Chapter 1

Introduction

1.1 Background

Fitness testing and appropriate advice about exercising at a safe level can be a powerful trigger for personal positive action. Testing will become substandard if the methods used to ascertain levels of fitness are proved to be invalid and unreliable. Aerobic capacity is the ability to take up, transfer and utilise oxygen and is important to the functioning of an individual. According to the ACSM (2000) the basic aim of using submaximal testing helps to determine the heart rate to one or more submaximal work rates and then these can be used to predict the maximum volume of oxygen consumption, this is based upon the physiological principle that there is a direct linear relationship between heart rate and workload. This is the basis for all submaximal testing that use heart rate as a measure of intensity using the maximal heart rate formula. Although submaximal testing involves substantial errors it does give useful information on a person’s functional capacity (Howley & Franks 1992). Maximal oxygen uptake can be reasonably predicted from sub maximal work (Johnson and Siegel 1981) although Bouchard et al (1990) stated the only way to determine an individuals’ functional capacity is to measure it during a maximal test, this is not always safe or practical to carry out. The changes in heart rate (HR), rating of perceived exertion (RPE) and blood pressure (BP) following an exercise programme make a sub maximal test a good
mechanism for showing changes in cardio respiratory function (Howley & Franks 1992).

Most activities of daily living represent exertion at sub maximal exercise levels.

There are several methods available for the objective evaluation of functional exercise capacity. Some provide a very complete assessment of all systems involved in exercise performance (high tech), whereas others provide basic information but are low tech and are simpler to perform (American Thoracic Society 2002, Weisman & Zeballous).

The classical method of measurement of cardio respiratory fitness is by direct measurement of maximum oxygen uptake ($VO_{2\text{max}}$) or aerobic capacity (ACSM 2000). However, this gold standard test requires expensive equipment and a high level of technical expertise and supervision. It is also unsuitable for those individuals for whom exhaustive exercise is not recommended.

Patients with cardiac disease often present with limited activity levels and decreased exercise capacity, step tests and walk tests are used as a means of evaluating functional status and monitoring treatment effectiveness. Sub maximal exercise testing is therefore a common alternative to determine and predict a patient’s cardio respiratory fitness (Stevens and Sykes 1996). These tests also indicate the patients’ ability to undertake the demands of daily living e.g. walking. They are considered objective measures that provide a means of monitoring response to treatment (Singh 1992) and also allow exercise to be
individually prescribed at the appropriate level and may also be used as a health risk indicator (ACSM 2000).

Use of VO$_{2\text{max}}$ is not feasible because it requires sophisticated equipment and participants must exercise to the point of volitional fatigue under medical supervision.

Walk tests and step tests require less technical expertise and equipment than traditional laboratory tests which normally use treadmill or cycle ergometers, making them less expensive and more easily administered. They also employ an activity that individuals perform on a daily basis (Singh 1992). Bearing in mind the continual drive in the NHS to save money but also prove and improve the effectiveness of treatments and programmes by valid outcome measures, it is important that we can test individuals using only a limited budget but with reliable tools.

1.2 Definition of Cardiac Rehabilitation (CR)

In 1993 the World Health Organisation defined Cardiac Rehabilitation as follows

“The rehabilitation of cardiac patients is the sum of activities required to influence favourably the underlying cause of the disease, as well as to ensure the patients best possible physical, mental and social conditions so that they may, by their own efforts, preserve, or resume when lost, as normal a place as possible in the life of the community. Rehabilitation cannot be regarded as
an isolated form of therapy, but must be integrated with the whole treatment, of which it forms only a facet.”

A more streamlined definition is to be found in the Scottish Intercollegiate Guidelines Network (SIGN) Jan 2002

“Cardiac Rehabilitation is the process by which patients with cardiac disease, in partnership with a multidisciplinary team of health professionals, are encouraged and supported and maintain to achieve optimal physical and psychosocial health.”

Traditionally Cardiac Rehabilitation (CR) has been provided as a standard package of care for patients following an acute cardiac event such as myocardial infarction (MI) or coronary artery bypass surgery (CABG). However it is now recognised that other patients with established coronary heart disease (CHD), such as angina, chronic heart failure and cardiac transplantation, would also benefit from this multiphasic intervention.

A multidisciplinary team is needed to deliver the optimum programme to the individual. Furthermore, each programme is individually prescribed so that patients have to take their own responsibility to change their lifestyle.

Fitness tests enable individualised prescription of exercise, fitness improvements to be monitored and help to motivate participants by establishing goals that are achievable.
1.3 Aim of the study

To look at the reliability of the ISWT and the CST when performed to assess functional capacity, to see if they are interchangeable when used for the purpose of measuring changes in exercise capacity.

In the clinical setting if we use two different tests for the same purpose it is important to establish whether the two tests are interchangeable. Altman & Bland (1986) suggested that the coefficient of relation only represented the strength of relation between the two variables, not the agreement between them. If the differences are too large, even if they correlate well, they would not be interchangeable in the clinical setting. Sykes and Roberts (2004) found that the CST was highly repeatable (95% limits of agreement was 4.5 mlO$_2$/kg/min) in addition to high correlation with the maximal test.

For the purposes of this research the Incremental Shuttle Walk Test (ISWT) and Chester Step Test (CST) were compared in the context of the cardiac rehabilitation programme. There is evidence of their general reliability and test retest validity (Singh 1992, Sykes 1998). The CST was developed for use with apparently healthy individuals (Sykes 1995). In 1992 Singh and colleagues developed the ISWT, a walk test based on the 20m shuttle run test (Léger, Lambert 1982) to assess functional capacity originally for individuals with pulmonary disease, but is also now widely used with patients with heart failure (Morales et al 1999). SIGN Guidelines (2002) recommends the use of the ISWT as a measure of exercise capacity in cardiac rehabilitation, it is considered more suitable for the elderly rehabilitation population who perform poorly on a treadmill test and is a cost effective alternative (Singh, Morgan,
Scott, Walters and Hardman 1992). There have been reports of a good correlation between ISWT and peak VO$_2$ in patients with heart failure (Morales et al 1999).

The need to undertake a practice test has been identified with the ISWT within the cardiac population (Morales et al 1999, Fowler et al 2005, Jolly et al 2008). The need for a practice test with the CST has not been established (Sykes, Roberts 2004), Buckley et al (2004) stated that the CST is reliable on a test-retest basis although they found the CST VO$_{2\text{max}}$ prediction validity is questioned.

The reason for this study is that practitioners employ both the ISWT and CST to evaluate the effectiveness of the exercise component of the Cardiac Rehabilitation Programme, the choice of test being dependant on the room available at assessment: The CST needing less room than the ISWT. It would be beneficial to have an indication of inter-test reliability in a cardiovascular rehabilitation setting.

1.4 Hypotheses:

1. There will be no difference between the results for the practice ISWT and the test carried out at the first session pre-programme

2. There will be no difference between the results for the practice CST and the test carried out at the first session pre-programme

3. The ISWT and the CST have equal reliability as predictive measures of cardiovascular performance
4. There will be no difference in the percentage change in recorded exercise capacity in the patients who have been enrolled and have completed the eight-week cardiac rehabilitation programme between the Incremental Shuttle Walk Test (ISWT) and the Chester Step Test (CST).

5. Patients have no preference between the two tests

1.5 The Role of Exercise

Coronary heart disease (CHD) (also known as coronary artery disease (CAD)) is characterized by a narrowing of the small blood vessels that supply blood and oxygen to the heart (coronary arteries). CHD usually results from the build up of fatty material and plaque (atherosclerosis). As the coronary arteries narrow, the flow of blood to the heart can slow or stop. The disease can cause chest pain (stable angina), shortness of breath, heart attack, or other symptoms.

Those with CHD vary in many respects depending on disease severity, extent of left ventricular (LV) impairment, age, gender, orthopaedic problems, co-existing medical conditions, medication, risk factor status and initial fitness level.

The greatest benefits to those with cardiac disease will accrue from using the largest possible muscle mass in repetitive movements. The inclusion of a variety of exercise modes minimises the incidence of over-use injuries and will maximise peripheral adaptations.

Exercise seems to restore impaired vascular function in both peripheral and myocardial vessels in patients with coronary artery disease, peripheral vascular disease or in patients with risk factors for these diseases (Hambrecht et al. 1998). The studies on apparently healthy subjects are not as clear cut. In 2007 Hannukainen et al found no improvement in myocardial perfusion reserve and endothelial function in peripheral arteries and myocardial vessels after increased physical activity and fitness in young healthy adult men.

There have been found to be differences between intermittent and continuous endurance training, the former improves both central and peripheral components whereas the latter is mainly associated with greater oxygen extraction (Daussin et al 2007)

Studies show quite consistently that regular exercise training restores impaired vascular function (1997; Hambrecht et al., 1998), but the results on how exercise training influences vascular function in apparently healthy and low-risk subjects are controversial (Bergholm et al., 1999; Clarkson et al., 1999; DeSouza et al., 2000).