Fortnightly review

Environmental control systems for people with a disability: an update

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It is of great importance that disabled people should have sufficient help to achieve their potential. There are many ways of reducing handicap. Aids for mobility and communication are well known, but the use of "environmental control systems" is less well described.¹ The collaboration of technologists, engineers, therapists, and medical staff has led to the development of systems that enable people with a wide range of impairments to control their home environment and offer some choice to the individual (R S F Schilling, unpublished).

Method

This review is based on a literature search in late 1995 and was financed by the NHS research and development programme for people with physical and complex disabilities. In view of the paucity of publications on the subject, we used a wide range of sources. We searched the following on-line and CD ROM databases: Medline, CINAHL, PsychLIT, BIDS, ASSIA PLUS, ERIC. We included early work on environmental control systems and case reports to give a historical perspective. We have highlighted the technological aspects of equipment design by including papers on microelectronics and robotics. We also included several official publications to provide an insight into the organisational aspects of provision of environmental control systems. Finally, much valuable information came from personal contact with colleagues interested in environmental control systems, disability organisations, and manufacturers.

What are environmental control systems?

The first environmental control system, known as Possum (Patient Operated Selector Mechanism), was produced in the 1950s for survivors of the polio-myelitis epidemic.² The early systems, which were developed at Stoke Mandeville Hospital, allowed access to typewriters and basic equipment. Use then spread to patients with other diseases, such as cerebral palsy.³ The next 30 years brought some improvements in the design and range of devices that could be operated with environmental control systems, and these improvements paralleled the developments in household appliances. These control systems, however, were

Summary points

Environmental control systems, using sophisticated electronics, enable people with severe physical impairment to use a wide range of electrical devices

Small, unobtrusive control units (resembling remote controls units for television) may have up to 500 functions; switching can be individually designed for users with complex motor problems

Environmental control systems are commonly used for home security (including door intercoms, door release, and alarms), adapted telephones, television, lights, and internal intercoms

Referral for provision of a system is made by doctors or therapists to the local "environmental control coordinator," who arranges a medical assessment to determine the disabled person's eligibility and a discussion to decide on a system to meet his or her needs

Provision of environmental control systems involves doctors, therapists, the local social services department, and technologists

Use of environmental control systems improves patients' self esteem, reduces their dependence on carers, and improves family relationships

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cumbersome. Advances in technology, particularly within microelectronics, have since led to increasingly sophisticated control systems, which now have the potential to operate communication aids and wheelchairs as well as household equipment.⁴ Many environmental control systems incorporate a remote control unit similar to that used with television sets, which is unobtrusive and easy to mount on a wheelchair (fig 1). Larger display units may still be required for people with visual impairment and those with learning or perceptual difficulties who need to use icons rather than words to operate the system (fig 2).⁵ Additionally, some units provide auditory cues to supplement images.

Fig 1 Remote control unit of environmental control system showing typical selections that can be operated by user

The current systems incorporate a control unit, which activates peripheral devices by means of infrared or radio signals.² The unit is controlled by the user with a switch. The devices to be controlled are chosen by the user in discussion with a medical assessor and a therapist. The most commonly used devices are remotely controlled loudspeaking telephones (which may include amplification for hard of hearing people) and intercoms.^{6,7} Home security is popular—systems enable users to activate an external alarm resembling a burglar alarm. Some devices are activated directly—for example, a door release—while others are controlled via a plug-in device to normal sockets. Most electrical equipment can be operated with an environmental control system (box 1). Fixed wiring is needed only for intercoms and adapted telephones.

It is important to use an appropriate switching device that is within easy reach of the user. Input control may be via a standard pressure or a “suck-puff” switch (fig 3). A wide range of head controls, however, have been designed for people with minimal coordinated function of their upper limbs.⁸ Those with complex disabilities can use an individually designed switching mechanism,⁹ which may be mechanical or use computer software to accommodate the user’s disability.¹⁰ The user first triggers the switch to activate the control unit, which starts scanning a menu of equipment to be operated (the scanning speed can be altered to suit the user). A light moves between successive functions to indicate the choice, and this is accompanied by a beep. To select an option the user triggers the switch a second time. Some environmental control systems enable users to operate a computer, which can be beneficial for recreation, education, and work. These systems are particularly popular with younger people. They also have the facility for some stored speech, so they can be used when answering the telephone or the door intercom.

Box 1

Typical devices that can be operated with environmental control systems

- External intercom
- Internal intercom
- Door (lock and release)
- Loudspeaking telephone
- Alarm
- Room lights
- Television, video cassette recorder, radio
- Hi fi system
- Curtains
- Electrically controlled bed (for different positions)
- Page turner
- Mains 13 amp power points
- Computer

Who uses environmental control systems?

Environmental control systems have proved particularly useful for people with high spinal cord injuries; with a control system they need less help from carers and have an increased quality of life.¹ Some spinal injury units in New Zealand use basic control systems in their rehabilitation programmes^{11,12} to encourage patients’ independence.¹³ Acceptance of control systems during early rehabilitation, however, has been shown to be variable, possibly because of the stigma associated with being disabled.¹² In the past, control systems were primarily for recreational use, but with the increased use of computers and home working they have assumed an increasing vocational role.¹⁴ Users of control systems are more independent than non-users, particularly in educational and social activities.¹⁵ Control systems have also been used experimentally in nursing homes, where they were well received

Fig 2 Large remote control unit with display for people with visual impairment or learning or perceptual difficulties

by residents; they were also shown to reduce pressure on the nurses.¹⁶ In the family, control systems can liberate a carer who previously could not leave the disabled person unattended. The reduced dependency may have a beneficial effect on family relationships and can also raise the individual's self esteem. For people who live alone, appropriate equipment may enable them to stay in their own home and avoid institutional care.¹⁷

Some people—such as those with motor neurone disease—will usually be given priority at an early stage because of their poor prognosis. People with Parkinson's disease may not benefit from technical aids in the early stages but may find them useful later. Children can also be provided with control systems. For children with advancing disease, such as Duchenne's muscular dystrophy, equipment is installed to mitigate some of the functional effects of disease progression. People with stable conditions—such as cerebral palsy—can use environmental control systems to access their home environment more effectively.¹⁸ This encourages an independent lifestyle and promotes a sense of achievement and self reliance.¹⁹ Control systems have even been installed in some university halls of residence to enable disabled students to take advantage of higher education.

Box 2

Environmental control systems available through NHS supplies contracts

Commercial company:	System:
Steeper	Sec 1b, Fox, Persona
Possum	PSU 6, Companion, Freeway, Compact
Scientific and Technical Developments	Gemini Total Control

Referral and assessment

Referrals for provision of environmental control systems are made by general practitioners, consultants, or therapists to the local "environmental control coordinator." He or she then arranges for an "environmental control assessor" to visit and provide a report on the disabled person's abilities and needs.²⁰ The criteria that must be fulfilled before equipment is installed have been defined by the Department of Health.²¹ They refer to the presence or the anticipation of severe physical disease, but the assessor is allowed some flexibility to account for the patient's clinical need.²² It is important to assess cognitive function to ensure that the patient understands how to use the system. Some systems have over five hundred functions, whereas others have five; if the equipment is too complex for someone, it is unlikely to be used. Any expected deterioration in a patient's condition should also be noted, as changing need should be accommodated, as far as possible, by the system installed. Partial sight and blindness are not great barriers to using control systems as large icons and auditory signals can be used.

The assessor sends the medical report to the coordinator, who then arranges a case conference. This is generally attended by a representative from the social services department, the manufacturer of the control system, and possibly by involved doctors and

Fig 3 "Suck-puff" switching device for user with limited coordinated function of upper limbs

therapists. It is important that the disabled person takes an active part in deciding which devices will be controlled by their equipment. For many users a fairly simple list of tasks is all that is required of the system.¹⁸⁻²⁴ The manufacturer installs the equipment, teaches the person how to use it, and provides ongoing technical maintenance and support.²²

Until April 1995 environmental control systems were provided by the Department of Health from a centrally held budget. Provision has now been devolved to the NHS regions. Such a move may provide the opportunity to better coordinate the provision of environmental control systems with other services for disabled people, but concern has been expressed that it may lead to reduced funding for equipment (R S Hanspal, unpublished).²¹⁻²² The NHS Supplies Authority has negotiated with three companies who manufacture equipment, and eight types of control unit are now available (box 2). The exact specification of the equipment that is installed results from assessing the person's abilities and needs (box 3).²⁵

The cost of installing a typical system that allows controls to be used in two rooms with a door intercom and door release is about £4500. The time between referral and installation is 3-12 months. A fast track system with rapid assessment and rental of equipment has recently been developed for people with rapidly progressive disease processes.

Box 3

Users' needs

Number of functions
Types of function
Input—for example, stored telephone numbers
Speech (some units have a stored speech facility)
Portability (does it need to be mounted on a wheelchair?)
Needs of carers—for example, to override remote control
Servicing and technical back-up

Training and research

Environmental control assessors are usually consultants in rehabilitation medicine. Training standards have been set by the British Society of Rehabilitation Medicine.²¹ Assessors are required to attend regular meetings to keep up to date with the latest developments in this rapidly expanding field. No reliable outcome measure exists to assess the effectiveness of control systems, making it difficult to measure any cost benefit.²⁶ The provision of environmental control systems has previously not been well publicised, leading to either late referral or non-referral.²⁴ This suggests that the problem of unmet requirement needs to be addressed.²² Standards are being set for service delivery to reduce the time between referral and installation of equipment. Consultation with user groups is leading to technical advances, with the aim of developing a unified input system for wheelchairs, communication devices, and environmental control systems.²⁷⁻²⁸ Scope also exists for addressing the issue of "failed installations" (E Dymond et al, unpublished)—when equipment has been installed but is not being used.²⁵

Developments in technology

The development of multipurpose remote control devices to control domestic appliances is likely to lead to the "intelligent home" in the 21st century. This will be ideal for adaptation for disabled people, and environmental control systems may then lose some of their stigma as they will be associated with more mainstream household equipment.¹⁹ The weak link in most systems is the interface between the user and the equipment.²⁹ New switching systems are being developed, however, that will allow the use of coloured icons and sound cues to indicate commands.³⁰ This will enable user-specific programming of the switching system to cope with the user's own methods of communication. Work is in progress using voice recognition for switching purposes.³¹⁻³² Problems have arisen, however, in accommodating changes in a user's voice patterns, so voice recognition is not being used in standard production.

Need for coordinated approach to assessment and provision

It is the Department of Health's policy to prevent disability and minimise its effects on the individual, to promote independence, and to involve disabled people in decisions regarding care packages.³³ What is really needed is a holistic assessment of each person's needs. This must involve both health and social services staff. A disabled person may need to use many services, including medical, therapeutic, and community services. Currently, these resources are fragmented, and the agencies involved in providing care are often poorly coordinated. A move towards a "one-stop shop" approach may evolve, with a coordinated approach encompassing all groups working with disabled people. In fact, the developing service for provision of environmental control systems provides a model for this type of care package, with the involvement of doctors, therapists, social services staff, and engineers. Increased collaboration between user groups and engineers has been suggested so that the equipment

available better fulfils the needs of disabled people as perceived by themselves.⁸

Installation of an environmental control system can be liberating for both the disabled person and their carers. It is vital, however, that their needs are monitored to ensure that sufficient resources are being used to enable that person to achieve their life goals.

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- Platts R, Fraser M. Assistive technology in the rehabilitation of patients with high spinal cord lesions. *Paraplegia* 1993;313:280-7.
- Dacey J, Shealey S. Using technology to control the environment. *Am J Occup Ther* 1987;41:717-21.
- Jenkin R. POSSUM: a new communication aid. *Special Education* 1967;56:9-11.
- Arruabarrena A, Buldain G, Gardeazabal L, Gomez E, Jal 2: an integrated tool to enhance communication of disabled people. *J Med Eng Technol* 1989;13:28-33.
- Curtin M. Technology for people with tetraplegia. *BJ Occ Ther* 1994;419-23.
- Pehringer M. Assistive devices: technology to improve communication. *Otolaryngol Clin North Am* 1989;22:143-73.
- Von Maltzen W. Usage patterns of environmental control units by severely disabled individuals in their homes. *IEEE Transactions in Rehabilitation Engineering* 1995;3:222-7.
- Dymond E, Potter R. Controlling assistive technology with head movements. *Clin Rehabil* 1996;10:93-104.
- Thornett C. Designing special switches and control systems for multiply handicapped young people—a problem led approach. *J Med Eng Technol* 1990;14:87-91.
- Curtin M. Technology for people with tetraplegia, part 1. *BJ Occ Ther* 1994;57:376-80.
- Woods B, Jones R. Environmental control units in a spinal injuries unit, a review of 10 years' experience. *Int Disabil Studies* 1990;12:137-40.
- Jones R, Hooper R, Armstrong D, Fisher C, Tait J. A multi-patient environmental control system for a spinal injuries unit. *Med Biol Eng Comput* 1980;18:607-15.
- Kirby N. The individual with high quadriplegia. *Nurs Clin North Am* 1989;70:621-3.
- McDonald D, Boyle M, Schumann T. Environmental control utilisation by high level spinal cord patients. *Arch Phys Med Rehabil* 1989;70:621-3.
- Efthimiou J, Gordon W, Sell G, Stratford C. Electronic assistive devices, their impact on the quality of life of high quadriplegic patients. *Arch Phys Med Rehabil* 1981;62:131-4.
- Symington D, Lywood D, Lawson J, McLean J. Environmental control systems in chronic care hospitals and nursing homes. *Arch Phys Med Rehabil* 1986;67:322-5.
- Bell F, Whitfield G, Rollet P. Investigation of POSSUM users in Scotland. *Int Rehabil Med* 1987;8:105-12.
- Thornett C, Langner M, Brown A. Disabled access to information technology—a portable, adaptable, multipurpose device. *J Biomed Eng* 1990;12:205-8.
- Prouse P, Ross-Smith K, Brill M, Singh M, Brennan P, Frank A. Community support for young physically handicapped people. *Health Trends* 1991;23:105-6.
- British Society of Rehabilitation Medicine's Environmental Control Special Interest Group. *Prescription for independence*. London: BSRM, 1994.
- Department of Health. *Environmental control systems*. Heywood, Lancashire: DoH, 1993.
- Mandelstam M. *Environmental control systems, investigating provision*. London: Disabled Living Foundation, 1992.
- Barnes M. Environmental control systems—an audit and review. *Clin Rehabil* 1994;8:362-6.
- Platts R, Andrews K. How technology can help rehabilitation. *BMJ* 1994;309:1182.
- Medical Devices Agency. *Environmental control systems, an evaluation*. London: HMSO, 1994. (No A14.)
- McKenna M, Maynard A, Wright K. *Discussion paper 101*. Centre for Health Economics, University of York, 1992.
- Kwee H. Rehabilitation robotics—softening the hardware. *IEEE Engineering in Medicine and Biology* 1995;330-5.
- Barnes M. Switching devices and independence of disabled people. *BMJ* 1994;309:1181-2.
- Dymond E, Potter R, Griffiths P, McClelland E. A week in the life of Mary; the impact of microtechnology on a severely handicapped person. *J Biomed Eng* 1988;10:483-90.
- Flachberger C, Panek P, Zagler W. Compose Autonomy! An adaptable user interface for assistive technology systems. *European Context for Assistive Technology* 1995;105:13-6.
- Summers G, Cochrane G. Evaluation of a voice activated environmental control system for disabled people. *Clin Rehabil* 1988;2:231-9.
- Noyes J, Haigh R, Starr A. Automatic speech recognition for disabled people. *Applied Ergonomics* 1989;20:293-8.
- National Audit Office. *Health services for physically disabled people aged 16-64*. HMSO: NAO, 1992.

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