Upper Extremity Assistive Devices: Assessment of Use by Spinal Cord–Injured Patients With Quadriplegia

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Key Words: activities of daily living • orthotic devices • spinal cord injuries

The prescription of upper extremity assistive devices that facilitate physical functioning is a major component of the rehabilitation process. For the person with a spinal cord injury and resultant quadriplegia, these devices mean the difference between dependence and independence, inactivity and productivity. Although these devices are used on a daily basis during the hospital stay, they may be discarded once the person returns home.

Literature Review

The literature is replete with information that describes assistive devices and their uses (Hale, 1979; McCluer, Conry, Gephardt, Rice, & Wilke, 1971), but there is a dearth of information that documents the long-term effectiveness and use of devices once the patient has returned to the community. One exception to this is the vast amount of information on prosthetic devices developed within the framework of the Veterans Administration (Kay & Wellson, 1969). These efforts have resulted in the continual modification and improvement of artificial limbs.

Occupational therapists (Malick & Meyer, 1978; Trombly & Scott, 1977) and orthotists (Kay, 1969) have been the primary contributors to the body of knowledge on the use of upper extremity assistive devices to facilitate function during the performance of activities of daily living. Although these efforts describe the mechanics, fitting procedures, and training
required for the adequate functioning of the device and the patient, little effort has been made to assess the long-term utilization and satisfaction with devices during the years following the patient's discharge from the rehabilitation program.

Most studies on the functional outcomes of spinal cord-injured patients after rehabilitation only briefly address the issues of the use of assistive devices. Grynbaum, Kaplan, Lloyd, and Rusk (1963) reported that of the devices most often used by paraplegic and quadriplegic patients before 1959 (e.g., reachers and electric can openers), most had been acquired by the patients themselves after discharge. Symington and Mackay (1966) studied 12 patients 2 years after rehabilitation to determine functional independence and reported that more devices were necessary early in rehabilitation and that, once hand skill and strength increased, these devices were frequently discarded. This small sample, however, did not provide specific information on the use of devices. In their investigation, Rogers and Figone (1980) reported that the majority of the subjects in their follow-up study of self-care skills continued to use at least some of the devices prescribed during rehabilitation but that this use did not appear to be associated with improved function. They suggested that there was a need to project patients' requirements on the basis of the community re-entry as well as to better assess patients' compliance. This view was supported by the work of Welch, Lobley, O'Sullivan, and Freed (1986), who reported that equipment use decreased when patients returned to their communities and that a better assessment of patients' life-styles, skills, and desires must be performed before these patients leave the hospital.

In a study on the use of devices by children, McGrath et al. (1985) reported that although many devices were retained in use with high levels of satisfaction, the activities of daily living devices were most likely discarded or broken. Investigators from the spinal cord-injury service at the Veterans Administration Medical Center in Milwaukee, Wisconsin, reported that the most frequently prescribed assistive devices that were not used included flexor hinge hand splints, opponens hand splints, and adapted feeding and grooming equipment (Bhatt, Köhli, Melvin, & Maeman, 1987). One of the reasons given for the lack of use was the inordinate amount of time required to put these devices on.

In recent years, attempts have been made to assess consumer satisfaction with devices that have a relatively limited market and high development costs. Many of the Rehabilitation Engineering Centers of the National Institute of Handicapped Research (now called the National Institute on Disability and Rehabilitation Research) have developed highly specialized and technically sophisticated hardware. A major emphasis has been in the areas of mobility systems and their interfaces. The Rehabilitation Engineering Center at the Children's Hospital at Stanford (California) (1980) clinically evaluated the technical performance of and clients' satisfaction with several mobility aids designed for specific patients. The population studied did not include many spinal cord-injured patients with quadriplegia. However, the significance of this study lies in the investigators' efforts to identify and quantify factors that contribute to the use of and satisfaction with prescribed devices.

Consumer information systems such as ABLEDATA contain descriptions and vendor information on a broad spectrum of devices used by persons with physical disabilities. Long-term evaluation of these devices, however, is virtually nonexistent in the literature or in the data banks.

The primary objective of the present study, therefore, was to determine spinal cord-injured quadriplegic patients' long-term use of and satisfaction with devices prescribed during their first rehabilitation experience.

Methodology

Research Design

This study was a longitudinal prospective investigation in which an oral questionnaire was the primary tool. The questionnaire, which we administered, was developed to determine the extent to which quadriplegic patients used and were satisfied with various types of devices 1 and 2 years after their first rehabilitation experience. The devices were categorized as follows: (a) feeding, (b) splints and slings, (c) dressing, (d) hygiene and grooming, (e) communication, and (f) miscellaneous.

The devices were either commercially available, therapist-adapted, and therapist-fabricated, or orthotist-constructed. The feeding devices included plate guards, built-up utensils, swivel utensils, rocker knives, and cup and straw holders. The splints and slings included overhead slings, ball-bearing feeders, universal cuffs, reciprocal orthoses, cock-up splints, and wrist supports. The dressing devices included buttoners, zipper pulls, and dressing sticks and loops. The hygiene and grooming devices were built-up brushes, combs, toothbrushes, razor holders, and shaving cream dispensers. The communication devices included pencil and telephone holders and built-up writing tools. The miscellaneous devices included reachers, book holders, and card holders.

1 Available through the National Rehabilitation Information Center, 8455 Colesville Road, Suite 935, Silver Spring, MD 20910.
Subjects

The population studied consisted of 56 subjects with spinal cord injury resulting in quadriplegia. Fifty men and 6 women between the ages of 14 and 77 participated. Persons with brain injury in addition to spinal cord injury were excluded from the study. Spinal cord-injury levels ranged from C2 to T1; 66% of the subjects had lesions between C4 and C7. There were no statistical differences regarding age range, sex, or level of injury between the subjects with complete versus incomplete lesions.

Measurements and Observations

A computer-generated random sampling of quadriplegic patients discharged from The Institute for Rehabilitation and Research in Houston, Texas, was obtained. The medical and occupational therapy records provided information on age, sex, diagnosis, onset, and discharge date as well as prescribed and ordered devices for each patient. Other pertinent descriptive data relative to the subjects were obtained from the subjects themselves, including relevant information on the family and home situation, living arrangements, current vocational and educational activities, avocational pursuits, and financial sponsorship. Descriptive data were obtained regarding the prescribed upper extremity assistive devices. For each device, the interviewer obtained data on such topics as who fabricated the device and who was responsible for training the patient in its use. In addition, the interviewer established patterns of use and levels of satisfaction. If a device was still in use, the subject was queried regarding the frequency and duration of use. Satisfaction was assessed with Likert rating scales that addressed the device’s fit, appearance, mechanical performance, and functional performance. The average score for these four criteria comprised the overall satisfaction level.

We noted if a device had been prescribed for more than one activity. The subject was also asked if this same device was in use for all of the activities for which it was originally prescribed. If a device was no longer in use, the subject was asked to provide information on the length of time the device was used before it was discarded. The subject was then asked to identify and rank the factors that contributed to his or her discarding the device. Among the factors considered were the following:

1. Improvement in physical functioning
2. Mechanical failure of the device
3. Alternative solutions found
4. Modification in living arrangements
5. Lack of compliance (patient did not want to use it)
6. Device was outgrown
7. Device was cosmetically unacceptable

The data were analyzed with an analysis of variance with repeated measures.

Results

Of the 250 devices prescribed for the 56 participating subjects, 25% were feeding devices, 45% were splints and slings, 7% were dressing devices, 6% were hygiene and grooming devices, 11% were communication devices, and 6% were miscellaneous devices (see Table 1). Of the 56 subjects, 34 (60.7%) were between 14 and 29 years of age, 15 (23.2%) were between 30 and 49 years of age, and 9 (16.0%) were between 50 and 77 years of age. Nine (16%) subjects had spinal cord injuries at level C4 and above, 39 subjects (69.6%) had injuries at levels C4 and C5 to C7, and 8 subjects (14.2%) had injuries at levels C7 to C8 and T1. Thirty-eight (67.8%) subjects were neither in school nor employed during the 2 years after rehabilitation. A four-way analysis of variance incorporating the major grouping factors of age, level of injury, and work and school status indicated that patterns of use for all devices were similar regardless of the subpopulations studied. However, an analysis of the repeated-measures factor (i.e., mean level of device use over three time periods) indicated a significant decrease over time (p < .001). The data for individual device categories are described below and are summarized in Table 2.

Feeding devices were prescribed for 71% of all subjects and made up 25% of all devices prescribed. Of the 63 devices prescribed, 30 (48%) were in use at the end of year 1, and 19 (63%) of those in use at the end of year 1 were in use at the end of year 2. Overall, 30% of all feeding devices prescribed during rehabilitation were still in use at the end of year 2. The decline in the use of feeding devices was significant for years 1 and 2.

Splints and slings were prescribed for 79% of all subjects and represented the most frequently prescribed device category. Of the 112 devices prescrived device category.

### Table 1

**Summary of Upper Extremity Assistive Device Prescription Patterns**

<table>
<thead>
<tr>
<th>Device Category</th>
<th>No. of Subjects Prescribed Device (N = 56)</th>
<th>No. of Devices Prescribed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td>40 (71%)</td>
<td>63</td>
</tr>
<tr>
<td>Splints and slings</td>
<td>44 (79%)</td>
<td>112</td>
</tr>
<tr>
<td>Dressing</td>
<td>16 (29%)</td>
<td>18</td>
</tr>
<tr>
<td>Hygiene and grooming</td>
<td>13 (23%)</td>
<td>16</td>
</tr>
<tr>
<td>Communication</td>
<td>23 (41%)</td>
<td>27</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>13 (23%)</td>
<td>14</td>
</tr>
</tbody>
</table>

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scribed, 67 (60%) were in use at the end of year 1, and 44 (66%) of those in use at the end of year 1 were in use at the end of year 2. Overall, 39% of all splints and slings prescribed were still in use at end of year 2. The decline in the use of splints and slings was significant for years 1 and 2.

**Dressing devices** were prescribed for 29% of all subjects. Of the 18 devices prescribed, 7 (39%) were in use at the end of year 1, and 6 (86%) of those in use at the end of year 1 were still in use at the end of year 2. Overall, 33% of all dressing devices prescribed were in use at the end of year 2. Although the decline in the use of dressing devices was significant for year 1, it was not significant for year 2.

**Hygiene and grooming devices** were prescribed for 23% of all subjects studied. Of the 16 devices prescribed, 9 (56%) were in use at the end of year 1, and 4 (44%) of those in use at the end of year 1 were in use at the end of year 2. Overall, 25% of all hygiene and grooming devices prescribed during rehabilitation were in use at the end of year 2. Although the decline in the use of hygiene and grooming devices was significant for year 1, it was not significant for year 2.

**Communication devices** were prescribed for 41% of all subjects. Of the 27 devices prescribed, 14 (52%) were in use at the end of year 1 and 10 (71%) of those in use at the end of year 1 were in use at the end of year 2. Overall, 37% of all communication devices prescribed were in use at the end of year 2. Although the decline in the use of communication devices was significant for year 1, it was not significant for year 2.

**Miscellaneous devices** were prescribed for 23% of all subjects. Devices in this category included such items as devices for recreation (e.g., book racks) and accessibility (e.g., reachers). Of the 14 devices prescribed, 8 (57%) were in use at the end of year 1, and 4 (50%) of the devices in use at the end of year 1 were in use at the end of year 2. Overall, 29% of all miscellaneous devices prescribed were in use at the end of year 2. The decline in the use of miscellaneous devices was significant for years 1 and 2.

The most frequently cited reasons for discarding a device were “improved physical function” (45%) and “alternative solutions found” (45%). The subjects reported a high level of satisfaction with the devices retained in use. On a scale of poor (1) to excellent (5), year 1 satisfaction was 4.24 and year 2 satisfaction was 4.55 (see Table 3). Thirteen devices prescribed were never received by the subjects and seven devices discarded during the 1st year were put back into use during the 2nd year (i.e., four splints, two dressing devices, and one communication device).

### Discussion

Although the prevalence of quadriplegia is relatively low, the rehabilitation of quadriplegic patients is extremely costly. A portion of the cost is attributable to the array of assistive devices prescribed for these patients to enhance their performance of activities of daily living. In this study, we sought to establish the use of and satisfaction with these devices for three reasons. First, we thought it was essential to establish whether patterns of the prescription of devices were appropriate to the needs of the patient and whether the devices prescribed performed their intended short- and long-term functions. Second, we sought to

### Table 2

**Summary of Upper Extremity Assistive Device Use**

<table>
<thead>
<tr>
<th>Device Category</th>
<th>No. of Subjects Prescribed Device (N = 56)</th>
<th>No. of Devices in Use in Year 1</th>
<th>No. of Devices in Use in Year 2</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
<th>p&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feeding</strong></td>
<td>40</td>
<td>65</td>
<td>30 (48%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Splints and slings</strong></td>
<td>44</td>
<td>112</td>
<td>67 (60%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Dressing</strong></td>
<td>16</td>
<td>18</td>
<td>7 (39%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Hygiene and grooming</strong></td>
<td>13</td>
<td>16</td>
<td>9 (56%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>23</td>
<td>27</td>
<td>14 (52%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td>13</td>
<td>14</td>
<td>8 (57%)</td>
<td>&lt;.007</td>
<td>&lt;.04</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>135 (54%)</td>
<td>250</td>
<td>135 (54%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ns = not significant.

<sup>a</sup> Based on mean level of use at end of year 1.

<sup>b</sup> Based on mean level of use at end of year 2.

### Table 3

**Subjects' Satisfaction with Retained Upper Extremity Assistive Devices (N = 56)**

<table>
<thead>
<tr>
<th>Device Category</th>
<th>Average Satisfaction of Continued Users</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Feeding</strong></td>
<td>4.32</td>
</tr>
<tr>
<td><strong>Splints and slings</strong></td>
<td>4.05</td>
</tr>
<tr>
<td><strong>Dressing</strong></td>
<td>4.13</td>
</tr>
<tr>
<td><strong>Hygiene and grooming</strong></td>
<td>4.43</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>3.98</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td>4.44</td>
</tr>
<tr>
<td><strong>All categories</strong></td>
<td>4.24</td>
</tr>
</tbody>
</table>

Note. Subjects rated satisfaction on a scale of poor (1) to excellent (5).
determine the extent to which these devices remained in continued use by patients. Third, we attempted to assess whether current methods of patient education in the use of each device are effective and appropriate for patients with quadriplegia. Forty-five percent of the subjects discarded devices because of "improved physical function" and 45% discarded them because of "alternative solutions found." These data may indicate that the use of the equipment may have been prerequisite for the gain in functional performance. The weaning from dependence on equipment reflects a positive outcome of the rehabilitation process.

Clearly, feeding devices and splints and slings are the categories prescribed most often for the largest numbers of subjects. Furthermore, these categories of devices were retained in use most frequently. The splints and slings category also includes the most expensive devices. Conversely, dressing and hygiene devices were prescribed for the fewest number of subjects and, combined with miscellaneous devices, represent the greatest decline in use. There was no statistical difference in device use between subjects who were in school or employed and those who were not, nor was there any difference in device use across levels of injury.

We determined that there is a high level of satisfaction with devices that are retained at least 1 year after a person's first rehabilitation experience. Most of these devices have proved to be functional and reliable. Many devices, however, are discarded within the 1st or 2nd year, representing a cost of $8,240. Although this does not represent an enormous sum considering the cost of rehabilitation for the spinal cord-injured quadriplegic patient, occupational therapists and other members of the health care team must be acutely aware of cost containment in today's medical economic climate.

The results of this study have heightened therapists' awareness of the efficacy, durability, and utility of upper extremity assistive devices. In some cases, occupational therapists have developed alternatives to traditional, commercially available, costlier devices. These alternatives have included some devices inexpensively fabricated by the occupational therapists themselves (considering both the materials and the therapist's time) and the identification of less expensive models of the equipment. In other cases, patients used occupational therapy equipment from which they were weaned before discharge. By determining the long-term use of and satisfaction with these devices, the occupational therapist is able to eliminate some devices, modify methods of instructing patients in the use of some devices, and develop alternative products. The consumer, the sponsor, and the professional will find this financially beneficial.

Although there may be incidents of device overprescription, this does not appear to occur in the categories of the most expensive devices.

Summary and Recommendations

Fifty-four percent of the devices prescribed during rehabilitation were in use at the end of year 1, which indicates a significant decline in device use (p < .001). A further significant decline in device use occurred by the end of the 2nd year, to 35% of all prescribed devices still in use (p < .008).

The results of this study indicate that, for the most part, current prescription practices and training methods, at least where more expensive devices such as reciprocal orthoses are concerned, are appropriate and effective. Nevertheless, therapists must be vigilant in prescribing only the most necessary devices. New in-service training programs for staff and students have been implemented in the occupational therapy department of The Institute for Rehabilitation and Research during staff development meetings and at the orientation lectures for new staff members. Discussions have included the results of this study and their implications on practice, brainstorming on alternative temporary devices to be used during a transitional functional stage of rehabilitation, and consideration of the factors involved in psychological acceptance of the equipment to be used.

A close working relationship between the occupational therapists at our hospital and equipment manufacturers and distributors has been established. Through regularly scheduled in-service training and demonstrations, the occupational therapists are able to keep current on available rehabilitation equipment. In addition, the occupational therapists have an opportunity to test such equipment and to direct consumers to the most useful and cost-effective devices.

Today, reimbursement for rehabilitation services and equipment is a major concern among health care providers. Third-party payers require evidence of rehabilitation outcomes before they can decide what funds they will allocate. The clinicians who provide the services and prescribe the equipment, therefore, are becoming much more aware of how to document outcomes and obtain follow-up information to justify payment. Empirical studies that result in objective and quantifiable information on the positive outcomes of occupational therapy intervention will continue to enhance the credibility of the profession. ▲

Acknowledgments

We dedicate this manuscript to the memory of Roxan Ballweber, OTR, former Director of Occupational Therapy at The Institute for Rehabilitation and Research, Houston, Texas.
We wish to thank C. Don Rossi for his assistance with the data analysis.

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References


