High-Level Quadriplegia: An Occupational Therapy Challenge

(quadriplegia; rehabilitation; skills, living; spinal cord injuries, therapy)

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Rehabilitation of the C1 to C4 quadriplegic person is a relatively recent phenomenon. Few rehabilitation facilities accept the challenge these patients present. This paper describes a comprehensive occupational therapy program for the C1 to C4 quadriplegic person. It presents the objectives and mechanisms for treating these individuals (e.g., range of motion, strengthening existing musculature, functional activities training, pressure sore prevention, and equipment prescription) and introduces new approaches to increasing function through current therapeutic and engineering technological advances. The quality of life of these patients may well be determined by their exposure to functional activities in occupational therapy.

The National Spinal Cord Injury Association reports there are currently 500,000 spinal cord-injured individuals in the United States (1) and anticipates 20,000 new injuries each year, of which approximately 50% will suffer quadriplegia. Of 3,950 quadriplegic persons followed by the Spinal Cord Injury Data Bank between 1975 and 1979, 649 (16%) had injuries of C1 to C4 spinal level. The average age of onset was 29.1 years (compared with 28.5 for the entire spinal cord-injured population), and males comprised 86% of the population, compared with 82% of the entire spinal cord injury population (2). Of the high cervical injuries, 50% were the result of vehicular accidents. Current emergency medical techniques have enabled many of these individuals to survive the initial trauma.

The phrase “high-level quadriplegic” describes an individual who has sustained an injury to the spinal cord at any segmental level between the C1 and C4 vertebrae. For the purpose of this paper, this term refers to those individuals with any or all of the following conditions: a) diminished or no motor and sensory innervation below C1 to C4, b) total or partial dependence on respiratory or other breathing aids, c) long-term medical and personal care needs, and d) limited functional recovery expected.

It is only within the last 15 years that many individuals with spinal cord injury at the C1 to C4 levels survived the initial trauma; those who did survive were confined to intensive care units and acute hospitals. Until recently, rehabilitation of those individuals was unknown or extremely limited. Few facilities, private or public, would accept them for rehabilitation. There is little published information that addresses the occupational therapy treatment of the C1 to C4 quadriplegic patient. Therefore, functional activity and the control of one’s environment have only re-

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recently been considered part of the rehabilitation program for this special population.

Primary objectives in the rehabilitation of C1 to C4 quadriplegic patients include education regarding their care and exposure to functional activities. Because the domain of occupational therapy is functional activity, occupational therapy is one of the most important health services delivered during the rehabilitation process. The quality of life for C1 to C4 quadriplegic patients may be determined by their experiences with functional activities during rehabilitation. These activities may be transferred then to marketable vocational skills and thus to employment. This paper presents an occupational therapist's approach to and treatment of this special population.

**Review of Literature**

For many years, occupational therapists have been involved with the rehabilitation of individuals with spinal cord injuries. However, only within recent years have the occupational therapist and other rehabilitation professionals been challenged to develop effective programs for the rehabilitation of the high-level quadriplegic person. Issues such as survival, hospitalization expense, realistic activities, and technological advances contribute to the development and success of such programs.

Advances in medicine and engineering technology have increased the survival rate of the C1 to C4 quadriplegic person (3, 4). However, the costs of treating individuals with these injuries are often enormous because of major medical complications and the need for specialized management. Although statistics on etiology, age at onset, length and expense of hospitalization, and diagnostic levels were found in the literature (5, 6), published material on the rehabilitation and occupational therapy treatment of the C1 to C4 quadriplegic person is limited.

Young and Harris (5) studied 364 people with high-level quadriplegia and found that hospitalization costs ranged from a mean expense of $55,000 to $84,000 during the initial medical-rehabilitation period. Of these subjects, 13% had an initial hospital expense of over $100,000, and 2% incurred an expense between $100,000 and $200,000. One subject had a $920,000 initial hospital expense. These figures illustrate the high cost of rehabilitation of high-level quadriplegic patients and further substantiate the need for organized treatment programs to ensure timely delivery of occupational therapy services.

The use of mouthstick activities with the C1 to C4 quadriplegic patient is a major component of an occupational therapy program. Skills in these activities allow patients to perform otherwise impossible tasks. According to Jay (7), people with these levels of spinal cord injuries are not commonly seen in rehabilitation centers because of either an early death or too severe of a traumatic injury. Two major textbooks used in occupational therapy schools do not address C1 to C3 quadriplegic persons, but these books state briefly that mouthstick activities may be performed by C4 quadriplegic persons. The mouthstick activities mentioned are typing, page turning, and writing. Additional activities (e.g., painting and playing cards, checkers, and chess) are explained and illustrated. Functional aids references (10, 13) describe the use of mouthsticks and construction guidelines for them. Although the literature is replete with information that describes types of mouthsticks and their uses, there appears to be no information describing a structured program of mouthstick training or other aspects of occupational therapy treatment for the C1 to C4 quadriplegic patient.

During the early 1970s, many new electronic assistive devices for the disabled were developed and marketed (14, 16). The mass marketing of the microcomputer has made a significant impact on the lives of both able-bodied and disabled individuals. Vanderheiden (17) suggested that microcomputers serve a dual purpose for disabled individuals: a) they help individuals perform tasks denied to them due to their disability; and b) they can be modified in a way that allows the disabled person to use all the microcomputer's computing and word-processing powers. The International Software/Hardware Registry (20) is a resource developed by Trace Research and Development Center to help disseminate programs and provide adaptations to enable disabled individuals to better access computers.

The New York Regional Spinal Cord Injury System (NYSCIS) Rehabilitation Program developed an occupational therapy electronics evaluation laboratory (16) to ensure adequate clinical evaluation of technical aids, such as environmental control systems, mobility control systems, typewriter control systems, and electric page turners. Because the high cost of many of these technical devices prohibits most occupational therapy departments from having them readily available for patient evaluation, the
published summary findings of the NYSCIS Occupational Therapy Electronics Evaluation may be a useful reference for occupational therapists, vocational counselors, physiatrists, engineers, and consumers (16). A retrospective study conducted at NYSCIS revealed that "when the activity patterns of users and non-users of an environmental control system were compared, the users were significantly more active, spent more time in educational activities, and were performing more independently than non-users" (16, p 18). The same technological advances that helped to save the life of the high-level quadriplegic person yesterday have the potential to improve the quality of that life today. Although this utilization impact appears to be significant, a major difficulty that confronts users of this equipment is a lack of funding for the equipment.

Program Description

The occupational therapy program at The Institute for Rehabilitation and Research in Houston, Texas, is based on 25 years of clinical experience in the rehabilitation of individuals with spinal cord injuries. It is rooted in treatment approaches developed at a specialty hospital for patients with the severe physical and respiratory effects of polio. This program has changed over the years to incorporate the latest medical, mobility, and technological advances. These advances have allowed occupational therapists to initiate functional programs for this population. Since 1959, 289 individuals with spinal cord injuries between the levels of C3 and C4 have participated in this program. During the early phase of hospitalization following acute spinal cord injury, issues of spinal stability, respiratory function, and the medical concerns of circulation and metabolism are the priorities. Once the body systems are stabilized, the rehabilitation team is charged with maximizing the patient’s potential. This is accomplished through a comprehensive, multidisciplinary program of which occupational therapy is a major element. The occupational therapist continuously interfaces with the other members of the rehabilitation team, including the physician, physical therapist, respiratory therapist, social worker, nurse, therapeutic recreational specialist, and vocational counselor as well as with special consultants in the orthotics and rehabilitation engineering departments.

Initial Phase of Occupational Therapy Treatment

The major objectives in the initial phase of occupational therapy treatment are a) increasing passive and active ranges of motion, b) strengthening the innervated musculature and building endurance, c) initiating a progressive wheelchair sitting program and functional skills, and d) beginning training with advanced technological equipment.

Range of Motion. Range of motion is a major component in the rehabilitation program. Basic reasons for passive range of motion include the a) prevention of contractures, b) prevention of joint pain caused by contractures, c) prevention of joint deformities, and d) mobility of the joints. Limited joint range of motion may inhibit dressing, transfers, and positioning in bed or wheelchair and may be painful. Limitation in range of motion of the neck may hinder the patient’s ability to perform mouthstick activities, to drive a chin-controlled motorized wheelchair, or to operate an environmental control unit. In addition to helping the patient perform range of motion exercises of the upper extremities, the occupational therapist may also provide the patient with platform hand orthoses to maintain proper hand positioning and prevent contractures and joint deformities.

Strengthening and Endurance Exercises. The strength of the innervated muscles is determined, and an exercise program is developed. These muscles may include sternocleidomastoids, levator scapulae, upper trapezius, spinalis muscles, and splenius muscles. Strengthening of the innervated musculature may be accomplished by doing isotonics/isometric exercises or by performing mouthstick activities.

Progressive Wheelchair Sitting. Progressive wheelchair sitting is initiated when the patient’s orthopedic surgeon determines that there is spinal stability. In addition, there should be no evidence of ischi, sacral, or trochanteric pressure sores. A full-reclining-back wheelchair is positioned at a 50° reclined angle; if the patient is in need of ventilatory support, then the bedside respirator is used. The patient usually sits on a foam cushion of medium-to-firm stiffness that is 7.5 cm (3 in.) thick. The foam allows ease of transfer and pressure relief. During the initial sitting sessions, blood pressure is monitored. Hypotension (dizziness) may occur when the patient is transferred from the bed to the reclined sitting angle. Lack of muscle tone throughout the body may cause the blood to "pool" in the abdomen or lower extremities, thus resulting in decreased blood pressure. An abdominal binder and elastic hose are worn to mini-
mize this. The wheelchair is tilted back until the patient's blood pressure stabilizes. Blood pressure readings of 80/60 to 130/80 are the parameters used to determine the sitting angle. The reclining angle of the wheelchair is decreased until blood pressure is within the parameters mentioned. Portable respiratory equipment may be placed on a platform mounted on the back tilt bars of the wheelchair so the patient can be mobile for subsequent sitting sessions.

This progressive wheelchair sitting program is continued until the patient maintains an adequate blood pressure reading while sitting at an 80° or 90° angle. If the C1 to C4 quadriplegic patient does not have innervation of the muscles that hold his or her head in an upright position, the angle of the wheelchair is adjusted appropriately. A U-shaped neck foam support (see Figure 1) may be used to support the patient's head in an upright position if he or she is unable to do so.

**Functional Activities Training**

Functional activities training introduces the C1 to C4 quadriplegic person to activities and ways of performing those activities that will maximize his or her abilities. In this program, the functional activities include painting, page turning, playing table games, typing, and using the microcomputer.

**Painting.** The patient may paint either by holding a mouthstick with a paintbrush attached to it or by holding the paintbrush itself in his or her mouth. Initially, the patient paints vertical and horizontal lines across a piece of paper positioned and secured to a tilted table top. Then the patient paints simple geometric figures (e.g., squares, circles, rectangles, diamonds, and figure eights). Gross motor assignments allow the patient to gain a sense of control and coordination with the paintbrush. Watercolor and tempera paints are recommended because they dry quickly, allowing the patient to take the painting home after the therapy session. Mastery of these tasks may take several therapy sessions, depending on (the patient's) neck strength and endurance. Large prewriting pattern painting is practiced before an attempt is made to paint large alphabet letters. As the patient's lettering skill improves, he or she is encouraged to decrease the size of the letters. Progress is recorded by retaining dated photocopies of all paintings and painting exercises.

The patient progresses from paper to ceramic painting. He or she selects a simple ceramic piece to glaze using a paintbrush mouthstick. Ceramic glazes may be painted on in any manner and still result in a smooth finish after kiln firing. Because ceramic pieces can be purchased commercially, the patient may continue this activity after discharge from the hospital as an avocation or vocation. The end product has positive psychological benefits because the patient has a sense of accomplishment when the project is complete. Some patients may also smooth the rough edges of the ceramic greenware piece if they have developed sufficient control in using the greenware cleaning tool.

**Page Turning.** Developing page-turning skills allows the patient to read for educational or leisure purposes. The tool used for turning pages is a dowel stick 13 mm (0.5 in.) in diameter and approximately 35 cm (12 in.) long to which a large pencil eraser is attached on the distal end. The eraser provides friction against the page. The proximal end has either plastic tubing or a dental acrylic U-shaped plate for
the mouthpiece. A book or magazine is placed on a slanted tabletop or bookstand. The eraser end of the dowel stick is placed on the bottom right corner of the right page of the book. Pressure is applied in a diagonal direction toward the left to turn the page. This activity requires frequent practice to develop skill.

**Table Games.** Leisure time pursuits are an important aspect of rehabilitation. Patients may be trained to manipulate various table game pieces (e.g., playing cards, dominoes, chessmen, checkers, backgammon chips, tabletop video machines, and Hi-Q pegs). Mouthsticks such as the “birdbeak” and “vacuum-wand” as well as conventional dowel mouthsticks are used. It may be necessary to adapt the playing pieces so the patient can manipulate them. A simple adaptation is a pipe cleaner wrapped around the playing piece with one end of the pipe cleaner extending upward so it can be picked up with a birdbeak mouthstick. Playing boards may be adapted to a smaller scale if neck rotation is limited by either reduced strength or joint range of motion. Small magnetic travel games are used when the board game must be tilted toward the patient to reach all areas of the board. Card holders are used to support the patient’s playing cards (see Figure 2), and a birdbeak mouthstick is used to grasp the card from the dealer and place it in a card holder.

**Typing.** A mouthstick with a large eraser on the end can be used to depress the keys of a typewriter. An electric typewriter with a built-in correction unit and return key is recommended. The typewriter may be tilted toward the patient at an angle where the patient can view all of the keys. If there is adequate strength in the neck flexors, extensors, and rotators, then the patient can use those muscles to move his or her head and, in turn, move the mouthstick to hit the typewriter keys. If neck musculature strength is inadequate, a support system is used to stabilize the head. Then, the patient can use his or her tongue to move the mouthstick to different positions to hit the desired keys. The patient is instructed to depress each successive row of the typewriter keys on the keyboard. The therapist may need to adjust the position of the typewriter to enable the patient to reach all keys. If the patient is unfamiliar with the keyboard, the therapist initiates a teaching process from a standardized school typing book. Accuracy and speed of typing may serve as signs of improvement in this skill. Typing can be used by patients as a communication as well as a vocational tool.

**Microcomputer Use.** Therapists may choose to use the microcomputer (see Figure 3) for teaching mouthstick typing because its keys are easier to depress than electric typewriter keys and because it is easier to edit text. The manner in which a patient enters data into a microcomputer depends on physical capacities (e.g., facial, oral, and neck muscle strength, endurance, and coordination). Conventional access to the standard computer keyboard may not be feasible; therefore, the occupational therapist must evaluate and train the patient with the most efficiently used input system. An interface may be needed; this is a mechanism by which an individual has access to a machine or other object to accomplish a specific goal (14). There are many adaptive interface systems commercially available (18, 19) that can be used with the Apple II and Apple IIe computer to provide a variety of transparent input routines. These input routines in-
clude scanning, Morse code, and direct selection techniques. These adaptive interface systems take the input, manipulate it, and inject the characters into the computer in such a way that the computer thinks that they are coming from its own keyboard. In this way, a patient can use a "sip-and-puff" switch to literally "type" on the keyboard of the computer.

**Mobility.** Wheelchair mobility provides high-level quadriplegic persons with one of their most achievable functional activities and also allows them to regain some control over the environment. Differences of opinion exist regarding the selection of wheelchair styles, especially with reference to automatic full-reclining back versus a manual reclining back power wheelchair. Out observations of patients using either type revealed no differences in skin or medical complications between the two groups.

Both manual and motorized wheelchairs are considered and prescribed by occupational therapists to meet the individual mobility needs of each patient. The wheelchairs described in this section have been used with C1 to C4 quadriplegic persons at The Institute for Rehabilitation and Research. (This hospital not only specializes in the treatment of spinal cord injuries but also is one of few centers in the US that accepts high-level quadriplegic persons for rehabilitation.)

**The Manual Wheelchair.** Recommended is the semireclining or full-reclining back model. This chair provides the patient with an adequate high-back, optional headrest support and allows the patient to sit upright or at a variety of angles that best support a position for head control and function. This wheelchair is usually ordered with a detachable, adjustable desk or full-length armrests and a lapboard. The lapboard provides trunk support; when made of Plexiglas, it allows the patient to observe the full body and thus compensate for severe sensory deprivation. Thoracic side supports may be ordered to augment stability and trunk balance. The manual wheelchair is equipped with swing-away, detachable footrests, although some patients may request elevating legrests, which reduce hypotension or allow them to recline for pressure relief. Each wheelchair has a safety belt and chest strap to secure the patient. Special head positioners have been fabricated to provide safe and adequate support for patients with C1 to C3-level injuries when they travel in a van. It may be necessary to equip this wheelchair to accommodate respiratory equipment. The occupational therapist, in collaboration with the orthotist, designs this adaptation. The basic manual wheelchair with the above options costs approximately $2,000 to $2,500. A manual wheelchair is recommended even if the person is to receive a power chair. It serves as a back-up against possible malfunction of the motorized chair, is easier to transport, and is more compatible in size with most doorways. Approximately 25 to 50% of high-level quadriplegic persons will receive only a manual wheelchair.

**The Power Wheelchair.** For this group of patients, the most frequently prescribed is the semireclining or full-reclining back model. This chair provides the patient with an adequate high-back, optional headrest support and allows the patient to sit upright or at a variety of angles that best support a position for head control and function. This wheelchair is usually ordered with a detachable, adjustable desk or full-length armrests and a lapboard. The lapboard provides trunk support; when made of Plexiglas, it allows the patient to observe the full body and thus compensate for severe sensory deprivation. Thoracic side supports may be ordered to augment stability and trunk balance. The manual wheelchair is equipped with swing-away, detachable footrests, although some patients may request elevating legrests, which reduce hypotension or allow them to recline for pressure relief. Each wheelchair has a safety belt and chest strap to secure the patient. Special head positioners have been fabricated to provide safe and adequate support for patients with C1 to C3-level injuries when they travel in a van. It may be necessary to equip this wheelchair to accommodate respiratory equipment. The occupational therapist, in collaboration with the orthotist, designs this adaptation. The basic manual wheelchair with the above options costs approximately $2,000 to $2,500. A manual wheelchair is recommended even if the person is to receive a power chair. It serves as a back-up against possible malfunction of the motorized chair, is easier to transport, and is more compatible in size with most doorways. Approximately 25 to 50% of high-level quadriplegic persons will receive only a manual wheelchair.
to use strengthened neck musculature and to have better control. Those patients with poor head control usually are able to operate a sip-and-puff control with a modified safety switch. This switch is used if the patient loses control of the pneumatic straw-like control switch. The power wheelchair is equipped with the same style armrests, footrests, lapboard, side supports, and head supports and positioners as is the manual wheelchair. Costs vary depending on the type of control ordered. A completely adapted power wheelchair for the high-level quadriplegic person costs $4,500 to $7,500.

When prescribing any wheelchair, it is important to consider the patient's living situation, educational and vocational potential, transportation, and maintenance. The occupational therapist has the primary role of informing the patient and the family of options, costs, maintenance record, and transportability of the wheelchair. With this information, the patient can become an active participant in the selection process.

Control of Environment

The most devastating aspect of high-level spinal cord injury is the total loss of control. Initially, the patient is unable to perform any of the most basic functional daily tasks and is totally dependent on others. Not only is the patient unable to move but, in many cases, he or she is unable to breathe without help. The primary objective of the rehabilitation team and most challenging task is to restore areas of control to the patient. This is accomplished through education and the application of technology.

Education. It is important to educate the patient regarding treatment objectives and procedures. The patient is then taught to verbally direct his or her own care in the areas of body positioning in the bed and wheelchair, functional equipment placement, and exercise and range of motion programs. While the patient is in the rehabilitation setting, the entire team coordinates efforts that enable the person to develop effective communication skills. The therapist helps the patient identify the most effective way to direct others. Practice and repetition are essential, as are reinforcement and consistency. For this program to succeed, the patient must become an active participant. This occurs when the person is allowed to make choices in the areas that do not interfere with medical management. For example, patients may be given a choice of functional activities, clothes to wear, and scheduling. At the time of discharge, many of these individuals have been able to direct their care in an effective and assertive manner.

Technology. Technology allows the C1 to C4 quadriplegic person to regain control in some areas of function. There is a variety of equipment available that allows the patient to mechanically control parts of the environment, allowing some of the freedom and privacy that the patient had before the injury. The types of equipment most frequently introduced are environmental control systems (ECS) and microcomputers. The selection of the appropriate ECS depends on range of motion and strength, discharge placement, and adaptability of the equipment. The ECS can be controlled by pneumatic, tongue, rocking lever, or brow switches. The system may have a built-in telephone and the capability to manage several simple on/off devices (e.g., television, lights, radio, and fan). It is adaptable to situations that require momentary or latching operations, such as using electric beds, drawing drapes, selecting radio and television channels, and using an intercom system. Safety features include a loud call signal, an emergency buzzer, a remote control emergency call, and the intercom system. These options provide an opportunity for the high-level quadriplegic person to have some safe, independent time alone.

The ECS also can interface with a microcomputer, resulting in additional areas of control. Microcomputers can be adapted to operate as a vocational tool in the home and eventually allows the patient to control household operations, money management, and home-to-office operations.

Prevocational Training

The physical limitations of people with C1 to C4 quadriplegia pose severe problems in accomplishing vocational tasks. Activities resulting in marketable vocational skills are integral to occupational therapy treatment. A patient's interest, motivation, and intellectual capacity are important factors in determining the most effective prevocational training methods. The occupational therapist collaborates with the patient to develop a training program that meets the patient's individual needs. Many of the previously described functional activities are prerequisites to the achievement of prevocational tasks. Activities such as neck strengthening and mouthstick activities are the preliminary tasks required for the carry-over and application of marketable skills.

Some of the prevocational training skills developed include typing, writing, activating small appliances
are used when numbers are needed for reference. The therapist adapts the work station to position and stabilize the calculator for optimal use. The therapist develops a program of assignments for the patient and observes, evaluates, and documents improved patient skill and accuracy.

Dictaphone/Tape Recorder Use. Some patients are able to record their verbal messages by using a dictaphone or tape recorder. The therapist evaluates the various types of devices available, assessing factors such as activation, positioning, and stabilization. The patient practices activating the device by use of a mouthstick or other switching technique. Clarity of voice is important for translating recorded communication; therefore, the tape recording sessions provide feedback to the patient. A student can use this skill to record class assignments and term papers; a business person can use this skill to dictate letters.

Microcomputer Use. A microcomputer is one of the best modes of accomplishing work tasks and serves as an adjunct to an ECS. It allows a person to use his or her home as a work station. Learning to type and to use a microcomputer may be accomplished concurrently. One barrier to computer operation is the patient's inability to access the standard computer keyboard. Therefore, the therapist evaluates the patient's physical capacities to activate the microcomputer. The patient may use a mouthstick, an interfacing scanning system by way of a pneumatic switch, a browntippen, a tongue switch, an electromyographic switch, a mercury switch, or voice activation. Because most microcomputers have training tapes that instruct a person on the basic operations of the computer, these tapes are reviewed by the patient in collaboration with the occupational therapist. Commercially available standard software packages are used for computer activation practice. These include word processing packages, accounting packages, environmental control programs, music, entertainment, and graphics. Appropriate positioning and stabilizing of the microcomputer are critical factors in successful microcomputer use. Although work tables for computers and other mechanical and electronic equipment are commercially available, the therapist often must modify and adapt the station to meet individual needs. We photographed specialized computer mounting systems for future reference. Today, because many businesses use microcomputers, having this skill makes the patient a more marketable candidate. Alternative interfaces may be necessary if traditional keyboard activation is not possible.

Painting. Art guilds for disabled people have been established to encourage talented artists to exhibit and market their art works. Patients are exposed to a variety of painting media, such as watercolor, oil, or acrylic painting, ceramic and stoneware painting, and acrylic embroidery. Painting may be pursued as an avocational activity which has great psychological benefits (see, Figure 4).

Verbal Instruction. The patient is given assignments to verbally direct a variety of tasks. For example, the patient may be asked to give the therapist directions to the hospital administrator's office or to give instructions to assemble a simple woodwork project or prepare a meal. The accomplishment of these tasks depends on the accuracy of the patient's verbal instructions. The therapist provides feedback to
Mouthstick painting

The patient on clarity and effectiveness of the instructions. Because many occupations depend mainly on verbal instruction, the refinement of this skill allows the patient to become a more successful candidate for occupations such as receptionist, paging operator, teacher, or psychological or information service spokesperson. The C1 to C4 quadriplegic person uses verbal instruction in vocational pursuits and in fulfilling a role congruent with family life. Disabled parents will need to instruct their children in various developmental tasks. The accuracy of the verbal direction will be critical to the child's successful achievement of the tasks.

Modified Work Station Organization. Employment will be determined by prevocational skills acquired and work station adaptation. Information about modified work station adaptations and the positioning and stabilization of equipment is critical to the performance of vocational tasks. Therapists collaborate with rehabilitation engineers to design and fabricate modified work stations that facilitate a patient's optimal performance in an occupation.

Financial Concerns

ECS, microcomputers, and power wheelchairs provide patients who have a high-level spinal cord injury with greater independence and control in life. Unfortunately, the cost of these items is high and is seldom financed through third-party payers. The patient and the family have usually exhausted their savings by the time it is appropriate to order such equipment. The acute care hospitalization for the high-level quadriplegic may exceed $114,000 and may be complicated by essential lifesaving techniques. Therefore, these individuals may not reach the rehabilitation hospital until after enormous sums of money have been paid. The result is limited funds for rehabilitation services and equipment. Third-party reimbursement agencies do not readily accept the fact that the use of the equipment (e.g., power wheelchair, ECS, and even microcomputers) will eventually reduce the cost of patient care by allowing the patient more independence, reduced nursing care, and employment opportunities.

The patient's local community can often be a great source of funds for equipment. Civic clubs, religious affiliations, neighborhoods, and often an entire town will organize block parties, garage sales, cookouts, and car washes to raise money for equipment that will integrate the patient back into his or her community.

Discussion

Within the last five years, 75 patients with C1- to C4-level spinal cord injury participated in this occupational therapy program. Of these patients, 4 died before discharge from the rehabilitation facility, 62 were discharged to their homes, and 9 were discharged to nursing homes.

Of the survivors, 96% were using a mouthstick for functional activities at time of discharge. Because of limited finances, only 49% received a power wheelchair, and only 9% received ECS. Fewer than 5% received a microcomputer, and these were obtained through private funds or were provided by the patient's employer. Special interface switches, used for emergency power wheelchair braking systems and/or for microcomputer activation, were purchased for 7% of this population. The occupational therapy program for functional activities for the high-level quadriplegic person assisted 16% to return to a vocation and 19% to continue or to extend their education in public schools and universities.

Summary

The primary purpose of the occupational therapy program described in this paper is the development of skills that maximize independence for C1 to C4 quadri-
plegic persons. Despite severe physical disability and often decreased respiratory function, these individuals often achieve a level of function and control that was impossible in the previous decades. Occupational therapy, in combination with medical and engineering technology, has had a major impact on the rehabilitation of these patients.

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