Contemporary Themes

Telephone monitoring of patients with pacemakers in the west of Scotland

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Abstract

A regional telephone pacemaker follow-up service has been established in the west of Scotland. Medical care is provided by clinics at district general hospitals in Ayrshire, and the pacemaker signals are transmitted by telephone from these clinics to a pacemaker centre in Glasgow. The success of the pilot project in Ayrshire will allow expansion of the service to include hospitals in other areas of the west of Scotland. The scheme is carefully monitored to ensure that patients with pacemakers receive adequate attention with a minimum of inconvenience.

Introduction

Patients with pacemakers have been followed up by telephone in the United States for the past ten years,^{1,2} but the method has not been widely used in the United Kingdom. The shorter distances to travel, more rigorous control over data transmission by telephone, and dissatisfaction with the technical performance of the transmission techniques have in the past reinforced a general feeling that it was "more important to follow up patients than pacemakers."

The advent of the more predictable end-of-life mode of the lithium anode power sources coupled with considerable advances in telephone transmission equipment suggested that this type of follow-up be re-examined. Giving each patient a transmitter was considered unreasonable because of the expense, the operational problems likely to be encountered by the patients, and the necessity of a medical assessment of the patient's well-being.

It was therefore decided to establish clinics in district general hospitals with transmitting facilities to a pacemaker centre in Glasgow. The clinical experience of the general physician in the district general hospital is then coupled with the technical experience of the pacemaker centre. The district general hospital clinic is a screening unit that not only adequately follows up a

patient whose pacemaker is functioning properly but also is capable of detecting any malfunction. The patient can then be referred to the pacemaker centre for further investigation and the elucidation of the problem.

Patients and methods

DESIGN OF A PILOT SCHEME

The area covered by the West of Scotland Health Boards extends from Dumfries, 75 miles south of Glasgow, to Oban, 100 miles north-west. The central conurbation is administered by the Greater Glasgow Health Board, which has five teaching hospitals. The surrounding

FIG 1—Numbers of patients with pacemakers in the six areas forming the West of Scotland Health Boards on 31 December 1978. One half of the patients reside within the Greater Glasgow Health Board boundary.

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area is served by five area boards, each of which contains several district general hospitals. The distribution of patients with pacemakers in these six areas is shown in fig 1. Although half the patients reside within the Greater Glasgow boundary, many have to travel considerable distances to the pacemaker clinics in Glasgow. A pilot telephone transmission scheme was started in Ayrshire with three

centres, Kilmarnock, Ballochmyle, and Ayr, serving the north, east, and south of the area. Monthly clinics are held at each centre (actually coinciding with the physicians' own outpatient clinics), from which telephone transmissions are made to the department of clinical physics in Glasgow. The starting date was 1 March 1980. After that date patients were "transferred" to their nearest clinic in Ayrshire when they attended their parent pacemaker clinic in Glasgow.

Records of the patient's history, details of the pacemaker, and the results of each clinic visit are kept both centrally and at the transmitting clinics. A clinic visit entails electrocardiography, a telephone transmission to Glasgow, and a medical examination by a consultant physician (or his deputy). A report of the clinic visit is sent to the patient's general practitioner and a copy is sent to the cardiologist in Glasgow responsible for the patient. Procedures for emergency admissions and readmission for surgical interventions remain unchanged, the patient always returning to the hospital where the pacemaker was implanted. A record is kept of how each patient travelled to the pacemaker clinic and the number of miles saved by attending the telephone clinic.

TELEPHONE TRANSMISSION EQUIPMENT

Because of the requirement to measure and display the pulse width of the pacemaker impulse in addition to the rate, the Cardiotrak* system was chosen. This system had already been modified to satisfy the Post Office's requirements for transmission over the telephone network. The system consists of a central receiver and several transmitters. Electrocardiographic voltages and the pacemaker artefact are measured by four stainless steel electrodes placed on the chest. The electrodes are an integral part of the transmitter and no electrode jelly is necessary. The amplified signal modulates an audio frequency centred at 1900 Hz. This audible signal is coupled via the Post Office telephone to the receiver based in Glasgow. At the receiving end the signal is demodulated and converted back into a voltage, which drives a pen recorder. Although a 50 Hz filter is provided by the receiver, the unfiltered signal is almost invariably acceptable (fig 2).

FIG 2—An unfiltered output signal from the telephone transmission receiver. This patient has a bipolar ventricular paced, ventricular inhibited pacemaker.

The presence of a pacemaker artefact in the electrocardiogram (ECG) activates the digital part of the circuitry in the transmitter and receiver. The digital signal is decoded at the receiver end and displayed as a pulse width in milliseconds to two decimal places. The range of pulse widths is from 0.01 to 2.56 milliseconds. The receiver determines the time between successive pacemaker artefacts in milliseconds and converts this to the pacemaker pulse rate that is displayed as the number of pulses a minute to one decimal place.

In this way an accurate indication of the pacemaker pulse width and rate can be transmitted in addition to the equivalent of a single-channel ECG. The proper function of the pacemaker can be checked from the ECG strip, the optimum orientation of the transmitter electrodes being chosen by the receiving interpreter. The apparatus copes with a wide range of input millivoltages so that both unipolar and bipolar pacemaker signals can be transmitted and interpreted.

Results of the pilot scheme

In the first 12 months of the pilot scheme 85 patients were "transferred" back to the care of the three Ayrshire district general hospitals. The first clinic was on 14 May 1980, and at the end of the trial period (28 February 1981) 26 clinics with 106 patient transmissions had taken place. All transmissions were technically satisfactory. One mal-

functioning pacemaker system was detected, a ventricular demand (VVI) unit with intermittent failure to sense. The patient was symptomless but attended a Glasgow pacemaker clinic one week later, when it was decided not to intervene surgically. Four elective replacements of mercury-powered generators after three years' implantation were arranged at the telephone clinics. The one emergency admission (to a Glasgow hospital) was for a patient who was intermittently failing to pace (documented on an ECG). Despite the fact that the threshold was found to be reasonably low at operation, the patient received a complete new pacemaker lead and generator, which have continued to function normally. One pacemaker was found to be extruding, and a complete new system had to be implanted at a different site. Two patients died from causes unrelated to the pacemaker.

PATIENT CARE

Although to apply rigorous statistical analysis is inappropriate to such a short-lived trial, the Ayrshire group of patients may be regarded as a subset of the complete set of west of Scotland patients. Since in 1980 783 patients came under the care of the pacemaker clinics in Glasgow and since 85 patients were transferred to the Ayrshire subset, this subset represents about 10% of the west of Scotland set. A more accurate estimate of this representative fraction may be made by calculating the number of patient-months of follow-up supplied by the pacemaker clinics in the west of Scotland and in Ayrshire (table). In fact, the Ayrshire pilot scheme represents 6.2%

Number of patient-months of follow-up supplied by the pacemaker clinics in the west of Scotland and Ayrshire. (Numbers in parentheses are expected numbers for Ayrshire calculated as a simple fraction of the west of Scotland numbers)

	West of Scotland	Ayrshire
Patient-months	10 278	637
Clinic visits	1 725	106 (107)
Attendance at clinics	87%	98%
Elective changes of generator	52	4 (3.2)
Generator failures	35	0 (2.2)
Reoperations	139	6 (8.6)
Emergency admissions	22	1 (1.4)
Deaths	60	2 (3.7)

of the patient-months of follow-up care provided by the pacemaker clinics in the west of Scotland. The table allows a comparison of the actual figures for elective generator changes, generator failures, reoperations, emergency admissions, and deaths for the Ayrshire patients and the expected figures for the same group of patients calculated as a fraction (6.2%) of the total west of Scotland figures. It also shows no discrepancy between the predicted and actual figures for elective changes of generator, generator failures, reoperations, emergency admissions, and deaths.

TRAVEL SAVED

One of the primary aims of the scheme is to save patients travelling to Glasgow. Enabling them to visit a centre in Ayrshire has reduced the average mileage a patient has to travel to a clinic from 35.6 to 11.8 miles, and for those 30 patients who travel by ambulance the average journey has been reduced from 38.4 to 15.4 miles.

Discussion

The scheme has been well received by the patients, who are spared tiring journeys not only to Glasgow but to the hospitals once they reach the city. They also feel less apprehensive visiting their own local hospital. Two patients have preferred to continue travelling to Glasgow, which they are welcome to do provided that they make independent travel arrangements. The scheme has also been well received by the medical and nursing staff of the Glasgow clinics and has contributed towards easing

*Cardiologic (UK) Ltd, 26 Carver Street, Sheffield S1 4FS. Cost of receiver £1900, cost of one transmitter £155 (1979 prices).

the numerical burden on these clinics. New duties have fallen on the medical and nursing staff of the Ayrshire hospitals. Although no new clinics have been formed, the arrangements provide an additional four to eight patients for an already existing outpatient clinic. The telephone calls are received by one of the two physicists, who are also responsible for keeping the records.

There is little overall difference to the NHS costs of staffing the clinics in the district general hospitals and staffing those in Glasgow. The time of the medical staff, the nursing staff, and the ECG technicians is roughly the same except that the service and its costs are now transferred to Ayrshire. A telephone call from the Ayrshire hospitals (under 35 miles) costs 46p for five minutes in the morning.

The reduction in the distances of ambulance travel is the major saving for the NHS. The total saving is 2760 miles (4416 km) a year at a cost of £0.7 per mile³—that is, over £2000 a year. This sum is roughly the cost of the equipment.

There are potential problems that did not materialise during the time of the trial. Those patients with programmable pacemakers will still have to attend the Glasgow clinics when it is necessary to reprogram the generators. The transmitting and receiving systems have proved reliable over the trial period.

Conclusion

A regional telephone pacemaker follow-up service has been established based in Glasgow with district general hospitals as medical care centres. A pilot project in three Ayrshire hospitals

has proved successful, and the system will now be expanded to include hospitals in the Dumfries and Galloway and the Argyll and Clyde areas. Potential savings to the NHS by reducing ambulance journeys in the west of Scotland exceed £10 000 a year. The scheme is carefully monitored to ensure that patients with pacemakers receive adequate attention with a minimum of inconvenience.

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Reading for Pleasure

Ancient preferred to modern

R M SYKES

Few would deny that Dickens was a great entertainer. His hold on the reading public of his time has probably never been approached, let alone equalled, by any other novelist. The dwarf Quilp in *The Old Curiosity Shop* is the most likable villain in fiction, his only rival for this title being the Italian Count Fosco in Wilkie Collins's *The Woman in White*. In Evelyn Waugh's *A Handful of Dust* the hero ends his days in the South American jungle, employed by a wealthy illiterate to read Dickens's works to him. In a book quiz programme on the BBC World Service it was asked in which book this event occurred. The opinion of the speakers was that it was an enviable and not an unhappy fate to be paid to read Dickens. In a "Letter from America" Alistair Cooke mentioned an American writer who before beginning work each day gets through two chapters of Dickens, and when he reaches the end of the last book goes back to the first.

As an entertainer, then, Dickens's stature is beyond question. Judgment of his position as a social reformer depends in part on the opinions of the individual concerning the desirability of social reform. What of the novels themselves, as novels? Chesterton wrote that strictly speaking there was no such thing as a Dickens novel, that any work of Dickens would contain given proportions of good and bad stuff, and that a character or two could be transposed from one book to another without causing much disturbance. He believed that *Pickwick Papers* was the greatest of the achievements. Dickens's early works were lacking in plot but contained humour, pathos, and suspense in abundance. In his later books humour is less prominent, with greater emphasis on plot and moral responsibility. The novel which marks the transition is *Dombey and Son*. It is an alternative viewpoint to Chesterton's to believe that Dickens's greatest work is in these later novels. It seems to me that *Bleak House* is in a class of its own among English novels, and that class is of the highest. The organisation is immense and detailed: there are no passages that one would want to omit, not a word too many; the characters are numerous and varied, and the arrival of any other, even Mr Pickwick, would result in a fatal imbalance.