

## Rehabilitation Article

# Voice Control of Environmental Control Systems

Lothian's Electronic Assistive Technology provides Environmental control equipment to enable people with special needs to control electrical/electronic equipment within their homes.

At present there are 57 such installations of environmental control equipment within the Lothian region. Most of the equipment fitted uses a scanning method for the selection of options from a display panel. Voice control is also an option and at present there are five installations of voice based environmental control equipment in Lothian, the first of which took place four years ago.

Voice recognition has been available as a method of computer control for a number of years. There are two main producers, IBM and Dragon Systems. Both require a head worn microphone and a microcomputer and have the advantage of adapting to changes in the user's voice. It is possible to use this software for environmental control by fitting an infrared transmitter to a microcomputer or wheelchair mounted laptop computer. However the former would contrast with the trend within environmental control towards portable compact equipment and the latter would result in reduced reliability because the laptop computer, due to its hard drive, is more prone to damage caused by vibration than a dedicated environmental control unit.

Our experience with voice based systems has been with the Sicare Pilot (figure 1). The Pilot is a compact voice operated unit that can be clamped to the user's wheelchair or positioned on an overbed table. Two models are available, one that transmits infrared only and another that transmits radio signals as well. The Pilot includes a database of standard infrared codes and can, if an additional IR box is purchased, learn the codes for standard infrared remote controls. The Pilot has a built in microphone or alternatively a small external microphone can be fitted. A small LCD screen provides visual indication and a built in speaker enunciates the command just recognised. The Pilot can be operated with one or two switches, as a backup method to voice control.

Figure 1.



The Pilot utilises a menu tree structure of commands (see figure 2). This tree structure is constructed during installation with commands being classified into branches associated with different devices e.g. TV, telephone, intercom etc. Infrared signals are then assigned to each command by either selecting from a database of infrared signals or training the Pilot with infrared signals from the user's remote controls. Voice profiles are then linked to each command by training the Pilot with the user's voice.

Figure 2.



The tree structure is necessary to maximise recognition reliability so at any stage in its use the Pilot is looking for the user to utter one of a few commands in the active branch of the menu, and not looking for the full vocabulary. The Pilot can store a maximum of 64 voice profiles but the tree structure makes it possible to reuse particular voice profiles within different contexts. For example the numbers 0, 1, 2, 3 can be used both within the telephone and TV branches of the menu making the Pilot's memory the limitation on the maximum number of commands. The manufacturer states that they have configured a Pilot with 410 commands and noted that less than 50% of available memory was used.

Fixed display scanning environmental control units such as the Steeper Fox and Gewa Prog have a maximum number of commands of 62 and 161 respectively. This is less than the Pilot but sufficient for most users. Alternatively the SRS 100, a scanning environmental control unit with a LCD screen could be considered. This device, because of its dynamic display, has a maximum number of commands limited only by its memory. The manufacturer states that the SRS 100's maximum number of commands is 2500.

### Criteria for selecting voice control

- 1) Users must have a reliable repeatable voice.
- 2) Users must have a sufficiently good memory to memorise the Pilot's menu tree structure.
- 3) The user's level of disability should probably exclude other simpler options. The Pilot is approximately 2.5 times the cost of the Gewa Prog or Steeper Fox so initial and replacement costs will be significantly greater. Also, a number of follow up visits may be required, in the weeks immediately after installation, to retrain problem voice profiles. These follow up visits obviously represent a cost in terms of staff hours.
- 4) It's helpful if the user has a good motivation to work with technology. One reason is to fully exploit the functionality offered by the Pilot but also a high level



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## Botox® Abbreviated Prescribing Information

**Presentation:** Vial containing 100 units (U) *Clostridium botulinum* type A neurotoxin complex (900kD). **Indications:** Symptomatic relief of blepharospasm, hemifacial spasm, idiopathic cervical dystonia (spasmodic torticollis) and severe axillary hyperhidrosis. Focal spasticity - dynamic equinus foot deformity due to spasticity in ambulant paediatric cerebral palsy patients (two years or older) and wrist and hand disability due to upper limb spasticity associated with stroke in adults. Safety and efficacy in the treatment of blepharospasm, hemifacial spasm, idiopathic cervical dystonia, or focal hyperhidrosis in children has not been demonstrated. **Dosage and Administration:** See Summary of Product Characteristics for full information. Reconstitute with sterile unpreserved normal saline (0.9% sodium chloride for injection). BOTOX® doses are not interchangeable with other preparations of botulinum toxin. **Blepharospasm:** Inject using a 27-30 gauge needle. Initially, 1.25-2.5 U injected into the medial and lateral orbicularis oculi of the upper lid and the lateral orbicularis oculi of the lower lid. Subsequently, the dose may be increased up to two-fold. Initial dose should not exceed 25 U per eye. Total dose should not exceed 100 U every 12 weeks. **Hemifacial spasm:** Treat as for unilateral blepharospasm (as above). Inject other affected facial muscles as needed. **Cervical dystonia:** Inject using a 25, 27 or 30 gauge needle (for superficial muscles) or 22 gauge (deeper musculature). Tailor dosing to individual patient based on the head and neck position, location of pain, muscle hypertrophy, body weight and response. Do not inject sternocleidomastoid muscle bilaterally. Maximum total dose usually not more than 200 U. **Hyperhidrosis of the axillae:** Inject using a 30 gauge needle. Inject 50U intradermally to each axilla, evenly distributed in multiple sites 1-2 cm apart. **Paediatric cerebral palsy:** Inject using a 23-26 gauge needle into the medial and lateral heads of the affected gastrocnemius muscle. Recommended total dose: 4 U/kg. Divide dose between two limbs if injected on same occasion. Repeat dose not more frequently than every two months. **Focal spasticity associated with stroke:** Inject using a 25, 27 or 30 gauge needle (superficial muscles) or longer needle for deeper musculature. Multiple injection sites may facilitate more uniform contact with the innervation areas of the muscle, especially in larger muscles. Tailor dose and number of sites based on size, number and location of muscles involved, the severity of spasticity, and the presence of local muscle weakness. **Contra-indications:** Known hypersensitivity to any constituent. Generalised disorders of muscle activity (e.g. myasthenia gravis). Concomitant use with aminoglycoside antibiotics or spectinomycin. Bleeding disorders of any type, anticoagulant therapy and whenever there is any reason to avoid intramuscular injections. Pregnancy or lactation. **Warnings/Precautions:** Relevant anatomy and changes due to prior surgical procedures must be understood prior to administration. Extra caution with injection sites close to structures such as the carotid artery and pleural apices. Do not exceed recommended dosages and frequencies of administration. Adrenaline and other anaphylactic measures should be available. For intramuscular injection and in the treatment of hyperhidrosis for intradermal injections ONLY. **Blepharospasm:** Reduced blinking following injection of the orbicularis muscle can lead to corneal exposure, persistent epithelial defect and corneal ulceration, especially in patients with Vllth nerve disorders. Careful testing of corneal sensation in eyes previously operated upon, avoidance of injection into the lower lid areas to avoid ectropion, and vigorous treatment of any epithelial defect should be employed. **Cervical Dystonia:** Limiting dose into the sternocleidomastoid muscle to less than 100 U may decrease the risk of dysphagia. **Hyperhidrosis of the axillae:** Consider secondary causes of hyperhidrosis to avoid symptomatic treatment without the diagnosis and/or treatment of underlying disease. **Focal Spasticity associated with paediatric cerebral palsy and stroke:** Not intended as a replacement for the usual standard of care regimens. Not likely to be effective in improving range of motion at a joint affected by a fixed contracture. **Interactions:** Effect may be potentiated by aminoglycoside antibiotics or other drugs that interfere with neuromuscular transmission e.g. tubocurarine-type muscle relaxants. Polymyxins, tetracyclines, lincomycin and muscle relaxants should be used with caution. **Adverse Effects:** Side effects may occur from misplaced injections temporarily paralysing nearby muscle groups. Excessive doses may cause paralysis in muscles distant to the injection site. **Blepharospasm:** Most commonly-reported: ptosis, lacrimation and irritation (including dry eye and photophobia), lagophthalmos. Ectropion, keratitis, diplopia and entropion reported rarely. Ectymosis occurs easily in the soft eyelid tissues. One case of angle-closure glaucoma. **Cervical dystonia:** Dysphagia, pain and soreness at the injection site and local weakness reported frequently. Less frequent: bruising at injection site, general weakness, malaise, nausea. Rare: drowsiness, numbness, stiffness, diplopia, ptosis, headache, dyspnea, fever, flu syndrome. Possible: neck weakness/instability head tremor, dysphonia, dry mouth, allergic reactions. **Axillary hyperhidrosis:** Perceived increase in non axillary sweating. Weakness of arm reported uncommonly. **Cerebral palsy:** Falling, leg pain, leg (local) and general weakness. Leg cramps, fever, knee pain, ankle pain, injection site pain, lethargy. **Focal upper limb spasticity:** Commonly reported: ecchymosis, pupura, injection site haemorrhage, arm pain, muscle weakness, hypertonia and injection site burning. Less frequent: hyperesthesia, arthralgia, asthenia, pain, bursitis, dermatitis, headache, injection site hypersensitivity, malaise, nausea, paresthesia, postural hypotension, pruritus, rash, incoordination, amnesia, circumoral paresthesia, depression, insomnia, peripheral oedema, vertigo. **Basic NHS Price:** £128.93. **Marketing Authorization Number:** 0426/0074. **Marketing Authorization Holder:** Allergan Ltd, Coronation Road, High Wycombe, Bucks HP12 3SH. **Legal Category:** POM. **Date of preparation:** February 2003. Further information is available from: Allergan, Coronation Road, High Wycombe, Bucks HP12 3SH.

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of user participation is required both during voice training and also afterwards when it's necessary to highlight any problem voice profiles.

- 5) Familiarity with voice control methods is useful but not essential. People who are already using voice control for computer use appear to take readily to the Pilot.
- 6) A strong aversion to any additional equipment may make the Pilot a good choice. One Pilot user, who had suffered a high level spinal injury, explained that he didn't want to have a switch positioned near his head as he felt this was the only part of him that was not disabled. The Pilot could be recommended for people who express this view at it results in a discreet solution with minimal equipment.

## Reliability

From our experience the Sicare Pilot would appear to be reliable if care is taken during voice training and during the setting up of the Pilot each day. During voice training there are five passes through the list of commands. The documentation recommends that each of these five passes be done at different times of day. This may present difficulties for those fitting the device because it is more time efficient for voice training to be done within a fixed time slot.

## Factors to Maximise Reliability

- 1) During training make the five passes through the command list with different levels of background noise.
- 2) Use the small clip-on microphone to make the Pilot less susceptible to background noise. Note the position and orientation of the microphone during voice training and ensure that the user has this information so carers can set the microphone up similarly each day.
- 3) Maximise the phonetic difference between commands. For example use "Dial Out" instead of "Dial" in order to include more syllables.
- 4) Structure the menu tree to minimise the number of commands within each branch. This is especially important for more safety-critical commands.

## Reliability for Safety-Critical Functions

There is some concern about using voice control for safety-critical commands e.g. to call for help via alarms. Our experience with the Pilot leads us to conclude that occasionally the user may have to repeat commands. This is especially the case when significant background noise is present, e.g. when the hi-fi is playing when it may be necessary for the user to wait for a lull in the sound before proceeding.

The risks have to be weighed up in each case in order to establish if backup switches are required. If there are factors that increase the risk in the event of a problem e.g. the user requiring a ventilator, then backup switches should be provided. For community alarms where assistance is being sought from a carer outwith the immediate home environment then, similarly, it would be wise to consider backup switches. We would also have serious concerns about voice control being used for the control of electrically tilting armchairs where there is a risk of injury to the user.

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