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 Improving Hand Recovery in Tetraplegia Through the use of Meaningful Occupations: A Qualitative Case Series

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**ABSTRACT**

**Purpose:** This qualitative descriptive study explored participants’, with chronic spinal cord injury (SCI), experiences with meaningful intensive task specific training (ITST). **Methods:** Three participants completed 24-ITST upper extremity motor therapy intervention sessions. Qualitative interviews were completed at three time points for a case series: baseline, within 7 days of the completion of the final ITST intervention session, and within one month of the final ITST intervention session for a total of 9 interviews. **Results:** Three themes were identified including: Quality of Movement Enhances Normal Use of Hands, Empowering Through Education and Motivation to Participate and Enhance Quality of Life. Through the use of motor learning concepts, positive reinforcement, and education positive outcomes were reported and promoted self-efficacy in all participants. **Conclusions:** A collaborative and client-centered approach to rehabilitation with a focus on performance-based goals was found to increase self-efficacy leading to greater independence and self-determination for participants. Interventions focusing on meaningful client-centered occupations are recommended. Individuals with chronic SCI typically do not have access to rehabilitation services and more research is needed on interventions to further explore the benefits of additional rehabilitation services and an increased focus on practitioner education on optimal interventions for chronic injury populations.

**Keywords:** intensive task specific training, client-centered, neuroplasticity, chronic spinal cord injury, self-efficacy



**INTRODUCTION**

Every year, there are approximately 18,000 new cases of spinal cord injury (SCI) in the United States, and between 250,000 and 500,000 new cases worldwide.1, 2 It is estimated that 288,000 people are currently living with a spinal cord injury in the United States.1 Efforts to minimize neurologic damage in acute SCI have met with limited success, and less than 1% of survivors completely recover leaving the vast majority of patients with a long-term disability that can significantly impact their quality of life.3-4 Furthermore, almost two-thirds of SCI cases are cervical, which constitutes the etiology for tetraplegia. 4,5 Because the initial injury often occurs during early adulthood, SCI can also translate to disproportionate healthcare costs associated with lifelong needs. The cost of clinical care for tetraplegia generally exceeds that of paraplegia because the presence or absence of upper extremity (UE) motor function can determine the difference between independence and the need for assistance in many activities of daily living (ADLs).4,6 In general, the loss of UE function that accompanies cervical SCI dramatically affects meaningful, independent engagement in multiple life domains, including basic and instrumental ADLs; mobility; general quality of life, including depression; family relations/caregiver burden; and societal integration.7 Dysfunction associated with chronic SCI will vary as ADLs and other life activities change throughout the lifespan. Thus, it is vitally important to establish effective interventions to maximize functional independence and prevent further disability in chronic cervical SCI.

Numerous studies have shown that the mature central nervous system can reorganize to a degree previously thought feasible only during the early post-natal period. This enduring morphological or functional reorganization, also known as neuroplastic change, can occur in corticospinal motor systems during motor performance and in response to either therapeutic interventions and/or nervous system injury.8-11 Extensive evidence shows that training that is active and highly repetitive with progressive challenge and salience (e.g. intensive task-specific therapy, functional tasks) is more conducive to neuroplastic changes. These concepts have significantly influenced modern rehabilitation.8, 12, 13 Recent studies in SCI have shown that intensive task-specific training can augment motor recovery, even in the chronic phase as shown by improvement in muscle strength in both upper and lower extremities, pinch, grasp, and other outcome measures of motor function.14 For example, Cortes et al. evaluated 10 subjects with chronic SCI who participated in 6 weeks of intensive motor training via a robotic device and reported significant post-intervention improvement in UE outcome measures compared to baseline.15 Raithatha et al showed that intensive task-specific training in the form of locomotor training can improve lower extremity function in participants with chronic and incomplete SCI.14 Mateo et al found that using cognitive approaches, such as motor imagery, in addition to UE rehabilitation were effective to increase grasp function for participants with chronic SCI ranging from six months to 30 months post-injury.16 Such evidence suggests that in individuals with a chronic SCI, intensive motor therapy can improve UE motor function and when paired with cognitive tasks functional neuroplasticity may occur.17 Additionally, evidence supports that motor function can be improved when adjuvant neuromodulatory intervention is paired with motor therapy in individuals with SCI.14

A meaningful task-specific approach is based on motor learning principles that utilize intensive participation in client-centered, occupational tasks in order to promote function.18 In this context, occupation is defined as “everyday activities that people do as individuals, in families and with communities that occupy time and bring meaning and purpose to life”.19 While literature focused on the utilization of a task-oriented approach for SCI is limited, there are studies that have demonstrated positive outcomes on function for individuals with SCI. Spooren and colleagues developed training modules using a task-oriented approach to address arm and hand performance in individuals with cervical SCIs.20 In their study, participants demonstrated improvement in various areas of arm and hand function, specifically in the area of performance satisfaction using the Canadian Occupational Performance Measure (COPM). It was suggested that a task-oriented model, based on client-specific goals, may be beneficial to individuals with chronic disabilities related to SCI because it addresses changing needs throughout the lifetime.20 Additionally, client-centered therapies can be used with an intensive task-specific approach, and have been found to be supportive of the transition between the curative, acute phase to functional management in the chronic phase of long-term disability.21

While most studies have focused on functional improvement and motor functions as outcome measures, few have explored the qualitative outcomes of intensive task-specific rehabilitation approaches from the patient’s perspective. Therefore, the purpose of this qualitative descriptive study was to understand the participant experiences with intensive task-specific training (ITST) specifically for UE performance. Additionally, the grand tour question of this study was to explore the role of perceived meaningfulness of intensive tasks specifically related to training illustrating the participants’ perception of their ability to perform in real-life, functional settings. Such data will pertain to satisfaction, personal function, quality of life, client-centered care, and/or other information that may be salient to functional recovery.

**MATERIALS AND METHODS**

**Ethical Statement**

All experimental protocols were approved by the institutional review board at the University of Kentucky (protocol# 50712). Informed written consent was obtained from all participants before this study enrollment. Preliminary results from this case series were presented at a local professional conference.

**Participants**

Participants in this qualitative study were part of a larger double-blinded, randomized study where the main objective of the project was to evaluate whether the application of non-invasive brain stimulation could maximize the effects of ITST specifically for UE. As such, one participant (Sam) received the active brain stimulation intervention, whereas the other two participants (Carrie and Ken) received the control intervention (sub-threshold sham stimulation). The focus of this case series was to describe the three participants’ experiences with ITST with a client-centered focus and explore the meaningfulness of the ITST intervention. Because this study was focused on the ITST experience, which was similar across participants, we are not further dividing the participants by group assignment.

Participants were considered for inclusion if they had suffered a traumatic, incomplete cervical SCI sustained at neurological level C4-C7 and classified as B, C, or D by the American Spinal Injury Association Impairment Scale (AIS); sustained injury at least 1 year prior to enrollment (i.e., chronic); and men and women between the ages of 18-65. Participants were excluded from participation if: they had a history of head injury, seizures, severe alcohol or drug abuse, or psychiatric illness; cognitive deficits severe enough to preclude informed consent; positive pregnancy test or being of childbearing age and not using appropriate contraception; decubitus ulcers that might interfere with intervention; cardiac or neural pacemakers or presence of ferromagnetic material in the cranium except in the mouth, including metal fragments from occupational exposure and surgical clips in or near the brain (as these are known to be potentially affected by brain stimulation); fixed UE contractures; untreated depression; concurrent participation in occupational therapy; and within 3 months of recruitment, an addition or change in the dosage of drugs known to exert detrimental effects on motor recovery.

**METHOD**

After obtaining consent, participants underwent a baseline (pre-intervention) motor function assessment and a qualitative semi-structured interview. The assessment and the interview were designed to determine the participant’s baseline level of functionality (COPM) and to gather information to aid in the motor function ITST treatment plan of meaningful activities.

Following the baseline assessment, participants completed 24-ITST UE motor therapy intervention sessions (3 sessions/week for 8 weeks). Each ITST session lasted for 2 hours, during which the ITST focused on skill acquisition using activities to improve functional use of the impaired UE. For example, Carrie indicated one of her goals was to apply nail polish to her fingernails. To shape this behavior and enable her to acquire this skill the therapist broke down the motor movements into the successive tasks needed to accomplish the goal. Step 1 was to identify and train the grasp pattern needed to hold the nail polish brush. Step 2 incorporated the UE movement needed to control the hand movements, as these were easier for Carrie than utilizing the wrist movements for controlling brush strokes. Step 3 built on the previous two steps and combined the grasp pattern with the UE movements. Once these steps were combined, Carrie then practiced for 3-5 sets of 20-30 repetitions. For each set, the therapist applied progressive resistance or made movement more difficult using the concept of shaping the movement. Tasks were repeatable and had an occupationally-oriented goal relating to daily living or a prerequisite to occupational performance, such as pinching, grasping, reaching, or release with 6 to 8 different occupational tasks being selected for each session. An ITST session differed from a traditional occupational therapy session as the focus was on increasing independence in activities of daily living, such as completing the overall task of bathing, dressing, and eating, and not a specific component of the task. Specific tasks were chosen by the participants the time practicing, number of repetitions, feedback was provided, and was recorded to ensure consistency and monitor progress across participants.

Qualitative outcomes were assessed at three-time points presenting a case series: baseline (prior to the start of the ITST intervention), within 7 days of the completion of the final ITST intervention session (immediate follow-up), and then within one month of the final ITST intervention session (1-month follow-up).

**Assessment of Meaningful Occupational Performance**

Occupational therapists conducted the Canadian Occupational Performance Measure (COPM). The COPM is a quality-of-life measure that uses a 10-point scale upon which clients score their own occupational performance, as well as their satisfaction with performance, in relation to up to five self-selected occupational tasks. The COPM was completed in an interview format and was designed to create a client-centered intervention. The COPM has high test-retest reliability for scores in both performances (0.89, p< 0.001) and satisfaction (0.88, p< 0.001). McColl et al. found that the COPM has moderate construct validity and high community utility with a population of community-living individuals.22 The minimal clinically important difference (MCID) of COPM specifically for SCI has yet to be established. However, for the purpose of this study, we used MCID of 2 for both COPM performance and satisfaction which has been established for patients with hand impairment.23

**Intervention**

Participants engaged in ITST interventions specifically focused on occupation-based goals established through the completion of the COPM. ITST interventions were focused on restoring participant motor skills or abilities previously lost which included trunk, head, and upper limb motor function and control for specific task performance. Participants were encouraged to visualize themselves completing an occupation-based goal using the motor skills they wished to achieve (motor imagery), and would then engage in the functional task itself (e.g. occupation-based intervention). If participants could not achieve the desired function-based outcome, then they would complete a component of the specific intervention to their own unique ability (e.g. shaping). Throughout the study, participants played an active role in the therapy process, by establishing goals but also engaging in problem-solving during interventions. Interventions promoting self-determination through active participant engagement were an important component of this research study as it has been shown to promote autonomy and motivation.24

An important distinction between the ITST exercises, which were aimed to increase grasp and/or pinch utilized in this study, and traditional occupational therapy was that participants were discouraged from using a tenodesis grasp (grasp patterns used with the wrist in extension and fingers in flexion). While tenodesis grasp may assist with holding objects with the hands after cervical SCI, it does not promote voluntary activation of the muscles involved with finger flexion. In order to elicit actual and voluntary activation of the fingers and to follow the concepts of neuroplasticity, grasp and pinch exercises in this study were performed with the wrist in flexion. Another important component of the ITST used in this study was to provide a multisensory approach that is also considered crucial to maximize neuroplasticity. Multisensory stimulation has been shown to produce functional changes in individuals with SCI.25 The multisensory approaches used in this study included providing individuals with tactile, auditory, and visual feedback. In addition, researchers prioritized providing participants with positive feedback. Participants were given verbal feedback, regarding the quality of their movement, in high amounts every time they completed a task or a component of a task to promote improved performance. Participants were encouraged daily to engage in their desired occupations daily as their home program utilizing the study’s preferred grasp and movement patterns.

**Data Analysis**

Semi-structured interviews were conducted by authors CSP and ACG for all participants. Baseline interviews addressed motivations for participation, quality of life, and personal goals related to the study. The completion and follow-up interviews provided a longitudinal understanding of the participants’ overall impressions of the study along with their satisfaction with their results. Interviews took place in private settings at the study site. Interviews were digitally recorded and transcribed verbatim.

Open-ended questions were used to collect rich responses and probing questions were asked if needed. Examples of some interview questions are:

* What are your goals for taking part in the study?
* What part of this study is important to you?
* What are your goals regarding your performance ability?
* What do you want to be able to do to take care of yourself?
* What is important to you to take care of yourself? Is there anything that is difficult for you that you feel participating in this study will make easier?
* Do you have any recreational activities that you are currently not able to participate in that you would hope to resume again upon completing the study?
* Why is it important for you to participate in this study?

At discharge and one-month follow-up questions included:

* Did you get the results you expected? Did you notice any results you were not expecting?
* What do you understand of what took place (interventions and assessments)?
* Did you learn anything about yourself during the study?
* Tell me about your participation, were you able to work your hardest or did anything interfere?
* Did you practice any of the interventions at home?
* What techniques or exercises did you find the most helpful?
* Did you notice any physical changes over the course of the study?
* Did you notice any changes in your abilities in taking part in activities during the study?
* What did you find meaningful during your participation in this study?
* Were there any emotional changes during the study?
* Did you notice any differences between the interventions you participated in and your previous therapy experiences?

The team analyzed all the data with a constant/comparative method of data analysis and collapsed the codes and categories into emerging themes.26 Initial coding was done individually and then cross-checked as a team where consensus was reached. Trustworthiness was addressed throughout the study with the primary investigators keeping field notes during the interviews and the team maintaining a reflexive journal during the interviews and transcribing. Bracketing or setting aside bias and taking a fresh perspective on the experience being studied was conducted during journaling.26 An audit trail was maintained on an electronic document and reported how decisions were made during routine discussions between the research team. Triangulation with the literature and member checking was completed.

**RESULTS**

Three chronic (≥ 1-year post-SCI, M = 9.33 years, SD=8.50) individuals were recruited for participation in this case series study to participate in interviews at three different time points. Table 1 includes demographic information of the participants and their COPM self-selected occupational task goals. Figures 1 and 2 represent the changes in the COPM performance and satisfaction scores (respectively) on the self-selected occupational task goals for Carrie, Ken, and Sam. Saturation of data was reached between the seventh and eighth interviews during the follow-up phase.

**Table 1.** Participant Demographics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Participant** | **Age at Participation** | **Years Post Injury** | **Location of Injury and AIS Classification** | **COPM Goals** | **Handedness** |
| Carrie | 41 | 9 | C6, B | Making bed, raking, applying nail polish and make-up, donning hair scrunchie | Right |
| Sam | 36 | 18 | C6, C | Cooking, opening packages, providing childcare | Left |
| Ken | 20 | 1 | C4, B | Feeding self, pinching for self-catheterization, writing | Right |

Three themes were identified reflecting the participant’s perceptions and experiences with the ITST UE training. The themes are: Quality of Movement Enhances Normal Use of Hands, Empowering Through Education, and Motivation to Participate and Enhance Quality of Life.

**Theme 1: Quality of Movement Enhances Normal Use of Hands**

 All of the participants shared how the study was focused on moving in normal patterns using a multisensory intervention approach to meet their goals. They described how task directions included the therapist demonstrating the movement, then the participant using motor imagery, feeling their extremity move (through proprioceptive passive range of motion manipulation initiated by the therapist), and then intentionally attempting to move the body part. Participants were educated on the benefits of repetitive motion, progressive activity challenges, and principles of motor recovery during the sessions. Setting their goals with the COPM and understanding the purpose of the study, facilitated the participants to take ownership of their performance and progress. This approach was different from previous experiences with traditional outpatient occupational therapy and they reported that they felt it was more empowering:

“In the past Occupational Therapy (OT) has been very helpful problem solving for me and this (study) has been more functional. So, I like this (study). Not that my OT experience was negative at all cause it wasn’t. It’s just, this was more functional, I think…well she (a previous OT) helped me try to figure out my hair once, we did work on that a little bit and she did help me figure out cooking stuff and mopping. So, those were productive things, but I felt like this (study) was more self-satisfying... Like being a better mopper is not giving me more confidence. It’s just giving me something more to do.” -Carrie

Sam described the difference in his movement between the current study now and previous therapy experiences by highlighting:

“I’m always trying to move different things or try different things or you know trying to be intentional with movement.”

In regards to the ITST movement in this study Carrie stated:

“like mentally I think is probably normal so just doing things in a more normal way that every other person kind of does, I think is nice for the brain”.

Repetitions of movements ranged from 3-5 sets of 20 for various pinches, elbow flexion and extension, and shoulder abduction and flexion per session. Core strengthening work was addressed during occupational tasks identified in the COPM and participants reported noticing changes in getting dressed as now being able to sit edge of the bed to don pants by shifting their weight left to right in a more fluid and quicker way. Similarly, participants noted other noticeable changes following their participation in the study:

“I would say handling utensils… is usually the biggest thing because it’s awkward and then I’m balancing trying to hold it. Now, I made a Cornish hen in my toaster oven and then I basted it for an hour and 25 minutes.” -Carrie, and

“It was a lot harder beforehand like feeding myself and after the study it’s a lot easier. When I first started, I would get like, maybe one or two bits of food in there, but now I can get like a full spoon.” -Ken

Incorporating intensive participation with multisensory information during movement with a shift to a voluntary grasp pattern (wrist in flexion and digit flexion) moving from a tenodesis pattern (wrist in extension and digit flexion) was used in this study. The participants shared how they perceived their hands grasping objects with two of them stating that prior to the study they were self-conscious about how their hands looked when doing a task and set a goal to ‘look normal’, they shared:

“I mean we did a lot of stuff for sensation…I did a lot of things like identifying, pulling marbles out of beans, and being able to identify the differences between the two objects and I got much, much faster at that. My brain finally found it, feeling has improved, they’re (fingers) are just more functional.” -Carrie

“try to prevent tenodesis. It’s pretty locked in there at this point. That was obviously the most helpful, because the amount of repetition, cause we’d do like 100 of them a day and then you switched to another activity and you do it for 5ish minutes but you’re not that long, enough time maybe to really feel the impact of it.” -Sam

“You know, I could pick up a lot of things before using tenodesis and tightness in my fingers. And now it’s more of an appropriate grasp, or a grasp that’s more what a normal hand would use.” -Sam

Lastly, Carrie recognized both physical and visual changes in her body during the study:

“My hand is more full… like around the base of my thumb… maybe in the webbing between my index and thumb”. -Carrie

Since the participants created their own goals to work toward during the study, they were clearly aware of their home programs and exercises to practice while at home in the evenings and after the study. This increased their repetitions of movement and facilitated personal accountability for their progress and overall self-determination. This contributed to the participants demonstrating gains in their performance and satisfaction scores in the occupations identified on the COPM (Table 2). The three participants demonstrated an average performance change score of 8.3 and an average satisfaction change score of 9.33 (see Figures 1 & 2) exceeding the MCID of 2 points.

**Figure 1.** COPM Performance Scores



**Figure 2**. COMP Satisfaction Scores



**Theme 2: Empowering Through Education and Therapeutic Environment**

During the study, the participants were educated on the concepts of motor learning and neuroplasticity, specifically, the whys and hows one should move to optimize their results. The focus was placed on core stability to allow the participant to maintain an upright sitting position and simultaneously engage with bilateral UEs in meaningful occupations instead of holding on with one extremity to balance. This included shifting grasp patterns away from a tenodesis which facilitated pinch during more fine motor control with various UE patterns to practice raking, opening packages, donning a diaper, scooping food while stabilizing plate, applying make-up, and fastening clothing snaps on a moving child. Typical movement patterns were explored first for each participant without trying to adapt the attempt for compensation. Providing feedback on the quality of movement and explaining the benefit of the activity with positive reinforcement helped the participant understand why they were being asked to focus on the quality of movement rather than simply focusing on accomplishing the task. They stated:

“I mean anytime I was doing something I was actively trying to do it (the study’s) way… Be it water bottles or packages, stuff like that.” -Carrie

“If it was fine motor application, I would try to do it that way (pinch with fingers). “It’s a lot to keep the 3 finger grasp at different angles.” -Sam, and

“We weren’t practicing picking pills up off the floor but my toddler knocked over a prescription bottle off my computer desk and least like 60 pills fell all over the carpet… Before I would not have been able to pick up that specific pill so, (the study) made picking up the pills easier…to be able to actually pick these up instead of just grabbing the dust buster or calling the doctor going, ‘can you write me another one of those’, or emptying out the dust buster (not) knowing how clean it was at the time.” -Sam

​​“It’s like you get to some of those exercises and it's like you understand why you’re doing it… it’s like okay…It’s going to be a helpful thing. You can see the real-world like application through an exercise. There’s like an easier buy in. You focus on it and work harder on it and like stuff like that”. -Sam

In addition to education, using a client-centered approach with the COPM goals this study further fostered participant involvement and buy-in during the therapy process. This process fostered a partnership being formed between the participant and study personnel. When asked what they gained from the study they shared:

“I think most of the practical stuff we’ve been working on. Just to come back to that. That’s the biggest thing from the study. And not having to rely on people”. (Ken) and

“I’m more functionally independent than I was”. -Carrie

Due to this newly built partnership, participants were more apt to open up and share tasks taught in prior rehabilitation stays that the participant was not comfortable with it, as Carrie stated:

“I mean mentally I hate using my teeth because it can be embarrassing depending on what you’re trying to do. It’s probably not great to use your teeth for everything.” -Carrie

The participants shared that during sessions the study personnel created a safe environment and only focused on their potential to improve hand function and perform desired occupations. They often gave verbal and visual feedback on typical movement patterns so the participants could visualize the movement. The feedback was always positive, supportive, and focused on improving the quality of movement. Once the participants were able to move in the desired pattern, resistance and repetition were used to increase strength in the motor response. They stated:

“I appreciate the feedback of them (study personnel) being able to feel it and tell me what’s happening and I appreciate seeing the feedback, um, you know when they would move their hands as my hand moved. “. -Carrie

“You know that’s always a positive environment so it’s very uplifting. -Carrie and

“When I’m reaching into the washer to pick up clothes and stuff…just the extension of the hand I can now reach down into the bottom of the washing machine and grab pretty much everything”. -Sam

Once the participants had the confidence that they had regained some of their previous/preinjury movement patterns they kept practicing and wanted to do more. Gaining new fine motor skills provided opportunities for the participants to use their hands in a “normal” way allowing for further skill development and occupational performance. Carrie was uncomfortable being seen using her teeth in public and allowing her to use a different grasp pattern reduced her reliance on using her teeth to accommodate for a lack of grasping strength. Additionally, this opened up new possibilities for task success and enhanced her confidence to use her hands, which in turn translated to her feeling more confident contributing to household tasks. She stated:

“I made dinner and I made the bed that day and I vacuumed the house and I put away all the clothes. I can add value to the house”.

Providing positive reinforcement, feedback, knowledge, focusing on the participant’s occupational interests, and having the therapist further foster their own belief in the participants’ enhanced functionality, our participants with chronic SCI experienced changes that affected their quality of life.

**Theme 3: Motivation to Participate and Enhance Quality of Life**

Given that our participant population included chronic SCI participants, we were interested to learn what was meaningful for each individual and what motivated them to participate in the current study. Adherence to a rehabilitation plan can be a substantial limitation for therapy outcomes, and as such, it is often a major focus of interventions. One way to improve adherence is to better understand the individuals’ motivations (or barriers) to fully engage in the therapy process, including the home program. To understand the factors that contribute to engagement in a rehabilitation process, we asked our participants what motivated them to participate in our study. One common motivational factor was their desire to contribute and advance research for all individuals with SCI. Two participants (Carrie and Sam) who were nearly 10 and 20 years post-injury (respectively) both had altruistic views on their participation. They indicated that while they would be pleased to improve hand function, they were more interested in contributing to gains for SCI research, which might lead to advances for other individuals with SCI:

 “… (if) I don’t get something from it (the study), but if that next person gets something from what was learned during the trial.. more power to that person.”-Sam

“I want to push forward the research for spinal cord injury”- Carrie

In addition to their hope to help drive future benefits for other individuals with SCI, the participants spoke of their desire to regain their independence. All participants mentioned their dependence on others for basic needs, such as feeding and, in some instances toileting, difficulties redressing after using a public restroom, not being able to contribute to household necessities, such as cooking and cleaning, and current limitations for childcare. As such, a recurring element was a hope to regain their independence and a desire to be less reliant on others. Ken summarized this point nicely when recapping his noted progress at the 1-month follow-up interview by saying:

“... what’s been improving is independence. Cause that’s really been working forward… because I want to go to a different college after I graduate from community college… being able to live on my own… with a little bit more independence, and not having to rely on people. That’s pretty much my end goal.”-Ken

Motivation to participate in this study was further reinforced by the participants indicating what tasks/end goals they wanted their ITST sessions to focus on. During the baseline interview and the COPM completion, participants were asked what they hoped to gain through participation in the study. While the overall focus, as mentioned above, was increased independence, each participant also had specific tasks that were meaningful for them and that they hoped to be able to perform at the conclusion of the study (see Table 1). For instance, Carrie hoped to be able to make the bed, better apply makeup and nail polish, help rake up debris outdoors, and to be able to put her hair up in a ponytail using an elastic or scrunchie. To this point, her sessions focused on accomplishing these goals as well as building overall core strength, upper body, and overhead work to regain fine motor movements that would enable her to engage in doing her hair and applying nail polish and makeup. When asked about the progress she noticed at her immediate post-intervention follow-up, Carrie reported:

“...it’s the menial stuff like throughout my day that’ll I go: ‘oh, I know I couldn’t do that before’ or like being able to lift a case of water off the ground. Before the study I would get aggravated with not being strong enough to lift the case of water, but then (after) I just did it the other day, I was like: ‘I couldn't do that before.’”- Carrie

For Ken, his main interests were being able to feed himself again and increasing his grip strength so he could take notes in class and working towards being able to self-catheterize. Therefore, Ken’s ITST focused on repetitive grasp motions with increased resistance for a pinch. When asked whether he was able to perform these tasks at the conclusion of the study, he reported:

“Feeding myself was a lot harder beforehand, and after the study, it’s a lot easier… its independence… it’s the first step to being able to live on my own.”- Ken

With Sam, his goals centered around opening packages, cooking, and childcare for his young son. Beginning with core strengthening, Sam’s weight shifted through his pelvis with upper extremity movement for dressing. His ITST sessions also used repetitive resistive grasp for zipper and Velcro use. At the conclusion of the study, Sam reported increased ease with dressing his son:

“... zippers have been easier. Specifically, on the toddler…”

Throughout the ITST session, meaningful tasks were broken down into smaller, more attainable components, such that the participants were easily able to master movements. These small successes, coupled with the therapist’s emphasis on improving the quality of hand movements, afforded the participants with achievable goals, allowing them to shape new skills. Furthermore, this shaping coupled with the education and positive reinforcement participants received during their ITST sessions helped to promote self-efficacy. Self-efficacy, or an individual’s belief in their capacity to execute and meet specific tasks or goals, also reflects an individual’s confidence to exert control over their motivation and behavior, which is of paramount importance for successful rehabilitation programs. 27, 28 Ken summarized this during his immediate post-intervention interview when he said:

“Yah, that’s just as important as having therapy here. It’s only 3 times a week. For me at least… that’s not enough to actually make progress. You have to put the work in on your own too…” -Ken

Similarly, both Carrie and Sam discussed how their self-perception of how they tackled tasks had changed following the study:

“... I feel like it’s always in my mind and I’m always paying attention. Whether it’s the right way or the wrong way. (I’m) Always thinking about it.”-Carrie

And “... I’m harder on myself because I know that I’m the only one policing myself now.” -Carrie at 1-month post

“I have a bad habit of using my teeth when opening small packages, like those you get with plastic cutlery. I’m like, ‘oh, let’s bite that and lift it open.’ But when I do sit there and focus on it you hear (the interventionist's name)’s voice back of your head. Even like when opening a water bottle of something.”-Sam at 1 month post

**DISCUSSION**

This study focused on the experiences of the participants with ITST for UE and understanding the role that perceived meaningfulness of intensive tasks related to improvements in real-life functional settings. Research on rehabilitation outcomes for persons with chronic SCI is limited, there is evidence indicating that recovery for persons in the chronic phase is possible, aligning with the results of this study.30 The ITST training in this study promoted a functional recovery, defined as participant perception of the progress toward functional outcomes, over a three-month time frame in participants with chronic SCI.31 Functional recovery was achieved by employing normal movement patterns while engaging in multi-sensory intervention approaches supported by neuroplasticity concepts, including motor imagery and meaningful occupation.32,33 Participants utilized high repetition training, which was accomplished within the intervention sessions, but also outside of the interventions as well. Participants were educated on neuroplasticity concepts, and as a result, were empowered through their education to continue with UE training outside of the research intervention sessions at home. Furthermore, ITST interventions used were all client-centered, with the participants choosing their meaningful goals and being engaged in the intervention planning process.  Self-determination, this process of participants setting their own goals and being involved in problem-solving throughout the rehabilitation process, was conducive to achieving positive outcomes in this study. The COPM was a fundamental component of this process as it assisted with guiding interventions and provided confirmation that participants perceived their performance and satisfaction to improve, consistent with the findings of other studies of persons with chronic SCI.34 Rehabilitation professionals should continue to use outcome measures to ensure participant and patient satisfaction in addition to the objective measures of UE function.

In this study, normal movement patterns are described as the increased active use of the hands, with participants being able to effectively grasp objects of varying sizes and shapes while utilizing different grasp patterns, specifically in the context of occupational performance. Participants began to engage in their daily activity without relying solely on the passive grasp pattern, tenodesis. Instead, the focus of motor control was on an active motion for the remediation of UE open kinetic chains.  Restoring open chain movement for persons with SCI has been achieved in previous studies, and by targeting the wrist angle, consisting of active range of motion, strength, and coordination, has been found to produce a more effective grasp function.24, 35 In this study, open-chain kinetic chains were described as successful when participants translated their improved motor coordination to various activities of daily living, i.e., a functional recovery. Improvements were seen in open-chained reaching with tasks such as personal hair care and cooking where the participants had to reach overhead or away from their body while maintaining an active, and functional grasp pattern for the task. Participants identified these specific tasks as not possible prior to their participation in this study. While more research on restoring the function of the wrist and hand for persons with chronic SCI is needed, participants in this study did report positive outcomes with both satisfaction and occupational performance per the COPM assessment. Since rehabilitation is often not accessible to persons with chronic SCI, many people do not have the opportunity to engage in any other grasp pattern training and may only rely on the techniques learned in the acute rehabilitation phase only. Research on functional grasp patterns for persons with tetraplegia is underexplored, yet persons with SCI prioritize recovery of UE function when working to progress their independence with activities of daily living.36, 37 Ongoing research on UE function for persons with tetraplegia is essential in promoting functional independence for this population. Research in the chronic phase is especially important as many people in the acute phase have more complex needs that limit their ability to participate in UE motor training during the early phase of rehabilitation. Furthermore, persons with chronic SCI have shown progress with complex motor tasks, years after their initial injury.16, 30, 35

Another important component of this study was the use of the UE in normal everyday tasks or occupations. Participants were working toward functional independence with their desired goals, and to achieve this, they engaged in occupation-based interventions in which the skills they were working to achieve were practiced within the context of their everyday occupation. While researchers had hoped to see a functional recovery with these identified goals, a surprising finding was participants reporting improved hand function with other tasks that were not part of their initial goals, such as picking up pills, writing, vacuuming, cooking, self-feeding and lifting heavier items off the ground. This finding was unexpected and was not included in the objective outcome measures. Participants shared that they worked on the skills outside of the therapy sessions as well, demonstrating the role of shared accountability between participant and therapist to achieve functional outcomes and occupational performance. A generalization of skills to multiple activities or contexts has been shown to be a characteristic of functional neuroplasticity.48 Further research should expand focus on other functional measures and should continue to include the perspectives of those with chronic SCI to better understand their needs and the impact of rehabilitation on motor control. Furthermore, throughout this research project, participants expressed their belief that they could and would achieve the desired results, consistent with Bandura’s teachings on self-efficacy.27-29 Participants were educated extensively about neuroplasticity principles of motor control, which may have played a role in their self-efficacy.

Finally, while the participants in this study had positive performance-based results due to the remediation of wrist angle function, the authors recognized that persons with SCI may not all use the same grasp patterns. Some persons with chronic SCI may desire more compensatory or adaptive strategies to optimize function and the desired performance patterns used in daily activity should not be assumed by those providing care. Even healthcare practitioners are not exempt from displaying ableism, discrimination, or devaluation of persons with disabilities, and researchers and healthcare providers must take caution to not assume the client’s goals center around returning to “normal” function.39 Instead, providers should focus on the goals of the client and their preferred motor patterns to plan their interventions accordingly.

**Limitations**

Future research on rehabilitation with persons with chronic SCI should seek to expand the sample size. Recruitment in the study presented was limited due to the COVID pandemic causing it to end prematurely. This case series had only three participants limiting the generalizability of the findings, but each participant was interviewed at three-time points providing longitudinal data collection over nine interviews. Despite the limitation of this small sample size saturation was reached and the positive results should encourage practitioners and researchers to consider adopting rehabilitation interventions that incorporate client-centered meaningful goals for persons within the chronic phase of SCI.

**CONCLUSION**

In this paper, we propose a collaborative approach to rehabilitation using client-centered meaningful goals with a focus on functional and performance-based outcomes in which the participants are actively involved in goal-setting and problem-solving throughout the rehabilitation process. Similar to other research studies, functional recovery was achieved for participants while in the chronic phase of SCI, and the study further advocates for including principles of self-determination and self-efficacy during rehabilitation services. Previous studies have explained that the thought or belief of an idea is a contributing factor to seeing neuroplastic changes.40 Other methods used to promote neuroplasticity included multi-sensory feedback, motor imagery, high repetition practice, self-efficacy, and participant and researcher accountability. Specifically, this study found that the inclusion of self-determination and client-centered care in practice is vital in promoting improved occupational performance and satisfaction with functional outcomes. These results were achieved by using the COPM to assess outcomes that guided care throughout the rehabilitation process by including interventions and goals that were personally meaningful to the clients. More studies are needed to address UE motor function for persons with chronic SCI and tetraplegia and the COPM may be a useful tool for ensuring participant performance and satisfaction.

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