Delays and adverse clinical outcomes associated with unrecognized pacing indications

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Summary

Background: A recent UK audit showed that a significant proportion of patients who received pacemakers had pacing indications previously overlooked, leading to significant delays to pacemaker implantation.

Aim: To investigate the reasons for, and morbidity associated with, overlooked pacing indications.

Design: Prospective observational study in a UK regional pacing centre and its referring district hospitals.

Methods: Hospital records from referring and implanting centres were reviewed for 95 consecutive patients undergoing first pacemaker implant to determine symptoms, investigations and hospitalisations occurring after documentation of a pacing indication.

Results: Thirty-three of ninety-five patients (35%) had a pacing indication overlooked, which was Class I in 14 patients and Class IIa in 19. Reasons for not making a pacing referral in these patients included: failure to recognize the indication in 14, making adjustments to potentially culprit medication in 15 and requesting additional ‘confirmatory’ tests in 4. Twenty-six patients (79%) with missed indications experienced adverse events after documentation of an indication, and before receiving a pacemaker: 23 had ongoing symptoms (including one cardiac arrest), three received temporary pacing wires and 18 were hospitalized with symptoms related to cardiac rhythm. Twenty-seven patients (82%) had a total of 38 additional specialist investigations after documentation of a pacing indication.

Conclusions: Documentation of an indication for pacing failed to trigger referral for permanent pacing in 35% of patients. This failure led to significant delays, morbidity and use of health service resource, which may have been avoided if timely recognition of the pacing indication had prompted referral. Failure to recognize pacing indications and reassessing symptoms and repeating investigation after changes to medication, often required for the management of associated tachyarrhythmias or other medical conditions, contribute to these delays, perhaps unnecessarily.

Background

The new permanent pacemaker implantation rate in the UK is substantially lower than that in the rest of Western Europe; currently 468 per million of population, compared with the Western European average in 2004 of 700 per million.1,2 There is also unexplained variation in implantation rates within England.3,4 As part of an investigation of this discrepancy, we undertook an audit of referral for permanent pacemaker implantation in the North of England network, which has pacing rates above the national average (at approximately 550 per million of population in 2007),5 to determine how patients were referred for pacing.5 During this audit it became clear that a significant number of patients had an indication for permanent pacing overlooked or ‘missed’ which led to very significant delays.5 We
now describe in further detail the reasons for and the clinical consequences of these delays.

Methods

The study was undertaken as a routine audit of current practice at our institution and was registered with the institution audit department; the methodology has been described previously.5 Hospital records from the referring and implanting centers were reviewed to determine the timings of symptoms, hospital contacts, pacing indications, referral to implanter and pacemaker insertion in 95 consecutive patients undergoing first pacemaker implantation for bradycardia at a single UK center during a 3-month period. The 2002 joint ACC/AHA/NASPE (American College of Cardiology/American Heart Association/North American Society of Pacing and Electrophysiology) guidelines for permanent pacemaker implantation were used to define pacing indications retrospectively by the auditors.6 Class I and IIa indications were regarded as appropriate triggers for pacemaker referral. Symptoms, investigations and hospital admissions were recorded both before and after documentation of a pacing indication. Electrocardiogram (ECG) and clinical data were reviewed by two cardiologists with an interest in pacing. Data did not show a normal distribution and are presented as median and range, with statistical comparisons performed using the non-parametric Mann–Whitney test.

Results

Overlooked indications and reasons

Thirty-three (35%) of the 95 patients had a Class I or IIa pacing indication that did not trigger a pacing referral (14 of 48 patients who were paced as urgent inpatient transfers and 19 of 47 patients who were paced from the elective waiting list). The symptoms and ECG diagnoses in these patients are shown in Table 1.

Fourteen (42%) of the 33 overlooked pacing indications were Class I, the remaining 19 were Class IIa. The overlooked indications and reasons for missing them are summarized in Table 2.

The pacing indication was apparently not recognized at a time when ECG documentation of significant conduction disturbance was available in 14 of the 33 patients (42%). In 15 patients (45%) the ECG abnormality was recognized, but was attributed to drug therapy which was subsequently altered. In the remaining four patients (12%) it was considered that further tests were required to confirm the diagnosis. Three of the 33 were asymptomatic but had ECGs consistent with advanced conduction system disease, fulfilling Class IIa indications for pacing.

Table 1 Symptoms and ECG rhythm of patients with unrecognized pacing indications

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Number of patients unrecognized</th>
<th>Total number of patients</th>
<th>Percentage of patients unrecognized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syncope</td>
<td>22</td>
<td>51</td>
<td>43</td>
</tr>
<tr>
<td>Dizziness</td>
<td>7</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>3</td>
<td>9</td>
<td>33</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>ECG diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHB</td>
<td>2</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>2° HB</td>
<td>4</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>AF + pauses</td>
<td>3</td>
<td>9</td>
<td>33</td>
</tr>
<tr>
<td>Bi/tri-fascicular block</td>
<td>6</td>
<td>7</td>
<td>86</td>
</tr>
<tr>
<td>SND</td>
<td>15</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>CI-CSH</td>
<td>3</td>
<td>7</td>
<td>43</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

CHB: complete heart block; 2° HB: 2nd degree heart block; SND: sinus node disease; AF: atrial fibrillation; CI-CSH: cardioinhibitory carotid sinus hypersensitivity.
Consequences of overlooked pacing indications

Delays to pacing

The interval from documentation of pacing indication to referral for pacemaker implantation was significantly longer for patients who had pacing indications overlooked in both the elective and urgent groups, as shown in Table 3. This resulted in a significantly longer overall delay from symptom onset to pacemaker implantation for these patients compared to patients without overlooked indications, adding a median of at least 3 months to the time to referral.

Failure to recognize a pacing indication was responsible for almost all of the delays to referral of over 6 months (as shown in Figure 1).

Ongoing symptoms

Twenty-six (79%) of the 33 patients with overlooked pacing indications experienced adverse events between the time of the first documented pacing indication and pacemaker implantation. Twenty-three patients experienced ongoing symptoms including syncope (10 patients), dizziness/dyspnoea (12 patients) and complete heart block with cardiac arrest (1 patient). Three patients subsequently received temporary pacing wires. Eighteen patients were hospitalized (1–5 admissions per patient, total 29 hospitalizations) with symptoms related either to bradycardia or uncontrolled tachycardia following withdrawal of rate-limiting medication.

Additional investigations

Twenty-seven (82%) of the 33 patients with overlooked pacing indications had one or more additional specialist investigations after a pacing indication had been documented, with a total of

<table>
<thead>
<tr>
<th>Pacing indication</th>
<th>Indication class</th>
<th>Number of patients</th>
<th>Reasons for not referring for PPM after pacing indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic CHB/2° HB</td>
<td>I</td>
<td>3</td>
<td>2, 3</td>
</tr>
<tr>
<td>Asymptomatic CHB/Mobitz II 2° HB</td>
<td>IIa</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Symptomatic AF with high-grade AV block</td>
<td>IIa</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Bi/tri-fascicular block with syncope not demonstrated to be due to AV block</td>
<td>IIa</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>SND with documented symptomatic bradycardia/chronotropic incompetence</td>
<td>IIa</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>SND with HR &lt;40 bpm when clear association between symptoms and bradycardia not documented</td>
<td>IIa</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Syncope with major abnormalities of sinus node function documented</td>
<td>IIa</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Recurrent syncope without clear provocative events and with a hypersensitive cardioinhibitory response</td>
<td>IIa</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>33</td>
<td>14, 15, 4</td>
</tr>
</tbody>
</table>

PPM: permanent pacemaker; CHB: complete heart block; 2° HB: 2nd degree heart block; AF: atrial fibrillation; SND: sinus node disease; HR: heart rate.
38 such tests performed in this group. These included Holter monitoring (19 patients), R-test (3 patients), implanted loop recorder (2 patients), or specialist Falls and Syncope Service assessment/carotid sinus massage/tilt test (6 patients).

**Discussion**

We have previously demonstrated that a substantial minority of patients (35%) undergoing permanent pacemaker implantation had a previous Class I or IIa pacing indication recorded that did not directly trigger a pacing referral.\(^5\) Further study has shown that patients with such ‘overlooked’ indications experienced a significant increase in the time to pacing referral following documentation of a pacing indication, and a significantly longer overall delay from symptom onset to pacemaker implantation. These delays were associated with substantial morbidity, with impacts on quality of life and health care resource utilization.

Patients with pacing indications awaiting pacemaker implantation have poor health-related quality of life scores such that delays to pacing should be minimized.\(^7\) In our study, we demonstrated that a high proportion (79%) of patients with overlooked pacing indications experienced specific adverse events between the time of documentation of a pacing indication and pacemaker implantation. Ongoing symptoms included syncope and even cardiac arrest due to heart block. Three patients (9%) received temporary pacing wires, which are associated with a substantial risk of complications and morbidity,\(^8\) and which could have been avoided if a permanent pacemaker had been implanted at the time the pacing indication was first documented. Eighteen patients (55%) had a total of 29 emergency admissions to hospital as a consequence of symptoms related to cardiac arrhythmia after a pacing indication had been documented. These might have been avoided. There were also 38 additional specialized investigations undertaken in 27 patients, which have obvious costs in terms of healthcare resource utilization.

The only comparable study is that of Simpson et al.,\(^9\) who examined the consequences of logistical delays in pacemaker implantation in patients referred urgently for pacing. The majority of adverse events observed were related to temporary pacing which occurred in 42%. Adverse events were directly related to waiting times: 16% who waited <2 days had an adverse event, compared with 58% who waited >6 days. Two hospitals with different arrangements for provision of pacing and different delays were examined, allowing the conclusion that

### Table 3

Delays to pacemaker referral and implantation in patients with overlooked pacing indications

<table>
<thead>
<tr>
<th>Interval</th>
<th>Urgently paced group (n=48)</th>
<th>Electively paced group (n=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval from documentation of pacing indication to referral in days, median (range)</td>
<td>Recognized indication (n=34)</td>
<td>Overlooked indication (n=14)</td>
</tr>
<tr>
<td>Interval from symptom onset to PPM implantation in days, median (range)</td>
<td>0 (0–11)</td>
<td>153 (6–7330)</td>
</tr>
</tbody>
</table>

PPM: permanent pacemaker.

![Figure 1](image-url) Intervals from documentation of a pacing indication to referral for pacemaker implantation for patients with recognized and overlooked pacing indications who were paced urgently and electively.

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adverse events were a consequence rather than a cause of delays. Our study extends the findings of Simpson et al.,9 as we examined delays and morbidity in patients referred both electively and urgently, and also prior to the index hospital admission for pacemaker implantation.

Numerically, the largest group of patients in whom a referral for pacing was not made at the time of first documentation of a pacing indication had sick sinus syndrome. Although sinus node dysfunction was recognized as a cause of the patient’s symptoms in the majority, medication change with subsequent reassessment, often including repeated ambulatory monitoring, was made in 9 of 15. It was recognized over 25 years ago that concomitant heart disease should be treated optimally and that the use of antiarrhythmic drugs should be assessed carefully in order not to aggravate bradycardia in those with the tachy-brady syndrome.10 It was realized that in some patients, an ideal balance is not obtainable and a pacemaker will have to be inserted in order to allow for appropriate drug therapy. The pacemaker guidelines used as the standard for this study accept that ‘in some patients, bradycardia is iatrogenic and will occur as a consequence of essential long-term drug therapy of a type and dose for which there are no acceptable alternatives’.6 In patients such as these, symptomatic bradycardia remains a Class I indication for pacing.6,11 It may be difficult in clinical practice to determine early in the course of a patient’s management which drugs are essential and which are not, and continued observation during alteration to a patient’s drug therapy may be appropriate. However, as the design of our study required a definition of pacing indication made retrospectively from hospital notes and without the luxury of contemporaneous clinical contact with the patient, we assumed that all drug therapy was necessary, although we recognize that this may be an oversimplification.

Modifications to drug therapy were also made in three of nine patients with high-degree atrioventricular (AV) block. There is evidence to suggest that stopping drugs, such as beta blockers and calcium channel antagonists, which act on the AV node in patients with AV block has little effect on the requirement for permanent pacing.12 presumably because the site of block in these patients is often within the His Purkinje system, distal to the AV node.

The indication for pacing that was least often recognized was bi- or trifascicular block. This, in a patient with syncope, is accepted as a Class IIa indication for pacing when other causes of syncope have been excluded. The likely cardiac causes of syncope in a patient with bifascicular block are either high grade AV block or ventricular tachycardia. Taking a pragmatic approach, if the patient presents with syncope and bifascicular block, has no history of coronary artery disease or previous myocardial infarction and has normal ventricular function demonstrated on echocardiography, AV block is the likely diagnosis; if there is coronary disease and/or moderate or severe impairment of left ventricular function then ventricular tachycardia and further cardiological investigation should be considered.

**Potential limitations**

Pacemaker indications for the purpose of the study were diagnosed retrospectively by chart review and rigid adherence to pacemaker guidelines.6 This has led to a very ‘black and white’ approach, which may not reflect clinical practice, particularly in an elderly population with multiple comorbidities.

Pacemaker implantation was the index event in our study population; we have not been able to identify patients with pacemaker indications who have not been referred for pacing. We were not able to identify patients in whom an approach of reinvestigating after withdrawal of rate-limiting medication was successful in relieving symptoms without resort to pacing.

**Implications and conclusions**

This study has several implications: first, that those in hospital (mainly general and care of the elderly physicians) to whom potential pacemaker recipients present need further help in determining which patients should be referred for pacing; second, that the diagnosis can often be made without recourse to extensive investigation and third, it raises the question of whether rate slowing drugs (mainly sinus node or AV nodal blocking drugs, such as beta blockers, digoxin and calcium antagonists) should be considered as contributing significantly to bradycardia-related symptoms or not.

The reasons for the apparent shortfall in pacing in the UK are not clear: this relatively small study suggests that lack of knowledge of pacing indications ‘at the front line’ leads to delays, and by inference, that not all patients who might benefit from pacing are referred for consideration of it. The first step in solving a problem is identifying the cause; this study has identified one possible contribution. Based on this, we have directly measured knowledge of ECG interpretation and pacing indications,13,14 and have instituted a teaching program in secondary care in general medicine and care of the elderly in our cardiac network and beyond.5,13–15 Reaudit of the effect of this is currently underway. This study was
not able to quantify the input of primary care to the diagnosis of a pacing indication; however, it is likely to be relatively small as overall 75% of our patients were admitted to hospital as emergencies with bradyarrhythmia-related symptoms, often without primary care input. Consequently, we feel that educational effort should be concentrated in secondary care in the first instance. Although the 12 lead ECG is most often the first test performed which will allow a correct diagnosis, we think it unlikely that ECG screening alone will be sufficient, as the diagnosis of a pacing indication usually relies on a combination of both symptoms and an ECG abnormality, which may be relatively subtle.

Conflict of interest: M.S.C., C.J.P. and J.M.M. have received financial support from devices companies for attending educational meetings. J.M.M. and C.J.P. have received honoraria for speaking from devices companies and J.M.M. supervises a research fellow funded by an educational grant from a devices company.

References