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REVIEW

Assistive technology in elderly care

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Abstract

New developments in assistive technology are likely to make an important contribution to the care of elderly people in institutions and at home. Video-monitoring, remote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms can improve older people's safety, security and ability to cope at home. Care at home is often preferable to patients and is usually less expensive for care providers than institutional alternatives.

Keywords: *assistive technology, elderly people*

Introduction

Recent developments in new technology are the subject of intensive research destined to make an important contribution to the care of older people, both in institutions and at home. Electronic sensors, video-monitoring, remote health monitoring and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms can improve patients' safety, security and ability to cope at home.

Since care in the community is preferable to most patients and is usually less expensive than in care homes, systems using advanced technology to support people at home could benefit both patient and care provider.

Equipment

The aids and devices available are continually improving. The following types of equipment are currently available.

Community alarms

Alarm systems have been available in the United Kingdom for about 40 years and are now installed in the homes of over 1 million people [1]. Originally designed for elderly people and low income groups, who rarely had access to a telephone, they consisted of a pull-cord device with an audio box on the wall to speak to a control centre or warden. The community alarm service began around 20 years ago and was originally set up to provide a service to tenants in sheltered housing when the warden was off site.

Nowadays, alarms are used in sheltered housing where they are 'hard wired' into each flat. These alarm systems operate from pull-cords which, when activated, alert the warden to the call. The warden is then able to communicate with the tenant through a two-way speech connection. When the warden is not available, the alarm systems are switched over through the telephone network and all calls are diverted to a remote call-handling site.

New equipment on the market includes portable alarm units, which patients can use in their own homes. These units have given over 300 000 people in the UK access to support services without the need to move to sheltered housing. The alarms are activated by pressing a button on the unit itself, but also by a trigger which can be worn as a pendant or on the wrist. This trigger sends a radio signal to the alarm unit which, once activated, automatically rings the community alarm control centre (or any other pre-set number). The unit allows two-way speech, so the centre can determine the nature of any emergency and send assistance. The community alarm service has a response team permanently on standby to visit homes where necessary.

The service can only be effective if the person recognizes an emergency and has the physical and mental capacity to press the alarm button (e.g. is conscious). Sometimes, people fail to operate their alarm system when there is a genuine emergency. The reasons for this are not clear, but may be a result of

a false assessment of their own condition or simply a reluctance to disturb a service operator.

The community alarm system can relieve anxiety and increase the confidence of people living alone [2]. It has developed an infrastructure of communications, databases, control centres and response networks which is well established in the UK and which has gained the confidence and trust of older people and professionals alike. The service is especially useful when people live in isolation. The community alarm system provides an ideal framework on to which recent developments in electronic and telecommunication technology can be added, so future generations of the community alarm system are likely to form part of an integrated telecare system.

Video-monitoring

Recent developments in communications processor design, video and audio compression algorithms, network protocols and cost effective manufacturing can provide colour audio-video communication in real-time over the ordinary telephone line. This equipment is designed primarily for remote surveillance in the security industry, but can be adapted for domestic audio-video communication. It requires access to a touch-tone telephone. The video can be viewed either on a monitor or a domestic television. No computer is required at either end.

A box about the size and shape of a video cassette tape, the master transceiver, is required at each end and is connected to a standard telephone line and up to three cameras. Depending on the number of cameras at the patient's end, the relative can use the remote selection control facility to scan the accommodation and determine the patient's location (have they fallen? are they on the floor?). The cameras have the ability to pan, tilt and zoom electronically. The system is compatible with and can be linked into other alarms, so a fire alarm, for example, can generate a video call to the relative who can see and assess the situation and call for help. Different video-monitoring systems are available, using either normal telephone lines or ISDN (high-speed telephone lines), which give better audio-video communication. The systems include personal identification number security which allows high privacy.

Health monitors

The health monitor is the same size and shape as a wrist watch and is worn on the wrist. It continuously monitors pulse, skin temperature and movement. Over the first few days, it develops a pattern for the individual user and any deviation from that pattern generates an alarm. It is designed to detect collapses, faints, blackouts or any events which affect the monitored variables. The alarm is transmitted via a radio link to a small device called a multi-link, which feeds into the community alarm system to generate an emergency call at the community alarm centre. This device can be used to monitor a person's general well-being and may be useful as a fall monitor. It can also be used as a wandering detection system since whenever the wearer goes out of radio range of the multi-link (approximately 45 m) an alarm is generated. It may be useful as an alerting mechanism for people with a serious illness such as terminal carcinoma and a live-in relative or carer.

Fall detectors

These are small bleep-sized devices designed to be worn around the waist or the upper chest. Mostly they use a two-stage detection mechanism—an accelerometer and a tilt meter—to reduce the number of false alarms. The accelerometer detects an impact greater than a certain threshold, representing the minimum impact to be detected. The tilt meter determines the wearer's orientation [3].

Three types are currently available:

1. Tunstall—this accelerometer and tilt meter detects impact first and then looks to see the wearer's angle of tilt. If horizontal, it then generates an alarm after a 15 s warning. During this 15 s, it bleeps and the alarm can be cancelled by placing upright. The device cannot be worn in bed.
2. Tele-alarm—this accelerometer and tilt meter measures tilt continuously and, if this changes by $> 45^{\circ}$ and is followed by an impact, generates an alarm. The device provides no warning of an impending alarm. It can be worn 24 h a day.
3. Technology in Healthcare—this measures the rate of change of tilt and generates an alarm if the tilt is $> 30^{\circ}/s$.

The Tunstall and Telealarm devices operate on the same principles, but with a reverse sequence of trigger mechanisms. All these devices generate an alarm locally at the person's home and through the telephone network at a pre-determined location, either the home of a relative or friend or, by default, if required, the community alarm centre. Patients with arthritis may have problems fitting the device, while those with hearing impairment may not hear the bleep warning to cancel the alarm. All these fall monitors have a button which, when pressed, activates the community alarm service, so obviating the need to wear a pendant alarm simultaneously.

Hip protectors

Hip protectors are specially designed underwear with polypropylene shields sewn inside. They are placed over the greater trochanter. When a person falls onto their hip while wearing these pants, the impact of the fall should be diverted away from the hip, preventing it from fracturing. They are produced in different sizes for women and men. Hip protectors appear to reduce the risk of hip

fracture within a selected population at high risk of sustaining a hip fracture [4].

Acceptability to users remains a problem, because of discomfort and problems with urinary incontinence and practicality. The lifespan of the underwear is usually around 6 months and each patient requires three sets at any one time.

Pressure mats

The pressure mat is an electro-mechanical device which detects a person mobilizing from a bed or chair. It provides an automatic communication link between the user and their carer. The monitor consists of two components: a pressure-sensing panel, which is located beneath the mattress or chair cushion, and a control unit, which is placed in a convenient position for the carer to operate.

A change in pressure is identified as the person moves from their bed or chair in any direction. This information is detected by the control unit, which gives an audible and visual alarm. The monitors are pre-calibrated for variability in weight, agility and differing bed types and will not require adjustment in general use. However, the control units have a simple adjustment to make them more or less sensitive. The monitor identifies only those movements which indicate that the person has got out of the bed or chair.

It can be used as a stand-alone aid or can be linked with existing nurse call or radio-paging equipment. It has several applications: (i) as a communication aid between vulnerable people and their carers, (ii) to produce a behaviour profile by alerting to night-time wandering and (iii) as a fall prevention measure by alerting the carer to a person's movements.

Similar pressure monitors (weight detectors) fit under the leg of a bed or under a bedside mat and raise the alarm when the person had been out of bed for a variable predetermined period. These are useful at night, particularly if there is a live-in carer or relative. They are useful to detect night-time wandering, for falls prevention and to construct a wandering or mobility profile. These pressure mats can be linked to a lighting system: illumination increases when the person arises.

Door alerts

These electro-mechanical sensors attached to doors are useful for patients who wander at night. They can generate an alarm to a live-in carer or, by linkage to a video-monitoring system, can video-call a relative who lives some distance away.

Movement detectors

These infra-red detectors (as used in domestic burglar alarm systems) are useful for live-in carers or relatives who want to know if their elderly relative enters part of the property where they might be at risk. In some situations the detector forms part of an integrated network where it is linked to a lighting system so the lights intensify when a person enters the room and fade when he leaves.

Dawn/dusk lights

These are stand-alone lights which respond to ambient light levels. They are useful for people who get up at night to use the toilet. The light might help to prevent falls. A minimum level of ambient light is required successfully to operate audio-video telephone calls at night.

Smoke alarms

These detectors react to visible and invisible fire aerosols (products of combustion) and therefore can detect the early presence of fire, using either an optical or an ionization detector.

Fire alarms

These detectors measure the absolute temperature and the rate of change of temperature. They are suitable for areas where a smoke detector is unsuitable because of environmental conditions (smoke, dust etc.). They are used for those who are at risk of producing a fire at home—such as smokers and people who do their own cooking.

Cooker controls

A cooker control, plumbed into the cooker's gas supply, turns the supply off when high temperatures are detected. It also generates an automatic message to a control centre or a relative. It is often installed during the construction of 'smart homes'.

Electronic calendars/speaking clocks

Some cognitively impaired people often ask the time or date repeatedly. By pressing a button, these gadgets speak the time and date. They are useful as an orientation device and appear attractive.

Applications

Assistive technological equipment has been used in three different situations:

1. The retro-fit approach incorporates the equipment onto the community telephone alarm system, with its ready-made infra-structure of communications, databases, control centres and response networks. The equipment is individually tailored to the needs of patients in their own homes, depending on the results of a 'needs assessment'.
2. Unobtrusive sensors in the home can be used to collect lifestyle pattern data. The lifestyle data are analysed regularly, and the patterns of activity recorded, building up a profile of the user's activity. If a deviation from the normal pattern is detected,

a telephone message is automatically constructed and delivered to a carer.

3. 'Smart homes' incorporate numerous sensors, which are installed throughout the accommodation during its construction. The sensors are linked through an intelligent network to cut-off devices, which ensure the safety of the occupants (e.g. if excessive heat is detected in the kitchen, the cooker is automatically switched off). Most 'smart homes' incorporate environmental control systems for lighting, heating and ventilation.

Limitations

Although assistive technology should make an important contribution to the safety, security, independence and quality of life of elderly people living at home, there are some limitations. Not everyone will benefit from or accept new technological aids and devices, and each individual's situation must be carefully assessed. Many people may welcome the technology, although a few might view it as an invasion of privacy. Some equipment (e.g. community alarm systems) is relatively inexpensive, while video-monitoring is quite expensive. Elderly people who have visual, auditory or speech disabilities may not be able to use some of the technology. Finally, those who have other physical or cognitive impairments may have difficulty with some equipment.

Key points

- Assistive technology can make an important contribution to the care of elderly people in institutions and at home.
- The technology can be fitted following a needs assessment, incorporated in 'smart homes' or used to collect lifestyle pattern data and indicate deviations from this.
- It is important to assess each individual's situation and needs, and address issues of loss of privacy.

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