Nurse-coordinated multidisciplinary, family-based cardiovascular disease prevention programme (EUROACTION) for patients with coronary heart disease and asymptomatic individuals at high risk of cardiovascular disease: a paired, cluster-randomised controlled trial

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Summary

Background Our aim was to investigate whether a nurse-coordinated multidisciplinary, family-based preventive cardiology programme could improve standards of preventive care in routine clinical practice.

Methods In a matched, cluster-randomised, controlled trial in eight European countries, six pairs of hospitals and six pairs of general practices were assigned to an intervention programme (INT) or usual care (UC) for patients with coronary heart disease or those at high risk of developing cardiovascular disease. The primary endpoints—measured at 1 year—were family-based lifestyle change; management of blood pressure, lipids, and blood glucose to target concentrations; and prescription of cardioprotective drugs. Analysis was by intention to treat. The trial is registered as ISRCTN 71715857.

Findings 1589 and 1499 patients with coronary heart disease in hospitals and 1189 and 1128 at high risk were assigned to INT and UC, respectively. In patients with coronary heart disease who smoked in the month before the event, 136 (58%) in the INT and 154 (47%) in the UC groups did not smoke 1 year afterwards (difference in change 10·4%, 95% CI –0·3 to 21·2, p=0·06). Reduced consumption of saturated fat (196 [55%] *vs* 168 [40%]; 17·3%, 6·4 to 28·2, p=0·009), and increased consumption of fruit and vegetables (680 [72%] *vs* 349 [35%]; 37·3%, 18·1 to 56·5, p=0·004), and oily fish (156 [17%] *vs* 81 [8%]; 8·9%, 0·3 to 17·5, p=0·04) at 1 year were greatest in the INT group. High-risk individuals and partners showed changes only for fruit and vegetables (p=0·005). Blood-pressure target of less than 140/90 mm Hg was attained by both coronary (615 [65%] *vs* 547 [55%]; 10·4%, 0·6 to 20·2, p=0·04) and high-risk (586 [58%] *vs* 407 [41%]; 16·9%, 2·0 to 31·8, p=0·03) patients in the INT groups. Achievement of total cholesterol of less than 5 mmol/L did not differ between groups, but in high-risk patients the difference in change from baseline to 1 year was 12·7% (2·4 to 23·0, p=0·02) in favour of INT. In the hospital group, prescriptions for statins were higher in the INT group (810 [86%] *vs* 794 [80%]; 6·0%, –0·5 to 11·5, p=0·04). In general practices in the intervention groups, angiotensin-converting enzyme inhibitors (297 [29%] INT *vs* 196 [20%] UC; 8·5%, 1·8 to 15·2, p=0·02) and statins (381 [37%] INT *vs* 232 [22%] UC; 14·6%, 2·5 to 26·7, p=0·03) were more frequently prescribed.

Interpretation To achieve the potential for cardiovascular prevention, we need local preventive cardiology programmes adapted to individual countries, which are accessible by all hospitals and general practices caring for coronary and high-risk patients.

Funding European Society of Cardiology through an unconditional educational grant from AstraZeneca.

Lancet 2008; 371: 1999–2012

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Introduction

The scientific evidence for cardiovascular disease prevention is compelling;[1] it shows that lifestyle intervention, risk factor management, and cardioprotective drugs can reduce cardiovascular morbidity and mortality in patients with established atherosclerotic disease and those at high risk (Systemic COronary Risk Evaluation [SCORE]) of developing the disease.[1,2] However, results of risk factor management in patients with coronary heart disease in the European Action on Secondary and Primary prevention through Intervention to Reduce Events (EUROASPIRE)[3–5] study showed that cardiovascular disease prevention in routine clinical practice is inadequate. Most patients are not referred to a cardiac rehabilitation programme and less than a third attend.[6] The EUROASPIRE[4,5] survey in 2000 described the management of coronary patients as a "collective failure of medical practice". The EUROACTION model was developed by the European Society of Cardiology to help patients with coronary heart disease, high multifactorial risk, and diabetes outside specialist cardiac rehabilitation centres to achieve the lifestyle, risk factor, and therapeutic targets defined in the prevention guidelines in routine clinical practice.[7] The aim of this

Panel: Primary endpoints

Goals

Smoking

- Not smoking

Diet

- Saturated fat <10% of total dietary energy per day
- Fruit and vegetables >400 g per day
- Fish >20 g per day
- Oily fish >3 times a week
- Alcohol <30 g per day

Anthropometry

- Body-mass index <25 kg/m^2
- Waist circumference: for women ≤80 cm; for men ≤94 cm

Physical activity

- 30–45 min of moderate intensity physical activity 4–5 times a week

Blood pressure

- <140/90 mm Hg (<130/85 mm Hg in people with diabetes)

Blood cholesterol

- Total cholesterol concentrations <5·0 mmol/L
- LDL cholesterol concentrations <3·0 mmol/L

Blood glucose and diabetes

- Blood glucose concentrations <6·1 mmol/L
- Good glycaemic control in patients with diabetes (haemoglobin A_{1c} <7%)

Cardioprotective drug management

Cardioprotective medications are prescribed as clinically indicated, at doses used in clinical trials for all coronary heart disease and high-risk patients.

- Antiplatelet drugs
- β blockers
- Angiotensin-converting enzyme inhibitors or angiotensin-II receptor blockers
- Lipid-lowering drugs (statins)

study was to assess whether a nurse-coordinated, multidisciplinary, family-based, ambulatory, preventive cardiology programme (EUROACTION) in hospital and general practice could increase the proportions of patients and their families achieving the goals for cardiovascular disease prevention compared with usual care (panel).[8]

Methods

Study population

A matched, paired cluster-randomised controlled trial (figure 1) was done in 12 (six pairs) general hospitals in France, Italy, Poland, Spain, Sweden, and the UK, and 12 (six pairs) general-practice centres in Denmark, Italy, Poland, Spain, the Netherlands, and the UK. Hospitals and primary-care centres were randomly assigned to intervention or usual care. The trial started in April, 2003, and was completed in September, 2006.

Consecutive patients (men and women) were prospectively identified. Hospital patients were less than 80 years of age and had coronary heart disease—ie, acute coronary syndromes or exertional angina. Patients in general practice were at least 50 years of age and less than 80 years of age with no history of cardiovascular disease but at high risk of cardiovascular disease (SCORE ≥5% during 10 years, either now or when projected to age 60 years) and not on any treatment; or were on treatment with antihypertensive or lipid-lowering drugs, or both, started in the past year, and no history of diabetes mellitus; or were diagnosed with diabetes mellitus within the past 3 years. Exclusion criteria for all patients in the hospitals and general-practice centres were severe heart failure, severe physical disability, or dementia.

Written informed consent was obtained from all patients and their partners, and ethics approval was obtained from the local ethics committee for each centre.

Study design

In the hospital intervention group, all eligible patients with coronary heart disease and their partners were invited for a nurse assessment of lifestyle, risk factors, and drug treatment. In the hospital usual-care group, a randomly selected subsample (18%) of eligible patients with coronary heart disease, but not their partners, had baseline assessments (figure 1). All eligible patients and their partners in the hospital intervention group were invited for reassessment at 16 weeks, together with the same subsample of patients in the usual-care group. All identified patients with coronary heart disease and their partners in the hospital intervention and usual-care groups were invited for reassessment at 1 year (figure 1).

In the general-practice intervention group, all eligible high-risk individuals and their partners were invited for a nurse assessment of lifestyle, risk factors, and drug treatment. In the usual-care group, a randomly selected subsample (332 [29%]) of high-risk individuals, but not their partners, had baseline assessments (figure 1). All identified high-risk individuals and their partners in the intervention and usual-care groups were invited for reassessment at 1 year (figure 1).

The EUROACTION preventive cardiology intervention programme in hospital and general practice

In the hospitals, cardiologists and nurses recruited eligible patients and their families. After a multidisciplinary assessment of lifestyle, risk factors, and drug treatment by a nurse, dietitian, and physiotherapist, couples attended at least eight sessions—one every week—in which they were assessed by each member of the team (nurse, dietitian, and physiotherapist). The patients and their partners then attended a group workshop and a supervised exercise class. The cardiologists initiated and uptitrated the cardioprotective drugs and the nurses monitored risk factors and adherence to drug treatments at each session. At 16 weeks, patients and their partners were reassessed by the whole team and a report was sent to their family doctors.

In the general-practice centres, family doctors and nurses recruited patients and their families. The programme started with the same nurse assessment of lifestyle, risk factors, and drug treatment as for the hospital patients but was open ended. At each visit—one every week—couples were assessed by the nurse—who led the group workshops—and by the family doctors responsible for drug treatment. The patients and their partners did not have supervised exercise classes.

Patients in the hospital and general-practice centres were assessed for family lifestyle, risk factors, medications, health beliefs, anxiety and depression, illness perception, and mood.[9–15] Patients were provided with a personal record card for lifestyle and risk factor targets and their families with family support packs.

The panel shows the primary outcome measures. In the hospitals, patients were encouraged to achieve a healthy lifestyle with support from their families, other people attending the programme, and the health professionals—ie, hospital nurses, dietitians, and physiotherapists—who used stages of change[16] and motivational interviews.[17] In the general-practice centres, the nurses assessed and managed lifestyle by the same behavioural approaches as those used in the hospitals.

To help all smokers in the family to quit tobacco completely, the nurses assessed the present smoking status, health beliefs, and history of tobacco smoking, and previous attempts to quit. Nicotine dependence was assessed with the Fagerstrom test.[18–21] The nurse helped smokers to prepare for an attempt to quit, set a date, and made contingency plans for a relapse. For those who had already stopped smoking, the aim was to prevent a relapse. Cessation of smoking was self reported and validated by a breath carbon monoxide concentration of less than 6 parts per million.

To achieve a healthy family diet associated with the lowest risk of cardiovascular disease, patients and their families' knowledge and attitudes to diet were assessed by the dietitian (in hospital) or nurse (in general practice). The food-habit questionnaire (validated against a 7-day diet diary)[22] was administered by structured interview to assess food intake. Weight, height, and waist circumference were measured and body-mass index (BMI) was calculated (weight [kg] per height [m²]).[23] In a randomly selected subsample of families in the hospital programme, the dietitians undertook a macronutrient dietary analysis based on two 24 h dietary recalls with a standardised method of explicit food description,[24] so that food from different cultural settings could be described in the same way.

The dietitians (in hospital) or nurses (in general practice) gave advice in terms of food (not nutrients) and patterns of eating for the family and set realistic goals for patients and their families. For individuals with a BMI of 25 kg/m² or more, the initial goal was a weight loss of at least 5% during 1 year. The dietitians saw family members individually at each attendance, organised the healthy eating and weight management workshop, and advised on local community facilities.

To achieve a 30–45 min of moderate intensity activity, four to five times a week as a family, the physiotherapist (in hospital) or nurse (in general practice) assessed habitual and physical activity patterns, functional capacity, and other factors that affected activity participation by families. The 7-day activity recall diary provided an estimate of participation in physical activity.[25] A physical activity plan for the family was developed with realistic goals. In the hospital, the physiotherapist interviewed families individually at each attendance to review goals, and led a group-based progressive endurance exercise training programme once a week. Individuals exercised at 60–75% of a predetermined asymptomatic maximum heart rate. The programme was not equipment-based, so it could be followed in the community and families were provided with a home-based exercise and physical activity plan. In general practice, a physical activity plan was developed in the same way but without a supervised exercise class. Additionally, a step counter (Yamax Digi-Walker SW200 pedometer, Yamasa Tokei Keiki, Tokyo, Japan[26]) was used to motivate patients and their partners in both hospital and general practice. The total physical activity prescription was used to equip families with the necessary knowledge and skills to achieve and maintain the physical activity target safely in the community and during the long term.

For the **personal record card and family support pack** see http://www.escardio.org/euroaction

Nurses monitored the blood pressure and concentrations of cholesterol and glucose in all patients, and reviewed the results with physicians who treated the patients appropriately to achieve targets that were less than the 1998 European targets (panel). Patients with newly diagnosed diabetes mellitus were referred to diabetes specialists. The nurses educated families about their drugs to improve compliance.

In the hospitals, nurses coordinated a rolling programme of eight workshops—one a week—for coronary heart disease; cardiovascular risks—ie, lifestyle and risk factor control; cardioprotective medications; and return to work and leisure. In the general-practice centres, the workshop programme focused on lifestyle and risk factors.

On completion of the 16-week hospital programme, patients and their partners were reassessed for lifestyle, risk factors, and therapeutic management; results were sent to each individual's own family doctor. All identified patients—with coronary heart disease or at high risk—and their partners were invited back for reassessment at 1 year.

Laboratory analyses

Central laboratory analysis of total cholesterol, HDL cholesterol, triglycerides, glucose, and haemoglobin A_{1c} concentrations was undertaken at baseline, 16 weeks (hospital only), and 1 year. Serum concentrations of cholesterol, HDL cholesterol, and triglycerides were measured by enzymatic colourimetric tests with Roche

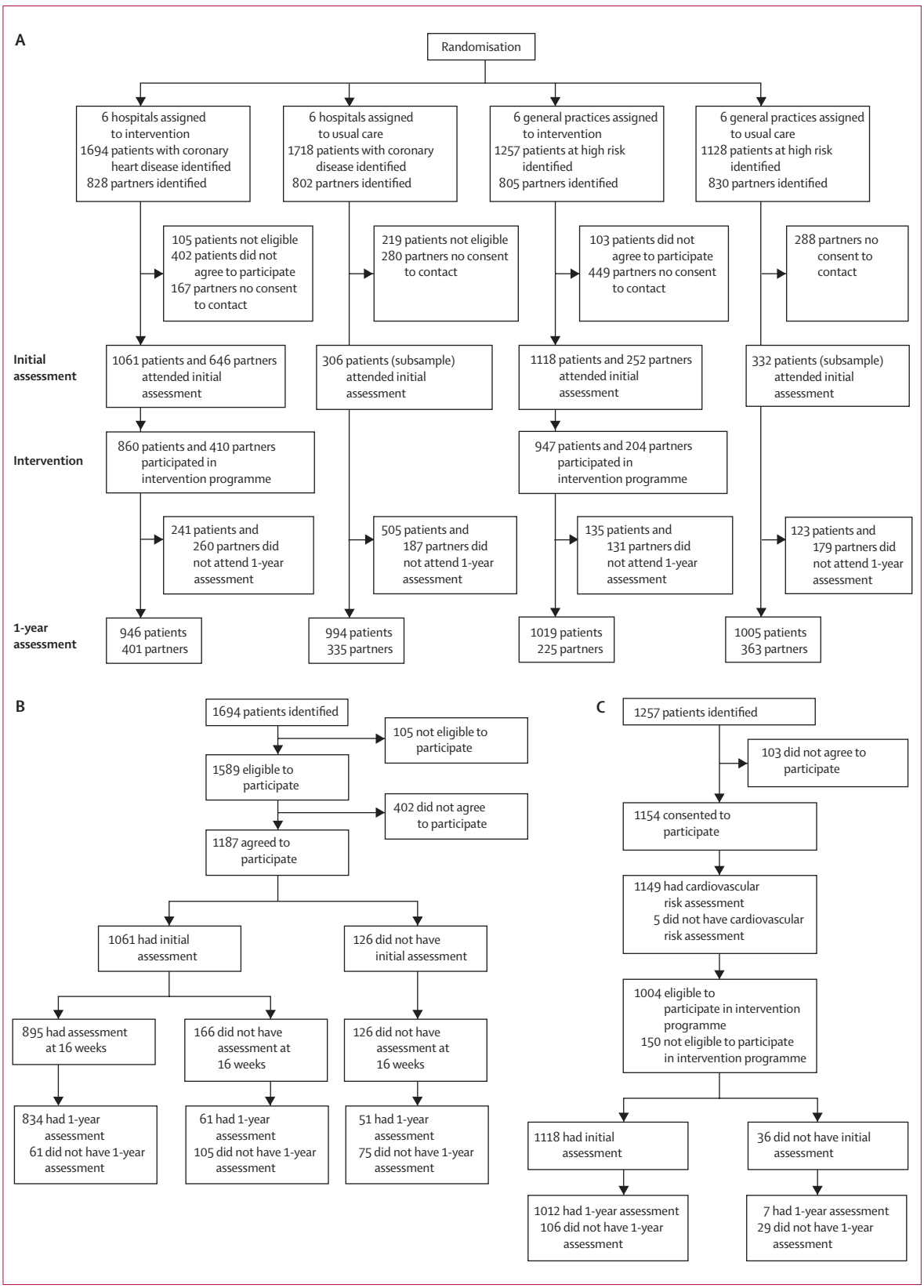

Figure 1: **Trial profile (A) and profiles of patients assigned to the hospital (B) and general-practice (C) intervention programmes**

liquid reagent assays (Roche Diagnostics, Basel, Switzerland) on a Roche 917 analyser (Roche Diagnostics). Plasma glucose concentrations were measured from fluoride oxalate samples with the hexokinase method on a Bayer Advia 1650 analyser (Bayer Diagnostics, Tarrytown, NY, USA). Haemoglobin A_{1c} was measured with the Multigent test on an Abbott Architect 8200 analyser (Abbott Diagnostics, Chicago, MI, USA). Between-batch coefficient of variation was less than 3·0% for cholesterol, 1·8% for glucose, and 1·5% for haemoglobin A_{1c}.

Statistical methods

The main statistical analysis based on intention to treat for prespecified primary endpoints (panel) was at a European level.[7] Six intervention hospitals were compared with six usual-care hospitals, and six intervention general practices were compared with six usual-care practices at 1 year with random-effects modelling. Additionally, post-hoc analyses of changes during the time between the initial and 1-year assessments are also reported, together with risk factor distributions. The results are reported according to CONSORT.[27]

For sample size calculations, the EUROASPIRE II study[4] was used to estimate the coefficients of variation for sample means and proportions. A sample size of 400 patients in both intervention and usual-care centres in each country was sufficient for detection of a 10% reduction in smoking, a 5% average reduction in bodyweight or systolic blood pressure, and a 10% reduction in mean total cholesterol concentration at the p=0·05 significance level with 80% power. The cluster coefficient for smoking was 0·200, bodyweight 0·011, systolic blood pressure 0·030, and total cholesterol concentration 0·062.[28]

Means and SDs were used to describe the continuous variables; frequencies and percentages were used to describe categorical variables. To account for clustering, the primary endpoints were analysed with random-effects modelling (with restricted maximum likelihood estimation) using SAS PROC MIXED (version 9.1.3) for continuous outcomes and SAS GLIMMIX (version 9.1.3) for binary outcomes. For the ordered categorical outcomes, proportional odds models were fitted within each country and the results combined with a random-effects meta-analysis. The results were not adjusted for multiple statistical testing. In a random subsample of usual-care patients, baseline measurements were taken so that a post-hoc comparison of change from baseline to 1-year between intervention and usual-care groups was possible. All identified patients and partners attending the 1 year reassessment were included in the statistical analyses (figure 1).

This trial is registered as ISRCTN 71715857.

Role of the funding source

The sponsor had no role in the design, data collection, data analysis, data interpretation, and writing of this report. The authors and the steering committee had full access to all data and had final responsibility for the decision to submit for publication.

Results

Table 1 shows patients and their partners' demographics, participation, and 1-year assessments in hospital and general-practice centres. Table 2 shows the results of the initial assessments and the proportions of patients and their partners achieving lifestyle, risk factor, and drug targets for cardiovascular disease prevention. Figure 1 shows the trial profile.

Among patients with coronary heart disease who reported smoking in the month before their cardiac event, a higher proportion in the intervention group were not smokers (validated breath carbon monoxide concentration <6 parts per million) at 1 year compared with the usual-care group (table 3; figure 2). The proportion of non-smoking high-risk patients in the intervention and usual-care groups did not differ (table 3). Non-smoking at 1 year was greater, although not significantly so, in the partners of patients in the intervention groups than in usual-care groups (table 3).

A higher proportion of patients with the coronary heart disease in the intervention group attained the dietary targets for saturated fat intake (subsample), fruit and vegetables, and oily fish at 1 year than the proportion of patients in the usual-care group (table 3). Similar differences were noted for high-risk patients in the intervention and usual-care groups, although the differences were only significant for fruit and vegetables (table 3).

The proportions of patients with coronary heart disease (ie, in hospital) attaining these dietary targets increased between the initial and 1-year assessments in both the intervention and usual-care groups, but the increase was greater in the intervention group than in the usual-care group for fruit and vegetables (difference in change 15·8%, 95% CI 2·2 to 29·3, p=0·03) and oily fish consumption (11·4%, 0·6 to 22·1, p=0·04). The increase was in favour of the intervention for saturated fat intake (11·2%, –16·1 to 38·4, p=0·34) and fish consumption (11·8%, –2·1 to 25·6, p=0·08). A similar pattern was noted for high-risk patients (ie, in general practice) with a change from baseline that was greater in the intervention group than in the usual-care group for fruit and vegetables (23·6%, 9·1 to 38·2, p=0·009). The increase was in favour of the intervention for fish consumption (16·5%, –0·1 to 33·1%, p=0·051) and oily fish consumption (2·2%, –1·7 to 6·2%, p=0·20). For partners of both groups of patients, the proportions achieving dietary targets were generally greater in the intervention groups than in the usual-care groups for all targets, although only significant for fruit and vegetables (table 3).

The proportions of patients with coronary heart disease and those at high risk achieving the target for self-reported physical activity at 1 year were significantly higher in the

	Hospital				General practice			
	Coronary patients		Partners		High-risk patients		Partners	
	INT	UC	INT	UC	INT	UC	INT	UC
Identified	1694	1718	828	802	1257	1128	805	830
Eligible	1589 (94%)	1499 (87%)	661 (80%)*	522 (65%)*	1189 (95%)	n/a	356 (44%)*	542 (65%)*
Initial assessment	1061 (67%)	306 (20%)†	646 (98%)	n/a	1118 (94%)	332 (29%)†	252 (71%)	n/a
Participation in EUROACTION	860 (81%)‡	n/a	410 (63%)‡	n/a	947 (85%)§	n/a	204 (81%)§	n/a
1–year assessment	946 (60%)	994 (66%)	401 (61%)	335 (64%)	1019 (86%)	1005 (89%)	225 (63%)	363 (67%)
Age group								
<55 years	210 (22%)	221 (22%)	92 (23%)	84 (25%)	226 (22%)	149 (15%)	42 (19%)	64 (18%)
55–64 years	334 (35%)	340 (34%)	154 (38%)	138 (41%)	447 (44%)	486 (48%)	112 (50%)	177 (49%)
≥65 years	402 (42%)	433 (44%)	152 (38%)	112 (33%)	346 (34%)	370 (37%)	71 (32%)	122 (34%)
Age (years)	62·5 (9·9)	63·0 (9·6)	61·6 (10·3)	60·7 (9·8)	62·0 (7·6)	62·8 (7·3)	61·8 (7·0)	62·0 (7·2)
Men	666 (70%)	695 (70%)	84 (21%)	71 (21%)	507 (50%)	577 (57%)	77 (34%)	120 (33%)
Diagnostic category								
AMI¶/HeartScore ≥5%||	451 (47%)	533 (54%)	n/a	n/a	431 (42%)	511 (51)	n/a	n/a
Unstable angina¶/BP-lipids||	156 (16%)	210 (21%)	n/a	n/a	272 (27%)	230 (23%)	n/a	n/a
Stable angina¶/diabetes||	339 (36%)	251 (25%)	n/a	n/a	316 (31%)	264 (26%)	n/a	n/a

Data are number, number (%), or mean (SD). INT=intervention. UC=usual care. n/a=not applicable. AMI=acute myocardial infarction. BP-lipids=patients on antihypertensive or lipid-lowering treatments. *Consent given by patients for their partners to be contacted. †Random subsample only. ‡Reported at 16 weeks as a proportion of patients at the initial assessment. §Reported at 1 year as a proportion of initial assessment. ¶Hospital group. ||General-practice group.

Table 1: **Patient and partner demographics**

intervention groups than in the usual-care groups (table 3). The proportion of patients with coronary heart disease achieving this target in the intervention group increased by 26·8% between the initial and 1-year assessments, compared with 0·8% in the usual-care subsample; the difference in change was 28·0% (95% CI 4·1 to 51·8, p=0·03). The proportion of high-risk patients achieving this target increased by 23·5% in the intervention group compared with a reduction of 10·2% in the usual-care subsample; the difference in change was 32·9% (11·8 to 53·9, p=0·01). Similar differences between the intervention and usual-care groups were noted among the partners of both groups of patients, although the proportions achieving their targets tended to be lower among partners than in patients (table 3).

Proportions of patients with coronary heart disease and those at high risk attaining the ideal BMI at 1 year, and the distribution of BMI, showed no significant differences between the intervention and usual-care groups (table 3; table 4).

However, for those coronary and high-risk patients with a BMI of 25 kg/m² or more at initial assessment, the proportions attaining ideal BMI (ie, <25 kg/m²) at 1 year were higher in the intervention group than in the usual-care subsample but not significantly so. In patients with coronary heart disease, the mean BMI change from baseline was –0·27 kg/m² in the intervention group compared with 0·44 kg/m² in the usual-care subsample; the difference in change was –0·69 kg/m² (95% CI –1·03 to –0·34, p=0·004). Mean BMI change for high-risk patients was –0·47 kg/m² in the intervention group compared with 0·13 kg/m² in the usual-care subsample, resulting in a difference in change of –0·56 kg/m² (–0·86 to –0·25, p=0·005). In those with a BMI of 25 kg/m² or more at initial assessment, proportions of individuals achieving weight loss of at least 5% at 1 year were higher for both groups of patients—ie, coronary heart disease and high risk—in the intervention groups than for patients in the usual-care groups, but significant only for the high-risk patients (table 3). Changes during the initial to 1-year assessments were reductions in mean weight in the intervention groups and increases in the mean weight in the usual-care subsample. The difference in weight change was –1·56 kg (–3·0 to –0·1, p=0·04) for patients with coronary heart disease and –1·51 kg (–2·53 to –0·50, p=0·01) for high-risk patients. The proportion of partners attaining ideal BMI target at 1 year did not differ between the intervention and usual-care groups (table 3). Partners were not screened in the usual-care group at baseline.

Proportions of patients with coronary heart disease and those at high risk of cardiovascular disease achieving ideal waist circumference at 1 year was slightly higher, though not significant, in the intervention groups than in the usual-care groups (table 3). However, comparison of the distributions of waist circumference between intervention and usual-care groups for both groups of patients favoured intervention (table 4).

For patients with coronary heart disease and a waist circumference greater than the target at initial assessment, the proportion of individuals attaining the

	Hospital			General practice		
	Coronary patients		Partners*	High-risk patients		Partners*
	INT	UC	INT	INT	UC	INT
Initial assessment	1061	306	646	1118	332	252
Not smoking (breath carbon monoxide <6 parts per million)	933/1058 (88%)	256/302 (85%)	521/643 (81%)	761/1110 (69%)	225/328 (69%)	200/244 (82%)
Saturated fat (<10% of total energy)†	64/148 (43%)	38/107 (36%)	37/83 (45%)	..	..	..
Oily fish (≥3 times per week)	33/1060 (3%)	15/304 (5%)	15/640 (2%)	55/1094 (5%)	10/331 (3%)	27/245 (11%)
Fish (≥20 g per day)	589/1060 (56%)	178/304 (59%)	373/640 (58%)	680/1096 (62%)	217/331 (66%)	159/245 (65%)
Fruit and vegetables (≥400 g per day)	480/1060 (45%)	85/304 (28%)	325/640 (51%)	548/1093 (50%)	117/331 (35%)	131/245 (53%)
Physical activity (≥30 min, ≥4 times per week)	273/1056 (26%)	74/304 (24%)	169/635 (27%)	313/1080 (29%)	107/331 (32%)	74/245 (30%)
Body-mass index (<25 kg/m^2)	229/1057 (22%)	71/303 (23%)	225/634 (35%)	209/1094 (19%)	61/331 (18%)	63/243 (26%)
Ideal waist circumference (men <94 cm; women <80 cm)	272/1056 (26%)	84/299 (28%)	192/632 (30%)	212/1087 (20%)	56/331 (17%)	50/241 (21%)
Blood pressure (<140/90 mm Hg or <130/85 mm Hg in individuals with diabetes)	680/1061 (64%)	200/304 (66%)	370/645 (57%)	406/1103 (37%)	125/331 (38%)	140/244 (57%)
Total cholesterol (<5 mmol/L)	700/951 (74%)	190/274 (69%)	61/167 (37%)	250/1089 (23%)	96/306 (31%)	25/81 (31%)
LDL cholesterol (<3 mmol/L)	695/930 (75%)	186/267 (70%)	69/165 (42%)	296/1053 (28%)	108/295 (37%)	28/78 (36%)
Haemoglobin A_{1c} (<7% in individuals with diabetes)	66/141 (47%)	15/36 (42%)	9/15 (60%)	234/327 (72%)	63/88 (72%)	‡
Antiplatelet drugs	1001/1061 (94%)	290/305 (95%)	58/643 (9%)	86/1118 (8%)	30/332 (9%)	28/246 (11%)
β blockers	828/1061 (78%)	259/305 (85%)	81/643 (13%)	147/1118 (13%)	40/332 (12%)	38/246 (15%)
Angiotensin-converting enzyme inhibitors	586/1061 (55%)	143/305 (47%)	72/643 (11%)	217/1113 (19%)	53/330 (16%)	29/246 (12%)
Statins	832/1059 (79%)	240/303 (79%)	62/643 (10%)	166/1118 (15%)	59/332 (18%)	29/246 (12%)

Data are number or n/N (%). INT=intervention. UC=usual care. *No initial assessment in the usual-care group. †Random subsample only. ‡Only two partners with self-reported diabetes had a haemoglobin A_{1c} measurement.

Table 2: **Coronary heart disease and high-risk patients and their partners achieving the primary endpoints at the initial assessment**

target at 1 year was 88/665 (13%) in the intervention group and 15/169 (9%) in the usual-care subsample, which was a difference of 5·8% (95% CI –0·9 to 12·5, p=0·08). Mean change in waist circumference from baseline for the same patients was –1·5 cm in the intervention group and –0·8 cm in the usual-care subsample—ie, a difference in change of –0·8 cm (–3·7 to 2·1, p=0·51). For high-risk patients in general practice with a waist circumference greater than the target at initial assessment, 58/798 (7%) achieved the target at 1 year in the intervention group and 8/195 (4%) in the usual-care subsample—ie, a difference of 3·2% (–1·5 to 7·9, p=0·19). Mean change in waist circumference from baseline was –1·66 cm in the intervention group and –0·21 cm in the usual-care subsample, which resulted in a difference of –1·61 cm (–2·61 to –0·61, p=0·009). The proportions of partners (of both coronary patients and high-risk individuals) achieving target waist circumference at 1 year were slightly higher in the intervention groups than in the usual-care groups, though the differences were not significant (table 3).

A higher proportion of coronary patients in the intervention group achieved the blood pressure target at 1 year than that in the usual-care group (table 3). Comparison of the distribution of systolic blood pressure between the intervention and usual-care groups in patients with coronary heart disease favoured intervention, but diastolic blood pressure was not different (table 4). Mean change in systolic blood pressure from baseline was 0·6 mm Hg in the intervention group compared with 4·2 mm Hg in the usual-care subsample—ie, a difference in change of –4·3 mm Hg (95% CI –10·4 to 1·8, p=0·13). Mean change in diastolic blood pressure was –0·5 mm Hg in the intervention group and 1·1 mm Hg in the usual-care subsample—ie, a difference in change of –2·2 mm Hg (–6·0 to 1·7, p=0·20). Of the patients with coronary heart disease and a blood pressure greater than the target level or those on antihypertensive medications, or both, 576/903 (64%) were treated and achieved the target goal for blood pressure; 311/903 (34%) were treated but not at the target goal; and 16/903 (2%) were not treated and not at the target goal in the intervention group compared with 522/962 (54%), 413/962 (43%), and 27/962 (3%), respectively, in the usual-care group (odds ratio [OR] 0·65, 0·42 to 1·01, p=0·05). The difference in the proportion treated and achieving the target goal at 1 year in the intervention group versus the usual-care group was 9·9% (–0·2 to 20·0, p=0·05).

A higher proportion of high-risk patients achieved the blood pressure target at 1 year in the intervention group than in the usual-care group (table 3). Comparison of the distributions of both systolic and diastolic blood pressures in high-risk patients favoured the intervention group (table 4). Mean change in systolic blood pressure between the initial and 1-year assessments was –7·6 mm Hg in the intervention group compared with –2·8 mm Hg in the usual-care subsample, a difference in change from baseline of –4·8 mm Hg (95% CI –10·2 to 0·6, p=0·07). Mean change for diastolic blood pressure was –4·1 mm Hg in the intervention group and –1·6 mm Hg in the usual-care group, a difference in change from baseline of –2·7 mm Hg (–5·9 to 0·6, p=0·09). Of the high-risk patients with a blood pressure greater than the target level or those on antihypertensive medications, or both, 297/722 (41%) were treated and at their target goal for blood pressure; 270/722 (37%) were treated but not at the target goal; and 155/722 (21%) were not treated and not at the target goal in the intervention group versus 156/755 (21%), 288/753 (38%), and 309/753 (41%), respectively, in the usual-care group (OR 0·37, 0·22 to 0·63, p=0·005). The difference in the proportion treated and achieving the target goal at 1 year in the intervention group versus the usual-care group was 20·3% (4·6 to 36·1, p=0·02).

The proportions of patients with coronary heart disease achieving their targets for both total and LDL-cholesterol concentrations at 1 year were slightly higher in the intervention group than in the usual-care group, though not significant (table 3); differences in distributions were not significant (table 4). The mean changes from baseline in concentrations of total and LDL cholesterol in the intervention and the usual-care groups were very small. Among the patients with coronary heart disease and total cholesterol concentrations greater than the target concentrations or those on lipid-lowering medication, or both, 618/811 (76%) were treated and at the target goal; 144/811 (18%) were treated but not at the target goal; and 49/811 (6%) were not treated and not at the target goal in

	Hospital						General practice					
	Coronary patients			Partners			High-risk patients			Partners		
	INT	UC	Difference	INT	UC	Difference	INT	UC	Difference	INT	UC	Difference
1-year assessment	946	994	n/a	401	335	n/a	1019	1005	n/a	225	363	n/a
Not smoking*	136/235 (58%)	154/327 (47%)	10·4% (–0·3 to 21·2); p=0·06	21/65 (32%)	10/57 (18%)	14·9% (–7·2 to 36·9); p=0·13	740/1007 (73%)	712/985 (72%)	0·8% (–13·1 to 14·7); p=0·89	187/220 (85%)	281/354 (79%)	7·6% (–0·6 to 15·8); p=0·07
Saturated fat (<10% of total energy)†	196/356 (55%)	168/417 (40%)	17·3% (6·4 to 28·2); p=0·009	96/160 (60%)	45/107 (42%)	13·5% (–24·0 to 51·3); p=0·31	..	..	..	..	..	..
Oily fish (≥3 times per week)	156/944 (17%)	81/994 (8%)	8·9% (0·3 to 17·5); p=0·04	42/397 (11%)	25/335 (7%)	1·3% (–7·2 to 9·8); p=0·71	113/1019 (11%)	60/1004 (6%)	6·7% (–4·1 to 17·6); p=0·13	44/225 (20%)	25/363 (7%)	11·1% (–0·3 to 22·5); p=0·054
Fish (≥20 g per day)	746/944 (79%)	665/994 (67%)	8·7% (–33·3 to 50·6); p=0·62	309/397 (78%)	212/334 (63%)	6·7% (–32·7 to 46·1); p=0·68	841/1018 (83%)	666/1003 (66%)	16·8% (–1·7 to 35·2); p=0·07	182/225 (81%)	238/363 (66%)	13·2% (–13·6 to 40·1); p=0·26
Fruit and vegetables (≥400 g per day)	680/944 (72%)	349/991 (35·%)	37·3% (18·1 to 56·5); p=0·004	286/397 (72%)	122/334 (37%)	34·5% (18·2 to 50·7); p=0·002	799/1019 (78%)	388/1001 (39%)	39·7% (18·1 to 61·3); p=0·005	173/225 (77%)	196/363 (54%)	25·1% (14·5 to 35·7); p=0·002
Physical activity (≥30 min, ≥4 times per week)	507/942 (54%)	194/992 (20%)	35·6% (20·0 to 51·3); p=0·002	163/400 (41%)	89/335 (27%)	18·7% (–0·6 to 379); p=0·06	512/1018 (50%)	222/1003 (22%)	29·4% (10·7 to 48·0); p=0·01	100/225 (44%)	89/362 (25%)	26·8% (4·1 to 49·6); p=0·03
BMI (<25 kg/m²)	257/945 (27%)	205/990 (21%)	5·3% (–3·8 to 14·4); p=0·20	147/384 (38%)	113/334 (34%)	7·1% (–7·2 to 21·3); p=0·26	230/1018 (23%)	220/1002 (22%)	0·6% (–6·9 to 8·0); p=0·85	65/222 (29%)	117/362 (32%)	–2·8% (–13·1 to 7·5); p=0·52
Weight loss (≥5% in patients with BMI ≥25 kg/m² at initial assessment)	135/695 (19%)	24/183 (13%)	6·2% (–7·1 to 19·5); p=0·28	..	..	..	134/814 (16%)	13/192 (7%)	10·4% (4·7 to 16·1); p=0·005	..	..	..
Ideal waist circumference (men <94 cm; women <80 cm)	292/945 (31%)	213/991 (21%)	8·7% (–2·7 to 20·3); p=0·11	107/384 (28·%)	86/334 (26%)	7·4% (–3·6 to 18·4); p=0·10	234/1009 (23%)	152/1001 (15%)	7·9% (–2·3 to 18·1); p=0·10	60/221 (27%)	89/361 (25%)	4·7% (–9·9 to 19·2); p=0·45
Blood pressure (<140/90 mm Hg; <130/85 mm Hg in patients with diabetes)	615/942 (65%)	547/990 (55%)	10·4% (0·6 to 20·2); p=0·04	266/397 (67%)	211/335 (63%)	8·0% (–8·2 to 24·2); p=0·21	586/1016 (58%)	407/1004 (41%)	16·9% (2·0 to 31·8); p=0·03	158/222 (71%)	193/363 (53%)	21·7 (2·8 to 40·7); p=0·03
Blood pressure (<140/90 mm Hg in patients without diabetes)	553/769 (72%)	490/816 (60%)	11·9% (1·2 to 22·6); p=0·04	..	..	..	459/687 (677)	356/735 (48%)	16·6% (0·5 to 32·8); p=0·04	..	..	..

(Continues on next page)

	Hospital						General practice					
	Coronary patients			Partners			High-risk patients			Partners		
	INT	UC	Difference	INT	UC	Difference	INT	UC	Difference	INT	UC	Difference
(Continued from previous page)												
Blood pressure (<130/85 mm Hg in patients with diabetes)	63/174 (36%)	57/174 (33%)	6·3% (–6·6 to 19·2); p=0·26	..	..	..	127/329 (39%)	51/269 (19%)	18·8% (0·9 to 36·7); p=0·04	..	..	..
Total cholesterol (<5 mmol/L)	664/857 (77%)	621/877 (71%)	6·6% (–5·8 to 19·0); p=0·23	85/245 (35%)	100/303 (33%)	3·0% (–48·7 to 54·7); p=0·60	345/965 (36%)	295/937 (31%)	2·4% (–9·9 to 14·8); p=0·64	68/205 (33%)	101/334 (30%)	1·7% (–2·9 to 16·3); p=0·76
LDL cholesterol (<3 mmol/L)	673/834 (81%)	633/856 (74%)	7·3% (0·9 to 15·4); p=0·07	105/245 (43%)	118/294 (40%)	4·5% (–50·0 to 59·0); p=0·48	419/936 (45%)	320/908 (35%)	8·7% (–5·2 to 22·7); p=0·17	80/203 (39%)	124/331 (37%)	2·3% (13·9 to 18·6); p=0·71
Haemoglobin A_{1c} (<7% in individuals with diabetes)	90/160 (56%)	77/144 (53%)	10·8% (–12·9 to 34·5); p=0·29	..	..	..	246/308 (80%)	155/237 (65%)	12·1% (–4·7 to 29·0); p=0·12	..	..	..
Antiplatelet drugs	881/945 (93%)	914/991 (92%)	1·6% (–1·8 to 5·1); p=0·28	54/399 (14%)	48/334 (14%)	–3·2% (–13·2 to 6·8); p=0·45	136/1012 (13%)	102/1004 (10%)	3·9% (–2·7 to 10·5); p=0·19	32/222 (14%)	33/363 (9%)	2·2% (–3·3 to 7·8); p=0·35
β blockers	722/945 (76%)	794/991 (80%)	–3·1% (–7·9 to 1·7); p=0·16	68/399 (17%)	57/334 (17%)	–1·2% (–12·0 to 9·6); p=0·79	176/1012 (17%)	158/1004 (16%)	–0·4% (–8·4 to 7·7); p=0·91	42/222 (19%)	45/363 (12%)	4·4% (–8·9 to 17·8); p=0·43
Angiotensin-converting enzyme inhibitors	495/945 (52%)	557/991 (56%)	–5·5% (–16·6 to 5·7); p=0·26	65/399 (16%)	35/334 (10%)	0·4% (–8·4 to 9·1); p=0·92	297/1012 (29%)	196/1004 (20%)	8·5% (1·8 to 15·2); p=0·02	27/222 (12)	40/363 (11%)	0·5% (–5·4 to 6·4); p=0·84
Statins	810/945 (86%)	794/991 (80%)	6·0% (–0·5 to 11·5); p=0·04	76/399 (19%)	50/334 (15%)	4·0% (–6·7 to 14·8); p=0·38	381/1012 (38%)	232/1004 (23%)	14·6% (2·5 to 26·7); p=0·03	49/222 (22%)	56/363 (15%)	7·2% (–6·2 to 20·7); p=0·23

Data are number, n/N (%), or difference between intervention and usual-care groups (95% CI). The difference in percentages were calculated by combining the country-specific differences using a random-effects meta-analysis. INT=intervention. UC=usual care. BMI=body-mass index. n/a=not applicable. *Hospital patients achieving the target goal as a proportion of the target population (self-reported smoking in the month before the index event); proportion of patients in general practice not smoking at final assessment. †Random subsample only.

Table 3: **Coronary heart disease and high-risk patients and their partners achieving the primary endpoints at 1 year**

the intervention group compared with 572/829 (69%), 152/829 (18%), and 105/829 (13%), respectively, in the usual-care group (OR 0·68, 95% CI 0·31 to 1·45, p=0·24). The difference between the intervention and usual-care groups in the proportion of patients treated and achieving the target goal was 7·4% (–5·8 to 207·0, p=0·21). For LDL-cholesterol concentration, 625/786 (80%) of patients with coronary heart disease were treated and at the target goal; 117/786 (15%) were treated but not at the target goal; and 44/786 (6%) were not treated and not at the target goal in the intervention group compared with 577/800 (72%), 129/800 (16%), and 94/800 (12%), respectively, in the usual-care group (OR 0·60, 0·35 to 1·02, p=0·06). The difference between the two groups in the proportion of patients treated and achieving the target goal was 8·1% (–1·0 to 17·2, p=0·07).

The proportions of individuals at high risk of cardiovascular disease achieving lipid targets at 1 year were substantially lower than those of patients with coronary heart disease, and the differences between the intervention and usual-care groups at 1 year were not significant (table 3), and the distribution of lipids was not significant (table 4). However, a considerably smaller proportion of patients achieved the total cholesterol target concentration at baseline in the intervention group (228/1000 [23%]) than in the usual-care subsample (72/221 [32%]) and mean concentration of total cholesterol was higher in the intervention group than in the usual-care group (5·7 mmol/L *vs* 5·5 mmol/L,

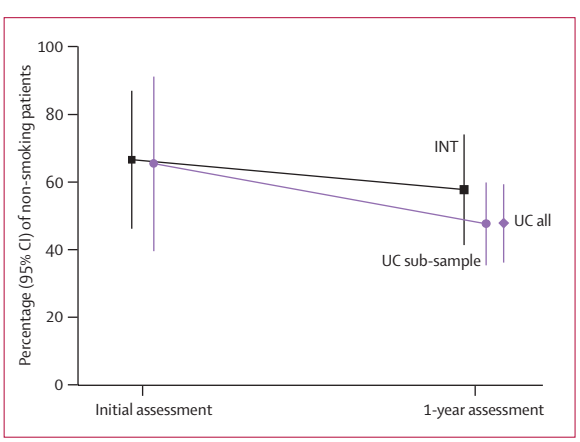

Figure 2: **Proportion of non-smoking patients at the initial and 1-year assessments among those reported as smoking in the month before the index event**

Error bars represent 95% CI. INT=intervention. UC=usual care.

p=0·002). In the intervention group, the proportion of patients achieving the total cholesterol target concentration increased compared with a reduction in the usual-care group, a difference in change of 12·7% (95% CI 2·4 to 23·0, p=0·025; figure 3). For LDL cholesterol, the proportion attaining the target concentration increased in the intervention group compared with no change in usual-care group, a difference in change of 16·7% (6·7 to 26·7, p=0·008; figure 3). The mean change in the concentration of total

cholesterol between the initial and 1-year assessments was –0·38 mmol/L in the intervention group compared with no change in the usual-care subsample, a difference in change from baseline of –0·34 mmol/L (–0·54 to –0·15, p=0·006). For LDL-cholesterol concentration, the change from baseline was –0·41 mmol/L in the intervention group versus –0·03 in the usual-care subsample, a difference in change of –0·34 mmol/L (–0·52 to –0·16, p=0·004).

Self-reported diabetes in patients with coronary heart disease at 1 year was the same in the intervention (174/946 [18%]) and usual-care groups (176/994 [18%]), and was 331/1019 (32%) for high-risk patients in the intervention group versus 269/1004 (27%) in the usual-care group, a difference of 5·1% (95% CI –11·4 to 21·7, p=0·46). Proportions of patients—with coronary heart disease and at high risk—with controlled diabetes (haemoglobin A_{1c} <7%) were higher in the intervention groups than in the usual-care groups, but the differences were not significant (table 3). Comparison of the distributions of fasting blood glucose concentrations between the two groups for patients with coronary heart disease and diabetes favoured intervention, but for the high-risk patients with diabetes the difference was not significant. No significant differences were noted for either group of patients in the distribution of haemoglobin A_{1c} (table 4). In patients with coronary heart disease, the mean fasting blood glucose concentration decreased by 0·07 mmol/L in the intervention group compared with a reduction of 0·15 mmol/L in the usual-care group, a difference in change of 0·06 mmol/L (–0·43 to 0·55, p=0·76). In high-risk patients the reductions were –0·46 mmol/L in the intervention group and –0·28 mmol/L in the usual-care group, a difference in change of –0·11 mmol/L (–0·75 to 0·53, p=0·67).

In patients with coronary heart disease treated with cardioprotective drugs, significant differences between the intervention and usual-care groups were noted only for statins (table 3), which were prescribed more frequently in the intervention group. In general practice, patients in the intervention group had more prescriptions for angiotensin-converting enzyme inhibitors and statins than did patients in the usual-care group (table 3). Overall, the use of cardioprotective drugs was much less

	Hospital				General practice			
	Intervention	Usual care	Odds ratio (95% CI)	p value	Intervention	Usual care	Odds ratio (95% CI)	p value
Body-mass index			0·77 (0·49–1·21)	0·20			1·14 (0·83–1·58)	0·34
<25 kg/m²	257/945 (27%)	205/990 (21%)			230/1018 (23%)	220/1002 (22%)		
25–29 kg/m²	436/945 (46%)	473/990 (48%)			433/1018 (43%)	490/1002 (49%)		
≥30 kg/m²	252/945 (27%)	312/990 (32%)			355/1018 (35%)	291/1002 (29%)		
Waist circumference			0·61 (0·39–0·97)	0·04			0·70 (0·53–0·93)	0·02
<94 cm (men); <80 cm (women)	292/945 (31%)	213/990 (22%)			234/1009 (23%)	152/1001 (15%)		
94–101 cm (men); 80–87 cm (women)	274/945 (29%)	256/990 (26%)			256/1009 (25%)	265/1001 (26%)		
≥102 cm (men); ≥88 cm (women)	379/945 (40%)	521/990 (53%)			519/1009 (51%)	584/1001 (58%)		
Systolic blood pressure			0·58 (0·38–0·88)	0·02			0·39 (0·23–0·65)	0·005
<140 mm Hg	672/942 (71%)	603/990 (61%)			728/1016 (72%)	611/1004 (61%)		
140–159 mm Hg	200/942 (21%)	247/990 (25%)			231/1016 23%)	250/1004 (25%)		
≥160 mm Hg	70/942 (7%)	141/990 (14%)			57/1016 (6%)	143/1004 (14%)		
Diastolic blood pressure			0·48 (0·18–1·28)	0·11			0·46 (0·26–0·81)	0·016
<90 mm Hg	848/942 (90%)	830/990 (84%)			875/1016(86%)	749/1004 (75%)		
90–99 mm Hg	69/942 (7%)	122/990 (12%)			116/1016 (11%)	196/1004 (20%)		
≥100 mm Hg	25/942 (3%)	38/990 (4%)			25/1016 (2%)	59/1004 (6%)		
Total cholesterol			0·78 (0·42–1·45)	0·34			0·84 (0·52–1·37)	0·41
<4 mmol/L	308/857 (36%)	295/880 (34%)			72/965 (7%)	64/937 (7%)		
4–4·9 mmol/L	356/857 (42%)	328/880 (37%)			273/965 (28%)	232/937 (25%)		
5–5·9 mmol/L	147/857 (17%)	173/880 (20%)			391/965 (41%)	368/937 (39%)		
≥6 mmol/L	(46/857 (5%)	84/880 (10%)			229/965 (24%)	273/937 (29%)		
LDL cholesterol			0·74 (0·46–1·17)	0·15			0·67 (0·40–1·13)	0·11
<2 mmol/L	270/834 (32%)	251/856 (29%)			94/936 (10%)	67/908 (7%)		
2–2·9 mmol/L	403/834 (48%)	382/856 (45%)			325/936 (35%)	254/908 (28%)		
3–3·9 mmol/L	126/834 (15%)	170/856 (20%)			377/936 (40%)	387/908 (43%)		
≥4 mmol/L	35/834 (4%)	53/856 (6%)			140/936 (15%)	200/908 (22%)		

(Continues on next page)

	Hospital				General practice			
	Intervention	Usual care	Odds ratio (95% CI)	p value	Intervention	Usual care	Odds ratio (95% CI)	p value
(Continued from previous page)								
Fasting blood glucose			0·83 (0·36–1·91)	0·58			0·67 (0·33–1·36)	0·21
≤6 mmol/L	508/688 (74%)	496/720 (69%)			549/643 (85%)	524/659 (80%)		
6·1–6·9 mmol/L	133/688 (19%)	150/720 (21%)			71/643 (11%)	97/659 (15%)		
7–7·9 mmol/L	38/688 (6%)	50/720 (7%)			18/643 (3%)	26/659 (4%)		
≥8 mmol/L	9/688 (1%)	24/720 (3%)			5/643 (<1%)	12/659 (2%)		
Fasting blood glucose (patients with diabetes)			0·43 (0·19–0·99)	0·048			0·50 (0·17–1·50)	0·17
≤6 mmol/L	34/159 (21%)	13/149 (9%)			89/305 (29%)	50/232 (22%)		
6·1–6·9 mmol/L	27/159 (17%)	21/149 (14%)			105/305 (34%)	53/232 (23%)		
7–7·9 mmol/L	36/159 (23%)	26/149 (17%)			54/305 (18%)	57/232 (25%)		
≥8 mmol/L	62/159 (39%)	89/149 (60%)			57/305 (19%)	72/232 (31%)		
Haemoglobin A_{1c} (patients with diabetes)			0·51 (0·20–1·32)	0·13			0·56 (0·22–1·41)	0·17
≤6%	58/160 (36%)	33/154 (21%)			131/308 (43%)	59/237 (25%)		
6–6·9%	39/160 (24%)	44/154 (29%)			115/308 (37%)	96/237 (41%)		
7–7·9%	36/160 (23%)	31/154 (20%)			36/308 (12%)	47/237 (20%)		
≥8%	27/160 (17%)	46/154 (30%)			26/308 (8%)	35/237 (15%)		

Data are n/N (%), unless otherwise indicated.

Table 4: **Risk-factor distributions in coronary heart disease and high-risk patients**

in general practice than in hospitals. Prescription practice adhered to local policy and doctors in the EUROACTION programme tended to prescribe cheaper generic drugs.

Discussion

The EUROACTION preventive cardiology programme reduced the risk of cardiovascular disease compared with usual care mainly through lifestyle changes by families, who together made healthier food choices and became more physically active than before the intervention. This change led to some weight loss and, for high-risk patients, a reduction in central obesity. Blood pressure control was improved and for patients with coronary heart disease without the use of additional antihypertensive drugs. Control of blood cholesterol concentrations in these patients was improved in both the intervention and usual-care groups; improvement was significant in high-risk patients because of the increased use of statins. However, the use of all cardioprotective drugs was substantially lower in primary care than in the hospitals.

Although these results are encouraging there is scope for improvement. The smoking cessation intervention based on advice reduced relapse in patients with coronary heart disease but had no effect on the high-risk patients. Even though the protocol recommended the use of smoking cessation therapies, these were not used because of cost. Although the same protocol for risk-factor management was used in hospital and general practice, use of blood pressure and lipid-lowering drugs was much more conservative in general practice. As a consequence, most of the high-risk patients did not achieve lipid targets. Diabetes care could have been improved if the intervention nurses had taken responsibility for diabetes management.

Although, exercise-based cardiac rehabilitation reduces both cardiac and total mortality, the results of a meta-analysis showed no difference in mortality effect between exercise-only cardiac rehabilitation and comprehensive cardiac rehabilitation.[29] Importantly, the effect of cardiac rehabilitation on total mortality was independent of coronary heart disease diagnosis, type of cardiac rehabilitation, amount of exercise intervention, or duration of follow-up. The contribution of secondary prevention programmes with or without exercise was assessed in a separate meta-analysis.[30] The effects on mortality and myocardial infarction were similar for programmes that included both exercise and risk-factor education, risk-factor education alone, or exercise alone. In a systematic review of trials of secondary prevention, multidisciplinary disease management programmes reduced admissions to hospital and recurrent myocardial infarction.[31] However, this distinction between cardiac rehabilitation and secondary prevention is artificial and these meta-analyses showed the benefits of a comprehensive approach to reduction of total cardiovascular risk. The EUROACTION model took this comprehensive approach and addressed all aspects of lifestyle, risk factor management, and cardioprotective drug treatments, which is likely to have the greatest effect on cardiovascular morbidity and mortality.

In primary prevention, the evidence for multiple risk factor interventions is less strong. In a systematic review of ten trials with outcome data, no significant effect on

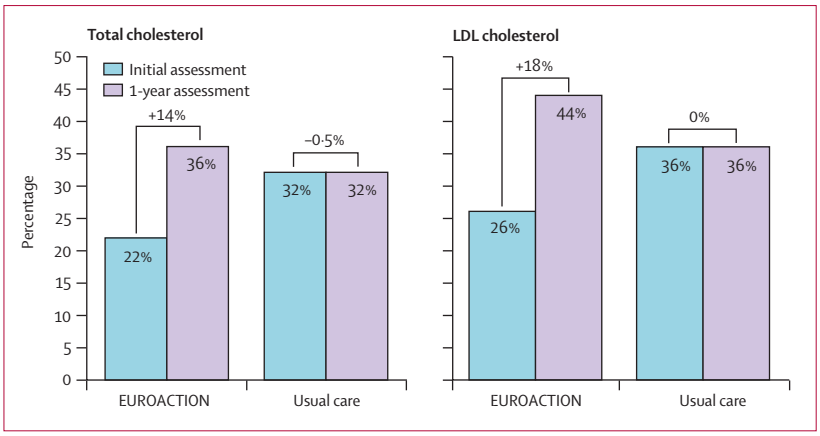

Figure 3: **Changes in proportions of high-risk patients achieving the European target for concentrations of lipids in intervention and usual-care subsamples between initial and 1-year assessments**
European target was less than 5 mmol/L for total cholesterol concentration and less than 3 mmol/L for LDL cholesterol.

total or coronary mortality was noted but a small and potentially important 10% reduction in coronary heart disease mortality might have been missed.[32] This apparent absence of effect on coronary mortality indicated a modest reduction in smoking and small changes (due to restricted drug treatment) in blood pressure and concentrations of lipids in these trials. By contrast, EUROACTION was more effective than usual care because a lifestyle intervention was combined with cardioprotective drugs that together reduced cardiovascular events.

The EUROACTION programme incorporated several important principles. It was intentionally set up in busy general hospitals and general practices, outside specialist cardiac rehabilitation centres, to provide a service for all coronary and high-risk patients in routine clinical practice. Integration of the diagnosis and management of patients with continued preventive care in the same medical facility is likely to result in increased and sustained participation. In the EUROASPIRE survey,[6] only a third of coronary patients attended cardiac rehabilitation, whereas two-thirds joined the EUROACTION programme. Recruitment was even better in primary care, with nine out of ten patients joining the programme. EUROACTION was inclusive because it addressed all the high-priority patient groups as defined in the guidelines.[7] We made no distinction between symptomatic coronary disease (secondary prevention) and those at high risk (primary prevention). All these patients are at high risk of cardiovascular disease and need professional support to achieve the same lifestyle and risk-factor targets. EUROACTION was a family-centred programme and actively involved patients' partners and other family members. A family intervention is appropriate because married couples show concordance for lifestyle, and concordance for change.[33,34] Those patients making the greatest changes had partners making similar changes.

EUROACTION was coordinated by nurses because of evidence that nurse-managed programmes improve lifestyle, risk factor control, use of medications, and quality of life.[35–41] The basis of EUROACTION was lifestyle change—ie, avoidance of tobacco, achievement of a healthy diet, and physical activity, which were all given equal weighting. For patients with coronary disease, supervised exercise was needed in the early stages, which was the role of the physiotherapist, but in primary care, nurses promoted physical activity in high-risk patients without supervision. They achieved an increase in physical activity without any adverse effects. Total risk assessment and management was a central principle of EUROACTION for both coronary heart disease and high-risk (as identified by SCORE) patients. So in addition to promotion of all aspects of a healthy lifestyle, comprehensive risk-factor management and appropriate use of cardioprotective drugs were all addressed. The EUROACTION programme did not use specialised hospital or community facilities; simple equipment was used for supervised exercise sessions so that the exercises could be replicated at home. As a consequence EUROACTION can be set up in any hospital or general practice without dedicated facilities.

A matched, paired cluster-randomised controlled trial has inherent limitations. Our study was statistically underpowered for three reasons. First, the number of patients and partners recruited was much smaller than expected. Second, although pairs of centres were matched, initial patient assessment revealed some unexpected differences in patient characteristics in both directions—ie, some favoured usual care and some favoured intervention. Third, heterogeneity between pairs of centres for some results which, given the small number of pairs, also reduced our power. Some of the differences in favour of intervention—eg, prevention of smoking relapse in patients with coronary disease, are still clinically important but not significant. Our analysis was by intention to treat because all patients and partners identified at baseline, irrespective of eligibility or participation, were invited back at 1 year. An underestimation of treatment effect is possible for three reasons. First, centres randomised to usual care knew they would be audited which might have led to improved practice. Second, a random subsample of usual-care patients had a comprehensive baseline assessment alerting them and their doctors to the need for change. Third, almost a fifth of usual-care patients received some form of structured cardiac rehabilitation that will have had some similarities to EUROACTION interventions. Overestimation of treatment effect might have occurred because not all those at baseline in the intervention groups came back at 1 year. These non-responders included a higher proportion of heavy smokers, obese, and sedentary patients than in the responders. However—the same bias is also true for usual care—of all those patients identified at baseline, slightly more than half came at 1 year. We know from other studies that non-responders tend to have unhealthier lifestyles and

poorer risk factor control. After all these caveats are taken into account, the EUROACTION programme, in both hospital and primary care, has shown real improvements in lifestyle, risk-factor control, and use of cardioprotective drugs compared with usual care. As well as showing the clinical effectiveness of the EUROACTION programme, we also have to answer the question is the EUROACTION programme cost effective? A cost-effectiveness analysis will be reported separately.

In conclusion, EUROACTION has shown that standards of preventive care in general hospitals and general practices across Europe can be improved. This nurse-coordinated, multidisciplinary, family-based, ambulatory programme achieved healthier lifestyle changes and improvements in other risk factors for patients with coronary heart disease and those at high risk of cardiovascular disease and their partners than those in usual care. EUROACTION is a model of preventive cardiology, which has been successfully implemented and assessed, and can be used in routine clinical practice. To achieve the effects of EUROACTION we need to go beyond specialised cardiac rehabilitation services and provide local preventive cardiology programmes, appropriately adapted to the medical, cultural, and economic setting of a country.

Contributors

A scientific steering group approved the protocol and study design and was responsible for the scientific integrity of the study. The national coordinators for each country were also members of the steering committee; they were responsible for identifying and recruiting the hospitals and general practices, obtaining ethics committee approval, appointing and supervising staff in the centres, and contributing scientifically to the publication of results. DAW was the principal investigator and led the central coordinating team. DAW, GDB, KK, and DDB contributed to the study design and development of the scientific protocol. KK and CJ participated in the development of case record forms. KK was the medical coordinator for the study. CJ was the research nurse coordinator for the study and participated in the set up and development of the intervention. AM participated in the development, coordination, and analysis of the dietetic part of the study. JJ and AH participated in the development, coordination, and analysis of the physiotherapy and physical activity parts of the study. SC had overall responsibility for data collection and quality assurance. GDB led the statistical centre. DDB was the statistician at the statistical centre. DAW, DDB, GDB, KK, TC, and SC participated in the statistical analyses. DAW, DDB, GDB, KK, TC, SC, and OF participated in the interpretation of the data. DAW, DDB, GDB, KK, CJ, TC, SC, and OF participated in the writing of the report. All authors have seen and approved the final version of the report for publication.

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Conflict of interest statement

DAW and OF are paid consultants to AstraZeneca advisory boards and have received honoraria for speaking at AstraZeneca-sponsored meetings. GDB and DAW have received research grants from AstraZeneca, and GDB from Solvay. AM is a member of the advisory board of Flora. The other authors declare that they have no conflict of interest.

Acknowledgments

This study was funded by AstraZeneca through the provision of an unconditional educational grant to the European Society of Cardiology. We thank Gary Frost, Barrie Margetts, Mike Nelson, and Charlie Foster for their advice on dietary and physical activity assessments.

References

1 Graham I, Atar D, Borch-Johnsen K, et al. European guidelines on cardiovascular disease prevention in clinical practice: fourth joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). *Eur J Cardiovasc Prev Rehabil* 2007; **28:** 2375–2414.

2 Conroy RM, Pyorala K, Fitzgerald AP, et al. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. *Eur Heart J* 2003; **24:** 987–1003.

3 EUROASPIRE Study Group. EUROASPIRE. A European Society of Cardiology survey of secondary prevention of coronary heart disease: Principal results. *Eur Heart J* 1997; **18:** 1569–82.

4 EUROASPIRE Study Group. Lifestyle and risk factor management and use of drug therapies in coronary patients from 15 countries. Principal results from EUROASPIRE II. Euro Heart Survey Programme. *Eur Heart J* 2001; **22:** 554–72.

5 EUROASPIRE Study Group. Clinical reality of coronary prevention guidelines: a comparison of EUROASPIRE I and II in nine countries. *Lancet* 2001; **357:** 995–1001.

6 Kotseva K, Wood D, De Bacquer D, et al, on behalf of the EUROASPIRE II Study Group. Cardiac rehabilitation for coronary patients: lifestyle, risk factor and therapeutic management. Results from the EUROASPIRE II survey. *Eur Heart J* 2004; **6** (suppl J)**:** J17–J26.

7 Wood DA, Kotseva K, Jennings C, et al, on behalf of the EuroAction Study Group. EUROACTION: a European Society of Cardiology demonstration project in preventive cardiology. *Eur Heart J* 2004; **6** (suppl J)**:** J3–J15.

8 Wood D, De Backer G, Faergeman O, Graham I, Mancia G, Pyörälä K. Prevention of coronary heart disease in clinical practice. Recommendations of the Second Joint Task Force of European and other Societies on coronary prevention. *Eur Heart J* 1998; **19:** 1434–503.

9 Herrmann C. International experiences with the Hospital Anxiety and Depression Scale—a review of validation data and clinical results. *J Psychosom Res* 1997; **42:** 17–41.

10 Kim MT, Hill MN, Bone LR, Levine DM. Development and testing of the Hill-Bone Compliance to high blood pressure therapy scale. *Prog Cardiovasc Nurs* 2000; **15:** 90–96.

11 Petrie K, Weinman J, Sharpe N, Buckley J. Role of patients' views of their illness in predicting return to work and functioning after MI: a longitudinal study. *BMJ* 1996; **312:** 1991–94.

12 Denollet J. Emotional distress and fatigue in coronary heart disease: the Global Mood scale (GMS). *Psychol Med* 1993; **23:** 111–21.

13 Moss-Morris R, Weinman J, Petrie K, Horne R, Cameron LD, Buick D. The revised Illness Perception Questionnaire (IPQ-R). *Psychol Health* 2002; **17:** 1–16.

14 Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Med Care* 1992; **30:** 473–83.

15 EuroQoL Group. EuroQoL—a new facility for the measurements of health-related quality of life. *Health Policy* 1990; **16:** 199–208.

16 Prochaska JO, DiClemente CC, Norcross JC. In search of how people change: applications to addictive behaviour. *Am Psychol* 1992; **47:** 1102–14.

17 Miller W, Rollnick S. Motivational interviewing. London: Guilford, 2002.

18 Prochaska JO, DiClemente CC. Self change processes, self efficacy and decisional balance across five stages of smoking cessation. *Prog Clin Biol Res* 1984; **156:** 131–40.

19 Fagerström KO, Schneider NG. Measuring nicotine dependence: a review of the Fagerström Tolerance Questionnaire. *J Behav Med* 1989; **12:** 159–82.

20 Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom K. The Fagerstrom Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. *Br J Addict* 1991; **86:** 1119–27.

21 Fagerstrom test of nicotine dependence. In: Orleans CT, Slade J, eds. Nicotine addiction: principles and management. New York: Oxford University Press, 1993: 413.

22 Mead A. Food habit questionnaire. PhD thesis (in preparation).

23 WHO. Measuring obesity: classification and distribution of anthropometric data. Copenhagen: World Health Organisation, 1989.

24 Slimani N, Deharveng G, Charrondiere RU, et al. Structure of the standardized computerized 24-h diet recall interview used as reference method in the 22 centers participating in the EPIC project. European Prospective Investigation into Cancer and Nutrition. *Comput Methods Programs Biomed* 1999; **58:** 251–66.

25 Blair SN, Haskell WL, Ho P, et al. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol* 1985; **122:** 794–804.

26 Welk G J, Differding JA, Thompson RW, Blair SN, Dziura J, Hart P. The utility of the Digi-Walker step counter to assess daily physical activity patterns. *Med Sci Sports Exerc* 2000; **32** (suppl)**:** S481.

27 Campbell MC, Elbourne DR, Altman DG. CONSORT statement: extension to cluster randomised trials. *BMJ* 2004; **328:** 702–08.

28 Hayes RJ, Bennet S. Simple sample size calculation for cluster-randomized trials. *Int J Epid* 1999; **28:** 319–26.

29 Taylor R, Brown A, Ebrahim S, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomised controlled trials. *Am J Med* 2004; **116:** 682–92.

30 Clark A M, Hartling L, Vandermeer B, McAlister FA. Meta-analysis: secondary prevention programs for patients with coronary artery disease. *Ann Intern Med* 2005; **143:** 659–72.

31 McAlsiter FA, Lawson FME, Teo KK, Armstrong PW. Randomised trials of secondary prevention programmes in coronary heart disease: systematic review. *BMJ* 2001; **323:** 957–62.

32 Ebrahim S, Beswick A, Burke M, Davey Smith G. Multiple risk factor interventions for primary prevention of coronary heart disease. *Cochrane Database Syst Rev* 2006; **4:** CD001561.

33 Wood DA, Roberts TL, Campbell M. Women married to men with myocardial infarction are at increased risk of coronary heart disease. *J Cardiovasc Risk* 1997; **4:** 7–11.

34 Pyke SD, Wood DA, Kinmonth AL, Thomson SG. Change in coronary risk and coronary risk factor levels in couples following lifestyle intervention. The British Family Heart Study. *Arch Fam Med* 1997; **6:** 354–60.

35 Khunti K, Stone M, Paul S, et al. Disease management programme for secondary prevention of coronary heart disease and heart failure in primary care: a cluster randomised controlled trial. *Heart* 2007; **93:** 1398–405.

36 Moher M, Yudkin P, Wright L, et al. Cluster randomised controlled trial to compare three methods of promoting secondary prevention of coronary heart disease in primary care. *BMJ* 2001; **322:** 1338–42.

37 Campbell NC, Ritchie LD, Thain J, et al. Secondary prevention in coronary heart disease: a randomised trial of nurse led clinics in primary care. *Heart* 1998; **80:** 447–52.

38 Campbell NC. Secondary prevention clinics: improving quality of life and outcome. *Heart* 2004; **90** (suppl IV)**:** 29–32.

39 Jolly K, Bradley F, Sharp S, et al. Randomised controlled trial of follow up care in general practice of patients with myocardial infarction and angina: final results of the Southampton heart integrated care project (SHIP). The SHIP Collaborative Group. *BMJ* 1999; **318:** 706–11.

40 Haskell WL, Alderman EL, Fair JM, et al. Effects of intensive multiple risk factor reduction on coronary atherosclerosis and clinical cardiac events in men and women with coronary artery disease. The Stanford Coronary Risk Intervention Project (SCRIP). *Circulation* 1994; **89:** 975–90.

41 DeBusk RF, Miller NH, Superko HR, et al. A case-management system for coronary risk factor modification after acute myocardial infarction. *Ann Intern Med* 1994; **120:** 721–29.