The Clinical Significance of Bundle Branch Block Complicating Acute Myocardial Infarction

2. Indications for Temporary and Permanent Pacemaker Insertion

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SUMMARY  The indication for prophylactic temporary and permanent pacing during acute myocardial infarction (MI) complicated by bundle branch block is high risk of progression via a Type II pattern to second or third degree (high degree) AV block during hospitalization or follow-up. In this study, determinants of high degree AV block during hospitalization and sudden death or recurrent high degree block during the first year of follow-up were examined in 432 patients with MI and bundle branch block.

Timing of onset of bundle branch block, the involved fascicles, and the PR interval were examined as determinants of risk of progression to high degree AV block during MI. At highest risk were 186 patients with blocks involving the right bundle and at least one fascicle of the left bundle which were not documented on prior electrocardiograms. Risk was similar with (38%) or without (31%) accompanying first degree AV block.

Patients with transient high degree AV block during MI had a 28% incidence of sudden death or recurrent high degree block during the first year of follow-up. Patients not continuously paced had a higher incidence of sudden death or recurrent high degree block than patients continuously paced (65% vs 10%, P < 0.001). Sudden death during follow-up also occurred in 13% of patients without high degree block during MI. A subgroup with 1) documented prior MI, 2) anterior or indeterminate acute MI, and 3) no symptoms of cardiac failure had a 35% risk of sudden death. The role of permanent pacing in this group is unknown.

Thus, patients at high risk of high degree AV block should receive prophylactic temporary pacing. Patients who survive high degree block with MI should receive temporary and then permanent pacing. Patients without high degree AV block during MI who nevertheless have a high risk of sudden death may benefit from permanent pacing.

WHEN BUNDLE BRANCH BLOCK complicates acute myocardial infarction, both hospital mortality and the risk of sudden high degree atrioventricular (AV) block are increased.17 To facilitate the optimal use of prophylactic temporary pacing, it is necessary to identify those parameters which determine the risk of development of sudden advanced AV block.

Late sudden death has long been recognized as a major problem in patients surviving acute infarction.10 In addition to the risk of ventricular fibrillation, patients with bundle branch block during myocardial infarction may be at risk of dying suddenly as a result of complete heart block. This latter mechanism has been postulated as an explanation of the high incidence of late sudden death in a subset of patients with bundle branch block who experience transient high degree AV block during acute myocardial infarction.1, 14, 16, 20 In these patients, the insertion of permanent pacemakers has been recommended. Other subsets of patients who have increased risk of late sudden death have not been identified,12 and the efficacy of permanent pacing has not been evaluated.

A multicenter retrospective project was designed to evaluate patients with bundle branch block complicating acute myocardial infarction. A previous study has documented the clinical characteristics of this group of patients.1 The purpose of this study is to evaluate the relationship between bundle branch block and the development of high degree AV block and sudden death and to determine the indications for insertion of temporary and permanent pacemakers.

Methods

Data on all patients with myocardial infarction and bundle branch block from five hospitals (Duke University Medical Center, Massachusetts General Hospital, Parkland Memorial Hospital, San Francisco General Hospital and Sinai Hospital of Detroit)
were reviewed. Patients with cardiogenic shock preceding either bundle branch block or high degree AV block have been excluded from the data analysis. Follow-up for at least one year was obtained in all patients. The clinical characteristics, determinants of mortality, and one-year follow-up of 432 patients with bundle branch block complicating myocardial infarction have been previously reported. Definitions of the terms used in this study are identical to those in the previous study.

High degree AV block refers to Type II second degree (2°) AV block or third degree (3°) AV block which is preceded by Type II block or which develops suddenly. High degree AV block does not include Type I 2° block or 3° AV block preceded by Type I 2° AV block. Bilateral bundle branch block includes right bundle branch block and left anterior fascicular block (RBBB + LAFB), RBBB + left posterior fascicular block (LBBB + LPFB), and RBBB + left bundle branch block (LBBB). The cause of death after discharge was listed as sudden death if in the absence of a gradually deteriorating clinical situation, the time interval from the onset of symptoms to death was less than 2 hours.

In addition to information pertaining to electrocardiographic evidence of old myocardial infarction, infarct location, type and onset of bundle branch block, degree and onset of AV block, worst Killip class of heart failure, and hospital and follow-up mortality and causes of death, the use of temporary and permanent pacemakers was noted. In the case of temporary pacemakers, the timing of pacemaker insertion was used to classify insertion as prophylactic (pacemaker inserted before development of high degree AV block) or therapeutic (pacemaker inserted after the development of high degree AV block or 3° preceded by Type I block, in most cases during resuscitation).

No protocols existed to guide decisions pertaining to temporary or permanent pacemaker insertion, which was performed at the physicians' discretion in each case. However, after reports from two institutions in 1973 suggested that long-term survival was improved and the risk of late sudden death decreased if patients received permanent pacemakers after transient high degree AV block, many patients who experienced high degree AV block and then survived hospitalization were discharged with permanent pacemakers.

In evaluating late sudden death after myocardial infarction with bundle branch block, a control group of 708 patients who never had bundle branch block or high degree AV block and survived their infarctions was obtained from the Duke Computerized Data Bank. The average age, infarct location, worst Killip class of heart failure, and electrocardiographic evidence of old myocardial infarction were noted in these patients and particularly in the subset of 48 patients who died suddenly after discharge. Using these parameters, the whole group and the subset of patients who died suddenly were compared to patients with bundle branch block during myocardial infarction to assess the role of bundle branch block in the incidence of late sudden death.

Differences in the incidence of events (high degree AV block and sudden death) between groups of patients were tested for statistical significance using two-way tables and the standard chi square distributions. P values < 0.05 were considered to be significant. In addition, the principle of Venn diagrams is used to identify subsets of patients with characteristics which either independently or in combination with other factors influence the risk of high degree AV block during hospitalization or sudden death after discharge.

### Results

#### High Degree AV Block During Hospitalization

Ninety-five patients (22%) experienced high degree AV block in the absence of preexisting cardiogenic shock. The factors which might be expected to influence the risk of high degree AV block are examined in table 1. Except for a slightly lower incidence of progression to high degree block in patients with indeterminant location infarcts (12% vs 24% for other infarct sites, P < 0.05), infarct location did not appear to influence the risk of high degree AV block. Specifically, high degree block was as common with inferior or posterior infarctions (20%) as with anterior infarctions (25%) or with anterior and indeterminant location infarcts considered together (22%). The presence of first degree (1°) AV block was associated with a 25% incidence of progression to high degree

<table>
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<tr>
<th>Table 1. The Influence of Different Variables on Risk of High Degree Atrioventricular Block in Patients with Bundle Branch Block During Myocardial Infarction</th>
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<tbody>
<tr>
<td>Infarct location</td>
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<tr>
<td>Anterior</td>
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<tr>
<td>Indeterminant</td>
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<tr>
<td>Inferior or Posterior</td>
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<tr>
<td>PR Interval</td>
</tr>
<tr>
<td>&gt; 0.20 sec</td>
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<tr>
<td>≤ 0.20 sec</td>
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<tr>
<td>Type BBB</td>
</tr>
<tr>
<td>LBBB</td>
</tr>
<tr>
<td>RBBB</td>
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<tr>
<td>RBBB + LAFB</td>
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<tr>
<td>RBBB + LPFB</td>
</tr>
<tr>
<td>ABBB</td>
</tr>
<tr>
<td>Onset BBB</td>
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<tr>
<td>Definitely old</td>
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<tr>
<td>Possibly new</td>
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<tr>
<td>Probably new</td>
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<tr>
<td>Definitely new</td>
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Abbreviations: Hi° AVB = high degree AV block; BBB = bundle branch block; LBBB = left bundle branch block; RBBB = right bundle branch block; LAFB = left anterior fascicular hemiblock; LPFB = left posterior fascicular hemiblock; ABBB = alternating bundle branch block.
block, compared to a 19% incidence in patients without high AV block ($P < 0.1$).

High degree AV block occurred twice as often in patients who had bilateral bundle branch block as in patients who had isolated left or right bundle branch block (29% vs 13%, $P < 0.05$). Likewise, risk of progression to high degree AV block was significantly higher in patients with new or indeterminant onset bundle branch blocks (which will be referred to as "new" blocks) than in patients with definitely old blocks (24% vs 13%, $P < 0.05$).

The interaction of PR interval and the type and onset of bundle branch block in determining the risk of progression to high degree AV block is depicted in figure 1. This figure is a Venn diagram of the 432 patients with myocardial infarction and bundle branch block, and it is subdivided according to the presence or absence of three variables: 1) $1^\circ$ AV block, 2) "new" bundle branch block and 3) bilateral bundle branch block. From this diagram, three groups of patients with either low, intermediate or high risk of progression to high degree AV block can be identified. The low risk group consists of patients with none or only one of the three factors present (risk = 10–13%); the intermediate risk group consists of patients with $1^\circ$ AV block and either "new" bundle branch block or bilateral bundle branch block (risk = 19–20%); and the high risk group includes patients with "new" bilateral bundle branch block regardless of the PR interval (risk = 31–38%).

Use of Pacemakers

One hundred eighty patients (42%) received temporary pacemaker therapy. In 102 patients the temporary pacemaker was inserted prophylactically, while in 78 patients the pacemaker was inserted for therapeutic reasons after progression to high degree AV block or to $3^\circ$ AV block preceded by Type I block (five patients). Two hundred fifty-two patients did not receive temporary pacemaker therapy.

Figure 2 summarizes the mechanism of death in subsets of patients categorized by the use of temporary pacemakers and by the presence or absence of high degree AV block. Of the 102 patients with prophylactic temporary pacemakers, 32 died as a result of power failure (31%) and two died as a result of recurrent sudden $3^\circ$ AV block later during their hospitalizations after temporary pacemakers had been removed. Of the 78 patients who required therapeutic temporary pacemakers, 69 were successfully paced. Twenty-five of these patients died during hospitalization as a result of power failure or other cardiovascular and noncardiovascular causes (35%) and four patients died suddenly later during their hospitalizations after their temporary pacemakers failed (one patient) or had been removed. Three of these patients had experienced high degree AV block, and one patient had $3^\circ$ AV block develop after Type I $2^\circ$ AV block. One of the deaths was unmonitored, while in the other three cases sudden $3^\circ$ AV block was
observed to occur. Another nine patients died when they developed high degree AV block because temporary pacemakers could not be successfully inserted in time to reestablish adequate circulation. By the criteria noted above for determining risk of high degree AV block, six of these patients had been at high risk, one at medium risk, and two at low risk. In eight patients no pacemaker insertion was attempted despite high degree AV block. All of these patients were hospitalized before 1970 and/or had inferior infarctions with sudden 3° AV block. None died immediately as a result of AV block, but three subsequently died as a result of power failure (38%).

Permanent pacemakers were inserted before discharge in 40 patients. Thirty patients who had high degree AV block during hospitalization were discharged with permanent pacemakers. Only three of these patients had persistent 2° or 3° AV block. One patient who had Type I block and nine patients who had not experienced 2° or 3° AV block during hospitalization were discharged with permanent pacemakers.

No serious ventricular arrhythmias or other life-threatening pacemaker-associated complications were noted either for temporary or permanent pacemaker insertion.

Figure 2. The use of pacemakers and the mechanism of death is examined in subsets of patients categorized by the presence or absence of prophylactic pacing and the presence or absence of high degree AV block. The numbers represent total patients in each subset and the patients who died due to the initial episode of sudden high degree AV block, shock or other causes, or recurrent high degree block in the hospital. Hi°AVB = high degree atrioventricular block.

Late Sudden Death and High Degree AV Block

Sudden death occurred in 45 patients during the first year of follow-up. An additional three patients developed new or recurrent high degree AV block. Thirty-three of 239 patients (13%) who had experienced neither 2° nor 3° AV block in the hospital died suddenly or developed high degree AV block (one patient) during the first year of follow-up. In addition, one of the 20 patients (5%) who had experienced Type I 2° AV block or 3° AV block preceded by Type II block died suddenly. This 13% incidence of sudden death or recurrent high degree AV block in the 259 patients without high degree AV block during their infarctions is contrasted to an incidence of 28% in the 50 patients discharged after surviving high degree AV block during myocardial infarction (P < 0.025).

Of the 14 sudden deaths or episodes of recurrent high degree AV block which occurred in patients who had progressed to high degree AV block while hospitalized, three occurred in the group of 30 patients discharged with permanent pacemakers (in one patient the pacing electrode was found at autopsy to be endothelialized in the right atrium), whereas 11 sudden deaths or episodes of high degree block occurred in the group of 20 patients discharged without
permanent pacemakers ($P < 0.001$). Four of the 14 sudden deaths or episodes of recurrent high degree block occurred within one month of discharge, five occurred between the first and sixth months, and five occurred between the sixth and twelfth months.

As noted above, five patients who initially survived high degree AV block died as a result of recurrent high degree block later during hospitalization. Each of these five patients was successfully paced during transient high degree AV block, but their pacemakers were then removed, turned off or failed to capture the ventricles. In addition, another patient experienced recurrent high degree AV block in the hospital after his temporary pacemaker was removed, but a therapeutic pacemaker was successfully inserted and the patient was discharged with a permanent pacemaker. When these six patients are considered with the 20 patients discharged from the hospital without permanent pacemakers after transient high degree AV block, the 26 patients who did not receive continuous pacemaker therapy after high degree AV block had a 65% incidence of sudden death or recurrent high degree AV block. This is contrasted to a 10% incidence in 29 patients who received uninterrupted pacemaker therapy (temporary + permanent) after progression to high degree AV block ($P < 0.001$). The incidence of non-sudden death during the first year of follow-up was similar for patients with and without permanent pacemakers. Table 2 summarizes the incidence of sudden death and recurrent high degree AV block in these two groups of patients.

Of the 50 patients who survived hospitalization after high degree AV block, 12 with RBBB + LPFB or alternating bundle branch block (ABBB) had a 42% risk of late sudden death or recurrent high degree block, while the 38 patients with LBBB, RBBB, or RBBB + LAFB had a 24% risk (range 18–33%); however, this was not statistically significant ($P < 0.1$). Thirty of the 50 patients had been at high risk of progression (i.e., “new” RBBB + LAFB or LPFB, or ABBB, regardless of PR interval) and 20 had been at intermediate or low risk. The incidence of late sudden death or recurrent high degree block was 33% in the high risk group and 20% in the other patients ($P < 0.25$). Thirty-nine of the 50 patients had anterior or indeterminant location infarctions, while 11 patients had inferior or posterior infarctions. The incidence of late sudden death or recurrent high degree AV block was 31% in the former group and 18% in the latter ($P < 0.25$). With both of these factors, the risk of sudden death or recurrent high degree block during the first year after discharge is still most affected by the presence or absence of a permanent pacemaker at discharge. In addition, the 42 patients who had persistent bundle branch block at discharge had a 24% incidence of sudden death or recurrent high degree AV block while the eight patients with transient bundle branch block had a 50% incidence of sudden death or recurrent high degree block. The patients continuously paced were comparable to those not continuously paced with respect to infarct location, presence of $1^\circ$ AV block at discharge, and the incidences of prior infarctions and power failure during acute infarction. The patients not continuously paced were older (69 years) than those continuously paced (61 years). The average age of the patients who died suddenly or experienced recurrent high degree block was 67 years in the group not continuously paced, and 57 years in the continuously paced group. Thus, the presence or absence of continuous pacing appears to be the strongest determinant of risk of late sudden death or recurrent high degree AV block in patients with bundle branch block and transient high degree AV block during myocardial infarction.

Potential determinants of risk of sudden death during follow-up were examined for the 249 patients who did not experience high degree AV block in the hospital and who were discharged without a permanent pacemaker. No single specific type and/or age of onset of bundle branch block was associated with an increased risk of these late complications. Patients who had been at high risk of progression while in the hospital but who had not developed high degree block were not at increased risk of sudden death or high degree AV block during the first year after discharge. Likewise, patients who had been prophylactically paced during infarction without high degree AV block detected also were not at increased risk compared to patients who had not been paced. The left-hand column of table 3 indicates that patients at high risk were 1) those with previous myocardial infarctions (30% risk) compared to patients without previous documented infarction (11% risk) ($P < 0.001$); 2) those discharged with persistent bundle branch block (16% risk) compared to patients without bundle

<table>
<thead>
<tr>
<th>Table 2. The Influence of Continuous Pacemaker Therapy on the Risk of Sudden Death or Recurrent High Degree Atrioventricular Block Following Transient High Degree Block During Hospitalization</th>
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</thead>
<tbody>
<tr>
<td>Monitored</td>
</tr>
<tr>
<td>No. patients</td>
</tr>
<tr>
<td>Continuous pacing</td>
</tr>
<tr>
<td>No continuous pacing</td>
</tr>
</tbody>
</table>

Abbreviation: Hi° AVB = high degree AV block. Continuous pacing = uninterrupted therapy with temporary + permanent pacemakers.
TABLE 3. Comparison of the Risk of Dying Suddenly after Discharge in Patients with Bundle Branch Block and in a Control Group of Patients Without Bundle Branch Block (No High Degree Atrioventricular Block)

<table>
<thead>
<tr>
<th></th>
<th>Bundle branch block</th>
<th>No bundle branch block</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>sd (%)</td>
<td>N</td>
</tr>
<tr>
<td>Total patients</td>
<td>249</td>
<td>(13)</td>
<td>708</td>
</tr>
<tr>
<td>Infarct location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior or indeterminant</td>
<td>190</td>
<td>(15)</td>
<td>394</td>
</tr>
<tr>
<td>Inferior or posterior</td>
<td>59</td>
<td>(5)</td>
<td>314</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Heart failure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Killip Class I or II</td>
<td>184</td>
<td>(12)</td>
<td>626</td>
</tr>
<tr>
<td>Killip Class III or IV</td>
<td>65</td>
<td>(17)</td>
<td>82</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Previous myocardial infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>33</td>
<td>(30)</td>
<td>346</td>
</tr>
<tr>
<td>No</td>
<td>216</td>
<td>(11)</td>
<td>362</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.001</td>
<td>NS</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>BBB at discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>171</td>
<td>(17)</td>
<td>—</td>
</tr>
<tr>
<td>No</td>
<td>78</td>
<td>(9)</td>
<td>—</td>
</tr>
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<td>P</td>
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branch block at discharge (6% risk) (P < 0.025); and 3) those with anterior or indeterminant infarct locations (15% risk) compared to patients with inferior or posterior infarctions (5% risk) (P < 0.05). The incidence of sudden death was not significantly influenced by the amount of clinical cardiac failure during infarction.

To examine the influence of bundle branch block on the risk of sudden death during follow-up after myocardial infarction, the Duke Computerized Data Bank was searched for a control group as described in the Methods section. Between 1967–1976, 708 patients were discharged and not lost to follow-up before one year after a myocardial infarction not complicated by bundle branch block or high degree AV block. The average age of this control group was 58 ± 11 years. Forty-nine percent had documented prior infarctions, 44% had acute inferior or posterior infarctions, and 12% developed power failure with the acute infarction. This compares to an average age of 66 ± 12 years in the bundle branch block patients, 13% of whom had documented prior infarctions, 24% of whom had acute inferior or posterior infarctions, and 26% of whom developed power failure. The risk of late
sudden death in subgroups of patients without bundle branch block during infarction is low (5%) in patients with inferior or posterior myocardial infarction. Risk is high (20%) in patients with anterior or indeterminant infarct locations who experience power failure during myocardial infarction; however, the risk is similar in younger patients with similar infarct location and power failure, but with no bundle branch block (15%). Patients with anterior or indeterminant location infarcts and Killip class I or II failure can be further divided in terms of risk of late sudden death by the presence or absence of bundle branch block at discharge and the presence or absence of a documented prior infarction. At low risk (5%) are patients without bundle branch block at discharge and no prior infarction; at intermediate risk (14%) are patients with bundle branch block at discharge and no prior infarction; and at high risk are patients who have a documented prior myocardial infarction with (32%) or without (50%) bundle branch block at discharge.

The risk of sudden death in patients without high degree AV block or significant cardiac failure is summarized in figure 4. This Venn diagram is subdivided according to the presence or absence of two variables: 1) anterior or indeterminant location infarction, and 2) documented prior infarction. Since persistent bundle branch block did not assist in isolating the high risk patients, it has not been incorporated into the diagram. Patients at low risk (0-11%) are those with inferior or posterior infarctions and patients with anterior or indeterminant location infarcts but no prior infarction. Patients at high risk (35%) are those with both an anterior or indeterminant location infarct and a documented prior infarction. Similar patients in the control group without bundle branch block had a 7% risk of sudden death in the first year after myocardial infarction.

**Discussion**

The incidence of high degree AV block was highest in patients with bilateral bundle branch block (RBBB + LAFB, RBBB + LPFB, or ABBB) which was of new or indeterminant onset. The lower risk of high degree block in patients with isolated RBBB or LBBB has been previously shown, but not consistently. Mullins and Atkins stated that isolated LBBB or RBBB (without 1° AV block) does not warrant prophylactic pacing. The reported propensity of patients to develop high degree AV block when bundle branch block is present before

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**FIGURE 4.** Risk of late sudden death in subgroups of 187 patients without high degree AV block or significant cardiac failure during acute MI. The circles represent patients with one of the two variables, and the area of overlap represents patients with both variables. The denominator of each fraction indicates the total number of patients in that subgroup, while the numerator indicates the number of patients who died suddenly during the first year of follow-up. The percentage of patients who died suddenly in each subgroup is noted in parentheses. ANT = anterior; IND = indeterminant; MI = myocardial infarction.
infarction is likewise variable.4, 12, 13, 18 Mullins and Atkins did not initially employ the timing of onset of bundle branch block to assist in establishing recommendations for prophylactic pacing,29 although in a later review of conduction disturbances, Mullins specifically recommended prophylactic pacing for old blocks.30 PR interval prolongation is generally considered to increase the risk of developing high degree AV block;19, 22 however, Lie found the PR interval was of limited value in predicting both H-V interval prolongation or progression to complete heart block.24 Type I 2° AV block is considered to be an indication for prophylactic pacing only when it occurs in the presence of an anterior infarction.25 The high mortality rate (83%) previously reported1 for patients with anterior infarction and 3° AV block which develops after Type I block would support this recommendation.

The use of prophylactic temporary pacemakers to reduce the mortality associated with progression to high degree AV block in the setting of acute myocardial infarction and bundle branch block is not established. The high mortality rate during infarction is caused predominantly by power failure, which is an expression of the large extent of myocardial damage.1-3, 5, 6, 11 Temporary pacing has not been shown to have a favorable effect on survival rates.3, 6, 9, 10, 16, 17, 22, 23, 27 However, a strictly statistical argument ignores the mechanism of dying for patients with and without prophylactic temporary pacing. Nine patients died as a result of sudden development of complete heart block in the hospital; six of these patients were in the high risk category. This provides reason to consider prophylactic temporary pacemaker insertion in those patients who are most likely to require artificial pacing during the course of their infarction. We therefore recommend that 1) prophylactic temporary pacemakers be inserted in patients at high risk by the criteria established in this study (43% of patients); and 2) prophylactic pacemakers not be inserted in the low risk patients (39% of patients).

Hospital survivors of myocardial infarction complicated by bundle branch block have a high incidence of late sudden death. Sudden death also occurs commonly in patients who survive infarction without bundle branch block,28 and factors other than bundle branch block have been implicated in the pathogenesis of late sudden death.29-31 The majority of sudden deaths outside the hospital due to cardiac disease are a result of ventricular fibrillation.30, 34 In patients with coronary artery disease, serious ventricular arrhythmias have been correlated with multivessel disease and left ventricular dysfunction.30, 34 In addition, the incidence of ventricular arrhythmias has been shown to be increased in patients with chronic intraventricular conduction defects.8, 35 Ventricular ectopy before discharge,28-31 depressed left ventricular ejection fraction,29, 31 and marked and/or persistent ST segment displacement36 all are associated with ventricular arrhythmias and sudden death after acute myocardial infarction. Lie et al.27 have recently shown that patients with acute anteroseptal infarction and bundle branch block have a high incidence of late ventricular fibrillation (one to six weeks after acute myocardial infarction). Thus, patients at highest risk of suffering late sudden death as a result of high degree AV block after acute myocardial infarction with bundle branch block need to be identified in order to maximize the therapeutic benefit of permanent pacing, while avoiding unnecessary pacemaker-associated complications9, 27 and expense.

The present study supports the previous reports that patients who survive transient high degree AV block during myocardial infarction with bundle branch block are at increased risk of late sudden death.13, 14, 19 Since pacemaker therapy appears to be partially protective against sudden death in this subset of patients with bundle branch block during myocardial infarction, and since seven episodes of recurrent high degree AV block were observed in the non-paced patients, recurrent high degree block, and not ventricular irritability or power failure, may play a prominent role in the genesis of sudden death in these patients. We therefore recommend uninterrupted use of temporary and permanent pacemakers in patients who survive high degree AV block during acute infarction with bundle branch block.

These results and recommendations are at variance with the study reported by Ginks,38 who examined the long-term survival (3–84 months) of 25 patients with myocardial infarction complicated by bundle branch block and high degree AV block. None of the patients died suddenly during the first year after myocardial infarction. Five of 21 patients without permanent pacemakers and one of four patients with permanent pacemakers died suddenly or had recurrent complete heart block after the first year of follow-up. The small number of patients with pacemakers in their series precludes rigorous statistical analysis and comparison to the present study.

In patients with bundle branch block but without high degree AV block during hospitalization, the incidence of sudden death during the first year after infarction is higher than in a control group with myocardial infarction without bundle branch block. However, it is similar to the incidence of sudden death or high degree AV block in patients with chronic bifascicular block.39, 40 When high degree AV block does not occur during hospitalization, patients who have 1) inferior or posterior infarctions, or 2) anterior or indeterminant location infarcts and, at worst, Killip class II during acute myocardial infarction but no documented prior myocardial infarction, have a low risk of sudden death. In these patients (58% of the patients discharged) permanent pacing is therefore unnecessary.

The risk of sudden death in patients with anterior or indeterminant location infarcts and power failure during hospitalization was high (20%), but not significantly higher than in a control group of similar patients without bundle branch block. The occurrence of power failure during acute anterior infarction is suggestive of extensive coronary artery disease and damaged myocardium, factors which predispose to
serious ventricular arrhythmias. Thus, it is unclear whether these patients (14% of patients discharged) would benefit from prophylactic permanent pacemaker insertion.

One group of patients did not have high degree AV block or significant cardiac failure during myocardial infarction, but were nevertheless at high risk of sudden death during the year after infarction. This group consisted of patients with documented prior myocardial infarction and acute anterior or indeterminant location infarcts with, at worst, Killip class II failure. The incidence of late sudden death (within one year) was 35%, compared to 7% in similar patients without bundle branch block. In their recent report of a 5½-year retrospective and prospective study of late in-hospital ventricular fibrillation after acute myocardial infarction, Lie et al. showed that 87 patients with acute anteroseptal infarction complicated by right or left bundle branch block had a 36% incidence of ventricular fibrillation during the first six weeks following acute infarction. Many had left ventricular aneurysms. The authors recommend prolonging monitoring in these patients, and the majority of their patients were treated with long term pharmacologic antiarrhythmic therapy. Thus, recurrent infarctions, left ventricular dysfunction, and/or lethal ventricular tachyarrhythmias may play a role in the genesis of many of the late sudden deaths in the subgroup of patients in this study with prior infarctions, acute anterior or indeterminant location infarcts with bundle branch block but no high degree AV block or significant cardiac failure. Unfortunately, unlike the group of patients with transient high degree AV block during infarction, in these patients without high degree block a control group with permanent pacemakers is not available to allow assessment of the possible protective effect of long-term pacing. Hence, the role of prophylactic permanent pacing in such patients (24% of patients discharged) remains unclear. Prolonged hospitalization with continuous monitoring, evaluation for aneurysmectomy, intermittent outpatient ambulatory monitoring, or aggressive antiarrhythmic therapy may help to decrease the high risk of sudden death.

In conclusion, these data demonstrate that 1) observation of the pattern and time of onset of bundle branch block permits stratification into groups of patients who would most likely, equivocally, or least

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**Figure 5. Recommendations for permanent pacing in patients with bundle branch block and myocardial infarction.** The boxes enclose descriptions of the subsets of patients in whom permanent pacemaker insertion is indicated, not indicated, or is of unclear benefit.
likely benefit from prophylactic temporary pacing; and 2) consideration of occurrence of high degree AV block during the acute phase, and of previous infarction, location of acute infarction, and amount of cardiac failure, provides similar capability for consideration of permanent pacemaker insertion. General recommendations for the use of permanent pacemakers are summarized in figure 5.

Prospective studies assessing the influence of permanent pacing and/or pharmacologic antiarrhythmic therapy on the risk of sudden death would be valuable in those subgroups of patients without high degree AV block during hospitalization.

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