Factors Influencing Prognosis of Bundle Branch Block Complicating Acute Antero-Septal Infarction

The Value of His Bundle Recordings

By K. I. Lie, M.D., Hein J. Wellens, M.D., Reinier M. Schuilenburg, M.D., Anton E. Becker, M.D., and Dirk Durrer, M.D.

SUMMARY
Of 50 consecutive patients with bundle branch block (BBB) complicating acute antero-septal infarction, 37 died in hospital. Patients with BBB of delayed onset or BBB of short duration had a significantly lower mortality. His bundle recordings were made in 35 patients without pulmonary edema or shock at the time of appearance of BBB. Thirteen of 16 patients with prolonged H-V intervals died compared to nine of 19 with normal H-V intervals ($P < 0.05$). In patients with bifascicular block, 11 of 15 with prolonged H-V intervals developed complete A-V block compared to ten with normal H-V intervals ($P < 0.005$).

Twenty-five of 33 patients with normal P-R intervals died compared to eight of 12 with first degree A-V block. Seven of 15 patients with prolonged H-V intervals had normal P-R intervals and four of these seven developed complete A-V block. We conclude that the length of P-R interval has no prognostic significance and is of limited value in predicting both prolonged H-V interval and development of complete A-V block. In contrast, His bundle recordings are of value in identifying patients with BBB complicating antero-septal infarction who are at immediate high risk for development of complete A-V block and death.

Additional Indexing Words:
Bifascicular block Complete A-V block His bundle electrogram

When bundle branch block complicates acute myocardial infarction, the site of infarction is usually antero-septal. The high mortality rate in these cases is considered to be due to extensive myocardial damage rather than to the conduction disorder itself. The true prognosis of bundle branch block complicating antero-septal infarction is difficult to establish, however, since in 40-83% of reported cases bundle branch block was already present on admission and may have reflected pre-existent lesions in the conduction system. The purpose of our study was to determine the incidence and prognosis of patients presenting with acute antero-septal infarction in whom bundle branch block could be considered a consequence of their infarctions. In these patients we evaluated the type, time of onset, and duration of bundle branch block and the P-R and H-V intervals in relation to mortality and development of complete A-V block.

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Material and Methods
Six hundred and forty patients admitted consecutively to the Coronary Care Unit because of acute myocardial infarction from February 1972 to January 1974 were evaluated. The diagnosis of acute myocardial infarction was based on a typical history of chest pain correlated with the appearance of diagnostic Q waves and characteristic serial changes in serum enzymes. Continuous electrocardiographic monitoring was performed in all patients. A 14-lead electrocardiogram was obtained at least six times a day during the first two days and twice a day thereafter.

In several patients the electrocardiographic data were stored on magnetic tape. Localization of infarction was defined according to criteria of Lipman and Massie. First degree A-V block was defined according to criteria proposed by Ashman. Type II second degree A-V block was defined according to criteria proposed by Langendorf and Pick. Diagnosis of bundle branch block was based on criteria proposed by the New York Heart Association and required a QRS duration of 0.12 sec or more. For diagnosis of left anterior and left posterior hemiblock we used the criteria of Rosenbaum. Left anterior hemiblock or left posterior hemiblock required a leftward shift of the QRS axis to $-30^\circ$ or less or a rightward shift to $+120^\circ$ or greater. Bifascicular block was defined as right bundle branch block with left anterior or left posterior hemiblock.

Bundle branch block and hemiblock were considered a complication of acute antero-septal infarction if they developed after admission or if the conduction disorder was not present on an electrocardiogram taken within six months prior to admission. Patients with bundle branch block on admission were excluded from the study if an electrocar-

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Temporary pacing was instituted in 44 patients as soon as bundle branch block was observed in association with acute antero-septal infarction. The pulse generator was placed in the demand mode in order to prevent Stokes-Adams attacks. For sensing, the intracavitary unipolar right ventricular complex was used.

In addition 35 of these 44 patients were studied by His bundle recordings following informed consent. During this procedure three electrode catheters were passed through the femoral vein using the Seldinger technique. A bipolar catheter was positioned in the right ventricular apex for stimulation, a tripolar electrode catheter was used for obtaining the His bundle electrogram12 and a third, unipolar catheter was used for recording the intracavitary atrial complex. Normal values for the H-V intervals in our laboratory range between 35 and 53 milliseconds.

The decision on whether or not temporary pacing or His bundle studies were performed depended upon the clinical condition, for which we used the clinical classification proposed by Killip and Kimbal.14 Six patients were not paced because of cardiogenic shock (class IV) and nine other patients were not studied by His bundle recordings because of the presence of pulmonary edema (class III) at the time of appearance of bundle branch block.

The results of our study were observed in the electrocardiogram of leads I, II, III, 
V1, and V6, the unipolar intraatrial lead and the His bundle lead, the last recording being made with help of an Elema amplifier type EMT 12. The electrocardiogram was taken on a 8-channel high frequency direct-writing Elema recorder.

The significance of differences in mortality rate was analyzed by use of Chi square test.

Results

Among 640 patients with acute myocardial infarction studied in the hospital, mortality was 18%. One hundred and seventy of the total number of patients presented with acute antero-septal infarction and of these 64 died (37.6%).

Incidence, Age, Sex, and Mortality

Fifty (29%) of 170 patients with acute antero-septal infarction had bundle branch block which could be considered a complication of the presenting infarction. The hospital mortality in these 50 patients was 74%.

The patients included 38 men and 12 women. Their ages ranged from 41 to 88 years (mean 63.1). There were no significant differences in mean age and sex distribution between patients with acute antero-septal infarction complicated by bundle branch block and those without bundle branch block (table 1).

Table 2 shows the incidence of pulmonary edema and cardiogenic shock at the time of appearance of bundle branch block and its relation to mortality and progression into complete A-V block. All 15 patients with either pulmonary edema or cardiogenic shock at the time of appearance of bundle branch block died, only two progressing to complete A-V block before death.

Type of Bundle Branch Block

Table 3 shows the incidence of the various types of bundle branch block and their relation to both mortality and development of complete A-V block. Right bundle branch block and right bundle branch block with left anterior hemiblock were the most frequent types of bundle branch block, while right bundle branch block with left posterior hemiblock was associated with the highest mortality rate. These differences are not statistically significant however.

Only patients with bifascicular block progressed into complete A-V block. Two patients with right bundle branch block and left posterior hemiblock passed through a phase of right bundle branch block with alternating left posterior and left anterior hemiblock before progressing into complete A-V block.

One patient developed left anterior hemiblock prior to right bundle branch block and left posterior hemiblock. This patient later showed a left bundle branch block pattern immediately prior to the development of complete A-V block.

Onset of Bundle Branch Block

Fourteen patients had bundle branch block on admission and 36 developed bundle branch block between two and 72 hours after onset of infarction. The majority of patients developed bundle branch block within 24 hours. Table 4 relates the onset of bundle branch block to both mortality and development of complete A-V block. None of the patients who developed bundle branch block later than 24 hours

<table>
<thead>
<tr>
<th>Incidence</th>
<th>Mean age</th>
<th>Male</th>
<th>Female</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients with antero-septal infarction</td>
<td>170</td>
<td>100</td>
<td>62.7</td>
<td>125</td>
</tr>
<tr>
<td>Patients with bundle branch block</td>
<td>50</td>
<td>29.5</td>
<td>63.1</td>
<td>38</td>
</tr>
<tr>
<td>Patients without bundle branch block</td>
<td>120</td>
<td>70.5</td>
<td>62.5</td>
<td>87</td>
</tr>
</tbody>
</table>
after onset of infarction developed complete A-V block. This group had a better prognosis (\(P < 0.05\)) than those developing bundle branch block within 24 hours of the onset of infarction (table 4).

Of 23 patients who developed bifascicular block after admission, 13 developed right bundle branch block simultaneously with the hemiblock; six developed right bundle branch block prior to hemiblock and in four the hemiblock preceded right bundle branch block.

Duration of Bundle Branch Block

Fifteen patients had transient bundle branch block. Duration of bundle branch block varied from two hours to six days. Bundle branch block persisted in four patients until discharge and in 31 until death. In the last group bundle branch block persisted for at least six hours. Table 5 relates the duration of bundle branch block to mortality and development of complete A-V block. Patients with bundle branch block of short duration (1–6 hours) had a better prognosis (\(P < 0.0002\)) than those with bundle branch block which lasted longer than six hours. Development of complete A-V block was not observed in the short duration group.

P-R, A-H, and H-V Intervals

Table 6 shows the range, mean value, and standard deviations of P-R, A-H, and H-V intervals and their relation to mortality and development of complete A-V block. The heart rate at the time of study of these intervals ranged from 60-140 beats/min. The mean heart rate was 105 ± 21.6. Patients who died showed a shorter mean P-R and A-H interval and a longer mean H-V interval than those who survived, whereas those who developed complete A-V block had a longer mean P-R and H-V interval than those who did not progress into complete A-V block. However these differences were not statistically significant.

Tables 7 and 8 show the incidence of first degree A-V block and a prolonged H-V interval respectively and their relation to mortality and development of complete A-V block. The presence of a first degree A-V block was not of prognostic significance, since 25 of 33 patients with normal P-R intervals died compared to eight of 12 with first degree A-V block. In contrast, 13 of 16 patients with prolonged H-V intervals (60 msec or more) died compared to nine of 19 with normal H-V intervals. (\(P < 0.05\)).

The 35 patients in whom His bundle recordings were made included 25 patients with bifascicular block and ten with right bundle branch block only. Fifteen of the 25 patients with bifascicular block showed a prolonged H-V interval and 11 of these 15 progressed into complete A-V block. Only one of the ten patients with bifascicular block and a normal H-V interval progressed into complete A-V block. These differences were significant (\(P < 0.005\)). Of the ten patients with right bundle branch block, in whom His bundle recordings were made, only one showed a

### Table 2

**Incidence of Pulmonary Edema and Cardiogenic Shock at Time of Appearance of Bundle Branch Block and its Relation to Mortality and Development of Complete A-V Block in Patients With Antero-Septal Infarction**

<table>
<thead>
<tr>
<th>Incidence</th>
<th>Mortality</th>
<th>Progression into complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>No or mild heart failure</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

### Table 3

**Incidence of Type of Bundle Branch Block and Relation to Mortality and Complete A-V Block in Patients With Bundle Branch Block Complicating Acute Antero-Septal Infarction**

<table>
<thead>
<tr>
<th>Incidence</th>
<th>Mortality</th>
<th>Progression into complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Right bundle branch block</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>Right bundle branch block and left anterior hemiblock</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>Right bundle branch block and left posterior hemiblock</td>
<td>14</td>
<td>28</td>
</tr>
</tbody>
</table>
prolonged H-V interval, while none of these ten developed complete A-V block.

Table 9 shows the incidence of first degree A-V block in patients with a prolonged H-V interval and its relation to the development of complete A-V block. Seven of the 15 patients with a prolonged H-V interval had a normal P-R interval and four of these seven progressed into complete A-V block.

Incidence of Type II Second Degree A-V Block and Complete A-V Block

Type II second degree A-V block was registered in two patients with bifascicular block and both later progressed into complete A-V block. Fourteen patients developed complete A-V block and all showed bifascicular block prior to its development. Only two of these 14 patients had pulmonary edema at the time of appearance of bundle branch block. His bundle recordings made in 12 patients prior to the development of complete A-V block showed a prolonged H-V interval in 11.

Ten of the 14 patients who developed complete A-V block benefited from temporary pacing. However all 14 patients died in hospital, power failure being the most frequent cause of death. In ten of these patients 1:1 A-V conduction was restored prior to death.

Table 4

<table>
<thead>
<tr>
<th>Onset of bundle branch block</th>
<th>Number of patients</th>
<th>Mortality (No.)</th>
<th>Complete A-V block (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 24 hours after onset of infarction</td>
<td>39</td>
<td>32</td>
<td>82</td>
</tr>
<tr>
<td>After 24 hours after onset of infarction</td>
<td>11</td>
<td>5</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Duration of bundle branch block</th>
<th>Number of patients</th>
<th>Mortality (No.)</th>
<th>Complete A-V block (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–6 hours</td>
<td>8</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>6–24 hours</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1–6 days</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Persistent until discharge</td>
<td>4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Persistent until death</td>
<td>31</td>
<td>31</td>
<td>11</td>
</tr>
</tbody>
</table>
Cause of Death

Twenty-five patients died from cardiogenic shock, seven from cardiac rupture, four from complicating ventricular fibrillation, while in one patient the mode of death could not be established.

Discussion

The mortality rate in patients with acute antero-septal infarction complicated by bundle branch block was more than three times as high as in patients with antero-septal infarction without bundle branch block. The mortality rate in the present study (74%) agrees with that found by Norris et al., Godman et al., and Gould et al., but is higher than that of other reports.

The discrepancy in mortality rate may be due to differences in selection criteria, since we excluded from our study patients with bundle branch block on admission, in which the conduction disturbance was either pre-existent or in which it could not be attributed with certainty to the presenting infarction.

In our study we found a significantly lower mortality in patients with bundle branch block of delayed onset, short duration, or bundle branch block associated with a normal H-V interval. The significance of the time of onset of bundle branch block has also been noted by Hunt and Sloman, who reported only one death in six patients who developed bundle branch block 20 hours after onset of infarction compared to three deaths in six patients, whose block developed within 20 hours after their infarction. Bauer et al. and Lichtstein et al. also reported a lower mortality in patients with transient bundle branch block in comparison to patients with persistent bundle branch block.

The use of His bundle electrocardiography in evaluating the nature of A-V block in acute myocardial infarction has been described before by Rosen et al. and Hunt et al. This has led to a better understanding of the pathophysiology of conduction disturbances in association with acute myocardial infarction. The prognostic significance of the H-V interval in patients with bifascicular block complicating acute myocardial infarction has been mentioned by Lichtstein et al. In their series eight of 12 patients with bifascicular block and a prolonged H-V interval died in comparison to one death in four patients with bifascicular block with a normal H-V interval. In the present study His bundle recordings were made in a larger group of patients. The presence of a prolonged H-V interval (60 msec or more) in patients with bundle branch block who were not in severe heart failure was found to be associated with a significantly higher mortality. Since the differences in mortality rate between patients with various types of bundle branch block were not statistically significant and the length of P-R interval was not of prognostic significance, His bundle recordings seem to be of value in determining the short term prognosis in those patients, who are not in severe heart failure at the time when bundle branch block

<table>
<thead>
<tr>
<th>P-R interval</th>
<th>Number of patients</th>
<th>Mortality</th>
<th>Progression into complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>33</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>First degree A-V block</td>
<td>12</td>
<td>8</td>
<td>67</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 7

P-R Interval in Relation to Mortality and Progression into Complete A-V Block in Patients With Bundle Branch Block Complicating Acute Antero-Septal Infarction

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>Mortality</th>
<th>Progression into complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>13</td>
<td>81</td>
</tr>
<tr>
<td>19</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 8

H-V Interval in Relation to Mortality and Progression into Complete A-V Block in Patients with Bundle Branch Block Complicating Acute Antero-Septal Infarction

<table>
<thead>
<tr>
<th>H-V interval</th>
<th>Number of patients</th>
<th>Mortality</th>
<th>Complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>33</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>First degree A-V block</td>
<td>12</td>
<td>8</td>
<td>67</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 9

Incidence of First Degree A-V Block in Patients with Bifascicular Block and a Prolonged H-V Interval and Its Relation to Progression into Complete A-V Block

<table>
<thead>
<tr>
<th>P-R interval</th>
<th>Number of patients</th>
<th>Complete A-V block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal P-R interval</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>First degree A-V block</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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block first was recorded. Furthermore, 11 of 15 patients with bifascicular block and a prolonged H-V inter-
val progressed into complete A-V block as com-
pared to one of ten patients with bifascicular block
and a normal H-V interval. This suggests that the His
bundle recording in acute antero-septal infarction is
also of value in identifying a group of patients with
bundle branch block and intact conduction, who are
at immediate high risk for development of A-V block.
This is in contrast to patients with chronic bifascicular
block because the development of chronic conduction
disturbances at the bundle branch level occurs over a
much longer period.\(^{19}\) It should be stressed that the
length of P-R interval was only of limited value in
predicting both prolonged H-V interval and develop-
ment of complete A-V block. Seven of 15 patients with
bifascicular block and a prolonged H-V interval had a
normal P-R interval and four of these seven progressed
into complete A-V block.

In our study only patients with bifascicular block
progressed into complete A-V block. This is in contrast
to other studies\(^{2, 4, 20}\) in which patients with right bun-
dle branch block also progressed into complete A-V
block. This can be explained by our observation that
in six of our 23 patients who developed bifascicular
block after admission right bundle branch block
preceded left anterior or left posterior hemiblock. This

type of development of bifascicular block can be

easily missed if only a modified lead V\(_1\) is recorded\(^{21}\)

and 12-lead electrocardiograms are not taken fre-
quently.

The low incidence of left bundle branch block in
our patients with acute antero-septal infarction, which
is in contrast with the findings of other reports,\(^{1, 2, 4, 6}\)

seems surprising at first sight. In our series of 640 in-
farcts we have observed 24 patients who exhibited left
bundle branch block on their first myocardial infarc-
tion electrocardiogram and 13 other patients who
developed left bundle branch block after admission.
In 20 patients with left bundle branch block on admi-
SSION, the block was shown to be pre-existent following
studies of the previous electrocardiograms. In the
remaining four patients the left bundle branch block
was rate dependent and none of these showed acute
antero-septal infarction during nonaberrantly con-
ducted beats. The 13 patients who developed left bun-
dle branch block after admission included ten patients
with acute inferior myocardial infarction, two with
acute antero-lateral infarction and only one with acute
antero-septal infarction. The discrepancy in incidence
of left bundle branch block between the present study
and other reports\(^{1, 2, 4, 6}\) is presumably due to
differences in selection criteria since our data indicate
that in more than 50% of cases the left bundle branch
block could be documented as a pre-existent conduc-
tion disorder. The present study also suggests a rela-
tion of site of infarction to type of bundle branch
block. This point will only be elucidated following
post mortem angiographic and histopathologic
studies.

Ten of 14 patients who developed complete A-V
block benefited temporarily from cardiac pacing and
in all ten 1:1 A-V conduction was restored prior to
death. Since in 11 of 14 patients who developed com-
plete A-V block the cause of death was cardiogenic
shock, we completely agree with the statement of
Norris\(^{20}\) that temporary pacing in these patients
would be very useful if some more definitive treat-
ment of power failure were available. At present we feel
that prophylactic pacing in patients with bundle branch
block complicating acute antero-septal infarction
should be considered only to prevent Stokes-Adams
attacks. We would recommend that a prophylactic
pacing catheter be inserted only in patients with
bifascicular block complicating acute antero-septal in-
farction, especially if this is associated with a
prolonged H-V interval. This procedure is probably
not necessary in patients with bifascicular block of
short duration or of delayed onset or in those who are
in pulmonary edema or cardiogenic shock at the time
of appearance of bundle branch block.

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