The Effect of Beta Blockers on Heart Rate Response during the Chester Step Test

Joanne Gilchrest

Acknowledgments

I would like to thank firstly John Buckley for his guidance throughout this entire process. I would also like to thank Mike Morris for his time and guidance through the stats and ethical approval stage and Stephen Fallows for his time and guidance during the ethical approval stage.

I would also like to thank all the participants who took part and my colleagues at the Countess of Chester for their support during the testing period.

Special Thanks are reserved for my family who without their continued support none of this would have been possible.

Abstract

Purpose: The Objective of this study is to ascertain that as the intensity of exercise increases through the stages of the Chester Step Test (CST) does the difference between the beta blocked(BB) and the non beta blocked(NBB) participants heart rate(HR) response increase.

Methods: The study utilised a repeated measures design. Twenty males with a mean age of 58.9 (±6.1) taking Beta Blocker medication completed the CST on two occasions within one week of another. A further Seven males and thirteen females with mean age 61.5 (± 6.3) who were not taking Beta Blockers data from previous study data using the Chester Step Test was used to compare the HR and Rating of Perceived Exertion(RPE) responses at each stage of the CST. Each stage of the CST lasted two minutes after which HR and RPE were collected until the participant achieved 80% of predicted Maximum Heart Rate or RPE 15.

Results :HR was significantly different between the two groups at each stage of the CST $p=<0.05$. RPE was significantly different between the two groups at each stage of the CST $p=<0.05$. Limits of Agreement suggested test-re-test reliability of the CST for BB participants with the worse case HR being 11bpm above the mean in the final stage of the CST.

Conclusions: The data suggests that as intensity of exercise increases as does the difference between the BB and NBB HR response. The data implies there may be some sex differences which will need investigating further. RPE was shown to be significantly different between the two groups. The data also showed that the CST is reliable for participants taking BB.

Key words:, RPE- Rating of perceived Exertion, CST- Chester Step Test, BB – Beta Blocked NBB- Non Beta Blocked

Declaration

This work is original and has not been previously submitted in support of a Degree, qualification or other course.

Signed.....

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1.0 Introduction

1.1 Background

Coronary heart disease (CHD) is the leading cause of mortality in the UK (www.heartstats.org). However, since the 1970's mortality rates for CHD have been falling (heartstats). This increase in survival rate has been attributed in more than half the number of deaths to reductions in major risk factors such as smoking, physical inactivity and diet (Unal, Critchley & Capewell, 2004) and therefore emphasising the importance of education in these risk factors. CHD is a complex disease process, although survival rates are increasing, if not treated appropriately it can have a major impact on an individual's quality of life by effecting both physiological and psychological well being (Lear & Iganaszewski, 2001).

The impact of CHD on people's quality of life has led to a set of National Standards for the treatment of CHD (NSF, 2000). One aspect of these standards is Cardiac Rehabilitation which is defined as a multi-disciplinary programme to relieve ongoing symptoms, prevent future cardiac events and to promote an individual's return to a full and normal life (NSF, 2000).

To achieve these standards many Cardiac Rehabilitation programmes now incorporate a comprehensive exercise programme within the Rehabilitation process (Schmid, 2005). This has evolved from studies since the 1950s which have shown a decrease in mortality in those who became increasingly physically active following a cardiac event. Prior to this the main prescription following myocardial infarction was six months of bed rest (BACR, 1995).

1.2 Exercise Prescription and HR

Since this change in guidelines to incorporate exercise into cardiac rehabilitation, further emphasis has been placed on the correct intensity at which to prescribe exercise to be both safe and effective.

Guidelines set by BACR (1995), ACSM (2006), AACVPR(2004) currently suggest a training intensity of 40-80% of Maximum Heart Rate (MHR) or 40-70% Heart Rate Reserve (HRR). These guidelines enable practitioners to prescribe safe and just as importantly effective exercise to patients.

HR is used for exercise prescription due to research of over 100 years highlighting that it has a maximal value that can't be surpassed despite increases in exercise intensity which mirrors the increase in cardiac output which is a much more invasive to measure (Roberg & Landwehr, 2002). Maximal heart can therefore be interpreted as the upper limit for an increase in central cardiovascular function (Roberg & Landwehr, 2002). HR is also used for exercise prescription, as it is a marker of physiological strain on the skeletal muscles and with systolic blood pressure can be used as a marker of myocardial strain (Thow, 2006). The ease of being able to monitor HR and its direct relationship with VO_2 max is why HR has become the most commonly measured exercise response (Buckley, Holmes & Mapp, 1999) & (Astrand & Christensen, 1964). This relationship between HR and VO_2 max allows for the same exercise prescription to be applied to all persons regardless of age or physical state.

The method of calculating MHR for an individual has in recent research been questioned. Since the 1930's MHR has been shown to be approximately 220 minus the individuals age and is the method that has been used to calculate a person's predicted Max HR in all current exercise prescription guidelines. Astrand, Astrand, Halback and Kilbom, (1973) however found the error of predicting max Hr from 220-age to have a standard deviation of +/-10bpm therefore meaning a person's predicted max hr could be out as much as 20bpm above or below the age estimated MHR. This is of a particular concern in cardiac populations as it could easily lead to over

prescribing a persons exercise and increasing the risk of ischemia or arrhythmia. On the reverse this could also lead to many patients not achieving an effective Heart rate during exercise to cause positive physiological adaptations to occur within the body. A study by Karvonnen, Kentala and Mustala (1957) allowed for a more accurate relationship between %HRmax and VO_2max by using the difference between HR at rest and HR on maximal exertion. This is known as the HRR method. This method also uses if an exact MHR cannot be used the 220-age method to calculate a predicted MHR leaving it also flawed.

Londeree and Moeschberger, (1984) and Tanaka, Monahan, and Seals, (2001) found the method of 220-age to underestimate max HR in older populations therefore being quite relevant to the cardiac rehabilitation patients. Robergs and Landwher, (2002) concluded in their review of literature relating to MHR that population specific formula should be used to predict maximal heart rate. For the purpose of this study the Tanaka method was chosen to predict MHR.

1.3 Exercise Prescription and Beta Blockers

Issues can arise in prescribing exercise for patients on certain cardiac medications namely Beta blockers.

Since the introduction of Beta Blockers in the 1960's they have been one of the key medications for CHD patients, and now unless contraindicated are a standardised prescription (DOH, NSF 2000). Beta blockers are one of the main medications to take into consideration when prescribing exercise due to their effect on the cardiovascular response to exercise. Head, (1999), and Chapaluka Elbl, Nehyba, Tomaskova, and Jedlicka, (2005) stated the primary therapeutic effects of Beta Blockers are a reduction in resting blood pressure and resting heart rate and HR during exercise, a reduction in myocardial oxygen uptake and a stabilising effect upon electrocardiographic abnormalities. Both selective and non-selective Beta Blockers have a similar effect on the cardiovascular system reducing blood pressure, and heart rate

during both rest and sub-maximal exercise. Some studies of BB have shown BB to reduce exercising heart rate by 20-30% and cardiac output by 5-23% where as others have reported no change (Head,1999)

1.4 RPE and Exercise Prescription.

Due to the discrepancies that can occur when prescribing patients HR, RPE has also been used by many practioners to compliment THR. Rating of perceived exertion is “the act of detecting and interpreting sensations from the body during physical exertion” (Noble & Robertson, 1996). The use of RPE as a tool of exercise testing and analysis has become as widely accepted as HR as a marker of physiological intensity (Buckley, Holmes & Mapp, 1999). RPE is commonly used in clinical settings to assess fitness and monitor prescription as safe and effective levels of exercise, physical activity or rehab purposes (Buckley & Eston 2007)

1.5 Aim of Study

The aim of this study is to look at how Beta Blockers affect heart rate response during incremental exercise. A group of participants taking Beta blockers will have their heart rate and rating of perceived exertion compared with an age match group to determine if the slope of the heart rate trend lines between beta blocked and non beta blocked participants are parallel, or does the difference increase as the intensity intensifies. It will also be used to determine if participants taking beta blockers require like with other sub-maximal tests a practice attempt.

1.6 Hypotheses

The difference between the beta blocked and non beta blocked participants heart rate will raise as the intensity of the exercise increases.

Rating of perceived exertion (RPE) will be the same for both groups at the increasing exercise intensity.

The Chester step test will not require a practice attempt for participants on Beta blockers.

2.0 Literature Review

2.1 Exercise in Cardiac Rehabilitation

Almost 200 years ago the first evidence for exercise as part of the treatment for Coronary heart disease arose. Dr Heberden reported a patient who was suffering from chest pain, after sawing wood for 30 minutes each day had managed to alleviate his chest pain (Buckley, Spurway &Mclaren, 2008). Despite this finding, for many years Doctors continued to follow Thomas Hiltons "rest and pain" method and advocated up to 6 months prolonged rest for anyone who had suffered a myocardial infarction (Shephard & Balady, 1999). Since the 1960's this treatment has been phased out and replaced with moderate to vigorous exercise for both the prevention of coronary heart disease and as a major part of the secondary treatment for those who have had angioplasty, coronary artery bypass grafts or a myocardial infarction (Shephard & Balady, 1999).

This change in practice has occurred as exercise has been shown to have a beneficial effect on several coronary heart disease risk factors.

- Exercise has been shown to lower blood pressure for up to 12 hours post exercise (Pescatello, Fargo, Leach, & Scherzer, 1991).
- Beneficial effects on glucose ,metabolism and insulin sensitivity (Shephard &Balady,1999)
- Physically active males and females have a more favourable waist hip ratio (<0.9) (Troisi, Heinhold, Vokonas & Weiss, 1991)
- Reduction in total cholesterol, LDL cholesterol and an increase in HDL cholesterol (Tran & Weltman, 1985).

Regular cardiovascular or resistance training leads to specific changes in the muscular and cardiovascular systems that overall lead to an improvement in functional capacity. For a healthy individual these changes consist of a decrease in heart rate at rest and at any given sub-maximal exercise intensity. This is due to four main training adaptations – a stronger heart, more blood vessels around the muscles, better oxygen extraction by the muscles and more oxygen in the blood (Buckley, et al. 1999). Studies have

shown that patients with CHD can have the same improvements (Balady, Fletcher, Froelicher, Hartley, Krauss, Obermann et al. 1994). This training effect allows an individual to exercise at a higher work load with a lower heart rate (Shephard & Balady, 1999). This training effect can be particularly beneficial for patients with CHD who have an ischemic threshold as they may be able to increase the amount they are able to do before reaching said threshold (Ehsani, Martin, Heath & Coyle, 1982, Thompson 2005).

2.2 Physical Activity versus Physical Fitness

Since the change in practice to encourage exercise post a cardiac event, there has been much debate as to whether being physically active or physically fit is required to produce the best benefits for cardiovascular health. Physical activity is defined as any voluntary muscular movement that raises the energy demands of the body above resting (Buckley, et al. 1999). This differs from physical fitness which is defined by the ACSM “as the ability to perform moderate to vigorous levels of physical activity without undue fatigue and the capability of maintaining such ability throughout life” (ACSM, 1990). Both physical activity and fitness benefit cardiovascular health with positive effects on blood pressure, cholesterol levels, blood glucose, obesity and fibrinogen levels (Buckley et al.1999).

One of the first studies to advocate the benefit of physical activity for the reduction of CHD was that published by Morris, Heady and Raffle (1953). The study compared bus conductors and bus drivers and there mortality rates from CHD. The study found that the conductors who spent hours walking the length of the buses as well as up and down the stairs on the buses experienced half the CHD mortality rates as the drivers who would spend their entire day sitting (Morris et al. 1953).

One of the key studies to suggest physical fitness through higher levels of physical activity to lower the risk of CHD was that by Sesso Paffenberger and Min Lee (2000). Sesso et al. (2000) investigated the quantity and intensity of physical activity required for the primary prevention of CHD.

Through following 12,516 men they found males with multiple risk factors for CHD who expended in excess of 4200 kJ per week had a lower CHD risk than those expending less than 4200kJ.

Shaper and Wannamethee, (1991) British regional heart study is another key study which highlighted as with the Sesso et al. (2000) study that those who engaged in higher levels of activity had a reduced incidence of CHD that was greater than the reduction in those who engaged in low levels of activity. Though the low levels of activity still showed a reduction in incidence of CHD compared to sedentary individuals.

Williams (2000) conducted a meta- analysis of physical fitness and physical activity studies and risk of CHD. Williams, (2000) found that physical fitness and physical activity have significantly different relationships to CHD risk. Williams (2000) found that reductions in relative CHD risk are nearly twice as great for physical fitness as it is for physical activity.

2.3 Physical Fitness for exercise prescription and long term mortality rate in CHD

Exercise capacity and activity status have become well established predictors of Cardiovascular and overall mortality (Myers, Prakash, Froelicher, Partington & Atwood, 2002). With evidence for primary prevention of CHD suggesting the more activity that is engaged in at more vigorous levels, lowers the risk for CHD more than low levels of exercise. Studies for secondary prevention of CHD have investigated the benefit of physical fitness for reduction in long term mortality.

Kavanagh, Mertens, Hamm, Beyene, Kennedy, Corey et al. (2002) Examined the prognostic importance of maximal cardiopulmonary testing and found that exercise capacity was a powerful predictor of mortality more so than other established risk factors such as smoking and diabetes. Kavanagh et al. (2002) looked at exercise test data for 12,169 males with documented ischemic heart disease. Findings showed that a VO_2 peak of

15-22 (4.3-6 Mets) resulted in a 38% decrease in risk of cardiac death but a VO_2peak of >22 ml/kg per min an exercise capacity of > 6.3 Mets resulted in a 61% reduction in risk of cardiac death. The findings of Kavanagh et al (2002) show that even a small exercise induced gain in aerobic power should thus make a major difference not only in functional capacity but also in survival prospects.

Myers, et al. (2002) Investigated the exercise capacity of males referred for exercise testing and their mortality rates. This study differed from the Framingham study, and the aerobics centre longitudinal study in that it assessed 6213 males with and without documented cardiovascular disease. Results showed that exercise capacity is strong predictor of risk of death. The study found that with every 1 met increase in treadmill performance; this was associated with a 12% improvement in survival. Myers et al (2002) concluded like Kavanagh et al. (2002) that exercise capacity is an important prognostic factor in patients with cardiovascular disease. The findings of Kavanagh et al. (2002) and Myers et al. (2002) are further supported by the earlier studies of Blair, Kohl, Barlow, Paffenberger, Gibbons and Macera (1995) who also observed a 7.9% reduction in mortality for every one minute increase in maximal treadmill time which can be roughly equated to 1 met as in the Myers et al (2002) study.

Dorn, Naughton Imamura and Trevisan (1999) also examined whether a supervised exercise programme improved 19 year survival in male Myocardial Infarction patients. Dorn et al. (1999) also found each 1 met increase in work capacity from baseline to the end of the trial resulted in consistent reductions in all cause and Cardiovascular Disease mortality risk.

The Studies all show that an improvement in physical fitness is key to long term survival. Poor physical fitness is an easily modifiable risk factor and is commonly seen in patients on cardiac rehabilitation programmes. Improvements in fitness over time improve prognosis as highlighted by research over recent years. As exercise capacity is a strong and independent predictor of outcomes the literature supports the value of an exercise test as a clinical tool to obtain a patients level of physical fitness, as

its non-invasive, relatively inexpensive and provides a wealth of clinically relevant information.

With research showing many benefits from exercise this has led to exercise guidelines for patients with CHD being created. These guidelines for prescribing exercise to CHD patients suggest a training intensity of 40-80% of Maximum Heart Rate which should be taken from a maximal exercise test. The guidelines suggest the level is not too high so a patient is unable to obtain desired duration and clinical risk increases and that the level is not too low so a patient is unable to achieve their full health and clinical benefits (ACSM, 1994, BACR, 1995 and AACVPR, 2004).

2.4 Importance of Exercise Prescription

As with pharmacological therapy exercise also requires a prescription to find the most suitable dose with minimal side effects. Exercise prescription is a key part of any patients care in cardiac rehabilitation. The exercise must be pitched at a level below the patient's ventilatory threshold as anything above this level could be potentially harmful for the patient (Tegtbur, Pethig, Machold, Haverich & Busse, 1986). Training above a patient's ventilatory threshold has been known to trigger, arrhythmia, ischemia, and thrombosis (Tegtbur et al. 1985, ACSM, 1994, BACR 1995). On the other side an exercise programme that is to low in intensity may not be effective to produce the physiological benefits that exercise is known to produce for patients with CHD with particular reference to risk factor modification (Gossard, Haskell, Taylor, Mueller & Rogers, 1986 and Gordon & Scott, 1995).

Despite exercise prescription the risk of an adverse event during exercise does increase by as much as 16.9 fold during and immediately after exercise (Metkus, Baughman & Thompson, 2010 and Albert, Mittleman, Chee, Lee, Hennekens & Manson, 2000). The risk is highest among sedentary patients who undertake vigorous exercise abruptly (Thompson, Franklin, Balady,

Blair, Corrado, & Estes et al. 2007). Despite this increased risk during exercise the figures for the annual absolute risk of a cardiac event are small with an estimated 1 sudden death per 15-18,000 participants (Thompson et al. 2007). The risks are therefore outweighed for most patients by the benefits that can be gained (Metkus et al. 2010). The majority of the risks associated can be argued to be substantially reduced through appropriate exercise prescription for each individual patient.

2.5 Need for Sub-maximal testing for Exercise Prescription

The most important aspect of prescription to ensure safe exercise is to ascertain the correct target heart rate (THR) for each individual patient. Commencing a programme at the appropriate heart rate is vital for patients with CHD as high levels of catecholamine's and metabolic acidosis are known to trigger an arrhythmia especially in the basis of patients with diseased myocardium (Schmid 2005). Through fitness testing either maximally or sub maximally it allows practitioners to obtain a variety of information and to monitor a patients starting and completing fitness levels. Thompson (2005) stated that CHD patients should undergo symptom limited exercise testing to determine maximal HR which is in agreeance with the ACSM and BACR guidelines and exclude important ischemia, cardiac symptoms or arrhythmias that may occur whilst a patient is exercising as stated by Schmid (2005), ACSM (1999), BACR (1995). Fitness Testing therefore assists in exercise prescription by ensuring an appropriate training heart rate for each individual patient is obtained that will allow appropriate physiological adaptations to occur, and avoid the risk exercising at a heart rate that may induce a clinical cardiac event such as ischemia or arrhythmia (Mckardle, Katch & Katch 2001). Schmid, (2003) argues that as most patients on cardiac rehabilitation programmes have been re-vascularised, there is little need for a maximal exercise test for the purpose of exercise prescription. Although Maximal exercise testing is considered the gold standard for gaining information to prescribe exercise for an individual, it's not practical for most cardiac rehabilitation departments to conduct. There

is the ethical view that if a participant is not being assessed for the clinical determination of ischemia (due to symptoms), which is not the case with the majority of patients attending cardiac rehabilitation programmes, due to the high rate now of re-vascularised patients, then the test shouldn't really be conducted as it can be quite stressful for the patients to be taken to their maximum.

2.6 Chester Step Test

The Chester Step Test (CST) is a multi-staged step test, which requires participants to step on to and off a low step at a rate set by a metronome beat. Every two minutes heart rate (HR) and Rating of perceived exertion level (RPE) are checked and recorded and then the stepping rate is then increased by 5 steps. The heart rate and RPE levels that are recorded are then used to predict subjects VO_2max, (Sykes, 1998 and Sykes & Roberts, 2004).The CST is highly flexible in nature, with ranging step heights and step rates and limited equipment required, (Buckley Sim, Eston, Hession, & Fox, 2004).

In order to prescribe exercise intensity it is often necessary to estimate a patient's maximal oxygen uptake (VO_2max) capability. However, in a clinical setting it is not feasible to directly determine VO_2max as this may jeopardise patient safety, therefore sub-maximal exercise testing is required to estimate VO_2max, (ACSM, 2006).

The CST provides a valid and reliable estimation for aerobic capacity for healthy individuals (Sykes & Roberts, 2004). However, other research has highlighted that the CST's reliability and validity for participants taking beta-blocking medication must be further evaluated, (Buckley et al. 2004). Research has proven that taking beta-blocking drugs can significantly reduce maximal HR by as much as 20-30%, (Eston & Thompson, 1997). The Chester step test is a possible valid alternative to the maximal exercise test to aid with exercise prescription for the purpose of assessing an individual's

heart response to exercise and gaining an insight into the patients functional capacity in terms of MET's achieved.

2.7 Beta Blockers and Heart Rate

Since the change in practice in the 1950's to incorporate exercise programmes into patients' rehabilitation together with the complex nature of CHD, exercise prescription is a key element to ensure safe and effective exercise (Schmid, 2005). Issues can arise in prescribing exercise for patients on certain cardiac medications namely Beta blockers.

Since the introduction of Beta Blockers in the 1960's they have been one of the key medications for CHD patients, and now unless contraindicated are a standardised prescription (DOH, NSF 2000). Beta blockers are one of the main medications to take into consideration when prescribing exercise due to their effect on the cardiovascular response to exercise. Head (1999), and Chapaluka, Elbl, Nehyba, Tomaskova and Jedlicka (2005) stated the primary therapeutic effects of Beta Blockers are a reduction in resting blood pressure and resting heart rate and HR during exercise, a reduction in myocardial oxygen uptake and a stabilising effect upon electrocardiographic abnormalities. Both selective and non-selective Beta Blockers have a similar effect on the cardiovascular system reducing blood pressure, and heart rate during both rest and sub maximal exercise. Some studies of BB have shown BB to reduce exercising heart rate by 20-30% and cardiac output by 5-23% where as others have reported no change (Head,1999)

The first studies investigating the effect of BB on heart rate and Rating of perceived exertion (RPE) response appear to be around 1979. Sjoberg Frankenhaeuser, and Bjurstedt, (1979) examined the effect of propanolol on healthy male subjects during five workloads on a cycle ergometer. They found that heart rate was significantly reduced but that the decrease in heart rate did not affect their perceived exertion of the task, implying that heart rate is not a prominent indication for perceived effort during exercise. This study only looked at healthy subjects and was only based on a single dose of beta

blocker, where as patients at cardiac rehabilitation programmes are long term users of beta blockers and the effect can vary over time as a person's body adapts to the medication.

Van Hawaarden Binkhorst, Fennis, and Van Laar (1979) carried out a trial of the non-selective Beta Blocker propanolol and the Beta selective Blocker metoprolol on hypertensive patients. The participants were required to carry out moderate exercise which was based on heart rate being below 150bpm which was chosen at random with no clear definition as to why this figure was chosen. The study showed a significant difference in exercising heart rate between the placebo and when the patients were Beta Blocked. The study showed an average of 30bpm between heart rate difference between placebo and Beta Blocked patients. RPE was once again shown to not be effected by Beta Blockers.

Peason, Banks, and Patrick (1979) studied the effect of a single dose of propanolol and metoprolol on cardiovascular responses to progressive exercise in healthy trained male subjects. They found an increase in RPE when the participants were taking the Beta Blocker , Joyner, Freund, Jilka, Hetrick, Martinez, Ewy et al (1986) suggested the reason for this may be related to trained individuals already have an increased stroke volume and decreased heart rate for a given exercise intensity, however they may be unable to tolerate a working at 50-60% under BB as their body is unable to cope with a further heart rate reduction as there stroke volume is unable to increase further to already previously being at almost maximum. For this reason trained individuals may perceive this level of work much harder than an untrained individual also on BB. In such cases this is likely to be linked to haemodynamic effects as well as any metabolic effects. Another flaw with this study was only one dose of Beta Blockers was given to the participants where it can take up to 4 weeks to adapt to a dose of BB. HR was during the study despite this flaw significantly reduced once again by an average of 20bpm, though again the study does not look at specific heart rate intensity.

A classic study by Davies and Sargeant (1979) created the trend lines that as exercising intensity increased HR between Beta blocked and non – Beta

Blocked participants went up parallel with an average of 20-40 bpm between the two groups heart rates at a given intensity and that RPE was unaffected by the Beta Blockers.

Some more recent studies have shown similar findings to those raised previously but in patients with CHD rather than healthy individuals. Lamont, Romito, Finkelhor, and Kalhan (1997) found in patients with Good left ventricular function and no residual ischemia Beta Blockers can reduce a persons maximal heart rate by 20-40bpm.

One of the most recent studies to examine the effect of beta blockers on heart rate response for exercise prescription was Wosnich, Hofmann, Fruhwald, Kraxner, Hodl, Pokan et al. (2003) investigated the effect of Beta blockers on percentage heart rate max and heart rate reserve models, in healthy male subjects. Wosnich et al. (2003) were concerned about the accuracy of exercise prescription based on MHR in patients on BB. They found that mean HR was significantly lower at rest -15bpmin the BB group compared to the placebo, as was the mean HR at the aerobic threshold and anaerobic threshold. The % MHR was significantly lower at the thresholds Aerobic threshold 60-64% respectively and anaerobic threshold 82-86% between BB participants and placebo, therefore when pts on BB are encouraged to exercise at 85% of MHR they may well be exercising above their anaerobic threshold if this figure has not been taken from a clinical exercise test. Wosnich et al. (2003) went on to conclude that for patients on BB RPE should be used instead of %HRR to prescribe exercise or alternatively upper limits for %HRR should be lower for patients taking BB. The main flaws with this study were a small sample size of 10 people, and they were all healthy subjects.

Although previous research has offered vital insight into the effect of Beta blockers on participants' heart response during exercise, few studies have looked at the effect of BB on Heart rate response on participants with CHD and are of a more accurate age as to those seen most commonly on cardiac rehabilitation programmes.

One of a few studies to look at the effect of BB in participants with CHD was Liu, Brodie and Bundred (2004). Liu et al. (2004) found parallel regression lines between BB and NBB participants HR during the modified Bruce protocol. Suggesting no difference as the intensity of the exercise increased, this being in keeping with the findings of Davies and Sargeant (1979). They also found when comparing HR and RPE to Borg Healthy people HR response to exercise slope that the slopes of the BB and NBB older persons were much less acute. This finding further emphasises the importance of establishing HR and RPE relationships for the purpose of exercise prescription. They concluded that Patients on BB require HR specific equations where as RPE was shown to be unaffected by BB with both groups showing the same RPE response during the modified Bruce.

Tabet, Meurin, Teboul, Tartiere, Weber, Renaud et al. (2008) investigated the effect of BB on prescribing exercise for CHD patients from HR achieved on a cardiopulmonary exercise test, through HR driven exercise sessions and participants perception of exercise. They found that prescribing exercise based on HR achieved at VT led to lower exercise intensity for the session compared to when the participants determined the exercise intensity based on their own feelings. In the HR driven session participants rated the session at 10-11 on the Borg scale where as the participants' perception sessions were perceived as more difficult but not exhausting. They concluded that as the respiratory exchange ratio for the higher intensity sessions showed no involvement of the anaerobic system these sessions allowed for greater recruitment of the aerobic capacities and were therefore more effective.

2.8 Rating of Perceived Exertion

Every individual perceives exertion (Noble & Robertson 1996) from day to day tasks to active recreation levels of physical strain and exertion are indiscriminately subjected to psychophysical self appraisal (Borg, 1998).

The Rating of perceived exertion (RPE) scale was created by Gunner Borg (1968). Borg proposed that the development of a universal rating scale that was both practical and accurate in measuring perceptual intensity was required (Borg, 1998, Buckley et al. 1999 and Buckley & Eston 2007). The subjective scale created by Borg was designed to run parallel to physiological markers of physical effort (Noble & Robertson, 1996). Buckley and Eston (2007) stated that using such a scale would enhance understanding of internal mechanisms that individuals use to interpret and then adapt physical exercise. Noble and Robertson (1996) also found that a persons perception of physical exertion allows them to monitor feelings of exercise intensity by sensory feedback which therefore allows an individual to pace themselves appropriately during a specific bout of exercise.

Buckley, Sim, Eston, Hession, and Fox. (2004) stated that as intensity increases the sensations of exertion become stronger and more apparent to an individual to the point where the activities start to feel difficult or physically challenging.

2.9 Reliability of RPE

Eston and Williams (1988) assessed reliability of RPE for prescribing exercise intensity. Sixteen healthy subjects attended four separate exercise sessions 5 to 7 days apart, reliability was constantly high between trials (0.8 and greater). Eston and Williams therefore concluded RPE is a useful frame for the regulation of high levels of exercise intensity. The study found that small amounts of practice with the scale improve its applicability at lower levels of exercise.

Robertson and Noble (1997) found that RPE is an effective means of representing an appropriate exercise intensity for patients attending cardiac rehabilitation programmes.

Gutmann, Squires, Pollock, Foster, and Anholm (1981) compared patients RPE responses on an initial ETT and then in subsequent exercise sessions.

Gutmann et al. (1981) found that RPE was reliably related to HR during the exercise sessions.

Buckley Sim and Eston (2009) is one of the most recent studies which investigates the reliability of RPE. Buckley et al. (2009) compared RPE at the same exercise level intensity between an initial Exercise Tolerance Test that was performed within a mean of 12 days post myocardial infarction, and two subsequent gym sessions. There was no significant difference found in HR between the three sessions. They found RPE during the initial ETT to be significantly different $P<0.008$ between ETT and gym session 1 and the ETT and gym session 2. Buckley et al (2009) findings suggested initial RPE ratings soon after MI on ETT are inflated compared to responses at the same treadmill work rate during two subsequent cardiac rehabilitation sessions, therefore concluding caution is advised in using RPE from an initial ETT to guide initial exercise prescription in patients. Buckley et al. (2009) also looked at during this study the reliability of reproducibility of RPE. They found good reliability for RPE between the two gym sessions with only one participants RPE differing by <2 scale points. These more recent findings by Buckley et al cast doubt on those earlier studies by Eston and Williams and Gutmann et al.

2.10 RPE Beta Blockers and HR

Buckley and Eston (2007) stated RPE acts as a concurrent or substitute marker of significant physiological responses brought about by varying intensities of exercise such as %MHR. Literature has highlighted that an RPE of 14/15 corresponds to 80% of MHR and thus a feasible end point to any sub-maximal exercise test (Buckley et al 2004).

Eston and Connelly (1996) stated the RPE scale has gained widespread acceptance for gaining a subjective estimate of work intensity and as a means of monitoring and regulating exercise intensity. Eston and Connelly supported this statement with findings in their research of, high correlations

between HR and RPE in individuals on BB. There was however some evidence in the study to suggest that RPE response is mediated at higher absolute work rates. Eston and Connelly (1996) stated that because BB caused a decrease in HR and cardiac output at rest and during exercise, a decrease in myocardial contractility and a decrease in coronary and muscle blood flow. These effects can in turn initiate premature fatigue and apprehension in the exercising patient. Therefore RPE provides important information and may be used to increase the accuracy of monitoring and prescription of exercise intensity in the cardiac population.

Eston and Thompson (1997) investigated the efficacy of Borgs RPE to predict maximal exercise levels to control exercise intensity in patients taking BB for hypertension. There were two groups each made up of 10 men and 10 women in the control group were subjects who had risk factors for CV disease but weren't taking any medication. In the treatment group participants were well established on the cardio-selective BB atenolol. Participants were required to carry out 2 sub-maximal exercise tests during which RPE was reported for each increment. In test one participants used RPE in estimation mode where they reported RPE at the end of each increment. During Test 2 participants used RPE in production mode where they regulated the work rate based on their perception of effort at four determined points on the RPE scale (9, 13, 15, and 17)

Results showed no significant difference between maximal heart rate and maximal power output when predicted from the regression lines of RPE Versus HR and RPE versus power output during the estimation test. However the prediction of maximal power was lower in women in the control group and the treatment group when this was predicted from the effort production protocol ($p<0.01$). When Eston and Thompson further investigated the differences for females, it seemed that when women were requested to select an exercise intensity to correspond with a given RPE they became more conservative and tended to overestimate the exercise intensity that they selected. Thus RPE was high relative to the exercise intensity. This finding wasn't just exclusive to females they also found When the BB group and the women were asked to exercise at a specific RPE they

underestimated the level of exercise resistance required or overestimated the RPE For a given work rate.

Findings support a strong positive relationship between RPE, HR and work rate in these patients in both passive effort and active effort production protocols. Eston and Thompson advised caution, as prediction of maximal exercise levels may be lower when the effort production procedures are used particularly in females and BB patients.

2.11 Summary

In summary, the immediate and most obvious effects of BB are a reduction in competitive blocking of B adrenoreceptors. Hence during sub-maximal exercise patients receiving BB can experience moderate to large reductions in heart rate of between 20 and 30% (Head, 1999). A combination of BB and physical exercise is considered beneficial for patients with CV disease (NSF, DOH 2000). Ideally appropriate exercise intensity prescription for patients receiving BB requires a known maximal HR, this is however difficult to determine from sub-maximal exercise due to the moderate to large reductions in HR. Although BB treatment decreases MHR it does not alter the % of MHR and % of maximal oxygen uptake prescribed for exercise (Eston &Thompson, 1997).

RPE is often applied during graded exercise testing to obtain a subjective estimation of exercise intensity and is an accurate predictor of functional capacity in healthy adults. RPE has a strong relationship with HR oxygen uptake, minute ventilation, and other physiological variables within a wide range of healthy and clinical populations. RPE can therefore be considered as the ideal compliment or substitute to HR for exercise prescription in clinical populations. RPE can be used with confidence, of its safety and efficacy in CHD patients.

The only caution to be extended to the use of RPE on participants with BB depends on the type of BB used. Non-selective BB are associated with greater muscle fatigue, increased peripheral resistance and greater reductions in maximal oxygen uptake (Eston &Thompson, 1997). Cardio-

selective BB are likely to cause less local muscle fatigue which is an important consideration when using RPE as a means of regulating exercise intensity in these patients.

3.0 Methodology

3.1Participants

Twenty participants (all male) from the Countess of Chester Cardiac rehabilitation programme volunteered to take part in this study mean (SD) age58.9± 6.1.

Participants were included by conforming to the following inclusion criteria:

- Clinically stable (assessed by pre exercise health screen see appendix 1)
- Taking Beta Blocking medication
- Aged 50-65
- Post Myocardial Infarction, Angioplasty or Coronary Artery Bypass Graft.

Participants were excluded from the study based on the following exclusion criteria

- Outside age bracket
- Valve disease
- Current arrhythmia
- Ejection fraction of less than 40%
- Neurological and physical/ mobility limitations that affect ability to carry out the Chester step test.
- Blood Pressure systolic >200mmHg or diastolic 110mmHg
- Acute systemic infection

Data for a further 20 participants (7 Males and 13 Females) with a mean age of 61.5 (±6.3) who were not taking Beta Blockers was taken from a previous study. The study had collected data on non beta blocked (with risk factors for coronary heart disease (CHD) but no confirmed CHD) individuals during the Chester step test.

All participants were given a patient information sheet and when they agreed to take part were given a date for testing where they would then complete an

informed consent form and complete a pre test exercise screen to ensure they were suitable to complete the testing(See appendix1,2,3)

Participants were tested at their usual cardiac rehabilitation session therefore avoiding the potential stress of attending a hospital environment for the test and not adding any extra journeys to the participants in the study.

For this study to go ahead ethical approval was granted by NRES and Research and development at the Countess of Chester hospital. (See Appendix 4, 5)

To ensure participant confidentiality all participants were allocated a number between one and forty.

2.2 Experimental Design

The study was designed to assess the relationship between beta blocked and non beta blocked HR responses to the Chester Step Test –a sub-maximal incremental exercise test. The study was also designed to assess the validity and reliability of using the CST to assess HR and RPE response in beta blocked patients.

The study used a repeated measures design, consisting of two testing sessions 1 week apart per participant. All testing was performed at the Countess of Chester cardiac rehabilitation sessions in the fitness suite at the University of Chester.

2.3 Exercise testing

Each testing session consisted of 2 parts; present at all sessions was another member of the cardiac rehabilitation team who was also trained in immediate life support.

2.3.1 Part 1 Measurements taken on arrival

On arrival at the cardiac rehabilitation session, participants were asked to sit on a chair and rest for 10 minutes, to ensure a more accurate resting heart rate (RHR) was achieved prior to the test commencing. During this seated period on the first session participants were required to complete the informed consent and pre- test health screen. The answers given in the health screen allowed participants to be checked that they were suitable to participant in the test, namely by taking their prescribed medications and not having any symptoms of chest pain or shortness of breath in the last week.

After the 10 minute rest period participants RHR was taken through a radial pulse check for 15 seconds which also allowed for basic screening of any potential new onset of arrhythmia. Blood pressure was checked using an automated sphypgmanometer on the participants left arm, unless there was a clinical reason as to why the left arm could not be used. By checking the participants' Blood pressure it ensured no participant had a blood pressure that day that would exclude them from taking part. Participants predicted Maximal HR was determined from the Tanaka equation 207- (0.7*age) = MHR equation - 30 bpm for BB participants. The participants 80% of MHR was then generated, as a test termination point.

2.3.2 Part 2: Chester Step Test.

Each participant was required to complete the multistage CST once using the 0.15m adapted step. This step height was chosen on the recommendations of Buckley et al 2004 who stated that as the cardiac population have a decreased exercise tolerance the lower step will allow more of the test to be completed before an RPE of 15 or 80% MHR is achieved, therefore enhancing the amount of data collected.

Prior to the test commencing participants were fitted with a polar heart monitor to allow HR to be monitored. The participants were then given the following standard instructions on using the RPE scale.

- Anchoring of the top and bottom ratings to previous experiences of no exertion at all and maximal effort.
- Ensuring they were aware that they were giving an overall rating of the exertion incorporating physical, muscular and cardio-respiratory sensations.
- That there was no right or wrong answer
- That they could report their RPE at any stage during the test to ensure participant comfort.
- That the scale would be in full view at all times during the test

Participants then listened to the instructions for the Chester Step Test from the CST CD. Participants were then required to step on to and off the step at a rate set by the metronome beat from the CST CD. The test started at a pace of 15 steps per minute and increased by 5 steps per minute every 2 minutes up to a maximum of 35 steps per minute in the final stage.

At the end of each stage RPE was collected using Borgs 6-20 RPE scale and HR using polar HR monitors at the end of each stage until an RPE of 15, 80% of predicted MHR. The exercise test would also be stopped if any of the following were reported.

- Chest Pain
- Excessive shortness of breath(participant is unable to speak)
- Unable to keep up with the pace of the test
- Participant requested the test to be terminated

As the test was sub-maximal participants weren't being asked to work any harder than they would do in their usual cardiac rehabilitation session.

2.4 Statistical Analysis

The mean HR and RPE for each group at each stage of the Chester Step test were used to provide the basis for analysis. Analysis was completed using SPSS V.17 and Excel.

Linear regression analysis was performed using the equation y=steepness of slope and x the point of intercept of the y axis. By using this analysis it would allow form comparison of the steepness of the slopes between the BB and the NBB HR and RPE data.

Interaction between the groups and stage of the Chester Step Test was analysed using a mixed model ANOVA. For the mixed model ANOVA to be conducted the following assumptions were required to be met, Data is normally distributed and the data has homogeneity of variance. As there are less than 100 participants Shapiro-Wilk analysis is checked for normal distribution with a significance value of >0.05 required to pass the assumption. For Homogeneity of variance to be assessed Levenes statistic was consulted with a significance value of >0.05 required to meet the assumption. The interaction effect between the groups over the stages of the Chester Step Test would provide the p value. For this analysis a p value of <0.05 was used to imply statistical significance.

Independent t–tests were chosen to investigate at exactly which stage of the Chester Step Test significant differences between the two groups data were. The assumptions of normal distribution and homogeneity of variance were required to be met to continue with the t-test. This was assessed through the Shapiro-wilk and Levene statistic as with the mixed model ANOVA. For the results of the t-test to be classed as significant a p value of <0.05 was used.

Limits of Agreement (L.o.A) was chosen to assess reliability for both HR between test 1 and 2 and RPE between test 1 and 2 for the BB participants data. L.o.A was chosen as Lamb, (1998) suggested the Pearson correlation co-efficient is incorrect as the correlation is not sensitive to changes in the means of the two scores. Bland and Altman, (1986) also advocate the use of L.o.A due to its more complete appraisal of reliability. L.o.A uses data from 95% of subjects allowing therefore for extreme outlying data to be ignored in analysis.

4.0 RESULTS

4.1 Participants Overview

Twenty participants volunteered for the current study, all of whom completed the Chester Step test twice. Twenty further participants' data was used from a previous study to provide the non beta blocked participants' data. As Table 4.1 shows the data for stage 5 from the non Beta blocked participants is minimal therefore for the purpose of data analysis between the two groups only data collected from the first 4 stages of the Chester step test will be used. In observation to table 4.2 it can be noted that the Beta Blocked participants have the physiological characteristics that would be expected of participants on BB with a mean lower systolic and diastolic Blood pressure 117mmHg and 75 MmHg respectively and a lower mean Resting HR of 60bpm.

Table 4.1 Number of participants who completed each stage of the Chester Step Test

Participants	**CST Stage1**		**CST Stage2**		**CST Stage 3**		**CST Stage 4**		**CST Stage5**	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	20	20	20	20	20	20	19	19	18	18
NBB	20	20	20	20	17	17	11	13	5	6

Table 4.2 General information of participants (mean±SD)

Group	N	Sex	Age	Height (M)	Weight (kg)	BMI	Systolic BP (mmHg)	Diastolic BP (mmHg)	RHR (bpm)
BB	20	20 M	58.9 ±6.1	1.8 ±0.07	91.0 ±15.4	28.9 ±5.5	117 ±14	75 ±11	60 ±11
NBB	20	7 M 13 F	61.5 ±6.3	1.71 ±0.10	70.9 ±8.6	24.2 ±2.5	136 ±23	88 ±11	74 ±12

4.2 Analysis of Heart Rate Data

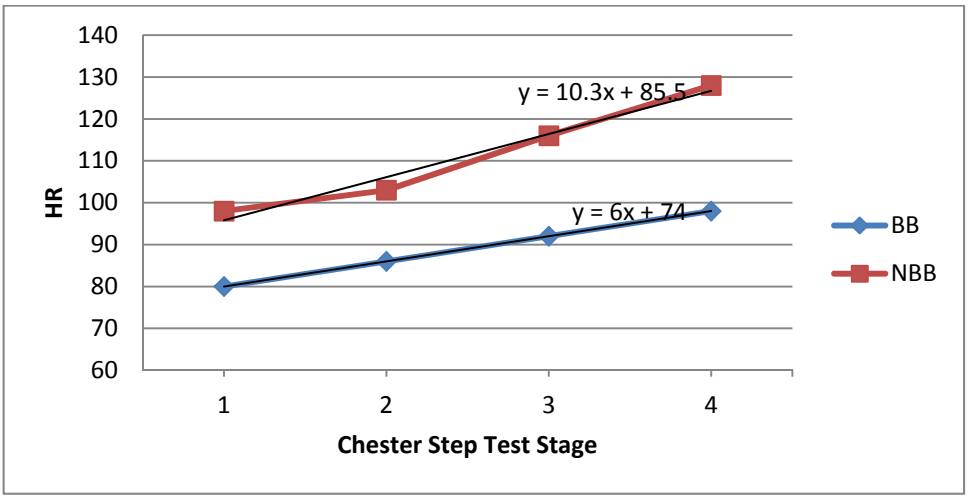

Fig 4.1 Test 1 - Comparison of HR at each stage of Chester Step Test

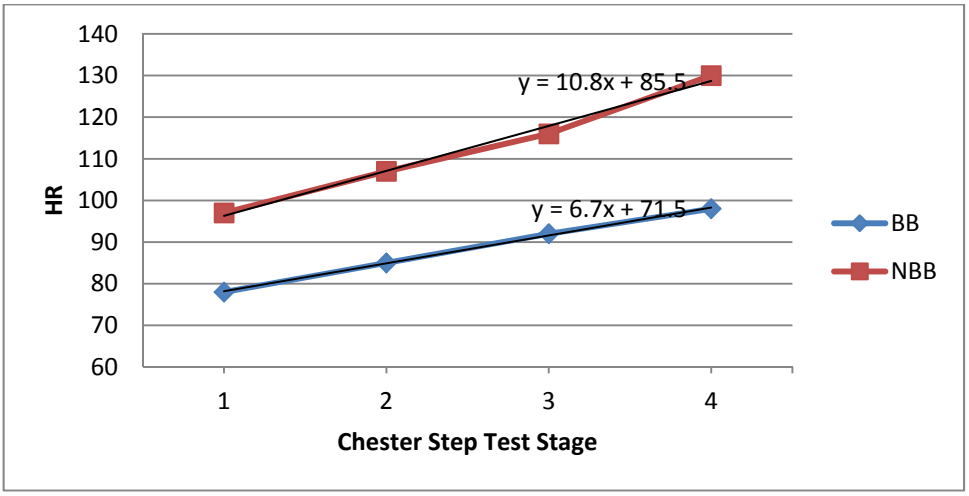

Fig 4.2 Test 2- Comparison of HR at each stage of Chester Step Test

Table 4.3 – Independent t-test findings for HR at each stage of Chester Step Test

	Stage1		Stage2		Stage3		Stage4	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	80 ±11	78 ±11.2	86 ±10.9	85 ±10.9	92 ±10.7	92 ±10.8	98 ±12.3	98 ±11.1
NBB	98±12	97±11	103±26	107±12	116±14	116±12	128±17	130±15
Difference mean	18	19	17	22	24	24	30	32
P value	P=0.000	P=0.000	P=0.012	P=0.000	P=0.000	P=0.000	P=0.000	P=0.000

Figure 4.1 shows the steepness of the slopes between the BB and Non BB participants HR at each stage of the Chester Step Test during test 1. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=10.3 and y=6 respectively, therefore suggesting a difference in Hr as the intensity increases. When looking at the mean differences between the groups at each stage of the test table 4.3, this shows a gradual increase in the difference in the mean as the intensity of the exercise increased through the stages. Further analysis via the mixed model ANOVA revealed significant differences exist between the groups data with $p \leq 0.05$. To find where the actual differences were between the groups independent t-test were run for each stage of the Chester Step test. The T-test found significant differences between the HR's of the two groups at all stages of the Chester Step test $p = \leq 0.05$. The t-test findings are summarised in table 4.3

Figure 4.2 shows the steepness of the slope between the BB and NBB participants in the second trial of the Chester Step Test. Once again the slope is steeper for the Non BB participants compared to the BB participants where y=10.8 and 6.7 respectively. A mixed model ANOVA was conducted to see if there was any significant difference between the 2 groups which once again found a significant difference in the data between the groups with

p≤0.05. Independent t-test was again conducted to find exactly where the differences between the two groups were. Again the t-test showed a significant difference between the 2 groups at all stage of the Chester Step test p=≤0.05. The t-test findings are summarised in table 4.3

4.3 Analysis of male only data for HR

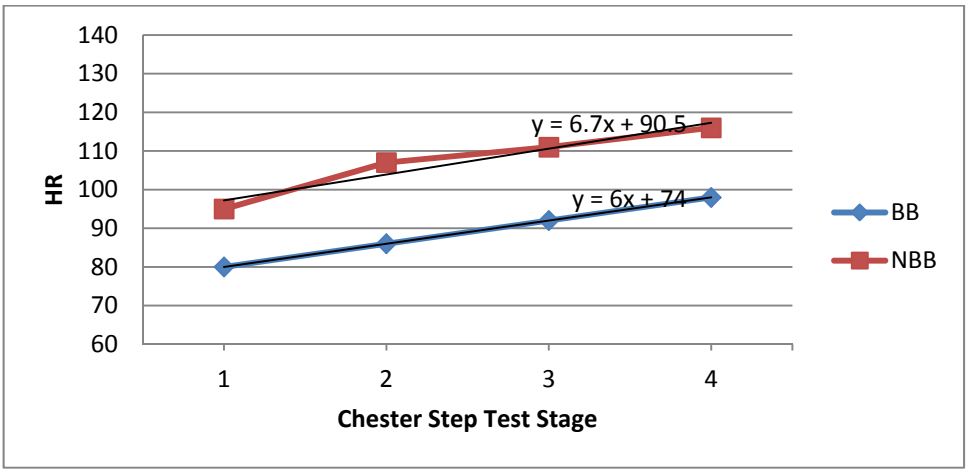

Fig 4.3.Test 1 - Comparison of HR at each stage of Chester Step Test for male participants

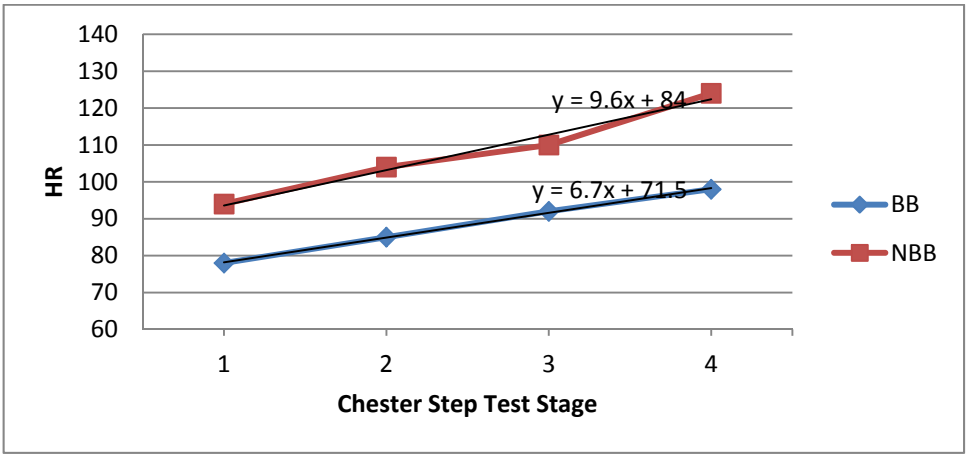

Fig 4.4 Test 2 - Comparison of HR at each stage of Chester Step test for male participants

Table 4.4 Independent t-test findings for HR at each stage of Chester Step Test

	Stage1		Stage2		Stage3		Stage4	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	80 ±11	78 ±11.2	86 ±10.9	85 ±10.9	92 ±10.7	92 ±10.8	98 ±12.3	98 ±11.1
NBB	95±11.5	94±12.1	107±19	104±16.4	111±15.6	110±14.4	116±14.4	124±15.8
Difference mean	15	16	21	19	19	18	18	26
P value	P=0.005	P=0.004	P=0.003	P=0.002	P=0.004	P=0.004	P=0.019	P=0.000

Figure 4.3 shows the steepness of the slopes between the BB and Non BB for the male participants HR at each stage of the Chester Step Test. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=6.7 and y=6 respectively. The difference in the slopes is much smaller that the slopes for the male and female combined data in fig 4.1 and fig 4.2, suggesting no increased difference in HR as the intensity increases. When looking at the mean differences between the groups at each stage of the test table 4.4, shows the mean difference between the groups HR for each stage of the Chester Step test to be very similar as the intensity was increased which differs from the results above with the gradual increase difference in the means as the intensity increased. Further analysis via the mixed model ANOVA still revealed significant differences exist between the groups data with p=≤0.05. To find where the actual differences were between the groups independent t-test were run for each stage of the Chester Step test. The T-test found significant differences between the HR's of the two groups at all stages of the Chester Step test p=≤0.05. The t-test findings are summarised in table 4.4

Figure 4.4 shows the steepness of the slopes between the BB and Non BB male participants HR at each stage of the Chester Step Test for test 2. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=9.6 and y=6.7 respectively. This finding is in keeping with the slopes in fig 4.1 and 4.2. When looking at the mean differences between the groups at each stage of the test table 4.4 shows a similar difference in the mean through stages 1-3 before a marked increase in the mean difference in stage 4. Further analysis via the mixed model ANOVA revealed significant differences exist between the group's data with $p \leq 0.05$. To find where the actual differences were between the groups independent t-test were run for each stage of the Chester Step test. The T-test found significant differences between the HR's of the two groups at all stages of the Chester Step test $p = \leq 0.05$. The t-test findings are summarised in table 4.4.

4.4 Analysis of %HRR data

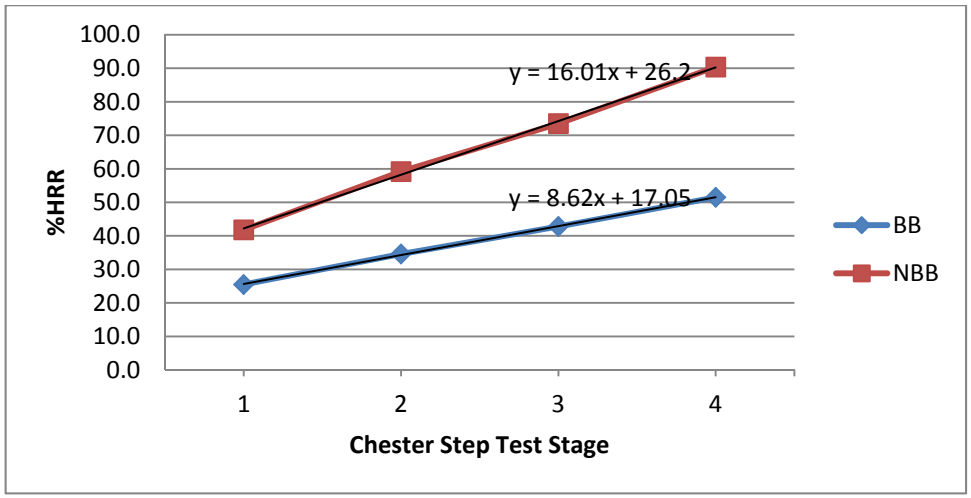

Fig 4.5 Test 1- Comparison of %HRR at each stage of Chester Step Test

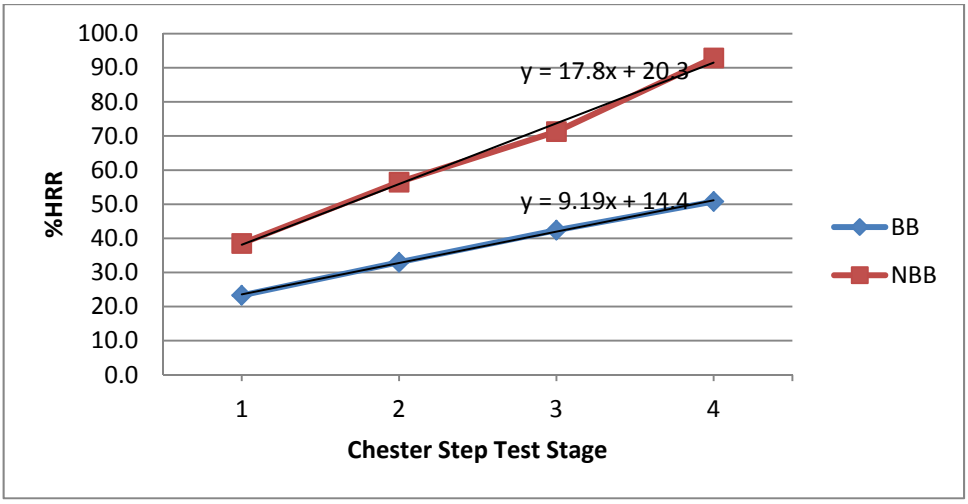

Fig 4.6 Test 2 - Comparison of %HRR at each stage of Chester Step Test

Table 4.5 Mean data for %HRR at each stage of Chester Step Test

	Stage1		Stage2		Stage3		Stage4	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	25.5±10.3	23.3±9.8	34.6±11.1	33±10.5	42.8±11	42.4±11.6	51.5±14.9	50.8±13.7
NBB	41.8±14.2	38.5±12.5	59.2±20.6	56.5±17.5	73.5±21.9	71.3±16.4	90.4±23.5	92.9±21.1
Difference mean	16.3	15.2	24.6	23.5	30.7	28.9	38.9	42.1

When comparing fig 4.5 test 1 %HRR and fig 3.6 test 2 %HRR data the steepness of the slopes are greater than the slopes for actual HR at each stage of the test as seen in fig 4.1- fig 4.4. Test 1 NBB slope is y=16.01 compared to the BB slope of y=8.62. A similar difference in the steepness of the slope is seen in test 2 data with a NBB slope of y=17.8 and BB slope of y=9.19. By using the %HRR means it takes away any effect for fitness. The mean difference for the two groups shows a gradual increase in the difference in the intensity with a much greater difference between the %HRR at the final stage of the Chester step test where the intensity of the exercise is greatest.

4.5 Analysis of RPE Data

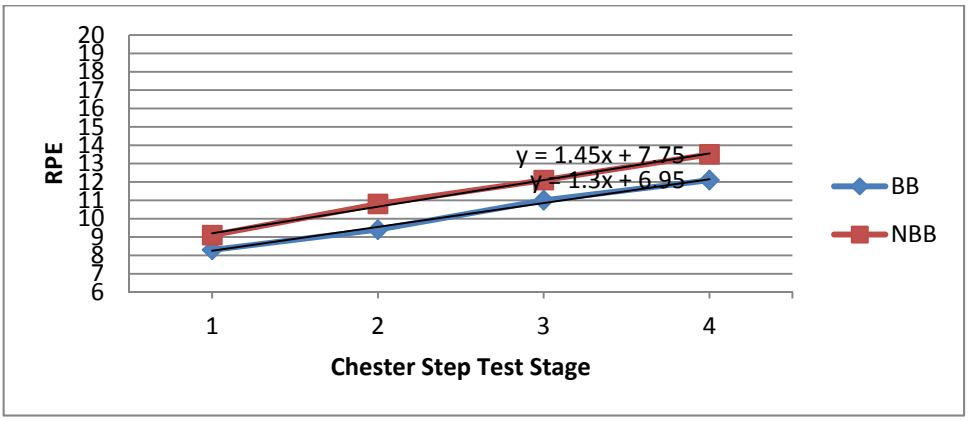

Fig 4.7 Test1 - Comparison of RPE at each stage of Chester Step Test

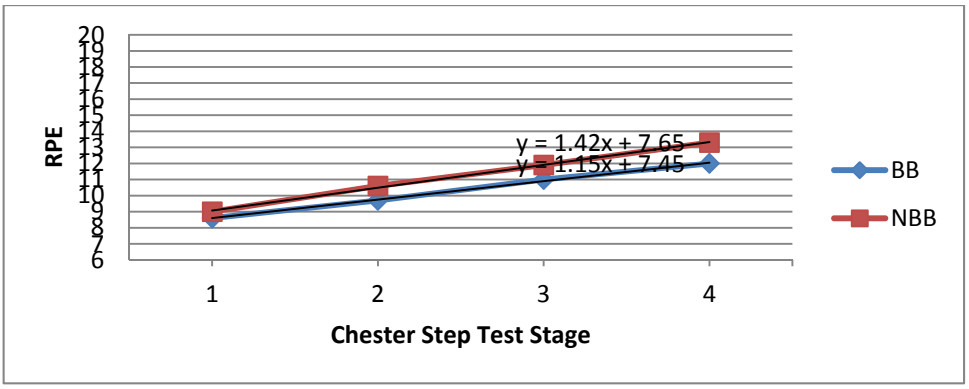

Fig 4.8 Test 2- Comparison of RPE at each stage of Chester Step Test

Table 4.6 *Independent t-test findings for RPE at each stage of Chester Step Test*

	Stage1		Stage2		Stage3		Stage4	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	8.3±1.1	8.6±0.8	9.4±1.4	9.7±0.9	11±1.1	11±0.8	12.1±1.0	12±0.5
NBB	9.1±0.9	9±0.9	10.8±1.7	10.6±1.7	12.1±1.7	11.9±1.3	13.5±0.9	13.3±1.3
Difference mean	0.8	0.4	1.4	0.9	1.1	0.9	1.4	1.3
P VALUE	P=0.018	P=0.154	P=0.008	P=0.041	P=0.022	P=0.002	P=0.002	P=0.000

Figure 4.7 shows the steepness of the slopes between the BB and Non BB male participants RPE at each stage of the Chester Step Test. The

steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=1.45 and y=1.3 respectively. When looking at the mean differences between the groups at each stage of the test table 4.6 shows the mean difference between the groups RPE for each stage of the Chester Step test to be very similar as the intensity was increased. Further analysis via the mixed model ANOVA revealed a p value of p=>0.05, however as p=0.09 it was decided to conduct the independent t test to see if there were any significant differences between the RPE in the groups across the stages. The t-test found significant differences between the RPEs of the two groups at all stages of the Chester Step test p=≤0.05. The t-test findings are summarised in table 4.6

Figure 4.8 shows the steepness of the slopes between the BB and Non BB male participants RPE at each stage of the Chester Step Test. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=1.42 and y=1.15 respectively. When looking at the mean differences between the groups at each stage of the test table 4.6 shows a similar difference in the mean as the intensity of the exercise increased until the final stage where the difference between the means was greater. Further analysis via the mixed model ANOVA revealed significant differences exist between the groups data with p=≤0.05. To find where the actual differences were between the groups independent t-test were run for each stage of the Chester Step test. The t-test found significant differences between the RPEs of the two groups at stages 2-4 p=≤0.05. No significant difference was found between the groups in stage 1 of the Chester Step test. The t-test findings are summarised in table 4.6.

4.6 Analysis of Male only RPE data

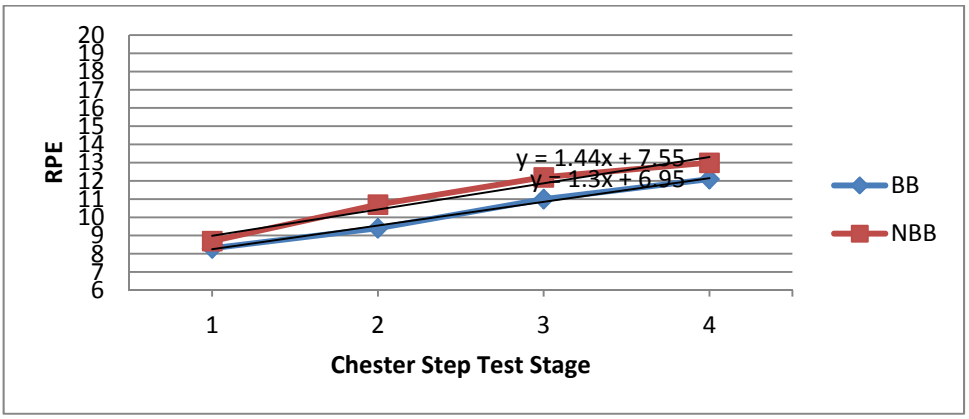

Fig 4.9 Test 1 -Comparison of RPE at each stage of Chester Step Test for male participants

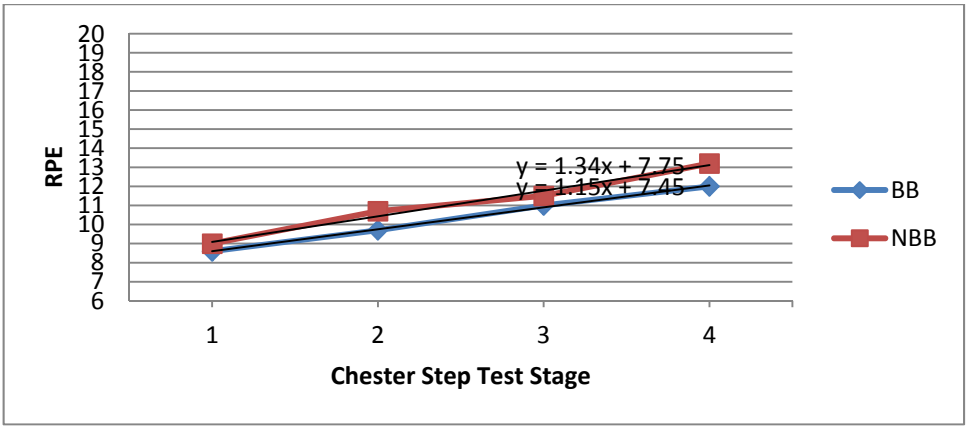

Fig 4.10 Test 2- Comparison of RPE at each stage of Chester Step Test for male participants

Table 4.7 Independent t-test findings for RPE at each stage of Chester Step Test

	Stage1		Stage2		Stage3		Stage4	
Test	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
BB	8.3±1.1	8.6±0.8	9.4±1.4	9.7±0.9	11±1.1	11±0.8	12.1±1.0	12±0.5
NBB	9±0.9	9±0.9	10.7±2.1	10.7±2.2	12.2±1.3	11.5±1.4	13±0.7	13.2±1.5
Difference mean	0.7	0.4	1.3	1.0	1.2	0.5	1.1	1.2
P value	P=0.394	P=0.304	P=0.089	P=0.107	P=0.061	P=0.176	P=0.136	P=0.003

Figure 4.9 shows the steepness of the slopes between the BB and Non BB male participants RPE at each stage of the Chester Step Test. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=1.44 and y=1.3 respectively. When looking at the mean differences between the groups at each stage of the test table 4.7 shows the mean difference between the groups RPE for each stage of the Chester Step test to be very similar as the intensity was increased further analysis via the mixed model ANOVA revealed no significant differences exist between the groups data p=>0.05.

Figure 4.10 shows the steepness of the slopes between the BB and Non BB male participants RPE at each stage of the Chester Step Test. The steepness of the Non BB participants slope is greater than the Beta Blocked slope where y=1.34 and y=1.15 respectively. When looking at the mean differences between the groups at each stage of the test table 4.7 shows a similar difference in the mean as the intensity of the exercise increased through the stages similar to that seen in the trials comparing both the male and female data. Further analysis via the mixed model ANOVA revealed significant differences exist between the groups data p=≤0.05. To find where the actual differences were between the groups independent t-test were run for each stage of the Chester Step test. The T-test found a significant difference between the RPEs of the two groups in the final stage of the Chester Step test p=≤0.05. The t-test findings are summarised in table 4.7

4.7 Limits of Agreement for Beta Blocked data

Table 4.8 Limits of Agreement for Beta Blocked data over two tests. 95% L.o.A (expressed in bpm) (bias± 1.96xSD_{diff})

Stage of Chester Step Test	LoA (HR- bpm)
Stage 1	1.8 ±3.5
Stage 2	2.8 ±5.5
Stage 3	2.7± 5.3
Stage 4	3.4 ±6.6
Stage 5	3.7 ±7.3

When assessing reproducibility of HR between two trails of the CST the 95% L.o.A technique was used. Table 4.8 shows the L.o.A for each stage of the CST. Stage 1 worst case is 5bpm above or 2 bpm below the mean HR which would be considered an acceptable deviation in clinical practice. When the 5bpm is taken as a % difference this equates to 6% which at the lower end of exercise prescription is acceptable, as this is unlikely to cause any problems. Stage 5 worst case is 11bpm above mean HR or 4bpm below which for the upper limit could be the difference between being at a patients ischemic threshold for which a patient with said threshold is advised to remain 10bpm below (ACSM) and is therefore much more clinically significant. When this is put as a % of the mean HR it equates to a 12% difference in the HR this difference could take a person at the upper limits of exercise to therefore exercising above current clinical exercise prescription guidelines.

Table 4.9 Limits of Agreement of RPE taken at each stage of Chester Step Test over 2 tests

Stage of Chester Step Test	LoA (RPE)
Stage 1	0.8 ±1.6
Stage 2	0.8 ±1.6
Stage 3	0.7 ±1.4
Stage 4	0.8 ±1.6
Stage 5	0.7 ±1.4

When looking at table 4.9 L.o.A for RPE, Stage 1 worst case is an RPE of 2.4scale points above the mean which is not ideal in a clinical setting as this could be the difference between finding an exercise light to somewhat hard. Stage 5 worst case is an RPE of 2.1 scale points above the mean which at the upper ends of the RPE scale could be the difference between 15 and 17 on the RPE scale.

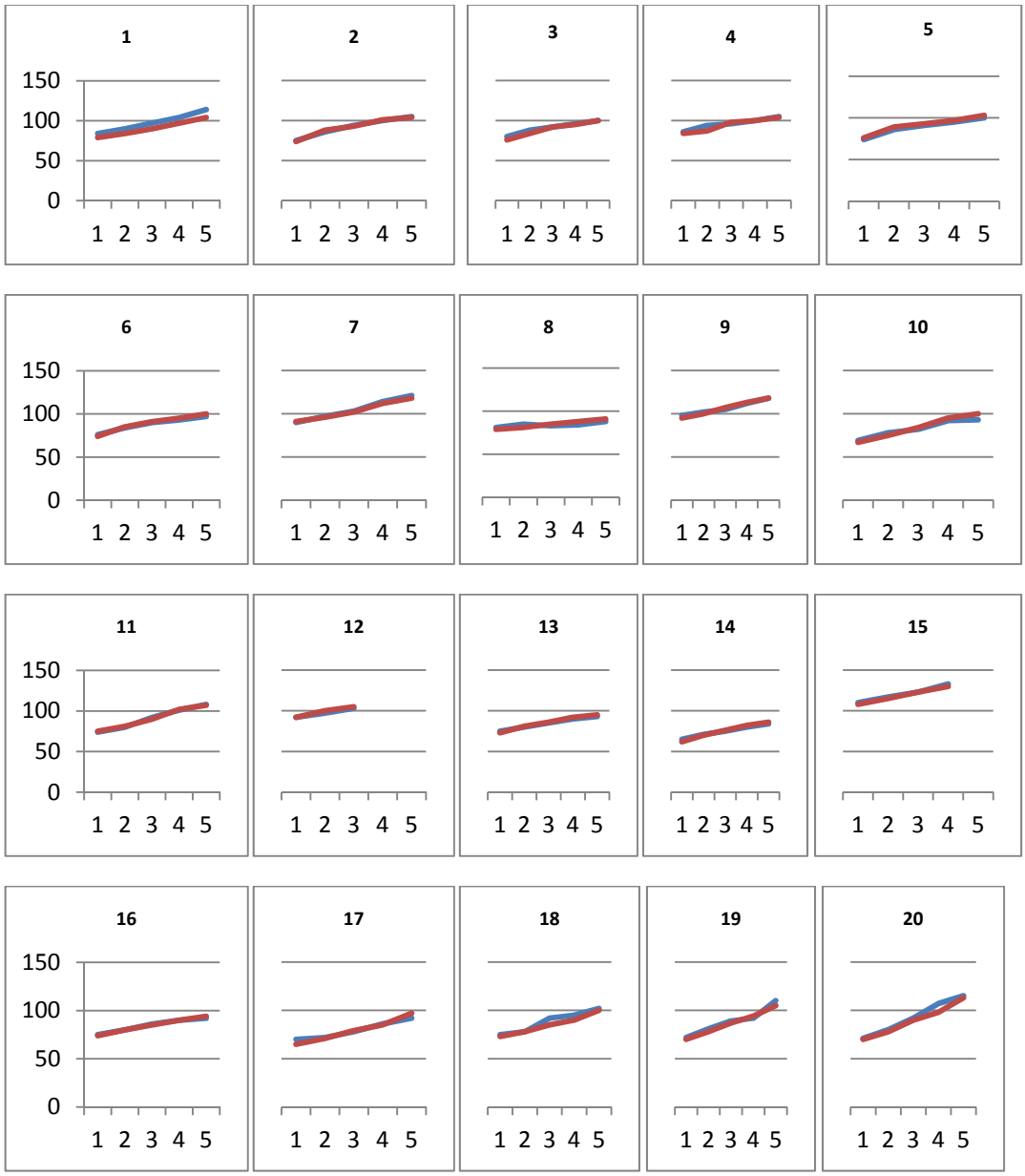

Fig 4.11 Individual Hr data for test 1 and test 2 (HR for test 1 is red line and test 2 blue line. HR is in Bpm on y axis and stage of CST is on x axis)

Figure 4.11 shows a close relationship between participants HR on test 1 and test 2. With only participants 1, 18 and 20 showing any obvious difference between their HR at each stage of the CST on test 1 and test 2.

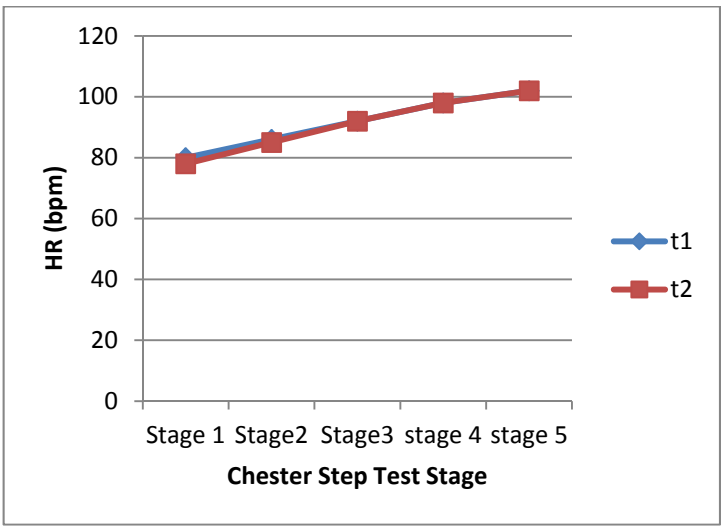

Fig 4.12 Mean HR at each stage of Chester Step test for Beta Blocked participants for test 1 and test 2

Figure 4.12 shows that the mean HR for participants over the two tests was identical for the final three stage with only slight elevation, in HR during stages 1and 2 of test 1 compared to test 2 This would suggest a strong degree of reliability between the HR collected over the two tests.

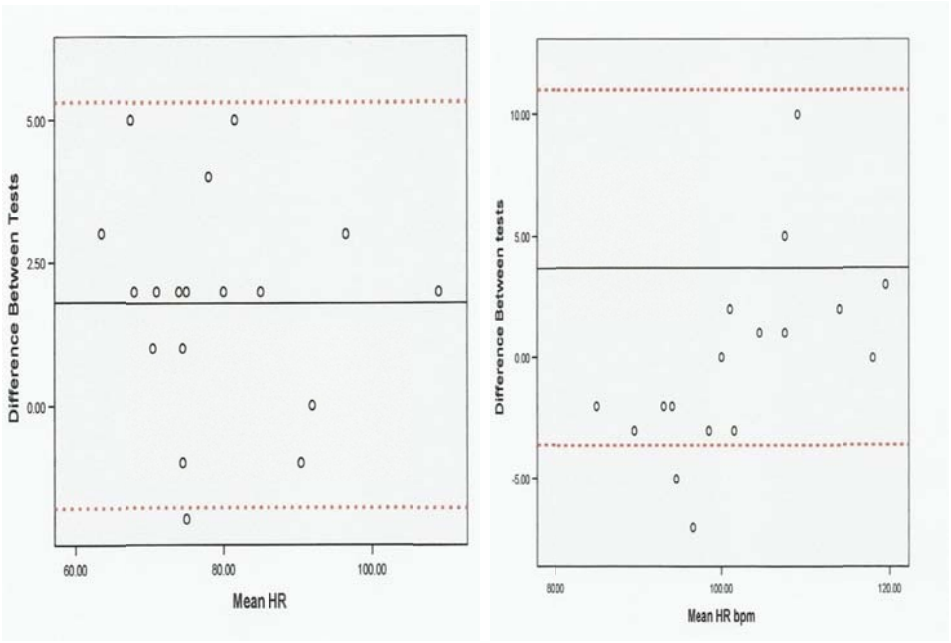

Fig 4.13 Bland and Altman Limits of Agreement for HR during Stage 1and Fig 4.14 Bland and Altman Limits of Agreement for HR during Stage 5

Figure 4.13 shows the 95% L.o.A for the mean HR and the difference between the HR in test one and test2. The graph shows allot of data around the mean with only one outside the 95% L.o.A.

Figure 4.14 shows a greater spread of the data from the mean during stage 5 with 2 pieces of data outside the 95% L.o.A.

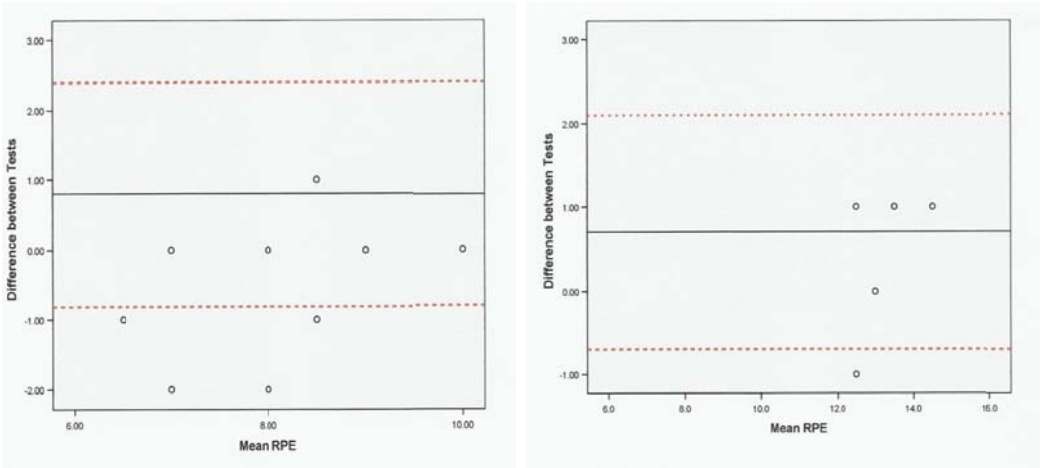

Fig 4.15 Bland and Altman Limits of Agreement for RPE during Stage 1 and Fig 4.16 Bland and Altman Limits of Agreement for RPE during Stage 5

Figure 4.15 shows 4 pieces of data outside the lower L.o.A for Stage 1 RPE data collected, suggesting an underestimation of RPE during test 1. Figure 4.16 shows the majority of data to eb around the mean with only one piece of data outside the 95% L.o.A.

5.0 Discussion

5.1 Overview

The study set out to assess the effect of BB on HR during incremental exercise and whether as the intensity of exercise was increased would the difference between BB and NBB HR responses increase. The key finding here was there was a significant difference between the two groups HR at each stage of the CST $P<0.05$ therefore accepting the null hypothesis. The second aim of the study was to assess if there was a difference in RPE ratings between the two groups during each stage of the CST. The results found RPE was not affected by BB despite showing a significant difference between the two groups RPE. This difference can be almost discounted by the parallel trend lines between the two groups RPE response, implying the difference between the two groups is more likely to be fitness than the effect of the BB. The final aim of the study was to assess the reliability of the CST in participants taking BB. The study showed good reliability between the two tests with L.o.A suggesting a maximum HR deviation of 11 bpm at peak exercise.

5.2 Heart Rate Analysis

The main finding of the study was a less acute slope for BB participants HR response to incremental exercise compared to NBB participants HR response to the same incremental exercise. The significant difference between the two groups HR through the t-test further confirms the difference between the two groups. The significant difference between the two groups HR is in keeping with the known physiological effects of BB, namely of a lower HR on exertion (Head,1999). The difference between the two groups HR was up to 25% or 20-30 bpm offering further support to the earlier findings of the effect of BB on HR compared to NBB HR by Van Hawaarden et al (1979), Pearson et al (1979), and Eston and Thompson (1997). When looking at the means of the two groups HR response, the difference between

the two groups at each stage of the CST increases as shown in table 4.4. The finding of an increase in the difference between the two groups and the non parallel slopes, contradicts the findings of Davies and Sargeant (1979) and Liu et al (2004), who suggested the HR relationship between BB and NBB during incremental exercise was a parallel one. It is difficult to explain the difference between the two groups as anything other than the effects of the BB. This statement is supported by the analysis of the HR response when %HRR is used instead of actual HR for the two groups at each stage of the CST. Through looking at %HRR at each level of the CST it allows for varying fitness levels between the participants to be discounted. The slopes between the two groups show the same relationship of an increase in the difference between the two groups as the intensity increases. The slopes for the %HRR are in fact much steeper than the HR slopes; this finding could have the most implications on exercise prescription. The findings of the BB mean %HRR at each stage of the CST are much lower than the current BACR, ACSM and AACVPR guidelines of 40-75%HRR. The BB group peak %HRR was 51%±14 with a peak RPE of 12 ±1 compared to the NBB peak %HRR of 91%±22 with a peak RPE of 13.5 ±0.9. This difference could of course be explained by the BB group being much fitter than the NBB participants. The finding is in keeping with that of Wosnich et al.(2003) who questioned the effect of BB on percentage HR max and found that when BB are participants are encouraged to exercise at 85% MHR they may well be exercising above their anaerobic threshold. This is something that would need much further investigation to offer an insight either way. When these findings are also considered with the recent research by Roberg and Landwehr, (2002) and Tanaka et al. (2001), thoughts on determination of MHR via the traditional 220-age method and its considerable flaws in the older and clinical populations. It further questions whether BB patients should have their own set of exercise prescription guidelines and not just the same set that are based on subjects not taking BB.

Another explanation for the difference in the data could be the difference between male and female. As all the BB data was males a comparison of HR at each stage of the CST was completed between males only from the

NBB group. Test 1 showed no difference in the steepness of the slopes, with the slopes running parallel as found by Davies and Sargeant (1979). There was a significant difference between the actual HR of the two groups as to be expected due to the physiological effect of the BB. Test 2 for the male only data showed similar findings to that seen for the male and female data. The main difference was seen between the means for the males with an increase in the difference between the means only been seen at stage 4. This finding slightly questions the findings of the slopes for the BB male and female data combined. However as the male only data is considerably different between the two tests, its evidence is inconclusive.

5.3 RPE Analysis

RPE findings between the two groups show a parallel relationship between RPE responses as intensity of exercise increases. The mean difference between the two groups was only on average 1 scale point. The finding of no effect of BB on RPE is in support of all previous findings of Pearson et al(1979), Eston and Connolly(1996) and Eston and Thompson (1997), who also found no effect of BB on subjects RPE rating during exercise. Due to the lack of difference in the relationship between the two groups RPE response, it offers further support, that the findings of the HR difference were related to the effect of the BB rather than fitness of participants. RPE for the male only data showed the same trend lines as the male and female data, suggesting no difference between the male and females RPE responses which were suggested by Eston and Thompson (1997). Eston and Thompson (1997) suggested that females had a tendency to over inflate their RPE rating for the same exercise level compared to male subjects.

The RPE findings of this study are different from most research findings in that the lower RPE readings for each stage of the CST are from the BB group. Eston and Thompson (1997) found in their study that not only females but those on BB had a tendency to over-inflate their RPE response. One possible explanation for this could again be the BB group were fitter than the NBB participants. Another possibility could be that in this study all participants were taking the cardio-selective BB compared to research by

Pearson et al. (1979) who used the non-selective BB Propanolol. Eston and Thompson (1997) stated cardio-selective BB is less likely to cause local muscle fatigue, compared to non-selective BB. Localised muscle fatigue can affect a person's perception of exercise. This study also used participants who were well established on their BB treatment where as many previous studies have used healthy individuals as subjects, who were given a one off dose of BB. The healthy participants in the studies may have overestimated their RPE due to the sudden physiological change they were experiencing due to the BB as found by Joyner et al.(1986) The RPE findings however could be explained for the BB as being potentially overinflated for the %HRR found for the BB participants compared to that of the NBB subjects.

5.4 Reproducibility of HR and RPE data on CST

The L.o.A data supports Sykes (1998) statement that the CST doesn't require a practice test. The difference in HR data was at stage one only a maximum of five bpm, which could be put down to human error in data collection and is not in clinical context a major difference between HR. The worst case difference in HR between the tests was up to 11bpm at stage 5 of the CST. This again in a clinical context isn't greatly significant considering the current recommended method for estimating MHR can be up to 20bpm above or below the initial figure obtained for an individual as stated by Roberg and Landwher (2002). When this figure is taken as % of HR there could be a difference of up to 11%, which for any patients with the possibility for ischemia on exercise could make a major clinical difference. The difference of 11% could potentially push a person into their ischemic or anaerobic threshold if they were exercising at the upper limits of exercise guidelines.

The findings for reproducibility of RPE are the same as that of Buckley et al (2009) with the greatest difference in RPE being 2 scale points. This finding supports the findings of Eston and Williams (1988) who also found excellent reliability for RPE between exercise sessions.

5.5Limitations to study

It is worth highlighting that for the L.o.A analysis a sample size of 40 is recommended by Atkinson and Neville (1998) cited in Coakes and Steed (2007) as this allows for improved reliability. Due to the time scale and the need to carry out 80 individual CST to achieve this sample size due to time constraints it was decided to halve the sample size.

The BB data was only able to be collected in the time frame on male participants and as seen in the data analysis this can have an effect on the HR data.

The data being compared in this study although completing the same test were conducted by different investigators. Although protocols between the two groups are similar, it can't be confirmed that the subjects underwent testing under the same conditions.

5.6 Suggestions for future research

The findings of this study generally supported the findings of previous studies. There were however a few differences to previous studies that could be researched further. The major difference between the two groups %HRR is an area which warrants further investigation as findings could have a long term effect on exercise prescription guidelines. The findings from this study would suggest the possibility of a separate exercise intensity guide for BB patients.

A larger sample size consisting of a full age range of Cardiac rehabilitation ages and incorporating both males and females on BB would allow for greater statistical power in findings and offer greater insight into some of the questions raised by this study of whether effects were purely related to BB or were there other possible contributing factors to the differences between the groups that were potentially masked due to the small specific sample size.

5.7 Conclusion

In conclusion this study clearly shows a greater difference between HR for BB and NBB at the upper levels of exercise intensity that can only realistically be explained by the effects of BB on HR rather than any other factor. This finding could have an effect on exercise prescription using %HRR for BB as there is potential if using current guidelines to exercise patients above their ventilator threshold. However this is a finding that needs considerable further research.

This study further adds to the growing body of research that RPE is unaffected by BB and that RPE is therefore a safe and practical tool to use for patients on BB to help guide their intensity within their exercise prescription.

With the finding that RPE is unaffected by BB, and the effect of BB requiring further research, it highlights the importance of in a clinical context of using at least both HR and RPE to guide exercise intensity in patients taking BB. By using this dual approach to monitoring exercise it will help reduce the risk of patients exercising in their anaerobic threshold which could happen when HR alone is used to monitor exercise. On the other side it can prevent patients not achieving appropriate levels of exercise for optimal physiological benefits which is still something to consider in particularly of the responses of females on BB.

References

Albert, C.M., Mittleman, M.A. Chae, C.U., Lee, I.M., Hennekens, C.H.and Manson, J.E. (2000). Triggering of sudden death from cardiac causes by vigorous exertion. ***New England Journal of Medicine***. 343 1355-1361

American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) (2004). **Guidelines for Cardiac Rehabilitation programmes.** (4th ed.) Champaign, IL: Human Kinetics.

American College of Sports Medicine (1990) Position Stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. ***Medicine and Science in Sports and Exercise***. 22(2) 265-274
American College of Sports Medicine (2006) **Guidelines for exercise testing and prescription.** (7th ed.) London: Lippincott, Williams and Wilkins.

Astrand, P. O. And Christensen, E.H. (1964) Aerobic work capacity.

Astrand, I., Astrand, P.O., Halback, I. And Kilborn, A. (1973) Reduction in maximal oxygen uptake with age. ***Journal of Applied Physiology*** 14 562-566

Balady, G.J., Fletcher, B.J., Froelicher, E.F., Hartley, L.H., Krauss, R.M., Obermann, A., Pollock, M.L. and Taylor, C.B. (1994) Statement on cardiac rehbailtation programs. ***Circulation.*** 90. 1602-1610

Blair, S.N., Kohl, H.W., Barlow, C.E., Paffenberger, R.S., Gibbons, L.W. and Macera, C.A. (1995) Changes in physical activity and all cause mortality. A prospective study of healthy and unhealthy men. ***Journal of American Medical Association***. 273 1093-1098

Bland,J.M. & Altman, D.G. (1986) Statistical methods for assessing agreement between two methods of clinical measurement. ***Lancet*** 307-310

Borg, G.A.V. (1998) **Borg's Rating of Perceived Exertion and Pain Scales.** Champaign, IL: Human Kinetics.

British Association for Cardiac Rehabilitation (BACR) (1995). **Guidelines for Cardiac Rehabilitation.** Oxford: Blackwell Science

Buckley, J. & Eston, R.G. (2007) In: Winter, E.M., Jones, A.M., Davison, R.R.C., Bromley, P.D.& Mercer, T.H. (eds) British Association of Sport and Exercise Sciences (2007) ***Sport and Exercise Physiology Testing: Guidelines. Volume 1: Sport Testing.*** The British Association ofSport and Exercise Sciences Guide. London: Routledge.

Buckley, J.P., Holmes, J. & Mapp, G. (1999) **Exercise on Prescription. Cardiovascular activity for health.** Oxford: Butterworth Heinemann.

Buckley, J.P., Sim, J., Eston, R.G. (2009) Reproducibility of ratings of perceived exertion soon after myocardial infarction: responses in the stress-testing clinic and the rehabilitation gymnasium. ***Ergonomics.*** 52(4) 421-427

Buckley, J.P., Sim, J., Eston, R.G., Hession, R. & Fox, R. (2004) Reliability and validity of measures taken during the Chester step test to predict aerobic power and to prescribe aerobic exercise, ***British Journal of Sports Medicine****.* 38, 197-205.

Buckley,J.P. Spurway, N. & MacLaren,D. (2008) **Exercise Physiology in Special Populations.** London: Churchill Livingstone Elsevier.

Chaloupka, V., Elbl, L., Nehyba, S., Tomaskova, I.& Jedlicka,F. (2005) Exercise intensity prescription after myocardial infarction in patients treated with beta blockers. ***Journal of Cardiopulmonary Rehabilitation,*** **25,** 361-365

Coakes, S.J. & Steed, L. (2007) **SPSS version 14.0 for Windows: analysis without anguish.** Sydney: Wiley.

Davies, C.T & Sargeant, A.J. (1979) The effects of atropine and practolol on the perception of exertion during treadmill exercise. ***Ergonomics***, 22, 1141-1146

Department of Health (DOH)(2000) National Service Framework(NSF) for Coronary Heart Disease Modern Standards and service models (online) available from http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4094275 (accessed 12th Oct 2010)

Dorn, J., Naughton, J., Imamura, D., and Trevisan, M. (1999) Results of a multicenter randomized clinical trial of exercise and long-term survival in myocardial infarction patients: The national exercise and heart disease project (NEHDP). ***Circulation*** 100. 1764-1769

Ehsani, A., Martin, W., Heath, G. and Coyle, E. (1982) Cardiac effects of prolonged and intense exercise training in patients with coronary heart disease. ***American Journal of Cardiology.*** 50. 236-254

Eston, R. G. & Connolly, D. (1996) The use of ratings of perceived exertion for exercise prescription in patients receiving beta-blocker therapy, ***Sports Medicine***, 2, 176-90.

Eston, R.G. & Thompson, M. (1997) Use of ratings of perceived exertion for predicting maximal work rate and prescribing exercise intensity in patients taking atenolol, ***British Journal of Sports Medicine***. 31, 93.

Eston, R.G. and Williams, J.G. (1988) Reliability of ratings of perceived exertion for regulation of exercise intensity. ***British Journal of Sports Medicine***. 22(4) 153-155

Gordon, N.F. and Scott, C.B. (1995) Exercise Intensity prescription in cardiovascular disease. Theoretical basis for anaerobic threshold determination. ***Journal of cardiopulmonary rehabilitation.*** 15-193-196

Gossard,D., Haskell, W.L., Taylor, C.B., Mueller,J.K., Rogers,F., and Chandler, M. (1986) Effects of low and high intensity home based exercise training on functional capacity in healthy middle aged men. ***American Journal of Cardiology.*** 57 446-449

Gutman, M.C., Squires, R.W., Pollock, M.L., Foster, C. & Anholm, J. (1981) Perceivedexertion-heart rate relationship during exercise testing and training in cardiac patients.***Journal of Cardiac rehabilitation***. 1:52-59.

Head, A. (1999) Exercise Metabolism and B-Blocker therapy. ***Sports Medicine.*** 27(2) 81-96

Joyner, M. J., Freund, B.J., Jilka, S.M., Hetrick, G. A., Martinez, E., Ewy, G.A. & Wilmore, J. H. (1986) Effects of beta-blockade on exercise capacity of trained and untrained men: a hemodynamic comparison. ***Journal of Applied Physiolology***. 60, 1429-1434

Karvonen,M.J., Kentala,E., and Mustala, O. (1957) The effects of training on heart rate : a longitudinal study. ***Annales Medicinae Experimentalis et Biologiae Fenniae***. 35 307-315

Kavanagh,T., Mertens,D.J., Hamm, L.F., Beyene, J., Kennedy, J., Corey,P. & Shephard,R.J. (2002) Prediction of Long –Term prognosis in 12,169 men referred for cardiac rehabilitation. ***Circulation*** 106. 666-671

Krone,R.J., Gillespie,F.M., Weld, F.M., Miller, J.P. & Moss, A.J. (1985) Low-level exercise testing after myocardial infarction:usefulness in enhancing clinical risk stratification. ***Circulation***. 71. 80-89

Lamb, K. (1998) Test-Retest Reliability in Quantitative Physical Education Research: A commentary. ***European Physical Education review.*** 4.(2). 145-152

Lamont, L.S., Romito, R.C., Finkelhor, R.S. & Kalhan, S.C. (1997) Beta1-adrenoreceptors regulate resting metabolic rate. ***Medicine and Science in Sports and Exercise***. 29, 769-774

Londeree, B.R. and Moeschberger,M.L.(1984) Influence of age and other factors on maximal heart rate. ***Journal of Cardiac Rehabilitation***. 41 44-49

Metkus,T.S., Baughmann,K.L. and Thompson, P.D. (2010) Exercise prescription and primary prevention of cardiovascular disease. ***Circulation***.121 2601-2604

Morris, J.N., Heady, J.A. & Raffle, P.A.B. (1953) Coronary heart disease and the physical activity of work. ***Lancet***. ii 1053-1057

Myers,J., Prakash,M., Froelicher,V., Do,D., Partington, S. & Atwood,E. (2002) Exercise Capacity and mortality among men referred for exercise testing. ***The New England Journal of Medicine.*** 346 (11) 793-801.

Noble, B. And Robertson, R. (1996) **Perceived Exertion**. Human Kinetics, Champaign, IL.

Peason, S.B., Banks, D.C. & Patrick, J.M. (1979) The effect of beta-adrenorecptor blockade on factors affecting exercise tolerance in normal man. ***British Journal of Clinical Pharmocology,*** 8, 143-148

Pescatello, L.S., Fargo, A.E., Leach, C.N. and Scherzer, H.H. (1991) Short-term effect of dynamic exercise on arterial blood pressure. ***Circulation*** 83, 1557-1561

Robergs,R.A &Landwehr R. (2002) The surprising history of the "HRmax=220-age" Equation. ***Journal of exercise physiology online***. Vol 5 (2)

Robertson,R.J. and Noble, B.J. (1997) Perception of physical exertion: methods, mediators and applications. In J.O Holloszy Exercise and Sport science reviews. Williams and Wilkins, 407-452

Schmid, J. (2003) Exercise prescription based on heart rate: a simple thing or science. ***European Journal of Cardiovascular Prevention and Rehabilitation.*** 10. 302-303

Sesso,H. D. Paffenbarger, R.S. & Min Lee, I. (2000) Health Study Physical Activity and Coronary Heart Disease in Men : The Harvard Alumni ***Circulation*** 102:975-980

Shaper, A.G., Wannameethee, G. & Weatherall,R. (1991) Physical activity and ischaemic heart disease in middle aged British men. ***British Heart Journal.*** 66 384-394

Shephard, R.J. and Balady, G. J. (1999) Exercise as Cardiovascular Therapy. ***Circulation.*** 99. 963-972

Sjoberg, H., Frankenhaeuser, M. & Bjurstedt, H. (1979) Interactions between heart rate, psychomotor performance and perceived effort during physical work as influenced by beta-andrenergic blockade, ***Biological Psychology***, 8. 31-43

Sykes, K. (1998) **Chester step test: resource pack (Version 3).** Chester College of Higher Education: Cheshire.

Sykes, K. & Roberts, A. (2004) The Chester step test- a simple yet effective tool for the prediction of aerobic capacity, ***Physiotherapy***. 90, 183-188.

Tabet,J., Meurin, P., Teboul, F., Tartiere, J., Weber, H., Renaud, N., Massabie, R., and Driss, A. B. (2008) Determination of exercise training level in coronary artery disease patients on B blockers. ***European Journal of Cardiovascular Prevention and Rehabilitation.*** 15. 67-72

Tanaka, H., Monahan, K.G., and Seals, D.S. (2001) Age-predicted maximal heart rate re-visited***. Journal of American College of Cardiology***. 37 153-156

Tegtbur, U., Pethig, K., Machold, H., Haverich, A., and Busse, M. (2003) Functional endurance capacity and exercise training in long term treatment after heart transplantation***. Cardiology*** 99 171-176

Thompson, P.D. (2005) Exercise prescription and proscription for patients with coronary artery disease. ***Circulation*** 112 2354-2363

Thompson, P.D., Franklin, B.A., Balady, G.J., Blair, S.N., Corrado, D., Estes, N.A., Fulton, J.E., Gordon, N.F., Haskell, W.L., Link, M.S., Maron, B.J., Mittleman, M.A., Pelliccia, A., Wenger, N.K., Willich, S.N, and Costa, F. (2007)American Heart Association Council on nutrition , physical activity and metabolism; American Heart Association on clinical cardiology; American College of Sports Medicine. Exercise and acute cardiovascular events: placing the risks into perspective: a scientific statement from the American Heart Association Council on nutrition, physical activity and metabolism; and the council on clinical cardiology. ***Circulation.*** 115 2358-2363

Tran, Z.V. and Weltman, A. (1985) Differential effects of exercise on serum lipid and lipoprotein levels seen with changes in body weight. ***Journal of American Medical Association***. 254 919-924

Troisi, R.J., Heinhold, J.W., Vokonas, P.S. and Weiss, S.T. (1991) Cigarette smoking, dietary intake and physical activity: effects on body fat distribution: the normotive aging study. ***American Journal of Clinical Nutrition.*** 53. 1104-1111

Unal, B., Critchley J.A., Fidan, D., and Capewell, S. (2005). Life-years gained from modem cardiological treatments and population risk factor changes in England and Wales, 1981-2000. ***American Journal of Public Health*** 95:103-8.

Van Hawaarden, C.L., Binkhorst, R.A., Fennis, J.F. & van Laar, A. (1979) Effects of propanolol and metoprolol on haemodynamic and respiratory indices and on perceived exertion during exercise in hypertensive patients. ***British Heart Journal***, 41, 99-105

Wosnich. M., Hofmann, P., Fruhwald, F.M., Kraxner, W., Hodl, R., Pokan, R. & Klein, W. (2003) Influence if beta-blocker use on percentage fo target heart rate exercise prescription. ***European Journal of Cardiovascular prevention and Rehabilitation***. 10, 296-301

Countess of Chester Hospital NHS
NHS Foundation Trust

University of Chester

Participant Information Sheet

Title of Project: Effect of Beta Blockers on Heart rate response during the Chester step test

You are being invited to take part in this research study. Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

The purpose of this research is to look at how Beta Blocking medication affects Heart Rate Response during incremental exercise. By comparing the heart rate response during the same submaximal incremental test of those who are on beta blocking medication and those who are not, this will then provide a foundation for further research to aid exercise prescription for cardiac patients who are taking beta blockers.

Why have I been invited?

You have been chosen due to your recent commencement on your cardiac rehabilitation programme, being in the appropriate age bracket and either taking or not taking beta blocker medication.

Do I have to take part?

It is up to you whether or not to take part. If you decide to take part you will be given this participant information sheet to keep and be asked to sign a consent form. If you decide to take part you are free to withdraw at any time, and a decision not to take part will not affect the research or your care in anyway.

What will happen to me if I take part?

You will be required to attend two exercise testing sessions which will take place at the Countess of Chester hospital, which will last approximately 30 min each. There will be a break of one week between the two testing sessions. For both sessions you will work up to approximately 75% of your maximum, which is the same level as you would be working during your regular cardiac rehabilitation sessions. The test will involve you stepping on and off a low level step to the beat set by a CD. In both testing sessions the following measurements will be taken:

1. Heart Rate (for which you will be required to wear a Polar heart rate monitor, which is a watch and a elastic strap around your chest)
2. Rating of perceived exertion (a measurement of how hard it feels while your exercising)

Before each testing session you will be required to fill out a brief health screen (there will be someone there to help you if you need it).

What are the possible disadvantages and risks of taking part?

It is possible when undertaking the test or after the test you may have some muscle discomfort in your legs.

What are the possible benefits of taking part?

There are no specific benefits for taking part, other than you will have a basic idea of your current level of fitness. However the information obtained may contribute towards more effective ways of prescribing exercise for future cardiac rehabilitation patients.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of Faculty of Applied Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the study will have access to such information.

What will happen to the results of the research study?

The results will be written up in a report and possibly used for research publication. Individuals who participate will not be identified in any subsequent report or publication.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part please contact:

Countess of Chester Hospital NHS
NHS Foundation Trust

University of Chester

CONSENT FORM

Title of Project: Effect of Beta Blockers on Heart rate response during the Chester Step Test

Name of Researcher: Joanne Gilchrest

Participant ID:

Thank you for reading the information about our research project. If you would like to take part, please read and sign this form.

PLEASE INITIAL THE BOXES IF YOU AGREE WITH EACH STATEMENT:

1. I have read the information sheet dated ... for the above study and have been given a copy to keep. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to Withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐
3. I know how to contact the research team if I need to. ☐
4. I agree to participate in this study. ☐

_____	_____	_____
Name of Patient	Date	Signature
_____	_____	_____
Name of person taking consent	Date	Signature

When completed 1 for participant: 1 for researcher 1 (original) to be kept in medical notes

Protocol for Chester Step Test

This test is a submaximal test. It is performed twice. Once at the first exercise session and repeated a week later.

Equipment

- Suitable room for testing.
- A step of the required height (15cm)
- Chester Step Test audio CD
- CD player of sufficient power output that it can be clearly heard by the participant.
- HR and RPE recording sheet
- Polar Heart rate monitor
- Rating of perceived exertion scale (RPE)

Safety Equipment required

- Defibrillator
- Oxygen
- Oxygen mask
- Phone

Method

1. Participants will be health screened to ensure their suitability to perform the test.
2. Baseline measurements will be taken for Blood pressure and polar heart rate monitor put on and resting heart rate taken..
3. Participant will perform the test.

Chester Step test

1. Set up room, with CD player, and 15cm step.
2. Explain to patient what is involved through each of the test and what measures will be taken at the end of each stage.
3. To begin the test the patient stands in front of the step and when the CD starts the patients steps on and off the step to the beat set by the CD.
4. At the end of each 2 minute stage (maximum of 5 stages) the participants HR and RPE are recorded.
5. The test is terminated when the participant achieves 80% of their maximal Heart rate (based on 220-age), they reach an RPE of 15(hard), they complete all 5 stages, or at a participants request to stop the test.