Is Mobitz type I atrioventricular block benign in adults?
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Objective: To assess the need for pacing in adults with chronic Mobitz type I second degree atrioventricular block (Mobitz I).

Design: Prospective study.

Setting: District general hospital.

Patients: 147 subjects aged ≥ 20 years (age cohorts 20–44, 45–64, 65–79, and ≥ 80) with chronic Mobitz I without second degree Mobitz II or third degree (higher degree) block on entry, seen from 1968 to 1993 and followed up to 30 June 1997. Sixty four had organic heart disease. The presence of symptomatic bradycardia was defined as highly likely in 47 patients (class 1); probable in 14 (class 2); and absent in 86 (class 3).

Interventions: Pacemakers were implanted in 90 patients for the following indications: symptoms in 74 and prophylaxis in 16.

Main outcome measures: The main outcome measure was death, with conduction deterioration to higher degree block or symptomatic bradycardia the alternative measure.

Results: Five year survival to death was reduced in unpaced patients relative to that expected for the normal population (overall mean (SD) 53.5 (6.7)% v 68.6%, p < 0.001; class 3, 54.4 (7.3)% v 70.1%, p < 0.001). Paced patients fared better than unpaced (overall mean (SD) five year survival 76.3 (4.5)% v 53.5 (6.7)%; p = 0.0014; class 3, 87.2 (5.4)% v 54.4 (7.3)%; p = 0.020; and organic heart disease, 68.2 (7.6)% v 44.0 (9.9)%; p = 0.0014). There were no deaths in the < 45 cohort. Survival to first outcome (main or alternative) was further reduced to 31.7 (5.0)% in 102 patients unpaced initially and 34.2 (5.7)% in class 3. Only the 20–44 cohort and patients with sinus arrhythmia had survival > 50% survival.

Conclusion: Mobitz I block is not usually benign in patients ≥ 45 years of age. Pacemaker implantation should be considered, even in the absence of symptomatic bradycardia or organic heart disease.

METHODS
The study group consisted of patients with Mobitz I notified to the Devon heart block and bradyarrhythmia survey during the period September 1968 to August 1993. The survey recruited directly from general practitioners and physicians of three Devon districts (population approximately 600 000). Excluded were professional athletes and patients with evidence of prior or coincidental Mobitz II or third degree block (higher degree block), transient block following acute myocardial infarction or carditis persisting for less than three weeks, and drug induced block. The criteria were fulfilled by 147 patients. In the absence of complications, patients were reviewed at approximately yearly intervals but by 1997 three had been lost to the study. The footnote to table I gives clinical details and criteria for hypertension. Criteria for organic heart disease were one or more of ischaemic heart disease.

Abbreviations: ACC, American College of Cardiology; AHA, American Heart Association; AV, atrioventricular; BPEG, British Pacing and Electrophysiology Group; CI, confidence interval; RR, relative risk
disease (past, clinical, or ECG evidence of myocardial ischaemia or infarct or cardiomyopathy), valvar or congenital heart disease, hypertension, or cardiac failure excluding that solely caused by cardiac arrhythmia.

**Electrocardiography**

Mobitz I was diagnosed based on standard criteria and reviewed according to Barold and Barold’s refinements. Blocked P waves followed by escape beats were a problem for classification in respect of suspected Mobitz II but in the case of Mobitz I serial ambulant recordings showed uninterrupted Wenckebach series in all but one instance. First degree AV block defined as a PR interval > 200 ms measured after a blocked P wave or during runs of 1:1 conduction was present in 86 patients. No inference on the site of block was attributed to 2:1 block or to sequences of two or more blocked P waves (advanced AV block). Sinoatrial dysfunction was present in five patients.

Vagal drive was assessed by measurement of the nearest 20 ms of up to five PP intervals before and after a blocked beat at times of constant overall heart rate (PP within 40 ms at start and finish of sequence). Suitable records (423) showing block in 118 patients were analysed and classified into three referral groups (table 1). Where different degrees of variability were found, the most pronounced was coded. Thirty two patients performed effort tolerance tests. His bundle electrograms and sinus node recovery times were measured in 19 patients and split His potentials were sought.

Pacemakers were implanted in response to incapacitating symptoms or the development of higher degree block, indications closely resembling the ACC/AHA guidelines of 1984. After 1982 older patients were offered pacemaker implantation prophylactically if there were no contraindications.

**Data analysis**

In addition to death, two alternative outcomes during follow up were used that are risk factors for death and reduce quality of life:

- deterioration of conduction to higher degree block (either episodic or persistent)
- onset of various other forms of symptomatic bradycardia, as defined in the ACC/AHA guidelines, where previously absent.

Survival was calculated for the group as a whole and separately for paced and unpaced patients divided into four cohorts by age (table 1). Patients who were initially left unpaced (n = 102) were analysed in respect of the alternative outcomes. Survival was calculated in months from the first prospective visit or from presurvey data if available (n = 30 cases) to death or to the last follow up appointment. Analysis was by the life table method. Survival was compared between groups by the log rank test. Age imbalance between groups was adjusted and the groups compared with Cox’s proportional hazards model. Survival curves were compared with those from an age and sex matched normal population. The incidence of

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**Table 1** Clinical details

|                  | On entry | Age cohorts (years) | On follow up |
|------------------|----------|---------------------|-------------|
|                  | Total    | 20–44               | 45–64       | 65–79       | >80       | Total |
| Sex ratio (men:women) | 1:1.9    | 10:5                | 16:9        | 47:23       | 25:12     |
| Data discovered during survey |          |                     |             |             |           |
| Syncope/presyncope* | 45       | 71.8                | 3           | 6           | 24        | 12      | 16 | 3 |
| Bradycardia induced dizziness/confusion | 15       | 68.6                | 1           | 3           | 10        | 1       | 4  |
| Bradycardia induced dyspnoea | 11       | 75.1                | 0           | 0           | 10        | 1       | 9  |
| Angina of effort† | 18       | 72.3                | 0           | 3           | 11        | 4       | 17 |
| Hypertension‡ | 23       | 76                  | 0           | 2           | 16        | 5       |
| Myocardial infarction | 21       | 72.7                | 0           | 4           | 11        | 6       | 6  |
| Valvar or congenital heart disease | 16       | 63.5                | 2           | 7           | 6         | 1       | 6  |
| Cardiac failure | 7        | 78.8                | 1           | 0           | 3         | 3       | 20 |
| Rheumatic fever‡ | 19       | 68.1                | 2           | 4           | 10        | 3       | 0  |
| Organic heart disease | 64       | 71.2                | 2           | 13          | 37        | 12      |
| Mobitz I on standard or ambulatory ECG | 112      | 71.6                | 8           | 15          | 57        | 32      |
| Mobitz I initially on ambulatory ECG only | 35       | 62                  | 7           | 10          | 13        | 5       |
| Bundle branch block* | 40       | 73.6                | 2           | 5           | 20        | 12      | 7  |
| 2:1 Block | 34       | 72.9                | 2           | 4           | 20        | 7       | 22 |
| Advanced block | 3        | 66.3                | 0           | 1           | 2         | 2       | 9  |
| PP interval varies <60 ms with Mobitz I** | 81       | 73.7                | 2           | 13          | 43        | 23      |
| 60 ms < PP interval < 120 ms with Mobitz I** | 12       | 67.8                | 2           | 1           | 5         | 4       |
| Sinus arrhythmia with Mobitz I***† | 25       | 53.8                | 9           | 8           | 4         | 4       |
| Mobitz I during bradycardia*** | 30       | 56.4                | 10          | 7           | 9         | 4       |
| His high block/prolonged AH interval†† | 14       | 57.1                | 4           | 3           | 7         | 0       |

*Syncope in 30, presyncope in 11, both in four; †includes one case induced bradycardia; ‡first two readings systolic > 160 mm Hg or diastolic > 95 mm Hg, heart rate > 50 beats/min; ††diagnosis on history only, criteria not available; †first had valvar heart disease; **bundle branch block: right 28 (with left anterior hemiblock 6), left 12; ***maximum variations including later records; ††variations > 120 ms or 10% less than shortest PP interval; †††not all on entry.
complete block in the normal population was estimated from the pacemaker implants in Scotland, England, and Wales for 1996, the year that had the highest rates in five year age groups (BPEG database, A D Cunningham, personal communication, 2001). Even a 50% underestimate by this method would make a less than 1% change in survival for the normal population, an error considered insignificant for the purposes of this study. The incidence of symptomatic bradycardia in the paced patients was compared with that in the unpaced patients.

**Referral groups and symptom classes**

The patients' state on entry was classified by referral group and symptomatic class. Reasons for referral were amalgamated into three groups with a fourth for uncodeable reasons.

- **Syncopal** reason for referral was defined as a disturbance of consciousness (syncope or presyncope)
- **Cardiac** reason was palpitation, breathlessness, chest pain, or suspected cardiac failure
- **Coincidental** reason was discovery of Mobitz I on the preoperative ECG, during the health check, or during an intercurrent infection or other disease.

If both of the first two were present, referral was classified as syncopal.

Symptom classes were defined as follows:

1. Highly probable: typical history of symptomatic bradycardia
2. Probable: a degree of uncertainty concerning the symptoms or the part played by bradycardia
3. No symptoms of bradycardia.

Class 1 and 3 accorded with those used by the ACC/AHA (1984) guidelines, and class 2 acknowledged doubt as to the relevance of bradycardia rather than the philosophy concerning the conduction defect.

**RESULTS**

**Outcome of death**

Most patients in the syncopal and cardiac referral groups had symptomatic bradycardia on entry (52 of 78 (67%) in the combined groups) and satisfied the criteria for classes 1 or 2. Those in the coincidental group were predominantly in class 3 (54 of 58 (93%)). Paradoxically the symptomatic groups had a significantly better rate of survival (fig 1). The main difference, other than survival, was the numbers given pacemakers (63 of 78 (81%) and 21 of 58 (36%), respectively). Overall the prognosis of unpaced patients was poor compared with the normal population, an error considered insignificant for the purposes of this study. The incidence of symptomatic bradycardia in the paced patients was compared with that in the unpaced patients.

As expected, paced patients fared better than unpaced patients in classes 1 and 2, but few were unpaced and they were much older. In class 3 the numbers of paced and unpaced were more evenly balanced with similar mean ages and proportions with organic heart disease (18 of 39 (46%) and 22 of 47 (47%)). Here the benefit in survival was highly significant.

In other groups, paced patients fared better than unpaced patients; table 2 gives significant differences. In addition, survival appeared to be prolonged in paced compared with unpaced patients in sinus arrhythmia (relative risk (RR) 0.29, 95% CI 0.07 to 1.22, p = 0.09) and to a lesser extent in the subgroups with no organic heart disease and variable PP interval (60 ms < PP < 120 ms).

In unpaced patients, those with bundle branch block fared worse than those without (RR 2.00, 95% CI 1.01 to 3.96, p = 0.047). The risk was greater in the group where Mobitz I was discovered on ambulant ECG than in patients in whom it was found on standard ECG, after correcting for age and pacing (RR 1.36, 95% CI 0.77 to 2.40).
His bundle electrograms showed an AH interval > 200 ms or intermittent high block in 14 patients (HV 70–80 ms in one), in whom survival appeared to be worse than in the other 133 patients (RR 1.54, 95% CI 0.27 to 3.34). No instances of split His were recorded.

**Alternative outcome**

Alternative outcomes were recorded in 59 patients after entry to the study (fig 3). Forty six developed higher degree AV block (three with Mobitz II and 45 with complete block, two having both). Most instances of higher block occurred before pacing but six followed implantation. Symptomatic bradycardia developed after entry in 27 of 102 (26%) patients but did not persist in any after pacing.

In 102 patients who did not have a pacemaker on entry and were followed up for 5902 months the incidence of higher degree AV block during 1996 was 92 per million per year (BPEG database). Other than the first cohort (20–44 years) and those entering with sinus arrhythmia, survival to an alternative outcome was no guarantee of subsequent freedom from deteriorating conduction, symptomatic bradycardia, or premature death. Over two thirds of such patients suffered from one of these outcomes within five years. This is at variance with traditionally held beliefs and the conclusions of the ACC/AHA task force reports.

The task force referred to evidence from Strasberg and colleagues, who stated that “without complicating organic heart disease, chronic second degree AV nodal block is usually benign” and commented that pacing was not helpful in those with heart disease unless there were other indications. These views were based on a study of 56 patients with second degree AV nodal block (all with ECG evidence of Mobitz I) divided into two groups. Group 1 consisted of 19 patients without organic heart disease; 14 were younger than 45, and 7 were athletes. Other than the inclusion of athletes, this group was similar to our youngest cohort. In both studies the prognosis was relatively good. Their group 2 (37 patients) shared features with our 64 patients with organic heart disease. Unpaced, these patients fared badly in both studies. However, in the former, heart disease was advanced, 24 being in cardiac failure (a high risk group irrespective of management) and only 10 were paced. In contrast the Devon study had few patients in heart failure and over half were paced, with a highly significant improvement in survival. We suggest that the data from both studies are compatible with the proposition that Mobitz I in patients aged > 45 years is, per se, an indication for pacing to improve both survival and quality of life (the latter being a major factor in the very old). Younger patients manage well unpaced, although even here the condition is not always benign.

The service implication of pacing most patients with Mobitz I may be best assessed as the potential increase in relation to current implants for complete heart block (the
numbers of which have been relatively constant in the past six years), since costs vary between cardiac units and countries. In our database the incidence of Mobitz I in comparison with that of complete heart block was 14%. However, since the Devon heart block survey was well known to the general practitioners in the area, our pickup rate may have been higher than in other services. Furthermore, half (74 of 147) of the patients were paced for standard indications during the study. Currently DDD systems are likely to be used in the majority of patients with complete block and Mobitz I, possibly with more VVI units in the former (say 40% and 10%, respectively). Analysis of the literature from 1996 indicated that despite the greater initial cost of DDD units, in the third year after implantation the cumulative costs of complications were lower than for those for VVI units.35 However, the total difference in cost benefit between the two systems remains controversial.83

| Groups                        | No. | Mean age |
|-------------------------------|-----|----------|
| Total pre-paced group         | 102 | 68.1     |
| First outcome                 |     |          |
| Alternative outcome           |     |          |
| Class 3                       | 77  | 67.4     |
| First outcome                 |     |          |
| Age cohort 1                  | 14  | 32.7     |
| First outcome                 |     |          |
| Alternative outcome           |     |          |
| Class 3                       | 10  | 33.1     |
| First outcome                 |     |          |
| Age cohort 2                  | 17  | 57.6     |
| First outcome                 |     |          |
| Alternative outcome           |     |          |
| Class 3                       | 16  | 57.2     |
| First outcome                 |     |          |
| Age cohort 3                  | 71  | 72.0     |
| First outcome                 |     |          |
| Alternative outcome           |     |          |
| Class 3                       | 51  | 77.3     |
| First outcome                 |     |          |
| Age cohort 4                  | 30  | 85.3     |
| First outcome                 |     |          |
| Alternative outcome           |     |          |
| Class 3                       | 21  | 85.7     |
| First outcome                 |     |          |
| Other groups                  |     |          |
| Organic heart disease         | 46  | 70.6     |
| No organic heart disease      | 56  | 66.1     |
| Bundle branch block           | 24  | 75.3     |
| No bundle branch block        | 78  | 65.9     |
| PP intervals vary < 60 ms     | 61  | 73.6     |
| Sinus arrhythmia with Mobitz I| 17  | 48.8     |

**Figure 3** Survival to first outcome including death and to alternative outcome alone in age cohorts and to first outcome in other groups.

**Figure 4** Survival to the first outcome (death, deterioration in conduction, or symptomatic bradycardia) in patients with Mobitz I and to death in a matched normal population. Curves for those unpaced on entry (n=102) and those without bundle branch block (BBB) (n=78) were highly significantly different from those of the normal population (p < 0.001, Kolmogorov-Smirnov one sample test).
to the current cardiac department budget for complete heart block.

Conclusions

Mobitz I was not benign in most of those studied who were aged ≥ 45 years. The majority, including patients in whom Mobitz I was discovered coincidentally or without symptomatic bradycardia, progressed to higher degree block, developed symptoms of bradycardia, or died prematurely if left unpaced. Other than age, organic heart disease and bundle branch block appear to be additional risk factors. No group with completely benign risk was identified, although patients with increased vagal tone did marginally better than the rest. Except for the youngest cohort, survival was significantly better for paced than for unpaced patients in virtually all groups studied.

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