CORONARY RISK FACTOR MODIFICATION AFTER CORONARY ARTERY BYPASS SURGERY

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Title Page

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By

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Abstract

This is a retrospective cohort study that examined whether major coronary risk factors change when compared preoperatively and 3 years postoperatively after coronary artery bypass surgery. Preoperative coronary risk factor data were obtained from a retrospective chart review. Three years postoperative risk factor data were obtained by hospital attendance with blood sampling, blood pressure measurements, weight and height measurements, and answering standard questionnaires. Results revealed a significant decrease in total cholesterol and LDL, a significant increase in blood pressure and body mass index, and a clinically significant change in smoking habits 3 years post surgery. Slightly more than half of the subjects reported an increase in exercise levels even though only one fifth of them attended cardiac rehabilitation program post surgery. Most subjects reported strong social support in helping them to modify their coronary risk factors.

Implications for the current strategies in the secondary prevention of coronary artery disease were examined.

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To my Mom and Dad, who have provided me with so much and have loved me unconditionally all these years. It was through your upbringing, I learned that with hard work, determination, and a steadfast belief in myself that anything is possible.

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Chapter 1. Research Question

This study was performed to determine whether major coronary risk factors changed 3 years after coronary artery bypass surgery in subjects who underwent the surgery between April 1, 1994 and March 31, 1995 in the Avalon Peninsula of Newfoundland, Canada. The coronary risk factors assessed in this study include hyperlipidemia, hypertension, smoking status, and obesity. A subjective questionnaire was also used to assess cardiac rehabilitation attendance, exercise level, risk factors counseling received, and the degree of social support available to subjects post coronary artery bypass surgery.

1.1 Literature Search Strategies and

Main search engines used to perform the literature search were PubMed on the World Wide Web and WinSPIRS 2.1 (MedLine on Silver Platter). Cross checked search engines were also used. These included Healthstar, CINAHL, and Cochrane Library of Systematic Review.

For the initial review of coronary risk factors and its relationship to ischemic heart disease, search criteria syntax entered into the search engine was "ischemic heart disease" [MeSH] AND ("risk factors" OR "risk factor") [MeSH]". Methodological term included "randomized control trial".

Further review of literature specifically in post CABG populations, additional search criteria syntax used was "AND ("after coronary artery bypass") AND ("control" OR "controlled" OR "modify" OR "modifies" OR "modifying" OR "modification") AND english [la] AND human [tg]. Methodological term was altered to "all studies".

Search yielded a total of 146 studies. Finger indexing was used to refine search related to the research question.

1.2 Review of Literature

Coronary heart disease (CHD) is the single largest cause of death in North American men and women. Management of CHD include treatment with medications and the more invasive direct revascularization of myocardium with percutaneous method or with open chest operation. This open chest operation is known as coronary intervention coronary artery bypass graft (CABG) surgery.

CABG surgery consists of the construction of new pathways (conduits) between the aorta (or other major arteries) and segments of coronary arteries beyond obstructive lesions for the purpose of bringing blood to myocardium made ischemic by these lesions. Since the early 1960's, reversed segments of autologous saphenous vein have been used as the conduit in the surgery. In 1968 Green used the left internal mammary artery to bypass the left anterior descending coronary artery, leading to better and longer graft patency rates. Segments of radial artery, arm veins, allograft arteries, and veins and synthetic tubes are now being used with variable results [1].

CABG surgery has proved its superiority over pharmacological treatment in patients with severe coronary artery disease [2]. This is based on analysis of the three largest clinical trials of coronary artery bypass grafting, the Veterans Administration Cooperative Study of coronary artery surgery (VACS) [3], the European Coronary Surgery Study (ECSS) [4], and the Coronary Artery Surgery Study (CASS) [5]. The sicker the patient, (as gauged by relevant measures of coronary disease and cardiovascular morbidity) the more likely CABG will prolong life. In summary, a CABG-related improvement in survival is therefore more likely to occur if there is a left ventricular dysfunction, multivessel disease, proximal coronary lesions (more muscle is threatened by such lesions), high-grade lesions as determined by angiography, more severe angina, or low-level inducible ischemia.

Despite good survival rates from initial CABG surgery, the narrowing and subsequent occlusion of the venous grafts, followed by recurrence of symptoms and increased in mortality, are major long term problems [4 6]. Because the success rates of re-operation are less favourable than after first

operation [7], interventions that slow the progression of atherosclerotic changes in the grafts and native coronary arteries are essential.

There is clear epidemiological evidence that coronary artery disease risk factors are important in the development of occlusion in bypass grafts. Factors that have been associated with the progression of atherosclerotic plaque in both grafted and native coronary vessels include hyperlipidemia, smoking, hypertension, obesity, and lack of exercise. Numerous studies have explored the relationship between these coronary artery risk factors and the development of atherosclerosis after coronary artery bypass surgery. Among these coronary risk factors, hyperlipidemia has been examined the most extensively in the literature.

1.2.1 Hyperlipidemia and Ischemic Heart Disease

Hyperlipidemia is a general term for elevated concentrations of any or all of the lipids in the plasma, including hypercholesterolemia and hyperlipoproteinemia. Serum lipoprotein analysis allows measurement of total cholesterol, triglycerides, and high-density lipoproteins (HDL). Low-density lipoproteins (LDL) concentration is then calculated using the formula LDL = Total cholesterol – HDL – (Triglyceride/5). Lowering serum lipids levels has been shown to decrease the risk of recurrent coronary events and procedures in patients with CAD as well as reduce the risk of developing CAD in people with hypercholesterolemia.

Campeau et al., 1984 [8] examined 82 patients angiographically 10 years after coronary artery bypass surgery. New lesions developed in 81.7% of patients – in the grafts, the native vessels, or both. Plasma levels of very-low-density lipoproteins (VLDLs) and low-density lipoproteins (LDLs) were significantly higher, and high-density lipoprotein (HDL)

levels were significantly lower in those patients with new disease 10 years after coronary artery bypass surgery. Univariate analysis showed that plasma cholesterol and triglyceride levels were significantly higher both at the time of surgery and at the 10-year follow-up in those with new lesions. These findings suggest that the development of atherosclerosis affecting both the grafts and native vessels may be related to the plasma lipoprotein levels. However, the effect of plasma lipoprotein levels on the progression of atherosclerosis may be underestimated, since to be eligible for this restudy patients had to survive for 10 years after surgery. There was no significant association between hypertension, cigarette smoking, and diabetes with the development of new lesions. This is not surprising given the relatively small number of patients studied and the fact that these factors were treated as discrete, not continuous, variables.

A subsequent study, by the same author [9], examined 1351 patients who had undergone bypass surgery 1 to 11 years before the intervention and who had an LDL cholesterol level between 130 and 175 mg per

deciliter (3.36 mmol/l and 4.53 mmol/l) and at least one remaining patent vein graft as seen on angiography. The study used a two-by-two factorial design to assign patients to aggressive or moderate treatment to lower LDL cholesterol levels (with lovastatin and, if needed, cholestyramine) and to treatment with warfarin or placebo. Angiography was repeated an average of 4.3 years after base line. The primary angiographic outcome was the mean percentage per patient of grafts with a decrease of 0.6 mm or more in lumen diameter. As measured annually during the study period, the mean LDL cholesterol level of patients with aggressive treatment ranged from 93 to 97 mg per deciliter (2.40 to 2.51 mmol/l); with moderate treatment, the range was from 132 to 136 mg per deciliter (3.41 to 3.52 mmol/l) ($P<0.001$). The mean international normalized ratio (INR), a standard used to measure coagulability of blood with higher numbers indicating less coagulable states, was 1.4 in the warfarin group and 1.1 in the placebo group ($P<0.001$). The mean percentage of grafts with progression of atherosclerosis was 27 percent for patients whose LDL cholesterol level was lowered with aggressive treatment, and 39 percent for those

who received moderate treatment (P<0.001). There was no significant difference in angiographic outcome between the warfarin and placebo groups. The rate of revascularization over four years was 29 percent lower in the group whose LDL cholesterol level was lowered aggressively than in the group receiving moderate treatment (6.5 percent vs. 9.2 percent, P= 0.03). The study concluded that aggressive lowering of LDL cholesterol levels to below 100 mg per deciliter (2.58 mmol/l) reduced the progression of atherosclerosis in grafts. Low-dose warfarin did not reduce the progression of atherosclerosis.

Although not specific to the post CABG populations, there are numerous other studies that have demonstrated significant reductions in major cardiovascular events (mortality, coronary mortality, total CHD events, and stroke), which often begin 6 to 12 months after starting lipid lowering therapy with the statin class of drugs [10 11 12]. The first study to show an absolute reduction in total mortality used a statin and was called the Scandinavian Simvastatin Survival Study (4S) [13 14]. It was a randomized double blind study of 35 to 70 years old subjects

(20% women) with a history of acute MI or angina pectoris with high total cholesterol treated with simvastatin. Total mortality was 8% in the drug group versus 12% in the placebo group. One hundred thirty five patients was the "number needed to treat" (NNT) for 1 year or 25 patients for 5 years to prevent 1 death. This benefit was also seen in women and in those older than 60. There was decreased cardiac morbidity and need for coronary artery bypass graft (CABG) surgery or angioplasty as found by previous studies. There was no difference in non-cardiovascular mortality, indicating simvastatin was safe as well.

As for effectiveness in secondary prevention with a mildly elevated cholesterol, the Cholesterol and Recurrent Events (CARE) [15 16 17] was also a randomized double blind study looking at 4159 patients (mean age, 59) with previous myocardial infarction (MI) over 5 years with a cholesterol < 240 mg/dL (6.20 mmol/l) (average total cholesterol, 209mg/dL (5.40 mmol/l)). Pravastatin 40 mg/d reduced risk of dying from CHD or having another MI by 24%, from 13.2% to 10.2%. All cause mortality was not decreased. In patients with LDL < 3.23 mmol/l

there was no reduction in events suggesting a threshold level. Subset analysis of 1283 patients aged 65 to 75 years who had had MI and had a plasma total cholesterol level less than 6.2 mmol/l (240 mg/dL) and a low-density lipoprotein cholesterol level of 3.0 to 4.5 mmol/l, 5 year event rates of major coronary events (coronary death, nonfatal myocardial infarction, angioplasty, or bypass surgery) and stroke were 28.1% in placebo recipients and 19.7% in pravastatin recipients (difference, 9% [95% CI, 4 to 13%]; relative risk reduction, 32%; $P < 0.001$).

The Long-term Intervention with Pravastatin in Ischemic Disease (LIPID) [18] was a similar secondary prevention study, which was able to show a drop in all causes of mortality in patients with a median cholesterol of 218 mg/dL (5.63mmol/l). It was a randomized double blind placebo controlled study done in Australia and New Zealand with 9014 patients, predominantly male, with a median age of 62 who were diagnosed after hospital discharge with either MI or unstable angina. After 6 years the pravastatin group had an incidence of CHD death of

6.4% compared to 8.3% in the control group. The statin group had a 11% overall mortality compared to 14.1% in the control group. All cause mortality and cardiovascular morbidity, and the need for angioplasty, hospitalization, and more relevant to our study the need for CABG surgery, were all lowered.

The Veterans Affairs High-Density Lipoprotein Cholesterol Intervention Trial Study (VA-HIT) Study [19] used gemfibrozil (1200 mg/d) to treat men with confirmed CHD whose primary lipid abnormality was HDL (LDL < 3.62 mmol/l, HDL < 1.03 mmol/l). They were able to reduce absolute nonfatal MI or death from coronary causes by 4.4% (21.7% to 17.3%) or a relative reduction of 22%. Unlike previous studies using gemfibrozil there was no increased all causes mortality.

In addition to these studies, a recent meta-analysis [20] indicates that even modest lipid improvements over a short-term period (e.g., 2 to 5

years) may reduce CHD events by up to 20% in patients 70 to 80 years of age.

1.2.2 Smoking and Ischemic Heart Disease

Numerous studies since the 1950s have shown that tobacco smoking is a major atherosclerosis and CHD risk factor. It is an even stronger promoter of acute CHD events, which is the reason why marked reductions in CHD events occur early after smoking cessation, falling to nearly the levels of control subjects within 6 to 12 months. These studies suggest that, compared with nonsmokers, those who consume 20 or more cigarettes daily have a twofold to threefold increase in total coronary heart disease. Moreover, these effects depend on dose; consumption of as few as one to four cigarettes daily increases coronary artery disease risk.

A study by Gerald et al. [21] followed up 340 men who had undergone CABG surgery with repeat angiography. After 5 years, 115 patients

were smokers and 225 were nonsmokers. The mean number of grafts per patient were similar in the two groups. The study found disease-free grafts in 39% of the smokers and 52% of the nonsmokers. The study suggested that men who continue to smoke are at significantly greater risk ($P < 0.05$) of artherosclerosis and occlusion than nonsmoking men.

Van Domburg RT et al. [22] studied 1041 patients who underwent CABG between 1971 and 1980. The preoperative and postoperative smoking habits of 985 patients (95%) could be retrieved and were analyzed in a multivariate Cox analysis. The median follow-up was 20 years (range 13 to 26 years). Smoking status before surgery was not associated with an increased risk of mortality. Patients who had smoked before surgery and those who had not smoked in the year before surgery had a similar probability of survival. However, smoking cessation after surgery was an independent predictor of a lower risk of death and coronary reintervention during the 20-year follow-up when compared with patients who continued smoking. When adjusted for

baseline characteristics, the persistent smokers had a 68% greater risk of death from all causes (RR 1.68 [95% confidence interval 1.33 to 2.13]) and a 75% greater risk of cardiac death (RR 1.75 [1.30 to 2.37]) as compared with patients who had stopped smoking for at least one year after surgery. The estimated benefit of survival for the quitters increased from 3% at five years to 14% at 15 years. The quitters were less likely to undergo repeat CABG or a percutaneous coronary angioplasty. This study concluded that patients who continued to smoke after CABG had a greater risk of death than patients who stopped smoking. They also underwent repeat revascularization procedures more frequently. With these results, the authors strongly recommended cessation of smoking after CABG.

Other observational studies that were not specific to post CABG patients also suggest a substantial reduction in the rates of subsequent cardiac events among patients with established heart disease who stopped smoking compared with those who did not [23 24].

1.2.3 Hypertension and Ischemic Heart Disease

Blood pressure in the human population is normally distributed, and the cutoff point for high BP is arbitrary. The diagnosis of hypertension in adults is made when the average of two or more diastolic BP measurements on at least two subsequent visits is 90 mm Hg or more or when the average of multiple systolic BP readings on two or more subsequent visits is consistently greater than 140 mm Hg.

Even though the number of studies on post CABG patients who are hypertensive are limited, it is reasonable to extrapolate from non CABG studies that hypertension is an important risk factors for coronary heart disease. There is overwhelming evidence in the literature that has established that blood pressure elevation is a common and powerful contributor to all of the major cardiovascular diseases, including coronary artery disease in non CABG patients. An early meta-analysis that evaluated over 5500 cardiovascular events found a 27 percent increase in risk of coronary heart disease and a 42

percent increase in risk of ischemic stroke for every 7 mm Hg elevation of diastolic blood pressure [25]. Even among individuals without diastolic hypertension, isolated increases in systolic pressure are a risk factor. Isolated systolic hypertension markedly increases risk for nonfatal myocardial infarction and cardiovascular death among both general population samples [26]. Isolated systolic hypertension has also been identified as an independent predictor of coronary artery disease.

Herlitz J et al. [27] performed a study to describe mortality and morbidity during a period of 2 years after coronary artery bypass grafting (CABG) in relation to a history of hypertension. Early mortality and morbidity were described during the first 30 days after CABG surgery while late mortality were described between day 30 and 2 years after CABG surgery. All patients in western Sweden in whom CABG was undertaken between June 1988 and June 1991 were studied. Patients with simultaneous valve surgery were excluded in this study. The author noted that patients with hypertension (n = 777) differed from patients without hypertension (n = 1348). In the hypertensive group,

the proportion of women was higher, they were older and more frequently had a history of congestive heart failure, diabetes mellitus, renal dysfunction, cerebrovascular disease, intermittent claudication and obesity. They were also more likely to develop post-operative cerebrovascular complications and myocardial infarction. Patients with hypertension tended to have increased mortality during the first 30 days after CABG while the late mortality (between day 30 and 2 years) was significantly higher than in non-hypertensive participants. Whereas the development of myocardial infarction was similar in both groups, the hypertensive subjects developed stroke more frequently during 2 years of follow-up. In a multivariate analysis including age, sex, previous cardiovascular diseases, smoking, ejection fraction, and the occurrence of three-vessel coronary artery disease, hypertension was not identified as an independent predictor of death either in the early (< 30 days) or in the late phase (30 days – 2 years) of follow-up. The study concluded that patients with a history of hypertension have a different pattern of risk factors. This group has a higher mean age, includes a higher proportion of women, and have a higher prevalence of congestive heart

failure, diabetes mellitus, renal dysfunction, cerebrovascular disease, intermittent claudication, and obesity. They also have an increased frequency of immediate post-operative complications and an increased 2-year mortality, even if a history of hypertension was not an independent predictor of death during the 2 years of follow-up.

1.2.4 Obesity and Ischemic Heart Disease

The currently preferred definitions of overweight and obesity are based on body mass index (BMI) determinations, which approximate total body fat content and correlate with disease risk. Overweight is defined as a BMI of 25 to 29.9 kg/m^2. Obesity is defined as a BMI greater than 30 kg/m^2, and morbid obesity by a BMI greater than 40 kg/m^2.

Obesity is a highly prevalent condition among patients with coronary heart disease. In a study of 225 participants in an urban cardiac rehabilitation program, 48% were found to be greater than 120% of ideal body weight. [28] In another review of 659 cardiac rehabilitation

participants from the more rural University of Vermont program, 69% were overweight with a body mass index (BMI = weight in kg/height in m^2) of greater than 25 kg/m^2, 53% were obese with a BMI of greater than 27 kg/m^2, and 31% were very obese with a BMI of greater than 30 kg/m^2.

In the Framingham Heart Study [29], obesity has been identified as a significant independent predictor of cardiovascular disease in both men and women and a desirable target for preventive interventions. However, most studies had only identified obesity as a dependant predictor of cardiovascular disease. Weight loss is known to be associated with the lowering of blood pressure levels, measures of insulin resistance, lipid levels, and clotting abnormalities [30]; however, no study has addressed the effects of weight reduction on secondary coronary events in a CHD population.

1.2.5 Diabetes Mellitus and Ischemic Heart Disease

Diabetes Mellitus is a group of metabolic disorders that results in hyperglycemia. These disorders have different etiologies, but their common manifestation, hyperglycemia, is associated with acute and chronic complications including cardiovascular diseases. The diagnosis of diabetes mellitus is made with confirmations of either fasting blood glucose of $\geq$ 7.0 mmol/L, plasma glucose value of $\geq$ 11.1 mmol/L during a 2 hour Oral Glucose Tolerance Test, or random plasma glucose of $\geq$ 11.1 mmol/L along with symptoms of diabetes such as polyuria, polydipsia, polyphagia, nocturia, weight loss, and blurry vision.

There had been extensive studies including the CASS study [31] that established diabetes mellitus as independent predictor of cardiovascular mortality. In the Framingham Study, 20-year follow-up

of individuals aged 45 to 74 years at the initial screening showed a twofold to threefold elevation in the risk of clinically evident atherosclerotic disease in those with diabetes as compared with the nondiabetic cohort [32]. These data also showed loss of the protection against CHD in women with diabetes, who had a rate of CHD mortality as high as that in diabetic men. In the Multiple Risk Factor Intervention Trial (MRFIT), more than 5000 men who reported taking medications for diabetes were monitored for an average of 12 years [33]. For every age stratum, ethnic background, and risk factor level, men with diabetes had an absolute risk of CHD death more than three times higher than that in the nondiabetic cohort, even after adjustment for established risk factors. Similar findings were seen in a large cohort of 11,554 white men and 666 black men between the ages of 35 and 64 screened from 1967 to 1973 and monitored prospectively for 22 years [34].

Several large studies have also emphasized the independent adverse effect of diabetes on mortality after CABG surgery. In the multicenter

Bypass Angioplasty Revascularization Investigation (BARI) study [35], patients with diabetes had a higher mortality rate than did nondiabetic patients, regardless of their mode of revascularization (CABG or PTCA). This finding was not unexpected, based on the differential of risk between the diabetic patients and all others. But even after the statistical adjustment for the differences in cardiovascular risk profile, (including age, sex, left ventricular function, dominance, kidney dysfunction, peripheral vascular disease, history of congestive heart failure and hypertension), diabetic patients showed, during the 5-year follow-up after enrollment, a significantly higher mortality rate than did nondiabetic patients. These findings are consistent with previous reports about patients with diabetes who have undergone CABG surgery by Morriss JJ et al [36]. In the Duke data base [37], the 5-year unadjusted survival rate was 74 percent among diabetic patients and 86 percent among nondiabetic patients treated surgically. In another study that examine diabetic population undergoing coronary revascularization, insulin dependence is an added adverse predictor of 5- and 10-year survival rates [38].

1.2.6 Other risk factors and Ischemic Heart Disease

A decrease in morbidity may be possible with strict diet modification and lifestyle changes as described by Ornish [39]. One hundred fifty of 194 patients who were candidates for revascularization were able to avoid surgery or angioplasty for at least 3 years. The program consisted of very low-fat, low-cholesterol diet (vegetarian, 10% fat, <10 mg/d cholesterol, high in complex carbohydrates and low in simple sugars), stress management techniques, moderate exercise, and psychosocial support. One may argue that these are only broad encompassing strategies that may well contribute to the lowering of the many coronary risk factors that was discussed earlier such as hyperlipidemia, hypertension, obesity, and perhaps smoking. More importantly, this study pointed out the importance of the related psychosocial issues such as stress management and support networks in the process of controlling coronary risk factors.

1.2.7 Multiple Coronary Risk Factors and Ischemic Heart Disease

In a recent multivariate risk factor analysis of clinical outcomes 15 years after coronary artery bypass graft surgery, Van Brussell et al. also showed that well-known pre-operative "classical" risk factors if still present late after surgery, influence the occurrence of clinical events and treatment of these factors may result in better long-term prognosis after venous bypass graft surgery [40]. Four hundred and twenty-eight consecutive patients who underwent isolated venous coronary artery bypass surgery were entered into this study. From the "classical" risk factors present 5 years after surgery, hypertension is an incremental risk factor for both overall and cardiac mortality, while smoking for all clinical events except mortality. The study also showed that obesity at the time of surgery is a risk factor for the occurrence of myocardial infarction during follow-up. This study emphasizes that much more attention should be paid to treat such factors in order to expect better long-term results after venous aorto coronary bypass grafting surgery.

1.3 The Problem

Despite clear evidence that appropriate management of post-CABG surgical patients should include comprehensive risk factor modification, a number of studies have shown that these risk factors are not being adequately addressed. One of these studies looked at the prospective investigation of 136 female-patients in Maryland and discovered that no significant changes in plasma lipid concentration were achieved and 59% of their patients continued to exhibit hypertension 6 months after CABG surgery [41]. An Australian study of 103 patients suggested that cigarette smoking received appropriate intervention and hypertension received some intervention while hyperlipidemia received insufficient intervention 12 months following CABG surgery [42]. In an earlier study in the Netherlands, in which 226 patients received instructions with regard to coronary risk factor modification, there was a significant reduction in hypertension prevalence, no significant modification of smoking but a significant increase in the prevalence of hypercholesterolemia [43]. These studies, however, have short follow up periods i.e. 1 year post CABG surgery. In addition, not all importantly known

coronary risk factors were included in their assessment. These studies investigated coronary risk factors that were limited to only hyperlipidemia, hypertension, and smoking status.

1.4 The Research Question

The studies mentioned above have shown that coronary risk factors were not properly addressed and modified shortly after CABG surgery i.e. 6 months to 1 year post-operatively. Therefore, I started conducting this research study in 1998 with the purpose of investigating the long term effect of CABG surgery i.e. 3 years postoperatively, on a wider selection of coronary risk factors. No long term data was available on the effect of coronary risk factors in patient who underwent CABG surgery at that time when this research was initiated. Therefore, my research question was "Do coronary risk factors change 3 years after CABG surgery?" The major coronary risk factors investigated include hyperlipidemia, hypertension, smoking status, and obesity. A subjective questionnaire was also used to assess cardiac rehabilitation attendance, exercise level, risk factor counseling received, and the degree of social support available to subjects post CABG surgery.

1.5 Background to the Study

This is a retrospective cohort study design that was developed to investigate whether coronary risk factors are modified in an extended period of time; i.e. 3 years after CABG surgery in an urban setting in the Avalon Peninsula of Newfoundland. A wider range of coronary risk factors was selected for this investigation compared to previously available studies. In addition to the commonly known risk factors such as hyperlipidemia, smoking status, hypertension, and BMI, this study also investigates by means of a post-CABG surgery questionnaire survey of the following:

a. The proportion of subjects who attended cardiac rehabilitation program post CABG surgery,

b. The proportion of subjects who altered their exercise activity levels post CABG surgery,

c. The proportion of subjects who received advice or counseling on cigarette smoking cessation, weight reduction, and diet modification pre- and post-CABG surgery, and

d. The degree of social support available to the subjects with regards to risk factors modification

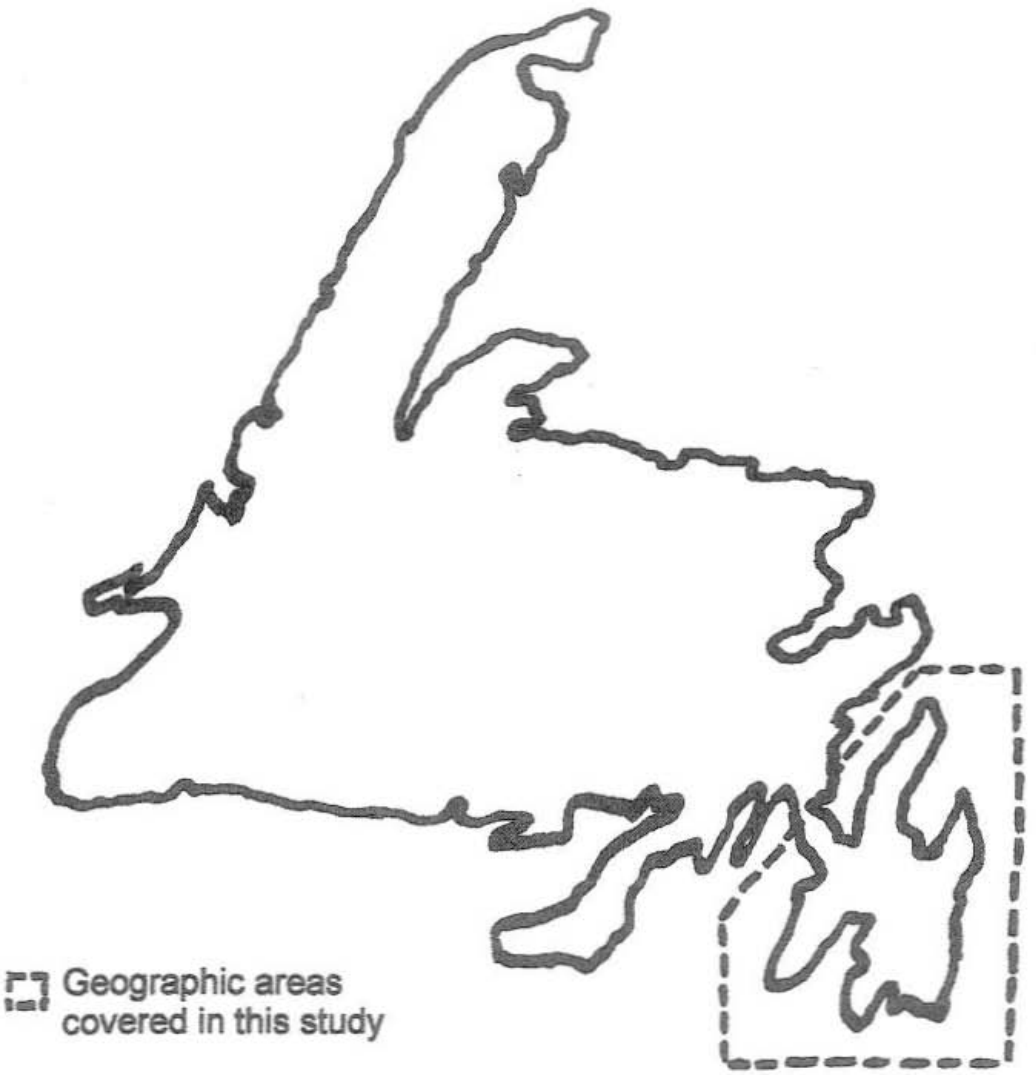
With these, we hope to identify any improvements that should be implemented to enhance the appropriate use of our cardiac rehabilitation service and health care providers' directed management of coronary risk factors.

Chapter 2 Methods

2.1 Subject Selection

A consecutive series of 109 subjects who lived within a 200 kilometer radius of St. John's, Newfoundland and underwent their first coronary artery bypass graft (CABG) surgery in the Health Sciences Center, St. John's between April 1, 1994 and March 31, 1995 were entered into this retrospective cohort study. Subjects were obtained from a listing of relevant medical records. The geographical areas of sample subjects' residences in the Avalon Peninsula of Newfoundland included the areas extending to Arnold's Cove in the west, Bay de Verde in the north, Placentia in the southwest and Trepassy in the south. This population was conveniently selected to allow the samples subjects to attend the hospital for the necessary interview and blood sampling in this study. An illustrated map of geographical areas covered in this study is shown in Figure 1.

2.1.1 Figure 1. Geographic Areas of Study Population



2.2 Data Collection

2.2.1 The Inclusion and Exclusion Criteria

Inclusion Criteria:

1. All persons who underwent a first CABG surgery at the Health Science Center during the study period, between April 1, 1994 and March 31, 1995.

Exclusion Criteria:

1. Persons who underwent coronary artery bypass surgery with concomitant valvular surgery when the latter was the primary surgical procedure.

2. Persons who underwent repeat coronary artery bypass surgery.

3. Persons who were diagnosed with a major or life threatening illnesses (i.e., malignancy) not related to coronary artery disease within 6 months post CABG surgery.

4. Persons who resided outside the geographical areas of study

5. Persons who either did not consent to the study, lost to follow-up, or died immediately following CABG surgery

2.2.2 Retrospective Chart Review

2.2.2.1 Subject Identification

The initial process involved the abstraction of data from the operating rooms' log books for subjects scheduled for CABG surgery during the study period. Potential subjects to be enrolled in this study were first identified by reviewing these contact schedule lists. Names of subjects, names of their attending and

family physicians, health insurance number, date of surgery, previous CABG surgery, concomitant surgical procedures, and history of serious life threatening illnesses were reviewed. Demographic data collected include sex, date of birth, contact telephone numbers, and address (Appendix Ia). Subject records were coded for the purpose of maintaining confidentiality. No names were used on the chart abstract forms. Access to subjects' names and code numbers was electronically limited by passwords to the principal investigator of the study. All records of subjects were kept in a locked room in the Cardiology Research Centre at the Health Science Centre.

In each case, subjects' medical records were obtained from the Department of Medical Records using subjects' health insurance numbers. I reviewed information concerning current and past medical and surgical history, diagnostic investigations, therapeutic interventions, and clinical outcomes for eligibility of entry using the criteria specified in this study.

2.2.2.2 Reviews of Medical Records

Retrospective chart reviews were then carried out for all subjects enrolled in this study using the guide in Appendix Ib. The data collected include hospital records of medical and social history (demographics, medical history, coronary risk factors identification), and physical examination (blood pressure measurement, weight, height) as well as prior laboratory investigations (serum fasting lipid profile). The portions of the medical record that were reviewed included those portions generated, directly or indirectly, by the physicians responsible for the care of the patients. And thus, information may be abstracted from the emergency record, outpatient notes, referral letters, admission history and physical examination, progress notes, problem lists, consultation reports, operative reports, physician order sheets, medication profile, test reports, discharge summaries and pertinent correspondence.

Positive cigarette smoking history is defined as any cigarette smoked in the 5 years period prior to CABG surgery. The number of cigarette smoked per day is determined by the largest number of cigarette smoked per day at any one time during this 5 years period. Blood pressure readings were taken from the most recent pre-CABG measurements. These are primarily from the vital signs pages of subjects' in-hospital charts. If blood pressure measurements were not available in these pages, then readings were taken from the pre-operative anesthetists' records. I was unable to determine if these measurements were performed in the sitting, standing, or supine positions. Weight and height measurements were taken from pre-operative anesthetists' records. Most recent fasting lipid profiles were taken from subjects' family physicians records within the 5 years period prior to CABG surgery. I was unable to determine the number of hours "fasted" prior to venepuncture for the fasting lipid profiles. Random lipid profiles were not accepted. Subjects' medication profile was obtained from the most recent list of medications

from the subjects' in-hospital charts or the anesthetists' records prior to CABG surgery. A positive history of counseling for weight reduction and diet modification were determined by any record of dietician/nursing referral or physician documentation of such sessions in subjects' chart. The same applies for a positive history of counseling for smoking. Any previous use of nicotine replacement (patch, gum, inhaler, nasal spray) or bupropion for the purpose of smoking cessation were considered positive history for smoking cessation counseling. Any records of wordings in subjects' files such as "advised, discussed, counseled, talked, warned, recommended, reduce, or stop" were accepted as a positive counseling history respectively in the 5 years period prior to CABG surgery. Exercise levels of subjects prior to CABG surgery were not available. This chart review system allows viewing of the documentation of counseling events that have taken place. However, it is recognized that these counseling events may have been performed but not documented.

2.2.3 Subject Survey

2.2.3.1 Subject Recruitment

The principal investigator met with the tertiary-care attending physicians in direct care of the subjects to explain the research project. Invitation letters addressed to the subjects were given to the attending physicians once they have agreed to introduce the me and the research study to their patients. These invitation letters were approved by the attending physicians.

Consent forms, accompanied by the invitation letters to attend the hospital for history-taking, physical examination, and collection of blood were mailed to the last known address of these subjects. Subjects were asked to reply either by mail, email, fax or reverse-charged telephone call. A self-addressed stamped envelope was enclosed to facilitate reply. Subjects who did not respond within 14 days were contacted by telephone

calls from the principal investigator of this study. Appointments were also made by the principle investigator for the subjects who consented to participate in this study to attend the hospital. Subjects who did not wish to participate in the study were excluded.

2.2.3.2 Subject Interview

All subjects who agreed to participate in this study attended the interview at the Health Science Centre and were seen by the me. I then took a history of cardiac and non-cardiac events post CABG surgery, cigarette smoking, diet modification, weight reduction, exercise, and present medication using a standardized questionnaire (Appendix II). Pre-operative risk factors were not asked at the interview in order to reduce recall bias even though this data may provide more complete pre-operative data. Reducing this recall bias would lead to increased validity of overall conclusions. However, this strategy may have resulted in

reduced sample size for comparison against post CABG data and thus reduced power of my conclusions. Medications classified as antihypertensive included all ACE inhibitors, A2R antagonists, diuretics, all vasodilators (nitrates, hydralazine, calcium channel blockers), and all sympathoplegics (beta-blockers, clonidine, reserpine). I was unable to exclude the use of these antihypertensives as antianginals. Medications classified as antilipid medications included all HMG-CoA reductase inhibitors, fibrates, resin, niacin, and probucol. Initially, a more detailed history was taken with the questionnaire than what was needed for this study. Only relevant information was abstracted for the purpose of this study. Subjects' heights, weights, and sitting blood pressures were also taken in a standardized fashion. Overnight fasting serum lipid profile levels also performed. All blood tests were analyzed at the laboratory of the center.

2.2.3.3 Standardized Assessment and Measurements

Height and Weight: Subjects' heights and weights were measured by a stadiometer and a clinical balance scale in light clothing with shoes removed. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared.

Blood Pressure: Subjects' blood pressures were measured to the nearest 1 mmHg in the sitting position in the right arm after sitting still for 10 minutes using a mercury sphygmomanometer. All blood pressure measurements were repeated at least twice. The average systolic and diastolic blood pressures were adopted for the purpose of this study.

Blood Sampling: Blood for fasting serum total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides was drawn through venepuncture in the right antecubital fossa after a

minimum of 12-hour fast. Standard enzymatic methods were used to measure serum cholesterol (cholesterol oxidase) and triglycerides (lipase-glycerol kinase (GK/GPO). HDL cholesterol was measured after precipitation of apolipoproterin B-containing lipoproteins with heparin and manganese, or with phosphotungstate and magnesium, and assayed by the cholesterol oxidase method. Values obtained using the photophotungstate and magnesium method were adjusted to be equivalent to those with the heparin and manganese method using the regression equation; phosphotungstate and magnesium method = 0.09x heparin and manganese method – 0.07. LDL cholesterol was calculated from the Friedewald equation [44].

Smoking Status: Current smoking status was assessed by the standard questionnaire (Appendix II). At baseline, smoking was defined as any use of cigarettes during the 6 months before admission. At 3 years post CABG surgery, smoking was defined

as any use of cigarettes at the time of follow-up. Average number of cigarettes smoked per day was also questioned.

Exercise Level: Physical activity was measured by asking subjects to complete the 7-DAY ACTIVITY RECALL [45] (Appendix III), a measure of total energy expenditure, at 3 years post coronary artery bypass graft surgery. The 7-DAY ACTIVITY RECALL is a self-reported measure of physical activity, including work and leisure activities, that asks individuals to quantify the time spent in light, moderate and vigorous activities on an average weekday and weekend day. An estimate of total kilocalories of energy per kilogram of body weight per day is then calculated. Original test-retest reliability of the components of the 7-DAY ACTIVITY RECALL ranged from 0.65 to 0.83 [35].

2.3 Outcome Measures and Data Analysis

The primary outcome measure was the presence of a significant modification in lipid profiles 3 years after CABG surgery. The secondary outcome measures included significant modification of arterial blood pressures, BMI, and cigarette smoking.

Descriptive statistics were used to describe distribution of subjects eligible for the study, level of counseling pre and post CABG surgery, exercise habits, and cardiac rehabilitation program attendance. The significance of any mean change in continuous variable risk factors from pre-operation to 3 years follow-up was determined by paired sample *t* tests; for dichotomous variables such as smoking status, the significance was determined by the Chi-square tests. Comparisons of baseline demographic characteristics and risk factor status were performed with tests of analysis of variance.

2.4 Sample Population

Sample population for this study is defined as all persons who lived in the Avalon Peninsula of Newfoundland and had underwent CABG surgery at the Health Science Centre, St. John's between April 1, 1994 and March 31, 1995.

I had initially hoped for 100% ascertainment based on this geographical location. However, I could only obtained 57% ascertainment to this study during the enrollment process. Calculations performed indicated that this sample size was inadequate for multivariate analysis but sufficient to allow me to assess BMI, blood pressure and a part of lipid profile, i.e. total cholesterol levels. An example of such calculations is as followed.

In the middle age group, for each 1% increase in total cholesterol, coronary heart disease risk increases by an estimated 3%.[46] It was determined that a 10% increase (Δ) in total cholesterol which is associated with 30% increase in cardiovascular risk would be clinically significant. Standard deviation (δ)

for fasting total cholesterol in subjects with ischemic heart disease is approximately 0.9. In order to achieve a statistically significance of $\alpha = 0.05$ and a power $(1- \beta)$ of 80% mathematically, a sample size of ≥ 28 subjects is needed.

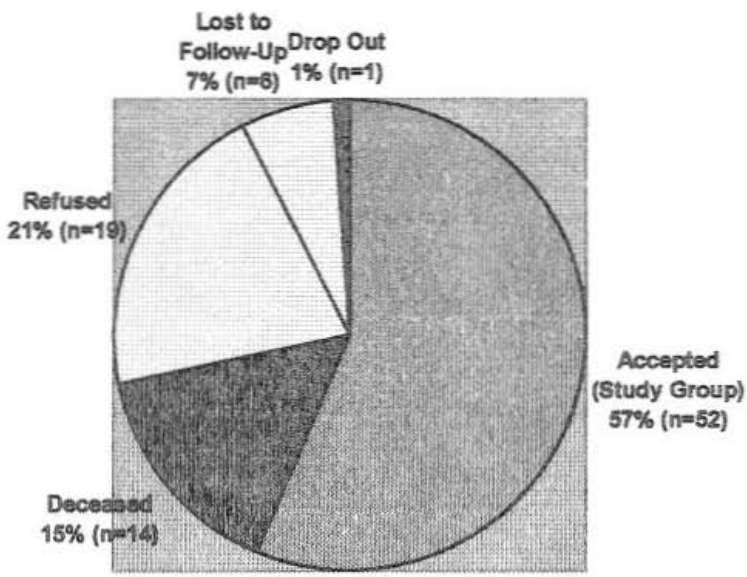
Limitation of this study resulting from the small sample size will be further discussed in this thesis.

Chapter 3. Results

Of a total of 109 subjects who had had CABG surgery performed within the specified geographical region and study period, 92 subjects were eligible to be entered into this study. All of these subjects underwent CABG surgery at the Health Science Centre where retrospective chart reviews were performed. The excluded subjects comprised 7 subjects who had concomitant valvular surgery, 7 subjects who had repeat CABG surgery, and 3 subjects who were diagnosed with metastatic breast cancer, breast cancer, and bladder cancer, respectively, shortly (within 6 months) after their CABG procedures.

Among 92 subjects who qualified to be included in this study, 52 (56.5%) subjects agreed and 19 (20.7%) refused to participate in the 3 years post-CABG follow up interview. Fourteen (15.2%) subjects died during the follow up period after CABG surgery including 3 subjects who died intraoperatively. Six (6.5%) subjects could not be contacted by mail, phone, or through their family physician and were, therefore, deemed lost to follow-up. There was 1 (1.1%) subject who dropped out halfway through the interview process. See Figure 2.

Figure 2. Distribution of Subjects Eligible for the Study



n = 92

3.1 Baseline Comparisons

Comparisons of baseline characteristics between subjects who consented to participate in the study (study group) and those who either refused to participate, dropped out, or were not contactable (non participant group) were performed for sex, age, lipid profile, arterial blood pressures, BMI, and cigarette smoking status.

Of the total of 52 subjects who consented to the study (study group), fasting total cholesterol levels were performed in 57.7% (n = 30) of subjects prior to their CABG surgeries. Complete fasting lipid profiles were measured in 44.2% (n = 23) of studied subjects prior to CABG surgery.

Of those who refused to participate, dropped out, or were not contactable for the study (non-participant group, n = 26), 20 subjects had had serum total cholesterol levels measured and 16 subjects had had the breakdowns of serum lipid profile performed.

The study group differed from the non-participant group in that there were fewer females (21.2%) as opposed to the 26.9% females in the non-participant group. The mean age for the study group was slightly older compared to the non-participant group (63.6 years old vs. 61.0 years old). Mean total cholesterol levels in the study group and non-participant group were 5.5 mmol/l and 5.6 mmol/l respectively. Mean systolic blood pressure and diastolic blood pressure were similar in both groups (126.9 mmHg/78.3 mmHg vs. 126.2 mmHg/72.2 mmHg respectively). Mean BMI was 29.2 Kg/M^2 in the study group whereas mean BMI in the non-participant group was 28.0 Kg/M^2. There were 12 and 6 cigarette smokers in the study group and non-participant group respectively, both representing 23% of each group (12 out of 52 in study group and 6 out of 26 in non-participant group).

I did not show any statistically significant differences in the baseline characteristics of subjects who consented to the study and those who either refused to participate, dropped out, or were not contactable for the study. However, the numbers studied are small

Comparison of characteristics between subjects who consented to participate in the study (study group) and those who died during the post-CABG period (deceased group) were also performed.

The study group (n = 52) differs from the deceased group (n = 14) in that there were fewer females (21.2%) in the study group when compared to the deceased group (28.6%). The mean age in the study group was younger (63.6 years old) as opposed to the deceased group (68.7 years old). Mean systolic and diastolic blood pressures were slightly higher in the deceased group (140.0 mmHg and 84.0 mmHg) when compared to the study group (126.9 mmHg and 78.3 mmHg). Mean BMI were similar in both groups (29.2 Kg/M^2 vs. 27.3 Kg/M^2). The percentage of cigarette smokers in the deceased group is higher (29%) compared to the study group (23%). I did not have the power to show any statistical significance in the all differences stated above between the study group and the deceased group.

Thirteen out of 14 subjects who deceased during the post-CABG period did not have lipid profile performed prior to their CABG surgery. Seven of these 14 subjects had had coronary events during the 3 years post-CABG periods.

These coronary events include myocardial infarction, congestive heart failure, and angina. The other 7 who did not experience post-CABG coronary events include 3 subjects who died intraoperatively as a result of complications during CABG surgery, 1 who died of cerebral bleed, 1 who died of liver cancer, 1 who died of colon cancer and 1 who died of sepsis during the follow up period post CABG surgery.

3.2 Comparisons in the Study Group before and 3 years after CABG Surgery

The mean follow up time period for the studied subjects was 3.2 years (n=52). Changes in major study outcomes, presented in Table 1 and Table 2 are as follows:

Table 1

Comparisons of MEANS in the Study Group before and 3 years after CABG Surgery

	Before CABG surgery	3 Years After CABG surgery	P value
Total Cholesterol Levels (mmol/l)	Mean = 5.65 ± 0.90 (n = 30)	Mean = 4.92 ± 0.84 (n = 30)	p < 0.001
Triglyceride Levels (mmol/l)	Mean = 2.08 ± 1.22 (n = 23)	Mean = 1.89 ± 1.08 (n = 23)	p = 0.291 (NS)
HDL Levels (mmol/l)	Mean = 1.15 ± 0.53 (n = 23)	Mean = 1.24 ± 0.34 (n = 23)	p = 0.410 (NS)
LDL Levels (mmol/l)	Mean = 3.31 ± 1.08 (n = 23)	Mean = 2.69 ± 0.80 (n = 23)	p = 0.010
Systolic BP (mmHg)	Mean = 126.9 ± 16.1 (n = 52)	Mean = 135.0 ± 17.3 (n = 52)	p = 0.003
Diastolic BP (mmHg)	Mean = 78.3 ± 9.0 (n = 52)	Mean = 85.3 ± 9.7 (n = 52)	p < 0.001
BMI (Kg/M^2)	Mean = 29.0 ± 5.7 (n = 52)	Mean = 30.1 ± 5.4 (n = 52)	p = 0.001
Number of smokers	n = 12	n = 8	
Number of cigarettes smoked per day among smokers	Mean = 13.3 ± 4.4	Mean = 12.5 ± 4.6	

Table 2:

Comparisons of PROPORTIONS in Study Group before and 3 years after CABG Surgery

	Before CABG surgery	3 Years After CABG surgery	p value
Total Cholesterol Levels	n = 30	n = 30	
≤ 5.2 mmol/l	36.7%	63.3%	p = 0.01
> 5.2 mmol/l	63.3%	36.7%	
Triglyceride Levels	n = 23	n = 23	
≤ 2.3 mmol/l	65.2%	78.3%	p = 0.456 (NS)
> 2.3 mmol/l	34.8%	21.7%	
HDL Levels	n = 23	n = 23	
≥ 1.0 mmol/l	52.2%	21.7%	p = 0.051 (NS)
< 1.0 mmol/l	47.8%	78.3%	
LDL Levels	n = 23	n = 23	
≤ 2.6 mmol/l	17.4%	60.9%	p = 0.021
> 2.6 mmol/l	82.6%	39.1%	
On Antilipid Medication	n = 30	n = 30	
Yes	56.7%	63.3%	p = 0.157 (NS)
No	43.3%	36.7%	
Systolic BP	n = 52	n = 52	
≥ 140 mmHg	30.8%	46.2%	p = 0.049
< 140 mmHg	69.2%	53.8%	
Diastolic BP	n = 52	n = 52	
≥ 90 mmHg	19.2%	53.8%	p < 0.001
< 90 mmHg	80.8%	46.2%	
Antihypertensive Medication	n = 52	n = 52	
On none	7.7%	11.5%	p = 0.250 (NS)
On 1 to 2 Antihypertensive Med	76.9%	75.0%	
On 3 to 4 Antihypertensive Med	15.4%	13.5%	
BMI	n = 52	n = 52	
≤ 25 Kg/M^2	26.9%	13.5%	p = 0.008
> 25 Kg/M^2	73.1%	86.5%	
Smoker	n = 52	n = 52	
Yes	23.1%	15.4%	p = 0.086 (NS)
No	76.9%	84.6%	

3.3 Result Analysis: Major Coronary Risk Factors

3.3.1 Hyperlipidemia

Of the total sample of 52 subjects studied, fasting total cholesterol levels were performed in 57.7% (n = 30) of subjects prior to their CABG surgeries. Complete fasting lipid profiles were measured in 44.2% (n = 23) of studied subjects prior to CABG surgery.

The proportion of subjects with high fasting serum total cholesterol (> 5.2 mmol/l) decreased significantly (p = 0.01, n = 30) from 63.3% before CABG surgery to 36.7% at 3 years post CABG surgery. The mean decrease in fasting serum total cholesterol levels was 0.73 mmol/l.

The proportion of subjects with fasting serum triglycerides levels > 2.3 mmol/l decreased from 34.8% before their CABG surgery to 21.7% at 3 years post CABG surgery. However, this decrease was not

statistically significant ($p = 0.456$, $n = 23$). The detected mean decrease in triglycerides levels was 0.19 mmol/l.

An opposite pattern was noted in the proportion of subjects with high fasting serum HDL levels. The percentage of subjects with serum HDL levels ≥ 1.0 mmol/l decreased from 52.2% before their CABG surgeries to 21.7% 3 years after their CABG surgeries. This decrease was, however, not statistically significant ($p = 0.051$, $n = 23$). Mean serum HDL levels increased marginally 1.15 mmol/l preoperatively to 1.24 mmol/l at 3 years post CABG surgery.

Similar to the proportion of serum total cholesterol levels, the proportion of subjects with serum LDL > 2.6 mmol/l decreased significantly from 82.6% before CABG surgery to 39.1% at 3 years after the surgery ($p = 0.021$, $n = 23$). The mean decrease detected was 0.62 mmol/l in this group of subjects.

The improvement in cholesterol levels can be partly explained by the increased percentage of subjects who were treated with antilipid medications 3 years post-CABG surgery (63.3%) as opposed to the percentage prior to their surgery (56.7%) and the potentially increase in the dosages of these medications. Data on dosages of antilipid medications were not collected. Other factors such as diet modification and increased exercise activity post-CABG surgery could also have had effects on this improvement in lipid profile.

Table 3

Comparison of subjects' demographic and post CABG lipid profile between the total enrolled subjects (n=52), subjects who had pre CABG lipid profile (n=23), and subjects who did not have pre CABG lipid profiled performed (n=29).

	Total Enrolled Subjects (n=52)	Subjects who had Pre CABG lipid profile (n=23)	Subjects who did not have Pre CABG lipid profile (n=29)
Sex	Male = 78.8% Female = 21.2%	Male = 82.6% Female = 17.4%	Male = 72.4% Female = 27.6%
Age	Mean = 63.6 ± 10.3	Mean = 62.1 ± 11.4	Mean = 64.7 ± 9.5
Total Cholesterol Levels (mmol/l)	Mean = 5.21 ± 1.04	Mean = 4.78 ± 0.83	Mean = 5.55 ± 1.08
Triglyceride Levels (mmol/l)	Mean = 1.78 ± 0.91	Mean = 1.89 ± 1.08	Mean = 1.69 ± 0.76
HDL Levels (mmol/l)	Mean = 1.16 ± 0.31	Mean = 1.24 ± 0.34	Mean = 1.09 ± 0.28
LDL Levels (mmol/l)	Mean = 3.22 ± 1.03	Mean = 2.69 ± 0.80	Mean = 3.63 ± 1.01

All subjects enrolled in this study (n = 52) had post CABG lipid profile performed. Table 3 showed comparisons of subjects' demographics and post CABG lipid profile among the total enrolled subjects (n = 52), subjects who had lipid profile investigated prior to their CABG surgery (n = 23), and subjects who did not have their lipid profiled investigated prior to their CABG surgery (n = 29). Subjects who did not have serum lipid profile determinations were slightly older and had higher proportion of women compared to the subjects who had pre CABG lipid profile determinations. Three-year post CABG lipid profiles in subjects who did not have pre CABG lipid profile performed appeared less well controlled compared to subjects who had pre CABG lipid profile performed. The former group had higher mean serum total cholesterol (5.55 ± 1.08 mmol/l vs. 4.78 ± 0.83 mmol/l), lower HDL levels (1.09 ± 0.28 mmol/l vs, 1.24 ± 0.34 mmol/l), and higher LDL levels (3.63 ± 1.01 mmol/l vs. 2.69 ± 0.80 mmol/l) compared to the latter. Serum triglycerides levels were relatively unchanged (1.69 ± 0.76 mmol/l vs. 1.89 ± 1.08 mmol/l) between the 2 groups.

3.3.2 Hypertension

All 52 subjects studied had had their arterial blood pressure measured prior to CABG surgery. The proportion of subjects with systolic blood pressures of $\geq$ 140 mmHg increased significantly from 30.8% before CABG surgery to 46.2% at 3 years after CABG surgery ($p = 0.049$, $n = 52$). The mean systolic blood pressure increased from 126.9 ± 16.1 before CABG surgery to 135.0 ± 17.3 at 3 years after CABG surgery.

This was also seen in the proportion of diastolic blood pressure $\geq$ 90 mmHg which increased significantly from 19.2% pre-CABG to 53.8% post CABG surgery ($p < 0.001$, $n = 52$). The mean increase in diastolic blood pressure was 7.1 mmHg. The mean systolic and diastolic blood pressures were 135.0 mmHg and 85.3 mmHg respectively at 3 years post CABG.

Reasons for the better control of blood pressure pre-CABG surgery will be discussed further in this thesis.

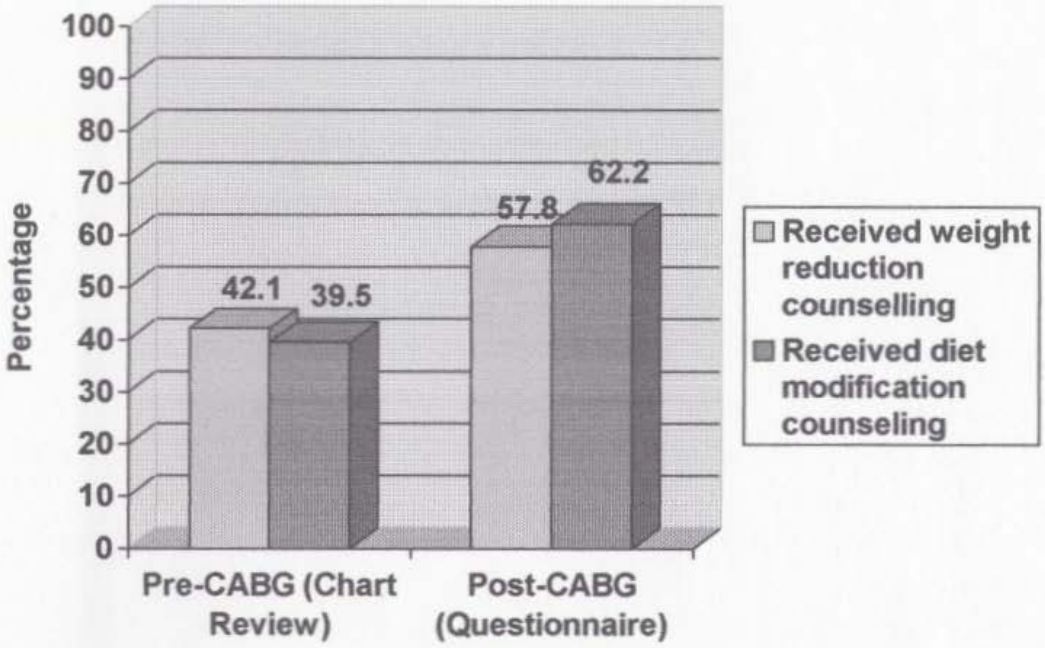
3.3.3 Body Mass Index

Height in meter (m) and weight in kilogram (kg) were available for all 52 subjects prior to CABG surgery. Body mass index (BMI) was calculated using these parameters. The proportion of subjects with body mass index (BMI) > 25 Kg/M^2 increased significantly from 73.1% before CABG surgery to 86.5% at 3 years post CABG surgery ($p = 0.008$, $n = 52$). The detected mean increase was 1.1 Kg/M^2.

Subjects with BMI > 25 Kg/M^2 consisted of 86.5% (n = 45) of the Study Group 3 years post-CABG surgery. Among these, 57.8% (n = 26) reported in the questionnaire that they have received advice or counseling with regards to weight reduction by healthcare providers, friends, or family members. The other 42.2% (n = 19) denied receiving this advice or counseling. Comparing to the 73.1% (n = 38) of pre-CABG subjects with BMI > 25 Kg/M^2, 42.1% (n = 16) were found to have documented weight reduction counseling in their charts prior to their surgery. Among the overweight 3 years post-CABG surgery

subjects, 62.2% (n = 28) reported they received advice on diet modification from healthcare providers, friends, or family members. The same number of subjects also reported that they modified their eating habit since their CABG surgery. Chart review of the pre-CABG period revealed that only 39.5% (n = 15) of overweight subjects had documented diet modifying counseling sessions either by the physicians, nurses, or the dietitians. See Figure 3.

Figure 3. Counseling Among Overweight Subjects (BMI > 25 Kg/M^2)



Despite an increase in the proportion of overweight subjects receiving weight reduction and diet modification counseling post-CABG surgery, the BMI among the overweight group had increased significantly comparing to their BMI pre-CABG surgery. This was an interesting finding and will be further explored in the discussion section.

The results of the self reported level of exercise questionnaire showed that among the overweight subjects, 22.2% (n = 10) reported that they were exercising less compared to their activities prior to CABG surgery, 26.7% (n = 12) reported no change in their activities before and after surgery, while 51.1% (n = 23) reported that they were exercising more after their CABG surgery. When compared to the non-overweight subjects (n =7), all of them reported that they were exercising more after their CABG surgery. It seems that exercise levels among the overweight subjects in this study differs from the non-overweight subjects in that approximately half (48.9%) of the overweight subjects were doing less activities or at the same level of activities post CABG surgery. These exercise level results obtained from questionnaire will be further addressed later.

Fasting lipid profiles were performed on all 52 subjects enrolled in this study 3 years post CABG surgery. Mean total cholesterol among the overweight subjects was higher (5.31 ± 1.05 mmol/l) compared to the non-overweight subjects (4.55 ± 0.73 mmol/l). Mean LDL levels

among overweight subjects was also higher (3.32 ± 1.01 mmol/l) compared to the non-overweight subjects (2.52 ± 0.91 mmol/l). These were not surprising findings as overweight individuals were more likely to have increased serum lipid determinations in general. Mean triglycerides and HDL levels appeared to be similar between overweight subjects (1.77 ± 0.87mmol/l and 1.15 ± 0.29 mmol/l respectively) and non-overweight subjects (1.83 ± 1.21 mmol/l and 1.20 ± 0.44 mmol/l respectively).

The results of this study appeared to indicate that even though fasting total cholesterol and LDL levels were significantly improved 3 years post CABG surgery, there were also higher proportion of overweight subjects after the surgery. One major drawback of such comparisons in this study is that while BMI were available for all 52 subjects in this study, comparisons of total cholesterol levels and LDL were only available for the 30 and 23 subjects who had had the lipid determinations done prior to CABG surgery.

3.3.4. Cigarette Smoking

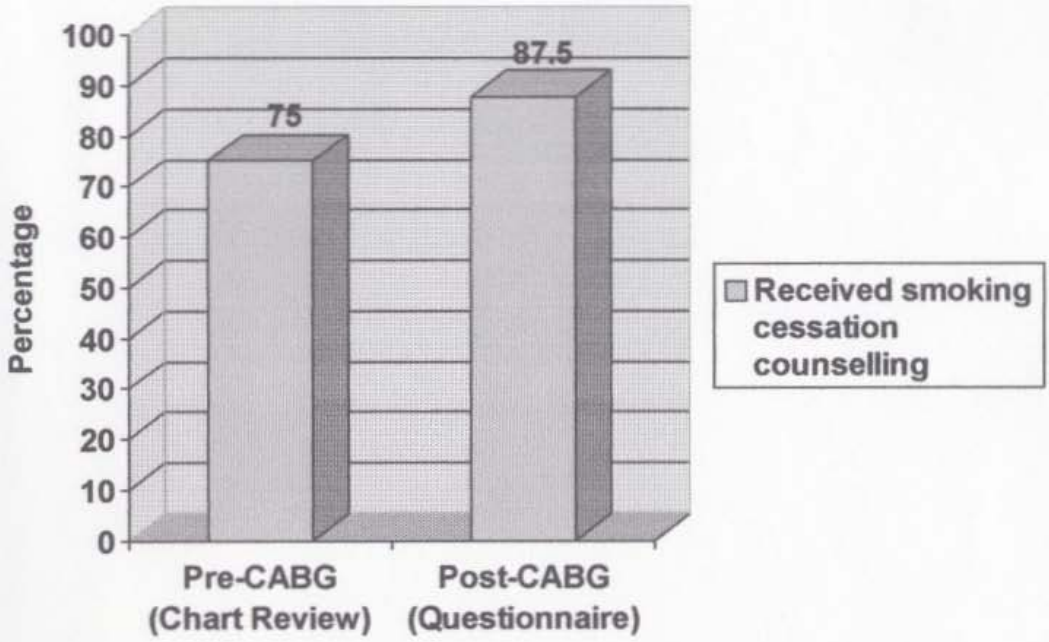
The smoking status of all 52 subjects studied was available in retrospective chart review. However, the number of smokers (n = 12) was too small to produce statistically meaningful results based on sample size calculation. The proportion of cigarette smoking decreased slightly from 23.1% before CABG surgery to 15.4% at 3 years after CABG surgery. However, this change did not appear to be statistically significant ($p = 0.086$, $n = 52$). This translates to only 4 out of the 12 smokers who had stopped smoking following their CABG surgery. The mean decrease in the number of cigarette smoked per day was approximately 1 cigarette per day among smokers 3 years post CABG surgery. This finding was not unexpected given the fact that cigarette smoking has long known to be a difficult behavior to modify. There were no new smokers 3 years after CABG surgery.

There were 15.4% subjects (n = 8) who were cigarette smokers 3 years after their CABG surgeries. Of these 8 subjects, 87.5% of subjects (n =

7) admitted that they had received advice or counseling with regards to smoking cessation either from healthcare providers, friends, or family members. 12.5% of subjects (n = 1) denied receiving any form of advice or counseling with regards to smoking cessation.

There were 23.1% subjects (n = 12) who were cigarette smokers prior to their CABG surgeries. Of these 12 subjects, smoking cessation counseling was documented in 75% of subjects (n = 9). See Figure 4.

Figure 4. Smoking Cessation Counseling Among Smokers

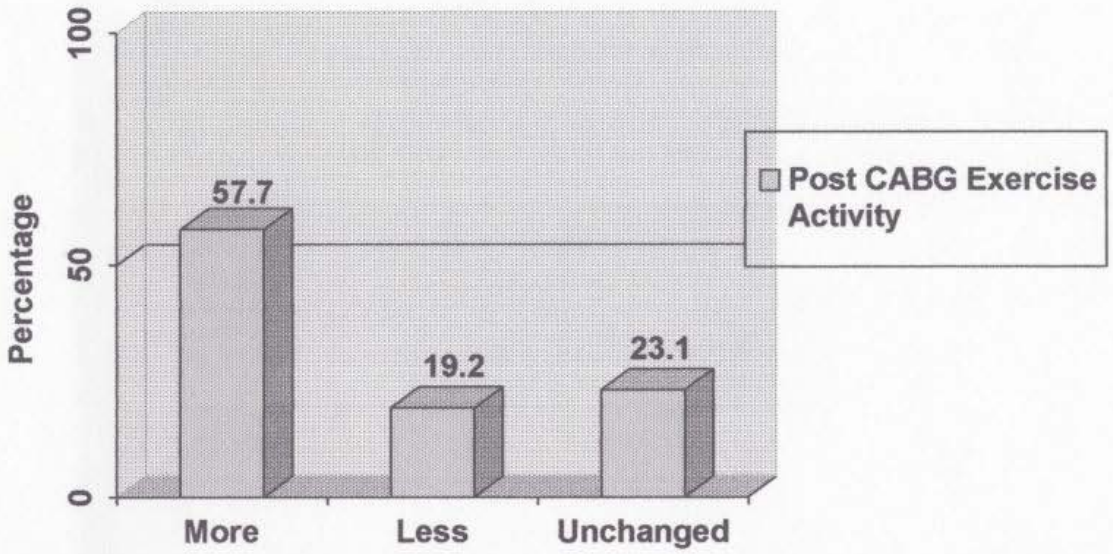


Similar to weight reduction and diet modification counseling, chart review of documented smoking cessation counseling may be an underestimation of the actual amount of advice subject received prior to their surgery. Figure 4 showed that the increase in the proportion of subjects receiving smoking cessation counseling post-CABG was very small. Perhaps this was one of many contributory reasons why the proportion of cigarette smokers had only decreased slightly from pre-CABG to post-CABG surgery.

3.3.5 Exercise Levels

Thirty subjects (57.7%) reported that they were physically exercising more at 3 years post CABG surgery compared to the period prior to their CABG surgery. Approximately 19.2% of subjects (n = 10) reported that they were exercising less compared to their activities prior to CABG surgery while 23.1% of subjects (n = 12) reported no change in their exercise activities before and after CABG surgery. See Figure 5. Information on factors that may have affected exercise levels such as angina, claudication, and musculoskeletal limitation were not collected.

Figure 5. Post-CABG Exercise Activities Level Compared to Pre-CABG Surgery



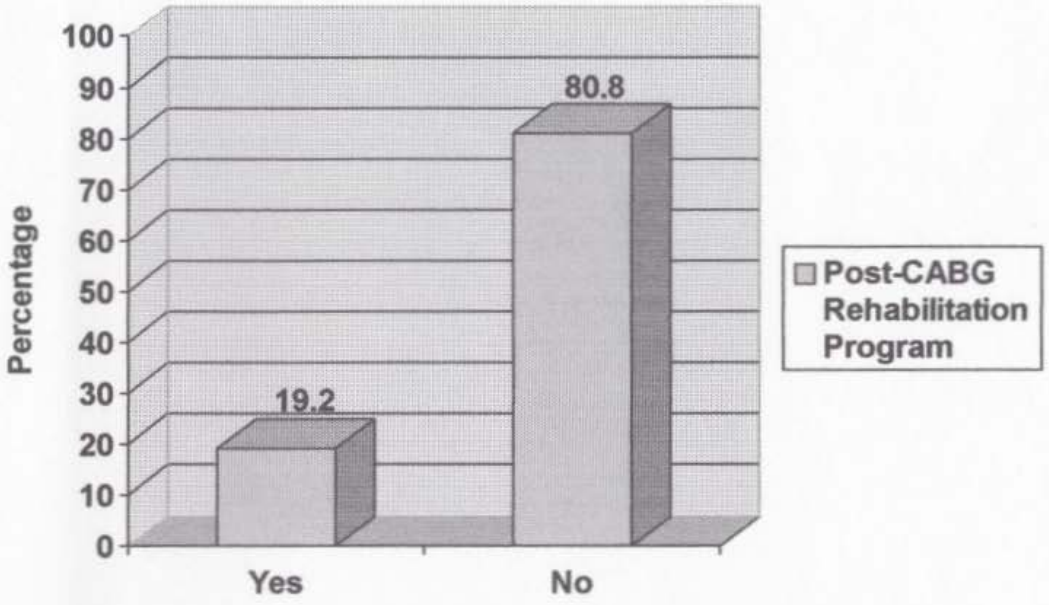
3.4 Result Analysis: Other Results

3.4.1. Cardiac Rehabilitation Program Attendance

Results from the questionnaire obtained in this study revealed that only 19.2% (n = 10) of the subjects had undertaken the cardiac rehabilitation program while 80.8% (n = 42) did not. See Figure 6. Post CABG lipid profile among subjects who had undertaken the cardiac

rehabilitation program had lower mean serum total cholesterol (4.79 ± 0.59 mmol/l vs. 5.31 ± 1.11 mmol/l), and lower mean LDL levels (2.85 ± 0.78 mmo/l vs. 3.30 ± mmol/l) compared to the subjects who did not attend the program. Mean serum triglycerides and HDL levels were relatively unchanged (1.73 ± 0.95 mmol/l vs. 1.79 ± 0.91 mmol/l and 1.09 ± 0.30 mmol/l vs. 1.17 ± 0.32 mmol/l respectively) between these 2 groups. Subjects who attended the cardiac rehabilitation program also had lower systolic and diastolic blood pressure at 3 years post CABG surgery compared to the subjects who did not attend the program (126.8 ± 23.8 mmHg vs. 136.8 ± 15.0 mmHg and 80.0 ± 13.1 mmHg vs. 86.5 ± 8.5 mmHg respectively). BMI at 3 years post CABG was also lower among subjects who attended the program (28.86 ± 5.4 Kg/M^2) compared to the subjects who did not attend the program (30.37 ± 5.4 Kg/M^2).

Figure 6. Post-CABG Cardiac Rehabilitation Program Attendance



3.4.2 Social Support

Of a total of 52 subjects studied, 84.6% of subjects (n = 44) reported that they had one or more family members, friends, or healthcare workers who gave them support in modifying their coronary risk factors during the 3 years post-CABG surgery period. No pre-CABG surgery data were extracted for this information.

Chapter 4. Discussion

4.1 Changes in Coronary Risk Factors

The aim of this study was to investigate whether coronary risk factors are modified in the long term; i.e. 3 years following CABG surgery in a selected group of subjects.

4.1.1 Hyperlipidemia

The most noteworthy finding in this study was the significant improvement in the lipid profile of subjects 3 years after CABG surgery. This result is consistent with a similar prospective cohort study designed by Skinner JS [47] which also observed a significant decrease in total cholesterol levels after examining 353 patients following their first time CABG surgery. It is well known that the progression of the atherosclerotic process can be slowed down both in the coronary arteries and the venous grafts by pharmacological lipid modification after bypass surgery [48]. Various potent lipid-lowering

agents are now available. Patients and healthcare providers have become more aware of the potential benefits of better lipid control in secondary prevention of coronary heart disease with both pharmacological and non-pharmacological methods. It has also been recommended to start patients on lipid-lowering agents immediately during the post operative course of stay in the hospital. These factors could possibly explain the significant decrease in fasting serum total cholesterol, and LDL levels in subjects post CABG surgery. Similarly, serum triglycerides levels had also decreased post CABG surgery although the decrease was not statistically significant.

4.1.2. Hypertension

A significant worsening of blood pressure control was found in this study. This pattern of worsening blood pressure is supported by a short term cohort study by Allen et al. [31] that examined 157 female patients 6 months following isolated first time CABG surgery. However, an open randomized controlled trial by Engblom E et al. [49] did not find any

significant changes between preoperative blood pressure and postoperative blood pressure. Engblom's study examined 228 post-CABG patients who were allocated into a rehabilitation group (n = 119) and a hospital (control) group (n = 109). The rehabilitation group received a 3-phase multifactorial institution-based rehabilitation program on modification of CAD risk factors. This program consisted of preoperative information session, postoperative group discussion, 5-hour nutritionist advice, 21-hour supervised exercise training over the period of 3 weeks, and finally a refresher course 8 months postoperatively. One would expect that a program such as that would lead to better control of blood pressure. However, there were no significant changes between preoperative blood pressure and 1-year postoperative blood pressure in either group in that study.

Engblom's study differs from my study in that I examined coronary risk factors modification over an extended 3 years post CABG surgery as opposed to Engblom's 1-year post CABG study. In my study, I believe that there was a heightened control of blood pressure among the

subjects while in hospital pre-operatively in order to minimize angina symptoms. Therefore, they were more likely to have optimized control of blood pressure as an initial non-surgical management approach prior to the enlistment for CABG surgery. As a result of this, my subjects had significantly lower preoperative blood pressure when compared 3-years postoperatively. In addition, the subjects in my study were 3 years older compared to the time when surgery was performed. As discussed earlier, their attending physicians may have had taken a more liberal approach with their antihypertensive treatment due to the fact that the patients were older, abiding by the notion that blood pressure increases with age. Perhaps a reexamination of Engblom's study groups at 3 years post would also revealed a significant increase in blood pressure.

In my study, pre CABG blood pressure measurements were extracted from chart review. These one-time blood pressure measurements may be not representative of the subjects' usual daily blood pressure in the periods prior to their CABG surgery. Furthermore, I could not ascertain

that these blood pressure measurements were done in a standardized fashion as the way how it was performed 3 years post CABG surgery. This is certainly a downfall in studies with retrospective design such as this one. This limitation will be discussed later in this thesis.

Anyhow, it is disappointing to see that approximately half of the study subjects (46.2%) continued to have systolic blood pressure ≥ 140 mmHg and more than half of subjects (53.8%) have diastolic blood pressure ≥ 90 mmHg 3 years after CABG surgery. One important factor that may have contributed to these findings include a higher proportion of subjects not on any antihypertensive medication at 3 years post CABG surgery (11.5%) compared to the pre CABG subjects (7.7%). The proportion of subjects on 3 to 4 antihypertensive medication were also lower (15.4%) pre CABG compared to 13.5% 3 years post CABG surgery. However, having said that, the mean systolic blood pressure of 135.0 mmHg and mean diastolic blood pressure of 85.3 mmHg were well within the respectable target of treatment among the post-CABG subjects.

4.1.3 Body Mass Index

In my study, a significant increase in body mass index (BMI) was detected despite an increase in the proportion of overweight subjects receiving weight reduction and diet modification counseling post-CABG surgery. The reason for this increase in BMI post-CABG surgery was likely to be multifactorial. Chart review of documented weight reduction & diet counseling/referral may be an underestimation of the actual amount of advice subject received prior to their surgery. Advice from family members and friends were almost never documented in the subjects' charts and therefore not available during chart reviews. Furthermore, physicians' progress notes were many times summarized and may not reflect the actual consultation that took place between the physicians and the subjects. In addition to that, subjects' files at the private clinics outside of the Health Science Centre were not reviewed. With improved symptomotology post CABG surgery, both the subjects and their healthcare provider may have taken a more lenient approach to risk factors modification. When

these factors were taken into consideration, I believe that the amount of diet modification and weight reduction counseling subjects received may well be unchanged pre and post CABG surgery. In short, it appeared in my study that counseling had not been effective in reducing the proportion of overweight subjects possibly due to the factors mentioned above.

There could be other compounding factors that could have affected subjects' BMI pre and post operatively. One of such factors include a probable more aggressive use of diuretic agents as antihypertensive agents that could result in lower weight among the subjects preoperatively. The data specifically on diuretics usage was not collected in this study. Future studies with larger sample size that takes into account the use of diuretic agents would be useful to assess the modification of BMI among the post CABG population. Other factors that could have affected the BMI among the study subjects include an increased age among the subjects and a somewhat lower levels of activities (as discussed earlier) 3 years post CABG surgery.

4.1.4 Cigarette Smoking

There was clinically significant change found in the smoking habits of subjects at 3 years post CABG surgery in this study. One third of smokers stopped smoking 3 years post CABG surgery. Even among smokers, they were smoking one fewer cigarettes compared to pre CABG periods. This is consistent with a prospective cohort study by Allen JK & Blumenthal RS [31] that showed a significant decrease in smoking habit at 6 months after CABG surgery. On the contrary, studies by Engblom E, et al. [39] and Allen JK et al. [50] showed that there was no significant difference in the smoking habits of patients who were randomized into the special intervention group that receive additional intervention on coronary risk factor modification compared to the usual (control) group at 12 months post CABG surgery.

In my study, there were only 12 subjects who were cigarette smokers prior to their CABG surgeries. Four out of these 12 subjects had stopped smoking following their CABG surgery. Given the small

number of smokers in my study, it is difficult to come to a firm conclusion with regards to smoking habit of subjects 3 years post CABG surgery.

4.1.5 Exercise Levels

Results from the questionnaires showed that 57.7% of subjects are physically exercising more at 3 years post CABG surgery compared to the period prior to their CABG surgeries. Nineteen point two percentage of subjects reported that they were exercising less compared to their activities prior to CABG surgery while 23.1% of subjects denied any change in their exercise activities before and after CABG surgery.

4.2 Impact of Cardiac Rehabilitation Program

Intensive rehabilitation programs were used in past studies to assess if coronary risk factors can be better managed in patients with IHD. However, there is evidence that usual postoperative care is no less effective than an intensive rehabilitation program in modifying certain coronary risk [39 40]. Modifying behavior such as smoking cessation, even if successful, was only effective in the short term at best while subjects were still actively participating in the programs that usually lasted for approximately 1 year. Long term results were less convincing. On the contrary, other studies [38 40] showed that certain risk factors such as total cholesterol and smoking habit improved even under normal postoperative care. Therefore, there is little advantage to the implementation of a special rehabilitation program for CABG compared to the existing one at this point. This study showed that only a small percentage (19.2%) of the 52 study subjects had undertaken the cardiac rehabilitation program after their CABG surgery. Our emphasis now should be a more efficient utilization of our existing cardiac rehabilitation program until we have more convincing evidence on the effectiveness of the

previously mentioned short termed intensive programs. Nevertheless, these specially devised rehabilitation programs undoubtedly paved the way for future studies.

4.3 Impact of Support Network

Of a total of 52 subjects studied, most subjects (84.6%) reported that they had one or more family members, friends, and/or healthcare workers who gave them support in controlling subjects' coronary risk factors. This finding is not surprising considering the possible indirect effects of the current public health strategies with widespread dissemination of information related to heart disease and its prevention through the media. This is particularly true with regard to approaches to increasing awareness of the detrimental effect of cigarette smoking. It is disappointing to see that even this level of social support found in this study had not resulted in a greater improvement in coronary risk factors specifically smoking cessation.

4.4 Limitations and Strengths of the Study

4.4.1. Limitations of Study

One major limitation of this study was the small sample size available for the before and after comparisons of risk factors modification. Although the number of study subjects was large enough mathematically to draw conclusions on risk factors such as total cholesterol, blood pressures, and BMI, it was unable to provide meaningful results on the other important lipid stratifications such as HDL and LDL as well as smoking habit among these subjects. From the calculations executed for all 4 major coronary risk factors, the most conservative estimate to ensure adequate study population was 199 subjects. This is due to the fact that a large sample size is needed in detecting a small change such as in HDL levels. As an example, in order to detect a 0.1 (10%) change in HDL cholesterol with δ=0.5, a sample size of $\geq$ 199 subjects was needed to achieve statistically significance of α=0.05 with 80% power.

Had a larger sample size been enrolled, calculation of risk ratio (division of total cholesterol by HDL) could have been performed to better assess coronary risk factor and its change over the 3-year period. A large sample size study also allows multivariate analysis to be carried out to assess modification of a single risk factor at a time while stratifying the other risk factors.

There are several possible strategies that could have been undertaken to improve compliance among respondent and thus enrollment for this study. From the experience I had, many subjects declined participating in the study for the interviews mainly because of time constraints and inconvenience with transportation to the hospital. For the purpose of future investigations, perhaps a "house call" method of subject interview and risk factors measurement would potentially solve the problem with small sample size in this study. However, this translates to greater use of resources as the investigator would be required to travel to subjects' residence to perform the interview process, measure subjects' height, weight, blood pressure, and perform venepuncture for

laboratory investigations. Portable means of risk factor measurements would then be required such as the portable sphygmomanometer, blood collection kit, and a portable scales and measurement tape for height. With these strategies in place, I believe the number of enrollment for the study would be greatly increased.

It is well known that subjects who refused to participate in the study may do worse with regards to coronary risk factors modification compared to patients who participated in the study. This is related to participants' likelihood of higher compliance with interests in healthcare providers' suggestions or advice with regards to health status. Taking into account these factors, the results of risk factor modification from this study could be overestimated.

As previously mentioned, retrospective chart collection of pre CABG blood pressure may not be representative of subjects' usual blood pressure prior to the surgery. This was certainly not done in a standardized fashion that can be reproduced in the methods of blood

pressure measurements 3 years post CABG surgery. This similarly applies to fasting lipid profiles whereby the fasted hours were unknown and that the results came from different laboratories where the blood samples were sent to. Subjects' weight and height measurements pre CABG surgery may not be performed in a uniformed manner in light clothing with shoes removed. The validity of this values and thus the results of this study could be increased had these pre CABG measurements were consistent and standardized using a prospective study design.

An observer bias could have been reduced by the use of a random zero sphygmomanometer as replacement of clinical mercury sphygmomanometer for the measurement of arterial blood pressure. This would potentially reduce bias on the part of the investigator who may have knowledge of subjects' risk factors parameters prior to measuring their arterial blood pressures. In addition, corroboration of smoking status using an Ecolyzer breath test could have been used to

potentially decrease bias. Neither of these apparatus was available in this study.

4.4.2. Strengths of Study

Persons who were diagnosed with a life threatening illness (i.e., malignancy) not related to coronary artery disease within 6 months post CABG were excluded from this study. This is because it was estimated that the long term benefit of coronary risk factors modification may no longer have been a priority in this particular group of subjects. This strategy had hopefully reduced bias that could have resulted in lower risk factor modification in this study sample.

A standard study questionnaire was used to effectively reduce the potential bias in having the subjects interviewed by the principal investigator who knew about the history of the patients. Without standard questions, the principal investigator may have unintentionally prompted or searched more diligently for a particular risk factor.

However, data collection via questionnaire may provide weaker evidence as self reports are subjective measurements.

Other than the subjects and their immediate care physicians, no other party was informed of their participation of this study. Contact of the physicians of subjects who participated in the study was done just prior to asking subjects to take part. This should have prevented the possible bias caused by a heightened attention given to the patients enrolled in the study with regards to coronary risk factor modification. One of the major strengths of this study design is minimization of a Hawthorn effect. The results of the lipid profiles were subsequently sent to subjects' individual physicians.

Chapter 5. Summary, Conclusions and Implications

5.1 Summary

Many coronary risk factors remained unimproved 3 years after CABG surgery. This was particularly true of hypertension, obesity, and smoking cessation. In fact, arterial blood pressures and BMI had worsened significantly during the 3 years post CABG period. Even so, the mean blood pressures of 135 mmHg systolic and 85 mmHg diastolic were good treatment target for this group of subject 3 years post CABG surgery. Results for BMI were rather disappointing considering only slight more than half of subjects (57.8%) who were obese with BMI > 25 Kg/M^2 reported that they had received advice or counseling on weight reduction during the 3 years period post CABG surgery. There was no significant decrease in smoking habit 3 years after surgery even though most smokers (87.5%) admitted to have received advice or counseling with regards to smoking cessation. Hyperlipidemia received appropriate intervention as it saw a significant

decrease in total cholesterol and LDL levels at 3 years post CABG surgery.

This study also revealed that approximately 58% of subjects were physically exercising more compared to the period prior to their CABG surgery even though only a minority (19.2%) of the subjects had undertaken the cardiac rehabilitation program post CABG surgery. There seemed to be a strong support social network around the subjects studied as most of them (84.6%) reported to have at least one person in helping them to monitor their coronary risk factors.

5.2 Conclusions and Implications of Study

According to the results of this study, current health care strategies in secondary prevention of coronary heart disease have only been partially successful, particularly in serum lipid modifications. Regardless of the apparent beneficial effects of lowering serum lipid levels, such benefits are much less apparent if modification of other

coronary risk factors is not also achieved. Efforts must now focus on cessation of smoking, reduction of body weight, and normalization of high blood pressure. With these secondary preventative strategies in controlling atherosclerosis, the future impact will likely be of great importance in substantially diminishing the rate of acute cardiac events and subsequently reducing the overall health care cost. With economic forces focusing on reducing costs while we attempt to secure access of everyone to quality medical care, one of the most urgent priorities in our medical care system should be prevention of heart and vascular disease as an alternative to increasingly expensive treatments for established disease.

However compelling the data are on the benefit of secondary prevention of coronary heart disease, major coronary risk factors such as smoking cessation and BMI are not being modified to meaningful levels. A detailed analysis of our preventative health care system is essential in understanding this deficit. Risk factor modification cannot readily be grafted onto a system focused on acute care encounters. I

believe that most of the failure to achieve risk factor modification in practice can be traced to the structural inadequacy of the acute care encounter as the basis for management. Physicians' success in facilitating this process is generally quite limited. In part, this is due to a lack of physician time during hospitalization or during increasingly brief outpatient encounters. Moreover, risk factor modification may receive a lower priority from physicians, who may preferentially attend to acute problems. Perhaps there is a place for a specialized nurse trained in modifying coronary risk factors with aggressive long term follow up in our system.

Finally, physicians may experience less professional and financial reward from prevention than they do from treatment. Although provincial health insurance varies across Canada, financial reimbursement for risk factor modifications is generally limited to only regular office visit fee schedule whereas treatments such as cryotherapy of plantar warts, vaccination, and psychotherapy counseling can be readily incorporated into a visit with additional

remuneration to physicians in our existing health care services. Furthermore, even though preventive care has become a watchword in the health care reform agenda, relatively smaller effort or reimbursement flows to preventive treatment (e.g., smoking cessation) as opposed to screening (e.g. mammography).

Perhaps behavioural principles may be more efficient than the more commonly used cognitive reasoning as a basis for coronary risk factors modification. With heavy media and public awareness programs currently in place, most patients may already understand the impact of these factors on their health. To change their behaviour, however, is another challenge of its own. A rich literature exists on the behavioral principles required to effect risk factor modification [51] [52]. One of the most important behavioral principles underlying effective risk factor modification is the need for multi-component programs and multiple encounters provided over an extended period. Perhaps the achievement of cigarette smoking cessation in one third of smokers in this study is a result of such endeavors.

This study showed that most overweight individuals received counseling with regards to weight reduction (57.8%) and diet modification (62.2%) respectively from health care professionals during the 3 years post CABG period. Yet, there was no significant change in the percentage of overweight subjects during the 3 years post CABG surgery period. I believe that there are other factors that limit the implementation of risk factors modification other than sole responsibility on the part of our health care providers. Patient compliance with adherence to lifestyle modifications will continue to be a major issue in our health prevention program today as will cost of medications.

Successful implementations of secondary prevention of coronary heart disease may require more complex interventions. Further research is warranted in this area. Outcome data from various cardiac rehabilitation programs might stimulate more successful prevention implementation strategies.

[1] Kirklin JW, et al. ACC/AHA Task Force Report: Guidelines and indications for coronary artery bypass graft surgery. J Am Coll Cardiol 1991; 17:543-589.

[2] European Coronary Surgery Study Group. Long term results of prospective randomized study of coronary artery bypass surgery in stable angina pectoris. Lancet 1982; ii:1173-80.

[3] Veterans Administration Coronary Artery Bypass Surgery Cooperative Study Group: Eleven-year survival in the Veterans Administration Randomized Trial of coronary bypass surgery for stable angina. N Engl J Med 1984; 311:1333-1339.

[4] Varnauskas E and the European Coronary Surgery Study Group. Twelve-year follow-up of survival in the randomized European Coronary Surgery Study. N Eng J Med 1988; 319:332-7.

[5] Alderman EL, et al. Ten-year follow-up of survival and myocardial infarction in the randomized coronary artery surgery study. Circulation 1990; 82:1629-1646.

[6] Campeau L. Late changes in saphenous vein coronary artery bypass grafts and their implications in clinical practice. Can J Cardiol 1987; 3 (Suppl A); 23A 9A.

[7] Lytle BW, Loop FD, Cosgroove DM, et al. Fifteen hundred coronary reoperations. Results and determinants of early and late survival. J Thorac Cardiovasc Surge 1987; 93:847-59.

[8] Campeu L, Enjalbert M, Lesperance J, et al. The relation of risk factors to the development of atherosclerosis in saphenous-vein grafts and the progression of disease in the native circulation. N Engl J Med 1984; 311, 1329-1332.

[9] Campeau L, Knatterud GL, Domanski M, et al. The effect of aggressive lowering of low-density lipoprotein cholesterol levels and low dose anticoagulation on obstructive changes in saphenous vein coronary artery bypass grafts. N Engl J Med 1997; 336:153-162.

[10] Byington RP, Jukema JW, Salonen JT, et al. Reduction in cardiovascular events during pravastatin therapy: Pooled analysis of clinical events of the Pravastatin Atherosclerosis Intervention Program. Circulation 1995; 92:2419.

[11] The Pravastatin Multinational Study Group for Cardiac Risk Patients. Effects of pravastatin in patients with serum total cholesterol levels from 5.2 to 7.8 mmol/liter (200 to 300 mg/dl) plus two additional atherosclerotic risk factors. Am J Cardiol 1993; 72:1031.

[12] Shepherd J, Cobbe SM, Ford I, et al. Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. West of Scotland Coronary Prevention Study Group. N Engl J Med 1995; 333:1301.

[13] Scandinavian Simvastatin Survival Study Group. Randomised trial of cholesterol lowering in 4444 patients with coronary heart disease: The Scandinavian Simvastatin Survival Study (4S). Lancet 1994; 344:1383-1389.

[14] Shaughnessy AF, Slawson DC. Simvastatin decreases mortality. J Fam Pract 1995; 40:498-499.

[15] Lewis SJ, Moye LA, Sacks FM, et al. Effect of pravastatin on cardiovascular events in older patients with myocardial infarctions and cholesterol levels in the average range:

Results of the Cholesterol And Recurrent Events (CARE) Trial. Ann Intern Med 1998; 129:681-689.

[16] Sacks FM, Moye LA, Davids BR, et al. Relationship between plasma LDL concentrations during treatment with pravastatin and recurrent coronary events in the cholesterol and recurrent events trial. Circulation 1998; 997:1446-1452.

[17] Sacks FM, Pfeffer MA, Moye LA, et al. The effect of pravastatin on coronary events after myocardial infarction in patients with average cholesterol levels. N Engl J Med 1996; 335:1001-1009.

[18] Long-term Intervention with Pravastatin in Ischemic Disease (LIPID) group. Prevention of cardiovascular events and death with pravastatin in patients with coronary heart disease and a broad range of initial cholesterol levels. N Engl J Med 1998; 339:1347-1357.

[19] Rubins HB, Robins SJ, Collins D, et al. Gemfibrozil for the secondary prevention of coronary heart disease in men with low levels of high-density lipoprotein cholesterol. N Engl J Med 1999; 341:410-418.

[20] Law MR, Wald NJ, Thompson SG. By how much and how quickly does reduction in serum cholesterol concentration lower risk of ischaemic heart disease? Br Med J 1994; 308:367-372.

[21] FitzGibbon GM, Leach AJ, Kafka HP. Atherosclerosis of coronary artery bypass grafts and smoking. CMAJ 1987; Jan, Vol 136:45-47.

[22] Van Domburg RT, Meeter K, Van Berkel DF, et al. Smoking cessation reduces mortality after coronary artery bypass surgery: a 20-year follow-up study. J Am Coll Cardiol 2000 Sep; 36(3):878-83.

[23] Aberg A, Bergstrand R, Johansson S, et al. Cessation of smoking after myocardial infarction: Effects on mortality after 10 years. Br Heart J 1983; 49:416-422.

[24] Daly LE, Mulcahy R, Graham IM, et al. Long term effect on mortality of stopping smoking after unstable angina and myocardial infarction. Br Med J [Clin Res] 1983; 287:324-326.

[25] MacMahon S, Peto R, Cutler J, et al. Blood pressure, stroke, and coronary heart disease: I. Prolonged differences in blood pressure: Prospective observational studies corrected for the regression dilution bias. Lancet 335:765-774, 1990.

[26] Neaton JD, Wentworth D. Serum cholesterol, blood pressure, cigarette smoking, and death from coronary heart disease: Overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. Arch Intern Med. 152:56-64, 1992.

[27] Herlitz J, Brandrup-Wognsen G, Haglid M, et al. Mortality and morbidity during a period of 2 years after coronary artery bypass surgery in patients with and without a history of hypertension. J Hypertens 1996 Mar; 14(3):309-14.

[28] Cannistra LB, Balady GJ, O'Malley CJ, et al. Comparison of the clinical profile and outcome of women and men in cardiac rehabilitation. Am J Cardiol 1992; 69:1274.

[29] Hubert HB, Feinleib M, McNamara PM, et al. Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the Framingham Heart Study. Circulation 1983; 67:968.

[30] Calles-Escandon J, Ballor D, Harvey-Berino J, et al. Amelioration of the inhibition of fibrinolysis in elderly, obese subjects by moderate energy intake restriction. Am J Clin Nutr 1996; 64:7.

[31] Barzilay JI, Kronmal RA, Bittner V, et al. Coronary artery disease and coronary artery bypass grafting in diabetic patients aged > or=65 years (report from the Coronary Artery Surgery Study [CASS] Registry). Am J Cardiol 74:334, 1994.

[32] Kannel WB, McGee DL. Diabetes and cardiovascular disease. The Framingham study. JAMA 241:2035-2038, 1979.

[33] Stamler J, Vaccaro O, Neaton JD, et al. Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial. Diabetes Care 16:434-444, 1993.

[34] Lowe LP, Liu K, Greenland P, et al. Diabetes, asymptomatic hyperglycemia, and 22-year mortality in black and white men. The Chicago Heart Association Detection Project in Industry Study. Diabetes Care 20:163-169, 1997.

[35] The BARI Investigators. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. N Engl J Med 1996;335:217-25.

[36] Morris JJ, Smith LR, Jones RH, et al. Influence of diabetes and mammary artery grafting on survival after coronary bypass. Circulation 1991;84(suppl III):III-275-84.

[37] Barsness GW, Peterson ED, Ohman EM, et al. Relationship between diabetes mellitus and long-term survival after coronary bypass and angioplasty. Circulation 96:2551, 1997.

[38] Weintraub WS, Stein B, Kosinski A, et al: Outcome of coronary bypass surgery versus coronary angioplasty in diabetic patients with multivessel coronary artery disease. J Am Coll Cardiol 31:10, 1998.

[39] Ornisch D. Avoiding revascularization with lifestyle changes: The multicenter lifestyle demonstration project. Am J Cardiol 1998; 82:72T-76T.

[40] Van Brussel BL, Plokker HWM, Ernst JMPG, et al. Multivariate risk factor analysis of clinical outcome 15 years after venous coronary artery bypass graft surgery. Eur Heart J 1995; 16:1200-1206.

[41] Allen JK, Blumenthal RS. Coronary risk factors in women six months after coronary artery bypass grafting. Am J Cardiol 1995; 75:1092-1095.

[42] Simons LA, Simons J. Coronary risk factors six to 12 months after coronary artery bypass surgery. Med J Aust 1987; 146:573-580.

[43] Leaman DM, Brower RW, Meester GT. Coronary artery bypass surgery: A stimulus to modify existing risk factors? Chest 1982; 81:16-19.

[44] Friedewald WT, Levy RI, Fredrickson DS. Estimation of concentration of low density lipoprotein cholesterol in plasma, without use of the preparative ulticentrifuge. Clin Chem 1972; 18:499-502.

[45] Sallis et al. Comparison of physical activity assessment methodology in five-city project. Am J Epidemiology 1985; 121:91-106.

[46] National Cholesterol Education Program. Second report of the expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel II). Bethesda: National Heart, Lung, and Blood Institute, National Institutes of Health, 1993. (Publication no. 93-3095)

[47] Skinner JS. Risk factor control five years after coronary bypass grafting. J Roy Coll Phys Lond 1996; 30:2:136-141.

[48] Blankenhorn DH, Nessim SA, Johnson RL, et al. Beneficial effects of combined colestipol-niacin therapy on coronary atherosclerosis and coronary venous bypass grafts. JAMA 1987; 257:3233-40.

[49] Engblom E, et al. Coronary heart disease risk factors before and after bypass surgery: Results of a controlled trial on multifactorial rehabilitation. Euro Heart J 1992; 13:232-237.

[50] Allen JK. Coronary risk factor modification in women after coronary artery bypass surgery. Nursing Research 1996; 45:5:260-265.

[51] Law M, Tang JL. An analysis of the effectiveness of interventions intended to help people stop smoking. Arch Intern Med 1995; 155:1933-194.

[52] Foreyt JP, Goodrick GK. Evidence for success of behavior modification in weight loss and control. Ann Intern Med 1993; 119:698-701.

Appendix

Appendix Ia	:	Subjects Identification For CABG Study
Appendix Ib	:	Chart Review Pre-CABG Surgery: Extraction of Data from Department of Medical Records
Appendix II	:	Subject Interview and Assessment at 3-Years Follow Up
Appendix III	:	7-DAY ACTIVITY RECALL
Appendix IV	:	Examples of Activities in Each Category

APPENDIX Ia

Subjects Identification For CABG Study

Extraction of data from CABG Operation Patients' Listing Schedule & Medical Records

1. Name _____
2. Sex _____
3. Age (DOB) _____
4. Health insurance number _____
5. Address _____
6. Phone number _____
7. Family doctor _____
8. Attending physician _____
9. Date of surgery _____
10. CABG as secondary concomitant procedure (e.g. valve surgery as primary procedure) Y / N
11. Repeat CABG surgery Y/ N
12. Diagnosed life threatening illnesses within 6 months post CABG (e.g. malignancy) Y / N

    Specify _____

Appendix Ib

Chart Review Pre-CABG Surgery

Extraction of Data from Department of Medical Records

Risk Factors Prior to CABG surgery:

13. Smoking status _____cigs/day

14. Blood pressure _____/_____mmHg

15. Weight _____kg

16. Height _____m

17. Fasting serum lipid profile *Photocopy*

18. Advice on weight reduction Y / N

19. Advice on diet modification/dietitian consultation Y / N

20. Advice on smoking cessation Y / N

21. List of Medications *Photocopy*

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Appendix II

An investigation of risk factor modifications after coronary artery bypass surgery in Newfoundland

Subject Interview and Assessment at 3-Years Follow Up

First, I would like to ask you some questions about your medical history.

1. Have you had a heart attack since your first bypass surgery?

   Yes/No

   If the answer is yes, can you please give me the number of attacks?

   _____

   and the date(s) of the attack(s)? _____
   DD/MM/YY

2. How many bypass surgeries have you had? _____

   What is(are) the date(s) of your bypass surgery(ies)? _____
   DD/MM/YY

3. Have you had a dye test (coronary angiography) since your first bypass surgery?

   If the answer is yes, indicate the number of test(s) _____

   and the date(s) of the dye test(s) _____
   DD/MM/YY

4. Have you participated in any form of cardiac rehabilitation program since your first bypass surgery?

   Yes/No

   How many cardiac rehabilitation programs have you attended?

_____

Where was/were the program(s) held? _____

5. Have you been admitted to the hospital since your first bypass surgery?

Yes/No

If the answer is yes please indicate the
Reasons: Dates:

1._____ _____

2._____ _____

3._____ _____

4._____ _____

6. Have you been diagnosed of any other diseases since your first bypass surgery? (e.g. cancer, renal failure, and etc)

Yes/No

If the answer is yes, please indicate the:

Disease(s) Date(s) of diagnosis

1._____ _____

2._____ _____

3._____ _____

4._____ _____

Now I would like to ask some questions about your risk factors for coronary artery disease.

7. Are you a:

current smoker _____ *Please go to 7.1*

former smoker _____ *Please go to 7.2*

non-smoker _____ *Please go to question 8.*

7.1 If you are a current smoker please indicate if you smoke: (*please tick only one*)

1 – 9 cigarettes/day ____

10 – 20 cigarettes/day ____

More than 20 cigarettes/day ____

7.2 If you are a former smoker please indicate when you stopped smoking.

Date: _____
DD/MM/YY

7.3 Have you tried to stop smoking yourself since your first bypass surgery?

Yes/No

If the answer if yes please indicate how many times you have tried to stop smoking yourself.

_____

When was the last time you smoked? _____
DD/MM/YY

7.4 Have you attended any smoking cessation programs since your first bypass surgery?

Yes/No

If the answer is yes please indicate where this is a: *Tick one or more*

physician initiated process____ (e.g. referral by a doctor)

self initiated process____

others (please explain) ____

How many times have you attended the smoking cessation programs since your first bypass surgery?

_____

Where was/were the smoking cessation program(s) held?

_____

When was/were the smoking cessation program(s) held?

_____
DD/MM/YY

7.5 Have you received any form of advice or counseling with regards to smoking cessation since your first bypass surgery?

Yes/No

If the answer is yes please indicate if the counseling or advice come from: (*Tick one or more*)

family doctor ____

heart specialist doctor ____

smoking cessation program ____

others (please explain) _____

How many times have you received advice or counseling with regards to smoking cessation by your doctor or the staff from the smoking cessation program since your first bypass surgery?

_____

When did you last received advice or counseling with regards to smoking cessation since your first bypass surgery?

_____
DD/MM/YY

8. Has a doctor ever diagnosed you of having diabetes mellitus?

Yes/No

If the answer is yes please indicate your usual blood glucose levels for the last one month

_____

When were you diagnosed of having diabetes mellitus?

_____
DD/MM/YY

9. Have you received any form of advice or counseling with regards to diet modification since your first bypass surgery?

Yes/No

If the answer is yes please indicate if the counseling or advice comes from: (*Tick one or more*)

family doctor ____

heart specialist doctor ____

dietitian ____

others(please explain) _____

How many times have you received advice or counseling from your doctor or your dietitian with regards to diet modification since your first bypass surgery?

_____

When did you last received advice or counseling with regards to diet modification since your first bypass surgery?

_____
DD/MM/YY

In your opinion, have you modified your diet intake since your first bypass surgery?

Yes/No

Are you currently taking any dietary supplements?

Yes/No

If yes, please indicate if you take one or more of the following:
(*Tick one or more*)

fish oils ____

seal oils ____

celery tablets ____

10. Have you received any form of advice or counseling with regards to weight reduction since your first bypass surgery?

Yes/No

If the answer is yes please indicate if the counseling or advice comes

from: (*Tick one or more*)

family doctor ____

heart specialist doctor ____

weight reduction program ____

others(please explain) _____

How many times have you received advice or counseling from your doctor or the staffs from the weight reduction program with regards to weight reduction since your first bypass surgery?

_____

When did you last receive the advice or counseling with regards to weight reduction?

_____
DD/MM/YY

11. In your opinion, do you exercise: (*please tick one only*)

more_____since your bypass surgery

less_____ since your bypass surgery

no difference_____ since your bypass surgery

12. How many family members, friends, relatives, and healthcare worker were helping you in controlling your coronary risk factors (i.e. stopping smoking, diet modification, controlling your blood pressure, encouraging you to exercise, and weight reduction) since your bypass surgery?

_____

13 List all current medications in the space below.

Appendix III

7-DAY ACTIVITY RECALL

Now we would like to know about your physical activity during the past 7 days. But first let me ask you about your sleep habits.

1. On the average, how many hours did you sleep each night during the last five weekday nights (Sunday-Thursday)?

   _____ hours

2. On the average, how many hours did you sleep each night last Friday and Saturday nights?

   _____ hours

Now, I am going to ask you about your physical activity during the past 7 days, that is, the last 5 weekdays, and last weekend, Saturday and Sunday. We are not going to talk about light activities such as slow walking, light housework, or unstrenuous sports such as bowling, archery, or softball. Please look at this list which shows some examples of what we consider moderate, hard, and very hard activities. (Interviewer: hand subject Appendix VI and allow time for the subject to read it over.) People engage in many other types of activities, and if you are not sure where one of your activities fits, please ask me about it.

3. First, let's consider moderate activities. What activities did you do and how many total hours did you spend during the last 5 weekdays doing these moderate activities or others like them? Please tell me to the nearest half hour.

   _____ hours

4. Last Saturday and Sunday, how many hours did you spend on moderate activities and what did you do? (Probe: Can you think of any other sports, job, or household activities that would fit into this category?)

   _____ hours

5. Now, let's look at hard activities. What activities did you do and how many total hours did you spend during the last 5 weekdays doing these hard activities or others like them? Please tell me to the nearest half hour.

   _____ hours

6. Last Saturday and Sunday, how many hours did you spend on hard activities and what did you do? (Probe: Can you think of any other sports, job, or household activities that

would fit into this category?)

_____ hours

7. Now, let's look at very hard activities. What activities did you do and how many total hours did you spend during the last 5 weekdays doing these very hard activities or others like them? Please tell me to the nearest half hour.

_____ hours

8. Last Saturday and Sunday, how many hours did you spend on very hard activities and what did you do? (Probe: Can you think of any other sports, job, or household activities that would fit into this category?)

_____ hours

9. Compared with your physical activity over the past 3 months, was last week's physical activity more, less, or about the same?

_____ 1. More

_____ 2. Less

_____ 3. About the same

Interviewer: Please list below any activities reported by the subject which you don't know how to classify. Flag this record for review and completion.

Activity (brief description)	Hours: workday	Hours: weekend day
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Appendix IV

Examples of Activities in Each Category

Moderate Activities

Occupational tasks:	1. delivering mail or patrolling on foot
	2. house painting
	3. truck driving (making deliveries, lifting and carrying light objects)
Household activities:	1. raking the lawn
	2. sweeping and mopping
	3. mowing the lawn with a power mover
	4. cleaning windows
Sports activities: (actual playing time)	1. volleyball
	2. Ping-Pong
	3. brisk walking for pleasure or to work (4.83km/hour (3 miles/hour) or 20 minutes/km (mile))
	4. golf, walking and pulling or carrying clubs
	5. calisthenic exercises

Hard Activities

Occupational tasks:	1. heavy carpentry
	2. construction work, doing physical labor
Household tasks:	1. scrubbing floors
Sports activities: (actual playing time)	1. tennis doubles
	2. disco, square or folk dancing

Very Hard Activities

Occupational tasks:	1. very hard physical labor, digging or chopping with heavy tools
	2. carrying heavy loads such as bricks or lumber
Household tasks:	1. shoveling snow,
Sports activities: (actual playing time)	1. jogging or swimming
	2. singles tennis
	3. racquetball
	4. soccer or ice hockey