International Encyclopedia of Rehabilitation

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This publication of the Center for International Rehabilitation Research Information and Exchange is supported by funds received from the National Institute on Disability and Rehabilitation Research of the U.S. Department of Education under grant number H133A050008. The opinions contained in this publication are those of the authors and do not necessarily reflect those of CIRRIE or the Department of Education.

Electronic Aids to Daily Living

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Introduction

Difficulty or inability to perform activities due to illness, injury, or impairments in function often results in a person's loss of independence and control of their environment. Consequently, this impacts participation in life tasks, work, and quality of life. Electronic aids to daily living (EADLs) assist persons with independence, performance of daily activities, and their ability to live meaningful lives. They provide alternative tools to operate and control electronic devices. They are used for everyday activities such as turning lights on and off, changing the television channels, playing music, opening and closing doors, and making phone calls. Individuals of all ages with a wide range of disabilities use EADLs to increase participation and independence in performing daily tasks.

Environmental control devices (now EADLs) were initially used to assist individuals with severe motor impairments (Bailey, 1993) who were unable to access or activate typical on/off switches and features of electrical devices and appliances. They provided an alternate means for access through an external switch connected to the EADL that enabled use of the person's skills and capabilities to control these devices in their living environments. EADLs now include a wide range of devices with various options for access that can assist persons with varied abilities and needs. For example, switch and voice activation systems enable access through both an external switch and the use of speech input; these systems continue to provide options for persons with severe impairments. EADLS with keyboards, button controls, or touch screens are accessed by those with movements that can be used to directly target and select keys or items. Computer systems with specialized software can be used by persons with impairments who require alternate keyboards, alternate pointing devices, speech recognition, eyegaze systems, and alternate output for access. Also, specialized devices often used by individuals who have multiple impairments have built-in EADL functions. These include some power wheelchairs and speech generating devices, devices that provide speech output to assist an individual with communication needs. They provide access to control electronic devices through a single control such as a joystick on a wheelchair, or an input method on the speech generating device that a user is familiar with. The need for additional devices, or to learn new controls is minimized (Lange, 2006).

EADLs are used to control lighting, appliances, multimedia devices including the television, recorders, and music and video devices, fans, electronic door openers, functions of electric beds, security systems, timers, alerting devices and alarms, telephones, thermostats, and other electronic devices. They assist persons who have severe motor impairments, but they are also used by persons who have difficulty with coordination and endurance, memory and cognitive impairments, sensory impairments, difficulty with language and reading, and those with other health issues (Ripat, 2006). EADLs are increasingly used to assist older persons with easier control of the home environment, and to maintain independence and safety as people experience changes in function as they age (Tomita et al, 2007, Cheek et al., 2005). Some of these changes

include weakness, decreased mobility, vision and sensory changes, difficulty with memory, arthritis and joint pain, and other medical conditions. For these individuals, EADLS are often used to assist with control of lighting, use of the phone, to open and close doors, to control room temperature, for safety alarms, for security systems, and increasingly to monitor and track medical-related issues.

With new technology options, the use of EADLs is being extended to other environments including work and school settings to facilitate participation and independence in work and educational activities, and to provide safety and security measures. They are also being used to assist with entertainment, leisure activities, and with health management to increase a person's quality of life (Craig, et al., 2004).

EADL Components

The EADL is the main unit used to transmit signals to one or more electrical devices and appliances to implement a desired action. For example, the EADL is used to send a signal to a lamp to turn the light on or off. Components of EADL systems can include X-10 functions, infrared functions, direct cable connections, telephone functions, and Z-wave functions, the hardware that is used for each function, and the end device that is being operated. Signals are sent through electrical lines, infrared waves, ultrasound, and radio waves depending on the functions in the unit. Some EADLs are multifunctional, and enable control of various devices through multiple modes of transmission.

X-10

To control devices with on/off functions such as lights and appliances, X-10 technology is used. This enables the transmission of signals through the electric lines. Lamps and appliances are connected to modules that are then plugged into existing electrical outlets. These modules interact with a transceiver to receive the signal through the electric lines in the home, work or other environments where the EADL is used. X-10 is also used to control thermostats, fans, window coverings and other appliances with on/off functions.

Infrared

Infrared functions enable control of the television, sound and multimedia systems, infrared telephones, and other devices operated with infrared controls. Infrared waves are light waves sent to an infrared receiver. For transmission, the EADL must be pointed at the object to be controlled and close proximity to the device being controlled is necessary. This may affect where the EADL is positioned and the setup of the environment where it will be used. Persons who use power wheelchairs with built-in infrared functions can use their wheelchair controller to operate infrared devices in various environments. Some speech generating devices used by persons who use augmentative communication also have an infrared function. With this, the EADL is integrated into one system enabling a single device to be used for multiple purposes. For example, with this function, a separate page on the speech generating device can be customized for television features such as on/off, channel up/down and volume up/down and for DVD functions. This provides ability to control devices without having to learn how to operate multiple systems.

Ultrasound

Some EADLs can transmit signals through ultrasound waves. A receiver connected to an appliance such as a fan recognizes the signal and activates the device. Radio waves have a greater range of transmission than other modes and the signal can pass through walls. Transmission is not limited to a single area and may be selected to allow for control of devices that are not in the same location.

Z-wave and Smart House Technology

Z-wave is a wireless system with a network of low radio waves. This is used to assist with the control of electronic devices. Lamps, appliances, and infrared devices are connected to modules and can be operated through remote controls in a home. They can also be controlled from outside of the home with a remote control. Smart house technology includes home automation systems where the entire home environment can be wired for control of electronic and communication devices. The control of lights, temperature, security systems, telephone, other appliances, and multimedia systems can be customized and automated. With these systems, use of remote devices can facilitate access from multiple locations in and outside a home.

Many multifunction EADLs are remote devices that can vary in size and appearance, provide for access through alternate input and output and enable control in various areas in the home. Most have text and or graphic labels and some may be further customized with large print, high contrast, color labels or graphics that include pictures, symbols, or icons. Some have LED displays, lights, and built-in speakers. Output from the EADL can include flashing or blinking lights, auditory beeps or cueing, and speech feedback. These options enable users with differing needs to access and activate the functions of the EADL. Today, these EADLs are increasingly being integrated in living environments with mainstream devices such as smart house technology, portable phones, personal digital assistants, digital recorders, book and music players, and other remote devices providing additional options for controlling the environment.

User Access

Direct Access

There are various input methods to enable individuals with disabilities to access an EADL. EADLs with keyboards, button controls, and touch screens are activated by direct selection. This is where a person chooses a key to type or indicates a desired item by touching or pointing to the item. For persons who have the ability to target and make a selection, this method can be used to quickly control devices. Key or button size, shape, number of choices, and direction and amount of force necessary for activation are considered when selecting an EADL. These are often adjusted or modified to enable accuracy when targeting and efficient use. Alternate mouse pointing devices such as trackballs and head pointing devices and on-screen keyboards provide options to enable persons with more severe impairments to use direct selection to control EADLs. These devices are often used by persons who may have limitations or difficulty with arm or hand movements but who are able to use other body or head movements to operate the pointing device to select keys or the desired item.

Switch and Scanning Access

Scanning is an alternate input method that allows individuals with severe impairments to independently control devices with use of an external switch that is connected to the EADL. An extensive range of switch types are available to enable a person to use any reliable body movements for successful switch activation. With this method, the EADL automatically scans or moves to each available item on the device. For example, to control a television, the scan would move to the television functions such as on/off, channel up/down, volume up/down, and mute. When the scan reaches the desired option, the user activates the attached switch to select that option which will then send the command to the television. When scanning, output from the EADL can include a light on the display, and or an auditory signal that provides information to the user of where the scan is and when to activate the switch. Auditory cueing and feedback is important for those who have impairments in vision and cannot see a display and for those who may be unable to read the necessary information on a display. With scanning systems, it is necessary to learn the scanning method, the devices and features to be controlled, and timing of the switch press or activation. Systems can be customized for speed, response time, scanning method and output to best meet the needs and skills of the user. External switches connected to an EADL enable many individuals with severe impairments to access the EADL and to control devices with minimal movements. These include switches activated through sip and puff, minimal muscle contractions, eye blinks, sound, and other movements that require minimal activations.

Voice Activation

Speech input or voice control is an alternate input method often available in multifunction EADLs. This is used by individuals with consistent speech patterns to control devices with a single or multi-word utterance. Words and speech commands are spoken to control device functions, to navigate through menus, and to program choices. Voice control can be used to activate a single device such a televison or it can be used to fully access a mutlifunction EADL or a computer with EADL functions.

Computers

Use of the computer expands options that enable access including use of alternate keyboards and pointing devices, scanning methods, speech input, and input through eye gaze or coding. Additional access features that assist with the use of EADLs include the use of picture displays as well as text displays, speech output that includes both auditory cueing and feedback, and the use of macros to automate tasks.

Determining EADL

Selection of an EADL requires consideration of a person's capabilities, preferences, and needs, and also the devices that need to be controlled, where the EADL will be used, and the types of transmission that are necessary. Evaluation of a user's function and skill will help to select the type of EADL that will be used to control electronic devices most effectively. This includes assessment of a person's mobility, strength and coordination, reliable body movements, and sensory and cognitive skills to help determine the type of input that will be used to activate the EADL and the output that is needed. Cognitive skills including motor planning, memory, ability to learn new tasks, and motivation can also impact the type of EADL and interface that is

selected. Specific environments also need to be considered to determine EADL components, the types of transmission needed, and needs related to installation and setup. User input and preference is imperative in determining appropriate EADLs. Funding sources vary depending on individual situations.

Research

The use of EADLs provides opportunities for individuals with impairments potential to live independently, increase participation in daily tasks, and to enhance quality of life. Noted benefits of EADLs for persons with disabilities include increased control of their environments and increased levels of independence (Ripat, 2006; Palmar & Seale, 2007; Harmer & Bakheit, 1999), increased sense of security (Stickel et al. 2002), assistance with adjusting to disability (Palmar & Seale, 2007) and increased feelings of competence in performing desired activities (Ripat, 2006). Croser et al. (2001) reported a decrease in frustration levels of users with motor impairments who used EADLs to operate devices that they were previously unable to control. There is a need for continued research and outcomes based measures to support the use of EADLs for increased function, performance and independence (Tam et al., 2003) and to support further research endeavors. Rigby et al. (2005) used these measures with persons with cervical spinal cord injuries to evaluate the impact of EADL use and found that users had greater independence and function in performing daily tasks than those who did not use EADLs. For individuals with severe impairments, research on efficacy to improve the reliability and usability of EADLs is necessary for user independence and quality of life.

With alternate options to control electronic devices, the benefits of EADL use for individuals with severe disabilities can result in increased learning and control of everyday tasks (Bailey, 1993, Erikson et al. 2004). This provides the opportunity for skill development and participation, especially for those with severe motor and cognitive impairments. For persons with severe and multiple disabilities that include impairments in vision, hearing, and or speech as well as severe impairments in movement, research efforts with advanced technologies are critical to provide opportunities for function. Multiple areas of research include brain-computer interfaces such as EEG brain waves and eye closure systems (Thuraisingham et al., 2007; Craig et al., 2002), eye movement systems, an infrared controls that utilize movement capabilities (Chen et al. 2007), and speech recognition systems.

With multiple multifunction EADLs available, factors related to user access, EADL functions and transmission, and interfaces with other devices must be considered to enable efficient control of the environment and to facilitate independence for persons with disabilities (Anson, 2006). Palmar and Seale (2007) found that the severity of user impairments influenced attitudes toward EADLs and that while some users with severe disabilities had positive experiences; others had restrictions with EADL use. Other issues related to EADL use include uncertainty and fear related to technology use (Erikson et al., 2004), and reliability (Judge et al. 2009). Training, consideration of issues related to specific disabilities, and customization for individual needs is important to facilitate learning and more successful use (Boman et al., 2007, Bailey, 1993). Also, setup of devices for optimal access and maintenance of devices are important for continued EADL use (Tomita et al., 2007, Croser et al., 2001). Further research is needed on how EADLs impacts users with different types of disabilities, as well as consideration of social aspects related to the use of EADLs. It is also needed to determine how the use of EADLs can contribute to the

prevention of functional decline, which features are most important for elder users, how to minimize learning demands, and effective options for more efficient access and implementation.

The use of EADLs is essential to persons with a wide range of disabilities who experience a loss of function to enable control of devices in their environment and to facilitate independence. This is necessary to further opportunities both in and outside of the home in environments that are meaningful to each user, and that will increase quality of life. With continued advances in technology, efforts need to be directed to finding new ways for integrating EADLs with other technology devices found in home, school, and work environments. Future work is also needed to assist with easier, reliable, and more efficient access for those with severe impairments, and to simplify use for those who need to learn how to control multiple functions.

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