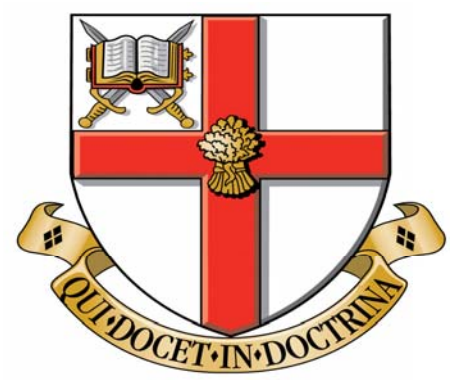

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"How optimal is the management of patients attending cardiac rehabilitation with coronary heart disease?"

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Contents

Abstract

Although evidence exists to suggest that post MI mortality is reducing in parallel with advancements in cardiology practice, 'optimal medical management' and risk factor control of patients with coronary heart disease (CHD) has been referred to as being sub-optimal compared to that shown to be effective in clinical research. With numerous treatment methods available for managing CHD, continuous analysis is required to ascertain which treatment methods are most beneficial in reducing mortality and improving outcomes for patients following a diagnosis of CHD. Additionally, increasing numbers of patients commence medical therapy with surgical intervention deferred. It is therefore imperative that patient treatment is optimised through adherence to clinical guidelines. This paper aims to explore the current standpoint on treatment options for CHD whilst analysing the extent to which evidence based guidelines translate into clinical practice. This will include the discussion of patient compliance and community follow up and the impact these factors have on outcomes for patients with CHD. This will be established by first exploring the effectiveness of treatment methods for CHD before discussing the use of cardiac rehabilitation as a resource for further improving outcomes following treatment.

Introduction

Cardiovascular disease (CVD) remains the leading cause of death in the UK, responsible for 46,000 premature deaths in 2010 (British Heart Foundation, 2012). However, post myocardial infarction (MI) and CVD mortality has reduced since 2002 with 30 day fatality reported as reducing from 42% to 32.1% in 2010, in males and from 42.2% to 29.9% in females (Smolina et al., 2012). This study captured individuals admitted to hospital with acute MI although it does not represent individuals who may present to private hospitals or individuals having had a 'silent MI' that is not detected immediately. The decline in mortality nevertheless could be explained by advancements in both primary and secondary prevention however, Smolina et al. (2012) did not state whether individuals admitted to hospital had a pre-existing diagnosis of CVD. The study period does however coincide with advancement in medical treatment of coronary heart disease (CHD) including the widespread, revolutionary introduction of percutaneous coronary interventions (PCI) to treat ST-segment elevation myocardial infarction (STEMI), rather than the use of fibrinolysis (Gershlick et al., 2013).

With a continuing requirement to conform to evidence based practice, in conjunction with the likelihood that cardiology will continue to advance in the future, it is important to assess how well treatments are achieving their aims in reducing cardiac related mortality and improving quality of life. Gershlick et al. (2013) question how realistic evidence based targets are in reality, in busy hospital departments such as 120 minutes from emergency response to balloon deployment for treatment of STEMI (National Institute for Health and Care Excellence [NICE], 2013). It is also suggested that clinical treatment may be sub-optimal compared to what is known to be effective

from research, particularly when individuals live in rural and remote locations. Prolongation of time to angioplasty has however been associated with worsening myocardial function and mortality with De Luca et al. (2004) reporting every thirty minute delay in reperfusion following MI to be associated with an 8% excess annual mortality. However, there is a lack of a randomised controlled trial to analyse the full extent of primary PCI time delay by comparing outcomes to that of traditional fibrinolysis treatment.

Additionally, with a rapid increase in prescriptions of cardio-protective medications over recent years, one would expect this to contribute to the reduction in mortality. Kotseva et al. (2009) investigated the extent to which the Joint European Guidelines on CVD Prevention (De Backer at al., 2003) were adhered to and whether medical therapies were reducing risk factors in individuals diagnosed with CHD across 22 European countries. Interestingly, 56% of patients remained hypertensive six months after diagnosis and 51% had total serum cholesterol above 4.5mmol/l, suggesting sub-optimal risk factor control. When investigated further, as few as 31% of patients were prescribed a beta-blocker and only a quarter of patients prescribed anti-hypertensive medication achieved target blood pressure levels, therefore remaining at risk of secondary events. This raises question to how effectively patients are followed up to ensure they receive appropriate medications, at evidence based doses. Additionally, patients may not be compliant with their drug regimes, a concept that will be explored as part of this review.

Optimal medical management of CHD

The term 'optimal medical management' refers to a combination of lifestyle modifications including physical activity and dietary behaviours. This is in addition to a recommended drug regime aimed to reduce mortality and risk of cardiovascular events whilst increasing exercise capacity and improving quality of life (Braunwald et al., 2000). Additionally, treatment for CHD includes medical management with or without revascularisation with either PCI (with or without stenting) or coronary artery bypass grafts (CABG). Despite well recognised guidance on the management of CHD, a 'one size fits all approach' does not seem feasible with such a complex process and controversy therefore exists as to which treatment options are most beneficial in reducing mortality whilst being cost effective.

CABG has demonstrated improved survival over medical treatment for patients with left main stem (LMS), triple vessel disease and/or diabetes. LMS disease carries the worst prognosis of all coronary lesions largely due to the vast area of myocardium covered. In untreated cases, the prognosis of such disease is reported as 37% at 3 years (Taggart et al., 2008). However, since the large scale introduction of PCI and advancements to the procedure with drug eluting stents, more complex diseases including that of the LMS are being treated with PCI as the primary choice of revascularisation. Recent research by Serruys et al. (2009) does however demonstrate CABG as the treatment of choice in three vessel or LMS disease and report higher rates of adverse events and repeat revascularisation for individuals undergoing PCI. However, the study fails to report on the degree of medical management that participants were receiving and whether this was equivalent for both groups. Additionally, the study does not comment on whether the CABG procedures were

performed on or off-pump despite the recognition that off-pump CABG reduces the risk of complications, particularly stroke, with a reduced procedure time. Although to date there is a lack of long-term data to confirm such benefits in relation to reducing overall CHD mortality however it is apparent that despite PCI producing comparable results in some patients, CABG remains the standard of care for complex disease.

Furthermore, studies comparing CABG to medical management report by 10 year follow up that 41% of patients started on medical therapy go on to receive revascularisation with CABG (Yusuf et al., 1994), suggesting medical treatment in some cases delays the inevitable. This study is however rather dated as it was conducted between 1972 and 1984 whilst the American Heart Association guidelines have been modified numerous times since. The study also pre-dates the use of off-pump CABG as on-pump procedures were performed whilst the heart was stopped. Concerns about the accuracy of grafting techniques of surgeons whilst the heart is still beating has been overruled by evidence that experienced surgeons demonstrate excellent results from this procedure although the risk of death (1 – 2%) is suggested to be equivalent for both procedure methods (Shekar, 2006). Further proposed benefits of off-pump CABG include reduced risk of postoperative atrial fibrillation, lower risk of stroke, neuro-cognitive and organ dysfunction. However research to date has only confirmed the reduced risk of postoperative atrial fibrillation with off-pump procedures (Møller et al., 2008), therefore larger trials are needed before concluding that the procedure also reduces the risk of death, MI and stroke.

On the contrary, Boden et al. (2007) report a high initial success rate with PCI but further comment that 34% of patients have angina one year after the procedure due to

residual CHD resulting from either re-stenosis or deterioration of the disease in other coronary lesions. They further report that PCI failed to produce initial benefits of reducing risk factors and cardiovascular events compared to that of medical management. The study does however report on the utilisation of optimal medical therapy in both treatment groups whereas previous research (Folland et al., 1997 & Pitt et al., 1999) failed to apply aggressive medical therapy to individuals undergoing revascularisation and subsequently reported that PCI produced no significant benefit over medical therapy in single or two-vessel CHD. Additionally, the study by Boden et al. (2007) was conducted between 1999 and 2004, prior to the introduction of drug eluting stents. Stent design and technology has also rapidly advanced with the benefit of reducing the likelihood of vessel re-stenosis. Drug eluting stents antagonise cellular reactions to prevent in-stent re-stenosis but it has been suggested that they do not impact on survival or prevent MI in single vessel disease compared to treatment with bare metal stents (Roiron et al., 2006). However, the use of drug eluting stents has rapidly increased in many countries due to reduced need for repeat interventions. Although research on rates of repeat intervention appears to fail to distinguish between revascularisation due to re-stenosis and that of disease progression in other lesions which PCI cannot alter, therefore the benefits stated are likely over-exaggerated. Nevertheless, in the UK in 2003, 17% of all stents used during PCI were drug eluting which rose further to 62% in 2005 (NICE, 2008).

Furthermore, lower success rates with PCI and stents appears common in patients with diabetes, due to the complex nature of the coronary anatomy, including longer lesion lengths but smaller vessel diameter, in addition to exaggerated inflammatory processes. Given that Type 2 diabetics have a twofold increased risk of developing

CHD (Giorda et al., 2004), this has historically led to CABG being the preferable procedure in these patients, particularly for multi-vessel disease due to improved survival and reduced need for repeat revascularisation (Mak, 2012). However, drug eluting stents have also been shown to produce more favourable outcomes in patients with diabetes (Garg et al., 2008) than bare metal stents, although this study did not further compare differences in outcomes between insulin and non insulin-dependant diabetics. Voudris et al. (2011) report a higher incidence of multi-vessel CHD among diabetics requiring insulin and a higher rate of revascularisation or CABG following PCI with drug eluting stents compared to non insulin-dependant diabetics. However it is not clear whether the rate of revascularisation is due to re-stenosis or disease progression therefore the long term effectiveness of drug eluting stents with insulin-dependant diabetes has been shown to be lower. The introduction of drug eluting stents does not appear to bridge the gap compared to treatment for non-diabetics, demonstrating the importance of individualised patient centered care and consultation prior to treatment selection.

Research such as Boden et al. (2007) also lacks detail on the nature of follow up patients receive to assess the effectiveness of medication regimes. With the aim of optimal medical management being to slow down the progression of the disease, it can be questioned whether individuals undergoing revascularisation are not only receiving the correct pharmacotherapy but that this is also of an optimal dose to produce significant benefit. Revascularisation with either PCI or CABG only addresses the lesions that have become obstructive to a degree that results in a patient becoming symptomatic. A lumen stenosis greater than 75% has historically defined clinically significant disease largely due to reproducible symptoms of angina during

stress testing correlating to such a degree of stenosis. However, research now suggests that as few as 14% of clinically incapacitating events occurs at a lumen stenosis of ≥75% (Maseri & Fuster, 2003). Nevertheless, patients with even mild CAD often have more extensive atherosclerosis, including that of other territories, even if this is not detected on coronary imaging. Therefore patients are vulnerable to occlusive events in carotid and femoral arteries, increasing the risk of stroke or peripheral vascular disease. Optimal medical management additionally treats the underlying disease in the entire vasculature (Lamy, Natarajan & Yusuf, 2011) therefore it may be more pertinent to view the treatment options of medical management with or without revascularisation as complimentary rather than competing as isolated management strategies.

Achieving safe levels of optimal medical management, particularly in patients following acute MI becomes challenging when hospital stays are shortened, which may be more cost-effective, relieving some of the economic burden faced by the NHS but potentially to the detriment of treatment optimisation. The NICE (2013) recommend the initiation of an angiotensin-converting enzyme (ACE) inhibitor, beta-blocker, dual anti-platelet therapy and statin following acute MI. Stewart, Woothipoom & Townend (2010) conducted a retrospective study of hospital discharge summaries for patients post MI and report 75.1% of patients as having been prescribed and discharged on sub-optimal doses of ACE-inhibitors and beta-blockers however, nearly all received optimal doses of statin and anti-platelet therapy. Stewart, Woothipoom & Townend (2010) defined a criteria for the optimal dose of medication however failed to provide evidence for the selection of the criteria in order to demonstrate that the doses have been shown to reduce post-MI mortality rates. This

nevertheless highlights a discrepancy in the optimisation of drugs with a range of possible doses, compared to that of drugs with fewer options.

Where possible, beta-blockers and ACE-inhibitors should be prescribed and increased in a similar fashion to that demonstrated as effective in clinical research (NICE, 2013). ACE-inhibitors have been shown to reduce mortality and reduce the likelihood of developing heart failure post-MI however the NICE guidelines do not recommend a standardised timescale for its initiation and titration. Pfeffer et al. (1997) report that initiation of ramipril, titrated up to its maximal dose within 60 hours post-MI improves left ventricular remodelling, providing a survival benefit over initiating ramipril 14 days after the event. Furthermore, the difference in speed of initiation and subsequent outcomes was significant and warranted early termination of the study. They additionally attempted to quantify the benefits of a low dose ACE-inhibitor however this failed to produce benefits proportional to the maximal dose, although the reliability of the measurement can be questioned as the dose prescribed to patients was half that of the lowest clinically recognised and prescribed dose. If treatment is sub-optimal, there is an increased risk that more patients will manifest symptoms of heart failure and have a greater risk of fatal and non-fatal ischemic and arrhythmic events, an important concept considering improvements to the treatment of MI have led to an increased burden of heart failure due to the increased likelihood of patients surviving but with damaged myocardium. The underlying cause in the majority of cases for developing heart failure includes myocardial necrosis with subsequent ventricular remodelling including left ventricular wall thinning, chamber dilation and compensatory hypertrophy (Cowie, Lacey & Tabberer, 2005). Therefore in order to reduce the chance of progression from acute MI to heart failure, patients need to

receive early reperfusion followed by optimal medical management both in hospital and in the community setting as advised in evidence based guidelines.

It is also well established that beta-blockers improve survival following MI (Freemantle et al., 1999), with the aim to reduce heart rate, myocardial oxygen demand and arrhythmias. However, Freemantle et al. (1999) report a variance in the time of commencement of the medication in their systematic review in addition to varying methods for administration including oral and intravenous. The optimal timing of initiation of beta-blockers in secondary prevention does appear unclear however in the clinical setting, delayed initiation of beta-blockers has been reported to vary from 2 hours to 28 days (NICE, 2013). Research does however demonstrate that beta-blockers are increasingly prescribed post-MI and Goldberger et al. (2010) report 93.2% of patients diagnosed with MI as receiving beta-blocker therapy. However, they report that only 17% achieved more than 50% of the target dose by hospital discharge with the majority (36.5%) receiving only 25% of the target dose. Community follow up was also assessed and reported that 3 weeks post discharge 54% of patients were still taking less than 25% of the medication dose demonstrated to be effective. This demonstrates inconsistencies in the speed of titration of beta-blockers and ACE-inhibitors with clinically effective doses commonly not reached prior to discharge whilst additionally highlighting the potential underutilisation of the community setting to ensure patients are appropriately followed up.

Recommendations on the up-titration of the medications have since been introduced to the NICE guidelines (2013) which state that hospital discharge summaries should include information on the titration of medications with the aim of ensuring

appropriate alteration in the community to achieve optimal benefit for the patient. The environment of a busy hospital department under increasing workload pressures may explain to some extent why this does not necessarily translate into practice. Stewart, Woothipoom & Townend (2010) report on interventions to improve doctors' instructions on hospital discharge summaries however, a six week intervention promoting adherence to the NICE guidelines, utilising posters on hospital computers with instructions on therapeutic doses failed to produce a significant improvement to doctors' comments. It was reported that this is likely due to confounding variables such as time constraints and the likelihood that discharge summaries are completed by junior doctors with limited experience of cardio-protective medications.

However, full responsibility cannot be placed on acute hospital trusts for the lack of medication titration as patients who are under the care of a specialist in an acute trust may find that their general practitioner is reluctant to address alterations to medications, rather opting to leave the prescription for the patient's next review with the specialist. Although, such appointments can be months after treatment, leaving the patient on sub-optimal management for a substantial amount of time, at arguable the most crucial time in the patient's recovery. Additionally, community and general practitioners may find difficulty in managing the adverse effects associated with dose titration as 80% of individuals with cardiovascular disease attending cardiac rehabilitation have at least one other illness (NACR, 2013) and therefore often require multiple medications, some of which contraindicate the use of certain cardio-protective medications. Furthermore, patient adherence may be associated with up-titration as increases to medication may be viewed negatively or seen as necessary because their condition is deteriorating. This highlights the importance of education

so that patients are aware of the benefits of optimisation from initiation of medical therapy. Although, Horne & Weinman (1999) report a positive correlation between beliefs that medications are necessary to maintain health and adherence however, education and number of medications taken did not predict adherence. Alm-Roijer et al. (2004) also found correlations between patients with greater knowledge of CHD risk factors and greater self-reported compliance with lifestyle changes but not with compliance of medications.

Shah et al. (2009) report medication adherence to progressively decrease over time with beta-blocker use reducing from 79% to 48% and ACE-inhibitors from 73% to 43% over a 3 year period. Enrolment in cardiac rehabilitation has however been associated with a greater likelihood of continuing cardio-protective medications post-MI and this has been reported to be independent of the number of rehabilitation sessions attended. Although the study does not establish why medications were discontinued and a proportion of patients may have stopped the medications for genuine reasons such as by instruction from a general practitioner or because they could not tolerate the medication. Further research on compliance, although self reported, found that at six month discharge of 18,809 post-NSTEMI patients, 78.1% were taking beta blockers, 89.8% ACE inhibitors and 94.7% anti-platelets (Chow et al., 2010). The premature discontinuation of dual anti-platelet therapy in patients particularly with drug eluting stents can increase the likelihood of stent thrombosis and subsequent adverse outcomes (Egred, Andron & Perry, 2008) therefore the NICE (2013) guidelines state the continuation of dual anti-platelet therapy for 12 months however, research is underway comparing outcomes with randomisation of patients to shorter term dual therapy.

Cardiac Rehabilitation

There is nevertheless the opportunity to promote adherence to drug therapy during cardiac rehabilitation and despite the fact that 13% of patients referred to a cardiac rehabilitation programme do not take it up (NACR, 2013), the uptake is gradually improving. The British Association for Cardiovascular Prevention and Rehabilitation's (BACPR, 2012) core components stipulate that the use of and adherence to cardio-protective medication should be assessed in order to facilitate the up-titration of medication with the aim of achieving evidence-based dosages. They further state this should include an assessment of the patients' beliefs, which has been shown to influence adherence to a greater degree than socio-demographic and clinical factors (Horne & Weinman, 1999). This emphasises the importance of cardiac rehabilitation as an independent component to delivering optimal medical management.

Comprehensive rehabilitation has been shown to reduce all-cause mortality by 13% and cardiac specific deaths by 26% (Heran et al., 2011). However West et al. (2012) report higher mortality rates for patients attending rehabilitation and no significant difference in mortality compared to those who do not attend. Although, despite the study being published in 2012, it was conducted between 1997 and 2000 and therefore failed to achieve their objective of assessment of a new era of MI management as current practice has evolved since as previously discussed, including early intervention and individualised rehabilitation. Additionally, West et al. (2012) failed to comment on the proportion of this mortality that was cardiac specific and further lack detail in their publication on the format of the rehabilitation programmes that were offered including the dose of the exercise component. Therefore it cannot be

conferred whether the programmes assessed were conforming to the BACR standards of that time. The safety of the exercise programmes included in the study can therefore be questioned as the author makes no reports of exercise testing protocols to ensure patient safety to exercise. West et al. (2012) further reports that at 12 month follow up only 65% of patients were taking statins, 43% ACE-inhibitors and 61% a beta-blocker. This demonstration of sub-optimal medical management of post-MI patients may in part explain the higher mortality rate observed. It is likely that a number of these patients may demonstrate symptoms of angina, demonstrating the importance of exercise stress testing prior to commencement of an exercise programme to establish whether symptoms are reproducible on exertion.

It can be argued that medical management should optimise exercise capacity without restrictions to exercise programmes such as that of ischemic thresholds as recommended by the American College of Sports Medicine (2014). Although, research is emerging that suggests that these guidelines require evaluation due to the limitations that they can place on patients with low ischemic burdens and resultant deprivation of the benefits of exercise. Noël et al. (2007) demonstrate that repeated exercise training above such a threshold has been well tolerated without evidence of myocardial injury, compromise to left ventricular function or inducible significant arrhythmias. However, this randomised controlled trial was relatively small therefore more evidence is needed from larger evaluations before the guidelines and current practice can be modified.

Nevertheless, research which questions the value of cardiac rehabilitation will ultimately impact on referrals. Ghisi et al. (2013) highlight patient benefit and

programme quality as influential factors on a specialist's decision to refer, with a G.P less likely to refer than a cardiologist. Research additionally demonstrates the strength of the medical professionals' recommendation as influential on patients' decisions to enrol onto programmes. Given the new era of primary angioplasty it is important to ensure that patients are encouraged to attend rehabilitation as opposed to believing that their condition has been treated with a 'quick fix' that does not require lifestyle and pharmacological intervention to treat the disease. This is supported by Barber et al. (2001) who report that patients who undergo CABG are more likely to be referred and attend rehabilitation than those who receive PCI or medical management post-MI. They further report that patients were more likely to participate if they have an appointment to see a cardiac surgeon or cardiologist arranged at hospital discharge, suggesting that rehabilitation is then viewed as part of their overall treatment prior to follow up.

When reviewing research such as Maron et al. (2010) who found no significant difference in achievement of risk factor targets when comparing optimal medical therapy (including lifestyle and pharmacological) with and without angioplasty in patients with stable CHD, it is clear that medications were provided at no cost to the patient which is likely to influence adherence as in clinical practice, prescriptions are heavily based on cost. Furthermore, Maron et al. (2010) did aggressively target pharmacotherapy and this was adjusted at follow up if patients were not achieving targets, by a nurse case manager. For patients attending cardiac rehabilitation, the BACPR (2012) recommend an initial appointment with a health professional within two weeks of discharge which could provide an ideal opportunity to assess adherence and discuss whether it is appropriate for the titration of medications, similar to that

demonstrated to be effective in clinical research. Although to date, there is a lack of information, in the U.K on whether rehabilitation programmes are able to offer such a service. The NACR (2013) reports on the staffing components of rehabilitation programmes across the UK but it does not identify whether services offer nurse led prescribing clinics.

Conway & Ferguson (2011) do however report on a UK cardiac rehabilitation programme where all specialist nurses are supporting in completing a non-medical prescribing course to enable the service to conform to BACPR (2012) standards and ensure medications are reviewed and titrated safely by a competent practitioner. Medications are reviewed five days after hospital discharge and within three weeks the patient is seen by a nurse prescriber to up-titrate beta-blockers and ACE-inhibitors and prescribe anti-anginal medication, where appropriate. Additionally, at the end of an eight week, phase III programme, the medications are re-reviewed, promoting a patient-centered approach to care. As this service is integrated into the routine care patients receive, this is expected as part of their treatment which may assist with adherence to a long term drug regime. An evaluation of the service reports that patients valued the level of care received and staff valued the opportunity to address issues such as why patients discontinue medications, uncontrolled hypertension and raised heart rates but additionally this highlighted instances whereby medications were reduced due to abnormal liver or kidney function or intolerable side effects which research such as Shah et al. (2009) fails to take account of.

Despite this providing a positive example of how services can link research with practice, this provides only one example from a single hospital department therefore

further research is needed on how well nurse prescribing services integrate with the standard practice of cardiac rehabilitation. Despite medication reviews being recognised in the BACPR standards, the NACR does not recognise pharmacotherapy assessment and/or education as an independent programme component that warrants evaluation. Additionally, the NACR collate data on the medications patients are taking but does not attempt to establish the dose of recommended medications to determine, in conjunction with assessment measures, whether patients are receiving optimal cardio-protective therapies. Even the National Service Framework for CHD (Department of Health, 2000) focuses heavily on lifestyle behaviours as part of cardiac rehabilitation without emphasising a pharmacotherapy element as part of this. Although, this was published prior to the updated NICE guidelines whereas the national need to raise awareness of the sub-optimal management of patients with CHD appears to have begun.

Conclusion

This review has highlighted the need to evaluate clinical practice and ensure patients receive the benefits derived from clinical research in order to facilitate the continuation of improved mortality rates post-MI. In the long term, sub-optimal doses have been shown to have no affect on the control of angina symptoms and can in fact increase rates of hospital re-admission and further cardiac events (NICE, 2013). It is however clear that the management of CHD is multifaceted and clinical decisions need to balance adherence to guidelines with judgments based on each individual patient including that of socio-economic factors. With medical therapy and symptom management more commonly opted for following initial diagnosis of CHD, it is

imperative that this treatment is as optimal as tolerated to give patients the best chance of avoiding further intervention whilst improving quality of life.

There does also appear to be strong evidence for the utilisation of an independent nurse prescribers in cardiac rehabilitation however before such a service is likely to be commissioned, services need to demonstrate how well patients' cardio-protective therapies are currently managed before looking for cost-effective ways to drive service improvement. It would therefore be worthwhile to assess the level of optimal medical management patients who are attending cardiac rehabilitation are receiving and investigate whether sub-optimal management can be highlighted by the demonstration of symptoms of angina and signs of ischemia by means of ST-segment depression during exercise stress testing. It would additionally be useful to analyse whether differences exists in the management of patients with medications and those who have additionally undergone revascularisation. Such research could also help to assess whether patients who are asymptomatic still demonstrate signs of insufficient myocardial perfusion which would not be detected unless the patient partakes in an exercise stress test as part of their cardiac rehabilitation. Furthermore, as evidence based practice is constantly evolving, research such as this may provide valuable information on whether the format of cardiac rehabilitation in terms of the exercise testing and prescription components could be further improved with the addition of an exercise stress test as a routine standard of care as opposed to functional capacity testing procedures.

Are patients with coronary heart disease optimally medically managed within cardiac rehabilitation? A service evaluation.

Word Count: 4124

Keywords: Exercise, Ischemia, non-medical nurse prescribing, ST-segment depression.

To my knowledge, this is an original evaluation and research to date has not addressed the medical management of patients by reviewing exercise test information particularly that of ST-segment depression. It is therefore felt that the British Journal of Cardiology would be the most appropriate journal for the evaluation's publication. Additionally, members of the BACPR are subscribed to the journal and would therefore be able to access the article which has been written to enable service improvement at Wirral Heart Support Centre but this may additionally benefit the delivery of cardiac rehabilitation services nationwide.

Abstract

'Optimal medical management' aims to reduce the risk of cardiovascular events and improve quality of life in patients treated for CHD however evidence suggests that the management of such patients is sub-optimal with under-prescription of cardiac medications commonplace (Kotseva et al., 2009). This evaluation aims to determine whether patients attending cardiac rehabilitation demonstrate myocardial ischemia when exercise tested and whether this can be related to under-prescription of medications.

101 exercise tests were retrieved retrospectively from patient's rehabilitation notes. 35 patients had been treated with medical management whereas 64 patients had additionally received revascularisation with PCI. A sub-maximal 12 lead ECG treadmill test had been completed which followed the modified BRUCE protocol. Baseline physiological measures, repeated at peak exercise were retrieved. An independent t-test was used to determine if there was a significant difference in peak ST-segment depression between the two treatment groups and spearman's rank

correlations were performed to assess for relationships between ST-segment depression, physiological variables and the dose of cardiac medications prescribed.

Patients who received medical management alone demonstrated greater ST-segment depression during exercise than those who were revascularised (p = .015). Relationships were also found between lower doses of bisoprolol and greater peak ST-segment depression (p = .009) and higher resting HR (p = .035). However no relationship was found between bisoprolol and peak HR or between the dose of ramipril and blood pressure at rest or peak.

The results confirm the sub-optimal management of cardiac rehabilitation patients and suggest that optimisation of medical therapy is likely to improve outcomes. The evaluation confirms the place of the exercise ECG as an integrated component of the cardiac rehabilitation service and provides evidence for the need for a non-medical nurse prescriber within rehabilitation providing this is a cost-effective alternative to improving communication with general practitioners.

Introduction

Cardiovascular disease (CVD) remains the leading cause of death in the UK, responsible for 46,000 premature deaths in 2010 (British Heart Foundation, 2012) although 30 day post myocardial infarction (MI) fatality has reduced from approximately 42% to 30% since 2002 (Smolina et al., 2012), likely due to advancements to primary and secondary prevention including increased prescriptions of cardio-protective medications and increased use of percutaneous coronary interventions (PCI) to treat ST-segment elevation MI.

Evidence however suggests that the management of patients with CHD is sub-optimal and in particular, the under prescription of cardiac medications compared to that known to be effective from clinical research. 56% of patients are reported to remain hypertensive six months after diagnosis and 51% have total serum cholesterol above 4.5mmol/l (Kotseva et al., 2009). Additionally, only a quarter of patients prescribed anti-hypertensive medications achieve blood pressures targets, remaining at risk of secondary events.

Achieving safe and effective optimal medical management, particularly following acute MI is challenged by shortened hospital stays. Nevertheless, initiation of an angiotensin-converting enzyme (ACE) inhibitor, beta-blocker, dual anti-platelet therapy and statin following acute MI is recommended (NICE, 2013) and guidance now recommends that instruction on the titration of these medications after discharge be included on hospital discharge summaries.

Optimal medical management may also include revascularisation with PCI however, Boden et al. (2007) provides

evidence that the management of these patient may also be sub-optimal, reporting a high initial success rate however 34% of patients have angina one year later due to residual CHD resulting from either re-stenosis or deterioration of the disease in other lesions. Medical management is therefore required in conjunction with PCI to slow the progression of the disease.

Comprehensive cardiac rehabilitation has additionally been shown to reduce all-cause mortality by 13% and cardiac specific deaths by 26% (Heran et al., 2011) and 43% of patients receive rehabilitation following MI, PCI and CABG. In spite of such benefits, exercise based rehabilitation may act as a trigger for myocardial ischemia or cardiac arrest in patients with CHD (Haskell, 1978) therefore exercise testing and risk stratification prior to commencement is recommended (BACPR, 2012). Heart rate (HR), blood pressure and symptom monitoring are typically obtained during exercise testing although, aside from calculating the rate pressure product (RPP), information is generally not obtained to assess for ischemic compromise during exertion by means of ECG monitoring.

'Optimal medical management' aims to reduce the risk of cardiovascular events, improve quality of life and optimise exercise capacity without restriction (Braunwald et al., 2000). Unique to cardiac rehabilitation at Wirral Heart Support Centre, patients undergo ECG treadmill exercise testing, allowing for the monitoring of ST-segment changes during exertion aimed to establish if restrictions such as ischemic thresholds are needed to exercise prescriptions, as recommended by the American College of Sports Medicine (2014).

Methods

The University of Chester, Faculty of Life Sciences Research Ethics Committee and Wirral Community NHS Trust approved the protocol of the service evaluation.

Participants

180 patients were selected at random who had attended the gym at Wirral Heart Support Centre as part of their cardiac rehabilitation between 2010 and 2014 following a diagnosis of cardiac conditions eligible according to the BACPR (2012) standards and therefore had clinical notes accessible within the department for review. Patients were included in the evaluation if they had a diagnosis of CHD and/or MI and had received treatment with medical management with or without revascularisation with PCI. Patients were excluded if their diagnosis was not related to CHD or if their treatment or diagnoses made interpretation of the ST-segment during exercise inaccurate.

Research Design

The aim of the service evaluation was to compare patients who have received medical management for CHD with those who additionally receive revascularisation with PCI to determine if there is evidence of myocardial ischemia following treatment. Evidence of myocardial ischemia was determined by ST-segment depression on an exercise ECG treadmill test, performed routinely as part of the patient's rehabilitation. Secondly, in order to establish whether patients' management is sub-optimal, the evaluation aims to assess whether the degree of ST-segment depression observed is related to the prescription and dose of cardio-protective medications recommended by NICE (2013).

Patients completed a sub-maximal treadmill exercise test prior to participating in a community based supervised exercise programme as part of their Phase III cardiac rehabilitation. Exercise testing followed the modified BRUCE protocol, was symptom limited and achievement of sub-maximal exertion was defined as a rating of perceived exertion (RPE) 15 and/or a heart rate of 80% heart rate reserve (HRR).

Measurement Procedures

Exercise testing was performed in accordance with the department's procedure for prescriptive exercise testing, led by either a competent cardiac rehabilitation nurse or exercise physiologist. Baseline measurements were taken at the start of the exercise test which included medications and their doses; medical history, treatment method, current symptoms of angina, resting ECG including resting level of ST-segment depression, resting heart rate (HR), resting systolic (SBP) and diastolic (DBP) blood pressure, measured with a calibrated, manual sphygmometer. A 12 lead ECG was recorded throughout the test using a calibrated CASE machine connected to a T-1200 treadmill (GE medical, US) and ECG lead placement followed the Mason-Likar system. RPE was recorded using the Borg (6-20) scale. HR and blood pressure were recorded at the end of each stage and myocardial oxygen consumption was subsequently estimated using a rate-pressure product (heart rate x SBP). Sub-maximal exercise capacity was expressed in units of metabolic equivalents (METS).

Data Analysis

As the assumptions for parametric data were met, analysis of difference in peak ST-segment depression between the two groups was performed using an

independent *t*-test and in order to demonstrate a significant difference between groups, $p \leq .05$. The relationship between ST-segment depression and dose of cardiac specific medications was analysed using a spearman's rank correlation as the data failed the assumptions of parametric data. Normality assumptions were verified with the K-Smirnoff test and homogeneity of variance with the Levene's Statistic. All statistical analyses were performed using a statistical software package (SPSS, version 21, Chicago, IL, USA).

Results

180 patient notes were reviewed for inclusion in the evaluation and 79 patients were subsequently excluded, the reasons for which are summarised in Table 1.

Table 1. Exclusion criteria.

Revascularisation with CABG	25 (32%)
Atrial fibrillation on resting ECG	8 (11%)
Paced rhythm on resting ECG	5 (7%)
Bundle branch block on resting ECG	6 (8%)
Valve disease	8 (11%)
Failure to reach sub-maximal exertion on exercise testing	1 (1%)
Other cardiac diagnosis	10 (13%)
Non-ischemic heart failure	13 (17%)

101 patients were deemed suitable for the evaluation, of which 64 had received revascularisation with PCI and concomitant medical management and 35 had received medical management alone. Additionally, 36 patients had a primary diagnosis of CHD, 35 STEMI, 27 NSTEMI, and 3 had been diagnosed with acute coronary syndrome (ACS). The characteristics of both groups are summarised in Table 2 (results are expressed as mean ± SD unless otherwise stated). 12% of patients had been experiencing symptoms of angina (42% were treated with PCI, 58% medical management) whereas 88% felt they were asymptomatic. Of the 12 patients experiencing angina, 50% demonstrated clinically significant ST-segment depression on the exercise test.

Table 2. Patient characteristics and exercise testing measurements.

Patient Characteristics/ Mean Exercise Testing Study Results	PCI (n =64)	MM (n = 35)
Patient Demographics		
Age (years)	60 ± 10.7	65 ± 10.7
Gender	Male: 52 Female: 12	Male: 25 Female: 12
No. of patient diagnosed with MI	44	21
Exercise testing baseline data		
Time of ETT from MI (weeks)	24.4 ± 31.32	17.3 ± 11.33
Resting HR (beats/min)	63 ± 10.6	68 ± 18.6
Resting SBP (mm Hg)	131 ± 20.4	137 ± 19.7
Resting DBP (mm Hg)	80 ± 12.1	80 ± 10.5
Dose of Bisoprolol (mg)	2.79 ± 2.21	1.42 ± 1.75
Dose of Ramipril (mg)	2.34 ± 2.83	2.74 ± 3.63
Peak exercise data		
Peak heart rate (beats/min)	112 ± 13.3	113 ± 18.4
Peak SBP (mm Hg)	160 ± 25.8	165 ± 15.8
Peak DBP (mm Hg)	79 ± 11.2	81 ± 11.7
Time completed of ETT (mins:seconds)	10.7 ± 3.1	8.88 ± 2.98
METs achieved at peak exercise	6.89 ± 2.30	5.54 ± 1.96
Peak exercise RPE	15 ± 0.9	15 ± 0.9
Peak exercise RPP (bpm.mmHg)	169 ± 37.8	178 ± 37.6
1 minute HR recovery (beats/min)	17 ± 7.54	14 ± 8.13

MI indicated myocardial infarction, ETT, exercise tolerance test; HR, heart rate, SBP, systolic blood pressure, DBP, diastolic blood pressure; METs, metabolic equivalent, RPE, rating of perceived exertion, RPP, rate pressure product

ST-segment depression

The results of an independent t-test demonstrate a significant (p = .015) difference in the level of ST-segment depression recorded at peak exercise between the two treatment groups. Consultation of the descriptive statistics reveals that patients treated with medical management alone demonstrated greater levels of peak ST-segment depression (-0.73 ± .59mm) compared to those treated with medical management and revascularisation with PCI (-0.44 ± .55mm). Furthermore, 24% of patients' demonstrated clinically significant levels of ST-segment depression (defined as ≥ -1.00mm, horizontal or down sloping depression) of which 11 had been treated with PCI and 13 with medical management. The estimated myocardial work (expressed as RPP) at peak exercise was also greater amongst patients treated with medical management compared to PCI (178 ± 37.6 vs. 169 ± 37.8bpm.mmHg, respectively).

Cardio-protective therapies

A significant, positive relationship was found between the dose of bisoprolol prescribed and peak ST-segment depression during exercise testing (p = .009, r = .259), therefore low dose bisoprolol was associated with greater levels of ST-segment depression. Bisoprolol dose was also significantly related to resting heart rate (p = .035, r = -.210) therefore larger doses of bisoprolol were associated with a lower resting heart rate. There was however no significant relationship

between dose of bisoprolol and HR at peak exercise (p = .069, r = -.182). No significant relationships were demonstrated with the dose of ramipril and resting SBP (p = .659), peak SBP (p = .616), resting DBP (p = .277) and peak DBP (p = .608).

Discussion

The results of this evaluation demonstrate that patients managed conservatively with medications alone demonstrate significantly greater levels of ST-segment depression when exercise tested compared to those who are additionally re-vascularised with PCI. The results are comparable to research from Davies et al. (1997) whereby initial revascularisation improved two-year prognosis in patients with evidence of ischemia, even if angina was controlled on conservative medical therapy.

The results also demonstrate that patients treated with PCI were able to exercise for longer before reaching fatigue and achieved a greater METs level during the sub-maximal test than those treated with medical management. Myers (2003) reports exercise capacity between 1 and 6 METs to represent a greater relative risk of death than greater capacities. This indicator of fitness level has additionally been shown to be more predictive of death than other well known risk factors for CHD. The present evaluation demonstrates comparable measures of average resting heart rate and blood pressure for the two groups which would not have been defined as tachycardia or hypertensive according to the NICE clinical guidelines (2011) and would not have indicated the need for restriction to exercise prescription in the absence of information from an ECG. Previous research does however

appear to use measures of heart rate, blood pressure and blood cholesterol as key measurement of risk factor management rather than measures of fitness and ST-segment depression such as Teo et al. (2009) who found the addition of PCI to optimal medical management did not improve nor did it worsen clinical outcomes including all-cause mortality and nonfatal MI in patients with stable CHD.

The heart rate recovery after exercise testing has also been demonstrated as independently predictive of cardiac mortality. Vivekananthan et al. (2003) performed symptom-limited exercise testing for patients with suspected CAD followed by invasive coronary angiography. The heart rate recovery was abnormal if it reduced ≤12 beats/min during the first minute after peak exercise and the mortality risk of an abnormal recovery rate was comparable to having severe CHD. The reduction in heart rate after exercise represents the withdrawal of the sympathetic nervous system and reactivation of parasympathetic nervous system however reduced vagal tone can adversely affect mortality. In this evaluation, the average heart rate recovery for patients treated with PCI was greater (17beats/min) than those treated with medications (14beats/min) and again suggesting that patients are at lower risk of adverse events if treated with PCI and medical management.

Conversely, an almost equal number of patients from each treatment group demonstrated clinically significant levels of ST-segment depression on their exercise test and therefore according to guidelines from the ACSM (2014), require restrictions to their exercise prescription for cardiac rehabilitation. This does therefore suggest that both management

strategies demonstrate evidence of sub-optimal management, reiterating that medical therapy and PCI should be viewed as complementary rather than opposing management strategies. Although angioplasty improves coronary blood flow, the treatment is restricted to specific vessels, therefore all patients would benefit from comprehensive risk factor control with concomitant optimal medical therapy. As such, this evaluation also sought to determine if the level of ST-segment depression can be related to a lack of optimisation of cardiac medications.

The results confirm that greater doses of the beta-blocker medication bisoprolol were associated with reduced significance of ST-segment depression during exercise testing. The average dose of bisoprolol was also greater amongst patients treated with PCI however, the average dose of both groups was relatively low in comparison to evidence that suggests the treatment is most effective when prescribed at the highest tolerated dose (Viskin et al., 1995), whereas the lower doses prescribed to patients in this evaluation appear typical of hospital discharge doses. The results also demonstrate that lower resting heart rates were associated with greater doses of bisoprolol and those treated with PCI demonstrated an average lower resting heart than those treated with medical management. This is particularly significant given that research reports one-year mortality as significantly increased in patients with a resting heart rate ≥ 67bpm (Umbrasiene, Ventsloviene & Babarskiene, 2011) which based on this parameter alone would suggest patients receiving medical management alone are at greater risk of mortality.

These results suggest that patient outcomes could be improved through the up-titration of beta-blockers however it is appreciated that this process is far from simplistic. Despite the evaluation being unable to comment on the reasons why the doses of bisoprolol were not optimised, typical reasons for the lack of optimisation of medications post-MI include the presence of contra-indications such as asthma, previous cerebrovascular accidents or symptoms of dizziness, dyspnoea and lethargy (Ong et al., 2012). Although, as the average time from MI to exercise testing in this evaluation was between 17 and 24 weeks, patients would have therefore had the opportunity for up-titration in the community had this been available and appropriate. Although NICE (2013) do not specify optimal timings of titration of beta blockers due to a lack of clinical evidence, they do recommend communication of titration plans in discharge summaries therefore it is feasible to consider that external factors such as poor communication between primary and secondary care and patient education could contribute to the results reported.

The role of a nurse prescriber in cardiac rehabilitation is a relatively new concept however the results of this evaluation provides evidence for its potential usefulness. Although with increasing pressures on staff within the NHS to work more cost-effectively this could affect the utilisation of such a service. It could therefore be argued whether cardiac rehabilitation staff can improve communication with general practitioners in order to facilitate the optimal management of patient medications. This could provide a more viable option initially than training nurses in non-medical prescribing in addition to providing

time for the conduction of appointments to ensure safe titration without compromise to the normal delivery of the service. Furthermore, those patients who do not attend or complete rehabilitation still require the same community monitoring as those who attend which emphasises the importance of ensuring information is communicated effectively on discharge summaries so that general practitioners can take responsibility for patient compliance and monitoring.

As the majority of patients were asymptomatic and therefore demonstrated silent ischemia, this also provides a rationale for the place of ECG exercise testing in cardiac rehabilitation as without this level of information, exercise prescription would be solely based on symptom monitoring and risk factor management. Furthermore, if individuals attending cardiac rehabilitation are sub-optimally medically managed, this negatively impacts the scope to safely prescribe beneficial exercise in cardiac rehabilitation due to potentially low ischemic burdens. ACSM (2014) guidelines define ischemic thresholds as exercise of 10beats/min below the heart rate at which clinically significant ST-segment depression was observed. However, Noel et al. (2007) challenge the guidelines in their randomised control trial of patients treated for CHD who either exercised above this threshold or adhered to current guidelines. Prolonged aerobic exercise inducing ST-segment depression between 1.0 and 2.1mm was not found to result in significant arrhythmias, impairments to left ventricular function or indications of myocardial injury.

Additionally, Miranda et al. (1991) report from a large study of patients

who underwent exercise testing followed by diagnostic angiography that exercise induced ST-segment depression is a better marker for CAD than that of exercise induced angina however ECG monitoring is not routinely used to evaluate low risk, asymptomatic cardiac rehabilitation patients and it can be argued whether safety to exercise could be achieved using cheaper alternatives such as by use of walking assessments which require less staff, time and equipment whilst being reliable. Although, the use of a six minute walking test (6MWT) has been criticised as merely measuring distance walked and symptoms as opposed to physiological parameters of blood pressure that can be used as indicators of aerobic capacity (Simms et al., 2007). Incremental shuttle walking has however been shown to be safe in patients with CHD and report a low risk of cardiac events with stress testing of 0% to 0.36% (Jolly et al., 2008) in addition to a low risk of adverse events during rehabilitation classes.

Pepera, Bromley & Sandercock (2013) also report only minor events provoked during incremental shuttle walking and ECG monitoring as part of cardiac rehabilitation, with the most significant event being silent myocardial ischemia. Although, low incidence rates with functional capacity testing may be a result of low individual effort and the study failed to report exact measures of ST-segment depression so it cannot be conferred whether the patients demonstrated clinically significant ischemia. Additionally, the ambulatory ECG monitoring was performed using a single lead whereas a 12 lead ECG provides additional information on the severity of the disease. The use of ambulatory ECG monitoring during exercise testing is

not commonplace in the UK despite the usefulness in identifying patients with the greatest risk of cardiovascular events during exercise however, the American Heart Association (Fletcher et al. 2001) clearly recommend the use of such monitoring in their guidance.

Study limitations

Some limitations of the evaluation should nevertheless be noted including that stress-induced myocardial ischemia is generally diagnosed on the basis of ST-segment changes, angina and ventricular arrhythmias however the author felt that analysis of arrhythmias was beyond the scope of this service evaluation. It is also recognised that the gold standard analysis of CHD is by the use of invasive coronary angiography and as such exercise testing has been less commonly used in the diagnostic management of patients with suspected CHD since the NICE (2010) chest pain guidelines were updated to utilise more accurate coronary imaging techniques. The sensitivity and specificity of exercise induced ST-segment depression is 68% and 77% respectively (Gibbons, 2002) with a range of 40% for one vessel disease and 90% for three vessel disease. If the exercise test had coupled the 12 lead ECG with cardio-pulmonary testing, this would have enabled more robust analysis of hemodynamic responses to exercise including oxygen uptake and the anaerobic threshold and therefore providing useful information for both CHD and heart failure patients. However, this would have implications on staffing and cost that would at present make it an unrealistic option for exercise testing cardiac rehabilitation patients.

Additionally, patients treated with CABG were excluded from the evaluation which represents a large

portion of CHD patients however this was based on evidence of non specific ST changes post surgery that would have made the interpretation less reliable due to the nature of the surgery. New ECG abnormalities including ST-segment elevation, depression and T wave inversion after CABG appears more common than after PCI (Yokoyama et al., 2000) although the prognostic importance of the abnormalities is not well established. Nevertheless, the specificity of ST-segment depression as a marker of ischemia on exercise testing following CABG is reduced due to post operative pericardial trauma and electrolyte imbalance.

Finally, Myers (2003) determined fitness levels for their study in terms of maximal exercise testing whereas the current analysis can only comment on fitness in terms of sub-maximal exertion. Myers (2003) additionally reports that the greatest reduction in mortality is seen when individuals increase their exercise capacity from ≤ 6 METs to ≥ 8 METs. This sets a target for improvement to exercise capacity by the end of the rehabilitation however, the service does not currently repeat any form of exercise testing at the end of the programme due to cost and staffing implications. Despite the exercise test being completed at least 17 weeks post MI, the exercise rehabilitation then runs for a 12 week period after and the present evaluation is unable to compare outcomes from this exercise test to that of the end of rehabilitation.

Conclusion

It is evident that there are advantages and disadvantages to exercise screening with ECG treadmill testing, including that the presence of a doctor on site restricts its facilitation and as

patients may have already undergone stress tests in the diagnosis of their CHD, staff should be cautious of over medicalising the patient experience. Nevertheless, the test provides valuable information that cannot be conferred from functional capacity testing and until further research emerges to confirm the safety of exercise training above ischemic thresholds, the test will continue to have a place as a routine part of the patient journey. For patients demonstrating clinically significant levels of ST-segment depression, the exercise test is normally repeated after 8 weeks of exercise training to enable comparison of such changes and physiological parameters including assessment of whether ischemic burdens occur at the heart rate and exercise intensity as previously noted. However, it could equally be argued that those who do not demonstrate clinically significant ST-segment depression at the beginning of the 12 week programme may deteriorate however, due to the cost implications of repeating the test at the end of the programme on every patient, selection may need to be based on an individual, symptom monitored basis, using clinical judgement. Nevertheless, this evaluation has provided strong evidence for the need to optimise medical management to ensure patients achieve the best possible outcomes. Therefore the service should prioritise investigating how best to utilise the information received from exercise testing and ensure those who demonstrate clinically significant ST-segment depression are assessed for potential up-titration of medications.

Future evaluation within the department would be beneficial if comparing ST-segment depression at baseline and after 8 weeks of exercise training. This would also help to guide the targeting of medical management

and may provide evidence for the need of a nurse prescriber in rehabilitation in the future. It would also be worthwhile factoring changes to medications during the same time period into such analysis to confirm benefits of up-titration. However, until such information comes to light and whilst the service needs to demonstrate it's cost effectiveness it may be worthwhile continuing to establish rigid procedures to facilitate better communication with general practitioners and consultants to enable effective up-titration of cardiac medications in the community. If this process appears to be unsuccessful or the timing of up-titration affected by poor communication, then this evaluation still provides evidence for the training of non-medical nurse prescribers who could integrate into the cardiac rehabilitation service.

University of Chester

Faculty of Life Sciences
Research Ethics Committee

frec@chester.ac.uk

Melanie Meadowcroft

28th April 2014

Dear Melanie,

Study title:	**Are patients with coronary heart disease 'optimally' medically managed within cardiac rehabilitation? A service evaluation.**
FREC reference:	**892/14/MM/CSN**
Version number:	**1**

Thank you for providing the documentation for the amendments recommended following the approval of the above application. These amendments have been approved by the Faculty Research Ethics Committee.

With the Committee's best wishes for the success of this project.

Yours sincerely,

Dr. Stephen Fallows
Chair, Faculty Research Ethics Committee

MSc Data Collection: Wirral Heart Support Centre

Patient Demographics (pg 1)

Age: _____

Diagnosis: CHD □ NSTEMI □ STEMI □ ACS □ HF □ Valve Disease □

Other _____

CHD Details: Vessel affected:_____

LV function: Normal Mildly impaired Mod–severe Unknown

Treatment: Medical Management □ PCI □ PPCI □ CABG □

No. of stents/grafts _____

Treatment Date / /

Other _____

Medications: Beta Blocker _____ ( )

ACE Inhibitor _____ ( )

Statin _____ ( )

Nitrates _____ ( )

Other _____ ( )

Current Angina Symptoms: Yes □ No □

Resting ECG: Sinus AF BBB Paced

Other _____

Patient to be included in study

Yes □ No □ Reason _____

ETT Data Collection (pg 2)

Date of test: / /

Time from event of ETT _____

Total Time completed of Mod Bruce: _____

Symptoms of angina: Yes/No

Max METS achieved: _____

Predicted Max HR	**Non-Blocked →**		**Blocked →**	
80% HRR				

Resting HR: _____ bpm Resting BP: _____ mmHg

Peak HR: _____ bpm Peak BP: _____ mmHg

Peak RPE: _____ Peak RPP: _____

1 minute HR recovery: _____ bpm

Resting ST depression: _____ mm None

Peak exercise ST depression: _____ mm None

ST depression in leads _____

Ischemic threshold set: Yes / No

Data entered on SPSS ☐

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