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CARDIAC SWIMMING AND A TRADITIONAL REHABILITATION PROGRAM OF BIKE-WALK-JOG; A COMPARISON OF MAXIMAL OXYGEN CONSUMPTION AND STRENGTH
CARDIAC SWIMMING AND A TRADITIONAL REHABILITATION PROGRAM OF BIKE-WALK-JOG: A COMPARISON OF MAXIMAL OXYGEN CONSUMPTION AND STRENGTH

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Kevin Timothy Kear, E.S., M.A.

* * * * * *

The Ohio State University
1983

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DEDICATION

To my wife Paula and my son Kiel.

Their love and support I will always cherish.
ACKNOWLEDGEMENTS

The data collection for this study included the cooperation of many highly trained individuals. I would like to thank them for their perseverance and dedication throughout the ten months of work:

To the memory of Dr. Edward Fox and his belief that to learn while doing a person should go after whatever is wanted, based on initiative, hard work, and sticktoitiveness. His support of this project and his major belief of getting the professional out into the mainstream will always be with me.

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To my subjects for their help, perserverance, and many hours of testing and training.

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To my parents whose support and confidence in me gave me strength and encouragement to continue through school to make my life more fulfilling.

And finally, to my wife Paula whose support in school and her good nature kept me sane. For her friendship and love, and her love for Kiel, I thank her.
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CHAPTER I

INTRODUCTION

Swimming, used as an exercise mode for the rehabilitation of cardiac patients, has just recently been accepted as a form of exercise therapy. Nationally, few programs offer swimming as an alternative exercise mode over the more traditional walk-jog or bicycle exercise programs. Although only a small number of studies have been done related to increases of maximal oxygen consumption while swimming, significant increases were reported. Although maximal oxygen consumption and other relevant concerns of the cardiac population has been evaluated in exercise training, the question of strength gains within this population has not been researched.

The two traditional programs, walk-jog and bicycle exercise, evaluate gains based on oxygen consumption. Those people requiring manual labor for work, therefore, are being evaluated on one component. The ability to return to physical labor is not being addressed based on strength, but on oxygen consumption.
The attitude that white collar workers do not need strength to return to work is common. Cardiac programs, in general, have no idea of the fitness level of the white collar worker in regard to strength or any group for that matter. It is well known that bed rest and recuperation from operative procedures decrease strength and lean body mass. Many heart attack or bypass patients want to return to active participation of strenuous leisure activities. These people are not evaluated on strength to determine if they are capable of resuming strenuous activities.

The evaluation of strength gains in specific areas by swimming, walking-jogging, and bicycling may, therefore, yield information as to what exercise activity increases or decreases a subject's strength. Whether or not there is upper or lower body strength gains in cardiac and high risk patients participating in different forms of exercise therapy is unknown. Ultimately, strength norms may be established as guidelines for recommending active participation for the cardiac patient.

**Purpose of the Study**

The purpose of the study was to evaluate the oxygen consumption and strength gains of a swimming program compared to those same changes found within a more traditional walk-jog and bicycle exercise program after training.
Group A: Patients who volunteered for the swimming exercise program. They consisted of men and a woman who had documented coronary artery disease, myocardial infarction, surgery or who were at high risk of heart disease.

Group B: Men and a woman who exercised in the traditional walk-jog program. They had documented coronary artery disease, had undergone coronary artery bypass, documented myocardial infarction, or were at high risk of heart disease.

Limitations of the Study

The limitations of the study were:

1. Population size: The size of the population was small due to the lack of patient referrals into the cardiac rehabilitation program by physicians.

2. Time: Exercise times were limited to the time of day 7:00 am to 8:00 am and 4:00 pm to 6:00 pm. The exercise session, therefore, could not take place at one time.

3. Facilities: Due to the lack of available pool space the study was limited to the Therapeutic Pool, a thirty foot pool. Only four subjects could swim at any given time due to the pool size.
4. Entrance to Swimming: The volunteers who wanted to swim had to first exercise in the walk-jog program for clearance of abnormal or dangerous arrhythmias.

Statement of the Problem
The success of exercise therapy for cardiac patients, for the most part, has been based on the grounds of changes due to oxygen consumption. Some programs, administratively, are set-up in progression from swimming to biking then eventually to a walk-jog program (91). Other programs offer a selection of either swimming, bicycling or jogging. Although increases of oxygen consumption and exercise tolerance are seen, the question of strength gains due to each progression has not been answered. If swimming skills are basically an upper body activity, then what is the value of progressing the group to the next level of a bike or walk-jog program that is mainly a lower body activity?

This study attempts to address the changes in strength and oxygen consumption by comparing a swimming program against that of a bike-walk-jog program.

Hypotheses:
1. H0: There is no significant difference in the pretest to posttest parameter of maximal oxygen consumption in groups A and B as a result of a training program.
2. H0: There is no significant difference in the pretest to posttest parameter of leg and arm strength in groups A and B as a result of a training program.
CHAPTER II

REVIEW OF LITERATURE

Review of the literature in relation to swimming cardiac patients indicates that very little has been done in this area. Tethered swimming studies of normals and of cardinals have been done, but again the sources are limited. The review itself will, therefore, include information about both cardiac running programs and tethered swimming programs of normal and cardiac populations and the physiology of swimming.

The literature related to strength development of a special population and values on the cardiac population are not available. The techniques and principles will be discussed in relation to isokinetic strength evaluation.

The sport of swimming has just recently been studied as a modality for cardiac rehabilitation and adult fitness programs. Those areas that have received attention are measurement of aerobic capacity through swimming flumes and tethered swimming apparatuses, and the comparison of work capacity of running and bicycle ergometry with that of swimming.

- 6 -
Physiological Responses in a Water Environment

It has been demonstrated that both birds and aquatic animals, like the seal, have the ability to restrict circulation and to direct blood flow to the central nervous system, heart, and lungs during submersion in water. Man has also exhibited the physiological response (dive reflex) of bradycardia to water immersion by slowing the heart rate to 50 beats, or lower, per minute. Irving, in 1939, reported the diving reflex (submersion syndrome) in man to show a heart rate decrease from 110 to 36 beats per minute (48).

Sholander showed that breath holding in animals would decrease their heart rates during water submersion and adjusted the circulation to send the decreasing oxygen to those organs (heart, brain) that could least endure anoxia (76). An important find was that the reflex constricted peripheral circulation, but central systolic pressure remained normal in animals. The reflex response was also found in dogs and man but was less pronounced. Craig, however, believed the diving reflex occurred due to a primary peripheral vasoconstriction with a secondary vagal effect due to baroceptor reflexes (17). Brick (11) found that in man, bradycardia could be related to breath holding alone, while Elsner (26) found that bradycardia was not related to breath holding but to submersion.
**Apnea and Diving.** When man performs under water diving, the physiological responses are similar to those of animals but are more limited. As an example, peripheral circulation to the hands of non-divers was reduced, while peripheral blood flow to the fingers and calves of experienced divers was not reduced during apnea following deep hyperventilation (82). It appears that there is a physiological adaptation in peripheral circulation due to diving.

**Depth.** Craig (17) reported that bradycardia was independent of depth of water up to 27 meters but could not be reproduced in simulated dives in a compression chamber. This illustrates the theory that water on the face must be present to initiate the dive reflex. At a depth of 6 to 9 feet of water, Craig’s subjects elicited a heart rate of 40-45 beats in 11-35 seconds. Craig further reported that slower heart rates due to submersion were found in children as well as in adults.

**Valsalva.** Valsalva maneuver, closing the glottis while increasing the pressure in the lungs during exertion building up pressure within the respiratory tract, has been a controversial topic for several years. Craig (17) observed that tachycardia, heart rate of 150 beats or more produced by apnea at different valsalva pressures, was
proportional to the increase of innerthoracic pressure. Cardiac arrhythmias during resting apnea in divers and non-divers have been observed by many researchers (53, 67, 68, 75). It is generally agreed that there is a great deal of variability in responses seen during the valsalva maneuver in individuals. Thornton (82) reported that there appeared to be little difference between EKG patterns in apnea obtained in the laboratory and apneic diving for long periods of time.

It has been demonstrated that arrhythmias also appear to be more frequent in submersion than during apnea and that pronounced bradycardia and arrhythmias are associated with the longer dives. The arrhythmias occurred late in the dive and during recovery (67, 68, 75).

When looking at valsalva, blood pressure and heart rate, Legg (56) reported that the reduction of the peripheral pulse during apnea could also be a reflection of the fall in blood pressure during valsalva. It has been observed that in some cases there was a complete absence of peripheral pulse waves in non-divers when they held their breath and performed an extreme valsalva (87).

**Training.** Recently, studying the effects of training techniques, modes, and frequencies has become popular. Thornton (82) studied 12 subjects for 24 weeks comparing the relationship of underwater swimming to the bradycardia
reflex. He observed that the bradycardia was more pronounced and occurred earlier in the experienced divers than in non-divers, but that underwater apneic swims three times a week did not show any training effects. Bove (10) and Hutinger (46) found that physical training seemed to augment bradycardia, while Craig (17) reported that children and poor adult swimmers showed a greater heart rate response than did the average swimmer.

**Maximal Oxygen Consumption.** Maximal oxygen consumption (Max VO₂) has been widely accepted as the single most valid measure of fitness of an individual's cardio-respiratory function (69). The methods and modes of testing are varied depending on the sport or activity being tested and the equipment available.

Total body mass ventilatory oxygen consumption (VO₂) is the amount of oxygen extracted from the air by the cells of working muscles. Maximal levels of oxygen extraction are performed using aerobic exercise on motor driven treadmills or bicycles. Maximal oxygen consumption is equal to maximal cardiac output times the AVC₂ difference. The larger the difference the more extraction of oxygen at the cellular sites and the more efficient the cardiovascular system.

In normal sedentary individuals Max VO₂ is reported at 30 ml/kg/min (69). Aerobic exercise has been reported to increase VO₂ by 25% (69). The increase is dependent on age,
sex and initial fitness levels. Other factors influencing percent increase are intensity, frequency, duration, and mode of exercise.

Patterson studied an N of 43 cardiac patients to assess Max VO2 levels and to compare the results with a functional classification. From his data the following classifications were made.

<table>
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<th>Classification</th>
<th>ml/kg/min</th>
<th>mets</th>
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<tr>
<td>limited</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>severely limited</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>guarded</td>
<td>12</td>
<td>&lt; 4</td>
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McDonough classified Max VO2 in three normal populations.

<table>
<thead>
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<td>heavy exerciser</td>
<td>63</td>
</tr>
<tr>
<td>moderate</td>
<td>55.7</td>
</tr>
<tr>
<td>sedentary</td>
<td>49.8</td>
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He suggested that lower values were seen in a cardiac population as a result of reduced left ventricular performance which could be attributed to either a decrease in stroke volume or an increase in pulmonary artery pressure which limits cardiac output (63).
Wilson and Fardy reported yet other normal values for a cardiac population.

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<td>severely limited</td>
<td>16</td>
</tr>
<tr>
<td>symptomatic</td>
<td>22</td>
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<tr>
<td>average sedentary</td>
<td>35 (91)</td>
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The improvement of maximal oxygen consumption on coronary heart disease patients without angina after a training program has been reported to be 16% (20, 21). Max VO2 improvement of angina patients has been seen as high as 32-56% (20, 21, 72). In normal middle-aged men an average increase of 17-19% has been noted (37, 38). Successful trainability of patients can then be based on the improvement from one classification and by computing the percent increase in direct measurement of Max VO2. It has been suggested by many researchers that treadmill time should not be equated to Max VO2 values. The relationship of treadmill time to oxygen consumption has been reported to be an r of .7 to .8, or accurate 50-64% of the time. Wilson and others also agree that treadmill time should not be a criterion of success within a cardiac population (91).

There are many studies that present good evidence that testing for Max VO2 must be specific to the type of training the subject has undergone. For example, an O2 consumption
test performed on non-bikers may be significantly lower when a bicycle ergometer is used as the mode of testing (62). This brings us to the discussion of specificity of test to training.

**Specificity.** Some of the research on swimming indicates that oxygen consumption is 92.2% of the values recorded during normal cycling. Heart rates in swimming at competitive speeds were found to be lower than in running (60) and cycling (2). Holmer studied three female and six male subjects using three styles of swimming. The results showed that the front crawl was more energy efficient than the breast stroke and back stroke, with the breast stroke being the least efficient. Regardless of swimming style, the average Max VO2 values in swimming were 89% of running, and 97% of cycling values. Comparative studies of maximal oxygen consumption during swimming were 5-20% lower than running and cycling (4); however, these reports were on highly skilled swimmers whose training was also very specific.

Lower Max VO2 in swimming can be altered on the basis of body position, working muscle masses, and skill level (59, 78). Stenberg, et al (78) reported that supine cycling produced lower oxygen consumption than did cycling in the sitting position. In swimming the supine position reduces the hydrostatic pressure in the legs and this, in
return, could cause a lower perfusion pressure in the capillary beds of the working muscles (27) reducing blood flow and O2 transport.

Astrand and Saltin (4) obtained Max VO2 values of 3.74 liters/min during swimming, 14% lower than that obtained cycling at 4.36 liters/min and 19% lower than recorded for running at 4.69 liters/min.

Magel and Faulkner (59) studied 26 highly trained college swimmers. A comparison of Max O2 to treadmill, tethered swimming and free swimming tests were made. It was found that a test, retest determination of the tethered swim had a reliability of r = .93 for Max VO2. There was no significant difference between treadmill running O2 consumption, or tethered testing, with an r = .85. There were significant differences in tethered swimming compared to treadmill running as follows: higher O2 extraction, lower pulmonary ventilation, tidal volume, respiratory exchange ratio and lower heart rates.

The specificity of training is a very important concern when dealing with training subjects in one mode of exercise, and then evaluating the results on another testing mode. In this study subjects were trained using swimming as the mode of exercise and the testing was done on a treadmill. Magel reported that improvement of maximal oxygen consumption during swim training was not evident when testing subjects
on the treadmill. However, when the same subjects were tested in the pool their values were significantly increased. Stenberg (78) believed that Max VO2 in the water would never be attained as the total muscle mass involved would be lower than in land activities. However, Holmer (23) and others had disproved those earlier theories. Swimmers can attain almost 100% VO2 on land as in water, however, the reproducibility of Max VO2 for each sport is believed to be very specific and related to the sport in which the athlete is trained.

Cardiac Swimming

The apprehension of directors and physicians to implement exercise in a pool environment is based on the fact that little is known of the effects on the cardiac patient. Blazek and Player reported that at the same workload, measured by heart rate, the myocardium is at less stress during water exercise than at the same work load during exercise on a bicycle ergometer or treadmill (89). It has been hypothesized that the decreased O2 demand on the myocardium is caused by a change in the hemodynamics of the body in the prone position and because of the lowering of the body temperature in the water during exercise (85).

The problem exists in prescribing exercise to a person in the water when using ergometry or treadmill data. "One
cannot simply prescribe exercise for the individual who will be participating in water exercise by the same procedures as prescribing exercise for one who will be involved in land exercise" (85, p. 151). There is a fallacy, according to Wilson (90), in relying entirely upon mets accomplished during a stress test on a bike or treadmill to the prescribed exercise in the water. Wilson advocates exercise stress testing on a bike or treadmill, but to adjust the prescription so that it is 5 to 10 beats per minute below the rate at which the graded exercise test prescription would be based.

The progression of exercise for the cardiac patient in the LaCrosse Exercise Program consists of walking through the water at the prescribed exercise prescription. Two to three weeks later a semi-support device was used. Several weeks later swimmers eventually advanced to the inverted back stroke. Only seldom did a patient put his face totally in the water or use the crawl stroke.

Foyer wrote an article on the use of pools for rehabilitation. He stated that in Uppsala, Sweden, a hospital has been using the pool to rehabilitate patients with myocardial infarctions since 1977. The hospital used telemetry equipment to make sure exercise heart rates were in their ranges and that arrhythmias did not occur. A 30-45 minute interval training system was employed and
hydrotherapy exercises followed. Swimming was used only when the patient's capacity improved. During swimming, patients wore a belt attached to a rope tied to the ceiling. Two springs were attached to the end of the rope to increase the work load. The inpatient hospital program director said that patients improved physically and psychologically and during a 10 year period had no mortalities due to the training (28).

Heigenhauser studied six post myocardial infarction patients and six normal sedentary males on their responses to both submaximal and maximal swimming and cycling stress tests. The graded tethered swimming test and cycle test were discontinuous. The cycling test consisted of pedalling at either 25 or 50 watts, based on the subject's age and health status, for five minutes of exercise then five minutes of rest. Increments were made by 25 or 50 watts depending upon ability (39).

During the tethered swimming test heart rates, standing and then submerged to the neck, were recorded. The cardiac patients used different strokes during the test: front crawl, breast stroke and side stroke. The subjects swam for three minutes at a work load of 1.14 kg. Five minutes of rest were allowed between work bouts. Each exercise bout was increased by 1.14 kg.
The results revealed that at any given VO2 the inactive normals had similar cardiac outputs (Q) and HRs during swimming and cycling. Heigenhauser revealed that the MI patients had lower (Q) and higher HRs during swimming compared to cycling (39). The MIs had a 21% lower VO2 during swimming than cycling. The lower (Q) was measured by CO2 rebreathing, and it was reported that stroke volume did not go above resting values when exercising in the pool. There were, however, no significant differences in maximal heart rates in swimming or cycling in the MI patients. Heigenhause believes that exercise prescriptions can be based on treadmill or a bike test.

Magder studied the effects of exercising myocardial patients in the flume with 8 patients, 8-17 months post MI. They were tested on a bicycle ergometer both sitting and supine. Magder reported a peak VO2 slightly higher in swimming compared to cycling and that max HR, ventilation, and O2 pulse did not differ significantly between the two forms of exercise.

**Introduction to Strength.** In 1967 the first data on the measurement of human muscle force using the Cybex Isokinetic Dynamometer was published. The device used to measure muscle force in this study was the Cybex II Isokinetic Dynamometer, Lumex Incorporated, Ronkonkoma, New York. The isokinetic device allows for control of the
angular velocity (speed) in degrees per second, while the
dynamometer allows a maximal contraction of a specific
muscle group through a full range of motion. The
dynamometer measures the amount of force produced during the
contraction with an electronic gauge measuring strength in
Torque \(\text{torque} = \text{distance} \times \text{force}\). Torque is the product of the distance \(d\) from
where force is applied to the center of the rotation point,
times the force applied \(f\).

\[
\text{TORQUE} = \text{distance} \times \text{force}
\]

If a subject applies a force of 40 pounds at a distance of
one foot from the axis of rotation of the joint being
measured, then torque equals 40 foot pounds.

Muscle strength decrease, atrophy of muscle tissues,
becomes apparent as the aging process proceeds. The
decrease in muscle mass has been attributed to both a
decrease in the number and of the size of the fibers (35,
74, 80, 83). The reduction in myofibril size and number is
a slow process. There seems to be a selective degradation
of size and number of myofibrils based on fiber type.
Yosjika (83), has found that fast twitch fibers decrease
both in size and number, while slow twitch fibers decrease
in number only (54, 55). There also appears to be a
decrease in the size of the motor unit area (23, 32, 34).
The enzymatic changes due to aging also are dramatic. Gutmann (31) has observed a decline in both glycolytic and oxidative enzymes, with the most dramatic decline in anaerobic energy substrates. The enzyme changes are not pronounced in slow twitch fibers (31). Smith reported that older males have a decrease in ATP, creatinephosphate (CP), glycogen and ATP/ADP ratios. These factors could also decrease strength (77).

Damon (19) reported declines in strength related to age. These declines in strength were observed whether measured isometrically, concentrically, or eccentrically. He measured peak force exerted as well as maximal velocity produced against a given mass. It was found that although the older men exerted less force than younger males the force velocity curves were similar in shape (19).

Hulten and Spande reported that fatigue rate was faster in older men when initiating an isometric contraction (77). It was also found that fast twitch fibers were recruited preferrentially over slow twitch as there is a lack of blood flow to working muscles.

Aging and Muscle Training

As a result of histochemical changes due to aging and the decrease in type II fibers, strength also declines. Carlson studied EMG amplitude and peak number of EMG waves
and found that both decrease as muscle fiber size declines. Researchers recently have attempted to study the effects training has on the retardation of the aging process and muscle strength. Moritani and de Vries (65) studied the effects of strength training over a period of time. After eight weeks of strength training middle aged persons and a young population, on a percent basis, both groups increased comparably (65, 79).

Isometric Gains

Ikai and Funkunaga (47) measured the increase of cross sectional area of arm flexors using ultrasound before and after 100 days of ten second isometric training. They reported an increase of 92% in strength with only a 23% increase in cross sectional area. Other researchers have shown increases of strength without concomitant increases in muscle area (19).

The theory which hypothesizes strength gains is primarily through three mechanisms:

1. the increased activity of the motor units and their discharges;
2. morphological changes of the myofibrils; and
3. increase in neural factors.

de Vries (65) trained the arm flexors of older subjects for eight weeks. It was demonstrated that although hypertrophy
of muscle tissue was not significant, strength gains were. Over the training period it was suggested that muscle training in the older subjects may be attributed entirely to neuromuscular factors. Furthermore, Smith stated "IEMG recordings and maximal strength appeared to increase at the same rate although muscle hypertrophy did not" (77, p. 162).

**Cardiac Weight Training**

For coronary heart diseased patients, physical training can be aimed at improving muscle strength and anaerobic and aerobic conditioning. Oxygen consumption must first take priority and then muscle development can follow after overall cardiovascular training. However, Hellerstein suggested that heart rate not exceed 150 beats, patients should be monitored, and weight training should be submaximal and done with intervals.

Saldivar (74) recently studied eight MI, CABG cardiac patients aged 31-62 who did weight lifting after participating in a 12 week cardiac rehabilitation program. At the end of the telemetried monitored exercise program the subjects could then enter a low weight, low repetition weight training program. The program consisted of one set of 10 repetitions beginning with 3 to 12 pounds of weight. Six upper body activities were the focus of the training, which met three times a week. All eight patients
participating had no symptoms, ST changes, or arrhythmias. As a result of the study it was concluded that a low weight and repetition strength training program could be safe for individuals with coronary heart disease.
CHAPTER III

METHODS AND PROCEDURES

The purpose of the study was to evaluate the changes of maximal oxygen consumption and strength after three months of training using swimming as the mode of exercise. The subject population consisted of cardiac patients at least two months post myocardial infarct (MI), post coronary artery by-pass graft (CABG), and high risk patients. Subjects at high risk had either experienced angina prior to entrance into the study or had documented narrowing of coronaries measured by catherization.

A maximal graded exercise test was administered using the Balke (Special) Protocol to each patient. A direct on-line oxygen consumption was measured during the test, while a three-channel continuous electrocardiogram recorded rhythms. Strength testing via CYBEX II was also administered to measure peak torques at the knee, shoulder, and elbow joints.
Subjects

The subjects for this study were between 34 to 64 years of age. All clients were referred into The Ohio State University's Cardiac Rehabilitation, Phase II (Bike-Walk-Jog) Program in Columbus, Ohio. All subjects were instructed to take their medications as prescribed by their physician.

Referral into the Program. All participants were referred into The Ohio State University's Cardiac Rehabilitation Program by a physician. They were at least two months post MI, CABG or at high risk. Those at high risk had a strong family history of coronary heart disease (CHD) prior to entrance into the program and had documented narrowing due to lesions.

Program Entrance and Preliminary Testing

Group A consisted of four males and one female who volunteered to use swimming as the mode of exercise after being involved with the bike-walk-jog program for at least one week.

Group B consisted of five males and one female who exercised in a bike-walk-jog program. Their exercise consisted of walk-jog on motor driven treadmills and stationary bicycling.
TABLE 1
Characteristics of Subjects

**SWIMMERS**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Classification</th>
<th>meds.</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tetrology of Fallot</td>
<td>Synthroid, digoxin</td>
<td>m</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>MI, (CABGx3)</td>
<td>Persantin, Inderal</td>
<td>f</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>MI</td>
<td>Motrin, Tenormin, Inderal</td>
<td>m</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>CHD (2x25-75%)</td>
<td>none</td>
<td>m</td>
<td>62</td>
</tr>
<tr>
<td>5</td>
<td>MI, (CABGx4)</td>
<td>procains, digoxin, Isordil, Atenolol, Procardia</td>
<td>m</td>
<td>64</td>
</tr>
</tbody>
</table>

**CONTROLS**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Classification</th>
<th>meds.</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Diastolic dysfunction CHDx1</td>
<td>Isordil</td>
<td>m</td>
<td>67</td>
</tr>
<tr>
<td>7</td>
<td>Paroxysmal tachycardia</td>
<td>Lanoxin, Synthroid</td>
<td>f</td>
<td>59</td>
</tr>
<tr>
<td>8</td>
<td>(CABGx2)</td>
<td>Persantin, prednisone</td>
<td>m</td>
<td>55</td>
</tr>
<tr>
<td>9</td>
<td>(CABGx4)</td>
<td>none</td>
<td>m</td>
<td>59</td>
</tr>
</tbody>
</table>

**Treadmill Testing.** The Graded Exercise Test was
administered to all subjects prior to entrance using the Balke (Special) Protocol (refer to Appendix B). A standard twelve lead electrocardiogram and blood pressure was recorded in the supine and standing positions. Consent forms and medical release forms were signed prior to testing. Patients were cautioned about reasons for stopping the test; some reasons being angina, muscle cramping, severe shortness of breath, dizziness, or not being able to keep up with the speed or incline of the treadmill (refer to Appendix F). A head gear apparatus was placed on the subject's head to stabilize the hose to the oxygen analyzer. A mouthpiece was inserted and a nose clip was positioned on the subject. Direct oxygen consumption was recorded every 30 seconds while exercising by using the Jaeger pneumotac, and O2 and CO2 analyzers. During the test the following data was recorded: EKG from leads I, V5 and AVF, blood pressure before the end of each stage, oxygen consumption, and perceived exertion as described by the Borg scale 6-21 (refer to Appendix F).

**Strength Testing**

All cardiac subjects, once admitted into the Cardiac Exercise Program, were administered two strength tests on the Cybex II Isokinetic apparatus. The tests were arranged on separate days at the subjects' convenience.
In case of emergency a drug bag and defibrillator were immediately accessible. Subjects' rhythms were monitored through the defibrillator at the lead II position. All forms were signed and symptoms for stopping the examination were discussed.

**Knee Evaluation.** The subjects were instructed to sit at the Cybex bench while thigh and belt support straps were put into place. The center of the rotary arm was placed at the lateral side of first the right and then the left knee. The length of the leg brace was positioned so that the pad was on the instep of the ankle joint resting just to the top of the condiles of the ankle. Once positioned the person was instructed to extend the leg forward as far as possible and then to flex it back to the original position at a very easy pace. This was done 10-15 times to allow time for adapting to the resistance of the machine. The resistance for all testing was set at 90 degrees per second at the 180 foot lb. scale setting.

**Breathing.** The subject was instructed to inhale on the command "Ready" then to extend the leg to 50% of subjective effort on "Go." While exerting, the subject was instructed to exhale throughout the extension and flexion movements. In this way the Valsalva maneuver was kept to a minimum. When Valsalva was initiated, a decrease in heart rate was
reported and the subject was instructed to exhale again. The second exertion, measuring for strength, was a practice at maximal effort. Exhaling throughout, the movement was recorded on the Cybex recorder at 10 mm/sec. The subject was allowed a ten second rest between the next three sets of contractions. A set consisted of both an extension and a flexion action. The CCU Nurse recorded EKGs during and immediately after each contraction. The right knee was tested, then the left knee was evaluated using the same procedures.

**Shoulder Evaluation.** The subject was asked to lie down on the Cybex Supine Bench and a belt strap was wrapped around the waist. The subject was positioned perpendicular to the rotary motor so that the arm was extended with the hand holding onto the hand grip. The Cybex supine bench was locked into position at 28-1/2 inches off the floor. The subject was asked to lock the elbow then to flex and extend the arm with rotation occurring at the shoulder joint. Padded stools were positioned in front and in back of the subject to absorb the impact during flexion and extension movements. Upon impact of flexion, the subject immediately started the motion back to the starting position. Allowing 10-15 repetitions to become accustomed to the machine, a 50% subjective effort was performed by the subject. A rest of 2-3 minutes was allowed before one maximal practice effort,
and then three full maximal efforts were attempted. The subject was allowed to rest 10 seconds between each set. In an attempt to decrease Valsalva, the subject was instructed to exhale throughout the effort. Both right and left shoulders were evaluated. Electrocardiograms were recorded during and immediately after the contraction.

Figure 1 demonstrates the measurement of torque at one specific joint angle. One of the benefits of the dynamometer, however, is its ability to measure strength through the entire range of joint motion.
Torque (ft.-lb.) = Distance (ft.) X Force (lb.)
= 1 ft. X 40 lb.
= 40 ft.-lb.

Figure 1: Demonstration of elbow torque
(as produced by flexors at approximately sixty degrees of flexion)
Figure 2: Demonstration of torque (produced through an entire range of joint motion (7)
Figure 3: Torque of Elbow Flexion Throughout Full Range
Elbow Strength. The subject was positioned at a 45 degrees angle on the supine bench; with the elbow secured the hand grip was lowered into the subject’s hand. The subject was instructed to flex and extend 10-15 times. A 50% subjective effort was done, exhaling to minimize Valsalva. After a 2-3 minutes rest, a maximal practice effort was done, and the next three sets of maximal efforts were performed with ten seconds rest between each set. Electrocardiograms were recorded during and immediately after each contraction.

Number of Strength Tests. The strength testing on the Cybex II apparatus consisted of two pretests and two posttests. The subjects were administered four sets of contractions with ten seconds rest between each set. One set consisted of maximal muscle contractions on both the right and left sides of the knee, shoulder and elbow joints. The highest torque value of Pretest I was averaged with the highest torque value of Pretest II. The same procedure was for Posttest I and II. The sum ranking of the pretests and posttests were then used for statistical purposes.

Entrance into the Cardiac Program. The test results and EKG recordings were sent to the Program’s Cardiologist who cleared the subjects for participation into the bike-walk-jog program.
Swimming Entrance. Telemetry monitoring during exercise sessions was routinely done on each cardiac subject. Sessions met three times a week. After one week of participation in the bike-walk-jcg program, at exercise prescriptions, the cardiac subjects could volunteer for the swimming program. Upon the medical director's decision, subjects were cleared for swimming.

Exercise Prescription. The maximal oxygen consumption in ml/Kg/min was taken from the maximal graded exercise test and placed on the ordinate of a graph. The heart rates for each corresponding workload were placed on the abscissa of the graph. Both group's training heart rates were established at 60-70% of the maximal oxygen consumption.

![Graph showing VO2 vs HR](image)

Figure 4: Maximal Oxygen Consumption to Prescription Heart Rates
**Exercise Sessions and Testing**

**Medical Supervision.** Medical supervision was voluntarily provided by coronary care nurses from The Ohio State University Hospital. The Medical Director cleared the four nurses for the supervisory position in the study. A CCU nurse was in attendance for all testing and exercise sessions. The nurses monitored the electrocardiograms for Cybex testing, graded exercise treadmill testing, and EKG interpretation required during exercise sessions. Other duties included taking subjects' pulses during swimming exercise sessions and notifying physicians of patient status in monthly reports.

**EKG Monitoring During Bike-Walk-Jog.** All the cardiac subjects' rhythms were telemetry monitored at the lead II position. A coronary care nurse and exercise leaders were in attendance at each session. Exercise sessions were held three days a week (Mondays, Wednesdays and Thursdays). Electrocardiograms were recorded from subjects on both bicycle ergometers and treadmill exercise modes.

**EKG Monitoring During Swimming.** Electrocardiograms were recorded at rest and every ten minutes during exercise using the Life Pack 7 Defibrillator. Subjects sat on the side of the pool while EKGs were recorded through the defibrillation paddles.
Monthly Reports. At the end of each month physicians were sent an update of their patient's progress. Reports included heart rates, blood pressure, duration of exercise and any problems on electrocardiogram or symptoms that were present at the session. In some cases where symptoms had changed, a telephone call was made to notify physicians of the change in patient status.

Swimming Schedule. The swimming sessions were scheduled at The Ohio State University's Therapeutic Pool. The length of the pool is 30 feet. Exercise sessions were three times a week: 7:00-8:00 am, 4:00-5:00 pm, and 5:00-6:00 pm on Mondays, Wednesdays and Thursdays.

Blood Pressure. Blood pressure was recorded just prior to exercise in the sitting position.

Stretching. Approximately ten minutes of upper body flexibility was done prior to exercise. Front and back arm pulls, and over the head and shoulder flexibility were performed. Sit-ups and wall push were also done on a routine basis prior to exercise.

Staffing. Staffing consisted of a Coronary Care Nurse and an exercise physiologist for the treadmill, strength evaluations, and swimming sessions. During the swimming sessions a lifeguard was also in attendance.
Swimming Techniques

Cardiac subjects swam two, thirty foot lengths of the pool using a skulling technique as their major mode of propulsion as a warm-up activity.

All beginning subjects were instructed to swim on the back using an elementary backstroke arm stroke. Arms were extended to shoulder height and then briskly brought down to the side. The recovery position consisted of slowly raising arms and hands to the chest and then out to the extended position once again. The legs were positioned slightly bent at the knees and feet rotated around in a bicycling action. The two movements used together were considered Level One swimming.

Level Two Swimming consisted of the same elementary back arm motion, however, leg action was changed. The cardiac patient was instructed to use the inverted frog kick and synchronize both legs and arms for propulsion. In this way lengths in the pool were increased, exercise prescription heart rates were maintained, and glides between exercise efforts were increased.

Level Three consisted of combining front crawl with level one or level two for periods of rest. Front crawl was used for two lengths of the pool, then the subject used the elementary backstroke with either a bicycle kick or frog kick for four lengths. As skill level and fitness increased
more lengths of crawl were added while lengths using the
backstroke were eliminated.

Level Four was the use of crawl exclusively. All of
the cardiac swimming patients finally achieved this level.

Subjects Data

The following was recorded during every exercise
session: resting blood pressure, resting heart rates,
exercise heart rates every 10 minutes via defibrillator
paddles, number of exercise lengths in the pool, total
minutes of exercise, subjective feelings about work for the
day, symptoms (if any), and a five minute post exercise
heart rate.

List of Equipment

Case Marquette Electrocardiograph
Jaeger Ergo-pneumotac
Physio Control Lifepak 7 Defibrillator
Dry Box
Drug Bag
Blood Pressure Cuff and Stand
Cyber
Cyber Auxiliary Supine Table
Rudolph Head Gear and Pulmonary Valve
Telemetry Vs. Quick Look Defibrillator Monitoring

Telemetry monitoring of patient rhythms is common within early discharge exercise programs and Phase II programs. A quick look at patient rhythms usually occurring in Phase III programs and are sometimes used for spot checking of patient exercise prescriptions. The paddles of the defibrillator are placed on the subjects' chest and EKG strip recorded.

In this study all subjects in the control group were telemetered throughout the three month period. Electrocardiograms were recorded several times, at rest and at the discretion of the Coronary Care Nurse, during exercise and during recovery. When interpreting the EKGs taken from the control group, the CCU nurse simply recorded heart rates and dates on the strips, omitting the number of arrhythmias seen. To retrospectively interpret heart rates at specific time intervals is, therefore, not possible. Arrhythmias during the session were recorded on the side in the comment areas or listed as PVCs seen during exercise. The number of premature beats were not counted in one minute time frames or were such a low number as not to be important.

The swim group was composed of volunteers who first exercised in the control group environment under telemetry. Upon entrance into the pool program EKGs were recorded at
rest and then 10 minute intervals once swimming began. Palpitation of pulses were done routinely to check exercise prescriptions. When EKGs were recorded the subjects had to leave the pool and sit or stand to have the EKG strip recorded from a defibrillator. They would then return to the pool and resume exercise. On each EKG strip heart rates, time into exercise, and arrhythmias were recorded.

In the case of one cardiac patient EKGs were recorded every five minutes into exercise and twice during recovery. His cardiologist allowed his patient to enter with the stipulation that close monitoring of the patient was necessary.
CHAPTER IV

ANALYSIS OF DATA AND RESULTS

The nonparametric statistical analysis was used by the researcher. It assumes that the pretest to posttest values in oxygen consumption and strength do not fall along a normal curve. The nonparametrics also assumes a small sample size. By ranking the observations the rank sum (W) test can be viewed as a way of transforming the outliers and are changed the most in value.

The advantages of nonparametric statistics in decreasing order of importance are:

1. Greater efficiency in a long-tailed distribution, including the order of outliers which are contaminated.

2. Confidence level is exactly as specified (57).

This study used a total of N = 5 in the treatment group and a total of N = 4 in the control group. The statistic, therefore, used was the Wilcoxon sum rank. This procedure ranked the medians of the difference between pre- and posttest periods of training between the samples of the population.
To analyze differences within each group pre to post training, the nonparametric Sign Test was used. This procedure calculates actual P values by assigning a probability. Once the pre- to posttest values are recorded the researcher found the mathematical difference. Those values which were positive in sign such as (+2), were compared to the table of binomial probability at P = .50 for either N = 5 (treatment) or N = 4 (control). If for example, in N = 4 the increase in strength only occurred in two out of the four subjects, then there were two positive and two negative values. The two positive values were then compared to the alpha levels set on the binomial statistics table. A P value was found and then compared to the previously set P of statistical difference of (P ≤ .10). The null hypothesis was then either rejected or accepted.

The hypotheses below were tested at the alpha level of p < .10 which used the u stat. The exact alpha level used for significance the Wilcoxon Rank Sum was P ≤ .095.

**HO:** There is no significant difference in pretest to posttest parameters of maximal oxygen consumption in groups A and B as a result of a three month training program.

**HO:** There is no significant difference in pretest to posttest parameters of leg, shoulder and arm strength in groups A and B as a result of a three month training program.
Group A: Consisted of four males and one female who volunteered to swim, as their mode of exercise, after completing at least one week of a traditional bike-walk-jog program.

Group B: Consisted of three males and one female who chose a bike-walk-jog program for their mode of cardiac rehabilitation exercise.

Both groups were administered a graded exercise test using the Balke (Standard) Protocol to measure oxygen consumption in ml/Kg/min. Strength was measured on the Cybex II Dynamometer, recorded in fcoat pounds. The right and left sides of the body were measured using extension and flexion actions at the knee, shoulder and elbow joints.

Results of Tests

The results of the Wilcoxon Sum Rank for pretest to posttest measures of maximal oxygen consumption and strength were evaluated at an alpha level of \( P \leq 0.10 \) after training. The medians of the treatment group, \( N = 5 \), were compared to the medians of the control group, \( N = 4 \), both pre-study and post-study to show statistical differences between the groups. The Sign Test was used to calculate statistical differences at a \( P \leq 0.10 \) within the groups.
Maximal Oxygen Consumption

There was no significant difference at the \( (P \leq .10) \) level in maximal oxygen consumption due to the two forms of training modes. The alpha bar was determined to be greater than \( (P > .548) \) (refer to Table 2).

The swim group showed significant difference pre- to posttesting (within group). The alpha bar was calculated at \( (P < .031) \). The control group also showed significant difference due to the training program. The alpha bar was found to be \( (P < .0625) \) (refer to Table 2).

Strength

The right and left sides of the body were measured for strength by using foot pounds as the unit of measurement. Extension and flexion of the knee, elbow, and shoulder joints were measured.

Knee Extension. There was no significant increase in strength of the right knee in either group, however, the left knee showed a significant increase at \( (P \leq .10) \) level. The reported \( (P) \) value was at alpha bar .032 (refer to Tables 3 and 4).

The (within) statistical procedure showed significant difference pre- to posttest values in swimmer right and left knee extension at alpha levels of .0312 for each side. The bike-walk-jog program did not show statistical significance on either the right or left sides.
Knee Flexion. There was no significant increase in strength of the right knee or the left knee for both groups (refer to Tables 5 and 6). The alpha bar was calculated to be greater than P of .548.

The swim group for within statistical significance showed improvement only on the left side with an alpha bar of .0312. The control group, however, showed significant improvement on the right and left sides with alphas of .0625 for each.

Shoulder Extension. Both the right shoulder and the left shoulder showed a significant increase in strength at the \( P < .10 \) level in the swim group. The alpha of the left shoulder was (alpha bar .056) and the alpha of the right shoulder was (alpha bar .095) (refer to Tables 7 and 8).

The swim group for (within) statistical significance had an alpha of \( P < .0312 \) for the left side only. The bike-walk-jog group (within) showed no significant difference.

Shoulder Flexion. There was no significant increase in strength of the right shoulder or the left shoulder in either group (refer to Tables 9 and 10).

The treatment group and the control group for (within) statistical differences, both exceeded the alpha level set
at \( (P \leq 0.10) \). Therefore, neither group showed significant differences.

**Elbow Extension.** There were significant results due to training between the treatment group and the control group. The left elbow at the \( (P \leq 0.10) \) level was determined to be \( (P \alpha \text{ bar} < 0.056) \). The right elbow at the \( (P < 0.10) \) level showed changes with a calculated \( P \) of \( (\alpha \text{ bar} \cdot 0.016) \) (refer to Tables 11 and 12).

The swim group for (within) statistical significance had a calculated \( (P < 0.0312) \) on both right and left sides. The control group for (within) groups, however, did not show significant differences.

**Elbow Flexion.** Elbow flexion showed a significant increase in strength, treatment to control group, with a \( (P \leq 0.10) \) level for both the right and left elbow. The left elbow alpha was slightly higher than the right elbow indicating a stronger left side (refer to Tables 13 and 14).

The swim group for (within) statistical differences showed significance on the right and left sides with a \( (P < 0.0312) \). The treatment group (within) showed no difference.
<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Swim)</td>
<td>24.4±5.4</td>
<td>29.5±4.2</td>
<td>23%</td>
</tr>
<tr>
<td>median</td>
<td>23.6</td>
<td>27.6</td>
<td></td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>31.05±7.8</td>
<td>36.9±5.4</td>
<td>22.5%</td>
</tr>
<tr>
<td>median</td>
<td>28.15</td>
<td>36.2</td>
<td></td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)
** Significant Within the Group
### TABLE 3

Strength Evaluation

**KNEE EXTENSION (RIGHT)**
(Foot lbs.)

(\(x, \pm SD\) Median)

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong> (Swim) median</td>
<td>84+27.1</td>
<td>89.1+27.1</td>
<td>67</td>
</tr>
<tr>
<td><strong>Group B</strong> (Bike-Walk-Jog) median</td>
<td>100+24.7</td>
<td>101.5+26.6</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)
** Significant Within the Group
<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A **</td>
<td>76.25+27.8</td>
<td>84.5+23.7</td>
<td>11.2%</td>
</tr>
<tr>
<td>(Swim) median</td>
<td>85.5</td>
<td>88.5</td>
<td>*</td>
</tr>
<tr>
<td>Group B</td>
<td>91.8+19.1</td>
<td>91.8+21.6</td>
<td>0%</td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>median</td>
<td>95.25</td>
<td>94.5</td>
</tr>
</tbody>
</table>

* Significant to (\(P \leq .10\)) Between Groups
** Significant Within the Group
## TABLE 5

Strength Evaluation

**KNEE FLEXION (RIGHT)**

(Foot lbs.)

($\overline{x}$, + SD Median)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>57.6±12.1</td>
<td>61.7±19.1</td>
<td>7.1%</td>
</tr>
<tr>
<td>median (Swim)</td>
<td>63</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>69.1±20.1</td>
<td>72.3±16.8</td>
<td>4.6%</td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>75.5</td>
<td>77.25</td>
<td></td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)

** Significant Within the Group
TABLE 6

Strength Evaluation

KNEE FLEXION (LEFT)
(Foot lbs.)

(\(\bar{X}, + SD\) Median)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre ((\bar{X}, + SD))</th>
<th>Post ((\bar{X}, + SD))</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A **</td>
<td>61.8+14.5</td>
<td>68.3+19.9</td>
<td>10.57%</td>
</tr>
<tr>
<td>(Swim) median</td>
<td>66</td>
<td>69.5</td>
<td></td>
</tr>
<tr>
<td>Group B **</td>
<td>62.1+14.4</td>
<td>66.7+13.4</td>
<td>7.47%</td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>66</td>
<td>69.25</td>
<td></td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)
** Significant Within the Group
### TABLE 7

**Strength Evaluation**

**SHOULDER EXTENSION (RIGHT)**  
(Foot lbs.)  
(\(\bar{x}, + SD\) Median)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Swim)</td>
<td>44.2+10.2</td>
<td>53.5+14.5</td>
<td>21%</td>
</tr>
<tr>
<td>median</td>
<td>44.5</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Group B (Bike-Walk-Jog)</td>
<td>48.5+13.6</td>
<td>52.8+14.0</td>
<td>8.9%</td>
</tr>
<tr>
<td>median</td>
<td>49.25</td>
<td>58.5</td>
<td></td>
</tr>
</tbody>
</table>

* Significant to \((P \leq .10)\) Between Groups  
** Significant Within the Group
TABLE 8

Strength Evaluation

SHOULDER EXTENSION (LEFT)
(Foot lbs.)
($\bar{x}$, + SD Median)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Swim)</td>
<td>45.2+15.6</td>
<td>55.6+16</td>
<td>23%</td>
</tr>
<tr>
<td>Gladia median</td>
<td>38</td>
<td>53.5</td>
<td></td>
</tr>
<tr>
<td>Group B (Bike-Walk-Jcg)</td>
<td>46.6+14.2</td>
<td>48+16.3</td>
<td>3%</td>
</tr>
<tr>
<td>Gladia median</td>
<td>48</td>
<td>53.75</td>
<td></td>
</tr>
</tbody>
</table>

* Significant to ($P \leq .10$) Between Groups
** Significant Within the Group
<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Swim) median</td>
<td>43.7+10.1</td>
<td>43.8+12</td>
<td>.22%</td>
</tr>
<tr>
<td></td>
<td>47</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>43.5+12.5</td>
<td>44.6+7</td>
<td>2.5%</td>
</tr>
<tr>
<td>median</td>
<td>45.5</td>
<td>45.5</td>
<td></td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)

** Significant Within the Group
<table>
<thead>
<tr>
<th>Group A (Swim)</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>median</td>
<td>36.8+10.4</td>
<td>42.3+9.4</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>41.5</td>
<td>44.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group B (Bike-Walk-Jog)</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>median</td>
<td>41.3+12.5</td>
<td>43.1+8.3</td>
<td>4.4%</td>
</tr>
<tr>
<td></td>
<td>42.25</td>
<td>45.75</td>
<td></td>
</tr>
</tbody>
</table>

(NOT Significant Between Groups)

** Significant Within the Group
## TABLE 11

**Strength Evaluation**

**ELBOW EXTENSION (RIGHT)**

(Foot lbs.)

\( (\bar{x}, \pm SD \text{ Median}) \)

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td><strong>32.5+9.2</strong></td>
<td><strong>37.5+10.0</strong></td>
<td><strong>15.4%</strong></td>
</tr>
<tr>
<td>(Swim)</td>
<td>33.5</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td><strong>median</strong></td>
<td><strong>33.5</strong></td>
<td><strong>37</strong></td>
<td><strong>15.4%</strong></td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td><strong>34.4+5.8</strong></td>
<td><strong>33.1+11.7</strong></td>
<td><strong>-4.0%</strong></td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>median</strong></td>
<td><strong>34.75</strong></td>
<td><strong>32.75</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Significant to \((P \leq .10)\) Between Groups

** Significant Within the Group
TABLE 12
Strength Evaluation

ELBOW EXTENSION (LEFT)  
(Foot lb.)  
(\(\bar{x}, + SD Median\))

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>31.8+10.8</td>
<td>37.1+11.4</td>
<td>16.7%</td>
</tr>
<tr>
<td>(Swim) median</td>
<td>35</td>
<td>36.5</td>
<td>*</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>33.1+6.2</td>
<td>31.8+10.6</td>
<td>-4.0%</td>
</tr>
<tr>
<td>(Bike-Walk-Jog)</td>
<td>median</td>
<td>34</td>
<td>32.75</td>
</tr>
</tbody>
</table>

* Significant to (\(P \leq .10\)) Between Groups  
** Significant Within the Group
# TABLE 13

**Strength Evaluation**

**ELBOW FLEXION (RIGHT)**

(Foot lb.)

\[
(\bar{x}, \ + SD \hspace{1mm} Median)
\]

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>(% Increment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (Swim) **</td>
<td>31.5±10.7</td>
<td>36±10.3</td>
<td>14.3%</td>
</tr>
<tr>
<td>median</td>
<td>33.5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Group B (Bike-Walk-Jog)</td>
<td>33.1±9.5</td>
<td>35.9±3.6</td>
<td>8.5*</td>
</tr>
<tr>
<td>median</td>
<td>35.75</td>
<td>36.25</td>
<td></td>
</tr>
</tbody>
</table>

* Significant to \( (P < .10) \) Between Groups

** Significant Within the Group
TABLE 14

Strength Evaluation

ELBOW FLEXION (LEFT)  
(Foot lbs.)  
($\overline{x}$, * SD Median)

<table>
<thead>
<tr>
<th>Group A ** (Swim) median</th>
<th>Pre</th>
<th>Post</th>
<th>(%) Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30.6*10.0</td>
<td>35.3*12.6</td>
<td>15.4%</td>
</tr>
<tr>
<td></td>
<td>37.5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Group B (Bike-Walk-Jog) median</td>
<td>30.5*9.0</td>
<td>32.9*3.5</td>
<td>7.9%</td>
</tr>
<tr>
<td></td>
<td>34.75</td>
<td>33.75</td>
<td></td>
</tr>
</tbody>
</table>

* Significant to ($F \leq .10$) Between Groups  
** Significant Within the Group

Discussion

The purpose of this investigation was to examine changes in maximal oxygen consumption and strength of two groups of cardiac or high risk patients participating in a cardiac rehabilitation program. Group A consisted of five subjects who volunteered to use swimming as their major mode of exercise after participating in a bike-walk-jog program for at least one week. Group B consisted of four subjects who volunteered to exercise in the bike-walk-jog program. In both groups maximal oxygen consumption and two pretests for strength were administered prior to entrance into the
program. At the end of three months of exercise the tests were re-administered to all subjects.

Maximal oxygen consumption is the major criterion for advancing the cardiac patient into higher forms of physical activity in a rehabilitation program. Although the American College of Sports Medicine has standardized the oxygen consumption data obtained from treadmill tests, oxygen consumption norms in specific populations such as, myocardial infarct, bypass graft, or high risk patients, is not available. The oxygen consumption data of this study combined several specific subgroups in cardiac rehabilitation to give a total view of the population. As an example, one subject had an unusual congenital heart problem not normally seen and his data was combined with the other subjects.

The first hypothesis referred to the significant difference of pre and post maximal oxygen consumption. Based on an alpha of a non-parametric statistic equalling .056, there was no difference between the swim group (treatment) and the bike-walk-jog group (control). For the difference to be significant, the calculated alpha bar would have had to have been greater than (P -548). It can be concluded that one group was no better than the other in the improvement of oxygen consumption. The percent improvement in Max VO2 for the swim group was calculated at an
improvement of 23 percent, whereas the improvement in the bike-walk-jog was 22.5 percent. The means also show that Group B (bike-walk-jog) started at a higher Max VO2 level, so therefore, would not be expected to improve as much as Group A (swimming).

Strength measurements in an older population have not been found in existing literature let alone in a cardiac population. The isokinetic Cybex II Dynamometer has been used exclusively among the young athletic population. Discussion of the values found in this study must be viewed by comparing the treatment group with the control group and without comparison of outside literature.

Hypothesis two is stated as: There is no significant difference in pretest to posttest parameters of leg and arm strength in Group A and B as a result of a training program. The researcher anticipated finding a significant difference of leg strength, either extension or flexion or both, in the control group. Since their mode of exercise consisted of treadmill and bike ergometry work, the strength gains in the legs were only expected in that group. However, strength gains in the swimming group were found in knee extension with the strength gain on the left side. The means from pretest to posttest of the treatment group from 76 to 85 foot pounds showed that the gains were much more dramatic than in the pretest to posttest of the control group which showed no gains.
It was interesting to note that there was no significant improvement of knee flexion strength in either group. One might have expected it due to the increase in means, however, the alpha level was very high, so therefore insignificant (refer to Summary Table).

Most of the upper body strength measurements showed a significant increase in strength except for shoulder flexion. The areas of improvement were shoulder extension, elbow extension and flexion, with elbow extension being the most dramatic improvement in the treatment group. Because the elementary back stroke position was used for the swim training, the specificity of the muscles used draw a vivid conclusion as to muscle to stroke relationship.

In the elementary backstroke, the arms are swept down to the side with the arm held straight at the elbow by the elbow extensor muscles. The movement at the shoulder joint is adduction. This is accomplished primarily by the adductors, the latissimus dorsi and the teres major, which are the same muscles which are important in shoulder extension. Thus, one would expect strength gains in the movements of shoulder extension and elbow extension.
Rhythm Monitoring

Subjects' heart rhythms and rates were monitored during all exercise sessions. The bike-walk-jog (control) subjects' rhythms were monitored at rest and continuously during exercise and recovery. The medical monitor used a telemetry system to observe heart rate and rhythms in the control group. Subjects' heart rate and rhythms in the treatment group (swimming) were monitored by using the quick look paddle made from a defibrillator. Their rhythms were recorded during rest and at 10 minute intervals during exercise, and during recovery.

Subject number two (see Table 17) entered the swimming program after first participating in the bike-walk-jog program. Premature ventricular contractions (PVC's) were reported in the bike-walk-jog and swimming programs. However, at the end of three weeks the PVC's subsided and occurred occasionally on days when the patient perceived fatigue prior to exercise.

Subject number one's initial record (see Table 17) was similar to that of subject number two. However, PVC's were more frequent. The subject's daily recordings of PVC's and PAC's were seen while in both bike-walk-jog and swim programs. Again, as in the first example, arrhythmias subsided during exercise in the swim program but took several more weeks of training before closing.
In order to effectively evaluate intermittent monitoring as a means to detect arrhythmias, a systematic procedure which holds all variables constant (e.g., intensity and duration of exercise, recording procedures, etc.) must be used for both the continuous as well as the intermittent monitoring procedure. In this study, variables of concern and recording procedures during the two modes of exercise were not held constant, as such, a comparison of the two methods is not appropriate.

**Future Direction**

Based on these conclusions improving upper body strength in a traditional cardiac rehabilitation program should be done with aggressive strength modalities. Although most bike-walk-jog programs use the upper body equipment, its use is sporadic and without proper and consistent training. It was apparent through the use of the Sign Test that there were strength increases in the legs due to a bike-walk-jog program, within a traditional cardiac rehabilitation program. Increases in Max VC2 should also be expected.

Strength research in older specific populations must be undertaken to develop normal values. People are living longer than ever before and will continue to be active. If loss of strength is going to interfere with the wishes of an
individual to jog, swim, or bike or partake in any activity then the challenge to change and improve exercise modes should be met by exercise physiologists. As an applied field of science, exercise physiology will have an impact on the lives of individuals within specific populations.

From the rhythm monitoring systems used in the bike-walk-jog and swimming programs, continuous versus intermittent, future investigation is suggested. It may be of interest to compare continuous telemetry monitoring with intermittent monitoring of subjects' rhythms if methods and procedures which can be held constant are the same.
CHAPTER V

CONCLUSIONS AND SUMMARY

The purpose of the study was to evaluate and compare oxygen consumption changes and strength changes in two forms of cardiac rehabilitation programs. The control group consisted of subjects in a bike-walk-jog cardiac rehabilitation program. The treatment group consisted of subjects who had first participated in the bike-walk-jog program for at least one week and then had the option of participating in a swimming cardiac rehabilitation program.

All subjects were at least two months post myocardial infarction or bypass surgery and had to be referred into the Ohio State University’s Cardiac Rehabilitation Program by their physician. All subjects were administered a maximal oxygen consumption graded exercise test on a treadmill using the Balke (special) Protocol.

The strength test consisted of isokinetic testing of the right and left knee, shoulder, and elbow joints in extension and flexion motions, at 90 degrees per second.
Testing was done with a Cybex II isokinetic dynamometer. After oxygen consumption and two strength pretests, the participants engaged in one of the two cardiac rehabilitation programs.

Training consisted of three months of exercise, three times a week. The control group exercised on motor driven treadmills for 20 to 45 minutes. The exercise prescription heart rates were determined at 60-70 percent of the maximal oxygen consumption.

Medical supervision was provided by coronary care nurses from the Ohio State University Hospital. The nurses monitored electrocardiograms during strength testing, graded exercise treadmill testing, and all exercise sessions.

In the bike-walk-jog program electrocardiograms were recorded via a telemetry system. The swimming group recorded electrocardiograms via defibrillator paddles on the Life Pack Seven Defibrillator.

At the end of three months both groups were administered both the oxygen consumption tests and strength tests.

The Wilcoxon Sum Rank statistic was used to analyze statistical significance at the (P < .10) level for between groups.
Table 15 summarizes those strength measures which were significant to the \((P \leq .10)\) level. The alpha bar levels were then computed to show the actual alpha. The Sign Test was then used to compute statistical significance at \((P \leq .10)\) level for within groups. Table 16 summarizes oxygen consumption and strength measures which were significant at \((P \leq .10)\) level.

**TABLE 15**

*Significant Strength Measures*

<table>
<thead>
<tr>
<th></th>
<th>(P)</th>
<th>(L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Extension</td>
<td>.143</td>
<td>* .032</td>
</tr>
<tr>
<td>Knee Flexion</td>
<td>&gt; .548</td>
<td>&gt; .548</td>
</tr>
<tr>
<td>Shoulder Extension</td>
<td>* .095</td>
<td>* .056</td>
</tr>
<tr>
<td>Shoulder Flexion</td>
<td>&gt; .548</td>
<td>&gt; .548</td>
</tr>
<tr>
<td>Elbow Extension</td>
<td>* .056</td>
<td>* .016</td>
</tr>
<tr>
<td>Elbow Flexion</td>
<td>* .100</td>
<td>* .095</td>
</tr>
</tbody>
</table>

* = significant to \((P \leq .10)\)
### TABLE 16

**Final Results**

Calculated Alpha Levels Within Groups

<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Swim)</td>
<td>(B-W-J)</td>
</tr>
<tr>
<td>Max VO2</td>
<td>* .0312</td>
<td>* .0625</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Extension</td>
<td>* .0312</td>
<td>* .0312</td>
</tr>
<tr>
<td>Knee Flexion</td>
<td>.8124</td>
<td>* .0312</td>
</tr>
<tr>
<td>Shoulder Extension</td>
<td>.1874</td>
<td>* .0312</td>
</tr>
<tr>
<td>Shoulder Flexion</td>
<td>.8124</td>
<td>.1874</td>
</tr>
<tr>
<td>Elbow Extension</td>
<td>* .0312</td>
<td>* .0312</td>
</tr>
<tr>
<td>Elbow Flexion</td>
<td>* .0312</td>
<td>* .0312</td>
</tr>
</tbody>
</table>

* = significant to \((P < .10)\)

* = significant strength improvement in swim group versus control group.

The following conclusions can be made from this study based on a \(N\) of 5 for treatment (swimming) and an \(N\) of 4 for control (bike-walk-jog) after nine months of data collected at The Ohio State University:

1. Although the mean percent increase of maximal oxygen consumption was 23% for swimming and 22.5% for bike-walk-jog neither program was
statistically better than the other. Improvement of oxygen consumption either in swimming or bike-walk-jog was the same, so therefore, both were very effective in increasing this parameter. Both groups, swimming and bike-walk-jog changed significantly in maximal oxygen consumption.

2. The swimming group had an unexpected significant increase in knee extension strength on the left side. The control group had no such increase. The use of the intermediate frog kick could in part explain this.

3. The swim group, in knee extension for right and left sides, also gained significantly. This illustrates that swimming can increase knee extension strength in cardiac patients.

4. Knee flexion within groups was significant on the left side in the swimming group and on both sides in the control group.

5. The control group had a significantly greater increase in knee flexion strength on both sides. The swimming group gained in knee flexion strength on one side only.

6. Shoulder extension strength gains were better for both groups on the left side of the body.
7. Neither group changed significantly in shoulder flexion.

8. Elbow extension strength in the swimming group, on both right and left sides increased significantly.

9. Elbow extension on the left side showed the highest area of strength improvement. The treatment group gained significantly more than the control group. It can be concluded that the upper body, due to the swimming treatment, had the highest strength improvement over all.

10. Elbow flexion strength changed significantly in the swimming group but not in the bike-walk-jog program.

It may be concluded that swimming was an effective exercise mode. The increases in upper body strength may help with daily living tasks. It is interesting to note that the control group had no such changes in upper body strength. Although, both groups had significant strength gain in some leg strength parameters.
Appendix A

RAW DATA
<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Classification</th>
<th>Sex</th>
<th>Age</th>
<th>Weight Kg</th>
<th>Height cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tetrology Fallot</td>
<td>M</td>
<td>47</td>
<td>68.2</td>
<td>170</td>
</tr>
<tr>
<td>2</td>
<td>MI,CABGx3</td>
<td>F</td>
<td>52</td>
<td>53</td>
<td>163</td>
</tr>
<tr>
<td>3</td>
<td>MI</td>
<td>M</td>
<td>44</td>
<td>77.3</td>
<td>180</td>
</tr>
<tr>
<td>4</td>
<td>CA Dis (2x25-75%)</td>
<td>M</td>
<td>62</td>
<td>75</td>
<td>170</td>
</tr>
<tr>
<td>5</td>
<td>MI,CABGx4</td>
<td>M</td>
<td>64</td>
<td>85.9</td>
<td>185</td>
</tr>
</tbody>
</table>

N = 5
4 male
1 female
### TABLE 18

**Characteristics of Controls**

<table>
<thead>
<tr>
<th>Control Classification</th>
<th>Sex</th>
<th>Age</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>diastolic dysfunction</td>
<td>M</td>
<td>67</td>
<td>77.3</td>
<td>175</td>
</tr>
<tr>
<td>arrhythmias</td>
<td>F</td>
<td>59</td>
<td>48.6</td>
<td>163</td>
</tr>
<tr>
<td>CABGx2</td>
<td>M</td>
<td>55</td>
<td>75</td>
<td>178</td>
</tr>
<tr>
<td>CABGx4</td>
<td>M</td>
<td>59</td>
<td>66.4</td>
<td>173</td>
</tr>
</tbody>
</table>

N = 4
3 male
1 female

---

### TABLE 19

**Raw Data, VO2 Treadmill...Subjects**

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Pre Study</th>
<th>Post Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/Kg/min</td>
<td>L.02 Kg</td>
</tr>
<tr>
<td>1</td>
<td>23.6</td>
<td>1.61</td>
</tr>
<tr>
<td>2</td>
<td>20.5</td>
<td>1.17</td>
</tr>
<tr>
<td>3</td>
<td>31.4</td>
<td>2.43</td>
</tr>
<tr>
<td>4</td>
<td>28.1</td>
<td>2.11</td>
</tr>
<tr>
<td>5</td>
<td>18.3</td>
<td>1.57</td>
</tr>
</tbody>
</table>

Total \( \sum \ 23 \)
### TABLE 20

Raw Data, VO2 Treadmill...Controls

<table>
<thead>
<tr>
<th>Controls</th>
<th>Pre Study</th>
<th>Post Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/Kg/min L.O2</td>
<td>Kg</td>
</tr>
<tr>
<td>6</td>
<td>25.4</td>
<td>1.08</td>
</tr>
<tr>
<td>7</td>
<td>27.7</td>
<td>2.39</td>
</tr>
<tr>
<td>8</td>
<td>28.6</td>
<td>2.09</td>
</tr>
<tr>
<td>9</td>
<td>42.5</td>
<td>2.82</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22.5</strong></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 21

Raw Data: Cybex, Knee Extension...Subjects

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Right Leg Pre Test</th>
<th>Right Leg Post Test</th>
<th>Left Leg Pre Test</th>
<th>Left Leg Post Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86</td>
<td>87.5</td>
<td>85.5</td>
<td>88.5</td>
</tr>
<tr>
<td>2</td>
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<td>65</td>
<td>55</td>
<td>64.5</td>
</tr>
<tr>
<td>3</td>
<td>58</td>
<td>60</td>
<td>39</td>
<td>56</td>
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<td>113</td>
<td>118</td>
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</tr>
<tr>
<td>5</td>
<td>108</td>
<td>115</td>
<td>104</td>
<td>111</td>
</tr>
</tbody>
</table>
### TABLE 22

**Raw Data: Cybex, Knee Extension...Controls**

<table>
<thead>
<tr>
<th>Controls</th>
<th>Right Leg</th>
<th>Left Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
</tr>
<tr>
<td>6</td>
<td>98</td>
<td>104</td>
</tr>
<tr>
<td>7</td>
<td>67.5</td>
<td>66</td>
</tr>
<tr>
<td>8</td>
<td>126.5</td>
<td>130.5</td>
</tr>
<tr>
<td>9</td>
<td>108</td>
<td>105.5</td>
</tr>
</tbody>
</table>

### TABLE 23

**Raw Data: Cybex, Knee Flexion...Subjects**

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Right Leg</th>
<th>Left Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
</tr>
<tr>
<td>1</td>
<td>68</td>
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<tr>
<td>2</td>
<td>38</td>
<td>34.5</td>
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<td>63</td>
<td>66.5</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>86.5</td>
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</tbody>
</table>
### TABLE 24

**Raw Data: Cybex, Knee Flexion...Controls**

<table>
<thead>
<tr>
<th>Controls</th>
<th>Right Leg</th>
<th></th>
<th>Left Leg</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
<td>Pre Test</td>
<td>Post Test</td>
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<td>78.5</td>
<td>78.5</td>
<td>67</td>
<td>70</td>
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</table>

### TABLE 25

**Raw Data: Cybex, Shoulder Extension...Subjects**

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Right Shoulder</th>
<th></th>
<th>Left Shoulder</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
<td>Pre Test</td>
<td>Post Test</td>
</tr>
<tr>
<td>1</td>
<td>44.5</td>
<td>55</td>
<td>35.5</td>
<td>50.5</td>
</tr>
<tr>
<td>2</td>
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<td>30.5</td>
<td>29</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
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<td>66</td>
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<td>4</td>
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</tr>
<tr>
<td>5</td>
<td>51.5</td>
<td>63</td>
<td>64.5</td>
<td>75</td>
</tr>
</tbody>
</table>
### TABLE 26

Raw Data: Cybex, Shoulder Extension...Controls

<table>
<thead>
<tr>
<th>Controls</th>
<th>Pre Test</th>
<th>Post Test</th>
<th>Pre Test</th>
<th>Post Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>64</td>
<td>62</td>
<td>62</td>
<td>60.5</td>
</tr>
<tr>
<td>7</td>
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</tr>
<tr>
<td>9</td>
<td>46</td>
<td>56.5</td>
<td>44</td>
<td>55</td>
</tr>
</tbody>
</table>

### TABLE 27

Raw Data: Cybex, Shoulder Flexion... Subjects

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Pre Test</th>
<th>Post Test</th>
<th>Pre Test</th>
<th>Post Test</th>
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<tbody>
<tr>
<td>1</td>
<td>49.5</td>
<td>53.5</td>
<td>27.5</td>
<td>44</td>
</tr>
<tr>
<td>2</td>
<td>26.5</td>
<td>24.5</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
<td>50</td>
<td>43</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>47</td>
<td>40</td>
<td>48</td>
<td>44.5</td>
</tr>
<tr>
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<td>43.5</td>
<td>51</td>
<td>41.5</td>
<td>47</td>
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</tbody>
</table>
**TABLE 28**

**Raw Data: Cybex, Shoulder Flexion...Controls**

<table>
<thead>
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<th>Controls</th>
<th>Right Shoulder</th>
<th>Left Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
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<tr>
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<td>47</td>
<td>49</td>
</tr>
<tr>
<td>9</td>
<td>56.5</td>
<td>51.5</td>
</tr>
</tbody>
</table>

**TABLE 29**

**Raw Data: Cybex, Elbow Extension...Subjects**

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Right Elbow</th>
<th>Left Elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
</tr>
<tr>
<td>1</td>
<td>30.5</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
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<td>40.5</td>
</tr>
<tr>
<td>5</td>
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<td>51</td>
</tr>
</tbody>
</table>
### TABLE 30

**Raw Data: Cybex, Elbow Extension...Controls**

<table>
<thead>
<tr>
<th>Controls</th>
<th>Right Elbow</th>
<th>Left Elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td>37.5</td>
</tr>
<tr>
<td>7</td>
<td>27</td>
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<td>41</td>
<td>47</td>
</tr>
<tr>
<td>9</td>
<td>35.5</td>
<td>28</td>
</tr>
</tbody>
</table>

### TABLE 31

**Raw Data: Cybex, Elbow Flexion...Subjects**

<table>
<thead>
<tr>
<th>Swimmers</th>
<th>Right Elbow</th>
<th>Left Elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Test</td>
<td>Post Test</td>
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<tr>
<td>1</td>
<td>30</td>
<td>37</td>
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<tr>
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<td>33.5</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>39</td>
<td>43</td>
</tr>
<tr>
<td>Controls</td>
<td>Right Elbow Pre Test</td>
<td>Right Elbow Post Test</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>6</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>7</td>
<td>19.5</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>41.5</td>
<td>38</td>
</tr>
<tr>
<td>9</td>
<td>34.5</td>
<td>35.5</td>
</tr>
</tbody>
</table>

**TABLE 32**

Raw Data: Cybex, Elbow Flexion...Controls
Appendix B

REFERRING PHYSICIAN FORMS
Dear Dr.

Your patient, __________, is interested in enrolling in the Cardiac Rehabilitation Program at The Ohio State University. This program is designed for those patients recovering from myocardial infarction, cardiovascular surgery, stable arrhythmias, those with an abnormal exercise test and/or are at high risk for coronary artery disease.

Your referral, and the information requested, is essential before we begin your patient in this program. Please complete the enclosed REFERRAL FORM and return it to this office at your earliest convenience.

I sincerely hope that you will view this service to the community as a worthwhile addition to patient care. If I or our medical director, Stephen Schaal, M.D. can be of any assistance in answering your questions concerning this program, please do not hesitate to call.

Sincerely,

Timothy E. Kirby, Ph.D.
Program Director
Cardiac Rehabilitation
(614) 422-5180

Enclosures
The Ohio State University Cardiac Rehabilitation Program offers a medically supervised exercise program to the general public. All applicants must be referred by their primary physician. Our Medical Director screens all applicants for the appropriate exercise program depending upon their medical history and results of physical examination performed by the referring physician.

I am referring this patient for the following medically supervised exercise program:

( ) EKG monitored
  open to: S/P MI, CAB, high risk, stable arrhythmias

( ) Non-EKG monitored
  open to: graduates of the above and high risk patients

PATIENT NAME ________________________________ AGE______HT_____WT-----
ADDRESS: ____________________________________
  ZIP .
PHONE: (home)____________________ (work)____________________

Date of last physical examination____________________

Thyroid abnormal? yes no Please indicate risk factors and values.
Chest auscultation abnormal? yes no ( ) hypertension ________
Murmurs present? yes no ( ) cholesterol_______
Peripheral pulse absent? yes no ( ) triglycerides_______
Gallop, abnormal heart sounds? yes no ( ) diabetes________
Abnormal masses? yes no ( ) smoker__________
Back problems? yes no ( ) family hx_________
Any joints abnormal? yes no ( ) inactive__________
  ( ) overweight_________
MEDICAL HISTORY: (please include a copy of test results if possible)

M.I. (date/type)______________________________________________

Cardiac Surgery (date/type)____________________________________

Arrhythmias (type)____________________________________________

CATH (date/results)____________________________________________

Nuclear Studies (date/results)____________________________________

Additional abnormalities:_______________________________________

MEDICATIONS:________________________________________________

___________________________________________________________

EXERCISE TESTS: A symptom limited exercise stress test will be
conducted in order that an accurate exercise prescription can be
made. Please include a copy of any exercise stress test conducted
within the past year.

SUMMARY IMPRESSION OF PHYSICIAN: (Any comments you wish to make
concerning your patient).

___________________________________________________________

I have examined the above patient who, to the best of my knowledge,
is free from infectious disease and is capable of participating in an
exercise program as well as periodic laboratory evaluations, under
the guidance of a trained staff and direction of a physician.

PHYSICIAN'S SIGNATURE _____________________________________________

PHYSICIAN'S NAME (print) ___________________________________________

ADDRESS________________________________________________________

Return to:
Cardiac Rehabilitation
337 West 17th Ave.
Columbus, Ohio 43210
Appendix C

PATIENT AND TESTING FORMS
THE OHIO STATE UNIVERSITY
CARDIAC REHABILITATION DEPARTMENT
HEALTH HISTORY

Date___________________ Personal Physician_____________________

I. GENERAL INFORMATION:

Name___________________ Age________ Date of Birth________ Ht. ______ Wt. ______

Local Address________________________ ___________ Zip____________________

Phone (Home)__________________ (Office)_________________ Social Security #________

Occupation________________________ Employer_____________________

Marital Status____________________ Education (highest level completed)_____________________

Spouse's Name________________________ Age________ Occupation_____________________

No. of Children____________ Ages________________ Religious Preference_____________________

IN CASE OF EMERGENCY, CONTACT: Name________________________ Phone_____________________

Health Insurance Carrier________________________ Policy #_____________________

II. MEDICAL SURGICAL HISTORY: Check (X) if answer is YES:

A. Have YOU ever had: Have any of your RELATIVES had: Have YOU recently had:

( ) Rheumatic Heart Disease ( ) Heart Attacks ( ) Irregular heart beat
( ) Heart murmur ( ) High Blood Pressure ( ) Chest pressure
( ) High Blood Pressure ( ) High Blood Fat ( ) Shortness of breath
( ) Gout ( ) Diabetes ( ) Heart Flushing
( ) Varicose Veins ( ) Obesity ( ) Cough on exertion
( ) Lung Disease ( ) Stroke
( ) Injuries to back, etc. ( ) Stroke
( ) Epilepsy ( ) Back pain
( ) Diabetes ( ) Swollen, stiff or painful joints
( ) Heart Attack ( ) Difficulty sleeping
( ) Heart Surgery ( ) Fatigue
( ) Kidney Disease ( ) Calf pain w/exercise
( ) Stomach Ulcers ( ) Nervousness
( ) Arthritis ( ) Fainting
( ) Hospitalizations ( ) Swollen ankles, legs
( ) Cardiac Catheterization ( ) Other problems
( ) Strokes
( ) Thyroid problems
( ) Dizziness or Fainting spells
( ) Nervous or Emotional problems
( ) Allergies
( ) Phlebitis
( ) Cardiac arrest
III. MEDICATIONS:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Frequency/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IV. CORONARY RISK FACTOR ANALYSIS:

Check if answer Yes

( ) Present Smoker: ( ) Cigarettes, ( ) Cigar, ( ) Pipe. Packs per day________

( ) Past Smoker: When Quit?______________ How?______________

( ) Overweight: # lbs+______________

( ) High Blood Pressure: ( ) on medication ( ) Diet controlled

( ) Diabetes: ( ) on medication ( ) Diet controlled

( ) High Cholesterol

( ) High Triglycerides

( ) No regular exercise program (at least 20 min., 3 x a week)

( ) Stressful lifestyle or job

( ) Family History of Heart Attacks (under 50)

( ) Family History of Strokes (under 50)

V. NUTRITION

( ) Are you on a special diet? Type_____________________________________________

( ) Are you adhering to this diet?

( ) Would you like more information about your diet? recipes? menus?

( ) Do you overeat?

( ) Do you snack frequently?

Cups/ Glasses Per Day: Coffee_____Wine _____Beer_____Alcohol_____

Body Build: Slender_____Medium______Heavy_______Obese_____

Who does most cooking at home? ____________Where are most meals eaten?_____________

VI. PHYSICAL FITNESS: How often do you engage in VIGOROUS activities for 20 minutes or more?

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NEVER</th>
<th>VERY</th>
<th>1 - 2 TIMES/WK.</th>
<th>3 - 6 TIMES/WK.</th>
<th>EVERY DAY</th>
</tr>
</thead>
<tbody>
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Interviewer
Borg's perceived exertion scale

PERCEIVED EXERTION

6
7 Very, very light
8
9 Very light
10
11 Fairly light
12
13 Somewhat hard
14
15 Hard
16
17 Very hard
18
19 Very, very hard
20
**BALKE (STANDARD) TREADMILL TEST**

1. **Preliminary Data**
   - Subject ____________________________
   - Resting Heart Rate ______
   - Age ______
   - Resting Blood Pressure ______
   - Test Administrator(s) ____________

**II Graded Exercise Test**

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<th>GRADE</th>
<th>DURATION (minutes)</th>
<th>VO₂ ml/kg/min</th>
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Recovery  2 minutes  walking 1.7mph/0% Grade  ______  ______  ______  ______  ______  ______  ______
4 minutes  sitting  ______  ______  ______  ______  ______  ______  ______
6 minutes  sitting  ______  ______  ______  ______  ______  ______  ______
8 minutes  sitting  ______  ______  ______  ______  ______  ______  ______

**Comments**

GRADED EXERCISE TEST PROGRESS REPORT
FOR

---------------------------
TESTING DATES: --------------- ---------------

RESTING: HEART RATE ___________ BLOOD PRESSURE ___________

-------------------
WEIGHT ___________ FAT % ___________ LEAN BODY WEIGHT ___________

-------------------
GXT PROTOCOL ___________ MAX VO2 ___________ METS ___________

-------------------
MAX BLOOD PRESSURE ___________ MAX HEART RATE ___________

-------------------
OXYGEN UPTAKE (VO2) AND HEART RATE RESPONSE TO GXT

-------------------
OXYGEN UPTAKE GRAPH

-------------------
TREADMILL TEST TIME GRAPH

-------------------
% CHANGE IN WORKING CAPACITY

NEW TRAINING RANGE IN METS ___________ ___________

TRAINING HEART RANGE ___________ ___________
Appendix D

CYBEX TESTING FORMS
Dear Mr.,

Enclosed is an explanation of your results evaluating muscle strength at the knee, shoulder, and elbow joints. Two tests were administered to you because it was found that the strength results were not reliable if tested only once. The right column will be the reference point on which I will focus; it is the average of your tests.

Key:  "R" = right side  extensors = part or limb
      "L" = left side that goes out away from the body.
      % = percent side which is weaker flexion = Towards body

Body weight _______ lbs.

Cybex II Evaluation/Peak Torque (ft-lb)

<table>
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<th>Pretest II 90 DEG/SEC</th>
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<td>Elbow Extension</td>
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<tr>
<td>Elbow Flexion</td>
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</table>

INTERPRETATION:

1. Your knee extensor muscles are weaker by % on the "" side. Your legs are producing strength of % of body weight. College age males achieve 90% and females achieve an average of 75%.

2. Your knee flexors (hamstrings) are % weaker on the "" side. Your legs are producing strength of % of body weight. College age males achieve 58% and females achieve an average of 48%.
Conclusion: Your extensors and flexors are

3. Your shoulder extensors are \% weaker on the "L" side.
4. Your shoulder flexors are \% weaker on the "R" side.

Conclusion: Your extensors and flexors are

5. Your elbow extensors are \% weaker on the "L" side.
6. Your elbow flexors are \% weaker on the "R" side.

Conclusion: Your elbow extensors and flexors are

As a general rule a difference of 10\% or more between the "L" and "R" sides is considered to be too big of a strength difference. Improvements on the weaker side above 10\% are recommended.
Appendix E

CONSENT FORM
Treadmill

CONSENT TO SPECIAL TREATMENT OR PROCEDURE

1. I hereby authorize or direct ________________________ or associates of his or her choosing, to perform the following treatment or procedure and such additional services as they may deem reasonably necessary in their best endeavors to achieve the stated objective.

Maximal Treadmill Test, with oxygen consumption collection including a 12 lead electrocardiogram for continuous monitoring, and strength testing on the Cybex.

The experimental research portion of the treatment or procedure is: Measurement of oxygen consumption during the test and to record the highest heart rate that can be attained, and peak strength on the Cybex.

This is done as part of an investigation entitled Exercise Training For Cardiac Rehabilitation Using Conventional Swimming Techniques And With The Use Of The Mask Snorkle And Fins.

1. Purpose of the procedure or treatment: To evaluate the patient's fitness as part of entrance requirements into the Ohio State Cardiac Rehabilitation Program. Maximal heart rates and oxygen consumption are used to prescribe appropriate exercise intensity for exercise rehabilitation.

2. Possible appropriate alternative methods of treatment: ____________________________ and strength testing on the Cybex (if not to participate in this study).

3. Discomforts and risks reasonably to be expected: Local muscular fatigue, general short-term exertional fatigue, possible soreness, exertional shortness of breath. Though the risk of heart attack is very low, it is possible but such cases are very rare as is the risk of death. Personnel trained in emergency procedures and emergency drugs will be immediately available, to minimize any possible risks to the patient. Other possibilities are: slow or fast heart rates, chest pain, fatigue, heart attack, death.

4. Possible benefits for subjects: (see above) It will be demonstrated that the patient through the exercise training will increase fitness levels. It is also common to see that exercise helps attain well being, self worth with 12 weeks of training scheduled between testing.

5. Anticipated duration of subject's participation: Two days or pre and post testing.

I hereby acknowledge that ________________________ has provided information about the procedure described above, about my rights as a subject, and he/she answered all questions to my satisfaction. I understand that I may contact whoever should I have additional questions. He/she has explained the risks described above and I understand them; he/she has also offered to explain all possible risks or complications.

I understand that the information obtained from me, or from the person I am authorized to represent, will remain confidential unless I specifically agree otherwise by placing my initials here ________________________ . I understand that, where appropriate, the U.S. Food and Drug Administration may inspect records of this research project.

I understand that I am free to withdraw my consent and participate in this project at any time after notifying the project director without prejudice to future care. No guarantee has been given to me concerning this treatment or procedure.

In the unlikely event of physical injury resulting from participation in this study, I understand that immediate medical treatment is available at University Hospital of The Ohio State University. Questions about this should be directed to the person named above. I also understand that the costs of such treatment will be at my expense and that financial compensation is not available.

I have read and fully understood the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ________________________ Time: ________ Signed ________________________ (Subject)

Witneses (s) ________________________ (Person Authorized to Consent for Subject - If Required)

Certify that I have personally completed all blanks in the consent form and explained them to the subject or his/her representative before requesting the subject or his/her representative to sign it.

Signed: ________________________ (Signature of Project Director or his/her Authorized Representative)

Form 55-0126 (Rev. 12/1981)
Appendix F

SWIMMING REPORT FORMS
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Interpretation of GXT
THE OHIO STATE UNIVERSITY
SCHOOL OF HEALTH PHYSICAL EDUCATION AND RECREATION
LABORATORY OF WORK PHYSIOLOGY
CARDIAC REHABILITATION

DEAR DR.

BELOW IS A SUMMARY OF PROGRESS FOR YOUR PATIENT ____________:
THIS SUMMARIZES EVENTS FOR THE MONTH OF ________________:

ATTENDANCE FOR THE MONTH HAS BEEN ___ SESSlONS OUT OF A POSSIBLE
_____ WHICH REPRESENTS _____ PERCENT.

THE PRESENT EXERCISE BEING ACCOMPLISHED in THE Therapeutic Pool
IS, on the average ____ laps in the 30 foot pool for an average time
of ____ minutes.

THE HEART RATE DURING EXERCISE AVERAGES _____.

WEIGHT AT THE END OF THE MONTH WAS ________.

COMMENTS CONCERNING THE PARTICIPATION OF YOUR PATIENT ARE NOTED
BELOW BY THE MEDICAL MONITOR OF HIS/HER EXERCISE SESSION.

---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------

IF YOU HAVE ANY QUESTIONS OR CONCERNS PLEASE CALL.

TIM KIRBY, PH.D.
PROGRAM DIRECTOR
422-5130
Appendix G

EMERGENCY PROCEDURES AND SUPPLIES
Personnel at the Pool and Qualifications

Recommendations

1. Two exercise leaders certified by ACSM with a minimum certification of Test Technologist and with additional certification in Advanced Life Support. The added certification covers the areas of defibrillation, aspiration, CPR, emergency drug therapy, EKG's, and care of the unconscious patient.

2. One life guard with WSI and CPR training. Major responsibilities being attentive visualance of patient to the shallow end of pool for evacuation.

3. Licensed CCU Nurse, certified to handle coronary emergencies with past experience in CCU's.

The Emergency Defibrillation Procedures in a Pool Environment

The EDPE System

An emergency situation exists with the recognition of some of the following signs: the patient pressing a hand against the chest or left arm, visual signs of total loss of consciousness and face in the water without movement; immediate appropriate action is necessary.
1. One Exercise Leader "EI" to call a pre-arranged paramedic unit. A unit whose response time to a call is adequate based on drill times, and is accustomed to responding to cardiac emergencies on a daily basis. Once the call has been made the EL enters the pool to assist.

2. The life guard enters the pool to carry the patient to the nearest shallow area as fast as possible.

3. One Exercise Leader to enter the pool with the full wooden back board and to approach the patient. The Life Guard and the Exercise Leaders position the board slipping it under the patient.
4. As the patient is floated to the side of the pool, the EL's lift the board head first. The board is then pushed onto the walking surface as the foot end of the board is swung around.

5. One EL proceeds to the head of the board as the other people then exit the pool and proceed to the leg end of the board.

6. The patient is lifted and carried to the DRY BOX area.

---

Fiber Glass

Dry Area

Safety Platform for Personnel

Substitution (thick rubber pad)
7. The DRY BOX is equipped with the following:
   a. An elevated platform so excess water can more effectively disperse for the safety of the staff during defibrillation,
   b. A totally isolated large rectangular box where water drips to a sealed area below isolating the patient from the staff and the patient from the pooled water,
   c. A small raised platform for the defibrillator to sit on for more advantageous viewing of EKG's,
   d. A defibrillator with patient cable (for transporting patient and long term viewing), gel, and electrodes (Silver, Silver Chloride),
   e. A towel to dry the chest of the patient and the upper torso of the staff attending the patient so that water does not drip onto the patient,
   f. Oxygen with mask,
   g. Ambu ventilator.
Drug Inventory at Site

1 - Tourniquet, elastic
1 - 20 gauge 1 and one quarter inch angiocath (green)
1 - Travenol minidrip solution administration set 2C002 60 dps
1 - Travenol extension set 2-Y injection 2C0053
1 - Roll one half inch tape
3 - 50 ml sodium bicarbonate injection 18 gauge one and one half inch long
1 - 10% Calcium Chloride inject. 21 gauge, one and one half inch long
1 - 3 way stopcock
1 - 10 ml Atropine Sulfate (purple) NDC 0074-4911-01
1 - Lidocaine packet
2 - Epinephrine injection USP 1:10,000
4 - Alcohol prep packets
1 - Deseret E-Z set infusions 19 gauge
1 - Bag of 5% dextrose in water
1 - Arm board
1 - Angiocath needle 18 gauge

8. Basic CPR procedures are initiated immediately. If a pulse is not present, compressions should start.
9. Nurse applies quick look paddles to the patient's chest to monitor EKG and to interpret the EKG.

10. If Ventricular Fibrillation is present Defibrillation should be administered as soon as possible. Refer to text for AHA recommendation.
Appendix H

CONTRAINDICATIONS FOR EXERCISE TESTING
Contraindications for Exercise Testing

1. Contraindications
   a. Acute myocardial infarction
   b. Unstable or at-rest angina pectoris
   c. Dangerous arrhythmias (ventricular tachycardia or any rhythm significantly compromising cardiac function)
   d. History suggesting excessive medication effects (digitalis, diuretics, psychotropic agents)
   e. Manifest circulatory insufficiency (congestive heart failure)
   f. Severe aortic stenosis
   g. Severe left ventricular outflow trace obstructive disease (IHSS)
   h. Suspected or known dissecting aneurysm
   i. Active or suspected myocarditis or cardiomyopathy (within the past year)
   j. Thrombophlebitis - known or suspected
   k. Recent embolism, systemic or pulmonary
   l. Recent or active infectious episodes (including upper respiratory infections)
   m. High dose of phenothiazine agents

2. Relative Contraindications*
a. Uncontrolled or high-rate supraventricular arrhythmias
b. Repetitive or frequent ventricular activity
c. Untreated severe systemic or pulmonary hypertension
d. Ventricular aneurysm
e. Moderate aortic stenosis
f. Severe myocardial obstructive syndromes
   (subvalvular, muscular or membranous obstructions)
g. Marked cardiac enlargement
h. Uncontrolled metabolic disease (diabetes, thyrotoxicosis, myxedema)
i. Toxemia or complications of pregnancy

3. Conditions Requiring Special Consideration and/or Precautions

a. Conduction disturbances
   1) Complete atrioventricular block
   2) Left bundle branch block
   3) Wolff-Parkinson-White anomaly or syndrome
   4) Lown-Ganong-Levine syndrome
   5) Bifascicular block (with or without first degree block)
Emergency Equipment and Drugs

1. Defibrillator - monitor with ECG electrodes - defibrillator paddles or portable DC defibrillator and portable ECG monitor

2. Airways - nasopharyngeal and oral (endotracheal)

3. Face mask and Robert Shaw valve

4. Oxygen

5. Suction apparatus

6. Syringes and needles

7. Intravenous sets

8. Intravenous stand

9. Adhesive tape

10. Laryngoscope

11. Drugs

   a. Sodium bicarbonate (IV)

   b. Catecholamine agents

      1) Epinephrine (IV)

      2) Isoproterenol (IV)

      3) Dobutamine (IV)

   c. Atropine sulfate

   d. Antiarrhythmic agents

      1) Lidocaine (IV)

      2) Procainamide (IV)

      3) Propranolol (IV/oral)

   e. Morphine sulfate

   f. Calcium chloride
g. Vasoactive agent (Norepinephrine)

h. Corticosteroids
   1) Methylprednisol
   2) Sodium Succinate
   3) Dexamethasone phosphate

i. Digoxin (IV/oral)

j. Lasix (IV)

k. Dextrose 5% in water

l. Nitroglycerine tablets

m. Amyl nitrite pearls
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