Cardiovascular Disease, Blood Pressure and Exercise

Cardiovascular disease is a major health concern in Australia. The morbidity and mortality rates from high blood pressure (hypertension) and cardiovascular disease are growing due to the large and rapid increase in the number of overweight and obese individuals in the population. Hypertension increases cardiovascular risk and although there are a range of cardiovascular conditions, the most common associated with obesity is arteriosclerosis. This can lead to serious cardiovascular complications such as myocardial infarction (heart attack), angina and ischemia.

**Myocardial Infarction (MI)**

What is it?

When there is vascular inflammation and an accumulation of lipids, macrophages, blood-clotting elements, calcium and fibrous connective tissue within the inner lining of coronary arteries this results in a disease known as coronary arteriosclerosis or disease (CAD). Particular changes that happen over a period of time cause arteries to become obstructed making it hard for normal blood flow to occur. Arteriosclerotic plaques or lesions can form, vascular remodeling and luminal stenosis can occur. This can happen in varying degrees. When there is obstruction of blood flow momentarily it is known as myocardial ischemia. When blood flow becomes completely obstructed it is known as myocardial infarction.

The most common area for these lesions to form is in the proximal, epicardial segments of coronary arteries at sites of abrupt curvature or branching. The effects of the lesions can be amplified by various other factors such as hemorrhage, ulceration, calcification or thrombosis. Plaque that forms in arteries is made of fibrous tissue and also a smaller amount of lipids. Not all plaques are the same. Some can be quiet and stable, others can be active and unstable. Unstable plaques can become a problem. Plaques that are classified as either mild to moderate sized (around 50% stenosis) that are unstable have the ability to fissure, rupture, and swell or a combination of all these things. If this does occur in a vulnerable region with a coronary artery it can lead to a sudden, complete and fatal obstruction to the artery resulting in an acute myocardial infarction (AMI).

There are things that can be done to avoid getting to this point. Reducing total and LDL cholesterol is a big factor. Latest research tells us that inflammation is a key factor in the arteriosclerotic process and CAD as well as triggering AMI. There are certain blood markers that indicate inflammation. One is called C-reactive protein (CRP) and the other is called lipoprotein-associated phospholipase A2 (PLAC). CRP is an indication of inflammation and has been shown to predict coronary risk in middle aged men and women. PLAC has been shown to predict cardiovascular events in patients who have relatively low levels of LDL. Prolonged ischemia (greater than 60 mins)
causes irreversible cellular damage and necrosis, leading to acute MI. Approximately one third of those who have a heart attack will die.

**Characteristics of an MI**

An individual may feel chest pain or pressure that is severe and prolonged in nature and may refer to other areas of the body such as the arms, back or neck. This may be accompanied by sweating, nausea or vomiting.

MI’s usually affect the left ventricle and occurs in two different ways. A transmural infarction involves the full thickness of the ventricular wall. A subendocardial infarction involves the inner half of the myocardium. Each type involves the permanent cessation of the contractile function of the necrotic area of the myocardium and impaired contractility in the surrounding ischemic muscle.

After somebody has an AMI, the risk of them having future cardiovascular problems is determined by 3 things;

- the extent of the left ventricular damage
- the degree of residual myocardial ischemia
- the level of cardiorespiratory fitness

Recent research suggests that reduced exercise capacity is the most likely factor to predict 5 year mortality.

**Effects on exercise**

Individuals who have had an MI in the past will have a reduced capacity in cardiorespiratory fitness. They will generally perform at around 50-70% of their age and gender norms. They will experience reduced cardiac output (stroke volume, heart rate or both).

**Benefits of exercise for those with cardiovascular disease**

The ACSM identifies some major benefits such as;

- Increased maximal oxygen consumption
- Improvement in ventilatory response to exercise
- Relief of anginal symptoms
- Decreases in body weight, fat, BP (particularly in hypertensives), total blood cholesterol, serum triglycerides and LDL cholesterol
- Increases in HDL
- Protection against triggering of MI
- Decreased coronary inflammatory markers (eg CRP, PLAC)

Recent studies have shown that exercise rehabilitation after MI elicits a 20-25% decrease in cardiovascular related mortality. Some studies suggest this is partly due to advancements in therapy of revascularization, however, at least one study has suggested it is a demonstration of the benefits of cardiac rehab in an exercise setting.
Management and Medications

Medication management is essentially used to minimize the severity of the heart disease. Individuals who are at moderate to high risk are likely to experience a high reduction in mortality from surgical procedures – coronary angioplasty and coronary artery bypass. Other interventions are also recommended such as stopping smoking, diet modification, increasing physical activity, weight loss, hypertension control and medications. All of these interventions have been shown to reduce mortality and morbidity by up to 25%. Combining treatments shows an even greater improvement.

Appropriate medication acts to decrease mortality after an AMI, reduce ischemic syndromes, improve symptoms of angina, reduce arrhythmias and inhibit platelet function. Anti-ischemic drugs include beta-blockers, calcium channel blockers, nitroglycerin and longer acting nitrate drugs. Other drugs that may be used include platelet inhibitors, anticoagulants, medications for heart failure such as digitalis, diuretics, ACE inhibitors, vasodilators, antiarrhythmic drugs and lipid altering drugs.

Cardiovascular medications can influence exercise. Different medications alter exercise capacity in different ways;

- Diuretics do not alter aerobic capacity so heart rate can be determined as per usual.
- Beta blockers act to decrease heart rate and exercise capacity. They can also sometimes stop or delay ischemia. Despite a reduced training heart rate, the ability to train is unaffected. Betablocker do not alter the relationship between VO2 max and HRmax so the usual 70-85% of HR max can be prescribed.
- Some medications will not affect the heart rate response to exercise such as vasodilators, ACE inhibitors and Angiotensin receptor blockers. They may however cause hypotensive episodes after exercise if an adequate cool down has not been performed.
- Calcium channel blockers do not alter functional capacity and may actually increase exercise tolerance. It is important to consider that some types of this medication lower the heart rate response at rest and during exercise so the clients prescribed training heart rate should be based on their medicated response.
- Alpha receptor blockers have an effect on both systolic and diastolic blood pressure but will not have much affect on heart rate so usual training prescriptions can be used.

Exercise programming

Recommendations include;

- whole body exercises involving both sets of limbs
- mild to moderate resistance training
- multiple short bouts of physical activity into daily life
- Intensity – 40-80% of HRR using PRE as well. A recent study concluded that the minimal heart rate to improve cardiorespiratory fitness in this population group is 45% HRR
- Frequency 4-7 nonconsecutive days per week
- Duration – 20-60 mins of continuous or accumulated interval exercise
- Warm up and cool down of at least 5-10 minutes
- Maximum benefit requires 5-6 hours per week of exercise
- Strength - 30-40% 1RM upper body, 50-60% 1RM lower body, avoid valsalva, 2-3 days per week, 2-4 sets of 12-15 reps, 8-10 different exercises

**Hypertension**

Elevated blood pressure is a major concern in Australia. It is linked with fatal and nonfatal cardiovascular disease, stroke, renal disease, and a whole range of other illnesses. There are risks with even slightly elevated blood pressure and the cardiovascular risk in particular rises as the level of blood pressure reading rises.

**Effects on the Exercise response**

An exercise session will cause a rise in systolic blood pressure for an individual who is unmedicated with hypertension. Their normal systolic blood pressure level is already at an elevated level so the level it reaches during exercise will be higher than an individual who does not have hypertension. In addition to this, their diastolic blood pressure may not change or may even rise during exercise as they have an impaired vasodilatory response.

Studies have shown that an individual who exercises for 30-45 minutes at a moderate intensity will have a reduction of 10-20mmHg in their systolic blood pressure in the 1 to 3 hours that follow the session. This can last for up to 9 hours after training and appears to be caused by a transient decrease in stroke volume. High blood pressure is best managed through lifestyle modifications such as exercise as well as hypertensive medications.

**Effects of exercise training**

Evidence suggests that endurance training can prevent those at risk of developing hypertension from getting elevated blood pressure. Studies have shown that exercise can also decrease blood pressure in those that are already hypertensive, with an average reduction of about 5-7mmHg in both systolic and diastolic blood pressure.

Individuals with hypertension who are physically active and have a higher level of cardiorespiratory fitness have a much lower mortality rate than those who are not active.

Resistance training does show a small decrease in blood pressure over time but has not been seen to show as much benefit as endurance training. Heavy resistance exercise involves a moderate increase in heart rate and cardiac output, however not to the same extent as endurance exercise. Heavy resistance exercise does induce a greater elevation in both systolic and diastolic blood pressure. Studies done on the benefit of resistance training in the long term are conflicting, however none have shown the same degree of reduction as endurance training.
Management and medications

The goal of treatment is to reduce cardiovascular risk by controlling blood pressure. Treatment will involve either medication or lifestyle modification, or both. The general goal is to reduce systolic blood pressure to a healthy range as once this is within normal range the diastolic goal will also have been reached.

Lifestyle modifications include:

- lose weight or maintain a healthy weight
- limit alcohol intake – 2 drinks or less in men, 1 drink or less in women
- Aerobic activity for at least 30 minutes on most days of the week
- Reduce salt intake
- Eat a diet full of fruits, vegetables and low in saturated fat and cholesterol
- Stop smoking

Medication will be given in combination with lifestyle modifications if;

- the level of blood pressure elevation is severe
- the individual also has cardiovascular disease
- the individual has other medical conditions
- there are other risk factors for cardiovascular disease

Most people who require drug therapy will require two or more medications. For those with uncomplicated hypertension a diuretic type drug will be first prescribed. If the level of hypertension is higher risk then this will often be combined with an antihypertensive drug. The aim of medication is to gradually decrease blood pressure and medication will be changed accordingly as time progresses.

Recommendations for Exercise Programming

A resting systolic blood pressure higher than 200mmHg, or a resting diastolic blood pressure higher than 115mmHg, is considered a contraindication to exercise. During exercise if systolic blood pressure reaches 250mmHg or if diastolic reaches 115mmHg then the exercise session should be stopped.

For those with extreme elevations in blood pressure (readings of greater than 180/110) it is generally recommended that exercise is added after drug therapy has begun.

Guidelines include;

- large muscle groups using aerobic endurance activities
- most, if not all days of the week
- aim for at least 30 minutes of activity per day – this can be continuous or accumulated
- aim for an intensity of 40% or 60%
- for individuals on beta-blockers consider that there will be a reduction in heart rate of around 30 contractions per minute
- alpha blockers, calcium channel blockers and vasodilators may cause post-exertional hypotension so it is important to incorporate a longer cool down

Research has also shown that exercise at a lower intensity appears to lower blood pressure as much, if not more than at a higher intensity. In exercise, aim for maintenance of systolic blood pressure less than 220mmHg and diastolic blood pressure less than 105mmHg. Resistance training can be beneficial but not as the only form of exercise as it doesn't act to improve blood pressure greatly. If using resistive training use lower resistances and higher repetitions (8-12 reps at 60-80% 1RM).

Vigorous exercise carries more risk than low-moderate exercise. With intense physical exertion plaques that have built up in arteries are more prone to rupture than in lower intensity exercise. For anyone beginning an exercise program that is in a detrained state, they need to start with low intensity exercise such as walking.

**Hormonal function and Cardiovascular Disease**

Leptin is a hormone responsible for maintaining a healthy body weight. There are leptin receptors throughout the body meaning that this hormone also plays a role in supporting cognition, immunity and blood pressure. High leptin levels have also been seen to be prevalent in certain population groups such as women with premenstrual syndrome and individuals with hypothyroidism. Certain cardiovascular conditions have also shown high levels of this hormone. Leptin receptors are expressed in coronary arteries and in the heart. Evidence supports that those with left ventricular hypertrophy, a major risk factor for congestive heart failure, have high levels of leptin. The higher the leptin levels, the greater the left ventricular mass. Research also shows that leptin also predicts fibrinogen, a clotting factor that is also a major indicator for heart disease.

**References**


Mukherjee R, Villereal D, Reams GP, Freeman RH, Tchoukina I, Spear RM, 2006, Leptin as a common link to obesity and hypertension, *Top Med Cardiovascular Disease*, 2:10


Myers, Jonathon, N, 2009, Chronic Heart Failure, *Exercise Management for Persons with Chronic Diseases and Disabilities*, Chapter 12, pp 92-97
