Successful Resuscitation of Two Near Simultaneous Cases of Cardiac Arrest with a Review of Fifteen Cases Occurring During Supervised Exercise

WILLIAM F. MEAD, M.D., HOWARD R. PYFER, M.D., JAMES C. TROMBOLD M.D., AND RICHARD C. FREDERICK

SUMMARY Two men with coronary heart disease experienced cardiac arrests during a recent exercise rehabilitation session. Fifteen cases of ventricular fibrillation have occurred in this program since 1968, making an average of one per six-thousand man hours of supervised exercise training. All were successfully resuscitated with no sequelae.

Analysis of the patients who experienced ventricular fibrillation suggests that treating patients with exercise-induced premature ventricular contractions with anti-arrhythmic drugs, proper attention to serum potassium levels, strict adherence to training pulse rates, and proper warm-up might help to prevent future similar events in an exercise program.

Due to the unpredictability of ventricular fibrillation it seems preferable that individuals who have known coronary heart disease participate in exercise training under proper supervision with appropriate emergency equipment available.

CARDIO-PULMONARY Research Institute (CAPRI)* provides rehabilitative exercise programs primarily for individuals with known coronary heart disease and persons at high risk. Progress is evaluated by the Bruce treadmill test. Exercise training is based on obtaining pulse rates between 70 and 85% of the maximum heart rate attained during the most recent exercise tolerance test. Walking, jogging, and calisthenics constitute the exercise program. Medical therapy is the responsibility of each participant's personal physician. More than 800 men and women have participated in the program from May 1968 through April 1975.

Case Reports

Two cases of ventricular fibrillation occurred on June 3, 1974, less than one minute apart, at CAPRI (Cardio-Pulmonary Research Institute, Seattle, Washington) during an exercise rehabilitation session and are described below.

Case A is a 54-year-old male with a history of hypertension and coronary heart disease. He had experienced an anterior wall myocardial infarction in 1972 and had been a participant in CAPRI for one year. He had no angina and had felt well the few days prior to and immediately before class. He worked as an engineer on a full-time basis. Medications included reserpine, 0.1 mg, hyralazine, 25 mg, hydrochlorothiazide, 15 mg, three times daily and diazepam occasionally. Sodium warfarin had been discontinued the month prior to his cardiac arrest. Serial exercise tests showed improvement in duration of exercise performance with a higher systolic blood pressure response during his latest test on March 20, 1974. Premature ventricular contractions (PVCs) were noted on the ECG during that test and had been recorded in class after jogging. He had a tendency to overexercise and had been cautioned previously to stay at his training level, which consisted of jogging one mile nonstop. It was noted in the previous month that his pulse rate after jogging was equal to or slightly in excess of his safe exercise limits of 145 beats/min (85% of his maximum heart rate reached on the March 20, 1974, exercise test).

Class had been in progress nine minutes and he had jogged 0.92 miles nonstop when he felt dizzy and collapsed. Ventricular fibrillation was noted by immediate ECG monitoring. He was defibrillated with one 400 watt-second shock and transferred to a nearby hospital where his course was uneventful. Admission hospital potassium was 3.1 mEq/liter. There were no ECG changes of enzyme elevations. He was discharged after four days.

A angiogram a few days later revealed single-vessel disease with a 95% occlusion of the proximal left anterior descending artery. After two weeks, he returned to rehabilitation classes at a reduced exercise level and with a new medical regimen of hydrochlorothiazide daily and procainamide, 500 mg, four times daily.

Case B is a 67-year-old male with a history of coronary heart disease and epilepsy. He had experienced a posterior wall myocardial infarction in 1970. He had been a participant in CAPRI for over three years. He had no angina and had felt well the few days prior to and immediately before class. He was under considerable emotional stress and had had recent episodes of insomnia. Routine medications included methchlorothiazide, 5 mg twice daily, digoxin, 0.25 mg once daily, diphenydantoin, 100 mg four times daily, and phenobarbital, 30 mg four times daily. The epilepsy had been under excellent control for the previous four years. He worked full time as a springmaker. Exercise tests had been conducted on the bicycle ergometer and his most recent test had been performed on December 13, 1973. At that time, a single PVC was recorded on the resting ECG, and a 40% decrease from his previous exercise performance was noted. Both premature atrial contractions (PACs) and marked ST-segment depression were present during exercise and recovery and both had been observed during previous tests.

Review of previous rhythm strips showed the PVCs had been noted immediately after jogging during the previous

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*From the CAPRI (Cardio-Pulmonary Rehabilitation Programs), Seattle, Washington.
Received June 13, 1975; revision accepted for publication July 28, 1975.
A review

A week. His exercise log revealed that during the previous month his pulse rate after jogging frequently was between 130-140 beats/min, which exceeded his safe training rate of 112 beats/min, (85% of the maximum heart rate attained on his last exercise test, December 13, 1973). He had been advised to jog more slowly.

On the morning of the cardiac arrest, the participant became dizzy and collapsed at the completion of his second set of prescribed jogging (0.25 mile nonstop), approximately ten minutes after the beginning of class. Ventricular fibrillation was noted by ECG monitoring. He was promptly defibrillated with a 400 watt-second charge and transferred to a nearby hospital where his course was uneventful. An admission hospital potassium level was 3.7 mEq/liter. There were no ECG changes or significant enzyme elevations. He returned to class after two weeks at a reduced exercise level, and with the additional medication, quinidine gluconate, taken twice daily. No angiographic studies were performed.

In comparing these two cases, both patients had coronary heart disease, a history of myocardial infarction, were on diuretics, had relatively low potassium levels, and had been exercising with pulse rates equal to or exceeding the upper limits of their recommended training ranges (table 1). Both were resuscitated in less than one minute after their cardiac arrest.

**Review of 15 Cases**

Thirteen additional cases of exertional ventricular fibrillation have occurred between 1968 and 1975 during the CAPRI exercise rehabilitation classes, making an average of one per 6000 man hours of supervised exercise training.  

A review of all 15 cases shows ages ranging from 34-67 with a mean age of 53.6 years. Five were cigarette smokers and six had a family history of myocardial infarction or sudden death.

Twelve of the men were referred to CAPRI with prior history of myocardial infarction and three were referred with a diagnosis of angina pectoris and no previous infarction. Participation in the supervised program ranged from 3-57 months with a mean of 18 months. Eight of the 15 cases occurred during the sixth to tenth month of participation and only one case occurred in a man who had been participating for less than six months. Blood studies taken prior to entering the exercise program revealed cholesterols rang-

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**Table 1. Case Summaries**

<table>
<thead>
<tr>
<th>Case A</th>
<th>Case B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>54</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>83.6</td>
</tr>
<tr>
<td>Previous MI</td>
<td>1972</td>
</tr>
<tr>
<td>Family history</td>
<td>None</td>
</tr>
<tr>
<td>Smoke cigarettes</td>
<td>Yes</td>
</tr>
<tr>
<td>Anti-arrhythmia medications</td>
<td>None</td>
</tr>
<tr>
<td>Cholesterol, mg/100 ml</td>
<td>275</td>
</tr>
<tr>
<td>Triglyceride, mg/100 ml</td>
<td>179</td>
</tr>
<tr>
<td>Potassium level, mEq/liter</td>
<td>3.1</td>
</tr>
</tbody>
</table>

**Exercise Tolerance Test Responses**

<table>
<thead>
<tr>
<th>Treadmill</th>
<th>Bicycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR&lt;sub&gt;max&lt;/sub&gt;, beats/min</td>
<td>170</td>
</tr>
<tr>
<td>SBP&lt;sub&gt;max&lt;/sub&gt;, mm Hg</td>
<td>240</td>
</tr>
<tr>
<td>PR/100</td>
<td>408</td>
</tr>
<tr>
<td>ΔHR</td>
<td>123</td>
</tr>
<tr>
<td>ΔSBP</td>
<td>50</td>
</tr>
<tr>
<td>Primary limitations</td>
<td>leg weakness</td>
</tr>
<tr>
<td>PVC's</td>
<td>Yes</td>
</tr>
<tr>
<td>ST-segment depression ( &gt;1 mm for &gt;1 min)</td>
<td>No</td>
</tr>
</tbody>
</table>

**Additional information**

- Months in training program: 14 | 40
- Routine nonstop jog in class, miles: 1.0 | 0.16
- Average HR during last 6 training sessions, % HR<sub>max</sub>: 85 | 98
- Angiography findings: 95% occlusion of proximal LAD (Decision pending) (Not recommended)

**Surgery**

Abbreviations: HR = heart rate; LAD = left anterior descending coronary artery; max = maximal; MI = myocardial infarction; PVCs = premature ventricular contractions; PR = pressure-rate product; SBP = systolic blood pressure.

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**Table 2. Characteristics of 15 Men Who Experienced Cardiac Arrest**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous MI</td>
<td>12</td>
</tr>
<tr>
<td>Smoked cigarettes</td>
<td>5</td>
</tr>
<tr>
<td>Taking anti-arrhythmics</td>
<td>0</td>
</tr>
<tr>
<td>PVCs last exercise tolerance test (ETT)</td>
<td>10</td>
</tr>
<tr>
<td>ST-depression last ETT</td>
<td>11</td>
</tr>
<tr>
<td>SBP drop last ETT</td>
<td>4</td>
</tr>
</tbody>
</table>

**Age**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.3</td>
<td>34 - 67</td>
</tr>
</tbody>
</table>

**Months in program**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>3 - 57</td>
</tr>
</tbody>
</table>

**Blood studies**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesterol mg/100 ml</td>
<td>226</td>
</tr>
<tr>
<td>Triglyceride mg/100 ml</td>
<td>161</td>
</tr>
<tr>
<td>Potassium mEq/L</td>
<td>4.2</td>
</tr>
</tbody>
</table>

**Exercise prescription during supervised class:**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jog nonstop miles</td>
<td>0.49</td>
</tr>
<tr>
<td>Jog - Total miles</td>
<td>1.4</td>
</tr>
</tbody>
</table>
ing from 187–265 mg/100ml with a mean of 226 mg/100ml and triglycerides from 69–292 mg/100ml with a mean of 161 mg/100ml.

Potassium levels on admission to the hospital following fibrillation ranged from 3.1–5.1 mEq/liter with a mean of 4.2 mEq/liter. Only one man had a blood potassium which fell below the normal range.

Analysis of previous exercise test responses of the 15 men reveals that ten had PVCs on the most recent test prior to their cardiac arrest. Eleven showed ST-segment depression and four showed a drop in systolic blood pressure at maximum exertion during their most recent exercise tolerance test (table 2). None was on anti-arrhythmic medications at the time of the incident.

During the six classes immediately prior to their incident nine of the 15 men had mean pulse rates which exceeded 85% of their maximum heart rate. All but one of the men experienced cardiac arrest during the first 20 minutes of class. All but one man had been active in the program for at least six months prior to the event.

Arteriographic studies were performed on 11 men following their cardiac arrest and the distribution of coronary artery disease is shown in table 3. Saphenous vein grafting was performed on eight of these men. Twelve men returned to the supervised program following their event in class. Two of these subsequently experienced sudden death and one experienced a stroke away from the supervised class within six months of their initial event (table 4). The mean length of survival for the 13 men who are still living after their cardiac arrest is 32.8 months per man for an annual mortality rate of 4.7%.

In our busy society, participants are frequently in a hurry and tend to slight the warm-up and cool-down phases of the exercise session. We now frequently call attention to this most important aspect of training.

### Discussion

The appearance of PVCs during the last exercise test of men who subsequently developed ventricular fibrillation during rehabilitative exercise raises the issue of effective prophylaxis. A history of PVCs might indicate the use of nitroglycerin or antiarrhythmic drugs. Gey et al.,* Lown and Wolf,* and Stone et al. have shown that this type of medication would be helpful in selected cases. Since we monitor our participants frequently with rhythm strips, we have an opportunity to evaluate drug therapy in a practical and inexpensive way. We have placed greater emphasis on bringing this rhythm abnormality to the attention of the referring physician. This type of communication also creates a better relationship with the referring physician.

A recent random sample of 117 participants revealed low serum potassium in four cases. In light of that prevalence and the hypokalemia in Case A, we have increased our emphasis on serum potassium levels in our correspondence with attending physicians. It should be noted, however, that aside from Case A, only one other case of fibrillation during our program was associated with low potassium level.

Since the last 12 men on whom we have exercise records had been training in excess of 80% of their maximum heart rate and nine had been exceeding 85% in earlier training sessions, we have paid closer attention to training heart rate and participants have been encouraged to exercise at pulse rates closer to the lower limits of their training range.

Because of the large number of participants (858), the varying time periods of participation, and the incompleteness of data in all cases, a definitive analysis of sensitivities and specificities is not feasible; however it is the authors’ opinion, based on continuous experience, that the factors contributing most to the enhanced risk for ventricular fibrillation are one or more of the following: exertional PVCs, ST depression, excessive heart rate, and hypokalemia.

In view of the unpredictability of ventricular fibrillation it seems preferable for individuals with known coronary heart disease to participate in exercise training under proper supervision with appropriate emergency equipment available.

### Acknowledgment

The authors would like to thank Alison Ross and Robert A. Bruce, M.D., for their help in preparation of this report.

### References

Successful resuscitation of two near simultaneous cases of cardiac arrest with a review of fifteen cases occurring during supervised exercise.
W F Mead, H R Pyfer, J C Thrombold and R C Frederick

doi: 10.1161/01.CIR.53.1.187

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/53/1/187

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