Preventing clinical heart failure: the rationale and scientific evidence

D A Wood

Heart 2002;**88**(Suppl II):ii15–ii22

The contemporary epidemiology of heart failure shows it is a common clinical problem, at least for the elderly and very elderly, and largely a consequence of coronary artery disease and hypertension.[1 2] Patients presenting for the first time with clinical heart failure have a median age of 76 years, and for many life expectancy is poor. A quarter die within three months, over a third by one year, and nearly one in two patients are dead by two years. Most deaths within the first three months occur during initial hospitalisation, and this depressing case fatality is despite appropriate use of modern medical and other therapies. So in contrast to clinical trials of pharmacological treatments in selected patients with heart failure, survival in unselected patients from the general population is, for the most part, much poorer. Although heart failure is the final common pathway for many and diverse cardiac pathologies, the most common is coronary artery disease. At this stage of the disease's clinical course the benefits of coronary artery interventions, both medical and mechanical, are necessarily limited by the extent of myocardial damage which explains much of the early case fatality. Therefore, preventing or postponing the development of heart failure caused by coronary artery disease is a more appropriate strategy, by addressing the determinants of atherosclerosis and its complications.

EPIDEMIOLOGY OF CLINICAL HEART FAILURE

The London heart failure studies have described the contemporary incidence, aetiology, and survival of patients with heart failure in the population. The first epidemiological study was in Hillingdon in northwest London, where 220 incident cases of heart failure were identified from a population of 151 000 over a 20 month period.[1] Incident cases were identified through general practitioners agreeing to refer all suspected cases of new heart failure to a rapid access heart failure clinic held at Hillingdon Hospital. Patients who were acutely ill were sent directly to the accident and emergency department in the usual way and identified by daily surveillance of all hospital admissions by a research nurse. In addition, general practitioners were asked to inform the study team of any patient in whom the diagnosis of heart failure had been made for the first time elsewhere—for example, while the patient was on holiday. One hundred and eighty (82%) cases were identified from surveillance of admissions to the local hospital and the remaining 40 (18%) from 157 referrals to the rapid access clinic. An audit of case ascertainment was performed by identifying all new prescriptions for diuretic drugs during the study period in a random sample of 10 practices. Of all suspected cases of heart failure identified in this way, 90% had been assessed by the study team either in the rapid access clinic or following acute admission to hospital.

The crude incidence rate was 1.3 cases per 1000 population per year for those aged 25 years or over. Incidence increased from 0.02 cases per 1000 population per year in those aged 25–34 years to 11.6 in those aged 85 years and over (fig 1). The median age of presentation was 76 years (73 years in men and 78 years in women) and 47% of male cases and 64% of female cases were aged 75 years or older. Incidence was higher in males than females (age adjusted incidence ratio 1.75, 95% confidence interval (CI) 1.34 to 2.29), and there was no statistical evidence that the incidence ratio changed across the age groups. Although the incidence rate was higher in men, the number of cases of heart failure in men and women was similar (118 men and 102 women) because there are more women in the elderly population.

The diagnosis of heart failure was made by a panel of three cardiologists, based on a majority decision of whether the case definition had been met, and the aetiology. To meet the case definition, as recommended by the working group on heart failure of the European Society of Cardiology, patients had to have appropriate symptoms (shortness of breath, fatigue, fluid

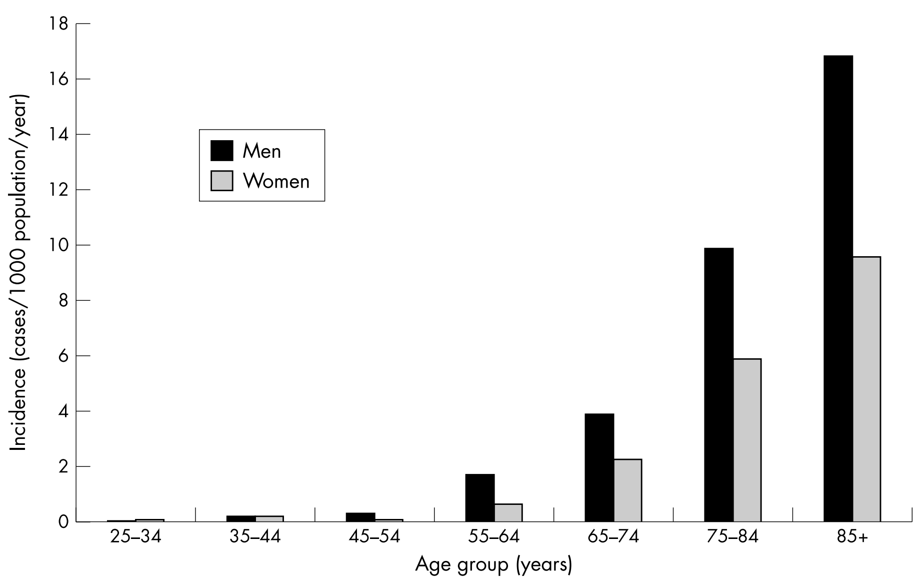

Figure 1 Incidence of heart failure in the population. Modified from Cowie *et al*.[1]

retention or any combination of these symptoms) with clinical signs of fluid retention (pulmonary or peripheral) in the presence of an underlying abnormality of cardiac structure or function. If an element of doubt remained the beneficial response to treatment for heart failure (for example, a brisk diuresis accompanied by substantial improvement in breathlessness) was taken to confirm the diagnosis. An underlying abnormality of cardiac structure or function was necessary to confirm the case as heart failure, but echocardiographic abnormalities were not sufficient in themselves to diagnose heart failure; patients had to satisfy the full case definition. The panel's decisions on case definition had a good reproducibility, as did the allocation of aetiology.

Coronary artery disease was considered the primary aetiology if the patient had a documented history of myocardial infarction (acute or in the past): unstable angina pectoris; a history of stable angina supported by evidence of reversible myocardial ischaemia; or coronary artery disease confirmed at coronary angiography. Hypertension was considered to be the aetiology if there was a history of hypertension from the general practice records or sustained hypertension (blood pressure > 160/95 mm Hg) during hospital admission, and there was no documented history of myocardial infarction or angina or evidence of other cardiac pathology. The presence and severity of underlying valvar heart disease was assessed from the history, clinical examination, and echocardiographic findings. The presence of cardiac arrhythmias were noted and the temporal relation of these to the development of heart failure ascertained.

The majority of cases were moderately or severely symptomatic (New York Heart Association functional class III and IV) and a past history of cardiovascular disease was common. Almost three quarters reported smoking at some time in their lives. The physical examination, chest radiography, and echocardiographic features were as expected in patients with heart failure. Sixty per cent were in sinus rhythm and almost a quarter had ECG evidence of previous infarction (pathological Q wave).

The single most common aetiology was coronary heart disease (CHD) (36%), and this co-existed with a history of hypertension in about half of these cases. Just under half of all heart failure cases had a history of hypertension (44%), but hypertension was considered the primary aetiology in only about a third of these cases; hypertension was therefore the primary aetiology in about 15% of all cases. Valvar heart disease was an uncommon cause of heart failure (7%). The remaining cases were allocated to a variety of other causes including alcohol, cor pulmonale, hypertrophic cardiomyopathy, and restrictive cardiomyopathy. In 34% of cases no aetiology could be allocated on the basis of the clinical information, principally non-invasive investigations, available at the time of panel review.

To further quantify the contribution of coronary artery disease to heart failure a second population study, the Bromley heart failure study, systematically undertook coronary angiography and myocardial perfusion imaging in incident cases of heart failure.[3] A total of 332 cases with new heart failure were identified over 15 months from a population of 292 000 in southeast London. The methodology of case ascertainment and assessment for the diagnosis of heart failure and its aetiology was the same as the Hillingdon study. In particular, coronary artery disease was identified as the primary aetiology, in the absence of angiographic data, using the same criterion as Hillingdon. The presence and severity of coronary artery disease was then further defined by performing coronary angiography in patients under 75 years. The age cut of 75 years for this investigation was determined by ethical considerations, including the potential benefit to the patient of information gained. This cut-off was close to the upper age at which revascularisation would normally be considered, while being as near to the median age of cases (76 years) as possible. One hundred and thirty six were under 75 years of age and angiography was undertaken in 99 (73%). Angiograms were reported visually twice; at the time of angiography and on a separate occasion by a cardiologist, specialising in interventional cardiology and blinded to clinical information. Anatomically significant coronary artery disease was defined as a luminal stenosis ⩾ 50% in one or more epicardial arteries. Functional significance was assessed by combining the anatomical data with information from the clinical assessment and non-invasive investigations, including myocardial perfusion imaging. Wherever possible cases with significant coronary artery disease underwent myocardial perfusion scintigraphy. Single photon emission tomography was performed with technetium. Another panel of three cardiologists re-evaluated the cases to allocate a final aetiology. In order for cases with anatomically significant coronary artery disease to be assigned to this aetiology, further evidence that the disease was related to the left ventricular dysfunction in the form of regional wall motion abnormalities, myocardial perfusion abnormalities or ischaemic valvar dysfunction was needed.

The final aetiology in the 136 cases < 75 years of age was based on all non-invasive and invasive data available and is shown in fig 2. Coronary artery disease was considered to be the primary aetiology in 71 (52%) of the cases. In three of these cases coronary artery disease was felt to be contributing to the aetiology, but was not the sole aetiology. Twelve (17%) of these 71 cases were assigned coronary artery disease as the aetiology in the absence of angiographic data. Either they died during the course of acute myocardial infarction associated with heart failure (10 cases) or declined angiography but developed heart failure during an acute myocardial infarction as evidenced by chest pain, ECG changes, and raised creatinine kinase (two cases). Seventeen (13%) out of 136 cases presented with heart failure with no identifiable aetiology and normal or anatomically non-significant coronary artery disease at angiography. In 13 (9.6%) of the 136 cases angiographic data were not available (five died, one declined, and seven had other medical conditions making angiography clinically inappropriate), and no aetiology could be identified on available non-invasive data. These cases remained classified as undetermined.

A comparison of the initial non-invasive panel aetiology and subsequent angiography/perfusion scan results in 99/136 cases with angiograms showed evidence of significant coronary artery disease in other panel attributed aetiologies (table 1). When the non-invasive panel diagnosed coronary artery

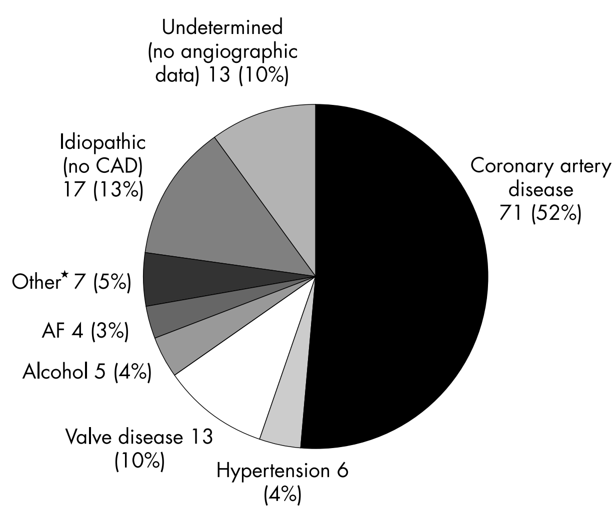

Figure 2 Final aetiology of heart failure in 136 cases aged less than 75 years using angiographic and myocardial perfusion data (where available). AF, atrial fibrillation; CAD, coronary artery disease. Reproduced from Fox *et al*,[3] with permission.

Table 1 Presence of coronary artery disease (in the 99/136 cases under 75 years with angiographic information available) in patients allocated by the case definition panel before study angiography to coronary artery disease (CAD), other aetiologies, or no aetiology. Reproduced from Fox *et al*[3] with permission

Aetiology allocated by panel before angiography	Normal or minor CAD	Significant CAD (≥50% stenosis in an epicardial artery)	Cases who underwent revascularisation before study entry
CAD (n=42)	2* (5%)	21 (50%)	19 (45%)
Other defined aetiologies (n=30)	14 (47%)	14 (47%)	2† (7%)
Aetiology undetermined by case definition panel (n=27)	17 (63%)	10 (37%)	0 (0%)
All cases (n=99)	33 (33%)	45 (45%)	21 (21%)

*One case who gave a history of myocardial infarction but no evidence of regional wall motion abnormality on ventriculography and only minor CAD found at catheterisation, and one case with clinical evidence of a myocardial infarction but anatomically non-significant CAD.
† Heart failure caused by valve disease—that is, non-aetiological CAD.

disease this was subsequently confirmed at angiography in the vast majority (95%) of cases. For other aetiologies significant coronary artery disease was found in just over half. For those in whom the non-invasive panel could not define an aetiology, significant coronary artery disease was found in over a third. So in total two thirds of the cases of heart failure < 75 years with angiographic data had evidence of significant coronary artery disease.

There were 21 cases who had not at the time of initial non-invasive panel assessment undergone angiography and they were assigned to hypertension, alcohol or atrial fibrillation. Fifteen (71%) subsequently underwent angiography and in seven (47%) important coronary artery disease was present. This included three out of five cases thought to be caused by hypertension. In the group of 40 out of 136 cases in whom the panel were unable to allocate an aetiology before angiography, 27 (68%) underwent catheterisation. Angiography demonstrated important coronary disease in 10 (37%) of these 27 cases. Overall the additional information from coronary angiography altered the initial panel aetiology of 18 cases.

For coronary artery disease to be defined as the aetiology of a patient's heart failure requires angiographic evidence of atherosclerotic disease and independent evidence that this disease is responsible for the myocardial dysfunction. Coronary angiography is the definitive investigation for coronary anatomy and was therefore considered essential to this epidemiological study. The functional importance of the coronary disease also needed to be determined. While no investigation can differentiate ischaemic myocardium from other forms of dysfunctional myocardium with absolute certainty, a more complete picture can be obtained by combining clinical, echocardiographic, and anatomical findings with myocardial perfusion imaging. In this study angiographic and other data confirmed that 71 (52%) (95% CI 43% to 61%) of the 136 cases of heart failure under 75 years were caused by coronary artery disease. It is likely that the 23 cases with non-invasively assigned aetiologies, other than coronary artery disease, and who did not subsequently undergo angiography, also had important coronary artery disease. Therefore, the proportion of all cases caused by coronary artery disease is likely to be higher than 52%. Assuming the proportion of important coronary artery disease in these cases is the same as in those who did undergo angiography, this would raise the overall proportion with aetiologically important coronary disease under 75 years to 59%.

The finding of coronary artery disease has potential treatment implications, beyond angiotensin converting enzyme (ACE) inhibitors, β blockers, and spironolactone, in terms of other treatments which can modify the underlying disease process and also revascularisation of an ischaemic myocardium. Coronary secondary prevention measures, such as aspirin and lipid lowering therapy, could prevent another coronary event and thus further deterioration in left ventricular function. Such treatments could be initiated if judged appropriate for an individual patient having taken account of comorbidity and other factors. A post hoc analysis of the 4S trial has reported that simvastatin is associated with a lower incidence of heart failure in coronary patients, reflecting a lower frequency of further myocardial ischaemic insults. However, in patients presenting for the first time with heart failure caused by coronary artery disease the potential reduction in risk of recurrent or progressive heart failure and death from a comprehensive multifactorial risk factor intervention programme has yet to be quantified in a randomised controlled trial. Nor is there any trial evidence to support revascularisation in the context of hibernating myocardium in heart failure.

SURVIVAL OF CLINICAL HEART FAILURE PATIENTS

In the Hillingdon heart failure study the 220 incident cases of heart failure have been followed up for mortality.[2] Date of death and certified cause of death were identified by flagging each patient's record at the National Health Service central registry using their NHS number. Since the initial report on survival based on 90 deaths over a mean follow up of 16 months (range 6–26 months) this cohort of 220 patients has now been followed up for 42 months and there have been 126 deaths. Figure 3 shows the survival curve for this cohort. Survival was 81% at one month, 75% at three months, 70% at six months, 62% at 12 months, 53% at 24 months, and 54% at 36 months. The majority of these deaths were related to cardiovascular disease. The standardised mortality ratio for cardiovascular deaths within this cohort was 18.1 at 12 months, representing an 18-fold increase (95% CI 15 to 23)

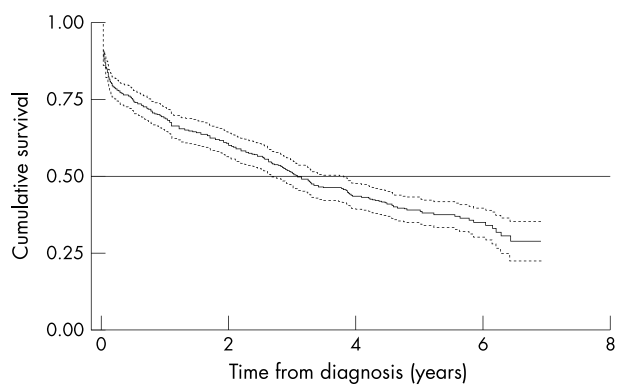

Figure 3 Survival of 552 incident cases of heart failure, from the London heart failure studies (with 95% confidence intervals). Modified from Cowie *et al*.[2]

compared with individuals of the same age and sex in the general population.

Almost a fifth of patients had died within the first four weeks of diagnosis, and most of these deaths were in hospital because of acute or established cardiovascular disease. The survival curve is for all new cases of heart failure and all aetiologies combined. However, this survival pattern is largely determined by cardiovascular disease and in particular coronary artery disease. The number of cases with other attributed aetiologies (some of whom will also have clinically important coronary artery disease) is not sufficiently large in the Hillingdon study to plot separate survival curves.

So survival of new cases of heart failure is poor, especially in the short term, and their prognosis is considerably worse than that reported from drug trials. There are several possible explanations for this difference. First, clinical trials tend to recruit a selected group of patients with a better prognosis than the generality of patients with heart failure. The typical average age of patients in a drug trial for heart failure is 60 years, compared with around 75 years for patients with heart failure in the population. Most trials also require that a patient has had stable heart failure for some months before recruitment; the average duration of heart failure for many patients entering clinical trials is two or three years. Such patients are "natural survivors" in the sense that they have survived the early high risk period. Heart failure is often associated with considerable comorbidity but such patients are also unlikely to be recruited to clinical trials. These biases will make the prognosis of heart failure appear better in clinical trials than it actually is for most patients. The results of the London heart failure studies are very similar to those reported from population based studies in the USA—the Framingham heart study,[4] the Rochester epidemiology project,[5] and the Olmsted County study.[6] Importantly, in the London studies patients were managed according to contemporary clinical guidelines for heart failure. For example, in the 163 out of 179 patients in the Hillingdon study surviving more than 30 days, 106 (65%) were prescribed an ACE inhibitor.[2] So survival is poor despite best treatments as demonstrated by the clinical trials, and many times worse than that of the general population.

RATIONALE FOR PREVENTION OF CLINICAL HEART FAILURE

So the contemporary epidemiology of clinical heart failure provides a strong rational for prevention because a large majority of cases are caused by coronary artery disease and hypertension, and the evidence that we can prevent the development of coronary heart disease, and its recurrence and consequences on ventricular function, is among the best of any aspect of clinical medicine.[7] It is illogical to wait until heart failure first presents in the elderly where the prognosis is poor, despite modern medical treatments, especially in the first few months after medical diagnosis. Therefore preventing or postponing the development of heart failure largely depends on the prevention of atherosclerotic disease, both acute and chronic coronary artery disease, and its complications. The case for coronary prevention is particularly compelling given that most heart failure patients present acutely to hospital and in those with coronary artery disease, about half are having an acute myocardial infarction. At least half of these patients are already known to have coronary or other atherosclerotic disease and were therefore already eligible for lifestyle, risk factor, and therapeutic intervention. If it were possible to reduce the incidence of acute and chronic coronary artery disease, both new and recurrent disease, and the underlying determinants of atherosclerosis such as hypertension and dyslipidaemia in the population, then the incidence of new cases of clinical heart failure could be reduced by at least half.

PREVENTION OF CORONARY HEART DISEASE

The Joint British Societies (British Cardiac Society, British Hypertension Society, British Hyperlipidaemia Association, and British Diabetes Association) defined priorities and strategies for CHD prevention in clinical practice together with lifestyle, risk factor, and therapeutic targets.[7,8] The National Service Framework for CHD adopted these priorities and endorsed the risk factor targets for blood pressure and blood lipids, and the appropriate use of prophylactic drug treatments such as aspirin, β blockers, ACE inhibitors, and statins.[9]

The priorities for CHD prevention in clinical practice are:

- patients with established CHD
- patients with other major atherosclerotic disease
- patients with hypertension, dyslipidaemia, diabetes mellitus, family history of premature CHD, or a combination of these risk factors, which puts them at high risk of developing CHD or other atherosclerotic disease; patients with diabetes mellitus are at particularly high risk of CHD.

Patients with symptomatic coronary disease are the top priority because they have declared themselves to medical services, and are at high risk of recurrent disease and heart failure. For these atherosclerotic disease patients every effort should be made to achieve the lifestyle, risk factor, and therapeutic targets shown in table 2. The care of coronary patients should embrace all aspects of cardiac prevention and rehabilitation. For some patients the initial presentation with an acute myocardial infarction results in heart failure, and for others progressive myocardial ischaemic insults eventually result in heart failure together with other contributing factors such as hypertension. Blood pressure is a risk factor for coronary artery disease, and an independent risk factor for heart failure as well. For some patients with an acute infarction the extent of myocardial damage may be so great that progressive heart failure is inevitable, and the extent to which drug therapies and other treatments can modify these patients subsequent clinical course is limited.

Yet for most patients presenting with symptomatic coronary disease exertional angina is the most common clinical manifestation, not myocardial infarction, and these patients usually have well preserved ventricular function. So addressing lifestyle and risk factor management in angina patients will reduce the risk of progressing to myocardial infarction and thus heart failure. Specifically, the use of antithrombotic, antihypertensive, and lipid modification medications will favourably modify the clinical course of the coronary artery disease and protect the myocardium.[7] For those patients who have a myocardial infarction complicated by left ventricular dysfunction, but no clinical heart failure, an ACE inhibitor reduces the incidence of progressing to severe heart failure.[10–12] In a post hoc analysis of the SAVE trial a β blocker in asymptomatic coronary patients with left ventricular dysfunction also showed a reduced risk of progression to severe heart failure.[13] Similarly in coronary and other high risk patients with preserved ventricular function, an ACE inhibitor also reduces incident heart failure.[14] For lipid lowering therapy the use of a statin in coronary patients (myocardial infarction and angina pectoris) without heart failure, in a post hoc analysis of 4S, also reduced the risk of developing heart failure.[15] Other lipid lowering trials have not reported on the incidence of heart failure but in both CARE and LIPID the risk of myocardial infarction was reduced and thus a reduction in subsequent risk of progressing to heart failure would be expected. Achieving the blood pressure target of < 140/85 mm Hg (and < 130/80 mm Hg in patients with diabetes) will further limit the contribution of blood pressure to the development of heart failure, both in patients with established CHD and in healthy individuals at high risk.

People at high multifactorial risk, without clinically overt CHD or other major atherosclerotic disease, can be identified

Table 2 Joint British Societies recommendations on lifestyle, risk factor, and therapeutic targets in patients with established coronary heart disease (CHD), or other atherosclerotic disease, and healthy individuals at high multifactorial risk. Reproduced from the summary of the Joint British recommendations on prevention of coronary heart disease in clinical practice,[8] with permission of the BMJ Publishing Group

Patients with CHD or other atherosclerotic disease	People without overt CHD or atherosclerotic disease at high risk (absolute CHD risk ≥15% over 10 years)
Lifestyle targets for all patients	
Stop smoking, make healthier food choices, increase aerobic exercise, and moderate alcohol consumption Body mass index <25 kg/m^2 is desirable, with no central obesity	
Targets for other risk factors	
Blood pressure < 140 mm Hg systolic and < 85 mm Hg diastolic	
• *All patients* to have blood pressure reduced to consistently < 140/85 mm Hg	Healthy individuals with • *Systolic blood pressure ≥160 mm Hg or diastolic blood pressure ≥100 mm Hg:* lifestyle advice and drug treatment if blood pressure is sustained at these levels on repeat measurements regardless of absolute CHD risk • *Systolic blood pressure 140–159 mm Hg or diastolic blood pressure 90–99 mm Hg:* CHD risk ≥15% or target organ damage: Lifestyle advice and drug treatment if blood pressure is sustained at these levels on repeat measurements — If CHD risk <15% and no target organ damage: Lifestyle advice and reassess annual • *Systolic blood pressure <140 mm Hg and diastolic blood pressure <90 mm Hg:* Lifestyle advice and reassess in 5 years
Total cholesterol <5.0 mmol/l (LDL cholesterol <3.0 mmol/l)	
• *All patients* to have total cholesterol reduced to consistently below 5.0 mmol/l (LDL cholesterol <3.0 mmol/l)	Healthy individuals with • *Familial hypercholesterolaemia or other inherited dyslipidaemia:* Lifestyle advice and drug treatment • *Total cholesterol >5.0 mmol/l:* CHD risk ≥15%: Lifestyle advices and drug treatment* if cholesterol sustained on repeat measurements — If CHD risk <15%: Lifestyle advice; reassess annually if risk is close to 15%
Patients with diabetes mellitus	
Total cholesterol <5.0 mmol/l (LDL cholesterol <3.0 mmol/l) Blood pressure <130 mm Hg systolic and <80 mm Hg diastolic (<125 mm Hg systolic and <75 mm Hg diastolic when there is proteinuria) Optimal glycaemic control: HbA$_{1c}$ <7%	
Cardioprotective drug treatment	
• Aspirin for all patients • β Blockers at doses prescribed in clinical trials after myocardial infarction, particularly in high risk coronary patients and for at least 3 years • Cholesterol lowering agents (statins) at doses prescribed in clinical trials • ACE inhibitors at doses prescribed in clinical trials for patients with symptoms or signs of heart failure at time of myocardial infarction, or in those with persistent left ventricular systolic dysfunction (EF <40%) • Anticoagulants for patients at risk of systemic embolisation with large anterior infarctions, severe heart failure, left ventricular aneurysm, or paroxysmal tachyarrhythmias	• Aspirin (75 mg daily) in individuals aged >50 years whose hypertension, if present, is controlled
Screening of first degree relatives	
• Screening of first degree blood relatives (principally siblings and offspring aged 18 years or older) of patients with premature CHD (men <55 years and women <64 years) or other atherosclerotic disease is encouraged and in the context of familial dyslipidaemias is essential	• Screen close relatives if familial hypercholesterolaemia or other inherited dyslipidaemia is suspected

*If resources do not permit drug treatment at 15% then 30% is the minimum acceptable.
ACE, angiotensin converting enzyme; EF, ejection fraction; HbA$_{1c}$, glycated haemoglobin; LDL, low density lipoprotein.

Trial acronyms

AFCAPS/TEXCAPS: Air Force/Texas Coronary Prevention Study
ASPIRE: Action on Secondary Prevention through Intervention to Reduce Events
CARE: Cholesterol And Recurrent Events
HOPE: Heart Outcomes Prevention Evaluation
LIPID: Long-term Intervention with Pravastatin in Ischemic Disease
SAVE: Survival And Ventricular Enlargement
SOLVD: Studies Of Left Ventricular Dysfunction
4S: Scandinavian Simvastatin Survival Study
WOSCOPS: West of Scotland Coronary Prevention Study

from the Joint British Societies' coronary risk prediction chart.[8] As absolute risk of CHD (non-fatal myocardial infarction and coronary death) increases, so lifestyle intervention should be intensified. Introducing drug treatment for raised blood pressure or lipid concentrations should be strongly determined by the absolute risk of developing disease. An absolute risk of CHD ⩾ 15% (equivalent to a cardiovascular risk of 20%) over 10 years is considered to be sufficiently high to justify drug treatment. For all high risk patients every effort should be made to achieve the lifestyle, risk factor, and therapeutic targets given in the table.

A meta-analysis of blood pressure lowering trials shows that antihypertensive therapy in the healthy population reduces the incidence of heart failure by 52%.[16] This finding is reinforced by the HOPE trial which included patients at high risk, but without symptomatic atherosclerotic disease and no left ventricular dysfunction.[14] HOPE reported a 23% reduction in the incidence of heart failure. In the prevention arm of the SOLVD trial both an ACE inhibitor and a β blocker (post hoc analysis) resulted in a lower risk of the combined end point of heart failure and death.[17] While the primary prevention lipid lowering trials have not reported the incidence of heart failure, the reduction in myocardial infarction in both WOSCOPS and AFCAPS/TEXCAPS is again likely to reduce the subsequent risk of heart failure.

AUDITS OF PREVENTIVE CARDIOLOGY PRACTICE

Unfortunately, national audits of lifestyle, risk factor, and therapeutic management of coronary patients in the UK, such as ASPIRE[18] and EUROASPIRE,[19 20] consistently show a majority of patients are still not achieving the blood pressure and cholesterol targets, despite an increase in use of prophylactic drug treatments. In the second EUROASPIRE survey, which included six centres in the UK, 8181 medical records were reviewed and 5556 patients (adjusted response rate of 76%) interviewed from 47 centres in selected geographical areas in 15 countries.[19] Consecutive patients < 70 years were identified retrospectively with the following diagnoses: coronary artery bypass graft, percutaneous transluminal coronary angioplasty, acute myocardial infarction, and myocardial ischaemia. Data collection was based on a review of medical records and then on interview and risk assessment at least six months after hospital admission.

Recording of risk factor history and management in hospital notes was incomplete, particularly for discharge documents. Only a minority (27%) had their weight recorded and less than half had a blood pressure measurement (49.6%) or cholesterol measurement (42.4%) in the discharge document. In the UK the figures were 12%, 30.9%, and 16.8%, respectively. At follow up interview (median time 1.4 years after hospital discharge) the risk factor profile was as follows (UK results for comparison in brackets): 21% (18%) of patients were smoking cigarettes, 31% (38%) were obese, 50% (52%) had raised blood pressure (systolic blood pressure ⩾140 mm Hg and/or diastolic blood pressure ⩾90 mm Hg), 58% (54%) had raised serum total cholesterol (total cholesterol ⩾5 mmol/l), and 20% (21%) reported a medical history of diabetes. Glucose control in these diabetic patients was poor, with 80% having plasma glucose > 6.0 mmol/l and 72% ⩾ 7 mmol/l. The use of prophylactic drug treatments at interview was as follows: aspirin or other antiplatelet drugs 86% (81%), β blockers 63% (44%), ACE inhibitors 38% (28%), and lipid lowering drugs 61% (69%).

In terms of therapeutic control only 49% of patients on blood pressure lowering medication had reached the European Societies' goal of < 140/90 mm Hg. The proportion was identical in the UK. Overall the majority (87%) of patients were on one or more blood pressure lowering drugs, although not necessarily initiated as antihypertensive therapy. The majority of patients were also on lipid lowering medication (61%); 50.6% on such medication, principally a statin, had achieved the cholesterol goal of < 5.0 mmol/l. In the UK the figure was 54.3%.

So a majority of coronary patients are not achieving the lifestyle, risk factor, and therapeutic targets either in the UK or elsewhere. In comparison with the first EUROASPIRE survey adverse lifestyle trends are apparent. There is an increase in the proportion of younger (< 50 years) patients smoking cigarettes, and a substantial increase in the prevalence of obesity in all countries.[20] There was virtually no change in the proportion of patients achieving the blood pressure target between surveys despite an increased use of antihypertensive medication in the form of β blockers and ACE inhibitors. The increased prevalence of obesity may be contributing to this failure to improve the proportion of patients achieving the blood pressure target. Although there is a real increase in the proportion of patients achieving the cholesterol target this still leaves a majority yet to do so. This improvement in lipid management reflects a substantial increase in prescriptions for lipid lowering medications, particularly the statins. The prevalence of undetected diabetes in the second survey is also a matter of concern, as this metabolic syndrome is associated with a particularly high risk of further coronary disease. Self reported diabetes was found in 19.6% of patients and this increased to 38% of all patients when those with a fasting glucose ⩾ 7.0 mmol/l were added. Obesity was much more common in those with known diabetes compared to those coronary patients without diabetes, and fewer diabetic patients had achieved the minimum European blood pressure target of < 140/90 mm Hg. However, a majority of patients with diabetes had achieved the cholesterol target.

When a patient presents with coronary disease, particularly premature disease, the opportunity to extend preventive activities to the family as a whole is presented. Cardiovascular screening of all first degree relatives of patients with premature CHD (men < 55 years and women < 65 years) is recommended.[7] In EUROASPIRE II there was a family history of CHD at any age in 54.8% of cases, and premature CHD (men < 55 years and women < 65 years) in 28.8% of cases. The figures for the UK were 53.8% and 30.8% respectively.[19] Yet in the EUROASPIRE II survey a large majority of first degree relatives (siblings and offspring) had not been screened for cardiovascular risk factors—a missed opportunity for primary prevention of coronary disease and heart failure.

In the healthy population there is even greater scope for more effective risk factor intervention in high risk individuals. In the 1994 health survey for England of 12 116 adults, awareness of hypertension was common among those with a blood pressure ⩾ 160/95 mm Hg, or receiving antihypertensive treatment.[21] However, among these hypertensives only 50% were receiving treatment and just 30% had their blood pressure controlled (< 160/95 mm Hg) by a rather more conservative criterion than today's target of < 140/85 mm Hg. In the same study cardiovascular risk factor management of diabetic patients was evaluated.[22] In 97 diabetic subjects 19%

were current smokers, 27% were obese and 38% had hypertension by the same definition used above; one third were untreated and less than one half of those on treatment had their blood pressure controlled to < 160/95 mm Hg. The current blood pressure target in diabetic patients is < 130/80 mm Hg.[7] Of those aged < 70 years 29% required lipid lowering therapy because their absolute multifactorial CHD risk was > 30% and almost all (94%) were not on treatment.[22] The current threshold for lipid lowering therapy is an absolute CHD risk ⩾ 15% over 10 years.[7] Finally, more than one quarter of these diabetic patients had poor glycaemic control (glycated Hb > 11% or an HbA_{1c} > 7.5%). So the potential for more effective risk factor management in primary prevention is also evident, and the challenge is even greater because the risk factor targets for blood pressure are now lower, especially for diabetic patients. Lipid management is now also an integral part of risk factor care, compared to the early 90s, and in contrast to blood pressure management, general practitioners are starting from an even lower baseline of care and therefore have much more work to do. In diabetic patients the traditional focus has been glycaemic control but this is now changing towards a much greater emphasis on other risk factors, especially the control of blood pressure and also lipids.

CONCLUSION

There is considerable potential throughout Europe, including the UK, to raise the standard of preventive cardiology by more effective lifestyle intervention, control of risk factors, and optimum use of prophylactic drug treatments in both patients with atherosclerotic disease and healthy high risk individuals. By achieving the lifestyle and risk factor targets, and through the appropriate use of prophylactic drug treatments, the progression of coronary disease and its complications will be reduced.[7 8] Specifically the risk of myocardial (re)infarction will be reduced and thus so will the progressive myocardial damage which ultimately leads to clinical heart failure. Only by addressing the causes and consequences of coronary artery disease and its impact on ventricular function will the incidence of heart failure be substantially reduced in the population.

....

Correspondence to: Professor David A Wood, Cardiovascular Medicine, Charing Cross Hospital, Cardiology Department, 5th Floor, Fulham Palace Road, London W6 8RF, UK; d.wood@ic.ac.uk

REFERENCES

1 **Cowie MR**, Wood DA, Coates AJS, *et al*. Incidence and aetiology of heart failure: a population-based study. *Eur Heart J* 1999;**20**:421–8.
2 **Cowie MR**, Wood DA, Coates AJS, *et al*. Survival of patients with a new diagnosis of heart failure: a population based study. *Heart* 2000;**83**:505–10.
3 **Fox KF**, Cowie MR, Wood DA, *et al*. Coronary artery disease as the cause of incident heart failure in the population. *Eur Heart J* 2001;**22**:228–36.
4 **Ho KK**, Pinsky JL, Kannel WB, *et al*. The epidemiology of heart failure: the Framingham study. *J Am Coll Cardiol* 1993;**22**:6–13A.
5 **Rodeheffer RJ**, Jacobson SJ, Gersh BJ, *et al*. The incidence and prevalence of congestive heart failure in Rochester, Minnesota. *Mayo Clinic Proc* 1993;**68**:1143–50.
6 **Senni M**, Tribouilloy CM, Rodeheffer RJ, *et al*. Congestive heart failure in the community: a study of all incident cases in Olmsted County, Minnesota, in 1991. *Circulation* 1998;**98**:2282–9.
7 **Wood D**, Durrington P, Poulter N, *et al* on behalf of the British Cardiac Society, British Hyperlipidaemia Assocoation, British Hypertension Society and British Diabetic Association. Joint British recommendations on prevention of coronary heart disease in clinical practice. *Heart* 1998;**80**(suppl 2):S1–29.
8 **British Cardiac Society**, British Hyperlipidaemia Association, British Hypertension Society, British Diabetic Association. Joint British recommendations on prevention of coronary heart disesese in clinical practice: summary. *BMJ* 2000;**320**:705–8.
9 **Department of Health**. *National service framework for coronary heart disease*. London: Department of Health, 2000.
10 **Pfeffer MA**, Braunwald E, Moye LA, *et al*, on behalf of the SAVE Investigators. Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after MI: results of the survival and ventricular enlargement trial. *N Engl J Med* 1992;**327**:669–77.
11 **The SOLVD Investigators**. Effect of enalapril on mortality and the development of heart failure in asymptomatic patients with reduced left ventricular ejection fractions. *N Engl J Med* 1992;**327**:685–91.
12 **Kober L**, Torp-Pedersen C, Carlsen JE, *et al*. A clinical trial of the angiotensin-converting-enzyme inhibitor trandolapril in patients with left ventricular dysfunction after myocardial infarction. Trandolapril cardiac evaluation (TRACE) study group. *N Engl J Med* 1995;**333**:1670–6.
13 **Vantrimpont P**, Rouleau J, Wun C-C, *et al*, for the SAVE Investigators. Additive beneficial effects of beta-blockers to angiotensin-converting enzyme inhibitors in the survival and ventricular enlargement (SAVE) study. *J Am Coll Cardiol* 1997;**29**:229–36.
14 **The Heart Outcomes Prevention Evaluation Study Investigators**. Effects of an angiotensin-converting-enzyme inhibitor, ramipril, on cardiovascular events in high-risk patients. *N Engl J Med* 2000;**342**:145–53.
15 **Kjekshus J**, Pedersen TR, Olsson AG, *et al*. The effects of simvastatin on the incidence of heart failure in patients with coronary heart disease. *J Cardiac Failure* 1997;**3**:249–54.
16 **Moser M**, Hebert PR. Prevention of disease progression, left ventricular hypertrophy and congestive heart failure in hypertension treatment trials. *J Am Coll Cardiol* 1996;**27**:1214–18.
17 **Exner DV**, Dries DL, Waclawiw MA, *et al*. Beta-adrenergic blocking agent use and mortality in patients with asymptomatic and symptomatic left ventricular systolic dysfunction: a post hoc analysis of the studies of left ventricular dysfunction. *J Am Coll Cardiol* 1999;**33**:916–23.
18 **ASPIRE Steering Group**. A British Cardiac Society survey of the potential for the secondary prevention of coronary disease: ASPIRE (action on secondary prevention through intervention to reduce events). Principal results. *Heart* 1996;**75**:334–42.
19 **EUROASPIRE II Study Group**. Lifestyle and risk factor management and use of drug therapies in coronary patients from15 countries. Pricipal results from EUROASPIRE II. Euro heart survey programme. *Eur Heart J* 2001;**22**:554–72.
20 **EUROASPIRE I and II Group**. Clinical reality of coronary prevention guidelines: a comparison of EUROASPIRE I and II in nine countries. *Lancet* 2001;**357**:995–1001.
21 **Colhoun HM**, Dong W, Poulter NR. Blood pressure screening, management and control in England: results from the health survey for England 1994. *J Hypertens* 1998;**16**:747–52.
22 **Colhoun HM**, Dong W, Barakat MT, *et al*. The scope for cardiovascular disease risk factor intervention among people with diabetes mellitus in England: a population-based analysis from the health survey for England 1991-94. *Diabetic Medicine* 1999;**16**:35–40.

QUESTION AND ANSWER SESSION

Question: I am not sure how cardiologists in hospitals can possibly be responsible for identifying and managing multiple risk factors such as blood pressure and for managing heart failure?

Professor Wood: I think the responsibility of primary care is to identify individuals with high multifactorial risk of developed heart disease and heart failure and manage them effectively, with the support to some extent of specialist clinics in hypertension and diabetes in hospital. But when a patient presents with symptomatic heart failure, I think those patients should all be seen by specialists in hospital. I say that because the diagnosis of heart failure is quite tricky. I'm embarrassed to say that I can get it wrong despite the availability of all of the investigations we have in the hospital setting. Also, I think the management of heart failure can be quite difficult—the original management plan should be laid down by a specialist who is most likely to be aware of the best available current evidence that can be applied to his or her patients.

Professor Hall: It should be a collaborative issue with a part to play by both primary care (who see by far the most people) and specialist clinics who pick up a small group of much more severely ill patients.

Professor Wood: I'm being provocative, but with serious intent. If you have cancer then you expect to be seen by a specialist and rightly so. You would expect to have the opinion of someone who knows something about your cancer, about its histology and its contemporary management on the basis of trial evidence. Why should you not see a specialist if you develop heart failure? The argument for all of this or part of this being done in primary care is actually a function of the difficulties we face in the health service and the demands on cardiology services and so on. But that should not detract from the argument that specialists are best placed to diagnose and manage heart failure.

Question: Your figures on the incidence of heart failure were interesting: 1.3 per thousand patients per year. In primary care we are looking at three patients per GP per year, two of which you say will be diagnosed in a hospital setting anyway. So we are looking at one patient per GP per year detection. I think those figures back up your argument.

Professor Wood: I absolutely accept that. I think that once the diagnosis and management plan have been made, then I think there is a need for some form of structured care between the hospital and general practice that will ensure optimal long term management.

Question: I like your argument about secondary prevention, and in primary care we are quite good at that. When you say that all patients with heart failure should be seen by specialists because their management is difficult to get right I am happy to accept that. How often in your experience does an echo or the fine tuned assessment of a patient significantly alter your management of a patient? I have a need for echos when I have real difficulty in knowing how much of their breathlessness is due to their heart or how much is due to other causes. There are times when it seems very obvious. By sending them to a specialist I want to know how that is going to change my management?

Professor Wood: You may have seen from the data I presented that about one in four of the patients referred to the rapid access heart failure clinics in both Hillingdon and Bromley turned out to have the clinical syndrome of heart failure. That means that about three quarters did not, which isn't a criticism of our colleagues in primary care, as it is a very difficult diagnosis to make sometimes. We expect GPs to have a low threshold for referring patients with a suspected heart failure. In the hospital service I would suggest that we need to observe patients and make repeated observations on a substantial proportion (which I can't quantify) before we come to a definitive opinion about the diagnosis of heart failure and its aetiology. Its not always a snap judgement; its not always florid pulmonary oedema in CCU. The spectrum of heart failure can make the diagnosis more complicated and require a little more consideration and a little more time. So how often do we change our minds in the light of a referral from general practice? I think quite a lot in practice.

Professor Hall: There is another role too: we talk a great deal about straightforward pharmacological treatments but there may well be other treatments available which will be effective for some of these patients, which they can only get to through further investigations—for example, viability studies or the use of complex pacing.