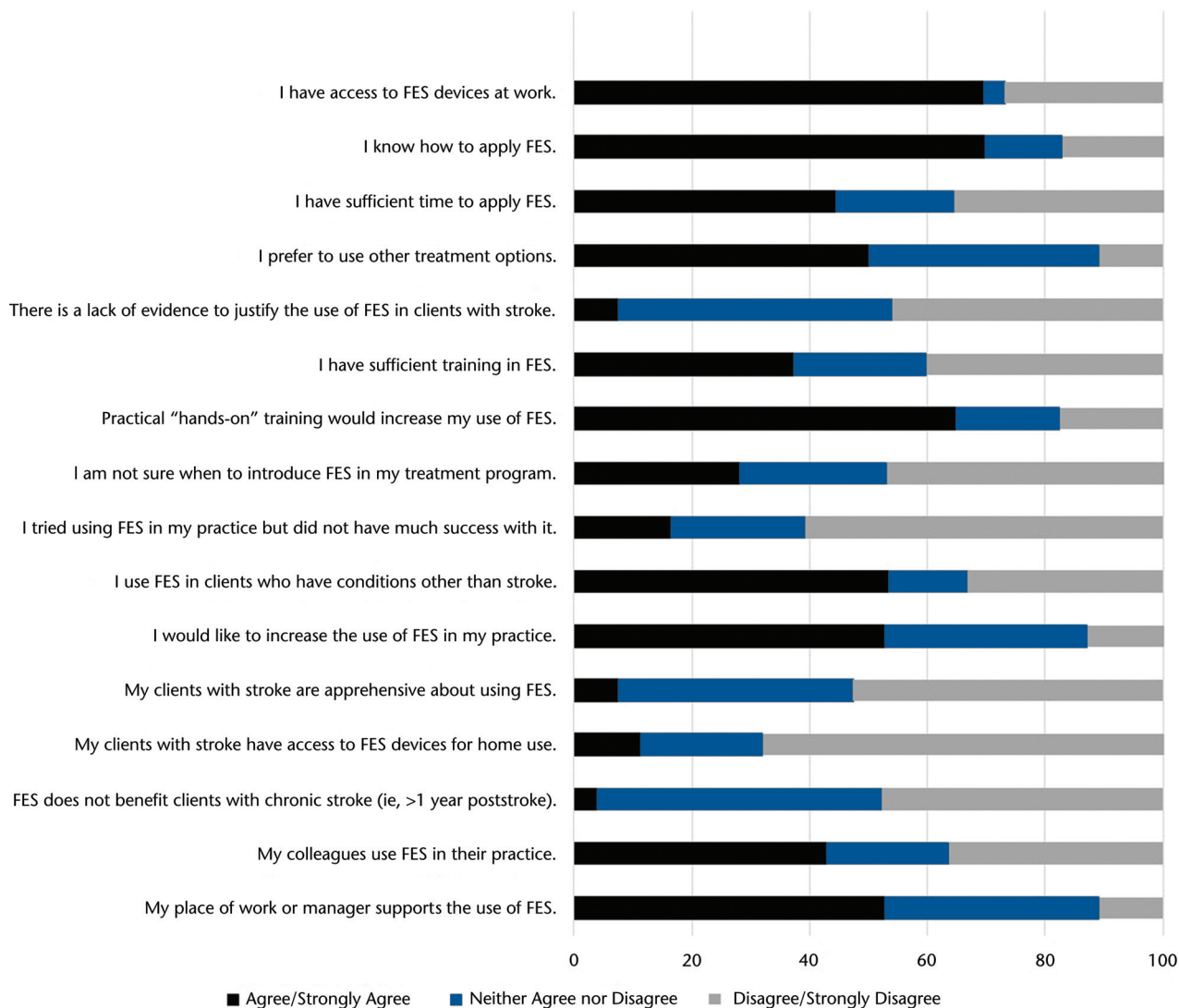


Figure 3.

Barriers to and facilitators of usage of functional electrical stimulation (FES). Responses to the closed-ended survey questions inquiring about barriers and facilitators are presented. Respondents were asked whether they agreed or disagreed with a series of statements (left side of plot). Percentage of respondents who agreed or strongly agreed (black bars), neither agreed or disagreed (blue bars), or disagreed or strongly disagreed (gray bars) are shown.

The third theme, the existence of supporting evidence for the efficacy of FES, refers to therapists being aware of the evidence and best practice guidelines for stroke. The fourth theme, client characteristics, refers to client factors that therapists perceive as being important for success with FES. More specifically, this theme includes characteristics that are likely to increase adherence to FES and the transition from a supervised program to a home program. The identified client characteristics included being motivated, being able to work independently,

having a supportive family, and having the appropriate equipment to complete FES therapy at home. Lastly, respondents identified specific therapeutic goals that facilitated their choice of FES as an intervention. Therapists reported choosing to use FES if the underlying goal was to increase muscle strength, improve motor recruitment, improve motor control, address shoulder subluxation or foot drop, or reduce pain.

For the barriers to FES use, 4 main themes were identified: (1) lack of resources; (2) therapists lacking knowledge, training, or expertise in FES; (3) the perception of FES being inappropriate for certain patients with stroke; and (4) therapist preference. With respect to resources, time was mentioned as a barrier more often than any other resource. Therapists reported short treatment sessions, short lengths of stay, large case-loads, and the time required to set up FES and change parameters as barriers. Other resource-related barriers included equip-

ment being inaccessible, equipment breaking down, limited support from the suppliers of FES devices, colleagues not using FES, and high staff turnover.

Respondents also reported a lack of expertise in FES as a barrier. Specifically, they referred to a lack of hands-on practice, not feeling prepared to apply FES correctly (eg, coordinate the timing of stimulation with the functional movement), not knowing exactly who will benefit from FES, and difficulty translating research into practice. A few respondents stated that commercially available FES devices are difficult to learn to use.

Therapists commonly reported that they perceived FES to be inappropriate for certain clients with stroke. Children were most frequently mentioned as being inappropriate candidates. Specific client factors (eg, dementia, spasticity, poor skin quality, frailty, poor sensation, presence of a pacemaker, acute injury, pain with electrical stimulation making it difficult to reach dosage requirements) were reported as being barriers to FES use.

The final theme for the barriers to FES use was therapist preference. Some therapists indicated that they prefer to use other interventions for their clients with stroke. A few respondents remembered electrical stimulation as uncomfortable and did not want to expose their clients to that.

Discussion

We surveyed 298 physical therapists to determine the state of FES use and knowledge of stroke rehabilitation. As we hypothesized, the majority of physical therapists are using FES infrequently for 6 common therapeutic goals, despite FES being supported in the best practice guidelines.¹⁻³ Furthermore, FES use was low across a variety of therapeutic applications, including gait training. We also found that a notable proportion of physical therapists are not aware of the scientific evidence and best practice guidelines for FES use in stroke rehabilitation. Our hypotheses regarding the barriers and facilitators of FES use for stroke care were supported. Access to resources (eg, education, time, equipment) was most

frequently cited as the factor that facilitates or prevents therapists from using FES. Consistent with this finding, we found a moderately strong, positive correlation between having continuing education in FES and FES use in clinical practice. Interestingly, just over half of the physical therapists who completed the survey would like to increase their use of FES.

Continuing Education Is Associated With Greater FES Use

The strongest correlate with FES use was postgraduate, continuing education in FES. This finding was supported by the responses to the open-ended questions, which suggested that physical therapists are more likely to use FES if they have received training in FES, especially hands-on training, and are knowledgeable about when and how to apply it.

There were no correlations between FES use and age or sex. Previous work showed that technology use in health care was more common among younger clinicians who graduated from university recently and among male clinicians.¹⁶ However, we did not see similar trends in our results. This finding may be because other factors, such as training, access to equipment, and the influence of colleagues, are much stronger predictors of FES use.

Likewise, a weak, but significant, correlation was found between FES use and knowledge of FES evidence. This finding is not surprising because scientific evidence is just 1 of 3 pieces of information that physical therapists learn to consider when implementing evidence-based practice, the other 2 pieces of information being client goals and clinical experience.^{17,18} Physical therapists appreciate the value of scientific evidence but do not always translate it into their practice.¹⁹⁻²¹

Knowledge of FES Evidence Is Not High

Although physical therapists acknowledge the importance of scientific evidence for clinical decision making,^{19,21} we found that many survey respondents were unaware of the evidence supporting the use of FES for stroke rehabilita-

tion. Knowledge was lowest with regard to the effectiveness of FES for hemiplegic shoulder pain; however, this finding may have been due to this best practice recommendation being relatively new.³ Similarly, some respondents questioned the appropriateness of FES for pediatric clients; however, there is literature supporting the use of FES in children.^{22,23}

The misconceptions and lack of knowledge about FES may reflect inadequate translation of knowledge from research to clinical practice, which has been previously identified as a challenge for health care professions.^{18,19,24} Zidarov and colleagues¹⁸ recommended a framework for knowledge translation in physical therapy. One key component is assessing the barriers and facilitators, followed by applying interventions that can effectively address the barriers. This component must occur prior to implementing the new evidence or intervention.¹⁸ Our results provide some insight into the barriers to and facilitators of FES use. This is a fundamental step toward increasing FES use in the future.

Barriers and Facilitators Identified

The reported barriers to FES use in stroke rehabilitation were not surprising—resources, training, client characteristics, and therapists' preferences are all important factors. Other studies have reported similar barriers to the implementation of evidence-based interventions. For example, one study investigating the addition of assistive technologies to stroke rehabilitation identified a lack of access as a main barrier.²⁵ Other authors have highlighted that a lack of time hinders the implementation of an intervention in clinical practice.^{11,26,27} Therapists' preference to use other treatment options could be related to reluctance to change routine. A previous study showed that at least one-third of therapists are reluctant to change their practices, causing a barrier in adopting new treatment strategies.²⁸ In contrast, facilitators common to this study and previous work are knowledge and confidence in the application of the intervention.^{26,29}

Future research should examine ways to address the barriers to FES use. For exam-

ple, more opportunities for continuing education in FES and the development of affordable and simple FES devices are needed. Currently, in Canada, only 2 provincial or territorial health care systems cover the cost of FES devices for home use. Thus, access to devices after discharge from inpatient or outpatient rehabilitation is limited for clients without private insurance. This situation is reflected by our finding that only 11% of physical therapists agreed or strongly agreed with the statement "My clients with stroke have access to FES devices for home use." The knowledge that many clients cannot continue with FES after discharge from rehabilitation may discourage some physical therapists from initiating FES.

It also is recognized that best practice implementation requires more than the typical passive approaches to knowledge translation, which increase the awareness but not the use of research findings.^{30,31} Ways to close the gap between awareness and use may include creating communities of practice around FES,³² "train the trainer" programs,³³ or establishing "knowledge brokers"^{18,32} of FES (ie, colleagues who can bring the research into a clinical setting and be an accessible resource on the topic for therapists).

Strengths and Limitations

One strength of this study is that it involved a large sample that reflects the current population of physical therapists in Canada. According to the Canadian Institute for Health Information, in 2011, the average age of physical therapists was 41.9 years,³⁴ compared with 41.5 ± 11.3 years in our sample. Similarly, 77.1% of physical therapists are female,³⁴ whereas our sample was 84.2% female. The distribution of education level was also very similar between our sample and the national statistics.³⁴ Moreover, we obtained survey responses from 8 of the 10 provinces and 2 of the 3 territories, increasing the generalizability of our results. One additional strength was the inclusion of open-ended questions in the survey. Through these questions, we were able to extract rich detail concerning the barriers to and facilitators of FES

for physical therapists involved in stroke rehabilitation.

One limitation of this work is that it cannot determine cause-and-effect relationships. For example, we identified a relationship between continuing education and FES use; however, the additional training may not be the cause of greater use. Instead, therapist preference may be the underlying cause; those therapists who desire to use FES in their practice are likely those attending continuing education opportunities.

In conclusion, FES is not widely used by physical therapists to address common therapeutic goals in stroke rehabilitation; however, just over half of the respondents would like to increase their use of FES. Improving access to necessary resources, such as continuing education and FES devices that are user-friendly and time efficient, may facilitate the implementation of FES into clinical practice.

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Appendix.

Functional Electrical Stimulation Survey^a

Functional electrical stimulation (FES) is the use of electrical stimulation of the peripheral nervous system to contract muscles during functional activities such as standing, walking, reaching, grasping, and so on.

Please tell us about yourself.

1. Male ☐ Female ☐
2. Date of birth: Month _____ Year _____
3. Province where you currently work _____
4. Population of city/town where you work:

☐ <10,000 people
☐ 10,000–100,000 people
☐ >100,000 people
5. Which health care setting do you work in?

☐ Acute Care
☐ Inpatient Rehabilitation
☐ Outpatient Rehabilitation
☐ Private Practice

☐ Home/community care
☐ Long-term care
☐ Research
☐ Other: _____
6. What is your primary area of practice?

☐ Neurological
☐ Orthopedics
☐ Cardiorespiratory
☐ Other: _____
7. For how many years have you been working as a physical therapist?

☐ <5 years
☐ 5–10 years
☐ >10 years
8. For how many years have you been working with clients with stroke as a physical therapist?

☐ <5 years
☐ 5–10 years
☐ >10 years
9. What is your highest level of education completed?

☐ DipPT
☐ BScPT
☐ MPT/MScPT (entry-level)

☐ DPT
☐ MSc (thesis-based)
☐ PhD
☐ Other: _____

(Continued)

FES Use in Stroke Rehabilitation

Appendix. Continued

10. In the past month, what percentage of your client caseload was stroke?

- ☐ 0% ☐ 1%–20% ☐ 21%–40% ☐ 41%–59% ☐ 60%–79% ☐ ≥80%

11. What is the age group of the clients who you work with?

- ☐ <18 years ☐ ≥18 years ☐ All ages

12. Did you receive FES instruction in your entry-level physical therapy program?

- ☐ Yes ☐ No ☐ Not sure

13. Have you taken a continuing education course in FES?

- ☐ Yes ☐ No

14. How frequently do you use FES to address the following goals for your clients with stroke:

	Most of the Time (≥80%)	Frequently (60%–79%)	Sometimes (41%–59%)	Occasionally (21%–40%)	Rarely (1%–20%)	Never (0%)
Prevent/reduce shoulder subluxation						
Improve arm function (eg, reach and grasp)						
Improve walking function						
Improve muscle strength/endurance						
Reduce hypertonia/spasticity						
Improve sensation						

If you use FES for goals not listed above, please enter those goals here:

15. How strongly do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I have access to FES devices at my place of work.					
I know how to apply FES.					
I have sufficient time to apply FES (eg, sufficient treatment duration or frequency).					
I prefer to use other treatment options.					
There is a lack of evidence to justify the use of FES in clients with stroke.					
I have sufficient training in FES.					
Practical “hands-on” training would increase my use of FES.					
I am not sure when to introduce FES in my treatment program.					
I tried using FES in my practice but did not have much success with it.					
I use FES in clients who have conditions other than stroke.					
I would like to increase the use of FES in my practice.					
My clients with stroke are apprehensive about using FES.					
My clients with stroke have access to FES devices for home use.					

(Continued)

Appendix.
Continued

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
FES does not benefit clients with chronic stroke (ie, more than 1 year poststroke).					
My colleagues use FES in their practice.					
My place of work or manager supports the use of FES as a treatment.					

What facilitates your use of FES in your practice, if anything?

What prevents your use of FES in your practice, if anything?

16. How strongly do you agree or disagree with the following statements?

There is strong scientific evidence^b that FES can:	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Improve arm function poststroke					
Prevent shoulder subluxation poststroke					
Improve walking performance poststroke					
Reduce hemiplegic shoulder pain					

^a The functional electrical stimulation survey may not be used or reproduced without written permission from the authors.

^b Strong evidence=finding supported by a meta-analysis or several randomized controlled trials.