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Wrist driven wrist hand orthosis use post-discharge by individuals with tetraplegia

Deanne Carraro-Clarke
San Jose State University

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**WRIST DRIVEN WRIST HAND ORTHOSIS USE
POST-DISCHARGE BY INDIVIDUALS WITH
TETRAPLEGIA**

A Thesis

Presented to

The Department of Occupational Therapy

San Jose State University

**In Partial Fulfillment
of the Requirements for the Degree
Master of Science**

**by
Deanne Carraro-Clarke
December 1997**

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APPROVED FOR THE DEPARTMENT OF
OCCUPATIONAL THERAPY:

Amy Killingsworth, M.A., OTR

MSED, OTR, FAOTA
Y. Lynn Yasuda, MSED, OTR, FAOTA

Heidi McHugh Pendleton, M.A., OTR

APPROVED FOR THE UNIVERSITY

ABSTRACT

WRIST DRIVEN WRIST HAND ORTHOSIS USE POST-DISCHARGE BY INDIVIDUALS WITH TETRAPLEGIA

by Deanne Carraro-Clarke

Thirty of 61 outpatients with C5, C6, and C7 tetraplegia who were issued wrist driven wrist hand orthoses (WDWHO) during inpatient rehabilitation participated in telephone interviews designed to determine post-discharge use of WDWHOs. These subjects all received rehabilitation at Rancho Los Amigos Medical Center (RLAMC) in Downey, California. The subjects were interviewed three months to seven years post-discharge. Of the 30 subjects interviewed, 18 continue to use their orthoses and two plan to use them in the future. Of the 12 who discontinued WDWHO use, eight subjects used their orthosis for the first three months following discharge. This study describes the reasons subjects give for discontinuing use, explains how often subjects use their orthoses, and describes which activities subjects perform with their WDWHOs. The data indicates that the WDWHO increases function of individuals with tetraplegia.

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CHAPTER 1

INTRODUCTION

Purpose

Custom fit wrist-driven-wrist-hand orthoses (WDWHO) have been prescribed for a select group of individuals with cervical spinal cord injuries since the late 1960s on the Spinal Injury Service at Rancho Los Amigos Medical Center (RLAMC) in Downey, California. These orthoses are expensive and are custom fit for patients with fair plus or above wrist extensor muscle grades. The purpose of this study is to describe how many individuals continue to use their WDWHO post-discharge and what functional activities the patients perform with them. Knowledge about this topic could greatly affect the amount and type of training done with patients and may cause therapists to be more selective when ordering this costly device.

Problem Statement

WDWHO are issued to patients with cervical spinal injury at RLAMC via recommendations by occupational therapists to increase function. According to reports by occupational therapists at RLAMC who serve the outpatient spinal injury population, however, the number of patients who continue to use their WDWHO as outpatients declines. Prior research in the United States has been conducted on this topic and has produced varied results (Allen (1971), Engel, W. H., Kmiotek, B. S., Hohf, J. P., French, J., Barnerias,

M. J., & Siebens, A. A. (1967), Knox, Engel, & Siebens (1971), Wise, Wharton, & Robinson (1986)). Some studies indicate that there is a high follow through of patients who use their WDWHOs, whereas others indicate that the number drops dramatically after discharge. This study was conducted to describe long term use of WDWHOs post-discharge by RLAMC patients.

Questions

1. How many subjects who were inpatients at RLAMC between 1988 and 1994 continue to use their WDWHOs three months to seven years post-discharge?
2. What do subjects state as factors leading to their decision to discontinue WDWHO use post-discharge?
3. How often are WDWHOs used by subjects three months to seven years post-discharge?
4. What common factors determine continued WDWHO use three months to seven years post-discharge (i.e. physical, social, personal, work related)?
5. What specific activities do persons with cervical spinal cord injury perform with their WDWHOs?

Definitions of Terms

Tetraplegia

Tetraplegia refers to "impairment or loss of motor and/or sensory function in the cervical segments of the spinal cord due to damage of neural elements within the spinal canal. Tetraplegia

results in impairment of function in the arms as well as in the trunk, legs and pelvic organs" (Maynard, 1996, p. 5).

Complete Spinal Cord Injury

A complete spinal cord injury is "an absence of sensory and motor function in the lowest sacral segment" (Maynard, 1996, p. 7).

Incomplete Spinal Cord Injury

An incomplete spinal cord injury results in "partial preservation of sensory and/or motor functions below the neurological level of injury and includes the lowest sacral segment" (Maynard, 1996, p. 7).

Zone of Partial Preservation (ZPP)

The ZPP refers to "those dermatomes and myotomes caudal to the neurological level that remain partially innervated. The term is used only with complete injuries" (Maynard, 1996, p. 7).

Tenodesis

Tenodesis is a functional grasp achieved during active wrist extension. Wrist extension causes the index finger and thumb to approximate, providing prehension to pick up and manipulate light objects. Wrist flexion allows the fingers to open and an object to be released.

WDWHO

The WDWHO is an orthosis commonly used at RLAMC by individuals with cervical spinal cord injury who have weak or absent function distal to the wrist and fair plus or greater wrist extension strength. A WDWHO provides an individual with three jaw chuck prehension achieved through active wrist extension. Wrist extension power is mechanically transferred to the finger pieces of the orthosis causing the first and second fingers to come together with the thumb. With a WDWHO, an individual can increase tenodesis power for improved function. On average, the WDWHO user can convert three pounds of wrist strength into one pound of pinch strength (Jack Greenfield, personal communication, January 1997). When the individual needs to release his pinch, he relaxes the wrist extensor.

The WDWHO was originally developed prior to 1955 in Warm Springs, Georgia. Between 1955 and 1960 Jack Conry, an orthotist who, at the time, worked at RLAMC, adapted the WDWHOs for his Polio patients (Jack Greenfield, personal communication, January 1997). In the late 1960s it was modified and became a commonly used orthosis by individuals with cervical spinal cord injury at RLAMC. The WDWHO has been modified since that time and continues to undergo improvements. Currently, the WDWHOs used at RLAMC are fabricated by the orthotics department which is located within the medical center. The forearm and palmar units are made out of an aluminum alloy, and the finger piece is made of stainless steel. The orthosis weighs approximately 5-6 ounces,

depending on the size of the user's hand. The orthotist's fabrication time is between 12-16 hours per WDWHO, which includes time to measure the patient's hand, fabricate the orthosis, and fine tune the fit to the patient's comfort and skin tolerance. Since this orthosis is custom made for each patient, a WDWHO costs approximately \$1300-\$1800. MediCal, Medicare, and private insurance typically cover the cost of these orthoses.

Research has been conducted at RLAMC on a WDWHO which accommodates for radial deviation during wrist extension (Kanzawa, 1994). This modification can provide the individual with a more powerful pinch and an improved fit. It does not limit movement to one plane of flexion and extension, but allows for an additional plane of radial deviation.

There have been different versions of the WDWHO available at facilities throughout the United States. These orthoses have been referred to by different names but are based upon the same basic principles. According to the literature, the Rehabilitation Institute of Chicago has used an orthosis called the RIC Tenodesis Splint. The Texas Institute for Rehabilitation and Research has used the Reciprocal Wrist Extension Finger Flexion Orthosis. Highland View Hospital in Cleveland, Ohio has used a Wrist-Driven Flexor-Hinge Splint.

Spinal Injury Levels/Key Muscles

The spinal injury levels included in this study are C5 complete with a ZPP below or incomplete, C6 complete or incomplete, and C7 complete or incomplete. Neurological levels are based upon criteria set by the American Spinal Injury Association (ASIA) and explained in the International Standards for Neurological and Functional Classification of Spinal Cord Injury booklet (Maynard, 1996). Manual muscle testing and sensory testing is completed to determine a neurological level by a doctor. A spinal injury level is given at the lowest level that has intact sensation and key muscles that score at least a 3 (active movement through full available range of motion against gravity). The key muscles for C5 injuries are the elbow flexors (biceps, brachialis), C6 are the wrist extensors (extensor carpi radialis longus and brevis), and C7 are the elbow extensors (triceps).

Patients with tetraplegia are also given a functional injury level by the occupational therapist. This level assists the therapist in organizing a treatment program and setting realistic long term and short term goals.

Inpatient

An inpatient is an individual who stays at RLAMC and participates in a structured rehabilitation program.

Outpatient

An outpatient is an individual who lives outside of RLAMC but receives therapy services from a therapist at the rehabilitation center.

Assumption

A well fitting WDWHO allows an individual with tetraplegia to gain a maximum amount of function.

Limitations

Several limitations were encountered during the conduction of this study. First, many potential subjects were unable to be contacted because the outpatient files at RLAMC often do not contain updated addresses and telephone numbers.

Also, chart reviews were done with the telephone interviews, and some of the documentation was incomplete. This resulted in difficulty gathering complete data.

Finally, some of the questions asked during the interview were subjective, such as why the subject stopped using his or her WDWHO. Therefore, the study determines the patient's perception of why he or she stopped WDWHO use. Through the retrospective telephone interviews, this study does not determine whether the individual's perceptions were accurate. For example, an individual could state that he or she stopped use because his or her muscles got stronger, but it is not possible to determine whether this statement is true from a physiological perspective.

Significance of the Study to Occupational Therapy

Occupational therapists analyze their patients' lifestyles to determine the benefits that adaptive equipment may provide. Through this study, information was gathered to help therapists understand key issues when deciding the appropriateness of a WDWHO for a particular patient. It is important that occupational therapists do outcome studies to validate the skills we teach our patients. This research can demonstrate to insurance companies, health care professionals, patients, and their families that occupational therapists have the resources and knowledge to improve lives by increasing independence.

CHAPTER 2

LITERATURE REVIEW

The frame of reference utilized in educating and training patients to use WDWHOs at RLAMC is occupational performance (Pedretti, 1990). This frame of reference provides direction to the treatment team and gives structure for organization and program development. Occupational performance outlines a treatment program which takes into consideration a patient's self-care, work, education, and leisure time performances within his roles. The training of WDWHOs incorporates all of the performance components of sensory-integrative functioning, motor functioning, social functioning, psychological functioning, and cognitive functioning to achieve a goal of maximum independence and self worth.

Success in using a WDWHO requires the use of several sensory integrative functions such as visual-perceptual cues, proprioception, posture, and sensory motor integration. Motorically, it requires joint flexibility, functional strength in specific key muscles, and functional tone. Cognitively, each patient must be able to understand directions, problem solve, concentrate, and integrate learning. The psychological component includes dealing with feelings about the orthosis, coping with a disability, and gaining self-worth by understanding the independence gained by using the orthosis. The social component includes communication with other individuals who

use the same orthosis, as well as coping with the public's reaction to an unfamiliar and stigmatizing device.

The occupational performance frame of reference outlines a treatment continuum which leads a patient through a progression from dependence to resumption of life roles. The first stage prepares the patient for performance skills. Before using a WDWHO, the patient must achieve fair plus or greater strength in his wrist extensors. The occupational therapist provides an exercise program to increase muscle strength. The patient also practices functional activities which strengthen key muscles. During Stage II the individual uses the WDWHO to perform "pre-functional activities" which incorporate physical, emotional, and cognitive systems. These activities are preparatory and may not be meaningful to the patient. Patients may practice using their WDWHOs to perform a variety of tasks such as picking up foam cubes, stacking blocks, sanding wood, or threading beads.

When a patient is competent in these enabling activities, the occupational therapist directs the patient toward purposeful activities (Stage III), which have an inherent goal and are meaningful to the patient. These activities often include eating, hygiene and grooming, writing, intermittent catheterization, accessing the telephone, playing games, working with arts and crafts, dressing, and performing home skills. In the final stage of the occupational performance continuum, the patient resumes his previous lifestyle, which may now include new roles, by returning to

his own environment and community. Patients may use their WDWHOs to participate at work, at school, at volunteer jobs, or during their leisure interests. The patient and occupational therapist work as a team throughout the rehabilitation program to ultimately reach this final stage.

Although the occupational performance frame of reference outlines a logical progression of patient achievement, there is often overlap in the sequence, and some patients are unable to complete Stage IV before discharge. These patients are educated about their options for the future which include outpatient occupational therapy.

For persons with tetraplegia, hand function is of primary importance in attaining maximum independence. There are several ways to increase hand function such as surgical intervention (tendon transfers), improved tenodesis, and the use of functional orthoses. All three of these strategies are used at RLAMC, but this report focuses on the use of a specific functional orthosis, the WDWHO.

The earliest study found describing a functional device that converts wrist extensor strength into pinch was published in 1954 by Bisgrove. Many studies have been published since that time (Allen (1971), Engel et al. (1967), Knox, Engel & Siebens (1971)) and the idea of fabricating a functional orthosis (WDWHO) for this purpose is now a popular one. Research and experience has proven that WDWHOs can be valuable tools which provide individuals with tetraplegia a functional pinch and, in turn, increase their independence. Current outpatient occupational therapists at RLAMC

perceived a decrease in the number of WDWHO users post-discharge. Some questions that arise are: 1) How many people with tetraplegia continue to use their orthoses after discharge? 2) Why do individuals with tetraplegia discontinue WDWHO use post-discharge? 3) How often and for what activities are the orthoses used? and 4) What common factors determine successful WDWHO users?

Prior research has been conducted in this area. Some studies find a high follow through rate of WDWHOs after discharge (Engel et al. (1967), Knox, Engel, & Siebens (1971), Wise, Wharton, & Robinson (1986)). One found minimal follow through post-discharge (Allen (1971)).

Knox, Engel, and Siebens (1971) found that out of 39 patients surveyed at the University of Wisconsin Rehabilitation Center, 35 continued to use their WDWHOs 3 months to 9 years after discharge (90%). At this facility the patient is educated about the orthosis, makes a decision that he wants one, and makes a verbal commitment to wear it eight or more hours a day while in the rehabilitation program. This philosophy could be the key to the high success rate found in this study. Also of significance is the fact that 49% of the WDWHO users in this study are employed and/or in school. Sixteen out of 17 of these individuals use their orthoses throughout the work or school day.

In 1967 Engel et al. also found a high percentage of WDWHO users post-discharge at the University of Wisconsin. Eleven out of 14 patients (81%) continued to use their orthoses. Two of the three

individuals who no longer use their orthoses discarded them when they developed adequate tenodesis and improved hand positioning. The high percentage of use found in this study is attributed to many different factors which include adequate training, motivation, patient acceptance, onset of normal tenodesis action, and wrist power. Engel believes that the greater the disproportion between what the patient wants to do and can do, the more likely he is to find a WDWHO useful.

In contrast, Allen (1971) found that only 18 of 42 patients (43%) at Highland View Hospital in Ohio continued to use their orthoses up to ten years post-discharge. Here, bilateral WDWHOs were routinely ordered early in a patient's rehabilitation program, and orthosis training was usually initiated when the patient was able to lift three to five pounds using wrist extension. Of the 24 individuals who no longer used their orthoses, 18 reported that they had increased function and no longer needed them, two reported that their function decreased, three reported that they did not use them because of poor fit, and two stated that they no longer had their orthoses. Allen credits acceptance of these orthoses to be directly related to an individual's need to accomplish an activity and his ability to apply the orthosis. The most obvious factor differing in this study from the previously described studies is the routine ordering of bilateral WDWHOs early in the rehabilitation program. Bilateral orthoses are very difficult to use. Using two WDWHOs takes a great deal of balance, coordination, and practice. Because training

begins with the patient using two WDWHOs, frustration increases and success decreases. Also, the patients do not receive education about the orthoses, and they do not make a decision whether they want to use them or not.

Although most studies find that WDWHOs are beneficial, it is the occupational therapist's job to determine which patients are appropriate for the orthoses. Krajnik and Bridle (1992) mailed surveys to occupational therapists who work in spinal cord injury clinics nationwide. The respondents answered questions regarding their decision to not issue dynamic orthoses. The reasons most commonly stated in descending order were patient nonacceptance, cost, lack of reimbursement, contractures, lack of a qualified orthotist, unsuitable patient population, and lack of family acceptance. The study determined how often dynamic orthoses are issued to individuals of different injury levels. Summing the responses for always, most of the time, and often for each injury level, it was found that 31% of individuals with a C5 injury were issued dynamic orthoses, 69% of C6, and 43% of C7. The most common reason stated for not issuing orthoses to all patients was patient non-compliance. Since most studies find a fairly high follow through rate of users, the results of this study suggest that therapists screen patients for acceptance prior to issuing WDWHOs.

CHAPTER 3
DESIGN AND METHODOLOGY

Questions

1. How many subjects who were inpatients at RLAMC between 1988 and 1994 continue to use their WDWHOs three months to seven years post-discharge?
2. What do subjects state as factors leading to their decision to discontinue WDWHO use post-discharge?
3. How often are WDWHOs used by subjects three months to seven years post-discharge?
4. What common factors determine continued WDWHO use three months to seven years post-discharge (i.e. physical, social, personal, work related)?
5. What specific activities do persons with cervical spinal injury perform with their WDWHOs?

Subjects

Criteria for Entry into the Study

1. Inpatients on the Spinal Injury Service at RLAMC between January 1988 and December 1994
2. Issued unilateral or bilateral WDWHOs

3. Neurological diagnoses:
 - C5 complete (with ZPP below) or incomplete
 - C6 complete or incomplete
 - C7 complete or incomplete
4. Available Occupational Therapy file or medical file

Design of Study

The data in this descriptive study was gathered through outpatient chart reviews and telephone interviews. The questionnaire was comprised mainly of closed ended questions with one open ended question. The subjects were interviewed by phone to increase the accuracy and clarity of answers. This was a retrospective study since it looked back at actions that have already occurred.

There were no risks anticipated to the subjects from participation in this study. The subjects were not identified with the data. The subjects were identified by numbers and the key connecting the names and numbers was kept in a locked filing cabinet. The supervisor and researcher each had a key to the filing cabinet and access to the records.

Data Collection Techniques

Data in this study was gathered through structured telephone interviews. A questionnaire (see Appendix B) was devised based upon one designed by Allen (1971). A pilot study was conducted

with ten outpatients who were injured more than ten years prior to this study to determine if the questions were clear. The results of the pilot study are not included in this study.

The subjects were telephoned and the purpose of the study was explained to them. Information was given to them regarding their participation (see Appendix A), and their consent was requested verbally. If they agreed to participate, the survey was conducted.

The questionnaire was also translated into Spanish. When appropriate, Spanish speaking individuals conducted the interviews.

Measures

Descriptive statistics were the primary methods used to summarize the results in this study. Percentages were calculated throughout the study and means are presented when appropriate. The results are summarized using bar graphs for increased ease in visualizing the data gathered.

CHAPTER 4

DATA AND RESULTS

Sixty-one individuals who were issued WDWHOs between May 1988 and January 1995 were identified through the RLAMC orthotics department. The orthotics department fabricates all WDWHOs that are issued by this facility. From this list, 30 subjects were successfully interviewed over the telephone either in English or Spanish. Sixteen people were unable to be contacted because their current phone numbers were unavailable. Eleven people did not answer their telephone after numerous attempts. One person spoke only Korean, and there was no translator available. Three people were deceased.

Demographic Data of Available Subjects

1. Onset of injury: 5/11/88 through 11/19/94
2. Mean age at time of injury: 18 (range: 14-55)
3. Gender: Males: 22 (73%) Females: 8 (27%)
4. Neurological SCI levels:
 - C5 complete (with ZPP below) or incomplete (37%)
 - C6 complete or incomplete (40%)
 - C7 complete and incomplete spinal cord injuries (23%)
5. Etiology: MVA: 15 (50%)
 - GSW: 10 (33%)
 - Diving accidents: 4 (13%)
 - Cervical disc disease: 1 (3%)

6. **Ethnic distribution:** Caucasian: 11 (37%)
African American: 9 (30%)
Hispanic: 6 (20%)
Other: 4 (13%)

How many subjects who were inpatients at RLAMC between 1988 and 1994 continue to use their WDWHOs three months to seven years post-discharge?

Graph #1 summarizes the percentage of subjects who were using their WDWHOs at the time of the interview. Eighteen out of 30 (60%) subjects were using their WDWHOs. Ten subjects (33%) no longer used their orthoses and did not plan to in the future. Two subjects (6%) stated that they were not presently using their WDWHOs but planned to in the future. One plans to use it to write when he begins school, and the other plans to use it for intermittent catheterization when he receives outpatient training.

Out of the 10 subjects who were not using their orthoses at the time of the interview and the 2 subjects that stopped but planned to use them in the future, 4 (13% of total subjects) discontinued use immediately after discharge (Graph #2). Three subjects (10%) stopped 1 to 3 months post-discharge, and 4 others (13%) stopped 4 to 6 months post-discharge. One subject (3%) stopped using his WDWHO 10-12 months after discharge. One of the two subjects who was not using it at the time of the interview but planned to use it when he began school, used it for one month after discharge. The

Graph #1

Graph #2

other subject who planned to use it for intermittent catheterization was issued it as an outpatient and used it for approximately two months after he received it. He was planning to attend outpatient therapy for proper I.C. training. For the purposes of this study, 3 months is the amount of time that distinguishes successful and unsuccessful WDWHO users. A subject who plans to use their WDWHO in the future may also be successful. In total, 83% of the subjects were using their WDWHOs at the time of the interview, used their WDWHOs more than 3 months after discharge, or planned to use their WDWHOs in the future. Therefore, 83% of the subjects were appropriately issued WDWHOs and can be considered successful users.

What do subjects state as factors leading to their decision to discontinue WDWHO use post-discharge?

The 12 subjects who were not using their orthoses at the time of the interview were asked to provide reasons for their discontinued use. Graph #3 summarizes the results. The subjects could give multiple answers. Six (50%) stated that their muscles got stronger so they felt they did not need it anymore, 8 (67%) stated they now use other equipment or their hands to do the tasks they used to do with their WDWHOs, 2 (17%) stated it did not fit correctly, 2 (17%) stated it was too bulky, and 2 (17%) stated that it takes too much time to put on.

Graph #3

How often are WDWHOs used by subjects three months to seven years post-discharge?

Of the 18 subjects who were using their WDWHOs at the time of the interview, how often did they use their orthoses (see Graph #4)? Three subjects (17%) stated that they use their WDWHOs less than one time per week. The others used theirs on a more consistent basis. Three subjects (17%) use their orthoses 2 to 4 times per day, approximately 4 days per week. Nine subjects (50%) use theirs 2 to 6 times a day, 7 days per week. These subjects would don and doff their orthoses for each activity. Three (17%) subjects stated they use their WDWHOs all day everyday.

What common factors determine continued WDWHO use three months to seven years post-discharge (i.e. physical, social, personal, work-related)?

As seen in Graph #5, there were 22 male subjects (73%) and 8 female subjects (27%) interviewed in this study. This study has a lower representation of males than average. The percentage of males versus females admitted to RLAMC during the same time period on the spinal injury service was 87% male and 13% female. Of the 22 males, 13 (59%) were using their WDWHOs at the time of the interview, and 2 (9%) planned to use their orthoses in the future. Seven (32%) were not. Of the 8 females, 5 (62%) were using their WDWHO at the time of the interview, and 3 (38%) were not. The

Graph #4

Graph #5

percentages are approximately equal for females and males using their orthoses after discharge.

The levels of injury included in this study are C5, C6, and C7 complete and incomplete tetraplegia. These are the subjects' medical diagnoses according to American Spinal Injury Association (ASIA) standards. There were 11 C5 subjects included in the study. Graph #6 summarizes the results. Eight (73%) of these subjects were using their orthoses at the time of the interview, and 3 (27%) were not. There were 12 C6 subjects. Seven (58%) were using their orthoses at the time of the interview, 3 (25%) were not, and 2 (17%) were not using it at the time of the interview but planned to use them in the future. Seven subjects had C7 injuries. Three (43%) were using their WDWHOs at the time of the interview, and 4 (57%) were not.

Graph #7 summarizes how the level of spinal cord injury is related to continued use. All 30 subjects were questioned about their abilities to don their WDWHOs. Twenty-two subjects (73%) were able to don their WDWHOs independently. The other 8 (27%) required assistance. Fifteen out of 18 users (83%) were independent donning their orthoses. Seven out of 12 (58%) non-users and future users were independent donning their orthoses.

In this study, 26 out of 30 subjects (87%) were issued WDWHOs for their dominant hands. The remaining 4 subjects (14%) were issued WDWHOs for their non-dominant hands because their

Graph #6

Graph #7

non-dominant hands had stronger wrist extensors. As seen in Graph #8, seventeen out of the 26 subjects (65%) who were issued WDWHOs for their dominant hand continued to use their WDWHOs, and 2 (8%) stated that they would use it in the future. One out of the four subjects (25%) who was issued a WDWHO for his non-dominant hand continued to use it. Two subjects stopped using their WDWHOs immediately following discharge. The other used his WDWHO for 5 months after discharge and then stopped using it because he felt his muscles got stronger.

There were 4 different causes of tetraplegia in this study which include 15 (50%) motor vehicle accidents, 10 (33%) gun shot wounds, 4 (13%) diving accidents, and 1 (3%) cervical disc disease. Graph #9 summarizes the relationship of etiology and continued WDWHO use. Of the 10 subjects who were injured from gun shot wounds, 5 (50%) were using their WDWHOs at the time of the interview, 1 (10%) planned to use it in the future, and 4 (40%) were not using their orthoses. Percentages were similar for the subjects injured in motor vehicle accidents. Nine (60%) were using their WDWHOs, and 6 (40%) were not at the time of the interview. Of the four subjects who had tetraplegia secondary to diving accidents, 3 (75%) continued to use their WDWHOs and the other one (25%) planned to use it when he began school. The subject who had tetraplegia secondary to cervical disc disease used his WDWHO for strengthening purposes.

Graph #8

Graph #9

Ethnicity was studied to determine its affect on continued use. There are four main ethnic groups represented in this study: 11 Caucasian subjects (37%), 9 African American subjects (30%), 6 Hispanic subjects (20%), and 4 of other ethnic backgrounds (13%). As illustrated in Graph #10, 7 (64%) of the 11 Caucasian subjects continued to use their WDWHOs. Of the 9 African American subjects, 5 (56%) continued to use their WDWHOs, and 1 (11%) planned to use it in the future. Five of the 6 (83%) Hispanic subjects were using their WDWHOs at the time of the interview. Of the "other" group, 1 (25%) subject continued to use his orthosis, 1 (25%) subject planned to use it for school in the future, and 2 (50%) stopped using their orthoses all together. The ethnic distribution in this study is not fully representative of the overall distribution of patients that were seen on the spinal injury service during the same time period. The average percentage during that time period was: 37% Hispanic, 32% African American, 23% Caucasian, and 8% other.

Graph #11 summarizes the type of wheelchair used related to continued use of WDWHOs. Of the 30 subjects interviewed, four (13%) use only a manual wheelchair, 19 (63%) use only a power wheelchair, and seven (23%) use both a manual and a power wheelchair. Out of the four manual wheelchair users, three (75%) continue to use their WDWHOs and the other one (25%) plans to use it in the future. Out of the 19 power wheelchair users, 11 (58%)

Graph #10

Graph #11

In order to use a WDWHO functionally, fair plus wrist extension is necessary. In this study all but 2 subjects had a fair plus, good, or normal wrist extension on the side that their WDWHO was issued by discharge. Of the 2 subjects who had only a fair wrist extensor at discharge, both subjects stopped using their WDWHO immediately following discharge.

In Graph #12 the relationship between a person's living situation and continued WDWHO use is demonstrated. Twenty subjects (67%) live with their families (2 also have a live-in attendant), 4 (13%) live alone, 5 (17%) live with friends or roommates (1 also has a live-in attendant), and 1 (3%) lives with an attendant. Of the 20 subjects who live with their families, 13 (65%) continue to use their WDWHOs post-discharge, 5 (25%) discontinued use, and 2 (10%) planned to use them in the future. Of the 4 subjects who live alone, 3 (75%) use their orthoses, and 1 (25%) does not. One (20%) of the subjects who lives with friends or roommates uses his WDWHO, and 4 (80%) do not. The subject who lives with an attendant uses his orthosis.

All of the subjects live in houses or apartments. None lives in skilled nursing facilities or board and care facilities. Most subjects require assistance with their self care. Eleven subjects receive help from family members, 16 from an attendant other than a family member, 2 from a friend or roommate that lives with them, and 1 completes all of his self care independently.

Graph #12

Educationally, 6 (20%) subjects did not graduate from high school (2 were in high school at time of interview), 7 (23%) had high school educations but did not continue further, 15 (50%) completed high school plus some college or trade school, and 2 (7%) were college graduates.

This survey indicates that 9 out of the 30 subjects (30%) were in school, and another 4 (13%) subjects were enrolled to begin classes within the next 4 months. Three (10%) subjects stated that they had been in school since their accident or were planning to go to school in the future, but they did not have concrete plans in place. Two of the subjects were in high school. Three subjects were in four year universities studying Business, Psychology, and Financial Planning. Four were in junior or community colleges studying Sociology, General Education, and Computer Programming. Two of the 9 subjects (22%) enrolled in school use their WDWHOs for school activities. Both of these subjects have their orthoses on for the entire school day and use it for writing, organizing papers, and filing.

In contrast to the 30% enrolled in school, only 2 subjects (6%) are employed. One of these subjects is also enrolled in a University. This subject is studying tax and financial planning and owns his own tax business. He has also set up a non-profit organization which teaches people with disabilities to water-ski. He uses bilateral WDWHOs. One he uses all day long and the other he puts on when he needs to type long documents. The other employed subject works

part time as a social worker. She uses her WDWHO all day everyday. and at work she uses it mainly for writing. Another 4 subjects (13%) demonstrated effort towards employment. For example, some work on an inconsistent basis or have completed a two week vocational evaluation program at RLAMC.

Twenty-two subjects out of the 29 (76%) subjects who were issued WDWHOs as inpatients stated that they felt they received enough training with their orthoses before they were discharged from RLAMC. Out of the 19 subjects who were issued WDWHOs as inpatients and who continue to use their orthoses or planned to use them in the future, 14 (74%) stated they received enough training during their inpatient stay, and 5 (26%) felt that they did not receive enough training. Out of the 10 subjects that discontinued their WDWHO use, 8 (80%) felt they received enough training as inpatients and 2 (20%) felt that they did not.

What specific activities do persons with cervical spinal cord injury perform with their WDWHOs?

The subjects were questioned regarding use of their WDWHOs while performing 25 various activities. They were asked the following questions: Is this an activity that you do? Do you perform the activity or do you receive help? Do you use your WDWHO for the activity? If so, how often do you use your WDWHO for the activity (never (<5%), sometimes (5-50%), often (50-95%), always (>95%)) (Table #1). If the subject did not perform the activity using his

Table #1

FREQUENCY OF WDWHO USE FOR VARIOUS ACTIVITIES

	Never (<5%)	Sometimes (5-50%)	Often (50-95%)	Always (>95%)	I don't do this	Helper does this
Eating with utensils	22 (73%)	2 (7%)	0 (0%)	5 (17%)	0 (0%)	1 (3%)
Cutting food	5 (17%)	0 (0%)	1 (3%)	2 (7%)	0 (0%)	22 (73%)
Eating finger foods	24 (80%)	4 (13%)	1 (3%)	0 (0%)	0 (0%)	1 (3%)
Drinking	25 (83%)	5 (17%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Applying deodorant	8 (27%)	2 (7%)	0 (0%)	1 (3%)	0 (0%)	19 (63%)
Brushing/combining hair	16 (53%)	1 (3%)	2 (7%)	2 (7%)	0 (0%)	9 (30%)
Applying toothpaste	12 (40%)	0 (0%)	0 (0%)	6 (20%)	0 (0%)	12 (40%)
Brushing teeth	21 (70%)	0 (0%)	1 (3%)	7 (23%)	0 (0%)	1 (3%)
Shaving face	11 (37%)	0 (0%)	0 (0%)	4 (13%)	11 (37%)	4 (13%)
Applying makeup	2 (7%)	1 (3%)	1 (3%)	2 (7%)	23 (77%)	1 (3%)
Intermittent catheterization	2 (7%)	0 (0%)	0 (0%)	3 (10%)	12 (40%)	13 (43%)
Emptying legbag	3 (10%)	0 (0%)	1 (3%)	0 (0%)	16 (53%)	10 (33%)
Managing telephone	26 (87%)	2 (7%)	0 (0%)	0 (0%)	0 (0%)	2 (7%)
Writing	17 (57%)	2 (7%)	1 (3%)	7 (23%)	0 (0%)	3 (10%)
Typing	13 (43%)	1 (3%)	0 (0%)	1 (3%)	15 (50%)	0 (0%)
Smoking/lighting cigarette	4 (13%)	0 (0%)	0 (0%)	1 (3%)	25 (83%)	0 (0%)
Managing TV or stereo	21 (70%)	1 (3%)	0 (0%)	2 (7%)	4 (13%)	2 (7%)
School related activities	6 (20%)	0 (0%)	0 (0%)	2 (7%)	21 (70%)	1 (3%)
Work related activities	0 (0%)	0 (0%)	0 (0%)	2 (7%)	28 (93%)	0 (0%)
Cleaning	5 (17%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	24 (80%)
Laundry/folding	4 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	26 (87%)
Cooking	5 (17%)	1 (3%)	1 (3%)	2 (7%)	0 (0%)	21 (70%)
Dressing	4 (13%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	25 (83%)
Playing games	15 (50%)	1 (3%)	0 (0%)	3 (10%)	11 (37%)	0 (0%)
Parenting	9 (30%)	0 (0%)	0 (0%)	1 (3%)	20 (67%)	0 (0%)

WDWHO, he was asked what other type of equipment, if any, was used for the activity.

The subjects were questioned about their WDWHO use while eating with utensils. Twenty-two subjects (73%) stated that they never use their WDWHO to eat, 2 (7%) stated they sometimes use it to eat, 5 (17%) stated they always use it to eat, and 1 stated that a helper assists him with eating. The most common equipment subjects use instead of a WDWHO are built-up handles (12 subjects) and universal cuffs (8 subjects). When eating finger foods, 24 subjects (80%) stated they do not use their WDWHO, 4 (13%) use it sometimes, 1 (3%) uses it often, and 1 (3%) has a helper assist him.

In cutting food, 21 subjects (70%) stated they require assistance from a helper. Two subjects (7%) stated they always use their orthosis to cut food, 1 (3%) stated he often uses it, and 5 (17%) stated they never use their WDWHO to cut food. Built-up handles and adapted knives were used by the five subjects who cut their food but did not use their WDWHO to do it.

For drinking, 25 subjects (83%) stated that they never use their WDWHO. Five subjects (17%) stated they sometimes use it to drink. These subjects stated they would use their orthosis to drink if they already had it on to eat a meal. Twenty-six subjects (87%) were able to drink independently without equipment and the other 4 (13%) use long straws.

The subjects were asked about their WDWHO use during toothbrushing. This activity was broken down into two parts which

were applying the toothpaste to the brush and brushing. Twelve subjects (40%) never use their orthosis to apply toothpaste, 6 subjects (20%) always use it, and 12 subjects (40%) receive help from another person. The individuals who apply their toothpaste but do not use their WDWHO use their hands to complete the activity. For the actual brushing task, 21 individuals (70%) never use their WDWHO, 1 (3%) often uses it, 7 (23%) always use it, and 1 (3%) receives assistance to brush his teeth. Built-up handles and universal cuffs were the most common equipment used instead of a WDWHO for toothbrushing.

The 19 male subjects were asked about their WDWHO use while shaving their faces. Eleven subjects (58%) stated that they never use their WDWHO to shave, 4 (21%) stated they always use it, and 4 (21%) stated that someone assists them with shaving. The individuals who do not use their WDWHO to shave use built-up handles, no equipment, or other adapted handles.

The 7 female subjects were interviewed regarding their WDWHO use with the application of make-up. Two (29%) never use their orthosis to apply make-up, 1 (14%) sometimes uses it, 1 (14%) often uses it, 2 (29%) always use it, and 1 (14%) requires assistance from a helper. More than 50% of the subjects use their orthosis at least sometimes to apply make-up. Built-up handles were sometimes used to aid in this task.

Intermittent catheterization is an activity that is often difficult to accomplish for individuals with C5, C6, and C7 tetraplegia without

the use of a WDWHO. Out of the 18 subjects who are on an intermittent catheterization program, 2 (11%) subjects never use their WDWHO to complete the task, 3 (17%) always use it, and 13 (72%) receive assistance from a helper. One subject has an extra WDWHO specifically for IC to keep the other one clean for eating and other tasks.

Individuals with spinal cord injury often find that a WDWHO is useful for writing. Seven subjects stated they always use their orthosis for writing. Two subjects sometimes use their WDWHO for writing, and 1 subject stated he often uses it. Three subjects stated that they do not write. Seventeen subjects do not use their WDWHO for writing, but instead they use built-up handles, Wanchik writers, or other adapted splints. Of the subjects who always use their WDWHO to write, one attends school, one works, one works and attends school, and one plans to begin school next semester.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

In this study, 25 out of 30 subjects used their WDWHOs 3 months to seven years after discharge or planned to use their WDWHOs for stated goals in the future. According to these numbers, 83% of the subjects can be considered successful WDWHO users or appropriate candidates. The results of this study indicate that current prescription practices are appropriate and effective. The details and results of this study can help therapists identify characteristics of appropriate WDWHO candidates to improve the percentages of successful users.

In working with a patient to decide whether a WDWHO would be an appropriate device to increase function, it is important to look at the whole person. This study attempts to outline general characteristics of successful WDWHO users based on its findings. This study, however, is based on a small sample of a unique population. The findings suggest that the therapist needs to consider the individual's potential to don the orthosis independently, his muscle strength in respect to hand dominance, the cause of injury, and the strength of his wrist extensors. Most importantly, the therapist needs to consider the individual's functional goals, level of motivation, and acceptance of the orthosis.

This study indicates that 77% of subjects who are independent donning their WDWHOs either currently use or plan to use their orthosis in the future (Graph #7). In contrast, only 37% of subjects

who require assistance in donning their orthosis currently use their WDWHO. This suggests that the ability to don a WDWHO correlates with successful users. Therapists should be able to look at a patient's overall muscle picture and predict their ability to don a WDWHO. This information should be taken into consideration when deciding the appropriateness of a WDWHO.

Seventy-three percent of subjects who were issued WDWHOs for their dominant hands currently use or plan to use their orthoses (Graph #8). Only 25% of subjects who were issued WDWHOs for their non-dominant hand currently use their orthoses. This figure suggests that hand dominance is an important factor to consider when deciding whether or not to issue a WDWHO.

The results shown in Graph #9 demonstrate the relationship between continued use and etiology. Of the subjects who were injured by gun shot wounds and motor vehicle accidents, 15 out of 25 (60%) currently use or plan to use their WDWHOs. Although this is a relatively high percentage, 4 out of 4 (100%) of the subjects injured in diving accidents currently use or plan to use their orthoses. The reason for the 40% difference is uncertain. The four subjects who were injured from diving accidents may be good athletes. In general, athletes are motivated, and this may carry over in their motivation to be as functional as possible.

This study indicates a relationship between continued use and the type of wheelchair used. All manual wheelchair users (100%) in this study continued to use or planned to use their WDWHOs in the

future, whereas only 63% of power wheelchair users continued to use or planned to use their WDWHOs (Graph #11). Again, the reason for this discrepancy is unclear. The manual wheelchair users may have lower injury levels, and so they may be stronger and a WDWHO may be easier for them to use.

In order to successfully use a WDWHO for functional activities, fair plus wrist extension is required. It is difficult for a therapist to predict whether a wrist extensor will be fair plus before discharge, but this appears to be an important factor in determining successful WDWHO users. Of the two subjects who had only fair wrist extension at discharge, both subjects discontinued their WDWHO use immediately following discharge. According to Waters et al. (1993), 97% of muscles that are trace or poor one month post injury will strengthen to fair or above one year post injury. Most of the motor recovery takes place within the first six months after injury and then plateaus, although recovery may still take place. In this study, 100% of wrist extensors that were trace or poor at one month post injury strengthened to fair or above one year post injury. When evaluating a patient for a WDWHO, this data should be taken into account.

Some individuals with fair wrist extensors are able to use a rubber band extension assist to help provide some resistance. If a patient's wrist extensor is too weak or the patient is uncertain about using a WDWHO, the therapist may decide not to order the orthosis at that time. Instead, the patient may be re-evaluated as an outpatient when his or her wrist extension strength reaches a fair plus. This

approach is especially important in this time of managed care, where services are driven by cost. WDWHOs are expensive devices and insurance companies will not support therapists issuing them if follow through of patients is low. Therapists need to prove to insurance companies that we know how to evaluate and train patients for long term use after discharge. Clear documentation is important to justify the cost of a WDWHO as related to increased function. Our education and analysis should be documented as well as the patient's functional WDWHO goals.

The previous examples are factors that occupational therapists should consider when working with a patient to decide the appropriateness of a WDWHO. The more important factors, however, involve the patient's internal motivation. A motivated patient is more likely to have functional goals that are important to him. If he feels that a WDWHO will best help him to succeed in his goals, then it is appropriate to issue a WDWHO. In particular, educational and vocational goals should be explored. In this study, 9 subjects were enrolled in school. Of these 9 subjects, 3 (33%) were WDWHO users and 2 (22%) used their WDWHOs for school-related activities. These two users, however, used their WDWHOs all day everyday. Similarly, the two subjects who work use their WDWHOs 100% of their day. One subject owns his own tax business and runs an organization which teaches people with disabilities to water-ski. He uses bilateral WDWHOs. He uses one orthosis all day, and the other he puts on when he needs to type long documents. The other employed subject

works part-time as a social worker. She uses her WDWHO all day everyday, and at work she uses it mainly for writing. This data shows that individuals who are motivated in educational and/or vocational areas are good WDWHO candidates.

This data can be compared to the results found in the study by Knox, Engel, and Siebens (1971) at the University of Wisconsin Rehabilitation Center. Forty-nine percent of the subjects in this study worked and/or attended school, and 16 out of 17 (94%) of these subjects used their WDWHOs throughout the school or work day. Knox, Engel, and Siebens found a higher rate of dedicated WDWHO users. This difference may be attributed to the more structured and stringent guidelines and patient commitments required by the University of Wisconsin Rehabilitation Center. Occupational therapists can analyze patients' school and vocational interests and incorporate the skills into therapy time. Skills may include filing, writing, turning pages, answering telephones, typing, or using a calculator or computer.

This study describes the typical characteristics of a WDWHO user to guide therapists in their decision to issue a WDWHO. It is important to have guidelines, but it is more important to look at each person individually and analyze the activities for which they plan to use their orthosis. For each activity there may be other equipment that would be more appropriate or desirable. This equipment may be smaller, lighter, more aesthetically pleasing, and/or less expensive. In this time of managed care, the cost of equipment and

services is becoming increasingly important. We need to look closely at the equipment we issue and analyze whether the benefits outweigh the costs.

It is important to spend time and fully include the patient in the decision of issuing a WDWHO. It is also important to address this decision as early as possible in a patient's program because a WDWHO takes time to be fabricated. At RLAMC a WDWHO takes approximately 4 to 6 weeks to be made, and an individual with C5, C6, or C7 tetraplegia currently stays an average of three months. The sooner the individual is issued his custom made WDWHO, the more time he has to practice using it. In the meantime, a sample WDWHO can be used.

How can an individual come to an educated decision about wanting or not wanting a WDWHO? It is the occupational therapist's responsibility to educate appropriate individuals on the advantages and disadvantages of a WDWHO and present all equipment options to the patient. The prospective user can watch other WDWHO users in the hospital, watch videos that demonstrate WDWHO use, and practice using clinic samples. If a patient appears interested, he or she should state activities for which he or she would use a WDWHO and make an agreement to use it a certain number of hours per day while he or she is an inpatient. At this time RLAMC does not have a written protocol outlining the requirements of a patient to receive a WDWHO. For this study it was often difficult to know how much or what kind of education was done by therapists or what commitments

were made by patients due to inconsistencies in documentation. If a protocol was fabricated, future research could address the use of WDWHOs post-discharge of patients for whom the protocol was followed in contrast to those for whom the protocol was not used.

This study has outlined the characteristics of WDWHO users, but it is also important to describe those individuals who discontinue use (Graph #2). Twenty-three out of 30 subjects (77%) used their orthoses more than 3 months after discharge. Seven subjects (23%), however, stopped using their WDWHOs within 3 months of discharge. The non-users were questioned about their reasons for discontinuing use (Graph #3). The two main reasons given were that their hand muscles increased in strength (6 subjects) and that it is easier to use other equipment (universal cuffs or built up handles) or their hands to perform activities (8 subjects). Other reasons given were that their orthosis did not fit properly (2 subjects), that it was too bulky (2 subjects), and that it took too much time to don the WDWHO (2 subjects). These are reasons that the subjects perceived to cause their discontinued use. This study cannot determine if the subjects truly increased in strength within those three months or if it is really easier to perform activities without their WDWHOs.

Other factors that appear to be causes of discontinued use are weak wrist extensors at discharge. Both subjects who achieved only fair wrist extensor strength at discharge discontinued use immediately. Also, individuals with C7 tetraplegia are less likely to use their orthoses than individuals with C5 and C6 tetraplegia. Some

individuals with C7 injuries gain enough finger flexor strength to function better without a WDWHO. Therapists need to try to "predict" whether a patient will become strong enough in his finger flexors not to need the orthosis anymore. This can often be a difficult decision. One option would be to issue a clinic sample until full wrist and finger strength is achieved. Then, the patient can be re-evaluated for the usefulness of a WDWHO as an outpatient.

In this study, 23 out of 30 subjects used their WDWHOs 3 months to seven years after discharge. These results can be compared to an article published by Knox, Engel, and Siebens in 1971. In this study, 35 of 39 individuals (90%) with tetraplegia continued to use their WDWHOs 3 months to 9 years following discharge. Although both percentages are high, why did more subjects in Knox, Engel, and Siebens' study continue to use their WDWHOs? Two main factors may be the key.

First, at the University of Wisconsin Rehabilitation Center where Knox, Engel, and Siebens' study was conducted, the patient is educated thoroughly about the WDWHO, makes a decision that he wants one, and then makes a verbal commitment to wear it eight or more hours a day while in the rehabilitation program. At RLAMC the patient is educated and makes a decision, but then may only wear the WDWHO while working with his occupational therapist on specific activities. After occupational therapy the patient may not wear the orthosis for the remainder of the day. A greater commitment needs to be made by the patient, and encouragement for its use outside of

therapy time needs to be stronger from all members of the patient's rehabilitation team as well as from the patient's family members.

Secondly, between 56% and 67% of the WDWHO users in Knox, Engel, and Siebens' study were in school and/or employed. In the study at RLAMC, 37% of the users were in school and/or employed. The difference in these percentages may demonstrate a difference in overall motivation among the groups. This difference may come from the type of patients seen at RLAMC, which serves a large number of lower income and indigent individuals. Many patients come to RLAMC without a solid work history. Also, many have previously worked in manual labor jobs. These jobs are physically demanding, so finding work after the onset of tetraplegia is more difficult. Many have a limited educational background, and therefore do not have the skills that would transfer over to less physical jobs. Many individuals are unable to work or enroll in a vocational program because they are not legal residents of the United States. In California, individuals with disabilities receive 620 dollars per month (as of August 1996) from Social Security, and in other states they receive less. This higher dollar amount may discourage individuals from finding jobs in California more than in other states. At RLAMC limited compliance and motivation by the patients on the spinal injury service is an ongoing problem. Many patients are unable to state functional goals, especially early in their rehabilitation programs. A low percentage of patients want to attend school or find a job. The occupational therapists at RLAMC may need

to spend more time addressing school and work issues. Education about the benefits of school and work should be addressed throughout the rehabilitation program, so patients understand their options and can make choices later in life.

In analyzing the activities that are performed with and without WDWHOs a great deal of information can be gathered and thoughts can be inferred. Intermittent catheterization (I.C.) is an activity that is private and can mean the difference between partial and complete independence for an individual. Dependence in I.C. can prevent a person from being able to work in a full time job, whereas independence can allow a person to work full time. In this study, 13 out of the 18 subjects on an I.C. program stated that they receive help for this activity (Table #1). If broken down by gender (Graph #13), 5 out of the 5 females (100%) on an I.C. program receive help for I.C. and 8 out of the 13 males (62%) on an I.C. program receive assistance. Three males (23%) are independent performing I.C. using their WDWHOs, and 2 males (15%) are independent without equipment, having enough finger flexion and thumb strength to hold and insert the catheter. For a difficult activity such as this, it is important to identify if I.C. is a goal early in the rehabilitation program. If so, this activity should be addressed early, and the patient should practice as often as possible during the inpatient stay. After discharge many individuals do not perform I.C. independently because they are not always given enough opportunity to practice as an inpatient, or they do not want to dirty their orthosis because they

Graph #13

use it for other activities. One subject has bilateral WDWHOs plus an extra one solely for I.C. The extra orthosis was issued because he wants to keep his others clean for self-care and vocational activities.

The lighter activities such as eating, toothbrushing, and shaving are performed with WDWHOs by 7 to 10 of the subjects (Table #13). The ability to perform these activities is generally improved with a WDWHO, but many individuals do not use their WDWHO to perform them because there are other adapted devices available. The other devices are smaller, lighter, and easier to don and doff. The WDWHO, however, helps the individual perform the entire activity more easily and independently. For example, an individual can use a universal cuff for eating but may require assistance in changing utensils, opening containers, or cutting their food. The universal cuff may help with part of the activity, but the WDWHO enables the individual to more easily complete the entire activity. It is the occupational therapist's job to inform the individual about all available options, assist the patient in exploring his options, and allow the patient to make educated decisions.

The WDWHO is a good option for people who write a lot (such as students) or need to write with fine details (such as artists). People who do not have a need to write a lot or in great detail have other options which they sometimes prefer such as short Wanchik Writers, built-up handles, and custom fabricated writing splints. In this study 10 subjects always, often, or sometimes write with their

WDWHOs (Table #13). Writing is one activity for which many subjects feel that their WDWHO is useful. One subject stated that he only uses his WDWHO to write and draw in fine detail. These are activities that are important to him and he feels that his WDWHO allows him to write and draw as well as possible

Recommendations for Further Research

Many questions for future research arise from this study. Future research may focus on the same questions, but may target subjects who are at least one year post injury. This would give subjects more time to accept their injury, adjust to their discharge environment, and make decisions regarding the usefulness of their WDWHOs. These subjects would also have more time to make educational and vocational decisions which may affect WDWHO use.

In this study, it was difficult to correlate continued WDWHO use with the education a patient received prior to ordering a WDWHO. At RLAMC WDWHO education and documentation is inconsistent among therapists. A protocol could be developed to establish guidelines for issuing WDWHOs which would include patient and family education and a patient commitment to use their WDWHO during their inpatient rehabilitation program. Future studies could then compare WDWHOs use post-discharge of patients who follow the protocol to those who were issued WDWHOs before the protocol was developed.

All of the individuals in this study who were injured in diving accidents continued to use or planned to use their WDWHOs in the future. This study, however, only included four subjects who were injured as a result of a diving accident. Future research could study a greater number of swimmers or athletes and determine the characteristics of this population that leads to the high percentage of continued WDWHO use.

In this study 83% of Hispanic subjects continued to use their WDWHOs post-discharge. Other research could study the differences of ethnicity on WDWHO use and, more specifically, could address the reasons for the high percentage of continued use in the Hispanic population.

Finally, a study to determine the attitudes that occupational therapists have about WDWHOs may be useful. A therapist's attitude and knowledge about a WDWHO may affect how a WDWHO is introduced to a patient, how much WDWHO use is encouraged, and whether or not other equipment alternatives are offered.

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APPENDIX A
INTERVIEW INFORMATION

Interview Information

My name is DeeDee, and I am an Occupational Therapist in the Spinal Injury Department at Rancho Los Amigos Medical Center. I am writing a thesis for my Occupational Therapy master's degree at San Jose State University. The study will provide information about the use of wrist driven hand splints by individuals with spinal injury after discharge from Rancho Los Amigos Medical Center. I would like to interview you over the telephone regarding your use of your splint. The interview will take approximately 15-20 minutes of your time.

Your participation is voluntary and you may choose not to participate in this study. If you do not participate, your relations with Rancho Los Amigos Medical Center will not be affected.

There are no risks to you for your participation in this study.

The results of this study may be published, but your information will remain anonymous.

Would you be willing to participate in my study? Your time would be greatly appreciated.

APPENDIX B
SUBJECT QUESTIONNAIRE

QUESTIONNAIRE

<p>1) Do you still use your wrist driven hand splint?</p> <p>☐ Yes</p> <p>☐ No</p> <p><i>[If yes, skip 6, 7, & 17]</i> <i>If no, skip 8, 9, 10, 11, 12, & 13]</i></p>	<p>7) Why don't you use your wrist driven hand splint anymore?</p> <p>☐ It is lost</p> <p>☐ It is broken</p> <p>☐ I can't put it on by myself</p> <p>☐ It's too much trouble to put it on</p> <p>How long does it take? _____</p> <p>☐ I have found other ways to do things</p> <p>☐ I use my tenodesis instead</p> <p>☐ I don't like the way it looks</p> <p>☐ It is harder to do things with it on</p> <p>☐ I did not get enough training with it before I left Rancho</p> <p>☐ My muscles strenghtened enough that I don't need it anymore.</p> <p>☐ Other: (please explain) _____</p>
<p>2) Were you issued a right, left, or 2 wrist driven hand splints ?</p> <p>_____</p>	<p>8) How many times a day/week do you use your wrist driven hand splint?</p> <p>_____ times/day</p> <p>_____ times/week</p>
<p>3) With whom do you live?</p> <p>☐ Alone</p> <p>☐ Family</p> <p>☐ Friends</p> <p>☐ Attendant</p> <p>☐ Significant other</p> <p>☐ Other _____</p>	<p>9) Are you able to put on your wrist driven hand splint by yourself?</p> <p>☐ Yes</p> <p>☐ No</p> <p><i>[If yes, answer question 9]</i> <i>If no, skip to question 10]</i></p>
<p>4) Do you have an attendant?</p> <p>☐ Yes</p> <p>☐ No</p>	<p>10) How long does it take to put on your wrist driven hand splint?</p> <p>_____</p>
<p>5) In what type of residence do you live?</p> <p>☐ Apartment/Condominium</p> <p>☐ House</p> <p>☐ Skilled nursing facility</p> <p>☐ Board and care</p> <p>☐ Other _____</p>	<p>11) How many times have you had your splint repaired?</p> <p>☐ 0 times</p> <p>☐ 1 time</p> <p>☐ 2 times</p> <p>☐ 3 or more times</p>
<p>6) How long after discharge did you stop using your wrist driven hand splint?</p> <p>☐ Immediately after discharge</p> <p>☐ 1 - 2 months after discharge</p> <p>☐ 3 - 6 months after discharge</p> <p>☐ 6 - 12 months after discharge</p> <p>☐ 1 - 2 years after discharge</p>	

12) Did you receive enough training with the wrist driven hand splint while you were an inpatient at Rancho?

- ☐ Yes, I felt comfortable using it when I left
- ☐ No, I did not feel comfortable using it when I left

13) Do you use a manual or power wheelchair?

- ☐ Manual wheelchair
Do you wear your splint while pushing your wheelchair?
- ☐ Yes
- ☐ No
- ☐ Power wheelchair
Do you wear your splint while driving your wheelchair?
- ☐ Yes
- ☐ No

14) Do you go to school?

- ☐ Yes
- ☐ No

If yes, do you use your splint at school?

- ☐ Yes
- ☐ No

If yes, for what? _____

How many hours during the day? _____

What type of school?

- ☐ University level
- ☐ Technical institute
- ☐ High school
- ☐ Other

What are you studying? _____

15) Do you work?

- ☐ Yes
- ☐ No

If yes, do you use your splint at work?

- ☐ Yes
- ☐ No

If yes, for what? _____

How many hours do you use your splint each work day? _____

What type of work do you do? _____

16) Overall, what do you think of your wrist driven hand splint?

17) [If not using wrist driven hand splint anymore]:

Would you be willing to donate your splint back to Rancho ?