Use of electronic devices in pain management

Far from being a recent phenomenon, electroanalgesia has been a feature of medicine for thousands of years. Perhaps it is now time that we let history teach us a lesson and look again at how the use of electronic devices in pain management may benefit our cash-strapped NHS.

ELECTROANALGESIA

History is replete with references to electroanalgesia – the use of an electronic current to control and manage pain – in a range of biological and medical treatments. Among one of electroanalgesia's first proponents was Scribonius Largus, physician to the emperor Claudius, who in 46 AD recommended the analgesic shock of the torpille (electric fish) in the treatment of pain (Largus, 1655). In 1855, Duchenne de Boulogne wrote a book entitled *Localised Electrification and its Application in Physiology, Pathology and Therapy*, while another enthusiast of the late 19th century, Leduc (1902), published an impressive series of work, among which was a study highlighting electrostimulation as an effective means of achieving local and general anaesthesia in patients undergoing surgery.

Yet, by the beginning of the 20th century, pharmaceutical interventions had already begun to predominate, whether in anaesthesia or pain management. According to unpublished data from the Proprietary Association of Great Britain and the Association of the British Pharmaceutical Industry, the NHS now writes 55 million prescriptions for analgesics a year at a cost of £265 million. The public then spends a further £370 million buying its own painkillers from pharmacies and supermarkets. Yet at what even further cost is this chemistry? No drug is without side effects, and while transient indigestion may seem a relatively small price to pay for the relief of a banging stress-induced headache, in anaesthesiology, the drugs used are always toxic to the nervous system and to certain organs, namely the heart, liver and kidneys (Limoge et al, 1999).

WHAT PRICE PAIN?

Routine anaesthesia keeps the patient in a particular state where the physiology of the nervous system is selectively disturbed and where metabolic disturbances affect function, contributing to postoperative illnesses (Baumann and Vourdh, 1968; Bodlander, 1975). Although pure electroanaesthesia may not yet be possible, its use in conjunction with pharmacodynamic drugs has been shown to permit a reduction in use of anxiolytics and neuroleptics by up to 45% and a reduction of morphinomimetics by 90%, while at the same time providing a less depressive general anaesthetic (Le Guillou et al, 1982; Naveau et al, 1992).

An audit of surgical patients by a team based at Birmingham's City Hospital NHS Trust, presented at this year's Pain Society meeting in York (F Hall, A Hahn, A Atkinson, 2001), revealed that almost a quarter of patients (23%) were spending up to a costly 45 minutes longer in the recovery room because their anaesthetist had underestimated the level of their postoperative pain. Yet current postoperative trials of both a low and high frequency device administering transcutaneous spinal electroanalgesia (TSE) may highlight the device as an effective and efficient means of pain relief following surgery.

Off the ward, a 1999 investigation in which the author was involved audited 60 randomly selected chronic pain sufferers from GP practices nationwide. Consultation rates of 2.96 visits in the 6 months before the 'at home' use of a TSE device fell to 1.84 over the 6 months of its use – a drop of 38%. This reduced workload alone represents a significant cost saving and may be a contributory factor in the ongoing investment made by the US Army Medical Research Development Command in trials assessing the potential of electronic devices in pain control and management.

MAKING THE CONNECTION

The late Professor Patrick Wall was credited not only with being the world's leading expert on pain, but also as being the father of modern electroanalgesia. With American neurosurgeon William Sweet, he invented the transcutaneous electrical nerve stimulation (TENS) device, which has brought relief to thousands of people worldwide. The rationale for the device, which sends out an electrical current to stimulate certain fibres within the peripheral nerves, is based on the gate theory of pain, which Wall developed with Canadian psychologist Ron Melzack and published in *Science* in 1965 (Melzack and Wall, 1965).

Although initially regarded with suspicion, the gate theory overturned the Cartesian model of pain travelling up a string of nerves from the extremities to the brain. Instead, it explained pain by suggesting that a gating mechanism within the spinal cord controlled the flow of signals to the brain in such a way as to determine whether or not they were perceived as painful.

Wall and Melzack argued that the body was capable of inhibiting pain signals by sending out chemicals to stimulate nerve fibres within the spinal cord to close the gate to the brain. While Wall and Sweet's TENS device aims to achieve the same shutting off effect, by advancing this argument, which was only taken seriously after clinical trials proved the efficacy of the TENS device, they opened up research into the neurochemistry of pain.

Wall also inspired his former student Dr Alexander Macdonald to take TENS a step further with the development of TSE. In 1995, Macdonald, along with physicist Dr Tim Coates, patented the first TSE device, designed to directly affect the mechanisms of the spinal column by emitting short wavelength, relatively high voltage pulses of electricity via electrodes placed at the top and bottom of the spinal cord. Initially, Macdonald and Coates saw their device as an alternative to Shealey's 1971 neurosurgical procedure, dorsal column stimulation, in which wires are implanted into the spinal column to induce analgesia. However, Macdonald has since spearheaded further TSE research.

In a clinical series prepared earlier this year following his stint as a doctor on call for Bristol's emergency primary care service, Macdonald used a device capable of 20 000 Hz and higher to treat a range of acute pain conditions in male and female adults patients being transported to hospital. He claims a relief rate of 50% to total, followed in an average of 10 minutes, with patients on admission able to enter into lucid conversation with doctors, their consciousness unclouded by drugs.

In monitoring the use of TSE in more than 8000 UK patients, no significant treatment side effects have ever been reported. There is no known interaction with drug therapies, and TSE has been successfully used in conjunction with other therapies, such as physiotherapy, TENS, acupuncture and osteopathic techniques.

Similarly, another technique, transcranial electrical stimulation (TCES), developed by the French professor of electrophysiology Limoge, suggests that electroanalgesia may be side-effect free. In a 1998 review of TCES, Limoge claims that after 30 000 major interventions undertaken in France and Russia since 1972, not even the most 'minor incident' is recorded for the technique in which the mechanisms of the central nervous system are again directly activated, this time via an arrangement of three electrodes on the head (a negative electrode placed in between the eyebrows and two positives in the retromastoid region).

Limoge maintains the main property of TCES is to potentiate some drug effects, especially opiates and neuroleptics, during anaesthetic clinical procedures. He concludes:

'TCES mechanisms are not completely elucidated but results obtained without undesirable effect are encouraging signs to continue investigations of this particular technique.'

Perhaps the time has come for us all to make the same connection. HM

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KEY POINTS

- Electroanalgesia is an approach to pain relief that has been used for many centuries.
- Pharmaceutical pain relief products cost the UK £635 million annually.
- Although pure electroanaesthesia may not yet be possible, its use in conjunction with pharmacodynamic drugs has been shown to permit a reduction in anxiolytics and neuroleptics by up to 45% and a reduction of morphinomimetics by 90%, while at the same time providing a less depressive general anaesthetic.
- The late Professor Patrick Wall is credited with being the father of modern electroanalgesia.
- While all drugs have side effects, electroanalgesia may be side-effect free.

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