AUDIT

Impact of the recommendations of the British Pacing and Electrophysiology Group on pacemaker prescription and on the immediate costs of pacing in the Northern Region

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Abstract

***Background*—The report from the Working Party of the British Pacing and Electrophysiology Group recommends the use of more sophisticated pacemakers in most patients. These proposals were initially circulated in September 1990 and are likely to have major cost implications. Their impact on pacing practice and the immediate costs of pacemaker hardware in the Northern Region were retrospectively audited.**

***Methods*—The pacing records of 550 patients undergoing a first pacemaker insertion at the Freeman Hospital between March 1990 and August 1991 were reviewed. The patient's age, indication for pacing, pacing mode, and the cost of generator and lead(s) were recorded. The cost was compared with the costs of pacing with the optimal and alternative modes recommended by the Working Party. The costs were calculated from the actual mean cost of the recommended unit over the 18 month period of study multiplied by the number of patients who would have received that unit.**

***Results*—96% of patients were paced for sinus node dysfunction, atrioventricular block, or atrioventricular block and atrial fibrillation. The mean (SD) ages of patients in each diagnostic group were: sinus node dysfunction 69·4 (14), sinus node disease and atrioventricular block 67·2 (17·6), atrioventricular block 73·9 (12·5), atrial fibrillation and atrioventricular block 74·0 (13·9), and carotid sinus hypersensitivity 74·6 (11·6) years. Over the 18 month audit period there was an increase in physiological pacing. AAI pacing in patients with sinus node dysfunction increased by 100% and DDD pacing in atrioventricular block increased by 56%. Over the whole 18 month period the adoption of the British Pacing and Electrophysiology Groups optimal recommendations would have increased expenditure on pacemaker hardware in the Northern Region by 94% and the use of the alternative mode would have increased it by 61%. For the last six months alone the excess would be 78% and 48%.**

***Conclusions* The adoption of the recommendations of the British Pacing and Electrophysiology group in the Northern Region would greatly increase the cost of pacing hardware. The greater part of this increase would be attributable to the routine use of dual chamber pacing in patients with atrioventricular block and the increased use of rate responsive units. The benefits of sophisticated pacing in a predominantly elderly population need to outweigh the disadvantages of the increased cost and complexity of follow up.**

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The complexity and cost of permanent pacing systems for treatment of patients with bradycardias are steadily increasing. Advances in pacemaker technology have led to the availability of more sophisticated units that preserve atrioventricular synchrony and are capable of increasing the rate of impulse generation in response to physical activity. In 1991 the British Pacing and Electrophysiology Group reported the conclusions of a working party on the prescription of pacemakers for symptomatic bradycardia.[1] This paper recommends the use of more sophisticated pacemakers in most patients. This is likely to entail a major change in the practice of most British

Table 1 Recommended optimal and alternative pacing modes

	Optimal	*Alternative*
SND	AAIR	AAI
AVB	DDD	VDD
SND + AVB	DDDR	DDD
	DDIR	DDI
AVB + AF	VVIR	VVI
CSS/MVVS	DDI	—

SND, sinus node dysfunction; AVB, atrioventricular block; AF, atrial fibrillation or flutter; CSS, carotid sinus syndrome; MVVS, malignant vasovagal syncope.

Table 2 Indications for pacemaker insertion

Diagnosis	Period 1	2	3	Overall (%)
SND	34	53	61	148 (27)
SND + AVB	2	3	1	6 (1)
AVB	106	98	125	329 (60)
AVB + AF	19	15	18	52 (9)
CSS	2	2	11	15 (3)

SND, sinus node dysfunction; SND + AVB, sinus node dysfunction and atrioventricular block AVB, atrioventricular block; AVB + AF, atrioventricular block and atrial fibrillation/flutter; CSS carotid sinus syndrome.

pacemaker centres and has considerable financial implications, both in terms of the initial outlay on pacing hardware and the more complex follow up that is required.

We audited pacing practice in the Northern Region to determine both the change in practice since the initial circulation of the findings of the working party in September 1990 and the effect of its recommendations on expenditure on pacing hardware.

Patients and methods

We examined the records of all patients undergoing a first implantation of a permanent pacing system in the Northern Regional Cardiothoracic Centre at the Freeman Hospital, Newcastle, from March 1990 to August 1991. This is the only centre for implanting permanent pacemakers in the Northern Region, which has a population of approximately three million. The age, indication for pacing, pacing mode, and the cost of the pacing generator and lead were recorded. The costings used were those current in August 1991 and were exclusive of value added tax. Individual costs included the cost of any replacement lead or generator that had to be inserted in the month after the initial procedure. Patients were grouped according to the time of pacemaker insertion: for period 1, 1 March 1990 to 31 August 1990; period 2, 1 September 1990 to 28 February 1991; period 3, 1 March 1991 to 31 August 1991. The costs of pacing with the optimal and alternative modes recommended by the Working Party were derived by taking the actual mean cost of the recommended unit over the 18 month period of the study and multiplying it by the number of patients who would have received that unit had the recommendations been followed. Unlike the true costs, these derived costs assume that no generator or lead had to be replaced. Table 1 shows the optimal and alternative pacing modes recommended by the British Pacing and Electrophysiology Group. The regional pacing service does not stock dedicated VDD units so DDD units were used instead. Data are expressed as mean (SD).

Results

Over the 18 month study period 550 new patients had pacemakers inserted. Table 2 shows the distribution of these patients by diagnosis in each six month period. In nearly all of them (96%) a pacemaker was inserted for sinus node dysfunction, atrioventricular block, or atrioventricular block with atrial fibrillation. The proportion of patients with each diagnosis remained more or less constant over the three periods except for a fivefold increase in the number with carotid sinus hypersensitivity in the last period. The mean ages of the patients in each diagnostic group were: sinus node dysfunction 69·4 (14) years, sinus node disease and atrioventricular block 67·2 (17·6) years, atrioventricular block 73·9 (12·5) years, atrial fibrillation and atrioventricular block 74 (13·9) years, and carotid sinus hypersensitivity 74·6 (11·6) years. Table 3 shows the type of pacing unit inserted for each diagnosis in each six month period. Two patients with carotid sinus hypersensitivity received an inappropriate AAI pacemaker.

During the first period 70·6% of patients with sinus node dysfunction received a VVI unit compared with 47·1% in period 2 and 41% in period 3. In contrast AAI units were inserted in 14·7% in period 1, 30·2% in period 2, and 31·1% in period 3. The atrium was paced either alone or in combination with the ventricle in 24% in period 1, 52% in period 2, and 59% in period 3. Patients receiving VVI units were on average 5–10 years older than those in whom the atrium was paced.

A high proportion of patients with atrioventricular block were paced with VVI units. Use of DDD pacemakers increased from 12·3% in period 1 to 19·2% in period 3. Only a small proportion of patients were paced VVIR

Table 3 Percentages of patients in each diagnostic group paced with each mode in each period

Period	VVI	VVIR	AAI	AAIR	DDD	DDDR	DDI	All*
SND: 1	70·6	5·9	14·7	—	2·9	5·9	—	34
2	47·1	—	30·2	5·7	15·1	1·9	—	53
3	41·0	—	31·1	8·2	11·5	1·6	—	61
SND + AVB: 1	50·0	—	—	—	50·0	—	—	2
2	66·7	—	—	—	—	33·3	—	3
3	—	—	—	—	100·0	—	—	1
AVB: 1	83·0	3·8	—	—	12·3	0·9	—	106
2	81·6	3·1	—	—	15·3	—	—	98
3	76·0	4·8	—	—	19·2	—	—	125
AVB + AF: 1	89·5	10·5	—	—	—	—	—	19
2	93·3	6·7	—	—	—	—	—	15
3	77·8	22·2	—	—	—	—	—	18
CSS: 1	100·0	—	—	—	—	—	—	2
2	—	—	50·0	—	50·0	—	—	2
3	9·1	—	9·1	—	9·1	—	72·7	11

SND, sinus node disease: SND + AVB, sinus node disease plus atrioventricular block; AVB; atrioventricular block; AVB + AF, atrioventricular block plus atrial fibrillation/flutter; CSS, carotid sinus syndrome.
*Total number of patients in each diagnostic group at each time.

Table 4 Mean (SD) cost for each pacing mode over the 18 month period

Mode	Cost (£)
VVI	631 (165)
VVIR	1773 (416)
AAI	927 (317)
AAIR	1642 (198)
DDD	1811 (255)
DDDR	1992 (255)
DDI	1845 (117)

and only one patient received a DDDR unit. Patients paced VVI were substantially older than those paced with more complex units. Similarly, most patients with combined atrial fibrillation and atrioventricular block were paced VVI, with VVIR units being used selectively in younger and more active patients.

Table 4 shows the mean cost of each mode of pacing over the 18 month period. Table 5 shows the actual mean cost of pacing for each diagnosis in each of the three time periods compared with the mean cost of following the British Pacing and Electrophysiology Groups optimal and alternative recommendations. The actual mean (SD) cost of hardware per patient increased from the first to the last period from £844 (433) to £1050 (476) for sinus node disease (25%), from £822 (554) to £913 (509) for atrioventricular block (11%), and from £727 (320) to £895 (519) for atrioventricular block and atrial fibrillation (23%). The mean costs of pacing sinus node dysfunction with atrioventricular block in period 1 and carotid sinus syndrome in period 3 are very high. There were only two patients in each of these groups and in each case one of the patients required a replacement generator, which considerably increased the mean cost. Over the 18 month period the adoption of the recommended optimal pacing practice would have increased the budget for pacing hardware by 94% and the use of the alternative units would have increased it by 61%. This would have increased the annual pacing budget from £333 535 to £647 163 for the optimal mode and to £536 289 for the alternative mode. By far the greater part of this excess would arise from the routine use of dual chamber pacemakers in patients with atrioventricular block. Pacing policy at the Freeman Hospital has clearly evolved in response to the recommendations and, if only period 3 is taken into account, the overall cost impact is less pronounced—an increase of 78% for the optimal mode and 48% for the alternative. This would result in an increase from £427 401 to £760 801 per year for the optimal mode and to £632 075 per year for the alternative mode.

Discussion

The report of the British Pacing and Electrophysiology Group on pacemaker prescription for symptomatic bradycardia proposes profound changes in pacemaker practice.[1] In response to these recommendations, which were initially circulated in September 1990, there were considerable changes in regional pacing practice. These changes resulted in an increase in the cost per patient for pacing hardware but the full implementation of the British Pacing and Electrophysiology Groups recommendations would result in a further substantial increase in expenditure.

Table 5 Actual mean (SD) costs (£) of pacing hardware for each diagnosis in each time period and calculated costs for the BPEG optimal and alternative recommendations

Diagnosis	FRH 1	FRH 2	FRH 3	BPEG 1	BPEG 2
SND	844 (433)	969 (510)	1050 (476)	1642	927
SND + AVB	2308 (484)	1142 (726)	1865	1992	1811
AVB	821 (554)	839 (491)	913 (509)	1811	1811
AVB + AF	726 (320)	657 (226)	895 (519)	1773	631
CSS	530 (28)	2260 (389)	1592 (441)	1811	1811

FRH 1, 2, and 3, Freeman Hospital periods 1, 2, and 3; BPEG 1, optimal recommendations of the British Pacing and Electrophysiology Group; BPEG 2, alternative recommendations of the British Pacing and Electrophysiology Group; SND, sinus node disease; SND + AVB, sinus node disease and atrioventricular block; AVB, atrioventricular block; AVB + AF, atrioventricular block and atrial fibrillation; CSS, carotid sinus syndrome.

The major changes in pacing practice within the Northern Region have been for sinus node dysfunction where the use of atrial pacing more than doubled. There is general agreement on the advantages of atrial pacing in patients with sinus node dysfunction. It reduces the incidence of atrial fibrillation, systemic embolism, and heart failure and may prolong life.[2,3] Previously, most patients with sinus node dysfunction received a VVI unit. The cost of switching from VVI to AAI pacing is relatively small but the widespread use of rate responsive atrial pacing or of dual chamber pacing in patients with sinus node dysfunction would add considerable expense. Current practice in the Northern Region is to implant rate responsive units only where chronotropic incompetence is considered likely to be an important symptomatic limiting factor—that is, in those patients who are otherwise active and mobile.

Many patients with sinus node dysfunction were paced with single chamber ventricular units even in the last six months of the audit. To some extent this is probably a continuation of previous pacing practice. There is, however, a case for the use of VVI units in very immobile elderly patients with intermittent or vague symptoms, when there are doubts about the presence of atrioventricular conduction abnormalities and where dual chamber pacing would be the only alternative.

The general adoption of dual chamber pacing in patients with atrioventricular block would add considerably to pacing costs in the Northern Region. Maintenance of atrioventricular synchrony in patients with atrioventricular block improved effort tolerance and subjective variables such as breathlessness, palpitation, and general wellbeing.[4] On this basis dual chamber pacing is clearly indicated in more active patients, who are likely to be younger. In patients with limited mobility, particularly the elderly, other factors must be taken into account and the potential benefits of physiological pacing weighed against the disadvantages. In the Northern Region only the Freeman Hospital has the necessary equipment and technical expertise to deal with complex pacemakers. Therefore any patient with a complex unit has to be followed up in Newcastle, which may entail considerable inconvenience, particularly for elderly or infirm patients, who in some cases may be faced with a round trip of over 200 miles. Another factor that must be taken into account is the increase in procedure time and the small increase in procedural complications associated with dual chamber pacing.[5]

This audit has considered only the immediate costs of changes in pacing policy. Many other factors such as increased technician training, increased complexity of follow up, and "quality of life" measures are impor-

tant long term. Regional pacing practice in the Northern Region has changed in response to the recommendations of the British Pacing and Electrophysiology group. The major change has been where the cost is least—atrial pacing for sinus node dysfunction. Implementation of the full proposals for DDD and rate responsive pacing would considerably increase expenditure on pacing hardware. In a cash limited service the potential benefit of a suggested change in treatment must be weighed against the extra expense and inconvenience.

1 Report of a working party of the British Pacing and Electrophysiology Group. Recommendations for pacemaker prescription for symptomatic bradycardia. *Br Heart J* 1991;**66**:185–91.
2 Rosenqvist M, Brandt J, Schuller H. Long term pacing in sinus node disease; effects of stimulation mode on cardiovascular morbidity and mortality. *Am Heart J* 1988; **116**:16–22.
3 Bianconi L, Boccadamo R, Di Florio A, *et al.* Atrial versus ventricular stimulation in sick sinus syndrome; effects on morbidity and mortality [abstract]. *PACE* 1989;**12**:1236.
4 Perrins JE, Morley CA, Chan SL, Sutton R. Randomised controlled trial of physiological and ventricular pacing. *Br Heart J* 1983;**50**:112–7.
5 Sutton R, Ingram A, Briers L, *et al.* Ten years of physiological cardiac pacing. In: Belhassen B, Feldman S, Copperman Y, eds. Cardiac pacing and electrophysiology. Jerusalem: R&L Creative Communications, 1987:141–2.

Correction

Coronary venous lipid peroxide concentrations after coronary angioplasty: correlation with biochemical and electrocardiographic evidence of myocardial ischaemia. *K G Oldroyd, J R Paterson, A G Rumley, H Eteiba, A P Rae, J Shepherd, S M Cobbe, I Hutton* (July issue, volume 68: pages 43–7.) There were several editorial mistakes in figure 3 of this paper, for which we apologise. A correct version is shown on the right.

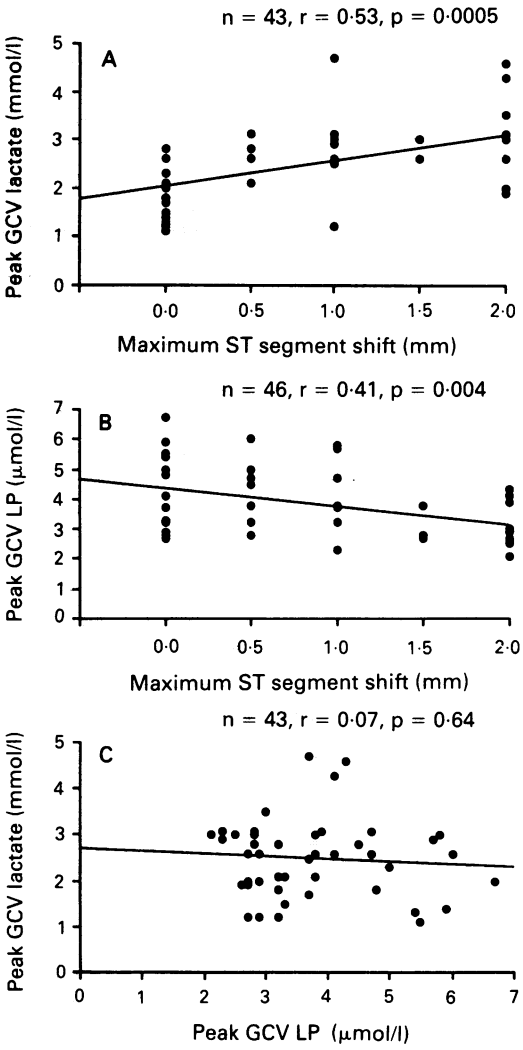

Figure 3 Simple linear regression analysis of the relation between (A) peak lactate concentration in the great cardiac vein (GCV) and maximum ST segment shift; (B) peak GCV lipid peroxide (LP) concentration and maximum ST segment shift; (C) peak GCV lactate concentration and LP concentration.