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Coronary Heart Disease Part II: Role of Physiotherapy

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Abstract

Cardiovascular diseases are the leading cause of disability globally and despite the advances in clinical care and medicine, continue to be the principal cause of morbidity and mortality. Cardiac Rehabilitation is a complex intervention which requires the input of a multidisciplinary team to deliver the recommended seven core components. Physiotherapists have the appropriate training, knowledge and skills to deliver the exercise component of cardiac rehabilitation and help patients return to their activities of daily life. However, cardiac rehabilitation remains underutilized due to poor referral and enrollment post discharge. Evidence have demonstrated the beneficial role of physiotherapy in cardiac rehabilitation. This review will analyze the physiotherapy management in all stages of rehabilitation, pre-surgery and post-surgery.

Keywords: Cardiac rehabilitation; secondary prevention; core components; exercise; physiotherapist.

1 Introduction

Cardiovascular diseases (CVD) are growing radically with an estimation of 12 million people dying each year, mainly in the developing countries (World Health Organisation, 2013). As the burden of CVD growths, coronary heart disease (CHD) is becoming the main cause of cardiac surgery worldwide (Go et al., 2013). The management of cardiac diseases requires the cooperation of a multidisciplinary team, including physiotherapists (Berney, Haines & Denehy, 2012). Physiotherapists join cardiologists and surgeons, nurses and other members of the multidisciplinary team in order to promote patients' health and help them return to their activities of daily life (ADL) (Balady et al., 2007; Mampuya, 2012).

In addition to that, physiotherapists also have a vital role in improving patients' functional recovery in pre-operative and post-operative phases. Early physiotherapy intervention has been shown to reduce complications, hospitalization rates and mortality, thus to promote quality of life (QOL) (Arcêncio et al., 2008). In the later stages of rehabilitation, physiotherapy is proven to be essential for patients' recovery as it enables them to return to their ADL (Arcêncio et al., 2008; Renault, Costa-Val, & Rossetti, 2008). During cardiac rehabilitation (CR), several multidisciplinary interventions aim to modify patients' risk factors (Lima, Cavalcante, Rocha & de Brito, 2011) as well as sustain and enhance the optimal level of physical functioning, socialization and mental status of the patient (Bethell, et al., 2000; Lima et al., 2011; Mampuya, 2012). This review will discuss the the physiotherapy management for each stage of rehabilitation.

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2 Physiotherapists' role in cardiac surgery

Taking into consideration the PPC that may develop, physiotherapists pre-surgery should identify those patients at-risk and prevent or minimize the possibility of complications (Pasquina, Tramer & Walder, 2003). Moreover, the role of physiotherapy has been well described in the guideline presented by the Association of Charted Physiotherapists in Cardiac Rehabilitation [ACPICR] (2015), in terms of cardiovascular and physical assessment.

Physiotherapists have a role in improving physical activity in all phases of CR, however, they mainly get involved in phase III (ACPICR, 2015). The components of these guidelines are based on patient's physical needs and the level of cardiovascular fitness (Thow, 2009; American College of Sports Medicine [ACSM], 2014; ACPICR, 2015). Overall, evidence from several studies demonstrate that pre-operative and post-operative physiotherapy contributes to early functional recovery and reduces the hospitalization rates (Borghi-Silva et al., 2005; Hulzebos et al., 2006; Mensah & Brown, 2007; Miranda et al., 2011; Pająk & Kozela, 2012). It is therefore important to involve physiotherapy in those phases of cardiac surgery (Lomi & Westerdahl, 2013).

2.1 Pre-surgical physiotherapy

Physiotherapists are involved in the preparation of cardiac patients before surgery (Miranda et al., 2011). Weakness of the inspiratory muscles in the pre-surgical phase is a risk factor for the development of pulmonary complications post-surgery (Tomich et al., 2007). According to Miranda et al. (2011) and Valkenet et al. (2011), physiotherapy before surgery can reduce the chances of respiratory and chest complications post-surgery and should be considered as part of the standard care for patients undergoing cardiac surgeries.

Figure 1. Patient using incentive spirometry.

Pre-surgical physiotherapy interventions aim to assess patient's functional capacity and educate on the exercises (Leguisamo, Kalil, & Furlani, 2005). Physiotherapists educate patients on how to get out of bed and chair, demonstrate and inform them about huffing, coughing techniques, breathing exercises and lower limb mobilisation (Leguisamo et al., 2005). Common techniques that are currently applied, include deep breathing exercises, such as incentive spirometry (Figure 1), hyperinflation therapy (intermittent positive pressure breathing [IPPB], continuous positive airway pressure [CPAP], and insufflation/exsufflation), and chest physical therapy (CPT) (often combined with aerosolized mucolytic administration, coughing exercises, postural drainage, and percussion and vibration) (Figure 2 & 3) (Groom, 2013).

Figure 2. Patient using a respiratory device.

Effective training prior to surgery seems to be beneficial as it improves the functional capacity of the lungs (Saglam et al., 2008), thus it reduces the hospitalization (Hulzebos et al., 2006). Moreover, Olsen and Anzen (2012) state that inspiratory muscles exercise up to 14 days' pre-surgery is able to improve inspiratory muscle strength up to 36%, therefore, reducing post-surgery pulmonary complications. In another study (Yánez-Brage et al., 2009) which used different respiratory techniques including assisted cough, and deep breathing exercises, there was a significant reduction of the incidence of atelectasis. Similar to the previous findings, Westerdahl et al. (2005) reported that deep breathing as a single technique reduced atelectasis post-surgery.

On the other hand, a study (Hulzebos et al., 2006) which assessed several respiratory techniques demonstrated that there is only a limited effect of pre-surgical physiotherapy regarding any post-surgery complication. However, his might be due to the small sample size of that study, and because 5 out of 10 patients died and 3 out of 5 had cardiac complications. However, physiotherapists use different respiratory approaches which could be a reason for lack of conclusive evidence (Arcêncio et al., 2008). Toumpoulis, et al. (2006) stated that those patients who are more likely to develop complications should be given attention before surgery. As an overall, patients' at-risk such as patients with

significant low pulmonary volume, reduced functional lung capacity and poor ventilatory muscle strength should receive pre-surgical physiotherapy (Morsch et al., 2009).

Figure 3. Physiotherapist performing the active cycle of breathing technique (ACBT).

Figure 4 and 5. Sternum protection techniques during cough.

Wound management and protection necessary immediately after the operation, should be taught to the patient during pre-surgical physiotherapy. In the first three days' post-surgery, protection involves placing the hands on the sternum during coughing, without applying excessive pressure to the skin (Figure 4). Later than three days' patient is instructed to place the hands into the armpits and gently stabilize the thorax (Figure 5). Moreover, overweight patients or those with severe cough are trained to use a stabilizing belt which offers an additional protection (Piwoda & Jastrzębska, 2005).

2.2 Post-surgical physiotherapy

Following cardiac surgery, the inspiratory muscle strength and the functional capacity of the lungs decreases (Borghi-Silva et al., 2005; Moreno et al., 2011). Romanini et al. (2007) stated that general anesthesia reduces functional capacity by approximately 20%, and Miranda et al. (2011) reported that post-surgery pain may be responsible for the reduced functional capacity and impairment of ventilation. As a result, the majority of these individuals may have PPC which are responsible for longer duration of hospitalization, morbidity and mortality (Felcar, Guitti, Marson, & Cardoso, 2008; Romanini et al., 2007).

3 Phase I of cardiac rehabilitation

The inpatient stage is often referred to as phase I (acute) which is important in assisting patient's pathway to recovery. Phase I will be the patient's first contact with the CR team, and may favorably or adversely influence their perception of secondary prevention (Proudfoot, 2006). This phase includes patient's assessment, education and mobilization (British Association for Cardiac Rehabilitation [BACR], 1995).

Recommendations from BACR (1995) suggest that patients should receive a graded mobilization and exercise program so that by discharge time the patient is ambulant and be able to attend the ADL. Kinesiotherapy is useful in phase I, as patients often struggle with pain, thus develop poor postural habits, abnormal motor control and decreased endurance due to activity avoidance (Brasher et al., 2003).

Figure 6. Patient monitoring puse rate.

Mobilization of the limbs, range of motion and walking within intensive care unit, have significant positive effects regarding the prevention of PPC (Haeffener, Ferreira, Barreto,

Arena, & Dall'Ago, 2008). These forms of exercises increase endurance, exercise tolerance, improve functional ability and independence of the individual. Despite these benefits of early mobilization, there is no agreement in the literature in regard to the best way of performing limb and trunk mobilization exercises (Hirschhorn, Richards, Mungovan, Morris, & Adams, 2008). Cycle-ergometer exercises are suggested after removal of the drainage (usually the 4th– 5th day after surgery) and the most frequently used initial workload is 25 Watts, for 5 minutes. Exercise must not exceed 6 in a 10-point Borg scale or 20% above the baseline heart rate (Piwoda & Jastrzębska, 2005). Breathing exercises can also be applied in this phase. To increase FRC of the lungs, an IS (Figure 1) can be used to monitor the progress (Pinheiro et al., 2011) and limit any post-surgery complications (Agostini, Calvert, Subramanian, & Naidu, 2008; Yamaguti et al., 2010). According to Thompson, et al. (1996), patients prior to discharge need to be informed how to assess their level of physical activity, measure their pulse rate (Figure 6) and rate their exertional effort with the Borg rating of perceived (RPE) exertion scale (Borg, 1998).Before patients discharge, health care professionals should make an assessment which involves individual's risk factors and stratification, whereas the educational sessions providing the appropriate information regarding risk factors and lifestyle modification (BACR, 1995).

4 Phase II of cardiac rehabilitation

The second phase is the initial post-discharge stage, lasting for 4-6 weeks. At this stage patients may feel isolated and insecure and may present elevated anxiety signs (Proudfood, 2006). The individualized exercise program is based on patient's functional capacity after a comprehensive assessment (ACSM, 2014). Exercise intensity is prescribed according to the ACSM guidelines (2014) based upon RPE, the metabolic equivalent (MET), estimated or measured maximal heart rate (HRmax) or maximal oxygen uptake (VO2max). The direct measurement of VO2max encompasses expensive equipment, specialist personnel and a maximal effort of the person (ACSM, 2014).

In addition, various methods for predicting VO2max from sub-maximal exercise has been used (Morris, Lamb, Hayton, Cotterrell & Buckley, 2010) but they also need specialised equipment most of the time.

There are several clinical tests which can be used to estimate the functional capacity, including: six-minute walking test, stair-climbing, shuttle test (Bradbury-Hough, 1996). Based on the results, a safe and appropriate exercise program can be prescribed for each individual. According to Enright et al. (2003), the six-minute walk test is a valid tool that is widely used by clinicians to estimate patients' prognosis. The authors also report that the six-minute walk test is able to assess the mobility and functional capacity post cardiac surgery. Moreover, the test can be perform by an individual with cardio-pulmonary disease in order to assess the endurance, a sensitive clinical indicator of the patient's condition (Rasekaba, Lee, Naughton, Williams, & Holland 2009). On the other hand, when the equipment or expertise to conduct a maximal exercise test is not accessible, the clinician must rely on the values obtained from HRmax prediction equations in order to prescribe exercise intensity (ACSM, 2014). Table 1 summarises some of the HRmax prediction equations..

Table 1. HRmax prediction equations

Author	Equation

Haskell and Fox (1970)	220-age
Inbar et al. (1994)	205.8 - (0.685 x age)
Tanaka, Monahan and Seals (2001)	HR_{max} = 208 − (0.7 × age)
Brawner et al. (2004)	HRmax=164-0.7x age

Abbreviations: HRmax: Heart Rate maximum.

Exercise consultation is advantageous at this stage in order to enhance adherence to both lifestyle modification and maintenance of exercise in phase II and future phases of CR. Moreover, physiotherapists at this phase should prescribe individualized home-walking programs and help patients to return to their ADL, thus to progress to phase III (Proudfood, 2006). Patients as previously reported in phase I, continue to use several methods to self-monitor their activities in order to avoid any complications (Proudfood, 2006).

5 Phase III of cardiac rehabilitation

This phase is traditionally the outpatient education and structured exercise program component of CR, lasting for 6-12 weeks. The key component of this phase is mainly the physical exercise, however, education and psycho-social counseling regarding risk factors and lifestyle modification are important (Proudfood, 2006). Ross and Campbell (2006) reported that health and fitness benefits from exercise have a direct dose–response relationship and therefore patients prior to phase III should undertake a risk stratification assessment as it is essential for their participation into an exercise program (BACR, 1995; Proudfood, 2006; ACSM, 2014).

The purpose of the risk-stratification is to identify patient's risk factors and place them in a risk category based on an increased likelihood of adverse effects (Ross & Campbell, 2006).

Table 2 shows the American Association of Cardiovascular Rehabilitation [AACVPR] (2007) risk factor classification. Individuals who do not meet the classification for either low or high are classified to moderate risk category (Proudfood, 2006). A supervised exercise session is offered at least 2 times per week, in addition to 1 session per week of education (Proudfood, 2006). It is essential that programs include the following components: a warm-up, conditioning phase and cool-down (ACSM, 2014; ACPICR, 2015). The recommended dose of weekly exercise can be achieved following the frequency, intensity, time and type (FITT principle) which is appropriate for the individual (ACPICR, 2015).

Table 2. Risk factor classification to participate into cardiac rehabilitation.

A low risk-individual would have all of would have the following:	**A high-risk individual the following: only one of**
• Normal hemodynamic response to exercise and recovery	• Decreased left ventricular function- EF <40%
• No evidence of myocardial ischemia	• Abnormal hemodynamic response with exercise and recovery
• Normal left ventricular function	• Persistent or recurrent ischemia at low levels of exercise
• Functional capacity of 7 METs or more	

- Absence of clinical depression

- Functional capacity of < 5 METs
- Survivor of cardiac arrest or sudden death
- Complicated recovery post event (CHF, Cardiogenic shock)
- Clinically significant depression

Abbreviations: CHF: Chronic Heart Failure, METs: Metabolic Equivalence, EF: Ejection Fraction.
Adapted from AACVPR (2007)

These programs should include exercises that improves flexibility, strength, balance and coordination (ACPICR, 2015). Table 3 shows the FITT principle for structured exercise. Low to moderate risk patients can exercise at a low to moderate intensity in the community (Armstrong, et al., 2004). However, high risk patients should be limited to hospital-based programs, supervised by health professionals (Stone, et al., 2001).

Table 3. FITT principle.

	Frequency	Intensity	Time	Type
CV exercise	2-3 times/week	40-70%HRR/ 11-14 BORG	20-60 min	Continuous/Interval
Strength and Endurance	2-3 times/week	30-40%1RM upper body 50-60% 1RM lower body	2-4 sets 10-15 reps	8-10 different large muscle groups

HRR: Heart Rate Reserve, RM: Repetition Maximum.
Adapted from ACPICR (2015).

During the program, physiotherapists should initially and continuously monitor and evaluate patients in order to ensure their safety and effectiveness of exercise. The monitoring level is based on individual's needs (Charted Society of Physiotherapists, 2012). Physiotherapists can monitor patients' exercise intensity using a combination of: heart rate response, blood pressure response, rate pressure product, RPE, observation and oxygen saturation levels (ACPICR, 2015). BACR (2006) stated based on evidence by Paffenbarger (1996), Paffenbarger and Olson (1996) that moderate physical activity most of the days with a duration of 30minutes is beneficial and may alter the CVD risk factors. However, continuous exercise (CE) may be very challenging for a patient with CHD, therefore, it is advisable to include "recovery" stations into the exercise program.

On the other hand, interval training (IT) which involves alternating short higher-intensity (HIT) and moderate-intensity workloads and has been used to train athletes, has demonstrated to be safe and effective in cardiac population as well (Rognmo et al. 2004; Warburton et al. 2005; Wisløff et al. 2007). Table 4 summarises the results of these studies.

6 Phase IV of cardiac rehabilitation

The individuals should be considered for transferring to a longer-term rehabilitation if they are medically stable and can exercise independently (BACR, 2006). Moreover,

participants in phase IV may wish to engage in different activities which will help maintain their psychological health and physical fitness (Dingwall, Ferrier & Semple, 2006).

Table 3. Interval training studies.

		Intervention			
Authors	**Sample**	**Frequency / Time**	**Equipment**	**Protocol**	**Outcome**
Wisløff et al. (2007)	27 **IT/ MICE/ CONTROL**	12 weeks 3 days / week	Treadmill	**IT** 50–60%HRpeak (3 min) with intervals at 90–95%HRpeak (4 min) [38min] **MICE** 70%HRpeak [47min] **CONTROL** (Walking and counseling) 70%HRpeak [47min]	Greater ↑ of LV, VO2peak,
Warburton et al. (2005)	14 **IT/MICE**	16 weeks 2 days / week additional 3 days /week	Walking/bike and stairs Cycle-ergometer with intervals at 90%	**IT** 40%VO2reserve (2 min) VO2reserve (2 min) [30min] 65% VO2reserve [Resistance exercise 30min] **MICE** 65% VO2reserve [30min] 65% VO2reserve [Resistance exercise 30min]	Similar ↑ of VO2peak in IT and MICE Greater ↑ of AT in IT
Rognmo et al. (2004)	21 **IT/MICE**	10 weeks 3 days / week	Treadmill	**IT** 4×4min at 80-90%VO2peak [33min] **MICE** 50-60%VO2peak [41min]	Greater ↑ of VO2peak in IT in contrast to MICE

Abbreviations: AT: anaerobic threshold, MICE: Moderate Intensity Continuous Exercise, IT: Interval Training, LV: left ventricle function, ↑: improvement, HRpeak: heart rate peak.

7 Conclusion

As a conclusion, cardiac surgeries have improved over the years; however, patients undergoing cardiac surgery may present some post-surgery complications. These complications are related to the type of surgical procedure, thus with the factors associated with the clinical condition of the patient. The management of these patients needs a multidisciplinary team approach including physiotherapists as they decline PPCs' and promoting patients' functional recovery in pre-surgery and post-surgery phases. Several approaches such as: chest physiotherapy, breathing exercises, incentive spirometry, acapella device, huffing and coughing techniques can be used to reduce the chances of developing respiratory and chest complications post-surgery and improve patient's status as it improves inspiratory muscle strength. Kinesiotherapy and

mobilization of the lower limb is valuable for these patients, however there is limited evidence on the beneficial protocol.

Moreover, physiotherapists should assess the patient and organize an effective exercise program in order to improve and maintain the cardiovascular benefits. HIIT based on several studies, seems beneficial for cardiac patients. Future research must focus on mobilization protocols, frequency of chest physiotherapy techniques and HIIT programs in order to improve rehabilitation for these group of patients.

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