ABSTRACT

NELSON, J. L. Changes of global coronary heart disease risk factors following a period of rehabilitation. MS in Adult Fitness/Cardiac Rehabilitation, December 2000, 36pp. (C. Foster)

A global risk factor prediction chart (Wilson et al., 1998) was utilized to determine if a reduction in CHD risk factors occurred during a 3-month rehabilitation period. Eighty-seven male and female Ss (39-79 yr) charts were examined at the start of rehabilitation and again after 3 months. Data collected from each chart included: gender, age, total cholesterol (TC), high-density lipoproteins (HDL), low-density lipoproteins (LDL), blood pressure (BP), smoking status, and if they were diabetic. TC levels significantly decreased with 73.6% (64/87) of the patients falling below 200 mg/dl. HDL levels significantly decreased in both genders, but 56.3% remained above 35 mg/dl. LDL levels significantly dropped with 50.1% (44/87) of the patients less than 100 mg/dl. National Cholesterol Education Program recommends that individuals with CHD should avoid levels about 100 mg/dl. There were no significant changes in BPs, as most patients were using antihypertensive medications. Most smoking cessation had occurred at the time of or prior to their cardiac event. At the conclusion of rehabilitation 6/11 (55%) had stopped. Subjects that were diabetic remained diabetic. In conclusion, there was a significant decrease in both the TC (52.9%) and LDL (57%) global risk number totals. Further investigations should be done in order to determine if a decrease in CHD risk factors continues to occur after the rehabilitation program.

CHANGES IN GLOBAL CORONARY HEART DISEASE RISK FACTORS FOLLOWING A PERIOD OF REHABILITATION

A MANUSCRIPT STYLE THESIS PRESENTED

TO

THE GRADUATE FACULTY

UNIVERSITY OF WISCONSIN-LA CROSSE

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE

MASTER OF SCIENCE DEGREE

BY

JODI L. NELSON

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AND TEACHER EDUCATION

UNIVERSITY OF WISCONSIN-LA CROSSE

THESIS FINAL ORAL DEFENSIE FORM

Candidate: Jodi Lee Nelson

We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree:

Master of Science in Adult Fitness/Cardiac Rehabilitation

The candidate has successfully completed the thesis final oral defense.

Thesis Committee Chairperson Signature — Date: 6/21/00

Thesis Committee Member Signature — Date: 6/21/2000

Thesis Committee Member Signature — Date: 6/21/00

This thesis is approved by the College of Health, Physical Education, Recreation, and Teacher Education.

Associate Dean, College of Health, Physical Education, Recreation, and Teacher Education — Date: 6/28/00

Director of University Graduate Studies — Date: 6/28/00

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It is hard to believe the year is over for our class and most of us have moved back home to start internships, with the rest of us soon to follow. New lives have begun and I can't wait to get out there, but first some thank yous are definitely needed.

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I want to thank everyone at Franciscan Skemp HealthCare's Cardiac Rehabilitation program for allowing me to do this and helping me whenever I needed it. Thank you Teri Pedace, and Jan Taggart for getting the ball rolling.

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I would also like to acknowledge my Aunt and Uncle, because without them I would have been living in my car. Thank you for taking me in for the year and for just putting up with me.

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INTRODUCTION

Coronary heart disease (CHD) is the number one cause of death and disability in the United States.[1-3] CHD is widely thought to be caused by a complex milieu of risk factors. Reducing these risk factors can possibly decrease the likelihood of developing CHD. When the Framingham Heart Study began in 1948, the National Heart Institute (which is now the National Heart, Lung and Blood Institute [NHLBI]), had been investigating the causes of CHD over a long period of time.[3] Over the years of data collection from this study, the term "risk factor" was applied to each of the conditions that were thought to contribute to the disease process.[1]

Many studies have evaluated CHD risk factors individually, but it was the Framingham results that led to the concept of multi-risk factors analysis for modeling and understanding the development and progression of CHD[4]. Anderson et al.[5] derived an equation that demonstrated an improved accuracy using multi-risk factors over single risk factors to predict CHD. The risk factors in the equation included the modifiable risk factors: high-density lipoprotein (HDL), total cholesterol, systolic blood pressure (SBP), smoking, glucose intolerance (diabetes), and electrocardiographic left ventricular hypertrophy (LVH). The equation also took into account the non-modifiable risk factors, which include age and gender. It was from this equation that an easy-to-use CHD risk factor prediction chart, which predicts probability of CHD for men and women, was designed. In 1998, Wilson et al.[6] introduced a new simplified equation and risk factor prediction charts for males and females (see Appendix A). The new equation removed the risk factor of LVH due to lack of standard universally accepted ECG criteria.[5] The new equation added the option to use either low-density lipoprotein (LDL) or total cholesterol (TC) in the formula and also included the diastolic

blood pressure (DBP). Although family history, physical activity, and obesity are important risk factors, due to their poorly quantified contribution to CHD they are not included in the equation.[6,7]

Exercise and risk factor modification-based cardiac rehabilitation programs have become a very important part of the healing process for patients with CHD. Studies have noted that both morbidity and mortality rates decrease following a rehabilitation program.[8,9] Cardiac rehabilitation is a secondary prevention strategy used by those who have had a cardiac event, such as a myocardial infarction (MI) or coronary artery bypass graft (CABG) surgery. It has been through this type of program that patients learn more about risk factors contributing to CHD and how to either eliminate them (as with smoking) or control them (as with hypertension and hypercholesterolemia).

The purpose of this study was to evaluate the magnitude of change in both individual and collective risk factors of participants enrolled in a community based Phase II Cardiac Rehabilitation Program. It was hypothesized that evaluation of risk factors as a single collective item would enhance the understandability of risk factor changes occurring during cardiac rehabilitation and would better reflect the degree to which cardiac rehabilitation programs are accomplishing the goal of promoting secondary prevention.

METHODS

Subject Selection

The Institutional Review Boards (IRB) for the Protection of Human Subjects from the University of Wisconsin-La Crosse and Franciscan Skemp Healthcare approved the study protocol. Each subject completed an informed consent (see Appendix B) prior to data collection. The subject charts gathered for the study came from patients of the Franciscan Skemp Healthcare Phase II Cardiac Rehabilitation Program in La Crosse, Wisconsin. All subjects had undergone

some type of coronary revascularization procedure prior to admittance into the rehabilitation program. Eighty-seven consecutive patients were chosen, 50 males and 37 females, ages 39-79 years. The 87 subject charts were chosen because they contained all pertinent information required to complete this study.

Methods and Procedures

Data collected from subject charts included gender, age, HDL; total; and LDL cholesterol, SBP, DBP, smoking, and diabetes history upon entry into the cardiac rehabilitation Phase II program. The information was then placed on the global risk assessment score sheet used by the American Heart Association (AHA) (see Appendix A) and risk points were calculated. Subsequent data were collected after 3 months at the end of the subjects' Phase II rehabilitation program, for evaluation of risk factor changes while attending the program. It was also documented whether the patient was on a lipid lowering agent and/or antihypertensive medication, which would aid in the change.

Statistical Treatment

Data collected from both trial periods were compared to test the hypothesis that patients significantly improved their risk factor scores during the program. Descriptive statistics and one-way analysis of variance (ANOVA) with repeated measures were used to determine different outcomes.

RESULTS

The means and standard deviations of the total global risk and of each of the cardiac risk factors used within the formula at each trial are shown in Table 1.

Table 1. Means and Standard Deviations of Male and Female TC and LDL Global Risk Factors and Cardiac Risk Factors for Trial 1 and Trial 2.

	Male		Female	
	Trial 1	Trial 2	Trial 1	Trial 2
Global Risk (TC)	6.94 (3.2)	5.94 (2.8)*	11.22 (3.8)	11.00 (4.0)*
Global Risk (LDL)	6.24 (3.2)	5.52 (2.5)*	10.86 (3.5)	10.19 (3.8)*
TC	193 (39)	170 (39)*	213 (35)	187 (39)*
HDL	36 (13)	35 (11)	43 (10)	42 (10)
LDL	125 (36)	103 (31)*	133 (37)	107 (37)*
Systolic BP	119 (16)	118 (18)	122 (19)	125 (18)
Diastolic BP	67 (9)	68 (9)	71 (10)	69 (10)
Smoking	.16 (.5)	.08 (.4)*	.38 (.8)	.27 (.7)*
Diabetes	.16 (.5)	.16 (.5)	1.08 (1.8)	1.08 (1.8)

Values are expressed as means (Standard Deviations)
*significantly different than trial 1, P< 0.05

One-way ANOVAs were done on the total global risk number and on each risk factor to determine main effects of trial, gender and trial by gender interactions. Changes in TC and LDL global risk totals are presented in Figure 1. ANOVA revealed significant main effects for gender and for trials, but no gender by trial interaction.

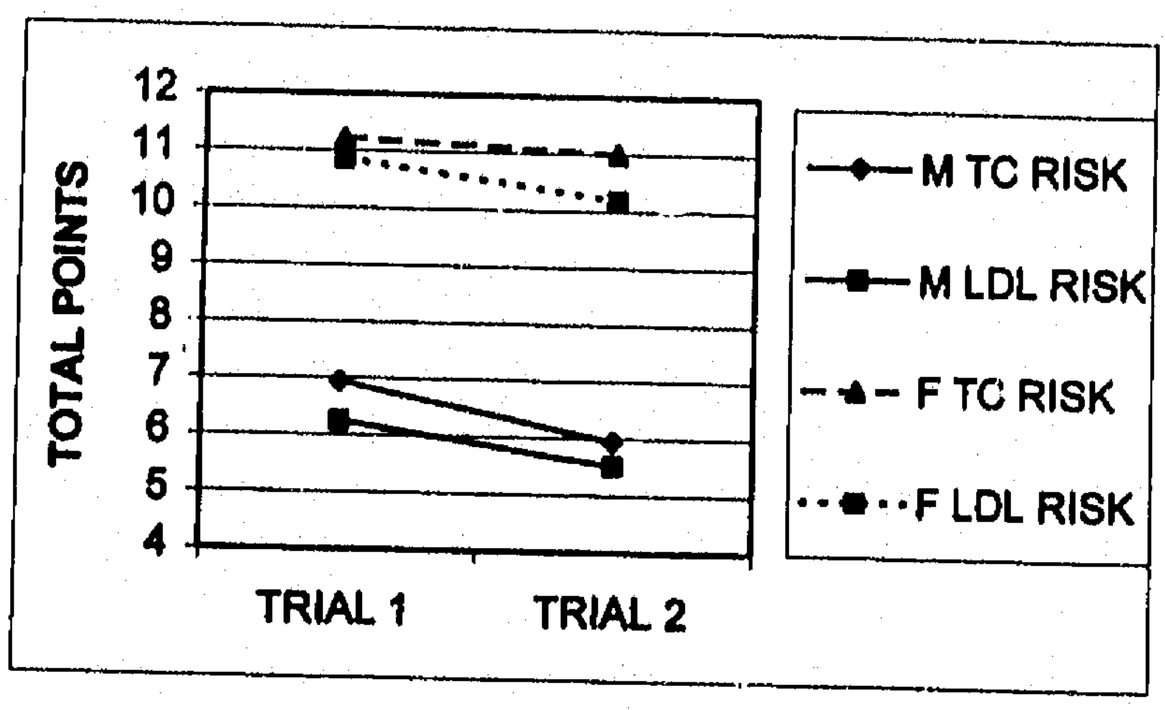

Figure 1. Total cholesterol and low-density lipoprotein mean global risk totals.

Changes in total cholesterol are presented in Figure 2. ANOVA revealed significant main effects for gender and for trial, but no gender by trial interaction.

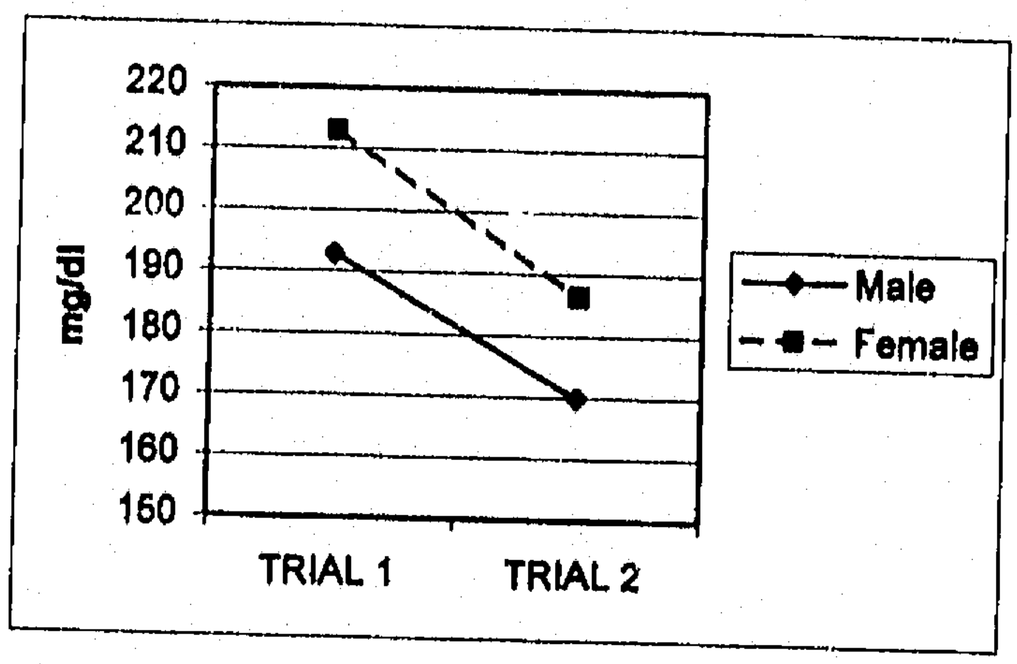

Figure 2. Mean total cholesterol values.

Changes in HDL values are presented in Figure 3. ANOVA revealed significant main effects for gender, but no main effect for trial or gender by trial interaction.

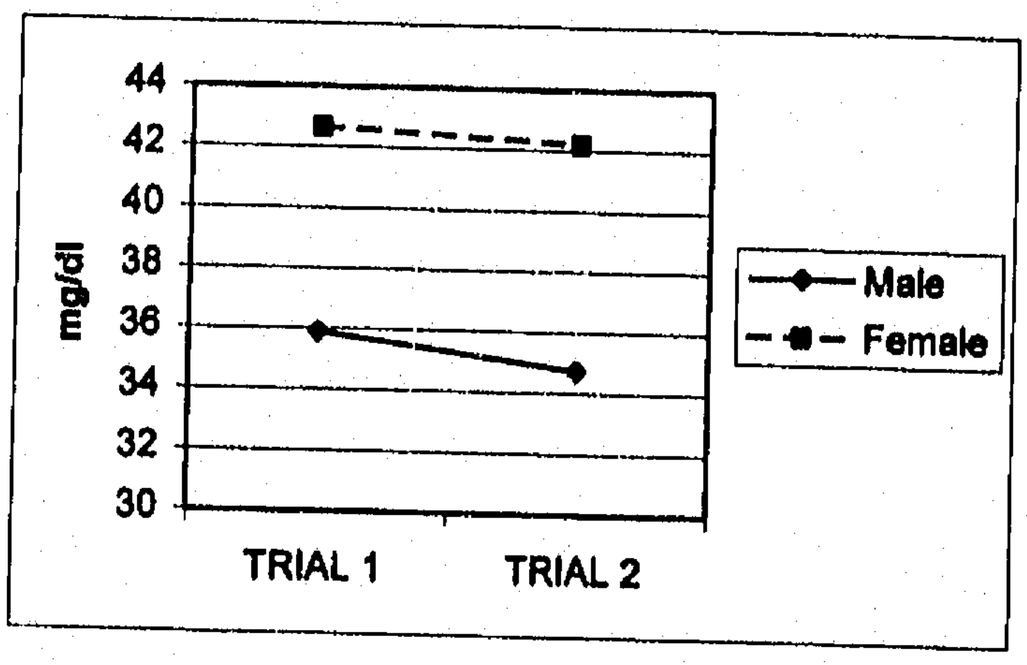

Figure 3. Mean high-density lipoproteins values.

Changes in LDL values are presented in Figure 4. ANOVA revealed significant main effects for trial, but no main effect for gender or gender by trial interactions.

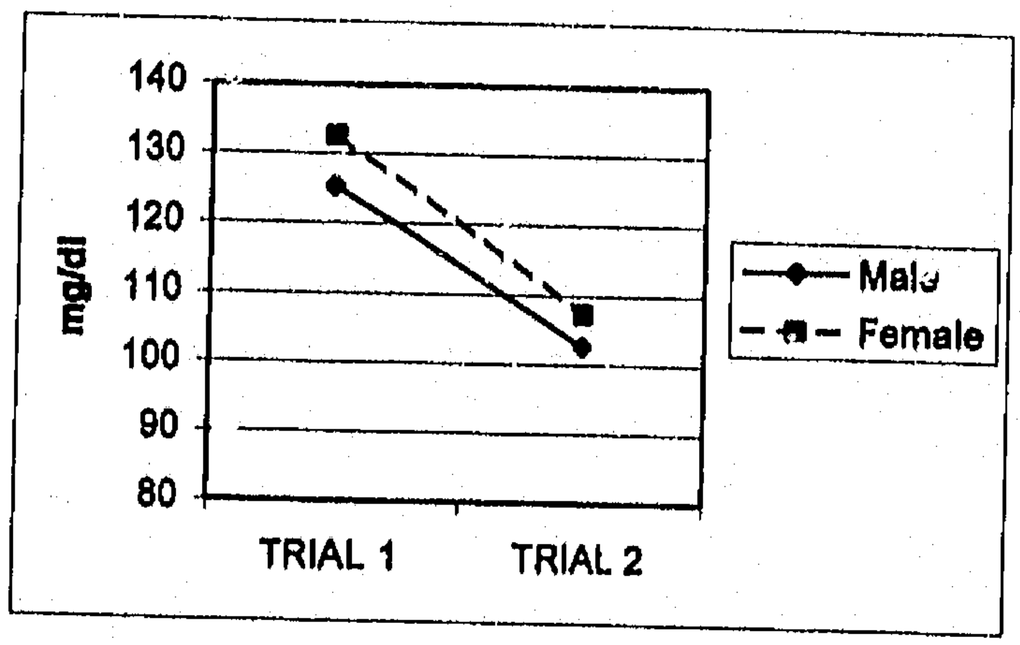

Figure 4. Mean low-density lipoproteins values.

Changes in systolic and diastolic blood pressures are presented in Figure 5. ANOVA revealed no significant main effects for gender or for trial and no gender by trial interaction.

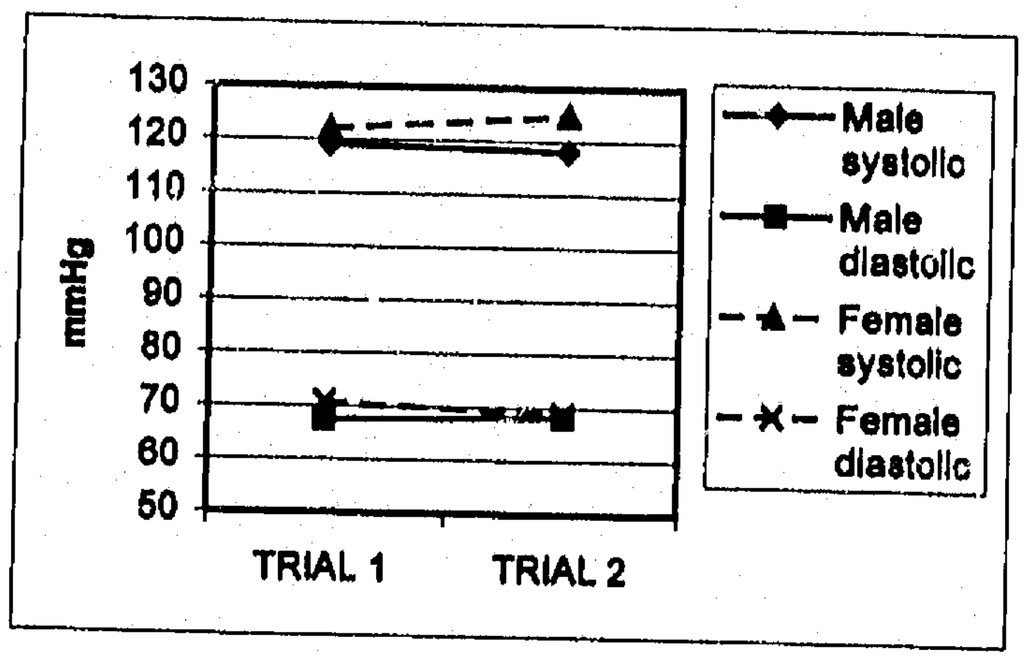

Figure 5. Mean systolic and diastolic blood pressure readings.

Changes in number of patients smoking are presented in Figure 6. ANOVA revealed significant main effects for trial, but not gender and there was no gender by trial interaction.

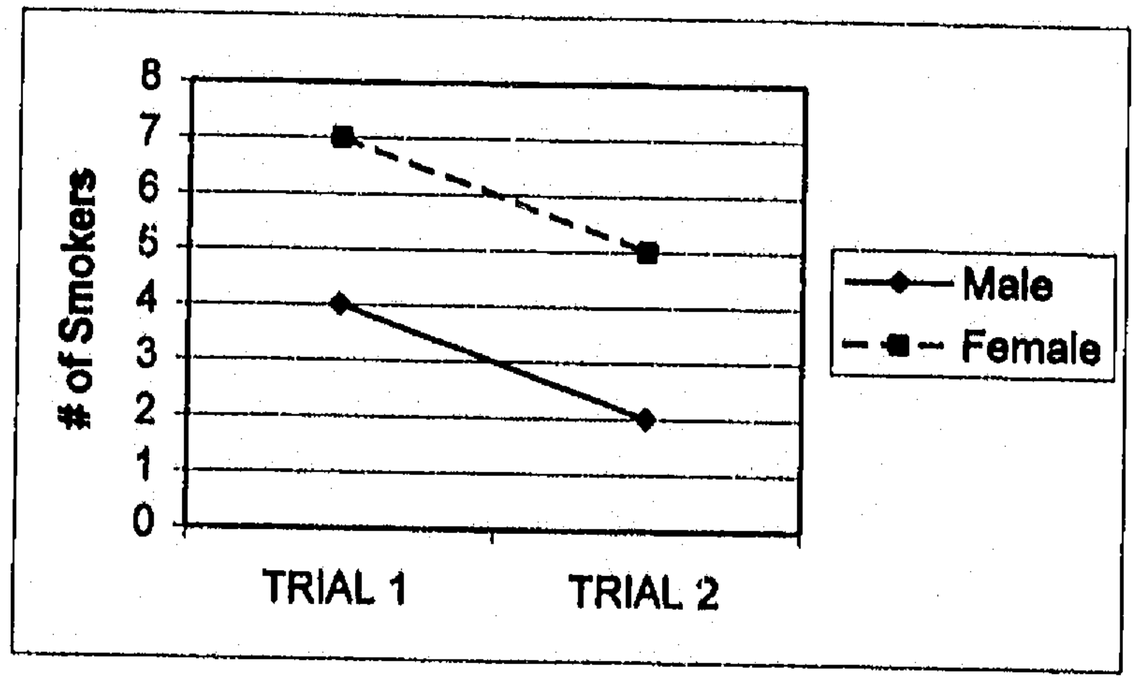

Figure 6. Number of patients smoking at time of trials.

Changes in diabetes are presented in Figure 7. ANOVA revealed no significant main effects for gender or for trial and no gender by trials interaction.

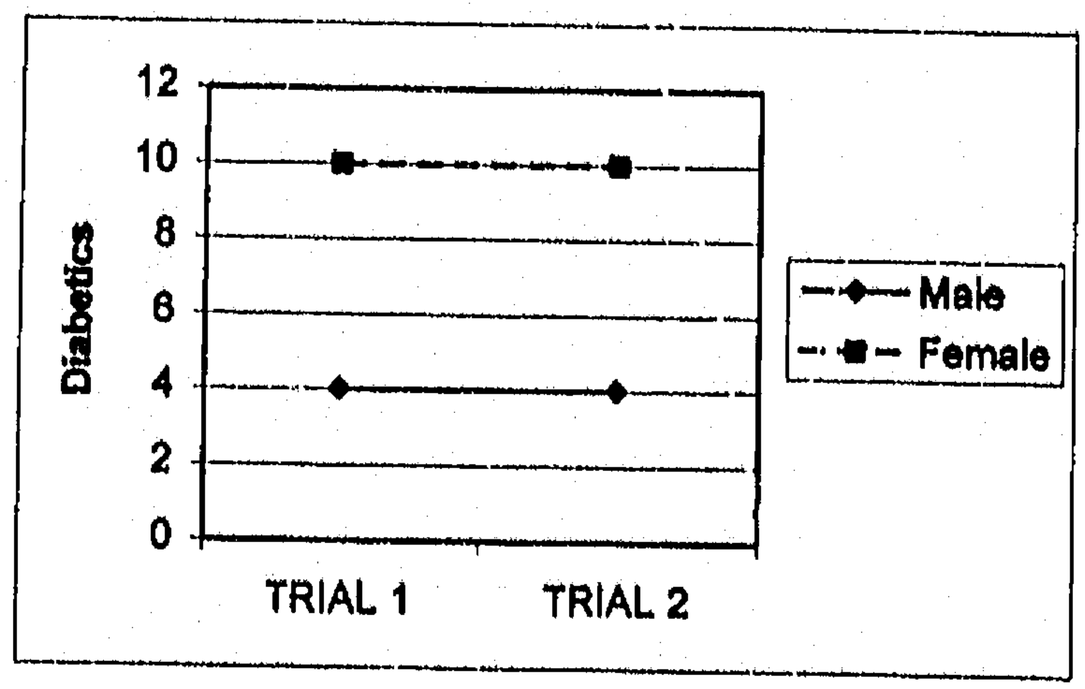

Figure 7. Number of diabetic patients at time of trials.

DISCUSSION

The reduction of the risk of a second cardiac event is a very important goal of the cardiac rehabilitation program. This study allowed assessment of one program's effectiveness in reducing CHD risk factors to prevent further events. It was determined that patients over 3 months of cardiac rehabilitation made changes to most modifiable CHD risk factors. The data collected on the males and females were interpreted separately and together, which made it possible to observe where significant changes were occurring. The global risk factor score revealed that an overall change in risk took place from trial 1 to trial 2. Fifty-four percent (27/50) of the males and 43.2% (19/37) of the females decreased their global risk factor score. When analyzed together, 52.9% (46/87) of subjects decreased their global risk factor scores. Six males and 2 females out of the 87 (9.2%) did not have a change in their global risk score, with the remaining subjects having an increase in their TC global risk score. A total of 57% (50/87) of subjects decreased their LDL global risk factor score, with 56% (28/50) of the males and 59% (22/37) of the females making up this total. Eight males and 3 females out of 87 (12.6%) did not have a change in their LDL global risk score, with the remaining subjects having an increase in their LDL global risk score.

Cholesterol changes are a very important part of lowering risk of CHD. Lipid lowering agents play a large role in lowering the risk of CHD. The National Cholesterol Education Program (NCEP)[10,11] recommended guidelines were closely followed in the rehabilitation program studied at this institution (see Appendix C). At the beginning of the rehabilitation program 32% (16/50) of males and 29.7% (11/37) of females were on a lipid lowering agent of some kind. At the end of the

3 month trial 82% (41/ 50) of males and 81.1% (30/37) of females were on some form of a lipid lowering agent.

Upon conclusion of the rehabilitation period 73.6% (64/87) of subjects had their total cholesterol under 200 mg/dl. Seventy percent of males (35/50), and 78.4 % (29/37) of females were below 200 mg/dl. Of the 23 individuals remaining above 200 mg/dl; four were above 240 mg/dl. One of those 4 individuals, a male, had been on 3 different types of lipid lowering agents and was placed on a lipid lowering drug combination at the time of the 3 month evaluation.

HDL of greater than 35 mg/dl was observed in 75.7% (28/37) of females. Only 21 out of 50 (42%) males were above 35 mg/dl. At the start of the cardiac rehabilitation program only 24% (21/87) of subjects had LDL values lower than 100 mg/dl. At the conclusion of 3 months 50.1% (44/87) of subjects had lowered their LDL's below 100 mg/dl. By gender, 48.6% (18/37) of the females and 52% (26/50) of the males were below the recommended guidelines of 100 mg/dl..

NCEP guidelines recommend that a person with known CHD should try to reduce or maintain a LDL of less than 100 mg/dl. This goal is reached more often when accompanied by cardiac rehabilitation.[12] This may be true due, in part, to systematic reviews of patient lipid levels prior to and following the 3 months of rehabilitation.[13] By attending cardiac rehabilitation, patients not only exercise, but are educated about lifestyle changes. They become aware of their lipid levels and why diet and drug adherence are very important for their well being.[14] A study from Mayo Clinic evaluated how frequently the NCEP goal was met in the clinical setting and what percentage of the met goal could be attributed to diet or drug therapy.[15] The 152 subjects had follow-ups for an average of 526 days after the initial assessment. Of the 152 subjects 59 (39%) were able to lower their LDL to reach the goal. Of these 59 subjects 65% (38) reduced their LDL

levels with the use of drug therapy and the other 35% (21) succeeded in reducing LDL levels with diet and exercise. Of the subjects followed over 90 days, 50.1% (44/87) had reduced their LDLs below the recommended level of 100 mg/dl. Only 2 out of the 87 were able to reduce or maintain LDLs below the recommended level with diet and exercise alone. It must be noted that of the 16 subjects not on a lipid-lowering agent, 50% reduced their LDL. One of those subjects had LDL below 100 mg/dl from the beginning of the rehabilitation period.

Joint National Committee-VI[16] (JNC-V) guidelines state that a normal blood pressure is a systolic blood pressure equal to or less than 130 mmHg and a diastolic blood pressure of 85 mmHg, with the diagnosis of first stage hypertension set at 140/90 mmHg. Patients undergoing any type of open-heart surgery are at a 15 to 40% of risk of developing hypertension before, during, or after the procedure.[17] Many patients are placed on antihypertensive medications to help control arrhythmias that may occur following surgery and others may have been on the medication prior to the event. Of the subjects in this study 61% (53/87) were on some type of medication at the conclusion of the rehabilitation program. Only 1 patient upon entering the program still had an extremely high blood pressure, with a reading of 160/100 mmHg. In general, most subject's blood pressures changed very little.

Subjects were classified as smoker's if they were smoking at the start of rehabilitation. It was noticed, but not noted, that a large number of smokers had quit either before or the day of their event. The female smokers seemed to be most resistant to breaking the habit, with 7 smoking at the beginning of rehabilitation and 4 continuing to do so after 3 months. Only 4 males were smoking at the start, with 2 continuing to smoke at the end.

All 14 (10 females and 4 males) of the diabetics were still classified as diabetic following the 3-month program. It was not documented what, if any, type of medication they were taking for their diabetes or how well they were controlling their glycemia. It was only noted that they were either insulin dependent or non-insulin dependent for control of glycemia.

CONCLUSIONS

Cardiac rehabilitation has been shown to improve recovering cardiac patients' quality of life, with its positive reinforcement of proper diet, exercise, and education of the risk factors that contribute to heart disease. Because doctors and clinics are more closely following the guidelines, such as the NCEP II and the JNC-IV, risk factor reductions should be, and are being, observed. In the present study, analysis of risk factor changes during the course of rehabilitation indicated a significant decrease in risk factors for both males and females. Most of the reduction in risk was attributable to decreases in LDL cholesterol, and most of this change is attributed to the use of lipid lowering pharmaceuticals. This suggests that improved clinical management and surveillance is the prime contributor to secondary prevention provided by participating in a cardiac rehabilitation program. The global risk assessment tool is a quick and clear way to help the patient know and understand their risk for the chance of another cardiac event. People can remember one number easier than they can remember 4 or 5. Further studies could be done on these subjects to see if they are still adhering to their prescribed diets, workouts, medication routine, and also, if those who quit smoking have remained nonsmokers at 6 months and at a year.

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APPENDIX A

RISK FACTOR PREDICTION WORKSHEET

Coronary Disease Risk Prediction Score Sheet for Men Based on Total Cholesterol Level

Step 1

Age	
Years	Points
30-34	-1
35-39	0
40-44	1
45-49	2
50-54	3
55-59	4
60-64	5
65-69	6
70-74	7

Step 2

Total Cholesterol		
(mg/dl)	(mmol/L)	Points
<160	≤4.14	-3
160-199	4.15-5.17	0
200-239	5.18-6.21	1
≥280	≥7.25	3

Key	
Color	Risk
green	Very low
white	Low
yellow	Moderate
red	High
	Very high

Step 3

HDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<35	<0.90	2
45-49	1.17-1.29	0
50-59	1.30-1.55	0
≥60	≥1.56	-2

Step 4

Blood Pressure					
Systolic (mmHg)	Diastolic (mmHg)				
	<80	80-84	85-89	90-99	≥100
<120	0				
120-129		0 pts			
130-139			1		
140-159					
≥160					2 pts

Note: When systolic and diastolic pressures provide different estimates for point scores, use the higher number

Step 5

Diabetes	
	Points
No	0
Yes	2

Step 6

Smoker	
	Points
No	0
Yes	2

Risk estimates were derived from the experience of the NHLBI's Framingham Heart Study, a predominantly Caucasian population in Massachusetts, USA

Step 7 (sum from steps 1-6)

Adding up the points	
Age	_____
Total Cholesterol	_____
HDL Cholesterol	_____
Blood Pressure	_____
Diabetes	_____
Smoker	_____
Point Total	_____

Step 8 (determine CHD risk from point total)

CHD Risk	
Point Total	10 Yr CHD Risk
≤-1	2%
0	3%
1	3%
2	4%
3	5%
4	7%
5	8%
6	10%
7	13%
8	16%
9	20%
10	25%
11	31%
12	37%
13	45%
≥14	≥53%

Step 9 (compare to men of the same age)

Comparative Risk		
Age (years)	Average 10 Yr CHD Risk	Low* 10 Yr CHD Risk
30-34	3%	3%
35-39	5%	5%
40-44	7%	4%
45-49	11%	5%
50-54	14%	6%
55-59	16%	7%
60-64	21%	9%
65-69	28%	11%
70-74	30%	14%

*Low risk was calculated for a man the same age, normal blood pressure, total cholesterol 160-199 mg/dL, HDL cholesterol 45 mg/dL, non-smoker, no diabetes

Coronary Disease Risk Prediction Score Sheet for Women Based on Total Cholesterol Level

Step 1

Age	
Years	Points
30-34	-9
35-39	-4
40-44	0
45-49	3
50-54	6
55-59	7
60-64	8
65-69	8
70-74	8

Step 2

Total Cholesterol		
(mg/dl)	(mmol/L)	Points
<160	<4.14	-2
160-199	4.15-5.17	0
200-239	5.18-6.21	1
[illegible]	[illegible]	[illegible]
≥280	≥7.25	3

Key	
Color	Risk
green	Very low
white	Low
yellow	Moderate
[illegible]	High
red	Very high

Step 3

HDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<35	<0.90	5
[illegible]	[illegible]	[illegible]
45-49	1.17-1.29	1
50-59	1.30-1.55	0
≥60	≥1.56	-3

Step 4

Blood Pressure					
Systolic (mmHg)	Diastolic (mmHg)				
	<80	80-84	85-89	90-99	≥100
<120	-3 pts	[illegible]	[illegible]	[illegible]	[illegible]
120-129	[illegible]	0 pts	[illegible]	[illegible]	[illegible]
130-139	[illegible]	[illegible]	0 pts	[illegible]	[illegible]
140-159	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
≥160	[illegible]	[illegible]	[illegible]	[illegible]	3 pts

Note: When systolic and diastolic pressures provide different estimates for point scores, use the higher number

Step 5

Diabetes	
	Points
No	0
Yes	4

Step 6

Smoker	
	Points
No	0
Yes	2

Risk estimates were derived from the experience of the NHLBI's Framingham Heart Study, a predominantly Caucasian population in Massachusetts, USA

Step 7 (sum from steps 1-6)

Adding up the points	
Age	_____
Total Cholesterol	_____
HDL Cholesterol	_____
Blood Pressure	_____
Diabetes	_____
Smoker	_____
Point Total	_____

Step 8 (determine CHD risk from point total)

CHD Risk	
Point Total	10 Yr CHD Risk
≤-3	1%
-1	2%
0	2%
1	2%
2	3%
[illegible]	3%
[illegible]	4%
5	4%
6	5%
7	6%
8	7%
9	8%
10	10%
11	11%
12	13%
13	15%
14	18%
15	20%
16	24%
≥17	≥27%

Step 9 (compare to women of the same age)

Comparative Risk		
Age (years)	Average 10 Yr CHD Risk	Low* 10 Yr CHD Risk
30-34	<1%	<1%
35-39	1%	<1%
40-44	2%	2%
45-49	6%	5%
50-54	8%	8%
55-59	12%	7%
60-64	12%	8%
65-69	13%	8%
70-74	14%	8%

*Low risk was calculated for a women the same age, normal blood pressure, total cholesterol 160-199 mg/dL, HDL cholesterol ≥45 mg/dL, non-smoker, no diabetes

Coronary Disease Risk Prediction Score Sheet for Men Based on LDL Cholesterol Level

Step 1

Age	
Years	Points
30-34	-1
35-39	0
40-44	1
45-49	2
50-54	3
55-59	4
60-64	5
65-69	6
70-74	7

Step 2

LDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<100	<2.59	-3
100-129	2.60-3.36	0
130-159	3.37-4.14	0
≥160	≥4.92	2

Key	
Color	Risk
green	Very low
white	Low
yellow	Moderate
	High
red	Very high

Step 3

HDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<35	≤0.90	2
45-49	1.17-1.29	0
50-59	1.30-1.55	0
≥60	≥1.56	-2

Step 4

Blood Pressure					
Systolic (mmHg)	Diastolic (mmHg)				
	<80	80-84	85-89	90-99	≥100
<120	0				
120-129		0 pts			
130-139			1		
140-159					
≥160					3 pts

Note: When systolic and diastolic pressures provide different estimates for point scores, use the higher number

Step 5

Diabetes	
	Points
No	0
Yes	2

Step 6

Smoker	
	Points
No	0
Yes	2

Risk estimates were derived from the experience of the NHLBI's Framingham Heart Study, a predominantly Caucasian population in Massachusetts, USA

Step 7 (sum from steps 1-6)

Adding up the points	
Age	_____
LDL Cholesterol	_____
HDL Cholesterol	_____
Blood Pressure	_____
Diabetes	_____
Smoker	_____
Point Total	_____

Step 8 (determine CHD risk from point total)

CHD Risk	
Point Total	10 Yr CHD Risk
≤-3	1%
-2	2%
-1	2%
0	3%
1	4%
2	4%
3	6%
4	7%
5	9%
6	11%
7	14%
8	18%
9	22%
10	27%
11	33%
12	40%
13	47%
≥14	≥56%

Step 9 (compare to man of the same age)

	Comparative Risk	
Age (years)	Average 10 Yr CHD Risk	Low* 10 Yr CHD Risk
30-34	3%	2%
35-39	5%	3%
40-44	7%	4%
45-49	11%	4%
50-54	14%	6%
55-59	16%	7%
60-64	21%	9%
65-69	28%	11%
70-74	30%	14%

*Low risk was calculated for a man the same age, normal blood pressure, LDL cholesterol 100-129 mg/dL, HDL cholesterol 46 mg/dL, non-smoker, no diabetes

Coronary Disease Risk Prediction Score Sheet for Women Based on LDL Cholesterol Level

Step 1

Age	
Years	Points
30-34	-9
35-39	-4
40-44	0
45-49	3
50-54	6
55-59	7
60-64	8
65-69	9
70-74	8

Step 2

LDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<100	≤2.59	-2
100-129	2.60-3.36	0
130-159	3.37-4.14	0
≥160	≥4.92	2

Key	
Color	Risk
green	Very low
white	Low
yellow	Moderate
	High
red	Very high

Step 3

HDL - Cholesterol		
(mg/dl)	(mmol/L)	Points
<35	<0.90	5
45-49	1.17-1.29	1
50-59	1.30-1.55	0
≥60	≥1.56	-2

Step 4

Blood Pressure					
Systolic (mmHg)	Diastolic (mmHg)				
	<80	80-84	85-89	90-99	≥100
<120	-3 pts				
120-129		0 pts			
130-139			0 pts		
140-159					
≥160					3 pts

Note: When systolic and diastolic pressures provide different estimates for point scores, use the higher number

Step 5

Diabetes	
	Points
No	0
Yes	4

Step 6

Smoker	
	Points
No	0
Yes	2

Risk estimates were derived from the experience of the NHLBI's Framingham Heart Study, a predominantly Caucasian population in Massachusetts, USA

Step 7 (sum from steps 1-6)

Adding up the points	
Age	_____
LDL Cholesterol	_____
HDL Cholesterol	_____
Blood Pressure	_____
Diabetes	_____
Smoker	_____
Point Total	_____

Step 8 (determine CHD risk from point total)

CHD Risk	
Point Total	10 Yr CHD Risk
≤-2	1%
-1	2%
0	2%
1	3%
2	3%
3	3%
4	4%
5	4%
6	5%
7	7%
8	8%
9	9%
10	11%
11	13%
12	15%
13	17%
14	20%
15	24%
16	27%
≥17	≥32%

Step 9 (compare to women of the same age)

Comparative Risk		
Age (years)	Average 10 Yr CHD Risk	Low* 10 Yr CHD Risk
30-34	<1%	<1%
35-39	1%	<1%
40-44	2%	2%
45-49	5%	3%
50-54	8%	5%
55-59	12%	7%
60-64	12%	8%
65-69	13%	8%
70-74	14%	8%

*Low risk was calculated for a women the same age, normal blood pressure, LDL cholesterol 100-129 mg/dL, HDL cholesterol 65 mg/dL, non-smoker, no diabetes

APPENDIX B

INFORMED CONSENT

THESIS STUDY: CHANGES IN GLOBAL CORONARY HEART DISEASE RISK FACTORS FOLLOWING A PERIOD OF REHABILITATION.

INFORMED CONSENT

I _____, give my consent to participate in this study, which evaluates my risk factors for coronary heart disease. I have been informed that personal information will be retrieved from my patient chart and incorporated into a formula that will give a prediction of the probability of my having a second cardiac event. I have been informed that my patient chart will be viewed and data will be collected at the beginning and end of my Cardiac Rehabilitation program, so that a comparison of the two time periods can be observed.

I have been informed that I will receive results of each data collection after the tabulation data and that the score will be explained. This may improve my understanding of changes that have occurred while I was in the rehabilitation program.

I have been informed that my participation in this study will be free of cost.

I have been informed that I may withdraw permission for evaluation of my records at any time without affecting the quality and quantity of services available to me.

I have been informed that my records and information will remain confidential and will not be revealed. However, I have been informed that summary data not identifiable by name will be presented at scientific meetings or published, so that the data can be beneficial to others.

I have been informed that I may contact Jodi Nelson at 608-526-3063, if I need to discuss any part of the study. I may also contact the thesis chairperson, Dr. Carl Foster at 608-785-8687. Questions regarding the protection of human subjects may be addressed to Dr. Garth Tymeson, chair, UW-La Crosse, Institutional Review Board for the protection of human subjects. (608) 785-8155.

Participant_____ Date_____

Researcher_____ Date_____

APPENDIX C

NATIONAL CHOLESTEROL EDUCATION PROGRAM GUIDELINES

Initial Classification Based on Total Cholesterol and HDL Levels*

Cholesterol Level	Initial Classification
Total Cholesterol	
< 200 mg/dl (5.2 mmol/L)	Desirable blood cholesterol
200-239 mg/dl (5.2-6.2mmol/L)	Borderline high blood cholesterol
240 mg/dl (6.2 mmol/L) or greater	High blood cholesterol
HDL Cholesterol	
< 35 mg/dl (0.9 mmol/L)	Low HDL cholesterol

*HDL indicates high-density lipoprotein

National Cholesterol Education Program (NCEP): Second report of the expert panel in detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel II). JAMA 269;3015-3021,1993

Treatment Decisions Based on LDL Cholesterol Level*

Patient Category	Initiation Level (mg/dl)	LDL Goal (mg/dl)
<u>Dietary Therapy</u>		
Without CHD and < 2 risk factors	>=160	<160
Without CHD and >= 2 risk factors	>=130	<130
With CHD	>100	<=100
<u>Drug Treatment</u>		
Without CHD and < 2 risk factors	>=190	<160
Without CHD and >= 2 risk factors	>=160	<130
With CHD	>130	<=100

*LDL indicates low-density lipoprotein; and CHD, coronary heart disease

National Cholesterol Education Program (NCEP): Second report of the expert panel in detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel II). JAMA 269;3015-3021,1993

APPENDIX D

REVIEW OF LITERATURE

REVIEW OF RELATED LITERATURE

Each day the world hears of a new medical breakthrough that may help to prolong a life. Much research has been done in the area of coronary heart disease (CHD) and many of the studies involve observing patients in a primary and/or secondary prevention setting. This particular study involves patients who were in the secondary stage of prevention. Therefore, the review of literature will discuss multi-risk factors, risk factors following a cardiac event that are used in the coronary risk factor prevention equation, and those factors that are not in the equation, but are important in the causes of CHD.

Multi-Risk Factors

When the National Heart Institute began the Framingham Heart Study in 1948, little was known about the cause of CHD, but the incidence of CHD seemed to be climbing each year.[1] The study was named after a suburb of Boston in which the research was conducted and continues to this day. According to the study protocol,[1] the subjects return biannually for physicals and laboratory tests. It has been from these biannual visits that, over the years, the major cardiac risk factors have been identified. The current prediction equations used the test results of males and females 37 to 74 years of age in 1971-1974. This would be the original subjects' 11th physical examination and the first physical examination for the original subjects offspring.[2,3]

Through the many studies conducted it has been found that the major independent risk factors for CHD are: smoking, hypertension, high; total; and LDL cholesterol, low HDL cholesterol, diabetes mellitus, and advancing age[1-2,4-7]. Risk factors classified as predisposing risk factors for CHD, include the following: obesity, physical inactivity, family history of CHD, ethnicity, and

psychosocial factors, but are not included in the risk factor equation[6]. It was thought that a single risk factor approach was not logical or effective, and that a multi-risk factor approach should be the focus.[4-5,7]

"Efficient risk evaluations required quantitative synthesis of the major contributors to cardiovascular disease into a composite score."[4] The U.S. railway workers study provided the information to devise a coronary risk equation, which was then incorporated into the development of a round slide rule, which calculated the percentage of risk by using multi-risk factors.[8] Entered into the equation was the men's age, serum cholesterol, diastolic blood pressure, and the number of cigarettes smoked daily.

Equations, using Framingham data, were developed that could be used to predict the probability of CHD by taking into consideration multi-risk factors instead of focusing on a single factor.[3] From these equations a CHD risk factor prediction chart was created for the American Heart Association (AHA). In 1998 an updated coronary disease equation was introduced that was more easily understood and simpler to use.[2,6] This newer version made changes to the original equation, by dropping left ventricular hypertrophy (LVH) and adding the option of using LDL or total cholesterol. β-coefficients of the Cox proportional hazards models were used in the development of the score sheet[6] and are used in the equations that follows:

Equation I

L_Chol_{men} =0.4826Xage-0.65945(if cholesterol <160) + 0.0 (if cholesterol 160 to 199) + 0.17692 (if cholesterol 200 to 239) + 0.50539 (if cholesterol 240 to 279) +0.65713 (if cholesterol ≥280) +0.49744 (if HDL- <35) +0.24310 if HDL-C 35 to 44) +0.0 (if HDL-C 45-49) -.05107 (if HDL-C 50-59) –0.48660 (if HDL-C ≥60) –0.00226 (if

BP optimal) +0.0 (if BP normal) +0.28320 (if BP high normal) +0.52168 (if BP stage I hypertension) +0.62859 (if BP stage II hypertension) +0.42839 (if diabetes present) +0.0 (if diabetes not present) +0.52337 (if smoker) +0.0 (if diabetes not present) +0.52667 (if smoker) +0.0 (if not a smoker)

G_Chol_{men}= 0.04826 X48.5926- 0.65945X0.07433 +0.17692X0.38851 +0.50539X0.16673 + 0.65713X0.05826 +0.49744 X0.19285 +0.24310 X0.35476 – 0.05107 X0.19646 –0.48660 X0.10727 –0.00226 X0.20048 +0.28320 X0.20048 +0.52168 X0.22820 +0.61859 X0.13057 +0.42839 X0.05223 +0.52337 X0.4058=3.0975 (For women G_Chol =9.92545, G-LdL for men =3.00069, and for women G_LDL = 9.914136)

Equation II $A = L - G$

Equation III $B = e^A$

Equation IV $P = 1 - [s(t)]^B$ (s(t)_Chol 10 years =0.90015 for men, 0.96246 for women; s(t)_LDL 10 years =0.90017 for men, 0.9628 for women

The equations were developed into a global risk assessment score sheet that health care professionals could use for their patients (see Appendix A). This score sheet identifies a single number, that gives the probability percentage of an individual's 10 year risk for CHD and allows for the comparison of an average person of the same age as the patient.

Major Risk Factors Following a Cardiac Event

After a cardiac event has occurred an individual must be mindful of risk factors, since the greatest risk factor for a second cardiac event is the presence of a first cardiac event. Because a coronary artery bypass graft (CABG) surgery has been performed or a stent has been placed to

open a narrowed artery, this does not guarantee it can never happen again. Studies have been done on the many risk factors leading to CHD. Those risk factors that were observed in this study were the ones that correspond to the risk factor equation developed for use by the AHA from data of the National Heart, Lung, and Blood Institute's (NHLBI) Framingham Heart Study.[3,5-8]

Hypercholesterolemia

The NHLBI and the National Institutes of Health (NIH) introduced the National Cholesterol Education Program (NCEP) in 1985. The goal of the NCEP was to increase awareness and try to reduce CHD by reducing high cholesterol levels in individuals.[9,10] It was documented that from 1983 until 1995 the percentage of individuals having a blood cholesterol screening had increased from 35 to 75%. Gore et al.[11] used Framingham data and observed that although changes in the plasma lipids occur with myocardial infarction (MI), a serum total cholesterol level within 2 hours of onset of symptoms of MI reliably reflected a patient's baseline levels prior to the MI. Therefore, a patient who did not have a prior cholesterol reading could have one done after a MI and be able to determine the levels before the MI. Strict cholesterol guidelines were established by the NCEP and were updated in 1993, with a greater emphasis placed on LDL levels of persons with known CHD.[9,10] A person is to be considered at low risk for CHD when their TC level is between 160-199 mg/dl, LDL-C level is 100-129 mg/dl, and HDL-C is $\geq$ 45 mg/dl in men and $\geq$ 55 mg/dl in women.[12] If a person has known CHD, the goal for LDL is below 100 mg/dl. Secondary prevention trials have revealed that a 10% reduction in cholesterol can reduce the rate of non-fatal re-infarction by 19% and by 12% for a fatal re-infarction.[13]

McBride et al.[14], Danlas et al.[15], and Hamick et al.[16] have done studies to determine if NCEP guidelines are being followed. They found that lipid management was not consistent among

physicians. Doctors were not ordering lipid profiles on a regular basis and a small percentage of those patients that would benefit from lipid lowering agents were actually being put on a lipid lowering agent. It was determined that patients who had undergone revascularization or had high LDL and/or triglycerides were more apt to be put on a lipid lowering agent. Researchers at Mayo Clinic[17] wanted to find out how often the NCEP goal is achieved in a clinical setting with or without drug therapy. One hundred and fifty-two cardiac rehabilitation patients managed their lipids with a strict diet, exercise, and lipid lowering drugs according to the NCEP guidelines. Thirty-nine percent of the patients achieved the LDL goal, 65% (38/59) had to use a lipid lowering agent, more intense diet routine, lose weight, and develop a more extensive workout to lower their LDL levels. On the other hand only 35% (21/59) of the patients were able to achieve their goal with diet and exercise.

Low fat diets alone have not been shown to lower LDL cholesterol. When comparing groups on low fat diets and groups on low fat diets plus a lipid lowering agent, the end result favors the diet-drug combination.[18] Appendix C lists the NCEP guidelines for when to initiate a lipid lowering drug. It is recommended that to lower cholesterol and increase HDL levels individuals need to use lipid lowering drugs, diet, exercise, and smoking cessation.[4] One of the first lipid lowering drugs on the market was the bile acid sequestrant (BAS), Cholestyramine, which was found to lower LDL (10--20%) and slightly increase HDL (3-5%).[10,19] Cholestyramine unfortunately increased the level of triglycerides. HMG Co A reductase inhibitors (statins) were introduced to the public in the late 1980's. Lovastatin was compared to Cholestyramine and showed a greater ability to lower LDLs (20-60%) and increase HDLs (5-15%) and decrease triglycerides (10-40%).[10,19] A third lipid lowering drug is nicotinic acid. Nicotinic acid is used to decrease LDLs (10-25%), increase HDLs (15-35%), and its main purpose is to decrease triglycerides (20-50%).[10]

Hypertension

It is thought that one in every four Americans is hypertensive, with hypertension being more common in men than women up to age 55 years.[20] According to Kannel and Schatzkin,[4] hypertension is a major contributor to cardiovascular and cerebrovascular disease. Men aged 65-74 from the Framingham Heart Study who were hypertensive had twice as great a risk of dying as men the same age that were normotensive.[4] The risk of heart failure with hypertension and LVH is three times that of someone with hypertension alone[4]. Left ventricular hypertrophy (LVH) and shearing of the arteries can develop when systolic blood pressure is above 180 mmHg. Hypertension is also of great concern for the cardiac patient having open-heart surgery. It is thought that 15-40% of surgical patients are hypertensive before, during, or after surgery, but the causes are unclear at this time and more studies are being proposed.[21]

The Joint National Committee (JNC-V)[7] describes stage I hypertension as a blood pressure in the range of 140-159/90-99 mmHg and stage II-IV as a blood pressure greater than 160/100 mmHg. Lifestyle changes, such as stress reduction, a reduced salt diet, regular exercise, and pharmacologic methods are used in the control of hypertension. The preferred medications for the initial control of hypertension are beta-blockers and diuretics, due to the demonstrated ability of these medications to reduce morbidity and mortality.[20] Other commonly used medications are angiotensin-converting enzyme (ACE) inhibitors and calcium channel blockers.

Smoking

Evidence shows that stopping smoking can do more to improve cardiovascular health than any other personal hygiene measure or public health action.[22] It has been found that the number of cigarettes smoked per day is a stronger factor for CHD than the number of years the person

smoked. A person who quits smoking has half the chance of having a MI compared to someone who continues to smoke.[4] Physicians are being observed to see how consistently they advise their patients about the risks of smoking and benefits of quitting. A study was conducted to examine physician compliance with NCEP guidelines and also noted the rate at which interns discussed smoking with their patients.[23] Of the 225 charts reviewed, smoking was documented 89% of the cases, but only 4% were counseled to quit. A 3 to 5 minute physician discussion about smoking cessation can increase the chance of an individual quitting.[24] Kannel et al.[22] notes that women who smoke and take oral contraceptives are also at risk for thromboembolic cardiovascular disease (CVD), especially after the age of 35 years. An individual who continues to smoke after percutaneous transluminal coronary angioplasty (PTCA) has an increased risk of restenosis, compared to an individual who either quit smoking or never smoked.[25]

Diabetes

Diabetes has become a very important risk factor in the development of CHD.[6] It is suggested that hyperglycemia is an independent risk factor, but commonly seen are accompanying risk factors such as hyperlipidemia, hypertension, and obesity, which also increase the chance of CHD.[26] There have also been findings that both type 1 and type 2 diabetics exhibit increased platelet aggregation and adhesion, which also increase the chances of CHD development.[27] Type 2 diabetes is of great concern, due to the fact that it is so common and usually occurs in the aging population.[11] According to the Framingham Heart Study, an individual was considered diabetic when their casual blood glucose is higher than 150 mg/dl at two exams per year in the original cohort and greater than 140 mg/dl in the offspring; they exhibited an abnormal glucose tolerance test, or they were taking insulin shots or oral hypoglycemic agents.[3,6,28] Current guidelines from the

Diabetic Association (ADA) have lowered the fasting glucose levels for diagnosis of diabetes. The prognosis of diabetics following a MI is very poor. Diabetics have an accelerated risk of MI (45% diabetic compared to 21% nondiabetic), and angina (57% diabetic compared to 35% nondiabetic).[28,29] Kannel and Schatzkin[1] believe that there is more to be gained by a multi-risk factor intervention for diabetics than for non-diabetics, which means correcting hypertension, lipid levels, obesity, and smoking. It has been thought that when the glycemic levels are normalized; the normal serum lipid levels will follow.[30] The impact of diabetes is proportionately greater on women than on men, effectively eliminating the CHD protection ordinarily provided to the female.[22]

Cardiac Rehabilitation

The World Health Organization (WHO)[31] defined cardiac rehabilitation as "the sum of various efforts to modify cardiovascular risk factors and to assist patients in regaining their normal place in the community and in leading active and productive lives." Some of the goals of rehabilitation are thought to be improved functional capacity, improved quality of life, and reduction in mortality and morbidity. Oldridge et al.[32] conducted a meta-analysis on random studies of patients who participated in comprehensive cardiac rehabilitation programs. Their findings suggested that a person who participates in a rehabilitation program had a greater chance of reducing the rate of a fatal event. A second meta-analysis that was conducted by O'Connor et al.[33] on studies of rehabilitation programs following a cardiac event was performed to determine if there was a significant benefit of exercise. The analysis revealed that there was a 20% reduction in mortality, a lower risk of cardiovascular mortality and fatal infarction through the first three years, and a decrease in sudden death the first year following the CHD event.

The Multiple Risk Factor Intervention Trial Research Group[34] held a trial, which compared high-risk men age 35 - 57 years. These men were put into two groups; one with special intervention and the other with usual health care. The special intervention involved classes on hypertension, cholesterol lowering, and smoking. The groups were followed for seven years. The group with special intervention had a greater decrease in risk factors, due to those that stopped smoking and responded to the hypertensive treatments.

Cardiac rehabilitation is not just of value in changing risk factors of CHD, but it has been found to help patients save money. Ades et al.[35] studied the effect of rehabilitation and the cost of rehospitalization. Those patients that participated in cardiovascular and strength training program exercised for 36 hours over 12 weeks, and also attended one hour of cardiac education.[35] Follow-up health care costs were reduced because of a lower rate of readmission for second cardiac events.

SUMMARY

The number of studies researching the multi-risk factor of CHD are numerous, with many of the more recent studies researching the multi-risk factor. Many of the studies commented on the advantage of using the multi-risk factor, because of its ability not to discriminate against those individuals who were either low-risk or high-risk. The multi-risk factor method has a use in the primary and secondary prevention levels. Individuals who have had a cardiac event must remain aware of the risk factors and that is where cardiac rehabilitation comes into play. Cardiac rehabilitation educates the individual of the benefits of a healthy lifestyle and therapeutic compliance to prevent the further progression of CHD. In this study, a 3 month cardiac rehabilitation program was clearly a vehicle for multi-risk factor change.

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