Arrhythmias Associated with Acute Respiratory Failure in Patients with Chronic Airway Obstruction*

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Electrocardiograms of 70 patients with chronic airway obstruction were examined from 148 consecutive admissions for acute respiratory failure. Forty-seven percent of the patients had major supraventricular or ventricular arrhythmias. These arrhythmias were documented on 36 percent of hospital admissions. Supraventricular arrhythmias were slightly more common than ventricular arrhythmias, the most frequent being atrial tachycardia and multifocal atrial tachycardia. Supraventricular arrhythmias tended to recur. Ventricular arrhythmias were often preceded by premature ventricular contractions, supraventricular arrhythmias, or other ventricular arrhythmias. Ventricular arrhythmias were associated with a poor prognosis; 70 percent of patients with ventricular arrhythmia died during the hospital admission and none survived to the end of the study period. These data suggest that continuous electrocardiographic monitoring of chronic airway obstruction patients with acute respiratory failure would be of value in predicting prognosis and identifying patients likely to develop serious arrhythmias; these findings may have therapeutic implications.

Although the literature suggests that cardiac arrhythmias are common in chronic obstructive lung disease, especially during decompensation, data are not available on the prevalence or type of arrhythmias from a consecutive series of chronic airway obstruction patients with acute respiratory failure, confirmed by arterial blood gas determinations. Knowledge of arrhythmias and outcome would be helpful regarding prognosis, aid in management, and, from a practical standpoint, justification of relatively expensive continuous monitoring equipment. To help gain this information we reviewed the electrocardiograms for two and one-half years of all adults with chronic airway obstruction who satisfied commonly accepted arterial blood gas criteria for acute respiratory failure. This method of electrocardiogram review minimizes the true incidence of arrhythmias, but continuous monitoring equipment was not routinely available for all patients in our intensive care unit. However, this information has been helpful in providing partial answers to the above questions. The prevalence, type and evolution of arrhythmias determined by this method are the subject of this paper.

MATERIALS AND METHODS

The study group consisted of adults fulfilling the American Thoracic Society criteria for chronic airway obstruction (CAO) and with the criteria for acute respiratory failure of an arterial Po2 less than 50 mm Hg with or without an arterial Pco2 greater than 50 mm Hg. Clinical histories of these patients were reviewed to ensure that the arterial blood gases accompanied an acute exacerbation. Data were included from consecutive admissions of patients with CAO and acute respiratory failure over a two and one-half year period. Patients with rheumatic and congenital heart disease were excluded. Coronary artery disease was not an excluding factor because of its frequency. One patient had a documented acute myocardial infarction after being included.

All electrocardiograms were reviewed from each admission during which a patient satisfied the arterial blood gas and clinical criteria for acute respiratory failure. All patients...
had at least one electrocardiogram, although the frequency of electrocardiograms varied considerably. Electrocardiograms of outpatients were also available. Data in this paper are limited to electrocardiograms performed during hospitalization for acute respiratory failure, except when specifically otherwise noted.

Data from 70 patients representing 148 consecutive admissions for acute respiratory failure over a two and one-half year period were studied. Age ranged from 22 to 80 years, with a mean age of 61.8. There were 55 men and 15 women.

Thirty-seven patients had a single admission, 18 patients had two admissions, and 12 had three or more admissions, with the greatest number of admissions per patient being nine. Six patients died on their first admission.

Electrocardiograms were examined for rhythm, presence and type of premature beats, and presence and type of heart block. Cardiac arrest was the only arrhythmia included which did not have to be documented by electrocardiogram. A diagnosis of cardiac arrest was accepted if a physician witnessed a clinical cardiac arrest and recorded this in the clinical record, with or without an electrocardiographic description. Cardiac arrest, as used in this paper, includes both asystole and ventricular fibrillation.

For the purposes of analysis, arrhythmias were arbitrarily divided into three groups: "minor" supraventricular, "major" supraventricular, and ventricular arrhythmias. "Minor" supraventricular arrhythmia include sinus tachycardia, sinus bradycardia, sinus arrhythmia, ectopic atrial pacemaker, and wandering atrial pacemaker. "Major" supraventricular arrhythmias include atrial tachycardia, atrial flutter, atrial fibrillation, multifocal atrial tachycardia and AV junctional tachycardia. Ventricular arrhythmias include ventricular bigeminy, AV dissociation, idioventricular rhythm, ventricular tachycardia and cardiac arrest. Isolated premature ventricular contractions (PVC's) and premature atrial contractions (PAC's) are considered separately.

RESULTS

Prevalence

The prevalence of "major" supraventricular and ventricular arrhythmias is listed in Table 1. A "major" supraventricular or ventricular arrhythmia occurred in 54 of the 148 admissions (36 percent) and in 33 of the 70 patients (47 percent). "Major" supraventricular arrhythmias occurred in 23 patients during 38 admissions and ventricular arrhythmias in 20 patients during 24 admissions.

Table 2 lists the prevalence of each individual rhythm. The most common arrhythmia was sinus tachycardia, occurring in 61 percent of patients and during 55 percent of admissions. Atrial tachycardia

and multifocal atrial tachycardia (MAT), almost equally common, were the most frequent major arrhythmias.

Course of "Major" Supraventricular Arrhythmias

During admissions with "major" supraventricular arrhythmias, premature beats were recorded approximately twice as frequently as during admissions in which NSR or "minor" supraventricular arrhythmias were found (Table 3). These differences are statistically significant with p<.005 and .02, respectively, by X^2 test. The premature beats were detected preceding the "major" arrhythmia in two-thirds and following the arrhythmia in one-third. Premature ventricular contractions were seen slightly more frequently than premature atrial contractions (18 vs. 9).

Patients with a "major" supraventricular arrhythmia on one admission tended to have recurrent "major" supraventricular arrhythmias on subsequent admissions. Data from patients with multiple admissions are displayed in Table 4. Fourteen patients with "major" supraventricular arrhythmias had multiple admissions; seven of these patients had recurrent "major" supraventricular arrhythmias on more than one admission.

If a "major" supraventricular arrhythmia persisted until the patient was discharged from the hospital, the arrhythmia persisted and was present on outpatient visits or on readmission. Nine patients were discharged with a supraventricular arrhythmia, and six of these patients had subsequent electrocardiograms. All showed persistence or recurrence of the arrhythmia.

Mortality (determined at the end of the study period) of patients with "major" supraventricular arrhythmias was greater than the mortality of pa-
ARRHYTHMIAS ASSOCIATED WITH ACUTE RESPIRATORY FAILURE

Table 3—Association of Premature Beats and Rhythms by Admission

<table>
<thead>
<tr>
<th>Rhythm (Other Than Premature Beats)</th>
<th>Admissions with Premature Beats</th>
<th>Admissions without Premature Beats</th>
<th>Admissions with Premature Beats, %</th>
<th>Type of Premature Beats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal sinus rhythm</td>
<td>11</td>
<td>25</td>
<td>(11/36) 30.5</td>
<td>PAC 1 Nodal 4 PVC 1</td>
</tr>
<tr>
<td>“Minor” supraventricular*</td>
<td>20</td>
<td>38</td>
<td>(20/58) 34.5</td>
<td>PAC 6 Nodal 4 PVC 8</td>
</tr>
<tr>
<td>“Major” supraventricular**</td>
<td>18</td>
<td>12</td>
<td>(18/30) 60.0</td>
<td>PAC 2 Nodal 0 PVC 9</td>
</tr>
<tr>
<td>Ventricular*</td>
<td>16</td>
<td>8</td>
<td>(16/24) 66.6</td>
<td>PAC 4 Nodal 0 PVC 6</td>
</tr>
</tbody>
</table>

*Most serious arrhythmia during admission.
**Excludes 8 admissions with both major supraventricular and ventricular arrhythmias, 5 with premature beats, 3 without.

Patients with “minor” supraventricular arrhythmias but less than that for patients with ventricular arrhythmias (Table 7). However, this depended on whether a patient with “major” supraventricular arrhythmia subsequently developed a ventricular arrhythmia. The difference in survival between those patients with “minor” supraventricular arrhythmias and those patients with only “major” supraventricular arrhythmias (ie, without associated ventricular arrhythmias) is not statistically significant. However, if all 23 patients with “major” supraventricular arrhythmias (including the 10 with supraventricular and ventricular arrhythmias) are compared with those patients with “minor” supraventricular arrhythmias, the difference is significant with p<.01 by X² test. If a patient with “major” supraventricular arrhythmia developed a ventricular arrhythmia, the mortality incidence was the same as that for those with only ventricular arrhythmias (100 percent).

Course of Ventricular Arrhythmias

Ventricular arrhythmias were also more frequently associated with premature beats than either NSR or “minor” supraventricular arrhythmias (Table 3). These differences were significant (p<.005 and .02, respectively). In every instance, the premature beats preceded the ventricular arrhythmia. The difference in association of premature beats with “major” supraventricular arrhythmias and with ventricular arrhythmias was not statistically significant.

Table 4—Arrhythmias in Patients with Multiple Admissions

<table>
<thead>
<tr>
<th>Arrhythmias</th>
<th>Patients withSame Arrhythmia&gt;1 Adm., No.*</th>
<th>Patients withSame Arrhythmia&gt;1 Adm., No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus tachycardia</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Supraventricular</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Ventricular</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>

*Excludes 2 patients with only NSR on 2 admissions each.

Table 5 shows the rhythms which precede ventricular arrhythmias on the same admissions. If a patient had more than one admission with the same ventricular arrhythmia (see Table 2), the data represents the last admission with that rhythm. A “major” supraventricular or another ventricular arrhythmia preceded the ventricular arrhythmia in nearly half the cases (15 of 31). Cardiac arrest was preceded by another ventricular arrhythmia in 8 of 15 instances. In only one instance was a ventricular arrhythmia (A-V dissociation) present on the initial electrocardiogram of a hospital admission.

Nearly half the patients with ventricular arrhythmias on their second or subsequent admissions had a “major” supraventricular or ventricular arrhythmia on a previous admission (Table 6). Cardiac arrest occurred 16 times in 15 patients. Five of these episodes were documented ventricular fibrillation. One episode of ventricular fibrillation was successfully treated with electrical defibrillation and the patient was discharged from the hospital. However, on a subsequent admission this patient again had cardiac arrest and died. Treatment of all other episodes of cardiac arrest was unsuccessful.

Patients with ventricular arrhythmias had a high mortality, both during hospital admission and as outpatients before the end of the study period. No patient with a ventricular arrhythmia survived to the end of the study period (Table 7). The difference in survival between the patients with ventricular arrhythmias and any of the other groups is highly significant (p<.001).

It can be seen from Table 5 that 14 deaths in the 20 patients with ventricular arrhythmias occurred during an admission for acute respiratory failure. Except for these 14 deaths in patients with ventricular arrhythmias, all other deaths occurred out of the hospital.

DISCUSSION

It is likely that a review of electrocardiograms and rhythm strips mounted in the clinical record,
the method used in this study, significantly underestimates the true prevalence of arrhythmias, but is identified in most of the sustained arrhythmias. Even though normal sinus rhythm and sinus tachycardia were the most common rhythms in this study, a high frequency and wide variety of other arrhythmias were documented. It is probable that more dangerous rhythms actually occurred than were documented. Previous reports have not shown such a high prevalence of major arrhythmias in pulmonary disease. However, most of these studies did not use arterial blood gas criteria or the diagnostic category of acute respiratory failure. One study utilizing arterial blood gas criteria for selection commented only on fatal ventricular arrhythmias, with a frequency far less than in the present study. Our use of specific blood gas criteria results in the selection of a more severely ill group than in previous studies; thus, the higher frequency of arrhythmias is not surprising.

Review of the data suggests that some rhythm abnormalities indicate that more ominous rhythms may follow. Major supraventricular and ventricular arrhythmias were often preceded by premature beats; this association was particularly striking for premature ventricular contractions and ventricular arrhythmias. Patients with supraventricular arrhythmias on one admission had a tendency to develop the same arrhythmias on subsequent admissions. This association appears less certain for patients with ventricular arrhythmias, but this may result from the fact that several of these patients did not survive the bout of acute respiratory failure associated with their first ventricular arrhythmia. In patients discharged from hospital with a supraventricular arrhythmia, the arrhythmia persisted or recurred as an outpatient, and these patients had supraventricular arrhythmias on subsequent admissions. Ventricular arrhythmias, especially cardiac arrests, were preceded by an increased frequency of major supraventricular arrhythmias or other ventricular arrhythmias, both on that same admission and on previous admissions.

Whether these observations on rhythms which tend to predict subsequent arrhythmias have therapeutic implications, depends on the etiology of the arrhythmias and their response to therapy. Because of the limitations of a retrospective study, we could not definitely determine significant clinical and laboratory data associated with arrhythmias. It is a distinct possibility that the arrhythmias reflect the severity of the underlying respiratory disease and arterial blood gas derangements, and that treatment of arrhythmias must be directed primarily at the respiratory disorder. This has been our clinical impression, but needs further objective documentation. It is also possible that therapy of the respiratory disease, especially drug therapy, may play a

### Table 5—Ventricular Arrhythmias: Associated Rhythms and Survival

<table>
<thead>
<tr>
<th>Ventricular Arrhythmia</th>
<th>Patients, No.</th>
<th>Preceding Rhythms on Same Admission</th>
<th>Subsequent Ventricular Arrhythmias</th>
<th>Died During Same Admission</th>
<th>Died During Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NSR only</td>
<td>ST</td>
<td>SV</td>
<td>V</td>
<td>SV &amp;V</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>15</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Idioventricular rhythm</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>A-V dissociation</td>
<td>4*</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ventricular bigeminy</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Preceding rhythms only add up to 3, as A-V dissociation was the rhythm on admission in 1 patient.

### Table 6—Ventricular Arrhythmias: Rhythms on Previous Admissions

<table>
<thead>
<tr>
<th>Ventricular Arrhythmia</th>
<th>Patients with Admissions, No.</th>
<th>NSR Only</th>
<th>ST</th>
<th>SV</th>
<th>V</th>
<th>SV &amp;V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac arrest</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Idioventricular rhythm</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A-V dissociation</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ventricular bigeminy</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
ARRHYTHMIAS ASSOCIATED WITH ACUTE RESPIRATORY FAILURE

Table 4

<table>
<thead>
<tr>
<th>Table 4—Rhythms and Survival*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhythm</td>
</tr>
<tr>
<td>NSR only</td>
</tr>
<tr>
<td>“Minor” supraventricular</td>
</tr>
<tr>
<td>“Major” supraventricular</td>
</tr>
<tr>
<td>“Major” supraventricular</td>
</tr>
<tr>
<td>&amp; ventricular</td>
</tr>
<tr>
<td>Ventricular</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

*Survival determined at the end of the study period.

The study period.

Whether these observations associating arrhythmias and survival have any implications for treatment depends on whether mortality is more directly associated with the presence of the arrhythmia or the severity of the lung disease. This remains to be determined. Certainly the fact that only one of 16 episodes of cardiac arrest and only one of four episodes of ventricular tachycardia were successfully treated suggests that the emphasis must be on prevention of these severe ventricular arrhythmias rather than their treatment.

Observations from this study on prevalence of arrhythmias, rhythm abnormalities allowing prediction of subsequent arrhythmias, and associations with prognosis as well as possible therapeutic implications, suggest that it would be of value to have constant electrocardiographic monitoring of all chronic airway obstruction patients with acute respiratory failure.

ACKNOWLEDGMENTS: The authors thank Alan M. Suzuki, B.S., Dennis Hepting, B.S., and Philip Archer, Sc.D., for their biometric assistance, and H. L. Brammell, M.D., for his review of the manuscript and suggestions.

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