The impact of health care advice given in primary care on cardiovascular risk

L H Lindholm, T Ekbom, C Dash, M Eriksson, G Tibblin, B Scherstén on behalf of the CELL Study Group

See pp 1099, 1109 and editorial by Toon

Abstract

***Objective*—To evaluate the additional benefit of "intensive" health care advice through six group sessions, compared with the advice usually offered to subjects with multiple risk factors for cardiovascular disease.**

***Design*—Prospective, randomised controlled clinical study lasting 18 months.**

***Setting*—681 subjects aged 30-59 years, with at least two cardiovascular risk factors in addition to moderately high lipid concentrations: total cholesterol ≥6·5 mmol/l on three occasions, triglycerides <4·0 mmol/l, and ratio of low density lipoprotein cholesterol to high density lipoprotein cholesterol >4·0. Most (577) of the subjects were men.**

***Main outcome measure*—Percentage reduction in total cholesterol concentration (target 15%); quantification of the differences between the two types of health care advice (intensive *v* usual) for the Framingham cardiovascular risk and for individual risk factors.**

***Results*—In the group receiving intensive health care advice total cholesterol concentration decreased by 0·15 mmol/l more (95% confidence interval 0·04 to 0·26) than in the group receiving usual advice. The overall Framingham risk dropped by 0·068 more (0·014 to 0·095) in the group receiving intensive advice, and most of the risk factors showed a greater change in a favourable direction in this group than in the group receiving usual advice, but the differences were seldom significant. The results from questionnaires completed at the group sessions showed that the subjects improved their lifestyle and diet.**

***Conclusion*—Limited additional benefit was gained from being in the group receiving the intensive health care advice. It is difficult to make an important impact on cardiovascular risk in primary care by using only the practice staff. Better methods of communicating the messages need to be devised.**

The members of the CELL Study Group are listed at the end of the article.

Health Sciences Centre Dalby/Lund, University of Lund, Lund, Sweden
L H Lindholm, *associate professor*
T Ekbom, *research fellow*
B Scherstén, *professor*

Central Middlesex Hospital Trust, London
C Dash, *clinical assistant*

University of Uppsala, Sweden
M Eriksson, *research assistant*
G Tibblin, *professor*

Correspondence to: Dr L H Lindholm, Health Sciences Centre Dalby/Lund, University of Lund, Helgeandsgatan 16, S-22354 Lund, Sweden.

BMJ 1995;310:1105-9

Introduction

Many cardiovascular risk factors have been described in epidemiological studies.[1-3] Several of these can be modified through a change in lifestyle. There has been disagreement, however, on how much a change in lifestyle—particularly in diet—can have on risk factors.[4] Primary health care can potentially influence the greatest number of individuals across a range of risk factors. We conducted a prospective, parallel group study of various interventions in patients with known risk factors—the CELL study (cost effectiveness of lipid lowering)—among primary care practices in Sweden. Randomly allocating the subjects to receive either "intensive" or "usual" health care advice was the key approach to modifying multiple risk factors. We compared the impact of changes in lifestyle among the subjects receiving intensive advice with the impact of such changes among those receiving usual advice and examined the changes in specific risk factors as well as the effect on total cardiovascular risk.

Subjects and methods

In Sweden most general practitioners and district nurses work in health centres run by the county councils. They are responsible for promoting health and for the care of geographically defined populations. At the start of our 18 month study Sweden had about 850 health centres; 32 of these participated in our study, which started in February 1990 and ended in April 1993. Most of the health centres were located in rural areas or small towns with little social deprivation. In each health centre one doctor and one or two nurses participated.

SELECTION OF SUBJECTS

To find eligible subjects the participating doctors and nurses examined their patients' files and advertised on notice boards and in the local press. Subjects with two or more of six cardiovascular risk factors (being male, obesity, smoking, hypertension, history of cardiovascular disease, and family history of cardiovascular disease before the age of 60) were invited to have their total cholesterol concentration measured in capillary blood plasma with Reflotron (Boehringer Mannheim, Germany). If the value was at least 6·5 mmol/l the subject was invited back for the concentration to be measured again. If the value was again at least 6·5 mmol/l the subject was examined to exclude secondary hyperlipidaemia. A fasting lipid profile analysis consisting of serum concentrations of total cholesterol, high density lipoprotein cholesterol, and triglycerides was carried out at Lund University Hospital with established methods.[5-7] These methods were standardised to reference preparations provided by the Centers for Disease Control and Prevention. Low density lipoprotein cholesterol concentration was calculated according to the formula proposed by Friedewald *et al.*[8] Venous blood was also analysed for serum concentrations of haemoglobin, alanine aminotransferase, aspartate aminotransferase, creatine kinase, creatinine, thyroid stimulating hormone, and fasting glucose.

The subjects who had attended twice were asked to attend a third time, about four weeks later. A subject was enrolled in the study if *(a)* the third measurement of total cholesterol concentration was at least 6·50 but not above 7·79 mmol/l, *(b)* the triglycerides concentration was below 4·0 mmol/l, *(c)* the ratio of low density lipoprotein cholesterol to high density lipoprotein cholesterol was 4·0 or above, *(d)* the other blood test results did not show any potential abnormality, and *(e)* the previous eligibility criteria, as described elsewhere, were met.[9] About 8% of the screened individuals entered the study,[9] although the differences between centres were considerable owing to their screening strategies.

RANDOM ALLOCATION

In all, 681 subjects aged 30-59 years with at least two cardiovascular risk factors and a moderately high cholesterol concentration were randomly allocated to two groups: those who were to receive usual health advice (n=342) and those who were to receive intensive advice (n=339). Table I gives background information

TABLE I—*Background information on 681 subjects at time of randomisation to two health care advice groups. Values are means (SD) unless stated otherwise*

	Health care advice	
	Intensive (n=339)	Usual (n=342)
Men/women	284/55	293/49
Mean (SD) age (years)	49·1 (6·6)	48·3 (6·7)
Cholesterol (mmol/l):		
Total*	6·82 (0·56)	6·82 (0·65)
Low density lipoprotein	5·00 (0·63)	5·02 (0·70)
High density lipoprotein*	0·90 (0·16)	0·91 (0·16)
Ratio of low density lipoprotein to high density lipoprotein cholesterol	5·73 (1·19)	5·70 (1·30)
Triglycerides (mmol/l)*	2·02 (0·90)	1·97 (0·85)
Glucose (mmol/l)	4·77 (0·71)	4·72 (0·73)
Weight (kg)	83·8 (13·1)	84·7 (13·9)
Body mass index (kg/m²):		
Men	27·0 (3·4)	27·2 (3·8)
Women	29·9 (6·1)	28·8 (5·6)
Waist: hip ratio	0·91 (0·07)	0·91 (0·07)
Blood pressure (mm Hg):		
Systolic	132·1 (14·7)	131·0 (14·7)
Diastolic	82·4 (8·3)	82·5 (9·1)
Smoking score†	2·5 (2·7)	2·4 (2·7)
Exercise score‡	1·7 (1·5)	1·9 (1·5)
No (%) of obese subjects:		
Men	58 (20·4)	72 (24·6)
Women	24 (43·6)	22 (44·9)
No (%) of smokers:		
Men	144 (50·7)	144 (49·1)
Women	32 (58·2)	24 (49·0)
No (%) of subjects with cardiovascular disease:		
Men	32 (11·1)	31 (10·6)
Women	3 (5·5)	4 (8·2)
No (%) of subjects with family history of cardiovascular disease:		
Men	131 (46·1)	141 (48·1)
Women	39 (70·9)	34 (69·4)
No (%) of subjects with hypertension:		
Men	68 (23·9)	78 (26·6)
Women	25 (45·5)	27 (55·1)

*Analysed at Lund University Hospital.
†Scored according to number of cigarettes smoked daily: 0=non-smoker or former smoker; 2=1-4 cigarettes; 4=5-14 cigarettes; 6=15-24 cigarettes; 8=≥25 cigarettes.
‡Scored according to walking or cycling (or equivalent exercise): 0=more than 30 minutes daily; 1=15 minutes daily; 2=15 minutes on alternate days; 3=15 minutes occasionally each week; 4=rarely any; 5=none.

on the subjects. The proportion of men in both groups was high—partly because being male was considered to be a cardiovascular risk factor, making it easier to recruit men than women. The recruitment of women was slow and was stopped in the later part of the study. Because men and women were randomised separately, however, the proportions of men and women were similar in both groups (table I). Because of the limited number of subjects, we analysed men and women together; separate analyses (data not given) showed no important differences between the sexes.

The drop out rate was low, with 637 subjects (325 receiving usual advice, 312 intensive advice) reaching the 12 month follow up and 626 (320 usual, 306 intensive) completing the 18 months of the study. Thus the drop out rate at 18 months was 8·1% overall, with no significant difference between the subjects receiving usual advice (6·4%) and those receiving intensive advice (9·7%). The most common reasons for patients withdrawing from the study were that they lost interest or moved house.

The randomisation was performed separately for each centre and each sex, with the numbers allocated to advice and treatment groups (see below) never being allowed to differ by more than two.

The randomisation consisted of a 2×3 factorial design. Subjects were allocated equally to the two types of health care advice: usual or intensive. Each of these two groups was at the same time divided into three equally sized groups, with one group receiving a lipid lowering drug (pravastatin), another receiving a matching placebo (double blind), and the third receiving nothing. Here we provide data only on the overall differences between the two main groups (intensive *v* usual health care advice).

We aimed at obtaining a 15% reduction in total cholesterol concentration, which seemed achievable, with motivation, through diet alone.[10–15] Targets for other risk factors were more difficult to set. All subjects were followed up at one month, and at two, six, 12, and 18 months. At each follow up total cholesterol concentration was measured as before. At each six monthly follow up blood tests and other vital measurements were performed, including a fasting lipid profile. No health care advice was given before randomisation.

USUAL HEALTH CARE ADVICE

At each visit the doctor instructed the subject to reduce fat in the diet, to reduce weight (if necessary), to take daily exercise, and to stop smoking (if appropriate). The doctor reinforced these instructions by giving the subject a small pamphlet.

INTENSIVE HEALTH CARE ADVICE

The subjects receiving intensive health care advice received the same advice as those receiving usual advice but also took part in a course of six group sessions led by a trained health care professional (participating doctor or nurse) in each health centre. The training was attendance at a one day training session in Uppsala before the study started and annual, two day, follow up meetings during the study. The ideal number of subjects for each group session was eight; we aimed at keeping each group the same throughout the study. The backbone of the sessions comprised five videos dealing with risk factors for developing myocardial infarction: diet, exercise, weight control, and the need for sleep and for relaxation. The same videos were used in each health centre. Each group discussed the videos.

An important part of the intensive health care advice was practical instruction in aspects of buying and cooking recommended types of food. The participants were also told about local facilities for exercise. Lifestyle was assessed during the group sessions with a separate seven point scoring system for several different symptoms, such as appetite, energy, quality of sleep, general wellbeing, and happiness.[16] Each of the first three sessions, held at monthly intervals, lasted about 90 minutes. The fourth session lasted all day and included reruns of the videos and other practical reinforcements of the messages. The fifth session was held 12 months after the start of the study and lasted for 90 minutes, with further reinforcement of the messages. The final session, held three to six months later, also lasted 90 minutes and served as another revision opportunity. To increase motivation, at each session the participating doctors and nurses asked the participants to fill in two forms—one about dietary habits and the other about changes in lifestyle. From the data in these forms we calculated scores for fat intake (subjects scored one point for each 1 g of fat), fibre intake, and changes in lifestyle; further details about these scores are given elsewhere.[17] Competition between the subjects and between the groups was encouraged.

MEASUREMENTS

Obesity was defined as a body mass index (kg/m²) of ≥30. Smoking was scored according to the number of cigarettes smoked daily as follows: 0=non-smoker or former smoker; 2=1-4 cigarettes; 4=5-14 cigarettes; 6=15-24 cigarettes; 8=25 or more cigarettes. Exercise was scored according to walking or cycling (or equivalent exercise) as follows: 0=more than 30 minutes daily; 1=15 minutes daily; 2=15 minutes on alternate days; 3=15 minutes occasionally each week; 4=rarely any; 5=none.

Blood pressure was measured, with cuff sizes appropriate to the circumference of the arm, to the

nearest 2 mm Hg after the subject had been supine for at least 5 minutes with the arm at the level of the right atrium.[18] Before the subjects could be randomised, blood pressure had to be controlled (with diastolic pressure < 95 mm Hg), preferably with drugs that had no effect on lipid concentration, such as angiotensin converting enzyme inhibitors, calcium antagonists, and α blockers. Overall cardiovascular risk was calculated from the Framingham equation,[19] and the change over time was calculated for each subject.

For key variables we calculated changes between values at baseline and 18 months. To quantify the additional impact of the group sessions we have expressed the results as the differences in these changes between the subjects receiving intensive health care advice and those receiving usual advice.

STATISTICAL METHODS

To eliminate completely any influence of drug treatment and any placebo effects we compared the two groups of subjects as follows. For each key variable we first calculated for each patient the difference between the baseline value and the value at 18 months. Then we calculated for each of the six groups attending group sessions, the mean of these differences. We then calculated for each treatment group (pravastatin, placebo, nil) the difference between the mean value among subjects receiving intensive health care advice and that among subjects receiving usual health care advice. Finally, we calculated the mean of these three mean differences (between the three treatment groups). We calculated standard errors and 95% confidence intervals in the usual way. To check whether the effects of receiving intensive health care advice were different in the three treatment groups we used a χ^2 test with two degrees of freedom for each outcome variable (see table II).

The number of subjects was determined by a power calculation related not to the questions discussed here but to comparisons between the six treatment groups: to be 90% sure of getting a two tailed 5% significance between two of the six groups, given that the true difference in cholesterol concentration between the groups was 0·33 mmol/l, we required 96 patients in each of the three treatment groups.

TABLE II—*Mean differences (95% confidence intervals) between group receiving intensive advice and group receiving usual advice in changes from baseline to 18 months (negative value shows that greatest decrease occurred after intensive advice)* and χ^2 test (2 df) for interaction between drug treatment and advice*

	Mean differences	χ^2 Test for interaction
Cholesterol (mmol/l):		
Total‡	−0·15 (−0·26 to −0·04)	2·50
Low density lipoprotein	−0·10 (−0·21 to 0·01)	1·94
High density lipoprotein†	−0·01 (−0·03 to 0·01)	3·78
Ratio of low density lipoprotein to high density lipoprotein cholesterol	−0·01 (−0·17 to 0·15)	1·13
Triglycerides* (mmol/l)†	−0·09 (−0·21 to 0·02)	0·44
Fasting blood glucose (mmol/l)	−0·01 (−0·14 to 0·13)	0·08
Weight (kg)	−0·25 (−0·84 to 0·34)	9·98 (P<0·01)
Body mass index (kg/m²)	−0·09 (−0·29 to 0·11)	10·3 (P<0·01)
Waist: hip ratio	−0·00 (−0·01 to 0·00)	2·05
Blood pressure (mm Hg):		
Systolic	−1·2 (−3·1 to 0·7)	3·46
Diastolic	−0·1 (−1·2 to 1·1)	6·98 (P<0·05)
Smoking score‡	−0·23 (−0·44 to 0·02)	1·00
Exercise score§	−0·01 (−0·21 to 0·20)	1·01
Framingham score[19]	−0·068 (−0·120 to −0·015)	5·78

*Based on results from 626 subjects.
†Analysed at Lund University Hospital.
‡Scored according to number of cigarettes smoked daily: 0=non-smoker or former smoker; 2=1-4 cigarettes; 4=5-14 cigarettes; 6=15-24 cigarettes; 8=≥25 cigarettes.
§Scored according to walking or cycling (or equivalent exercise): 0=more than 30 minutes daily; 1=15 minutes daily; 2=15 minutes on alternate days; 3=15 minutes occasionally each week; 4=rarely any; 5=none.

TABLE III—*Changes (SE) in scores for lifestyle, fat intake, and fibre intake between sessions*

	Sessions					
	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	1 to 6
Lifestyle:						
Change in score	−2·51 (0·39)	−0·89 (0·26)	−0·01 (0·29)	−0·12 (0·27)	−0·40 (0·37)	−3·81 (0·61)
No of subjects*	256	257	245	224	200	193
Fat intake:						
Change in score	−9·91 (1·84)	−3·90 (1·22)	−0·41 (1·21)	−0·45 (1·21)	0·06 (1·21)	−14·97 (2·12)
No of subjects*	259	260	253	233	211	202
Fibre intake:						
Change in score	0·37 (0·10)	0·22 (0·09)	0·13 (0·10)	0·16 (0·11)	0·05 (0·11)	0·91 (0·13)
No of subjects*	263	263	255	234	214	206

*Subjects who completed forms at both sessions.

Results

Table II shows the mean differences in the changes in values from baseline to 18 months between the group receiving intensive health care advice and that receiving usual advice. At the end of the study the mean total cholesterol concentration had dropped by 0·15 mmol/l more (95% confidence interval 0·04 to 0·26) in the group receiving intensive health care advice than in the group receiving usual advice. Overall, most variables showed a greater change in a favourable direction in the group receiving intensive advice than in the group receiving usual advice. These changes, however, seldom reached significance (table II). The changes were more pronounced after 18 months than after 12 months (data not given). From baseline to 18 months the overall Framingham score increased by 0·070 in those receiving usual health care advice, but by only 0·001 in those receiving intensive advice. Significant interactions between drug treatment (pravastatin, placebo, or nil) and health care advice (intensive or usual) were found for only weight, body mass index, and diastolic blood pressure (table II).

Attendance at the sessions providing intensive health care advice was good. The complete course of six sessions was run in all health centres. At the final session 87% (295/339) of subjects attended, with attendance at all the other sessions being over 90%. Most subjects (78% (264)) attended all six sessions.

Data collected from these sessions supported the findings from the overall evaluation of risk factors (table III). The response rate to the questionnaires that the subjects completed at each group session was lower than the attendance rate. The course of intensive health care advice had no impact on the subjects' smoking habits or alcohol consumption. There was a gradual decrease ($P<0·001$), however, in the amount of fat consumed and an increase ($P<0·001$) in the fibre content of the subjects' diet as well as an overall improvement ($P<0·001$) in lifestyle as the study progressed (table III). The proportion of subjects reporting no stress increased, and the number of subjects reporting sleeping problems decreased (data not given).

Discussion

The most important finding of our analyses was the limited additional benefit of a structured, intensive health care scheme compared with that of the usual health care advice given by general practitioners to subjects with multiple cardiovascular risk factors (table II). Our data also show that the subjects randomly allocated to the group receiving intensive health care advice attended the health education sessions and responded positively to the advice by changing their lifestyle, fibre intake, and fat consumption (table III). Results recently published from the family heart study[20] and the OXCHECK study[21] show a similarly small overall benefit of intensive health care

advice. Both these studies enrolled patients from the general population, but the intervention was focused more on those with the greatest risks. The authors of both studies concluded that health education should perhaps be targeted even more at people at high risk. We specifically selected subjects with multiple cardiovascular risk factors, but the overall impact even through our intensive group sessions was not appreciably different from that achieved in either of the other two studies.

In the family heart study the overall reduction of cardiovascular risk after one year was 16%. The greatest contribution (7%), however, came from reduction in systolic blood pressure. In our study high blood pressure had to be lowered before the subject could be randomised. Any further effect of the intensive health care advice on blood pressure was negligible.

At the one year follow up in the family heart study 4% fewer people smoked, making an overall contribution of 5% to the reduction of cardiovascular risk; neither the OXCHECK study nor our study showed any useful impact on smoking habits. Similarly, the family heart study reported a mean loss of 1 kg in body weight, but the OXCHECK study and our study showed no significant changes.

Both the family heart study and the OXCHECK study showed a small reduction in total cholesterol concentration (0·1 mmol/l and 0·14 mmol/l respectively). In our study the differences between the two types of health care at both 12 and 18 months' follow up were small (0·03 mmol/l and 0·15 mmol/l respectively). Before randomisation no specific dietary advice was given, to allow the maximum impact of the randomised health care advice on hyperlipidaemia.

RISK SCORES

Our results relating to the Framingham score can be interpreted by considering a hypothetical man: 50 years old; total cholesterol concentration 6·8 mmol/l and diastolic blood pressure 85 mm Hg; non-smoker; no left ventricular hypertrophy or glucose intolerance. The Framingham formula gave his eight year risk of coronary heart disease as 8·74%. If during the next 18 months his modifiable risk factors remained the same then his coronary risk would rise to 9·51%. If, however, he also underwent the changes that the subjects in our study receiving usual health care advice experienced on average then his eight year risk would increase to 9·31%. Alternatively, if his risk factors changed in line with the average in the group receiving intensive health care advice then his risk would increase only marginally, to 8·75%.

CHOLESTEROL CONCENTRATION

We have not given any data on the absolute lipid lowering effect in our six different subgroups because we have focused only on the difference between our two main groups—that is, the subjects receiving intensive health care advice and those receiving usual advice—and each of these two main groups was divided randomly into three treatment groups. Cholesterol concentration was reduced mainly in the subjects who received pravastatin, with equal distribution between the two main groups.

The fact that each of the two main groups was subdivided into three groups receiving different treatments is a complication in the design of the study. As table II shows, the effects of intensive health care advice differed between the three treatment groups—that is, there was significant interaction for weight, body mass index, and diastolic blood pressure, for which intensive care had least effect on the subjects who received pravastatin and most effect on those who received no treatment at all. Perhaps patients who are aware of their improvement in cholesterol concentration pay less attention to intensive advice.

Key messages

- Studies have suggested that health education should be targeted at people at high risk
- This multicentre study examined the effects of "usual" or "intensive" health care advice on 681 subjects aged 30-59 years with a moderately high cholesterol concentration and two or more other cardiovascular risk factors
- The intensive advice programme was based mainly on group sessions led by doctors and nurses from health centres
- The study found that after 18 months of intervention limited additional benefit was derived from the intensive health care advice
- Messages and the means of delivering them to individuals in need should be customised for each person

Our study was based entirely on primary health care and no extra staff were provided. Instead the practitioners and nurses in the health centres provided the intensive advice. Nevertheless, these staff were specially trained for this task. Studies that have shown a much greater effect on risk factors have generally been conducted in specialist centres.[10-13]

CONCLUSION

Perhaps the messages and the means of delivering them to individuals in need should be customised for each person. Lifestyle is greatly determined by social position and education. Health promotional activities should be designed to fit people's different perceptions of health and habits.[22 23]

Lessons should be learnt about the best ways of influencing people at risk of cardiovascular disease to make important changes to their lifestyle for their own good. Encouragement should be given because changes in cardiovascular risk, albeit small, can be achieved. The small differences between the studies may be due to chance or may be useful indicators for future interventions. The challenge for future studies is how to capitalise on what has been done and to devise more revolutionary methods for health education.

The study was supported by a grant from Bristol-Myers Squibb and the Swedish Medical Society. Data handling and monitoring by Ms Christina Slaug and the technical help of Ms Gerd Nilsson, who performed all the chemical analyses, are gratefully acknowledged. We thank the investigators at the following centres participating in the CELL study for their help: N Nörgaard (Höganäs), M Eliasson (Anderslöv), P Montnemery, C Nilzén (Bara), H Thimansson (Höör), P Burner (Burlöv), O Hansen (Markaryd), M Lundberg (Lund), I Magnusson (Råå), L-O Tobiasson (Sjöbo), S Ewers, C Svensson (Ljungby), A Niklasson, J Moses (Staffanstorp), M Ericsson-Alstad (Tollarp), J Nalepa (Landskrona), J Lindblom, C Rüden (Västerås), E Tivell (Laxå), T Nilsson (Delsbo), T Hasth (Tierp), M Mägi (Örebro), B Svensson (Eskilstuna), O Lindh (Karlskoga), G Sundgren (Munkfors), A Norring (Ljusdal), A Lindell-Lundberg (Ludvika), C Ehrfors-Storm (Sandviken), P Hellman (Hofors), A Lindqvist (Järfälla), L Lidberg (Norrköping), J-Å Åkesson, U-M Ödman (Linköping), I Rahm, S Johansson-Fredin (Skärblacka), and B Hallbrink (Österbymo).

The members of the CELL Study Group are: Scientific Committee: University of Lund, Sweden: Bengt Scherstén (chairman), Fredrik Buch, Tord Ekbom (coordinator), Åke Isacsson, Lars H Lindholm, Nils Tryding (Health Sciences Centre Dalby/Lund); Lars Borgquist (Institute of Economic Research); Jan Lanke (department of statistics); Peter

Nilsson-Ehle (department of clinical chemistry). Central Middlesex Hospital Trust, London: Clive Dash. Centre for Health Economics, Stockholm School of Economics: Bengt Jönsson, Magnus Johannesson (associate member). Department of Family Medicine, University of Uppsala, Sweden: Gösta Tibblin. Department of Primary Health Care and General Practice, University of Linköping: Erik Trell. Steering Committee: Lars H Lindholm (chairman), Clive Dash, Tord Ekbom (coordinator).

1 Kannel WB, Dawber TR, Kagan A, Revotskie N, Stokes J. Factors of risk in the development of coronary heart disease-six-year follow up experience. The Framingham study. *Ann Intern Med* 1961;55:33-50.
2 Keys A. *Seven countries: a multivariate analysis of death and coronary heart disease.* Cambridge, MA: Harvard University Press, 1980.
3 Rose G, Tunstall-Pedoe H, Heller RF. UK heart disease prevention project: incidence and mortality results. *Lancet* 1983;i:1062-5.
4 Ramsay LE, Yeo WW, Jackson PR. Dietary reduction of serum cholesterol concentration: time to think again. *BMJ* 1991;303:953-7.
5 Danielsson H, Ekman R, Fex G, Johansson BG, Kristensson H, Nilsson-Ehle P, *et al.* Changes in plasma high density lipoproteins in chronic male alcoholics during and after abuse. *Scand J Clin Lab Invest* 1978;38:113-9.
6 Roeschlau P, Bernt E, Gruber W. Enzymatische bestimmungen des Gesamtcholesterins in Serum. *Zeitschrift Klinischer Chemie und Klinischer Biochemie* 1974;12:226-30.
7 Wahlefeld AW. Triglyceride determination after enzymatic hydrolysis. In: Bergmayer HV, ed. *Methods of enzymatic analysis.* New York: Verlag Chemie, Weinheim, and Academic Press, 1974:1874.
8 Friedewald WT, Levy RI, Frederickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without the use of a preparative ultracentrifuge. *Clin Chem* 1972;18:499-502.
9 Johannesson M, Borgquist L, Nilsson-Ehle P, Jonsson B, Ekbom T, Lindholm L. The cost of screening for hypercholesterolaemia–results from a clinical trial in Swedish primary health care. *Scand J Clin Lab Invest* 1993;53:725-32.
10 Turpeinen O, Karvonen MJ, Pekkarinen M, Miettinen M, Elosuo R, Paavilainen E. Dietary prevention of coronary heart disease: the Finnish mental hospital study. *Int J Epidemiol* 1979;8:99-118.
11 Research Committee to the Medical Research Council. Controlled trial of soya-bean oil in myocardial infarction. *Lancet* 1968;ii:693-700.
12 Leren P. The effects of plasma cholesterol lowering diet in male survivors of myocardial infarction. A controlled clinical trial. *Acta Medica Scandinavica* 1966;446(suppl):1-92.
13 Franz ID, Dawson EA, Ashman PL, Gatewood LC, Bartsch GE, Kuba K, *et al.* Test of effect of lipid lowering by diet on cardiovascular risk. The Minnesota coronary survey. *Arteriosclerosis* 1989;9:129-35.
14 Hjermann I, Velve Byre K, Holme I, Leren P. Effect of diet and smoking intervention on the incidence of coronary heart disease. Report from the Oslo study group of a randomised trial in healthy men. *Lancet* 1981;ii: 1303-10.
15 Dayton S, Pearce ML, Goldman H, Harrish A, Plotkin D, Schickman M, *et al.* Controlled trial of a diet high in unsaturated fat for the prevention of atherosclerotic complications. *Lancet* 1968;ii:1060-2.
16 Tibblin G, Tibblin B, Peciva S, Kullman S, Svardsudd K. The Göteborg quality of life instrument—an assessment of well-being and symptoms among men born 1913 and 1923. *Scand J Prim Health Care* 1990;1(suppl): 33-8.
17 Lingfors H, Lindström K, Persson L-G, Bengtsson C, Lissner L, Ellegrd L, *et al.* Evaluation of a pedagogic dietary questionnaire aimed for health surveys. *Scandinavian Journal of Nutrition* 1994;38:106-11.
18 National Board of Health and Welfare (Drug Information Committee, Sweden). *Treatment of mild hypertension.* Uppsala: NBHW, 1987.
19 Kannel WB, Wolf PA, Garrison RJ, eds. *The Framingham study; an epidemiological investigation of cardiovascular disease, section 37. The probability of developing certain cardiovascular diseases in eight years at specified values of some characteristics.* Springfield: USS Department of Commerce, National Technical Information Service, 1987.
20 Family Heart Study Group. Randomised controlled trial evaluating cardiovascular screening and intervention in general practice; principal results of British family heart study. *BMJ* 1994;308:313-20.
21 Imperial Cancer Research Fund OXCHECK Study Group. Effectiveness of health checks conducted by nurses in primary care: results of the OXCHECK study after one year. *BMJ* 1994;308:308-12.
22 Downie RS, Fyfe C, Taunahill A. *Health promotion, models and values.* Guildford: Oxford University Press, 1993.
23 Festinger L. *Conflict, decision and dissonance.* Stanford: Stanford University Press, 1964.

(Accepted 9 March 1995)

Strategies for reducing coronary risk factors in primary care: which is most cost effective?

K Field, M Thorogood, C Silagy, C Normand, C O'Neill, J Muir

See pp 1099, 1105 and editorial by Toon

Abstract

***Objective*—To examine the relative cost effectiveness of a range of screening and intervention strategies for preventing coronary heart disease in primary care.**

***Subjects*—7840 patients aged 35-64 years who were participants in a trial of modifying coronary heart disease risk factors in primary care.**

***Design*—Effectiveness of interventions assumed and the potential years of life gained estimated from a risk equation calculated from Framingham study data.**

***Main outcome measure*—The cost per year of life gained.**

***Results*—The most cost effective strategy was minimal screening of blood pressure and personal history of vascular disease, which cost £310-£930 per year of life gained for men and £1100-£3460 for women excluding treatment of raised blood pressure. The extra cost per life year gained by adding smoking history to the screening was £400-£6300 in men. All strategies were more cost effective in men than in women and more cost effective in older age groups. Lipid lowering drugs accounted for at least 70% of the estimated costs of all strategies. Cost effectiveness was greatest when drug treatment was limited to those with cholesterol concentrations above 9·5 mmol/l.**

***Conclusions*—Universal screening and intervention strategies are an inefficient approach to reducing the coronary heart disease burden. A basic strategy for screening and intervention, targeted at older men with raised blood pressure and limiting the use of cholesterol lowering drugs to those with very high cholesterol concentrations would be most cost effective.**

Gwent College of Higher Education, Newport Business School, PO Box 180, Newport NP9 5XR
K Field, *senior lecturer*

Public Health and Policy Department, London School of Hygiene and Tropical Medicine, London WC1E 7HT
M Thorogood, *senior lecturer*
C Normand, *professor of health policy*

Department of General Practice, School of Medicine, Flinders University of South Australia, Adelaide 5001, Australia
Chris Silagy, *professor*

Imperial Cancer Research Fund General Practice Research Group, University of Oxford, Radcliffe Infirmary, Oxford OX2 6HE
C O'Neill, *nurse facilitator*
J Muir, *senior research fellow*

Correspondence to:
Dr Thorogood.

BMJ 1995;310:1109-12

Introduction

Coronary heart disease currently costs the NHS about £500 million annually (with an extra £10 million for prevention). In 1988 in England and Wales coronary heart disease accounted for 153 084 deaths,[1] and the government recently introduced a policy to reduce the incidence of coronary heart disease by 40% in people under 65 by the year 2000.[2] The 1993 general practice contract provided financial incentives for general practitioners to screen for and treat prevalent coronary disease risk factors,[3] but the effectiveness of of such programmes has been called into question.[4]

It is debatable whether coronary disease risk screening should be universal or targeted at high risk groups, who would gain more from the interventions. Silagy *et al* used data on the prevalence of coronary disease risk factors in participants in the OXCHECK trial to estimate how many people would need to be treated and how many potential coronary events would be averted with different screening strategies.[5] They showed that the ratio of events averted to workload fell as the screening strategies became more comprehensive but did not address costs. Recent results of trials of health promotion clinics in primary care have shown only modest reductions in risk.[6,7] To determine whether screening programmes are worth while we analysed the relative cost effectiveness of different coronary heart disease strategies in primary care.

Subjects and methods

In 1989, 11 090 men and women aged 35-64 years registered with general practices in Bedfordshire were randomly allocated to receive a health check during one of four years as part of the OXCHECK trial.[6] We used data on the prevalance of coronary risk factors