CLINICAL REHABILITATION

Afferent stimulation provided by glove electrode during task-specific arm exercise following stroke

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Abstract

Background: Sensory amplitude electrical stimulation (SES) and repetitive task practice reduce impairments and arm dysfunction when delivered separately following stroke.

Objective: To determine if home-based, task-specific arm exercise was more effective when administered concurrent with SES.

Methods: Thirty-eight subjects with chronic stroke and mean Fugl-Meyer Assessment (FMA) score 28/66 (15–45) participated. Subjects were randomly assigned to an SES ($n = 20$) or sham stimulation ($n = 18$) group. Subjects engaged in task-based home exercise for 30 minutes, twice daily, for four weeks while wearing a glove electrode on the impaired hand. Experimental subjects received SES while control subjects received sham stimulation during exercise. Primary outcome measures: FMA and Arm Motor Ability Test (AMAT).

Results: There were no significant between-group differences for outcome measures. There was a significant difference between the pre- and post-test scores in the SES group AMAT median time ($P = 0.003$ 95% confidence interval (CI): −14.304, −6.365; effect size: 0.84). Practice time was not associated with changes in outcomes. Subjects with more sensorimotor dysfunction had significantly greater improvements on AMAT median time ($P = 0.037$). There was a significant relationship between baseline FMA score and FMA change score ($r = 0.402$; $P = 0.006$).

Conclusions: This study describes a unique SES delivery system via glove electrode that enabled delivery of SES during home-based arm task practice in stroke survivors. Task practice with concurrent SES did not demonstrate significantly better effects than task practice with sham stimulation, however there was a trend for greater improvement in one activity measure.

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Introduction

There is a growing population of Americans living with stroke-related disability.[1] The majority of these individuals experience limited functional use of their involved arms[2] and accomplish daily activities primarily by using their non-paretic arms.[3] Arm dysfunction is associated with low subjective well-being following stroke.[4]

Recent literature has demonstrated that gains in arm function are possible following stroke, provided that interventions are task-based and of sufficient intensity.[5–9] Neuromuscular electrical stimulation (NMES) is provided at an amplitude sufficient to elicit a motor (muscle) response and has been used to assist individuals with insufficient active movement capacity for task-based practice, with positive changes reported in active movement and arm function outcomes following stroke.[10–13] Muscle fatigue, however, can limit the length of NMES sessions. Home-based electrical stimulation has been successfully employed, allowing the user to distribute practice sessions throughout the day, thus minimizing fatigue.[13–16]

Muscle fatigue does not limit the length of stimulation sessions when stimulus amplitude is at a sensory level. Numerous terms have been used to define sub-motor electrical stimulation, including cutaneous stimulation,[17] sensory stimulation,[18] somatosensory stimulation,[19] sensory transcutaneous electrical stimulation[20] and transcutaneous electrical stimulation.[21,22] For the purposes of this paper, the term sensory electrical stimulation (SES) will be used to describe stimulation amplitude 'at which the subject could just perceive the stimuli, but below the level that produced an observable or palpable muscle contraction' (ref. 14, p. 144). In healthy individuals, SES has been shown to result in increased cortical motor excitability[23–26] and short-term plastic changes in the sensory and motor cortices.[21,25,27,28] Following stroke, SES has been reported to enhance sensory perception,[14,17] arm function,[14,29–31] movement kinematics,[32] pinch force[18] and use-dependent cortical plasticity.[33,34] A recent systematic review concluded that SES has beneficial effects on motor recovery after stroke, especially when used in conjunction with active training.[20] In a lower extremity paradigm implemented following stroke, greater changes in motor cortical excitability were achieved when electrical stimulation was paired with voluntary activity.[35]

Previous studies reported administering SES using small surface electrodes in a relatively passive mode *prior to* exercise.[14,18,19,31,32,36,37] In those studies, electrodes were located on the pads of the fingertips[14] and over superficial peripheral nerves.[19,37,38] Glove electrodes have primarily been used to deliver electrical stimuli for the purposes of pain relief.[39] Only one previous study reported using glove electrodes following stroke.[40] The advantage of a glove electrode delivery system is that it permits the simultaneous delivery of SES *during* task-specific arm exercise.

The purpose of this study was to compare SES to sham stimulation delivered via glove electrode during task-specific arm exercise following stoke. We had three hypotheses: (1) that subjects in the SES group would experience greater changes in body structure function and activity-level outcome measures, (2) that the amount of practice time would be associated with outcomes and (3) that baseline motor capacity would be associated with outcomes.

Methods

Adults with stroke onset greater than six months prior were recruited from a local stroke registry. Inclusion criteria included a diagnosis of unilateral arm paresis following stroke at least six months previously and a score of 15–50/66 on the arm subscale of the Fugl-Meyer Assessment (FMA).[41] Exclusion criteria were botulinum toxin A to the involved arm within the past six months, motor impairment in the uninvolved arm, complaints of pain in either arm and contraindications to the use of electrical stimulation. Subjects received information about the purposes and procedures of the study and signed a consent form approved by the Offices for Protection of Human Subjects at Northwestern University.

A flow diagram of enrollment based on the Consolidated Standards of Reporting Trials (CONSORT) statement is illustrated in Figure 1.[42] Using a random number generator, the first 22 subjects were assigned to an experimental (SES) or
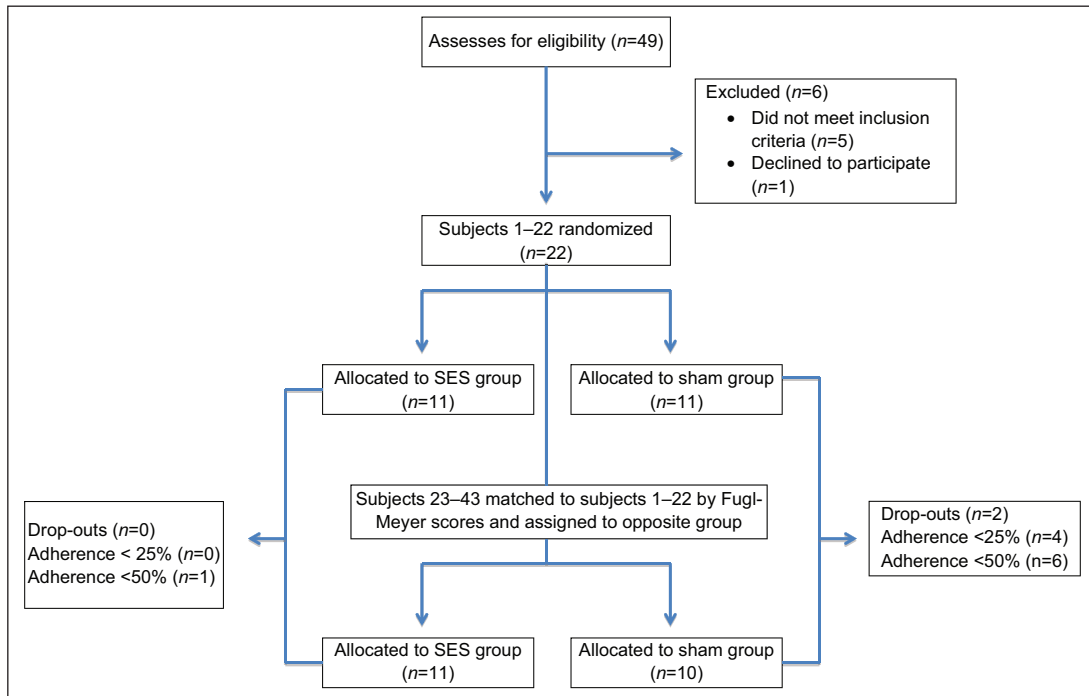
Figure 1. CONSORT flow diagram: 49 subjects were recruited; 43 met the inclusion criteria; 1 declined to participate. The first 22 subjects were randomized to an experimental (SES) or control (sham) using a random number generator. Subjects 23–43 were matched by Fugl-Meyer Assessment scores (= /– 3) to subjects 1–22 and placed in the opposite group.

control (sham stimulation). The remaining subjects were matched to subjects 1–22 by Fugl-Meyer Assessment scores (±3) and assigned to the opposite group.

Outcome measures were assessed at baseline and following the four-week intervention by a research physical therapist who was blinded to the subjects' group assignment. The two primary outcome measures were the FMA[43] and the Arm Motor Ability Test (AMAT).[44] Secondary outcome measures included the Motor Activity Log-14,[45] Perceptual Threshold Test – Electrical Stimulation (PTTES),[22] Nottingham Stereognosis Assessment,[22] Stroke Impact Scale-16[46] and the Tardieu Scale of Spasticity.[47]

The FMA measures active movement capacity and reflexes following stroke.[43] The reliability and validity of the FMA has been demonstrated in the post-stroke population.[41,48] The AMAT is composed of 28 unilateral and bilateral arm activities

involving manipulation of everyday objects. Scoring is based on functional ability, quality of movement and time.[44] The test has been shown to be valid, reliable and sensitive in stroke subjects.[44] The Motor Activity Log-14 measures an individual's perception of the quality and amount of arm function on 14 daily tasks following stroke. It has been reported to be a highly reliable, valid and responsive measure in chronic stroke.[49] The Nottingham Stereognosis Assessment measures stereognosis. Scoring is based on an individual's ability to identify or describe salient characteristics of the 10 standardized objects placed in the hand while blindfolded. The scale is reported to have high intra-rater and inter-rater reliability in a post-stroke population.[50] The PTTES measures a subject's perceptual threshold for electrical stimuli. This test has been reported to be reliable when used in the hand following stroke.[22] The Stroke Impact Scale-16

measures an individual's perception of the impact of stroke on 16 functional activities. It has been demonstrated to be a reliable and valid measure of limitations in physical activity following stroke.[46] The Tardieu Scale of Spasticity[47] examines spasticity or velocity-dependent increases in muscle tone. This test has been reported to be reliable and valid for use following stroke.

A programme of home-based, task-specific activities was individualized for each subject using the Canadian Occupational Performance Measure.[51] This tool employs a structured interview format to determine an individual's goals and priorities. A minimum of 10 practice activities was selected for each subject based on interest and motor capacity. Many of the tasks involved self-care, homemaking and leisure activities. Where possible, everyday objects were incorporated into the tasks; subjects that could actively grasp and hold the objects were instructed to do so, while objects were passively positioned in the hands of subjects with little or no active grasp. Bilateral activities were included where possible (e.g. opening containers, fastening clothing). Individuals with minimal proximal active movement performed activities primarily on a table top, while tasks for those with greater proximal movement capacity involved lifting and moving objects against gravity.

Subjects were told that they would be assigned to a sensory (SES) or a subsensory (sham) group. To control for placebo effects, both groups were described as involving exercise. All subjects were instructed to exercise at home using the glove electrode (Prizm Medical, Inc., Oakwood, GA, USA) with a second electrode over the common extensor muscle mass in the forearm (Figure 2). Subjects were instructed as to how to adjust the stimulation amplitude during practice sessions. Experimental group subjects were provided with an amplitude adjustment based on their PTTES results. Sham group subjects were instructed to adjust the stimulation to '10'. All subjects were instructed to exercise twice daily for 30 minutes, 5 days/week for four weeks (a total of 40 possible sessions). The stimulators' compliance meter recorded practice time for all subjects. During practice, subjects in the SES group received electrical stimulation with the

Figure 2. Subject performing a functional task while wearing the glove electrode and a second electrode on the dorsal forearm.

following current parameters: symmetrical biphasic waveform, pulse duration 250 microseconds, amplitude at sensory threshold, frequency 35 Hz, and a duty cycle of 10 seconds ON: 10 seconds OFF. Stimulation was delivered using an EMPI 300 PV (EMPI, Inc., St. Paul, MN, USA) neuromuscular stimulator. Subjects in the sham group wore an electrode glove and electrode attached to the sham stimulator. The sham stimulators' timer and lights were active; the amplitude was adjustable; however no current was delivered.

Power analyses were performed to determine sample size while ensuring detection of significant differences ($P = 0.05$). The analyses were performed for a non-parametric Wilcoxon paired sample sign rank test on the FMA scale for a power <0.9. The power for $n = 20$ was sufficient for comparisons with impairment scales such as the FMA.

Descriptive statistics were used to analyse subject pre-test characteristics. Mann–Whitney *U*-tests were used for comparison of group pre-test data (age, FMA score, length of time since stroke). An intention-to-treat analysis was employed using non-parametric statistics (Mann–Whitney *U*-test, Wilcoxon signed rank test and Spearman rank correlation coefficient). Bonferroni adjustments were employed for repeated comparisons. Hedges' *g* was used to calculate effect sizes for between groups

Table 1. Subject demographic data

	All subjects (*n* = 38)	Sham (*n* = 18)	SES (*n* = 20)	
FMA mean baseline score (max–66)	27.7 ± SD (15–46)	27.4 ± SD (15–46)	29.1 ± SD (15–45)	P = 0.558
Age (years)	60.6 ± SD (37–88)	59.5 ± SD (41–85)	61.6 ± SD (37–88)	P = 0.312
Time since stroke (years)	7.2 ± SD (1–29)	6.6 ± SD (3–14)	7.7 ± SD (1–29)	P = 0.895
Involved side	21 left; 17 right	11 left; 7 right	10 left; 10 right	
Gender	27 male; 11 female	14 male; 4 female	13 male; 7 female	

FMA, Fugl-Meyer Assessment.

comparisons.[52] The difference between the post-test and pre-test means divided by the standard deviation of the pre-test was used for within-group effect size determinations.[52] IBM SPSS versions 19 and 203 were used for all statistical analyses using a *P*-value <0.05.

Results

Forty subjects were enrolled. Thirty-eight subjects completed the study – 18 in the sham group and 20 in the SES group. There were 2 dropouts in the sham group and none in the SES group. Baseline FMA scores, age and length of time since stroke were not significantly different between the SES and sham groups (*P* = 0.558, *P* = 0.312). There was a similar distribution of involved side and gender between groups. Overall, there were slightly more subjects with left body involvement and 60% of the subjects were male (Table 1).

Total practice time as recorded by the stimulator compliance meter was not significantly different between groups (*P* = 0.144). The mean number of practice sessions was 37.5 (93.7%) of the recommended 40 sessions (31.9 sham, 42.4 SES; *P* = 0.396). Thirteen subjects practised for more than 40 sessions (6 sham, 7 SES). Seven subjects completed fewer than 50% of the recommended sessions (6 sham, 1 SES), while 4 subjects completed fewer than 25% (4 sham). The amount of practice time was not associated with a change in any outcome measure. The subjects who practised less than 50% of the recommended 40 sessions had significantly lower initial FMA scores than those who practised more than 50% (*P* = 0.027).

We did not find statistically significant between-group differences for change scores on the primary or secondary outcome measures (Table 2). However, there was a statistically significant difference between the pre- and post-test scores for the AMAT median time (*P* = 0.003) in the SES group (Table 3). The sham group showed a slight increase in AMAT median time (their performance was *slower* at post testing) while the SES group decreased median time by an average of 10 seconds. There was a moderate and significant correlation between the baseline FMA and FMA change scores (*r* = 0.402, *P* = 0.006) (Table 4). Subjects with more sensorimotor dysfunction at baseline, as evidenced by low baseline FMA scores (<28.29) and high PTTES thresholds (>1.67) had significantly greater improvements on the AMAT median time (*P* = 0.037) as compared with subjects who had high FMA scores and low PTTES thresholds at baseline.

Discussion

To our knowledge, this is the first study to report on repetitive task-practice while SES was delivered by glove electrode following stroke. Employing a glove electrode permitted simultaneous delivery of SES and repetitive practice. A previous study by Peurala and colleagues utilized sock and glove electrodes to deliver electrical stimulation at subsensory amplitude in a post-stroke population, and reported significant differences in experimental subjects' arm and leg motor capacity, walking distance, arm sensation and arm function.[40] That study differed from the present one in three ways: utilization of amplitude below the level of sensory appreciation,

Table 2. Between-group comparisons of change scores for primary and secondary outcome measures

	Mean AMAT median time (seconds)	Mean AMAT total score	Mean FMA total score	Mean FMA time difference (seconds)	Mean MAL-14	Mean NSA	Mean PTTES (mA)	Mean SIS-16
SES								
Mean ± SD	9.43 ± 10.28	0.05 ± 0.24	1.75 ± 3.46	1.42 ± 7.81	0.20 ± .88	0.95 ± 2.44)	0.08 ± 0.60	1.55 ± 7.01
Range	−22.277– 21.579	−0.357– 0.414	−4–9	−16.946– 27.499	−2.214– 2.214	−2–8	−1.17–1.33	−9–19
Sham								
Mean ± SD	2.00 ± 12.75	0.03 ± 0.44	1.24 ± 5.27	0.80 ± 4.70	0.11 ± 1.08	0.44 ± 1.76	0.75 ± 2.54	3.00 ± 5.91
Range	(−16.854– 19.510)	−0.786– 0.821	−6–17	−6.936– 14.193	−3.429– 1.714	−2–5	−0.83–9.67	−5–16
P-value	*P* = 0.075	*P* = 0.781	*P* = 0.439	*P* = 0.648	*P* = 0.599	*P* = 0.712	*P* = 0.918	*P* = 0.371
95% CI	(−17.186, 1.084)	(−0.259, 0.216)	(−3, 1)	(−2.762, 1.476)	(−0.500, 0.357)	(−1.000, 1.000)	(−0.333, 0.333)	(−2.000, 6.000)
Effect size	0.63	0.06	0.11	0.09	0.09	0.23	−0.36	−0.22

AMAT, Arm Motor Ability Test; FMA, Fugl-Meyer Assessment; MAL-14, Motor Activity Log-14; NSA, Nottingham Stereognosis Assessment; PTTES, Perceptual Threshold Test – Electrical Stimulation; SIS-16, Stroke Impact Scale-16.

stimulation was not delivered during exercise, and in-clinic treatment. The high degree of variability in electrode placement reported in prior SES studies[20] makes it difficult to determine optimal electrode delivery systems and location. Future research may be helpful in determining the relationship between electrode type, location, and outcomes.

The myriad of electrical current and task-practice parameters used in this and prior studies poses challenges in determining optimal intervention characteristics. Using a paradigm similar to that used in the present study, we reported improvements in arm impairment as well as function following combined SES and NMES.[14,15] However, in these studies, subjects were asked to pay attention to the SES but did not engage in task practice during stimulation.[14,15] Stimulation in the present study was administered *during* task practice in keeping with prior reports that active training during SES enhanced motor and functional recovery[20,53] and resulted greater changes in motor cortical excitability following stroke.[35] However, prior studies have reported benefits in movement and function when SES was delivered *before* exercise.[14,18,19,31,32,36,37] It

is unclear whether there is a differential effect when SES is delivered *before* compared to *during* exercise.

Current amplitude in the present study was adjusted above sensory but below motor amplitude in keeping with prior SES studies that reported positive motor and functional outcomes with this current intensity.[19,31,36,53] Laufer and Elboim-Gabyzon[20] recently published a systematic review of 15 studies that utilized SES post stroke. Eight of the 15 studies reviewed reported the electrical pulse characteristics that were employed. The current study's pulse frequency and duration were similar to those used in previous SES studies.[20] Seven reporting studies utilized continuous stimulation; only one study[54] utilized an ON:OFF duty cycle similar to the present study. The duty cycle was chosen for this study in an attempt to minimize sensory habituation, since attention to sensory stimuli has been reported to influence remodelling in the sensory cortex.[55] The effect of frequency and amplitude on cortical motor excitability was studied in healthy individuals who received one of four amplitude/frequency combinations via glove electrode.[26] Stimulation at either

Table 3. Within-group comparisons for SES and sham groups for primary and secondary outcome measures

	Mean AMAT median time (seconds)	Mean AMAT total score	Mean FMA total score	Mean FMA time difference (seconds)	Mean MAL-14	Mean NSA	Mean PTTES (mA)	Mean SIS-16
SES group								
Pre								
Mean ± SD	27.23 ± 11.18	2.11 ± 0.81	29.05 ± 8.48	10.88 ± 9.76	1.57 ± 1.09	10.65 ± 7.98	1.79 ± 0.94	64.95 ± 10.99
Range	8.446–51.036	1.036–3.821	15–45	0.148–40.298	0.5–4.29	0–19	0.50–3.83	45–79
Post								
Mean ± SD	17.80 ± 16.91	2.16 ± 0.82	30.8 ± 10.36	9.47 ± 10.39	1.77 ± 1.01	11.6 ± 7.69	1.71 ± 0.69	66.5 ± 9.21
Range	4.050–60.000	1.036–3.893	15–51	0.421–48.539	0.36–3.86	0–19	0.5–3.00	46–79
P-value	*P = 0.003	P = 0.305	P = 0.035	P = 0.279	P = 0.130	P = 0.116	P = 0.617	P = 0.571
95% CI	−14.304, −6.365	−0.177, 0.065	0.000, 3.000	−0.644, 2.674	−0.071, 0.536	0.000, 1.500	−0.333, −0.167	−2.000, −4.500
Effect size	0.84	0.06	0.20	0.14	0.18	0.12	0.09	0.14
Sham group								
Pre								
Mean ± SD	29.34 ± 14.81	2.14 ± 0.96	27.44 ± 9.30	8.45 ± 6.95	1.49 ± 1.16	10.28 ± 8.764	2.97 ± 3.05	63.44 ± 10.96
Range	6.223–52.381	0.643–3.481	15–46	0.503–29.163	0.00–4.79	0–20	0.50–13	47–78
Post								
Mean ± SD	26.58 ± 24.41	2.17 ± 1.15	28.61 ± 11.29	7.65 ± 5.05	1.60 ± 1.12	6.42 ± 8.66	2.22 ± 1.21	66.44 ± 8.82
Range	2.415–60.000	0.464–4.115	12–49	0.891–18.368	0.00–4.00	0–20	1.00–4.67	47–78
P-value	P = 0.5	P = 0.959	P = 0.462	P = 0.679	P = 0.300	P = 0.379	P = 0.875	P = 0.059
95% CI	−9.51, 5.0	−0.131, 0.274	−1.000, 3.000	−1.350, 1.980	−0.107, 0.607	−1.5, 0.5	−0.500, 0.250	0.000, 6.000
Effect size	−0.19	0.03	0.13	−0.12	0.09	−0.44	−0.25	0.27

*P < 0.00625.
AMAT, Arm Motor Ability Test; FMA, Fugl-Meyer Assessment; MAL-14, Motor Activity Log-14; NSA, Nottingham Stereognosis Assessment; PTTES, Perceptual Threshold Test – Electrical Stimulation; SIS-16, Stroke Impact Scale-16.

Table 4. Correlations between primary and secondary outcome measure change scores and pre-test FMA score and practice minutes

	Correlation with pre-test FMA	Correlation with practice minutes
Mean AMAT median time (seconds)	0.32 P = 0.025	0.099 P = 0.278
Mean AMAT total score	0.235 P = 0.078	−0.056 P = 0.369
Mean FMA total score	0.402 P = 0.006*	0.265 P = 0.054
Mean FMA time difference (seconds)	0.046 P = 0.393	0.073 P = 0.333
Mean MAL-14	0.598 P = 0.01	0.208 P = 0.106
Mean NSA	0.114 P = 0.248	0.016 P = 0.462
Mean PTTES (mA)	−0.015 P = 0.464	0.067 P = 0.344
Mean SIS-16	0.146 P = 0.190	0.032 P = 0.426

P < 0.0065.

sensory amplitude/50 Hz or motor amplitude/2 Hz was noted to induce comparable long-lasting effects on corticomotor excitability. Laufer and Elboim-Gabyzon speculated that the similarity of effect might be due to the fact that NMES activates muscle spindles and golgi tendon organs while sensory amplitude stimulation delivered via glove activates a large area of cutaneous receptors.[26] More rigorous studies are needed to better determine the physiologic and functional effect of various current characteristics.

Our study's four-week, 40-session treatment duration was within the range of the 10 studies reviewed by Laufer and Elboim-Gabyzon[20] that involved multiple sessions. The practice schedule utilized in this study, while similar to previous SES studies,[20] may not have been sufficient for a beneficial effect, compared with other arm interventions following stroke that utilized significantly more intensive practice schedules.[56,57] Knutson and colleagues[58] reported that six weeks of combined active practice with NMES improved hand movement and function, but a follow-up study demonstrated that extending the intervention period to 12 weeks resulted in greater gains.[59] A recent study reported on subjects who received electrical stimulation during repetitive task practice for 30, 60 or 120 minutes daily for eight weeks. Significant changes were seen in motor capacity (Fugl-Meyer scores) and function (Arm Motor Ability Test) only in the 120-minute group.[60] While this recent report suggests that longer practice sessions may be more beneficial, the optimal dose–response relationships for electrical stimulation interventions following stroke remain to be determined.

We found greater improvement in motor capacity and function in subjects with greater baseline motor capacity (FMA), which is consistent with what has been previously reported in interventions employing NMES[10] and with combined NMES and SES.[14] However, subjects with greater sensorimotor impairment at baseline had greater improvement on the AMAT median time. This finding is similar to that reported in an SES study which found a greater effect in subjects with lower baseline capacity.[31] The subjects who practised less than 50% of the recommended sessions had significantly lower baseline FMA scores than those who practised more than 50%. Perhaps subjects with more active movement capacity were able to practise higher level tasks that they found more interesting and/or functionally significant. Future studies might further explore this phenomenon by stratifying subjects by baseline motor capacity and tailoring practice tasks and schedules accordingly.

There were several limitations to the study. Since the intervention was carried out at home, we are unable to verify what subjects actually did during the time the stimulator was running. Had a researcher been present during training, assurances could have been made that the subjects not only adhered to the recommended practice tasks, but that tasks were progressed in difficulty as the subjects improved. In our study, several subjects in both groups reported difficulty donning the electrode glove. Glove donning problems may have compromised practice; however overall adherence was high (93.7%) and no subject reported not practicing due to the glove. In addition, use of the glove electrode precluded practise of some functional tasks involving water (e.g. washing dishes) or requiring fine manipulation (e.g. counting coins). Technical improvements in the electrode glove that increase the ease of donning and manipulating small objects would enhance its utility.

The glove electrode delivered stimulation over the entire surface of the glove rather than specifically over those muscles needed for individual tasks. Whether this affected outcomes is unclear. A recent study by Meesen and colleagues[28] suggests that SES effects in the motor cortex extend beyond the representation area of the stimulated nerve(s). Despite the fact that practice time was not associated with outcomes, there were more sham group subjects with low compliance. It is possible that feeling the stimulation may have been a positive or reinforcing experience for SES subjects. Our performance-based functional outcome was the AMAT,[44] a measure that has been used largely in constraint-induced movement therapy trials.[61] Positive findings in SES trials using the Jebsen–Taylor Hand Function Test as an outcome measure suggest that this may be a more sensitive functional outcome.[19,31,62] Future studies of this intervention

would be strengthened by the inclusion of a follow-up testing session. Finally, the relatively small number of subjects in this study limits generalizability.

The current study describes a unique sensory electrical stimulation delivery system via glove electrode during home-based task practice. We believe that future studies should explore whether SES during task-specific practice has greater effects if practice is more intensive or supervised by a researcher, compare the effects of SES administered *before* versus *during* task practice, and explore stratifying the intervention based on baseline motor capacity.

Clinical messages

- A glove electrode permits simultaneous delivery of electrical stimulation during arm task-specific arm exercise.
- Sensory amplitude electrical stimulation provided during functional task exercise may contribute to changes at the activity level post stroke.

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