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Review Article

Assistive technology for people with cerebral palsy

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Abstract. Assistive technology includes equipment, devices and software solutions that increase functional capabilities of people with disabilities and improve the quality of their lives. The article presents assistive technology for people with cerebral palsy. These are mobility aids that enable people with cerebral palsy independent walking. For those who cannot walk, proper seating is very important. People, who cannot propel manual wheelchair, can control electric wheelchair with various controls. There are several augmentative and alternative communication devices for people with cerebral palsy that are not able to speak. Finally, environmental control systems are presented.

Key words: Assistive technology, people with cerebral palsy, equipment, devices

1. Introduction

For most people, technology can make life easier, expanding life's choices and opportunities, which is even more significant for people with disabilities. Assistive Technology (AT) is defined as "any item, piece of equipment, or product system whether acquired commercially off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (1). It is a broad range of devices, services, strategies, and practices that are conceived and applied to ameliorate the problems faced by individuals who have disabilities (2). ATs range from low-tech aids, such as built-up handles on eating utensils, to high tech devices such as computerized communication systems, alternative access systems or powered wheelchairs. The ultimate objective of AT is to contribute to the effective enhancement of the lives of people with disabilities and elderly people by helping to overcome and solve their functional problems, reducing dependence on others and contributing to the integration into their families and society (3).

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People with a diagnosis of cerebral palsy (CP) often have significant physical limitations that prevent exploration and full participation to the environment. AT systems can provide opportunities for people with CP to interact with their world, enabling communication, and daily living skills. Efficient access and control of the technology are critical for successful use; however, establishing consistent access is often difficult because of the nature of the movement patterns exhibited by people with CP (4).

2. Mobility devices

There are many mobility devices that help people with CP to be mobile, either to walk or to move around in another way. Any equipment should be prescribed by professional staff according to the patient's needs (5). The device has to be appropriate for patient's functional abilities. In the case of a child, it should be appropriate for the stage of child's development and should not hinder child's developmental progress. Equipment should be made according to the patient's measurements and it must be adjusted as growth occurs.

Walking aids that help people with CP are: special footwear, ankle foot orthoses, short leg calipers, long leg calipers, reciprocal calipers, a thigh abduction splint, walking sticks, crutches, different walkers, etc. The patient's condition is one of the major factors influencing the type of the aid to use. Whenever these types of walking aids are used, attention must be given to the patient's posture, which may become too flexed at the hips and knees.

People with CP whose physical impairments prevent walking may need any of a number of devices to help them get around. Adults with CP may use them to navigate the workplace. Students with CP may use them in their school building and participating to the student activities. Mobility devices include manual or electrically powered wheelchairs, and powered recreational vehicles like bikes and scooters.

The advent of the computer age has made it possible to create sophisticated wheelchairs, which can give mobility back to those with poor motor control. If somebody has CP and is unable to effectively propel or steer the wheelchair manually, they can still navigate, thanks to the technology of switches and other special controls. Joysticks can be interfaced with the wheelchair's motor and computer in order to direct motion. In addition, switches are available for those who cannot manipulate a joystick. These switches come in a wide variety. Sometimes they are shaped like a button, and the push of a body part against the switch (such as a hand or foot) triggers an action, such as moving forward or turning. Other switches react to the presence of a body part; no touching is required. A wave of a hand or swing of a knee can activate these types of switches. If a person with CP can not control his/her hand or knee enough to trigger the switches, he/she can still be mobile, thanks to switches which respond to the position of the neck, head, and chin (6). Still other switches are manipulated by "sipping" and "puffing" air through a small straw. The sipping action will trigger the switch in one direction, and the puffing in the other. In "sip and puff" switches, often the lips are used to control which direction to move in. These advances provide the freedom those with CP or other physical impairments to get around on their own and become more independent.

3. Seating devices

Seating arrangement for CP patient with total body involvement is a very demanding process and can pose considerable problems for the multi-disciplinary team (7). The introduction of adaptive seating devices for young children who need support to sit have a meaningful, positive impact on child and family life (8). Parents report that their young children with CP are more able to engage in self-care and play activities when using specific adaptive seating devices (9).

Several studies (10-13) investigated the effect of seat inclinations. Improved postural control and reduction in pathological movements were achieved in anterior tilt; reduced postural sway was evident for children with spastic CP, sitting on anterior incline, and increased sway for those with hypotonia; extensor thrust was evoked when in posterior incline; and there was evidence of improved arm and hand function whilst seated in the functional sitting position as opposed to posterior seat incline. Regarding the seating position of people with CP in the wheelchair, the goal is to achieve an upright, forward facing position by using padding, structured chairs, straps or restraints to hold the body in a stable, safe, and comfortable manner.

Often, it is necessary to design positioning systems for a variety of settings, so that a person can participate in a number of activities. There might be a position which suits them best when they are in front of the computer, another for meal times, and yet another for relaxing with a good book. Some examples of equipment used for positioning are floor sitters, side lying frames, chair inserts, straps, trays, standing aids, bean bag chairs, special pillows, etc. Thanks to the advances in electronics, motorized wheelchairs now exist which can shift and adjust to support its occupant in various positions. One can even save certain settings so that with the push of a button, the wheelchair can shift them from one position to the next. This can greatly enhance a person's feeling of independence, as they do not require others to shift supports or padding for them.

4. Augmentative and alternative communication (AAC) devices

Every person needs some methods of communication in order to interact with others and have healthy social relationships. People with CP who are nonverbal or whose speech is not understandable enough to communicate effectively can benefit from using some type of communication device. Augmentative communication devices are tools and methods that help individuals to communicate more easily and effectively. They can include things as communication boards (a board with pictures representing patient’s daily needs), symbol systems, programmable switches, electronic communication devices, speech synthesizers, recorded speech devices, communication enhancement software, and voiced word processing. This technology can help a person with CP to overcome the difficulty of speaking and to feel more independent and take part in activities with others.

Communication boards are an inexpensive and practical mode by which an individual can communicate. This system does not involve any mechanical parts. A picture of an object (a hairbrush, a toy, food, or printed words) can represent what the person is attempting to say. The trouble with manual Communication boards is that the number of symbols are limited to the space of the board. The board must be portable and so cannot be too bulky or difficult to carry. Changing the symbols on the board can also be a tedious process. Computer technology has made simple communication boards much more versatile and useful. One example of the ability for computer programs is to store symbols easily, and then print a custom communication board every day to reflect the person's changing needs. On the other hand, there are electronic communication boards, which can use a hierarchy to display hundreds of times symbols more than a conventional board. A person with CP could drill down through a hierarchy to express their feelings, needs, or to construct sentences by combining small phrases. To create a message, the person would select a menu with a specific category. The categories on the screen are similar to folders on a computer. When one selects a category, subcategories are listed. Categories for a young child with CP might be school, home. The category home might be broken down into eating, having fun, family, friends, etc. Those subcategories are then broken down even further.

In the past, it would have been impractical to carry around a large personal computer and monitor in order to communicate via such electronic boards. Now that technology has allowed for the physical shrinking of computer components and light weight LCD screens, it is possible for people with CP to carry with them small, portable communication boards. Furthermore, these devices can do much more to facilitate effective communication. They can speak the phrase or sentence through a speaker so that the person with CP can have conversations with others. These devices, also known as augmentative and alternative communication (AAC) devices, can be used in a variety of ways. Some people with CP have good control of their upper extremities. If such a person requires the use of an AAC, they can simply touch the screen or use a computer mouse to choose the words and phrases they wish to speak. If that person has poor control over their arms, they can utilize switches. A switch works in tandem with scanning to form the sentences for the AAC. The computer will scan through the possible choices and the person hits their switch when the desired word or phrase is highlighted. This can in turn display new options to build upon the initial idea. Once the person is satisfied with their message, it is spoken by the computer. The switch can take the form of a button, foot pedal, or a mouth operated switch. Recently, it has been reported of a novel non-invasive vocal cord vibration switch for computer access (14) and of a multiple camera tongue switch for a child with severe spastic quadriplegic CP (15). Exciting new technology has made it possible for a camera to translate eye movements and blinks into computer input. The camera mounts just below the computer screen, and uses infrared light to track a person's eye movement and estimate with great accuracy what portion of the screen they are looking at. So a person would be able to simply look at the phrase they wanted to say on the computer screen and blink, dwell or use a switch to select it. Not only do these devices make it easier for people with CP to communicate, but it also gives that person much more freedom and independence.

The encouraging thing about the evolution of computer aided communications devices is that they can be endlessly customized to fit a person's specific needs. If a person with CP cannot speak clearly, and is also visually impaired, the device can speak the phrases to them through a headset or speaker (known as audio scanning). The person would then use their switch to select the proper phrase when it is heard. The device's external speaker would then say this out loud to the other party.

5. Environmental controls

Environmental Control Systems provide alternative access to devices such as lights, audio visual equipment, doors, telephones and much more. Sometimes one would have a remote control with settings for the various electronics in the house (lights, appliances, television, etc.). If the person is unable to manipulate a remote control, independent simple switches can be used to control the environment. Laser beam switches (where the switch is activated by breaking the beam) or pressure sensitive floor switches can be installed in doorways to activate lights as somebody moves around their house. A person can move their wheelchair to a certain spot in the room and activate a floor switch which would turn on the television. Environmental controls offer people with CP a large number of ways to have more control over their lives.

Environmental controls can be grouped into low-tech and high-tech systems. Low-tech systems provide somewhat limited control of one

or two devices. A low-tech switch can control an electrical device directly. If the switch needs to be activated for the electronic device to run, this is called a "direct control". The floor switch which turns on the television when pressed can be an example of a "direct control" switch. "Timed control" will let the device continue to run for a preset amount of time after a switch is hit once. If a device required one hit of the switch to turn on, and another hit to turn off, it's called a "latch control". High-tech systems are designed to provide more sophisticated control of a wide variety of devices. Most remote controlled or switch based high-tech systems require reading, though there are now several switch systems that have auditory scanning and speech feedback. This allows a person to speak commands into their device and hear what the resulting action is. Portability is very important for someone who needs control from a wheelchair since they are able to control various parts of their environment from different locations. The development of Personal Digital Assistant technology, smart phones and touchscreen operated devices such as iPAD have helped tremendously in making high-tech environmental control systems smaller, more powerful, and more portable.

Another option to control the environment is to use a person's AAC. By combining environmental controls into the AAC, the number of devices needed to learn the control can be reduced. Another benefit is that the user does not have to read if it is too difficult for them. The AAC can use symbols to operate things (like a picture of a TV, or lamp for example). On top of that, the operator does not even have to see the display, since the AAC can speak the options out loud.

Environment can be also controlled indirectly by a user, using an identification (e.g. radiofrequency identification, RFID), where the settings for the environment are adjusted to the individual user. This is a part of the area called ambient intelligence (16). Special antennas detect the presence of a user within a room and adjust the home automation (lights, shutters, windows, heating, air conditioning etc.) and media (TV, stereo) to the user.

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