A STUDY TO ASSESS THE EXERCISE HEART RATE & THE LEVEL OF RATE OF PERCEIVED EXERTION RESPONSES TO AEROBIC EXERCISE TRAINING IN POST CABG INDIVIDUALS

REGISTER NUMBER: 27091204

A DISSERTATION SUBMITTED TO
THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY
CHENNAI
IN PARTIAL FULFILLMENT FOR THE
REQUIREMENT OF THE DEGREE IN
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Head of the Institution: _____

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***Examiners:*_____**

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CERTIFICATE

This is to certify that the project work entitled "**A STUDY TO ASSESS THE EXERCISE HEART RATE & THE LEVEL OF RATE OF PERCEIVED EXERTION RESPONSES TO AEROBIC EXERCISE TRAINING IN POST CABG INDIVIDUALS"** was done by **R.TAMIL SELVI** a bonafide student of Master of Physiotherapy under THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY, CHENNAI.

PROJECT GUIDE

Prof. B.RAMKUMAR M.P.T. (CARDIO)
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CONTENTS

A STUDY TO ASSESS THE EXERCISE HEART RATE & THE LEVEL OF RATE OF PERCEIVED EXERTION RESPONSES TO AEROBIC EXERCISE TRAINING IN POST CABG INDIVIDUALS

INTRODUCTION

Coronary artery bypass graft surgery is one of the most frequently performed surgical procedure. Supervised exercise programme have been recommended to facilitate recovery immediately after surgery.

Cardiac rehabilitation is a widely accepted form of management for patient with cardiac disease. Cardiac rehabilitation is a process of restoring psychological, physical and social functions in people with manifestations of a coronary artery disease.

In past 40 years there has been a profound shift from the conservative approach that discouraged physical activity in cardiac patients to one which encourage as much activity as the patients symptoms and medical status allow.

In patients who have undergone a coronary artery bypass graft surgery, activities can decrease post surgical stiffness and prevent complications and decrease the incidence of severity of depression and anxiety and also improve self esteem.

In a 2006 study Strauber and colleagues hypothesized that aerobic exercise training could improve heart rate recovery while cardiac rehabilitation. It has been shown to positively effect. Such recovery in patients with coronary artery disease.

Cardiac rehabilitation with exercise training has been shown to improve exercise capacity and health related quality of life to retard the progression of atherosclerosis and to decrease morbidity and mortality in patients with coronary artery disease.

Based on these lines of evidence, the American College of Cardiology/ American Heart Association (ACC/ AHA) guidelines recommend aerobic exercise for all eligible patients with CAD, including those after Coronary Artery Bypass Grafting (CABG).

However among studies focussing exclusively on a CABG population, the existing evidence of the efficacy of exercise training is limited to improvements in exercise tolerance and psychological sense of well being.

The potential benefits of rehabilitation include an improvement is heart function, a lowering of the heart rate at rest and during exercise and a reduced risk of dying or developing complications from heart disease.

Low level walking during recovery is usually prescribed. It is normal to feel profusely tired the first few weeks after surgery, but this will go away in time- give yourself permission to be human.

Start off with multiple short duration (i.e. three to five minutes) exercise session per day gradually working up to longer durations fewer times per day. Walking 30 – 40 minutes no stop at a comfortable space, as they progress through the recovery period. The following generic graduated exercise plan as a guide.

The objective is to “Wean” patient from the shorter exercise bouts more times per day to the longer, continuous bouts less times per day. It can performed in a safety manner with good supervision and help elderly and cardiac patients to socialize to perform exercise and confidence in their every day life.

However, due to changing patient demographics, many more patients now have the opportunity to receive the benefits offered by cardiac rehabilitation. Multi-factorial intervention, including aggressive risk factor modification, has become an integral part of present day cardiac rehabilitation.

STATEMENT OF THE STUDY

A study to assess the exercise heart rate & the level of rate of perceived exertion responses to aerobic exercise training in post CABG individuals

AIM OF STUDY

To assess the exercise heart rate & the level of rate of perceived exertion responses to aerobic exercise in post CABG individuals.

NEED FOR THE STUDY

Coronary artery disease is the most common problem being faced by the people in the modern materialistic world. Exercise training increases cardio vascular functional capacity and decreases myocardial oxygen demand at any level of physical activity in apparently healthy persons and in most individuals with cardiovascular with cardiovascular disease. Regular aerobic exercise is required to maintain these training effects. The main aim of the study is to assess the exercise heart rate & the level of rate of perceived exertion responses to aerobic exercise training in post CABG individuals.

OBJECTIVES

- To assess the exercise heart rate to aerobic exercise in post CABG individuals.
- To assess the level of rate of perceived exertion response to aerobic exercise in post CABG individuals.

HYPOTHESIS

There is significant reduction in exercise heart rate & the level of rate of perceived exertion responses when aerobic exercise is given to post CABG individuals.

NULL HYPOTHESIS

There is no significant reduction in exercise heart rate & level of rate of perceived exertion responses when aerobic exercise is given to post CABG individuals undergoing cardiac rehabilitation program.

OPERATIONAL DEFINITION

Heart Rate

Heart rate is the number of heart beats per unit of time. It is a extremely useful indicator of response to activity. It can be measured by counting the radial pulse.

Rate of Perceived Exertion (RPE)

The RPE scale was conceived and introduced by Borg in early 1960 and is important adjunct heart rate in monitoring intensity of training in cardiac patients.

Original scale was 15 grade category from 6-20 with descriptive marker of subjective physical effort at every odd number. The RPE scale provides valuable subjective information related to amount of strain of fatigue the patients is experiencing during exercise. The recommended RPE level for the aerobic training is (11-13) which is between fairly light to some what hard.

Aerobic Exercise Training

Sub-maximal, rhythmic repetitive exercise of the large muscle groups during which the needed energy is supplied by the inspired oxygen. Aerobic exercise is defined as ‘any activity that uses large muscle groups can be maintained continuously and is rhythmic in nature”.

CABG

Coronary artery bypass grafting is a surgical procedure done to improve the survival by coronary revascularization and as well as angina free survival.

ANATOMY

OF CARDIOVASCULAR SYSTEM

The primary purpose of the cardio - respiratory system is to deliver adequate amounts of oxygen and removes wastes from body tissues. The circulatory system transports nutrients and aids in temperature regulation. It is important to note that the respiratory system and the circulatory system function together as a “coupled unit’.

The respiratory system adds oxygen and removes carbon dioxide from blood, while the circulatory system is responsible for the delivery of oxygenated blood & nutrients to tissues in accordance with their needs.

ORGANISATION OF THE CIRCULATORY SYSTEM

The human circulatory system is a closed loop that circulates blood to all body tissues. Circulation of blood requires the action of the muscular pump, the heart that creates the “pressure head” needed to move blood through the system.

Blood travels away from the heart in arteries and returns to the heart by way of veins. The system is considered “closed” because arteries and veins are continuous with each other through smaller vessels.

Arteries branch extensively to form a “tree” of smaller vessels. As the vessels become microscopic they from arterioles, which eventually develop into

“beds” of much smaller vessels called capillaries. Capillaries are the smallest and most numerous of blood vessels, all exchanges of oxygen, carbon dioxide, and nutrients between tissues and the circulatory system occur across capillary beds. Blood passes from capillary beds to small venous vessels called venules. As venules move back towards the heart they increase in size and become veins. Major veins empty directly into the heart.

The mixture of venous blood from both the upper and lower body that accumulates in the right side of the heart is termed “Mixed venous blood”. Mixed venous blood therefore represents and averaged of venous blood from the entire body.

STRUCTURE OF THE HEART

Heart is a conical hollow muscular organ situated in the middle mediastinum enclosed within the pericardium. Pericardium is a fibroserous sac which protects the heart and the roots of the great vessels. The heart is divided into 4 chambers and is often considered to be two pumps in one. The right atrium and the right ventricle from the right pump, while the left atrium and the left ventricle combine to make the left pump. The right side of the heart is separated from the left side by a muscular wall called interventricular septum. This septum prevents the mixing of blood from the two sides of the heart.

CHAMBERS OF THE HEART

Right Atrium

It is the ear-like muscular process, conical in shape which project from the upper and anterior aspect. It develops the pulmonary Trunk and the aorta on the right side. The superior venacava and inferior venacava enters postero – superiorly (superior venavava) and posterior – inferiorly (inferior vena cava)

Right Ventricle

From the conical dialation, infundibulum, the pulmonaly Trunk arises. The walls of ventricles are more muscular and thicker than atria. The right ventricular wall is thinner than the left as it has to pump the blood only to the lungs. The left ventricular wall has to pump the blood to the entire body.

Left Atrium

It is conical process projects from the upper and left corner. It overlaps the root of pulmonary trunk and aorta on the left side. The 4 pulmonary vein pierces it on each side to open into it. The oblique vein of marshall runs on it’s posterior wall and ends in the coronary sinus.

Left Ventricle

The walls of left ventricles are very thick and it has to pump the blood through the aorta to all the parts of the body.

VALVES OF THE HEART:

It preventing backward movement of blood, the heart contains four on-way valves. The right and left atrioventricular valves connect the atria with the right and left ventricles respectively. These valves are also known as the "Tricuspid valve" or right atrioventricular valve and the bicuspide valve or left atrioventricular valve. Backflow from the artieries into the ventricles in prevented by the pulmonary similunar valve (right ventricle) and the aortic semilunar valve (left ventricle)

NERVE SUPPLY OF THE HEART:

The heart is supplied by branched from the:

- Superficial Plexus
- Deep Plexus

BLOOD SUPPLY OF THE HEART:

The right and left coronary arteries arise from the right and left coronary sinuses in the root of the aorta just above the aortic valve orifice.

The coronary arteries divide into large and medium-sized arteries that run along the hearts surface (epicardial coronary arteries) and subsequently send smaller arterioles into the myocardium.

The left coronary artery begins as the left main artery and quickly divides into the left anterior descending (LAD) and circumflex arteries.

The Left anterior decending artery usually follows the anterior interventricular groove and, in some people, continues over the apex. This artery supplies the anterior septum (including the proximal conduction system) and anterior free wall of the left ventricle (LV).

The circumflex artery, which is usually smaller than the left anterior decending artery, supplies the lateral left ventricle free wall. Most people have right dominance: The right coronary artery passes along the atrioventricular (AV) groove over the right side of the heart; it supplies the sinus node (in 55%), right ventricle, and usually the AV node and inferior myocardial wall.

About 10 to 15% of people have left dominance: The circumflex artery is larger and continues along the posterior AV groove to supply the posterior wall and AV node.

VENOUS DRAINAGE

Coronary sinus is the chief vein which drains the heart.

Tributaries:

a) Great cardia vein
b) Oblique vein of the left atrium
c) Posterior vein of the left ventricle
d) Middle cardiac vein
e) Small cardiac vein
f) Anterior cardiac vein directly empties into the right atrium.

CORONARY ARTERY DISEASE

Coronary artery disease is characterized by atherosclerosis in the epicardial coronary arteries. Atherosclerotic plaques, the hallmark of atherosclerosis, progressively narrow the coronary artery lumen and impair antegrade myocardial blood flow.

The reduction in coronary artery flow may be symptomatic or asymptomatic, occur with exertion or at rest, and culminate in a myocardial infarction, depending on obstruction severity and the rapidity of development.

According to the American heart Association and American Stroke Association's 2006 publication on heart disease and stroke statistics, cardiovascular disease (CVD) remains the leading cause of mortality in the United States in men and women of every major ethnic group. It accounts for nearly 1.4 million deaths per year as of 2002 and was responsible for one in almost three deaths in the United States in 2003.

Approximately 13 million persons have a history of coronary artery disease and 7.2 million have suffered a myocardial infarction. Almost 2500 Americans die of CVD each day, an average of one death every 35 seconds. CVD claims more lives each year than the next four leading causes of death combined-cancer, chronic lower respiratory diseases, accidents, and diabetes mellitus.

PATHOPHYSIOLOGY

Coronary atherosclerosis is often irregularly distributed in different vessels but typically occurs at points of turbulence (eg, vessel bifurcations). As the atheromatous plaque grows, the arterial lumen progressively narrows, resulting in ischemia (often causing angina pectoris). The degree of stenosis required to produce ischemia varies with 0_2 demand.

Occasionally, an atheromatous plaque ruptures or splits. Reasons are unclear but probably relate to plaque morphology, plaque Ca content, and plaque softening due to an inflammatory process.

Rupture exposes collagen and other thrombogenic material, which activates platelets and the coagulation cascade, resulting in an acute thrombus, which interrupts coronary blood flow and causes some degree of myocardial ischemia.

The consequences of acute ischemia, collectively referred to as acute Coronary Syndromes (ACS), depend on the location and degree of obstruction and range from unstable angina to transmural infarction.

Coronary artery spasm is a transient, focal increase in vascular tone, markedly narrowing the lumen and reducing blood flow; symptomatic ischemia (variant angina- see Coronary Artery Disease: Variant Angina) may result.

Marked narrowing can trigger thrombus formation, causing infarction or life-threatening arrhythmia. Spasm can occur in arteries with or without atheroma. In arteries without atheroma, basal coronary artery tone is probably increased, and response to vasoconstricting stimuli is probably exaggerated.

The exact mechanism is unclear but may involve abnormalities of nitric oxide production or an imbalance between endothelium-derived contracting and relaxing factors. In arteries with atheroma, the atheroma may cause local hypercontractility; proposed mechanisms include loss of sensitivity to intrinsic vasodilators (eg, acetylcholine) and increased production of vasoconstrictors (eg, angiotensin II, endothelin, leukotrienes, serotonin, thromboxane) in the area of the atheroma. Recurrent spasm may damage the intima, leading to atheroma formation. Use of vasoconstrictipg drugs (eg, cocaine, nicotine) and emotional stress also can trigger coronary spasm.

Atheroma or atherosclerosis is a patchy focal disease of the arterial wall. Some arteries such as the radial artery and the internal mammary artery are largely spared, while others, notably the coronary arteries, are at high risk.

Fatty streaks develop as circulating monocytes migrate into the intima, take up oxidized low-density lipoprotein (LDL), from the plasma, and become lipid-laden foam cells. As these foam cells die and release their contents, extracellular lipid pools appear. Local and systemic factors extracellular lipid

pools appear. Local and systemic factors will determine whether a fatty streak resolves or progresses to an atheromatous lesion. In early atheroma, smooth mucle cells migrate into and proliferate within the plaque. As the lesion grows it encroaches into the lumen of the vessel and erodes the media.

A mature fibrolipid plaque has a core of extracellular lipid surrounded by smooth muscle cells and is separated from the lumen by a cap of collagen-rich fibrous tissue. Such plaques may rupture or fissure, allowing blood to enter and disrupt the arterial wall: this may compromise the lumen of the vessel and often precipitates thrombosis and local vasospasm. Plaque rupture may lead to rapid growth of the lesion or occlusion of the vessel and is thought to be the cause of most acute coronary syndromes.

The number and state of evolution of plaques both increase with age, but the rate of progression of individual plaques, even in the same patient, is very variable.

AEROBIC EXERCISE

Sub maximal, rhythmic, repetitive exercise of the large muscle groups during which the needed energy is supplied by the inspired oxygen.

CHARACTERISTIC OF AEROBIC SYSTEM:

- Glycogen, Fats and proteins are food fuel source.
- Oxygen is required.
- ATP is resynthesised in the mitochondria of muscle cell.
- The maximal capacity of the system is great 190 moles of ATP.
- The maximal power of the system is small (10 moles ATP/Minutes).
- This system predominates over the other energy system after the 2^{nd} minute of exercise.

PHYSIOLOGIC RESPONSE TO AEROBIC EXERCISE

The exercise pressure response the rapid increase in energy requirements during exercise requires equally rapid circulatory adjustments to meet the increased need for oxygen and nutrients to remove the end products of metabolism such as carbon dioxide and lactic acid and dissipate excess heat. The shift in body metabolism occurs through a coordinated activity of all the system of body, neuromuscular respiratory, cardiovascular metabolic & hormonal.

0_2 transport and its utilization by the mitochondria of the contracting muscle are dependent on adequate blood flow in conjunction with cellular respiration.

PERIPHERAL EFFECTS:

a) Generalized vasoconstriction occurs that allows blood to be shunted from the non working muscles, kidney, liver, spleen and splanchnic area to the working muscles.

b) A locally mediated reduction in resistance in the working muscle arterial vascular bed, independent of the autonomic nervous system, is produced by metabolites such ad mg2+, ca2+, ADP and Pco2.

c) The veins of the working as well as the non working muscles remain constricted.

d) A net reduction in total peripheral resistance results.

PHYSIOLOGIC CHANGES THAT OCCUR WITH TRAINNIG:

CARDIOVASCULAR CHANGES:

(i) Changes at rest:

a) A reduction in the resting pulse rate in some individuals because of:

(i) A decrease in sympathetic drive with decreasing levels of nor epinephrine and epinephrine.

(ii) A decrease in arterial rate secondary to biochemical changes in the muscles and levels of acetylcholine nor epinephrine and epinephrine in the arterial.

(iii) An increase in parasympathetic tone secondary tQ decrease in sympathetic tone.

CHANGES WITH EXERCISE:

A decreased myocardial oxygen consumption feel any given intensity of exercise. This result decreased pulse rate with or without a modest decrease in Blood pressure.

AEROBIC EXERCISE TRAINING

Exercise Programme.

1. The warm up period
2. The aerobic period (training period)
3. The cool down period

Warm up period

The purpose of the warm up period is to enhance the numerous adjustments that must take place before physical activity. During this period there are,

1. An increase in muscle temperature the higher temperature increases the efficiency of muscular contraction the rate of nerve conduction.

2. An increased need for oxygen to meet the energy demands for the muscle. Extraction from hemoglobin is greater than at higher muscle temperature, facilitating the oxidation process at work.
3. Dilatation of the previous constricted capillaries with increase in the circulation augmenting O_2 delivery to the O_2 deficit and the formation of lactic acid.
4. A increase in venous return this occurs as blood flow is shifted centrally from the periphery.

The Warm-up also prevents or decreases

(a) The susceptibility of the musculo skeletal system to injury by increasing flexibility

(b) The occurrence of ischemic ESG charges and arrhythmias.

The warm-up should be gradual and sufficient to increase muscle and core temperature without causing fatigue.

AEROBIC EXERCISE PERIOD

The aerobic exercise period is the conditioning part of the exercise program. Attention to the determinants of intensity, frequency, duration & mode will have an impact on the effectiveness of the programme. The exercise period must be within the person's tolerance-above the thrushold level for adaptation to occur and below the level of exercise that evokes clinical symptoms.

1. Continuous-Training

In the healthy individual continuous training is the most effective way to improve endurance. The actively can be prolonged for 20-60 minutes without exhausting the O_2 transport system.

2. Interval Training

In the healthy individual, interval training tends to improve strength and power more than endurance. The relief interval is either a rest relief or a work relief and its duration ranges from a few seconds to several minutes. A rest interval equal to one and a half times the work interval allows the succeeding exercise interval equal to one and a half times the work interval to begin before recovery in complete and stress the aerobic system. With a longer work interval the duration of the rest is not as important. A significant amount of high-intensity work can be achieved with interval or intermittent work if there as appropriate spacing of work relief intervals.

3. Circuit Training

Use of circuit training can improve strength endure by stressing the aerobic system. Circuit training employer a series of exercise activities. At the end of the last activity the individual starts from the beginning and again moves through the series. The series of activity if repeated several times.

4. Circuit-Interval Training

(a) Combining circuit and interval training to effective because of the interaction of aerobic and an aerobic production of ATP.

(b) In addition to the aerobic and anaeorbic system being stressed by the various activities with the relief interval there is on delay in the need for glycolysis and the production of lactic acid period to the availability of O_2 supplying the ATP.

THE COOL DOWN PERIOD;

A cool down period is necessary following the exercise period.

1) The purpose of the cool down period is:

(a) To prevent pooling of the blood in the extremities by continuing to use the muscle to maintain venous return.

(b) To prevent fainting by increasing the return of blood to the heart (or) brain as cardiac out put (or) venous return decreases.

(c) To enhance the recovery period with the oxidation of metabolic waste and replacement of the energy stores.

(d) To prevent myocardial ischemia, arrhythmias, or other cardiovascular complications.

2) Characteristics of the cool down period are similar to those of the warm-up period.

(a) Total body exercises such as calisthenics are appropriate.

(b) The period should last 5 to 8 minutes.

DETERMINANTS OF AN EXERCISE PROGRAM

Elicitation of the cardio vascular response in dependent on three critical elements of exercise Intensity, Duration and Frequency.

A. Intensity

Determination of the appropriate intensity of exercise to use is based overload principle and the specificity principle. Overload is a stress on an organism that is greater than the one regularly encountered during everyday life. To improve cardio vascular and muscular endurance an overload must be applied to there system.

Determination maximum heart rate and exercise heart rate for training programme provides the basis for the initial intensity of the Exercise heart rate determined. As a percentage of the maximal heart rate. The percentage used is dependent on the level of fitness of the individual.

The exercise heart rate is determined as a percentage of the heart rate reserve plus the resting heart rate maximum 0_2 consumption is the best measure of intensity.

B. Duration

The lower the intensity - longer the duration is needed. 20-60 minutes of continuous mode of aerobic activity. When the intensity is below the heart rate threshold a 45 minute continuous exercise period may provide the appropriate overload with high intensity exercise 10 to 15 minutes exercise periods are adequate 5 minutes daily period may be effective in some deconditional patients. The optimal duration of exercise cardio vascular conditioning is dependent on the total work done exercise intensity or frequency and fitness level.

C. Frequency

Frequency varies dependent on the health end age of the individual. 3-5 days/ week.

D. Mode

Any activity which uses larger groups and can be maintained continuously and is rhythmic and aerobic in nature (eg) walking, jogging, running, cycling, swimming.

LITERATURE REVIEW

1. Supervised cardiac rehabilitation programme early low, level and short term exercise training can improve the cardiac and physical functional status of patients post CABG. **Author/ year** (DJ Wright, S.G., Williams, R., Rilcy, 5 April 2002).

2. Regular aerobic exercise reduces the risk of overall mortality and cardiovascular mortality **Author/ year** (July 2003, Lee Anne Gassner, Sands Dunn, Neil Piles).

3. Regular aerobic exercise helps offset the deleterious effects of surgery and low level walking during recovery is usually prescribed – graduated post CABG surgery exercise regimen **(www.williamRsukala.com. by William R. Sukala, June, 2010)**.

4. Regular participation in aerobic exercise often results in a decrease in resting heart rate by 5 – 25 beats per minutes. The lowered resting heart rate from exercises training is proposed to be due primarily to an increase in the parasympathetic nervous activity with a minor decrease in sympathetic nervous discharge **Author/ year** (Katina, McLean, Dighton & Guz, 1982, Smith, Hudson Graitzer & Reiven, 1989).

5. **8 May 2009,** CABG were randomized to either 6 weeks of aerobic training 3 times a week, at 70-80% maximal estimated heart rate. Heart rate training group TG, neuro normal response to static exercise and reduced the levels of both lipids and marker of inflammation in post CABG patients. **(Pdfs, Journals/ www.com/ejcpr/2009/05/08.).**

6. **2006, study Strauber, and colleagues** hypothesized that aerobic exercise training could improve. Heart rate recovery, while cardiac rehabilitation has been shown to positively effect such recovery in patient with coronary artery disease.

7. Additional physical activity during cardiac rehabilitation leads to an improved heart rate recovery in male patients after coronary artery bypass grafting in addition to that in the cardiac rehabilitation to improve their cardiac autonomic control **Author/ year** (Shinji Sato, Ph.D., Shigeru Nakita, MD, Mitsura Majima, MD, June 2005).

8. **ACSM's guidelines (American College of Sports Medicine)** for exercise testing and prescription, states the need for low intensity exercise (eg) (brisk walking) throughout the life span. Such a recommendation is consistent with exposing the general population to low-risk physical activity to achieve health reelected benefits aimed at reducing cardiovascular and metabolic diseases, 286, section two, physiology of health and fitness.

9. **McArdle, exercise physiology 3rd edition (1991)** In essence, the heart is 'turned on' during exercise by an increase in sympathetic and decrease in parasympathetic activity combined with input from the central command in the brain. The capability of large portions of the vasculature to either constrict or dilate provides a rapid redistribution of blood to meet the tissue's metabolic requirements while maintaining an appropriate blood pressure throughout the entire system. 710-730, physical activity, health and aging.

10. **Bevegrad 57:26, 1963.** The large stroke volume of topflight endurance trained persons and the increase in stroke volume of sedentary subjects following aerobic training usually accompanied by a proportionate heart rate reduction during sub-maximal exercise. The major portion of the exercise cardiac output is diverted to the working muscle.

11. Short duration of physical training results in favourable cardiovascular performance and it may be described to autonomic modulation. **Indian Journal of Physiol Pharmacol. 2004; Author Rajes K. Sharma and K.K.Deepak.**

12. **Ginnuzzi et al** studies the impact of long term physical training programme on left ventricular size and function in a multicentre randomized trail involving a Cohort study of 80 patients. After 6 month study shows significant improvement in work capacity favourable

modification of the coronary circulation as well as increase in vagal tone and reduction in sympathetic activity.

13. Submaximal aerobic exercise decreases the sympathetic nervous system activity **(BJORNTOP, et al., 1998).**

14. The beneficial effects of aerobic exercise training in cardiac patients improves muscle strength improve cardio respiratory endurance **(PTH, 1393, February 25, 2002)**.

15. Regular exercise, which improves cardio respiratory fitness, is a powerful factor in enhancing health and well being, not only those with active life styles gain substantial health benefits from physical activity but regular exercisers tend to have healthier life styles compared to non exercisers **Author / Year (Joliffe et al., 2000)**.

16. **Howley and Franks (1992)** found there were changes in heart rate, blood pressure and rating of perceived exertion as a result of an exercise programme. They showed that sub maximal tests are a good mechanism for showing improvements in cardio respiratory function. There was an increase in functional capacity with an increase in the intensity of the exercises.

17. Heart rate is used to act as a marker of physiological strain of the exercising skeletal muscles **(Buckley, 2000)**.

18. **Froelicher and Myers (2000)** stated that in conjunction with systolic blood pressure, heart rate plays a role as a key indicator of myocardial strain in specific cardiac patients. The importance of cardiac rehabilitation after myocardial infarction (MI) and Coronary Artery Bypass Grafts (CABG) has been widely acknowledged. Physical inactivity increases the risk of developing coronary heart disease two fold (National Institute of Health Consensus Developmental panal). Structured exercise as a therapeutic intervention is central to cardiac rehabilitation as well as daily exercise which should also be encouraged as part of an active living philosophy **(sign Guidelines 2000)**.

19. The exercise component of cardiac rehabilitation has evolved from the recognition that physical deconditioning occurs following myocardial infarction and the knowledge that regular exercise protects against cardiovascular **(Pate et al. 1995)**. Improved physical fitness is an important outcome for cardiac rehabilitation. Accurate measurement of the exercise tolerance of cardiac patients prior to and on completion of a cardiac rehabilitation programme using an objective measure is important.

20. Heart rate is usually described as a % of maximum heart rate. This is based on the assumption that heart rate max and Vo_2 max coincide **(Astrand and Rhyming, 1954)**.

21. **Sykes (1998)** reported heart rate may be affected by anxiety, poor stepping or cycling technique, erratic breathing pattern, time of day and certain medications and drugs, anyone using sub maximal tests should be fully awake of the correct technique.

RPE self monitoring needs to be taught well. It is a crucial factor in the ability to self monitor **(Buckley, 2000)** this can be done by using Borg's Scale of perceived exertion **(Borg, 1998)**.

22. Effect of encouragement on walking test performance has to be taken into account and as far as possible any encouragement was standardised self paced test are not standardised and performance can be influenced by encouragment and the patient's motivation or mood **(Guyatt et al., 1984)**.

23. The ACSM Guidelines advocate the minimum duration of aerobic exercise is 20 minutes at more than 50% VO_2 max. The challenge is to promote physical activity and to motivate the population whether that is the cardiac or general population to continue this as part of their daily life.

METHODOLOGY

STUDY SETTING

The study was conducted in the out patient physical therapy department of Government Rajaji Hospital, Madurai.

STUDY SAMPLE

Fifteen male CABG patients were selected by purposeful sampling method from Government Rajaji Hospital, Madurai.

RESEARCH APPROACH

This study is a prospective study with an experimental same subject research design.

CRITERIA FOR SELECTION

Inclusion Criteria

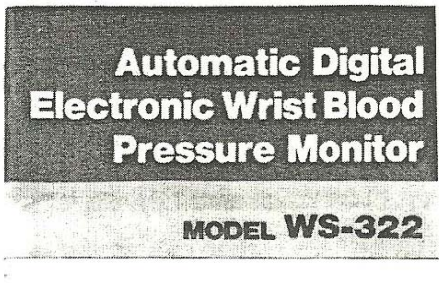
Asymptomatic low risk, uncomplicated male CABG individuals between age groups of 55 -70 years were included who are medically stable, uncomplicated and should have undergone traditional aerobic training for twelve weeks.

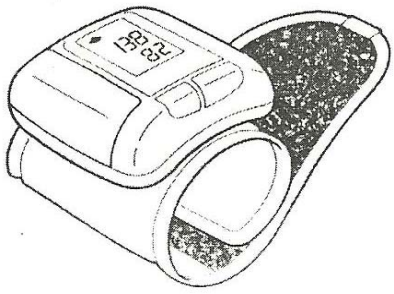
Exclusion Criteria

Women and patients with the recent symptoms of angina or ischemia are excluded. Smokers and alcoholic patients, and patients with uncontrolled hypertension, dysrythrmias, congestive heart failure, moderate and high risk patients and with other complications are also excluded.

EQUIPMENTS

Automatic digital electronic pulse rate and blood pressure monitor from Nissel Modern WS 322 was used to monitor the exercise heart rate.





Level of rate of perceived exertions scale by Borg (6-20) was used by the patients to record the level of exertion they felt during the exercise training.

BORG'S SCALE

20

19 VERY, VERY HARD

18

17 VERY HARD

16

15 HARD

14

13 SOMEWHAT HARD

12

11 LIGHT

10

9 VERY LIGHT

8

7 VERY, VERY LIGHT

6

GENERAL PROCEDURE

- The selected patients were received in the out patients physical therapy department and was monitored for the vital signs.
- As guidelines from American College of Sports Medicine for exercise testing and training programme, a brief explanation and demonstration about the aerobic exercise training were given to the selected patients.

Technique

Phase-I:- Warm up exercise was given in the form of stretching exercise. Flexion & extension with both and alternate lower extremity and slow walking for 10 minutes.

It increase tendon flexibility improve joint range of motion and enhance muscular performance.

Phase – II:-

Type of Exercise:-	Brisk walking for 30 minutes
Intensity of Training:-	It started with 60% gradually increased upto 75% of maximum heart rate.
Frequency:-	3 days/ week
Duration:-	30 minutes.

Phase – III:- Cool down period of exercise for 10 minutes slow walking.

- The rate of perceived exertion did not exceed RPE level (11-13) that the patient did not “Strain”
- The patient was oriented, correct breathing pattern should be maintained.
- Patient was advised to discontinue the exercise in any contraindicate warning signs or symptoms, especially dizziness, abnormal heart rhythm, unusual shortness & breath/ chest pain.
- The exercise heart rate was monitored using the automatic pulse rate monitor and the patient was asked to point out the level of exertion in the Borg’s scale of rate of perceived exertion (6-20) felt immediately after exercise.
- The training was given 3 days/ weeks same speed in first training session.
- The exercise heart rate & RPE level was recorded on each training session.
- After 8 weeks of aerobic exercise training the exercise heart rate and RPE responses of the first training session to the last training session were completed using paired ‘t’ test analyzed.

AEROBIC EXERCISE TRAINING GIVEN TO THE PATIENT

AEROBIC EXERCISE TRAINING GIVEN TO THE PATIENT

DATA ANALYSIS

Paired ‘t’ test was used to analyse the parameters between the first training session and the last training session.

FORMULAS USED

1. Mean $\overline{X} = \frac{\sum x}{N}$

$$SD = \sqrt{\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)2}$$

Where,

X = the individual score

X = the mean score

N = the total number of scores

2. $$t = \sqrt{\frac{\sum d}{\frac{N\sum d^2 - (\sum d)^2}{N-1}}}$$

Where,

t = ‘t’ value

Ed = the total of the differences

Ed2 = the total of the squared differences

N = number of subjects

Table -1

EXERCISE HEART RATE

Session	Mean	S.D.	t cal.	Significance
First	86.4	3.807	11	**
Last	83.46	3.544		

→ df at 14

→ ** 't' value significant at level 0.05.

BAR GRAPH: I

EXERCISE HEART RATE

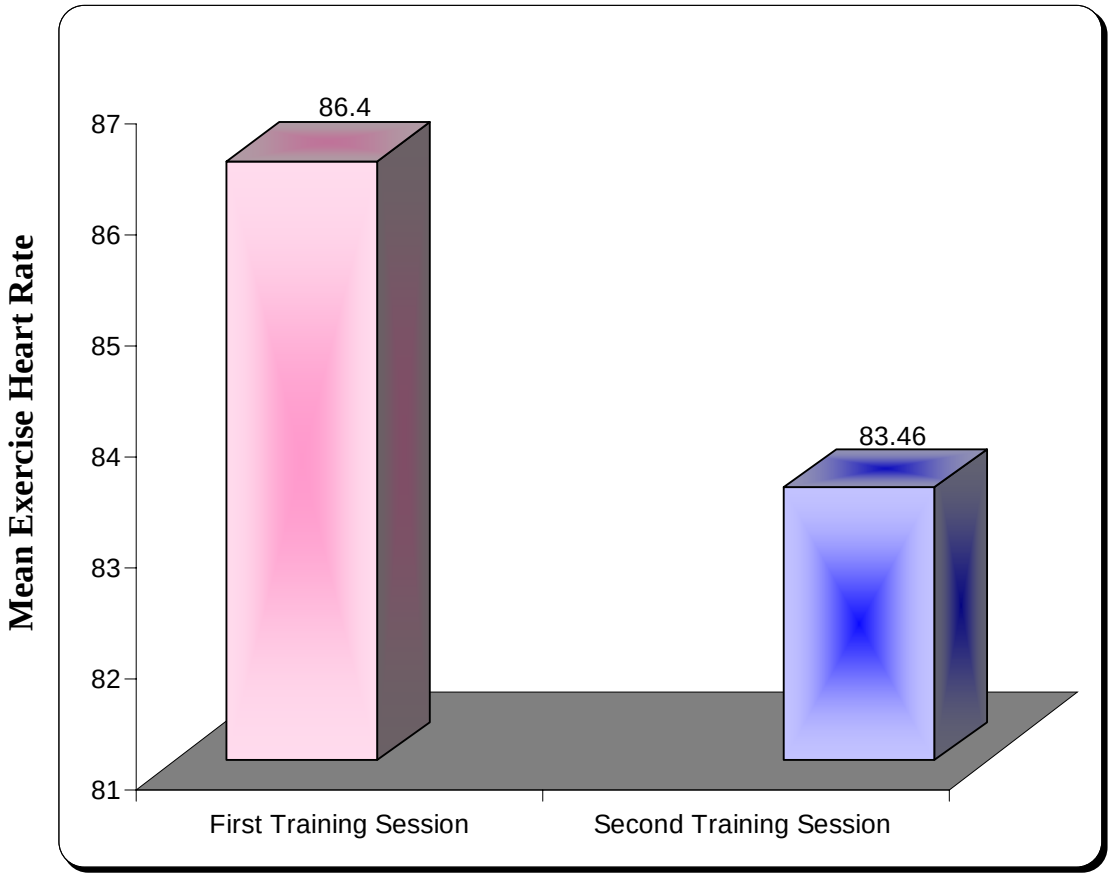


Table -2

LEVEL OF RATE OF PERCEIVED EXERTION

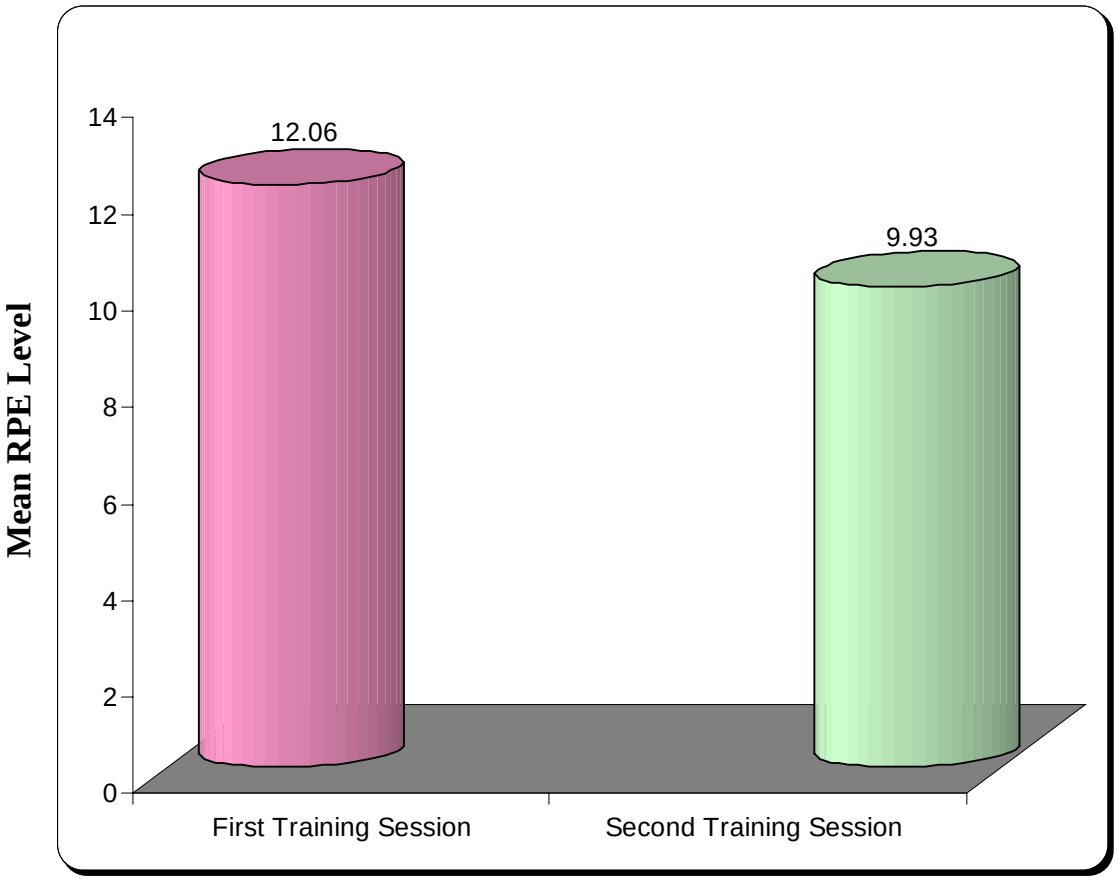
Session	Mean	S.D.	t cal.	Significance
First	12.06	1.077	16	**
Last	9.93	1.06		

→ df at 14

→ ** 't' value significant at level 0.05.

BAR GRAPH: II

LEVEL OF RATE OF PERCEIVED EXERTION



RESULTS

Table 1 shows the comparison of exercise heart rate in the first training session to the last training session after 8 weeks.

The mean value for exercise heart rate during first training session is noted 86.4, the standard deviation 3.807.

The mean value for exercise heart rate during the last training session is noted 83.46, the standard deviation 3.544.

The ‘t’ value was calculated to be at highly significant level 11 ($P<0.05$). This suggests there is significant difference in exercise heart rate while comparing the first and the last training session.

The Bar graph I shows the mean value for the exercise heart rate in the first training session and the mean value in the last training session.

The mean value has a significant reduction from 86.4 in the first training session to 83.46 in the last training session.

Table II shows the comparison of RPE level in the first training session to the RPE level in last training session after 8 weeks

The mean value for RPE level during the first training session is 12.06 and the standard deviation is noted to be 1.077.

The mean value for RPE level during last training session is 9.93 and the standard deviation noted to be 1.06.

The ‘t’ value was calculated to be at highly significant level 16 ($P<0.05$). This suggest that there is significant difference in the RPE level while comparing the first training session and the last training session.

The Bar graph II shows the mean values of RPE levels during the first training session and the last training session.

The mean value has a significant reduction from 12.06 in the first training session to 9.93 during the last training session.

DISCUSSION

The results given above shows significant reduction in exercise heart rate and RPE level responses to aerobic exercise training given for 8 weeks period.

It shows that the patient has adapted to the aerobic exercise training with an standard speed easily without fatigue and with reduced in exercise heart rate in the last training session compared to the first day of training session.

The RPE scale conceived by Borg is a very useful indicator for assessing the intensity of exercise. The researcher in this manuscript used RPE as an important indicator of intensity of exercise during the training.

The results were also supported by 2006 study, **Strauber and colleagues** stated that aerobic exercise training could improve heart rate recovery while cardiac rehabilitation has been shown to positively effect such recovery in patients with coronary artery disease. They conducted a retrospective study of 45 patients, who had completed aerobic cardiac rehabilitation programs. The result indicated that who have low exercise capacity even short term aerobic training and aid heart rate recovery.

Heart rate recovery after exercise depends on several factors, the intensity of exercise, the cardio respiratory fitness, cardiac ANS modulation, hormones

changes and baroreflex sensitivity. Different degrees of intensity of exercise would result in diverse types of heart rate recovery. After light exercise, heart rate follows an exponential decline to resting level. After moderate or heavy exercise, however, the recovery pattern is characterized by two distinct phases, an initial exponential drop followed by a slower decline to resting level (Darr et al., 1988).

Reason for Reducing Heart Rate in Exercise Training

Exercise training creates an imbalance between the tonic activity of the sympathetic accelerator and parasympathetic depressor neurons in favour of greater vagal dominance. This is mediated primarily by an increase para sympathetic activity and perhaps a decrease in sympathetic discharge. Training may also decrease, intrinsic rate of firing of the S.A node.

These adaptations accounts for the significance bradycardia after observed in highly conditioned endurance (subjects) or in sedentary subjects following aerobic training.

This study's results supports the literary study of **BEVEGRAD 57:26, 1963;** The large stroke volume of slight endurance trained persons and the increases in stroke volume of sedentary subjects following aerobic training usually accompanied by a proportionate heart rate reduction during sub

maximal exercise. The major portion of the exercise cardiac output is diverted to the working muscles.

This study also concretize the literary of Montoye, H.J. et al., 1957, Exercise Physiology by Katch & Katch, 3rd edition. From available data, it appears that if life extending benefits of exercises exist, they are more associated with the prevention of early mortality than an improvement (in overall life span).

Benefits of Cardiac Rehabilitation

Improved exercise capacity and decreased symptoms of angina, fatigue and shortness of breath.

20-25% reduction in mortality and major cardiac events (Squires et al., 1990).

Cardio Vascular Changes during Aerobic Exercise:

Cardio vascular and respiratory systems are intimately linked with aerobic processes, related changes occur that are both functional & dimensional. To facilitate oxygen delivery capacity during exercise.

Resting and sub-maximal exercise heart rate decrease during aerobic training especially for previously sedentary individuals. Consequently heart rate changes provide a convenient index to measure training improvement.

This study also concretize the literary review of **Shinji sate, Ph.d., Chicago** Addition physical activity during cardiac rehabilitation leads to an improved heart rate recovery in male patients after coronary artery bypass grafting.

The results of the present study in which increasing the out of program activity resulted in marked improvement of the heart rate recovery. Suggest that life style activity can effect an adequate increase in vagal reflex.

Evidence for a central mechanism, considered to be a release of inhibitory commands from the motor cortex to the parasympathetic center, or afferent stimulation from baro reflex or chemo reflex functions has typically, Utilized the initial R.R. interval changes during the post exercise recovery periods.

Imai et al., demonstrated that a release of inhibitory central command rather than baro or chemo receptor stimulation may play an important role in post exercise vagal reactivation, because the HR during the first 30 second of recovery minimally depends on the exercise intensity. We therefore hypothesize

that the improved, vagally mediated Heart Rate Recovery resulting from physical activity may be associated with changes in central command mechanisms.

Training Effects of Aerobics Exercises

It improved functional capacity, increase in maximal Co_2 & O_2 consumption and decrease in resting heart rate rapid return to sub normal heart rate. The maximal O_2 consumption of the trained men was significantly higher than for the untrained men.

Goals of Cardiac Rehabilitation

The medical goals are aimed at improving the quality of life, by increasing the exercise tolerance, prevention of recurrence of symptoms of chest pain and breathlessness, decreasing the rate of re-infarction, by retarding the under-lying pathological process and last but not the least, minimizing the risk of sudden death.

Decrease maximum O_2 during submaximal work load & reduced cardiovascular risk.

The American heart Association has also suggested the merits of aerobic training. The aerobic training helps to improve the cardio vascular fitness. It has also recommended that mild to moderate aerobic exercise training can provide an effective method for improving muscular strength and endurance, preventing and managing a variety of chronic medical conditions, modifying coronary risk factors and enhancing psycho social well being. Thus, aerobic exercise training decreases the myocardial demands during daily activities.

A manuscript from the journal of Indian Association of Physiotherapists has also supported that aerobic exercise training enhance cardio vascular health by producing changes such as decrease in exercise heart rate, exercise blood pressure and rest blood pressure (Efficiency of aerobic exercise training improve the functional capacity of patients with cardiac problems. An review of literature- Prof. A.G.Dhandapani, M.Venkatesh)

Exercise training for patients with cardio vascular disease was performed using the safety guidelines for aerobic exercise training in cardiac rehabilitation by American Association of cardio vascular and pulmonary rehabilitation.

As suggested by Michael L Pollock the exercise was given 3 days per weeks which will elicit favourable adaptation and improvement.

The proper breathing pattern was followed during exercise by Pollock.

They were assessed and recorded at every training session which showed at the end of 8 weeks a significant reduction and adaptation to aerobic exercise training with standard same speed.

The selection of patients to aerobic exercise training is also important to note. Many studies have proved safety in aerobic exercise training in low risk male patients with coronary disease. The safety in moderate to high risk patients is still studied. So the researcher has selected asymptomatic, uncomplicated low risk male patients under went CABG.

There are questions arising concerning the safety of aerobic exercise training in people with heart and blood vessel conditions. The AHA has recommended that there is no risk associated with aerobic exercise training in health persons and low risk cardiac patients.

Haennel R.G. in 1991 has also suggested aerobic exercise training adds to the effect of aerobic training in cardiac rehabilitation after CABG by improving cardic vascular fitness, muscular strength and endurance.

Numerous Investigations in low risk cardiac patients reported no cardio vascular events. The safety of aerobic exercise training with mild hypertension is also reported.

Absence of anginal symptoms, Ischemic ST depression, abnormal hemodynamics, complex ventricular dysrythmias and cardio vascular complications suggest that aerobic exercise training are safe for clinically stable men with coronary artery disease who are actively participating in rehabilitation program.

Thus aerobic exercise training can be prescribed to low risk post CABG male patients. Aerobic training which is safe, effective and adds to the effect of aerobic training in improving the cardio respiratory endurance, muscle strength and endurance, psycho social well being of individual. The CABG individual can do aerobic exercise with confidence.

LIMITATIONS

The study was conducted to asymptomatic low risk male CABG patients between age group of 55-70 years. The cooperation of the patients to the study was a limiting factor as many patients were reluctant to come to the outpatient department for training. So selecting such cooperative patients was found very difficult.

CONCLUSION AND RECOMMENDATION

To conclude, the study showed that there was significant reduction in exercise heart rate and RPE levels responses when aerobic exercise training was given to post CABG individuals under going cardiac rehabilitation.

There are various evidences that support the effectiveness of aerobic exercise training to post CABG patients. But the efficiency and safety benefits to women, older patients with low aerobic fitness, severe left ventricular dysfunction remain still unclear. Owing to lack of data unavailable, routine application of aerobic exercise training in moderate to high risk cardiac patients cannot be recommended at this time and requires additional study. Further studies can be done to analyse their effects also.

This study was done by giving aerobic exercise training 8 weeks initially to produce moderate fatigue and further studies can be done with progressive time & speed used to train patients to volitional fatigue.

The period of study is 8 weeks. It can also be aimed to increase the weeks also walking only prescribed other exercise are also included.

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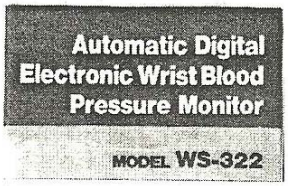
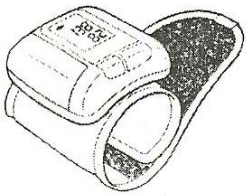
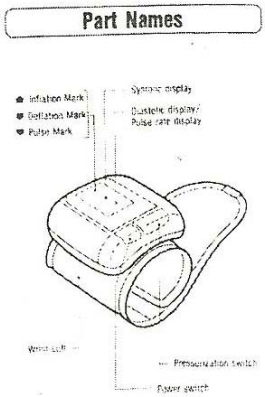
APPENDIX – I

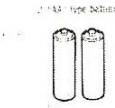
SAFETY GUIDELINES FOR AEROBIC EXERCISE TRAINING FOR CARDIAC REHABILITATION BY AACYPR

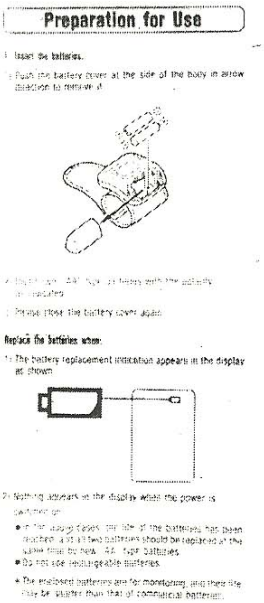


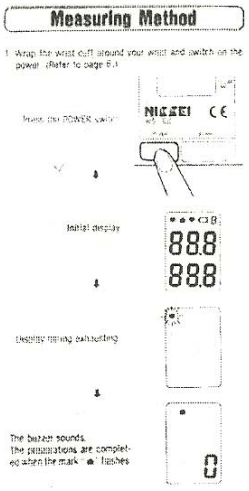


INSTRUCTIONS

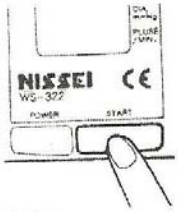








2. Press the START switch.
Press the START switch. Automatic pressurization will be made to the set pressurization value, and the buzzer will sound when pressurization has been completed. Please do not move your arm after pressurization has been started, still while measuring.



<In Case of Automatic Repressurization>
When insufficient pressurization is judged during the initial phase of measuring, repressurization to a value about 20 mmHg higher than the previous pressurization value may be executed. In order to prevent engorgement, set the pressurization value for future measurements about 60 mmHg higher than the systolic.

<To Stop Measuring>
Press the POWER switch. Pressurization will stop, the air will be exhausted rapidly, and the power will be switched off.

3. Measuring will be made.
Measuring starts automatically, and when a pulse is detected, the buzzer sounds and the "♥" mark starts to flash.
* As the blood pressure is measured during exhausting, do not move the wrist and fingers during measuring, and do not tighten your arm or hand muscles.

The display value decreases.

4. Measuring ends.
At the end of measuring, the buzzer sounds for about 1 sec. the "♥" mark flashes during exhausting, and the wrist cuff is depressurized.

Measuring completion

5. The measuring values will be displayed.
At the end of measuring, the systolic and the diastolic blood pressure are displayed at the same time. After a short while (about 3 sec), the pulse rate will be displayed. Afterwards, the blood pressure values and the pulse rate will be displayed alternately.
* At this time, the buzzer will sound, and if the "♥" mark flashes, the next measurement will be made.

Blood pressure display (for about 3 sec)

Alternate display

Pulse rate display (for about 2 sec)

6. Switch off the power.
This completes measuring of the blood pressure. The measuring results remain stored even after the wrist cuff has been removed.
To end measuring, press the POWER switch to switch off the power.

* If you forget to press the POWER switch, the power will be switched off automatically after about 3 minutes.

APPENDIX – II

SAFETY GUIDELINES FOR AEROBIC EXERCISE TRAINING FOR CARDIAC REHABILITATION BY AACVPR

1. Limit Aerobic Exercise training to patients who are asymptomatic mildly symptomatic.
2. Obtain your surgeon's approval before engaging any vigorous exercise.
3. Patient are instructed to do 5-10 minutes warm up and cool down phase before and after each session. It will help reduce your risk of injury or other post surgery complications.
4. Select an initial low level walking during recovery is usually prescribed.
5. Set a target of walking 45 to 60 minutes non stop at a comfortable pace as you progress through the recovery period.
6. Exercise 3 days per week. Three days in the beginning should be more than enough. Add extra days when you can comfortably perform three days without any ill effects or undue residual fatigue.
7. Focus on a moderate to somewhat hard pace where you're breathing just hard enough to perform the activity and carry on a conversation with an exercise partner.
8. Avoid breath holding. Breathe normally at all times.

9. Ratings of perceived exertion (6-20 RPE scale) should not exceed fairly light (11) to somewhat hard (13) during exercise training. Patients would not “strain”.

10. While in the early recovery phase, avoid overexerting yourself with strenuous/ vigorous exercise.

11. Walk or cycle on level surfaces to establish your fitness foundation. You’ll be able to handle the hills in due time. If you find yourself huffing and puffing, that should be an indicator to ease up on the accelerator!

12. Avoid excessive in the event of any contraindicate warning signs or symptoms, especially dizziness abnormal heart rhythm, unusual shortness of breath, and / or chest pain.

13. Discontinue exercise in the event of any contraindicate warning signs or symptoms, especially dizziness, abnormal heart rhythm, unusual shortness of breath, and / or chest pain.

14. Require patients to monitor and record heart response. RPE and symptoms following each exercise.

APPENDIX – III

INITIAL EVALUATION AND PLAN

Name _____ Hospital _____

Age_____ Sex _____Height_____ Weight _____

Referring Physician _____Date _____

Patient Address (Home) _____ Phone No. _____

Patient Address(Work)_____ Phone No._____

II. Medical History

III. Risk Factors: Family History _____

Cholesterol_____ Triglycerides_____ HDL_____ LDL _____

Smoking _____ Hypertension _____ Diabetes _____

IV. Medications (Dosage and frequency) _____

V. Coronary Artery Bypass Surgery

Date _____ Hospital _____ Grafts _____

Complications (if any) _____

VI. Social History

Marital Status _____ Occupation _____ Leisure time activity _____

VII. Aerobic fitness

VIII. Patients Goals

IX. Physical Examination

- Observation
- Palpation
- Auscultation

X. Musculo skeletal examination

XI. Plan

- **Aerobic exercise training programme**
    * Warm up period (5-10 minutes)
    * Aerobic exercise training
    * Cool down period (5-10 minutes)

Registered Physical Therapist _____ Date _____

* From Blessey Huhn, Ice, Irwin, Oschrin, Physical therapy, Inc. 1982.