5 Coronary Heart Disease

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1 Executive summary

Statement of the problem

Coronary atherosclerosis manifests as sudden cardiac collapse, acute coronary syndromes, exertional angina, non-fatal arrhythmias, heart failure and death. These manifestations are often collectively referred to as coronary heart disease (CHD). Coronary atherosclerosis is ubiquitous in our population and CHD is the most common cause of death in both men and women in the UK. In some groups it is more common than others, with variations in mortality and morbidity rates being apparent regionally and within socio-economic and ethnic groups throughout the UK.

The principal strategy for reducing the population burden of this disease is primary prevention. The Government's White Paper *Saving Lives: Our Healthier Nation* has made heart disease and stroke a priority. The major lifestyle causes of CHD are known and need to be addressed at a society level.

In patients with CHD, the majority survive their first clinical presentation. In patients with symptomatic disease, morbidity and mortality is reduced through therapeutic and revascularisation procedures and over the longer term by lifestyle changes, risk factor modification, and the use of prophylactic drug therapies.

The National Service Framework on CHD has set priorities and targets, and addresses both prevention and treatment in an integrated strategy. In addition to a public health strategy for prevention, a complementary clinical strategy is required for primary prevention of coronary atherosclerosis and its complications, the prompt management of symptomatic disease and then secondary prevention and rehabilitation.

Sub-categories

A clinical strategy for coronary atherosclerosis and its complications encompasses the following sub-categories of patients.

- **Pre-symptomatic:** Individuals at high risk of developing CHD and other atherosclerotic disease and patients with asymptomatic coronary artery disease in the general population.
- **Symptomatic disease:** Individuals with symptomatic manifestations of coronary atherosclerosis (sudden cardiac collapse, acute MI, unstable angina, exertional angina and heart failure).
- **Post-symptomatic:** Individuals whose symptoms of CHD have been assessed and managed and who require rehabilitation to reduce the risk of recurrent coronary disease, improve quality of life and increase life expectancy.

Prevalence/Incidence

Pre-symptomatic

(a) **Individuals at high risk of developing CHD and other atherosclerotic disease:** Overall, 12% of men and 5% of women under 75 years have a CHD risk of $\geq$15% over 10 years and are potentially eligible for treatment.

(b) **Individuals with asymptomatic atherosclerosis:** The prevalence of Q wave abnormalities on resting ECGs in the general population, where no history of CHD is reported, suggest that all clinical estimates of disease frequency underestimate the true burden of disease in the population.

Symptomatic patients

From the Bromley Coronary Heart Disease Register (BCHDR) the incidence of symptomatic disease in 25–75 year olds per 100 000 per annum are summarised below.

Incidence rates for:	All	Male	Female
Number of cases	620	378	242
Sudden cardiac death	36 (28–44)	57 (43–75)	22 (15–31)
Chest pain, cardiac in origin, no history of CHD	481 (480–482)	583 (582–584)	379 (378–380)
Exertional angina, no history of CHD	122 (108–137)	172 (146–201)	89 (74–106)
Non-fatal acute MI, no history of CHD	75 (64–86)	133 (110–159)	37 (28–49)
Unstable angina, no history of CHD	34 (27–42)	53 (39–70)	22 (15–31)

Other estimates of the incidence and prevalence of symptomatic medical presentations of CHD from regional and national surveys include the following.

- The Health Survey for England found the overall prevalence of exertional angina in the population aged 16 years and over was 2.6% in men and 3.1% in women. In both sexes prevalence increased with age, being negligible in those aged under 35, to almost 1 in 5 in those aged 75 and over. In the same survey 4.2% of men reported having had a 'heart attack' with the prevalence in women being half that of men. Again, in both cases prevalence increased with age.
- The OXMIS study found the overall age standardised event rate for non-fatal first and recurrent MI in men and women aged 30–69 years per 100 000/annum, was 171 and 50 respectively.

Heart failure

In the Hillingdon Heart Failure Study the overall incidence rate for clinical heart failure for all ages was 130 per 100 000/annum. A variety of studies have estimated the prevalence of heart failure between 3–16/1000 patients, which rises with age. The prognosis of heart failure is poor. In one study the one-year survival was 62%.

Future epidemiological trends

Mortality rates from CHD are falling. The decline is considered to be primarily a fall in events rather than a decline in case fatality. The decline in smoking is an important contributing factor, as are changes in the

national diet. The medical and surgical management of patients presenting with coronary atherosclerosis is also a contributing factor to the decline in CHD mortality by reducing case fatality.

Services available

Pre-symptomatic

There is no national policy for cardiovascular screening of the healthy population in primary care. Such patients are currently detected through new patient checks and opportunistic screening.

Symptomatic

(a) **Out of hospital cardiac arrest:** Community studies have shown that about 75% of cardiac arrests occur outside of hospital. Overall survival from out of hospital cardiac arrest remains poor. The NHS plans to continue the single paramedic response system, prioritising emergency calls and reducing response times for life-threatening emergencies from the present 14 minutes for 95% of calls in urban areas to 8 minutes for 90% of all calls in all areas.

(b) **Presentation and management of cardiac chest pain in the community:** A patient seeking medical advice for chest pain can do so through their GP or Accident and Emergency (A&E). For the GP the diagnosis can be difficult from the history alone. Options are to perform an ECG, send the patient to casualty, refer for an open access 12 lead ECG or refer for a cardiology outpatient opinion. Community surveys of angina showed most patients were traditionally managed by their GP; only a small minority were referred for specialist opinion and investigations. The preferred model of care is now hospital-based Rapid Access Chest Pain Units. For those presenting directly to casualty, patients can be triaged in a variety of ways including Chest Pain Assessment Units and then the doctor can admit, refer to cardiology outpatients or refer back to the GP.

(c) **Presentation and management of exertional angina in the community:** Criteria for referring patients with exertional angina from primary care to hospital outpatients are not defined in most districts. There is therefore likely to be a large variation in practice between districts and between GPs within a district. The preferred model of care for patients with exertional angina, which is becoming widely available, is a Rapid Access Chest Pain Clinic (RACPC). A majority of hospitals now provide a chest pain clinic facility, and interest in this approach will continue to grow. However, there is wide variation in the protocols for these 'one stop clinics' although the overall objective is to have patients assessed within two weeks of presentation.

(d) **Presentation and management of acute coronary syndromes:** For patients admitted to hospital with an acute coronary syndrome, the majority first seek advice from their GP, and around a third call an ambulance or present directly to the casualty department. About one in two patients are ultimately managed by a cardiologist. The majority of patients with an admission diagnosis of acute MI are given thrombolytics with the median time interval between hospital arrival and starting thrombolytic therapy being 76 minutes.

(e) **Coronary revascularisation:** Whether by coronary artery surgery or by percutaneous angioplasty, coronary revascularisation can both save lives and improve quality of life. Since 1980 there has been a fourfold increase in the number of coronary artery bypass graft (CABG) operations. Angioplasty and other coronary intervention procedures have increased more rapidly over a shorter time period. There are marked variations in revascularisation rates which are not closely correlated with the coronary disease burden. Revascularisation rates are lower in the UK than many other Western European countries.

(f) **Presentation and management of heart failure in the community:** The majority of patients developing clinical heart failure for the first time present as an acute medical emergency. The rest present to their GP and are either diagnosed and managed in the community or referred for specialist investigation and a consultant opinion. The diagnosis of clinical heart failure can be improved with the addition of echocardiography. More recently, natriuretic peptides are being used as diagnostic markers of heart failure. In practice, patients in the community are commonly diagnosed on clinical criteria alone, often supported by simple investigations such as the ECG and chest X-ray. There is evidence of underinvestigation of patients with suspected heart failure. Once the clinical diagnosis of heart failure has been made and the aetiology defined, subsequent management will include diuretics, ACE inhibitors (or AII receptor blockers), beta-blockers and spironolactone in some combination. Current evidence suggests underuse of these agents. The way in which these treatments are started, up-titrated and monitored varies considerably. Specialist heart failure nurses are being introduced in some districts to provide liaison care between the hospital and the community.

Post-symptomatic: Cardiovascular prevention and rehabilitation

After the acute medical/surgical management of patients presenting with CHD, the clinical strategy is to reduce the risk of recurrent disease, improve quality of life and increase life expectancy. Traditionally, cardiac rehabilitation has focused on supervised exercise sessions, but this is gradually evolving into comprehensive lifestyle programmes based on behavioural models of change. Risk factor management in terms of controlling blood pressure, lipids and diabetes, and the use of prophylactic drug therapies such as aspirin is also becoming an integral part of this approach to reduce cardiovascular disease. And finally, the psychosocial and vocational support required to help patients lead as full a life as possible is also provided.

Service provision still remains inadequate in many parts of the country. There is also wide variation in practice and in the organisation and management of cardiac rehabilitation services.

Effectiveness

Pre-symptomatic patients

(a) Individuals at high risk of developing CHD

- **Cardiovascular screening:** The evidence from randomised controlled trials (RCTs) of systematic (unselected) nurse-led multifactorial cardiovascular screening in primary care is disappointing showing small reductions in total coronary risk, achieved principally through lifestyle change. In contrast unifactorial intervention trials, usually with drug therapies, show significant benefits in coronary and other vascular morbidity and mortality for both antihypertensive and cholesterol modification therapies in primary prevention.
- **Lifestyle interventions:** Individuals who choose to stop smoking have a lower risk of subsequent CHD. The few RCTs of diet in primary prevention of CHD have principally tested a reduction in saturated fat and have shown no benefit in relation to CHD and total mortality. Trials of diet in relation to surrogate end-points for CHD, namely lipoproteins and blood pressure, have provided evidence that modifying dietary components can favourably influence these risk factors for CHD. RCTs of dietary supplements of vitamins and other food nutrients have provided no convincing evidence to support their use. The adoption of moderate physical

activity is associated with a reduced risk of non-fatal coronary disease and both cardiovascular and non-cardiovascular mortality.

- **Blood pressure and blood lipids:** Several large-scale RCTs have demonstrated that blood pressure lowering by drugs reduces cardiovascular morbidity and mortality. Antihypertensive treatment has resulted in a substantial reduction in the risk of stroke and heart failure associated with hypertension. Clinical evidence of the benefit of lowering blood cholesterol in relation to primary prevention of CHD has been obtained from several RCTs. In two recent trials of statins there was a significant reduction in the combined end-point of non-fatal and fatal coronary events.
- **Diabetes mellitus:** Although both types of diabetes are associated with a markedly increased risk of CHD, cerebrovascular disease and peripheral vascular disease there has been no convincing evidence from RCTs that glycaemic control has any benefit in relation to these macrovascular complications, but the control of other risk factors such as blood pressure does reduce coronary and other vascular risk.

Symptomatic patients

(a) **Out of hospital cardiac arrest:** Direct current cardioversion for ventricular flutter/fibrillation in the context of acute myocardial ischaemia/infarction is life-saving. In specialised areas of care in a hospital where staff are trained in all aspects of advanced cardiopulmonary resuscitation, the chances of surviving a cardiac arrest are optimal. For out of hospital cardiac arrests this is not so, and the evidence shows that only a small minority survive to reach hospital and then be discharged alive.

(b) **Chest pain in the community:** There is no evidence from RCTs that rapid assessment of chest pain will favourably modify the natural history of exertional angina. Such clinics resolve the diagnosis and initiate appropriate management.

(c) **Exertional angina:**

- **Drug therapy:** There is no evidence from RCTs that any therapeutic drug class used to treat the symptoms of angina has any survival benefit. However, there is trial evidence that prophylactic aspirin and cholesterol-lowering therapy with a statin reduces the risk of subsequent morbidity and mortality and can improve survival.
- **Coronary revascularisation:** Revascularisation of selected patients with stable exertional angina, either by coronary artery surgery or coronary angioplasty, will reduce morbidity and mortality.

(d) **Acute coronary syndromes:** Q wave MI, non Q wave MI and unstable angina.

Numerous trials have changed the management of acute coronary syndromes substantially, with further developments still to come. Effective interventions include:

- **Anti-ischaemic therapy:** Beta-blockers.
- **Anti-thrombotic therapy:** Anti-platelet therapy with aspirin and clopidogrel, alone or in combination. The National Institute of Clinical Excellence has recommended that all high risk patients are given a Gp IIb/IIIa receptor blocker as soon as possible on admission with a non-ST elevation acute coronary syndrome.
- **Acute anticoagulation:** Low molecular weight heparin.
- **Thrombolytic therapy:** For patients with an evolving MI, seen within 12 hours of the onset of symptoms, aged < 75 years. For older patients and those seen after 12 hours, or with other ECG changes, there is no convincing evidence for thrombolytic therapy.
- **Long-term anticoagulation:** The data for oral anticoagulation in addition to aspirin is contradictory.

- **Interventional therapy:**
  - **Primary angioplasty:** An alternative to thrombolytic therapy in an evolving MI when undertaken by a skilled interventionist.
  - **Early revascularisation:** The benefit of early revascularisation for high risk patients has been compared with a conservative medical approach in a number of trials, but requires further evaluation.
  - **Late revascularisation:** Patients following an MI are at high risk of reinfarction and coronary death. In the DANAMI trial those patients randomised to an invasive strategy, which included revascularisation of those with abnormal exercise tests, had a better outcome.
- **Other therapies:**
  - **Statins:** Although there is no convincing evidence for status in the acute phase of the disease there is compelling evidence for the long-term use of this drug class in reducing the risk of non-fatal and fatal coronary disease, other vascular disease and total mortality.
  - **ACE inhibitors:** In patients with an MI there is also evidence of mortality benefit for angiotensin-converting enzyme (ACE) inhibitors. Patients with symptoms or signs of heart failure at the time of MI, or with echocardiographic evidence of significant LV systolic dysfunction, will benefit from ACE inhibitors.
  - **Anti-arrhythmic drugs:** There is no single trial evidence for the prophylactic use of anti-arrhythmic drugs, other than beta-blockers, in the management of acute coronary syndromes. An individual patient meta-analysis of amiodarone following MI found a 13% reduction in the total mortality.

(e) **Heart failure:** ACE inhibitors and beta-blockers improve survival in all grades of heart failure. Digoxin therapy for patients whose rhythm is sinus in heart failure does not confer any survival benefit but may be useful for symptoms and to reduce hospitalisation. Although there is no clinical trial evidence for diuretic therapy, this treatment was beneficial to patients in heart failure when first used and all therapeutic agents with proven survival benefit are given in combination with diuretics. Few non-pharmacological treatments have been tested in large RCTs. Cardiac transplantation improves survival. LV assist devices may act as a bridge to transplantation. Revascularisation has not been tested in a RCT but case series suggest it is useful in patients with 'viable' myocardium. Complex biventricular pacing improves symptoms in highly selected patients.

Post-symptomatic patients

(a) **Lifestyle interventions:** Evidence from observational studies shows that patients who choose to quit smoking have a lower risk of recurrent disease and a longer life expectancy. Three RCTs have shown benefit from dietary modification following an MI, through supplementation with polyunsaturated fatty acids, by reducing the risk of recurrent disease and improving survival. There have been a large number RCTs of exercise rehabilitation following MI and two meta-analyses have shown that such rehabilitation reduces by 20–25% overall cardiovascular mortality.

(b) **Other interventions:** Although blood pressure elevation in patients with MI is associated with an increased risk of re-infarction, there is no RCT evidence of blood pressure lowering following the development of coronary disease. However, several classes of antihypertensive agents given to selected patients following MI have reduced subsequent coronary morbidity and mortality. There is compelling evidence that use of statins following the development of coronary disease is associated with a survival benefit. In patients with CHD, aspirin and other platelet-modifying drugs, beta-blockers, ACE inhibitors and anticoagulation have also been shown in single trials or meta-analyses to reduce total mortality.

Models of care

National Service Framework for CHD

The standards presented in the NSF for CHD should be adhered to and local delivery plans drawn up by relevant partners.

Cardiovascular screening

Screening of individuals in general practice should be multifactorial and absolute risk of developing CHD calculated using the Joint British Societies Coronary Risk Prediction Chart. All high risk relevant individuals should receive lifestyle advice in relation to smoking, diet and physical activity. Absolute CHD risk should be the major determinant of whether drugs are used in primary coronary prevention.

Sudden cardiac collapse

Patients with chest pain and no past history of CHD should call 999 or go directly to the nearest A&E department. Patients with known CHD who experience a recurrence of chest pain, or have worsening symptoms, should also seek immediate medical help from the same sources, or their GP. When a GP is called to see a patient with chest pain an ambulance should be called at the same time if the pain is considered to be severe. All patients for whom an ambulance is summoned because of chest pain or collapse should be given priority, and attended by a paramedical crew trained and equipped for advanced cardiopulmonary resuscitation. Relatives of patients with CHD should be offered the opportunity of training in CPR.

Exertional (stable) angina

All patients with exertional (stable) angina should be assessed by a cardiologist through a Rapid Access Chest Pain Clinic to confirm the diagnosis, initiate appropriate management and to select those high risk patients who may benefit from revascularisation. Lifestyle and other risk factors need to be addressed in this patient group. Elective coronary artery surgery in selected high risk patients relieves symptoms and improves prognosis. The availability of coronary surgery should be proportional to the standardised mortality ratio for coronary disease to ensure an equitable distribution of cardiac services on the basis of clinical need across the country.

Acute coronary syndromes

All patients with acute chest pain need to be assessed in hospital rapidly. Risk stratification of patients with acute coronary syndromes is critical in identifying those individuals at high risk of future events. A clinical history supported by an ECG and newer, more sensitive and specific markers of cardiac damage such as troponin T testing, can readily identify patients at high or low risk with acute coronary syndromes. Patients at high risk of adverse events should be admitted to a coronary care unit and be under the care of a cardiologist. Patients on other wards at high risk after an acute coronary syndrome should also have the input of cardiologists within the first 24 hours. All patients should receive aspirin from a general practitioner or other health worker if chest pain is considered to be cardiac in origin, unless the patient is allergic to aspirin

When faced with ST elevation MI, there are very few reasons why thrombolysis should not be given promptly, and where contraindicated primary coronary angioplasty should be considered as an

emergency. This latter procedure has maximal benefit only if available immediately by an experienced operator in an appropriate centre.

Minimising the time between initiation of thrombolytic or other anti-platelet treatments and both onset of symptoms (call to needle time) and arrival at hospital (door to needle time) will limit the amount of myocardial damage and consequent complications, and reduce mortality and improve quality of life.

Patients at high risk may require elective coronary arteriography during the same admission. Patients not at high risk will require an exercise tolerance test, ideally before discharge, to further differentiate these patients into high or low risk individuals. Although there is no direct trial evidence for anti-hypertensive therapy in the acute management of myocardial ischaemia/infarction, the use of intravenous nitrates, beta-blockers and ACE inhibitors will all lower blood pressure, and therefore it is reasonable to aim for a target BP of < 140 systolic and less than 85 mmHg diastolic in all patients in hospital. Nor is there any evidence in the acute situation for cholesterol modification therapy but the current recommendation is to initiate treatment with a statin if the initial random (non-fasting) cholesterol is 6.0 mmol/l on admission, but practice is changing and statins are sometimes being prescribed regardless of cholesterol levels. In selecting drug therapies, preference should be given to drugs which have been evaluated in RCTs and have been shown to be both efficacious and safe, and the doses prescribed should be those used in the trials.

Cardiovascular prevention and rehabilitation

All patients who survive their initial symptomatic presentation of coronary atherosclerosis require a programme which addresses all aspects of prevention and rehabilitation, integrated with continuing long-term care in the community. This process of care from hospital to general practice should address lifestyle, other risk factors, prophylactic drug therapies and other aspects of rehabilitation. The latter include knowledge of disease; its causes, treatment and prevention; psychosocial factors and occupational factors. Screening of first degree blood relatives of patients with premature CHD (men < 55 years, women < 65 years) should be considered.

Heart failure

All patients presenting for the first time with the clinical syndrome of heart failure should undergo specialist assessment to confirm the diagnosis, determine aetiology and initiate appropriate management. Coronary arteriography should be considered in all patients in whom the aetiology is unknown and who may benefit, if they have coronary artery disease, from risk factor modification and revascularisation. The optimal model of care for long-term management of heart failure between the hospital and general practice, in order to reduce the frequency of relapses, hospitalisations and improve survival, needs to be determined.

2 Statement of the problem/introduction

Coronary atherosclerosis is ubiquitous in our population and coronary heart disease (CHD) is the most common single cause of death in both men and women in the UK. Despite a decline in CHD mortality since the 1970s, the UK still has one of the highest death rates from this cause in the world.[153] There are large regional, socio-economic and ethnic differences in CHD mortality in the UK.[2,12,228] Death rates from CHD are higher in Scotland, Northern Ireland and the North of England than in Wales and the South of England. Male manual workers have higher death rates from CHD compared to non-manual workers and

the same differences are seen for women. South Asians living in the UK have higher death rates from CHD than average. Although the death rate from CHD has not been falling as fast as in some other countries, it has fallen in both men and women and at all ages under 75 years, but fastest for the youngest (35–44 years) age group. The death rate is also falling across all social groups and for both men and women, but the death rate is falling faster in non-manual workers and therefore the difference in death rates between social groups is increasing. The difference in death rates between South Asians and the rest of the population is also increasing because the death rate from CHD is not falling as fast in South Asians as it is in the rest of the population.

Coronary atherosclerosis manifests as sudden cardiac collapse, acute coronary syndromes (acute myocardial infarction and unstable angina), exertional angina and death in the community. Coronary atherosclerosis can also present with non-fatal arrhythmias or heart failure. Atherosclerosis also affects the rest of the arterial circulation, principally the aorta and its major branches to the head and limbs. Patients presenting with cerebral ischaemia or infarction, or symptoms of peripheral arterial disease, usually have coronary atherosclerosis as well. For those who survive these other clinical manifestations of atherosclerosis, the commonest cause of death is CHD.

Sudden collapse and death in the community is a first manifestation of many cardiac diseases but most of these deaths are due to coronary atherosclerosis.[21,24] Post mortem reveals acute thrombosis with acute myocardial infarction or ischaemia, but in only about half the cases. Importantly, the other victims have evidence of myocardial scarring due to one or more previous myocardial ischaemic insults despite the absence of any medical history of CHD. So acute myocardial infarction accounts for only half such deaths and for the other victims there is pathological evidence of one or more pre-morbid events, some of which may have been symptomatic although not medically assessed. Myocardial scarring alone is therefore a source of lethal ventricular arrhythmias in about half of all sudden cardiac deaths due to coronary atherosclerosis.

When the acute manifestations of coronary artery disease – sudden cardiac death and acute myocardial infarction – are considered together, then one in two patients with new or recurrent disease will have died within 30 days of their acute clinical presentation.[145,146,218,224] About 69% die in the community, 29% die in hospital and the other 2% die within 30 days of discharge.[192] However, when *all* first symptomatic expressions of coronary atherosclerosis are considered together – sudden cardiac death, acute coronary syndromes (acute myocardial infarction and unstable angina) and angina pectoris – the majority of patients survive their *first* clinical presentation, with less than one in five of all such incident events due to sudden cardiac death in the community. Therefore, considerable potential exists amongst those with symptomatic disease to reduce morbidity and mortality through therapeutic and revascularisation procedures and over the longer term by lifestyle changes, risk factor modification, and the use of prophylactic drug therapies such as aspirin, beta-blockers, ACE inhibitors, cholesterol modification therapy and anticoagulation.

Coronary artery disease accounts for over half of all new presentations of heart failure, another important clinical expression of coronary atherosclerosis.[42,45] In addition, a history of hypertension is present in about half of all cases of heart failure, although considered to be the primary aetiology in just under a third. When hypertension is added to documented coronary artery disease, then coronary atherosclerosis and its antecedents account for most heart failure presenting in the community.

Given that coronary atherosclerosis presents as sudden death, and non-fatal manifestations of coronary artery disease can cause profound morbidity and a shorter life, the principal strategy for reducing the population burden of this disease is primordial prevention – a societal strategy to prevent the development of atherosclerosis and its clinical sequelae. The Government's White Paper *Saving Lives: Our Healthier Nation* has made heart disease and stroke a priority with the following target by the year 2010: 'to reduce the death rate from heart disease and stroke and related illnesses amongst people under 65 years by at least a further third.'[54] The major lifestyle causes of CHD in the population are known – diet,[53] smoking[55] and physical inactivity – and need to be addressed at a society level.

The National Service Framework on CHD[139] has set priorities and targets and addresses both prevention and treatment in an integrated strategy. Therefore, in the context of a public health strategy for prevention, a complementary clinical strategy is required for primary prevention of coronary atherosclerosis and its complications, the prompt management of symptomatic disease and then comprehensive prevention and rehabilitation.

3 Sub-categories

A societal strategy addresses the determinants of smoking, unhealthy food choices, obesity, excessive alcohol consumption and physical inactivity in the population. In this context a clinical strategy for coronary atherosclerosis and its complications comprises the following:

1 **pre-symptomatic:** screening the healthy population. Identification and treatment of high risk individuals in the general population through cardiovascular screening followed by lifestyle and proven therapeutic interventions.
2 **symptomatic disease:** early assessment and management of symptomatic manifestations of coronary atherosclerosis (sudden cardiac collapse, acute myocardial infarction, unstable angina, exertional angina and heart failure) using proven medical and surgical treatments.
3 **post-symptomatic:** cardiac prevention and rehabilitation, to reduce the risk of recurrent coronary heart disease, improve quality of life and increase life expectancy.

Using this three-pronged approach to a clinical strategy for the management of coronary heart disease, it is useful to consider the following patient sub-categories:

Pre-symptomatic

(a) **Individuals at high risk of developing CHD and other atherosclerotic disease:** Traditionally, cardiovascular risk factors have been considered individually,[200] such as blood pressure[178] or blood lipid levels,[16] and treatment based on the actual level of a given risk factor regardless of overall multifactorial (absolute) risk of developing CHD. For example, an individual with a systolic blood pressure of 150 mmHg could have an absolute risk of CHD (taking into account all risk factors) over the next 10 years as high as 35% or as low as just 5%, depending on whether he is a smoker, what his lipoprotein levels are and whether or not he has diabetes mellitus. So assessment and management of coronary risk factors is evolving towards a multifactorial approach, and whether or not to treat a given level of blood pressure or blood lipids is now being assessed in the context of absolute CHD risk.[107,161,232,233] In the UK, a high risk individual has been defined as one whose absolute CHD risk over 10 years is $\geq 15\%$.[90,107,226]

(b) **Patients with asymptomatic coronary artery disease and other atherosclerotic disease:** With modern non-invasive techniques, imaging atherosclerosis in the coronary arteries (using MRI or ultrafast CT scanning for coronary calcification) and other vessels, including the neck (carotids and vertebrals), abdominal aorta and lower limb arteries is now possible. The place of these techniques in assessment and management of asymptomatic disease in the population remains to be established.

Screening for asymptomatic left ventricular dysfunction has been advocated but is as yet unproven.[127]

Symptomatic disease

Patients with coronary atherosclerosis can present clinically in one or more of the following ways:

(a) **Sudden cardiac collapse (and death) in the community:** Sudden cardiac collapse in the form of an abrupt loss of consciousness is most commonly due to a ventricular arrhythmia (ventricular tachycardia or fibrillation), and without cardiopulmonary resuscitation, and specifically direct current cardioversion, death will quickly follow. Spontaneous reversion of a ventricular arrhythmia to a normal cardiac rhythm in the context of coronary disease does occur and such patients can present with unexplained presyncopal symptoms or loss of consciousness.

(b) **Chest pain in the community:** Chest pain is a common symptom in the community and coronary disease is only one of many causes.

(c) **Exertional angina:** Chest pain on exertion – a retrosternal tightness or discomfort – which is relieved by rest is the commonest symptomatic manifestation of coronary artery disease. This symptom called angina is commonly associated with breathlessness and breathlessness alone may be an anginal variant.

(d) **Acute coronary syndromes:**
   (i) Unstable angina
   (ii) Non ST elevation myocardial infarction
   (iii) ST elevation myocardial infarction.

   The underlying pathology of coronary atherosclerosis, with ruptured plaque and intraluminal thrombosis, is common to all divisions of this syndrome except when triggered iatrogenically during coronary procedures. The distinction between these three diagnostic categories is therefore, to an extent, artificial because it depends on arbitrarily dividing those with myocardial ischaemia, but no myocardial necrosis, from those with ECG and/or laboratory evidence of necrosis, and this is a function of the sensitivity and specificity of enzyme estimation and other tests for myocardial necrosis. Cardiac troponins T and I are very useful for identifying patients with myocardial necrosis. These markers and CK-MB now provide the laboratory basis of diagnosing a myocardial infarction.

(e) **Heart failure due to coronary atherosclerosis:** Heart failure is a clinical syndrome which develops as a consequence of cardiac disease, and is recognised clinically by symptoms and signs produced by complex circulatory and neurohormonal responses to cardiac dysfunction. The European Society of Cardiology has defined heart failure as a constellation of symptoms, typically breathlessness and fatigue, signs of fluid retention and evidence of major cardiac dysfunction at rest together with, where appropriate, a clinical response to treatment.[209]

Post-symptomatic: cardiovascular prevention and rehabilitation

After prompt assessment and management of coronary disease – exertional angina, acute coronary syndromes and heart failure – which can include emergency or elective coronary revascularisation, the underlying causes of the disease need to be addressed and patients rehabilitated. The WHO defines the rehabilitation of cardiac patients as:

> . . . the sum of activities required to influence favourably the underlying cause of the disease, as well as the best possible physical, mental and social conditions, so that they may, by their own efforts preserve or resume when lost, as normal a place as possible in the community. Rehabilitation cannot be regarded as an isolated form of therapy but must be integrated with the whole treatment of which it forms only one facet.[234]

4 Incidence, prevalence and mortality

Pre-symptomatic

(a) **Individuals at high risk of developing CHD and other atherosclerotic disease:** The proportions of men and women (excluding patients with reported CHD or other arterial disease) who are potentially eligible for treatment at different levels of absolute CHD risk in England has been estimated by applying the Framingham risk function[6,7] to the Health Survey for England[157] (*see* Table 1). The Health Survey for England did not measure HDL cholesterol and this has been estimated from the equivalent survey in Scotland.[108] The Scottish survey is based on people aged 13–64, whereas in England the population 30–75 years was surveyed. For the age group 64–75 in England the average HDL cholesterol at age 64 years in Scotland was used. Overall, 12% of men and 5% of women under 75 years have a CHD risk of $\geq$ 15% over 10 years.

Table 1(a): Percentage of men and women in England at different levels of CHD risk.[+]

Aged 30–74		
Absolute* CHD risk (%)	**Men**	**Women**
> 30	3	–
25–29	5	2
20–24	8	2
15–19	12	5

* Framingham function: absolute risk of non-fatal myocardial infarction and coronary death over 10 years.
[+] Health Survey for England 1994.

Table 1(b): Percentage of men and women in England at different levels of CHD risk with a BP $\geq$ 140/85 mmHg, or cholesterol $\geq$ 5.0 mmol/l or both.

England		
CHD absolute risk (%)	**Men (%)**	**Women (%)**
Blood Pressure > 140/85 mmHg		
> 30	3.0	–
25–29	4.3	0.2
20–24	6.5	1.6
15–19	7.8	4.5
Total cholesterol > 5.0 mmol/l		
> 30	3.2	–
25–29	4.7	0.2
20–24	7.8	1.7
15–19	10.9	5.1
Blood pressure > 140/85 mmHg and Total cholesterol > 5.0 mmol/l		
> 30	3.0	–
25–29	4.2	0.2
20–24	6.1	1.6
15–19	7.0	4.5

(b) **Individuals with asymptomatic atherosclerosis:** The prevalence of Q wave abnormalities on resting ECGs in the general population, where no history of CHD is reported, suggest that all clinical estimates of disease frequency underestimate the true burden of disease in the population. The presence of Q wave abnormalities in apparently healthy individuals is partly explained by so-called silent myocardial infarction, but this could also arise because the patient did not report symptoms to a doctor, or a doctor misdiagnosed the symptoms and attributed them to some other pathology. Finally, Q waves on an ECG are not always due to coronary artery disease.

Symptomatic patients

The incidence of coronary heart disease – sudden cardiac death, acute coronary syndromes and exertional angina – is only available from specially conducted community surveys. The Bromley Coronary Heart Disease Register (BCHDR) is the first community register in the UK to identify all symptomatic medical presentations of CHD in one population.[194] All incident (first) presentations of sudden cardiac death, acute coronary syndromes (acute myocardial infarction and unstable angina) and exertional angina were registered for Bromley Health District in South East London (population 186 053 in men and women 25–74 years) for the period 1996–1998 (Figure 1 and Figure 2).

Figure 1: Incident (first presentation) of fatal and non-fatal cases of coronary heart disease in men and women (< 75 years) in the community. (Bromley Coronary Heart Disease Register).

SCD: Sudden Cardiac Death; AMI: Acute Myocardial Infarction; UA: Unstable Angina; AP: Angina Pectoris.

Figure 2: Incident (first presentation) of non-fatal cases of coronary heart disease in men and women (< 75 years) in the community. (Bromley Coronary Heart Disease Register).

SCD: Sudden Cardiac Death; AMI: Acute Myocardial Infarction; UA: Unstable Angina; AP: Angina Pectoris.

Incidence rates for sudden cardiac death, acute coronary syndromes (acute myocardial infarction and unstable angina) and exertional angina derived from this community survey are given in the text and Table 3, Table 7 and Table 8. These incidence rates for a population with an age-standardised CHD mortality under 75 years of 117 for men and 34 for women per 100 000 per annum can be adjusted for districts with different CHD mortality rates in order to estimate the expected number of new cases of disease for other parts of the country. There are no national data on CHD incidence.

Sudden cardiac death in the community

The incidence of sudden cardiac death, as a first manifestation of coronary artery disease, is not available from routine statistics. However, in England the HM Coroner's system requires all unexpected deaths in apparently well individuals with no history of CHD or other disease to have a post mortem examination. In a national survey of sudden cardiac death undertaken through a random sample of HM Coroners in England in men and women < 65 years with no history of coronary heart disease, 86% of all deaths were attributed to CHD (*see* Table 2).[20] Therefore, it is possible to enumerate the incidence of sudden cardiac death for a district, as a first manifestation of coronary artery disease, from HM Coroner's records, including post mortem reports and other medical information. Sudden deaths occurring outside the district can still be identified retrospectively as they are all ultimately notified to the Health Authority

Table 2: Cardiac causes of sudden unheralded death in England.

HM Coroner's post mortems in men and women < 65 years		
Coronary heart disease		560 (86%)
Acute ischaemia ± coronary thrombosis	290 (52%)	
Myocardial scarring (without acute ischaemia/infarction)	133 (24%)	
Coronary atheroma only (without acute ischaemia or scarring)	137 (24%)	
Left ventricular hypertrophy		52
Aortic valve stenosis		12
Idiopathic fibrosis syndrome		5
Myocarditis		5
Hypertrophic cardiomyopathy		3
Other rare cardiac causes		14
Total		651

according to postal address. The age/sex-specific incidence rates for sudden cardiac death from the Bromley Register are shown in Table 3. The incidence rate for sudden cardiac death (95% CI) due to coronary artery disease for the age group 25–74 years was 36 per 100 000/annum (28–44). The incidence for men was 57 (43–75) and for women 22 (15–31).

Table 3: Incidence (first presentation) per 100,000 population (25–74 years) per annum (95% CI) of coronary heart disease in men and women in the community (Bromley Coronary Heart Disease Register)

	Men		Women		All	
	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)
Angina pectoris	157	172 (146–201)	127	89 (74–106)	284	122 (108–137)
Unstable angina	48	53 (39–70)	31	22 (15–31)	79	34 (27–42)
Acute myocardial infarction	121	133 (110–159)	53	37 (28–49)	174	75 (64–86)
Sudden cardiac death	52	57 (43–75)	31	22 (15–31)	83	36 (28–44)
All	378	414 (374–458)	242	170 (149–193)	620	266 (246–288)

Other contemporary community surveys have recorded sudden and other deaths attributed to CHD in Belfast[69] and Glasgow[218] and Oxford[224] and three other British health districts[145,146] (*see* Table 9). However, these studies have only focused on acute coronary disease – sudden death, other deaths due to CHD and non-fatal acute myocardial infarction – and included both new (incident cases) and recurrent coronary disease with fatal events recorded up to 28 days after initial medical presentation. In the Oxford Myocardial Infarction Incidence Study,[57] conducted in a district with a similar age-standardised CHD mortality (118 for men and 36 for women per 100 000/annum) to Bromley, the sudden death rate (a fatal infarction in which death occurred before the patient could be seen by a doctor) for men and women (30–69 years) was 27 and 26 respectively.

Chest pain in the community

Chest pain is common in the community and breathlessness can be a variant of angina. The incidence rate for chest pain reported for the first time to medical services (a general practitioner or an Accident and Emergency Department) by patients with no history of CHD, and considered by the doctor to be

potentially cardiac in origin, was measured as part of the Bromley CHD register (*see* Table 4). The incidence rate for chest pain for the age group 25–74 years was 481 per 100 000 per annum (480–482); men 583 (582–584) and women 379 (378–380). The age/sex-specific incidence rates are given in Table 5 and Table 6. As the incidence rate for angina in women is about half that of men (*see* below), chest pain is a more common complaint in this group in relation to their true incidence of coronary disease.

Table 4: Number, age-specific incidence rates (95% CI) of chest pain per 100,000 population (25–74 yrs) per annum (the number and incidence of patients presenting for the first time with chest pain considered to be exertional angina).

Age	Non-anginal chest pains			All incident chest pain		
	No.	Incidence	CI	No.	Incidence	CI
< 25	7	8	5.9, 10	7	8	5.9, 10
25–34	54	116	115, 117	56	120	119, 121
35–44	150	360	359, 361	170	407	406, 408
45–54	229	553	552, 554	307	742	741, 743
55–64	224	749	748, 750	392	1,310	1309, 1311
65–74	190	710	714, 716	384	1,445	1444, 1446
< 75	854	312	341, 313	1,316	481	480, 482

Table 5: Number, age-specific incidence rates (95% CI) of chest pain in men per 100,000 population (25–74 yrs) per annum.

Age	Non-anginal chest pains			All incident chest pain		
	No.	Incidence	CI	No.	Incidence	CI
< 25	3	7	4, 10	3	7	3, 10
25–34	43	183	182, 184	44	187	186, 188
35–44	102	483	482, 484	120	568	567, 569
45–54	124	615	614, 616	182	903	902, 904
55–64	117	807	806, 808	234	1,615	1614, 1616
65–75	80	671	670, 672	213	1,787	1786, 1788
< 75	469	343	342, 344	796	583	582, 584

Table 6: Number, age-specific incidence rates (95% CI) of chest pain in women per 100,000 population (25–74 yrs) per annum.

Age	Non-anginal chest pains			All incident chest pain		
	No.	Incidence	CI	No.	Incidence	CI
< 25	4	9	6.3, 12	4	9	6.3, 12
25–34	11	48	46, 50	12	52	50, 54
35–44	48	233	232, 234	50	243	242, 244
45–54	105	494	493, 495	125	589	588, 590
55–64	48	311	310, 312	158	1,024	1022, 1026
65–75	43	293	292, 294	171	1,167	1166, 1168
< 75	385	281	280, 282	520	379	378, 380

Exertional angina

The age/sex-specific incidence rates for exertional angina in patients with no history of CHD from the Bromley CHD register are shown in Table 7 and Table 8 (*see* overleaf) . The incidence rate (95% CI) for exertional angina for the age group 25–74 years was 122 per 100 000/annum (108–137). The incidence rate for men was 172 (146–201) and for women 89 (74–106).

Angina is a symptom and therefore there is greater potential for misdiagnosis, particularly in women for whom chest pain is more commonly reported. Therefore angina incidence rates from this register inevitably count some patients who are subsequently shown at coronary arteriography to have normal coronary arteries. Incidence will therefore be inflated by including such healthy people, but refining the diagnosis by electro-cardiography, either at rest or on exercise, will underestimate true incidence. This is because the majority of patients with angina due to coronary atherosclerosis have normal resting ECGs, and only two-thirds show changes consistent with myocardial ischaemia (ST segment and/or T wave changes) on exercise and some of these will be false positives, particularly among women. So the true incidence of angina lies somewhere between the rate calculated for symptoms alone (regardless of ECG and other findings) and that derived for patients with symptoms, objective evidence of reversible ischaemia and coronary atherosclerosis at angiography.

Prevalence of angina has been estimated in population surveys using a standardised questionnaire. The Health Survey for England[157] used the Rose Angina Questionnaire and the overall prevalence (angina grade 1 and 2) in the population aged 16 years and over was 2.6% in men and 3.1% in women. It was higher in women than in men in all age groups except for those aged 75 and over, where 7.3% of men and 5.9% of women reported this symptom. In contrast, the overall prevalence of having ever been diagnosed by a doctor with angina was 5.3% in men (3.2% currently) and 3.9% in women (2.5% currently). In both sexes, prevalence increased with age, being negligible in those aged under 35 to almost 1 in 5 in those aged 75 and over (18.3% of men and 17.0% of women). The prevalence of angina as assessed by the Rose Angina Questionnaire showed a different pattern to reported doctor-diagnosed angina: the overall prevalence was lower than for reported doctor-diagnosed angina, and women reported more symptoms than men. Also the Rose Angina Questionnaire gave higher estimates in younger age groups and lower estimates in older age groups than self-reported prevalence. These different measures of prevalent angina can have different applications and from a clinical perspective a doctor diagnosis is more useful because it is not just based on symptoms but also takes account of other clinical information such as risk factors, investigations and a specialist opinion. Angina based on hospital discharges and deaths has no meaning for the community because most patients with exertional angina are never admitted to hospital at the time of their first presentation to medical services.

Acute coronary syndromes

The age/sex-specific incidence rates for non-fatal acute myocardial infarction and unstable angina, in patients with no history of CHD, from the Bromley CHD register are shown in Table 3, Table 7 and Table 8. The incidence rate for acute myocardial infarction for the age group 25–74 years was 75 per 100 000/ annum (64–86). The incidence rate for men was 133 (110–159) and for women 37 (28–49). The comparable incidence rates for unstable angina are: overall 34 (27–42), men 53 (39–70) and women 22 (15–31).

The Belfast and Glasgow MONICA Studies[69,218] and the Oxford Community Study[224] have all recorded non-fatal acute myocardial infarction, surviving up to 28 days after the initial presentation, and these events are based on both new (incident cases) and recurrent coronary disease (*see* Table 9). The MONICA studies in Belfast and Glasgow were both based on patients less than 65 years, whereas in Oxford the population studied was up to 79 years old. Unstable angina is not included in these surveys. In OXMIS the

Table 7: Number and age-specific incidence rates per 100,000/population (25–74 years) per annum (95% CI) of coronary heart disease in men in the community (12 months' data collection). (Bromley Coronary Heart Disease Register).

Age	Exertional angina			Unstable angina			Acute myocardial infarction			Sudden cardiac death			Total		
	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI
25–34	0	0	–	0	0	–	1	4	(0.1–24)	0	0	–	1	4	(0.1–24)
35–44	4	19	(5–48)	1	5	(0.1–26)	11	52	(26–93)	1	5	(0.1–26)	18	80	(47–129)
45–54	26	129	(84–189)	9	45	(20–85)	25	124	(80–183)	6	30	(11–65)	65	327	(253–417)
55–64	65	449	(346–572)	14	97	(53–162)	34	235	(163–328)	17	117	(68–189)	130	897	(749–1065)
65–74	62	520	(399–667)	24	201	(129–300)	50	420	(311–553)	28	235	(156–340)	164	1–376	(1,173–1,603)
25–74	157	172	(146–201)	48	53	(39–70)	121	133	(110–159)	52	57	(43–75)	378	414	(374–458)

Table 8: Number and age-specific incidence rates per 100,000/population (25–74 years) per annum (95% CI) of coronary heart disease in women in the community (21 months data collection). (Bromley Coronary Heart Disease Register).

Age	Exertional angina			Unstable angina			Acute myocardial infarction			Sudden cardiac death			Total		
	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI	No.	Inc.	CI
25–34	0	0	–	0	0	–	1	3	(0.1–16)	0	0	–	1	3	(0.1–16)
35–44	2	6	(0.8–23)	0	0	–	1	3	(0.1–18)	1	3	(0.1–18)	4	13	(4–33)
45–54	17	53	(31–85)	6	19	(7–41)	4	13	(3–32)	2	6	(0.8–23)	29	91	(61–131)
55–64	53	229	(172–300)	11	48	(24–85)	14	61	(33–102)	6	26	(10–56)	84	363	(290–449)
65–74	55	250	(188–326)	14	64	(35–107)	33	150	(103–211)	22	100	(63–151)	124	564	(469–627)
25–74	127	89	(74–106)	31	22	(15–31)	53	37	(28–49)	31	22	(15–31)	242	170	(149–193)

overall age-standardised event rate for non-fatal first and recurrent events in men and women aged 30–69 years per 100 000/annum was 171 and 50 respectively. The higher event rates in Oxford compared to Bromley are probably explained by the inclusion of recurrent cases of coronary disease in the Oxford study. The event rates for Belfast and Glasgow, where the age-standardised CHD mortality rates are 193 for men and 73 for women and 260 for men and 99 for women respectively, are much higher than the rates for Oxford and Bromley. The Belfast, Glasgow and Oxford studies describe a community picture for acute coronary events, based on both incident (new) and recurrent cases. However, a complete picture of acute coronary disease must include incident and recurrent cases of unstable angina – namely, the complete spectrum of acute coronary syndromes. Apart from the Bromley CHD Register there are no other contemporary community data on incidence or event rates for unstable angina.

The prevalence of myocardial infarction is reported in the Health Survey for England.[157] Overall in the population aged 16 years and over, 4.2% of men reported having had a 'heart attack' (0.6% in the last 12 months). Among women the prevalence was less than half that of men (1.8% and 0.3% respectively). In both cases prevalence increased with age: among men aged 65 and over, more than 60% had a 'heart attack', a tenth of them in the last 12 months. From the Rose Angina Questionnaire the prevalence of a 'possible myocardial infarction' was estimated at 8.6% in men and 5.6% in women; more than double the prevalence of a reported doctor-diagnosed heart attack. The term 'heart attack' is not necessarily understood by patients to be an acute myocardial infarction and therefore this term may include patients admitted to hospital with unstable angina or exertional angina as well. As with exertional (stable) angina, it is more useful to use the reported doctor diagnosis estimates than those from the Rose Angina Questionnaire for reasons already given.

A comparison of case fatalities for Oxford, Glasgow and Belfast for a population less than 65 years is shown in Table 9. About one in two acute coronary events (new and recurrent) are fatal within 28 days.

Table 9: Standardised event rates (new and recurrent) per 100,000 population and case fatalities for acute coronary disease in different populations in the UK.

	Men		Women	
	Event rate	**Case fatality (%)**	**Event rate**	**Case fatality (%)**
Age-standardised[a] event rates for men and women 35–64 years				
Belfast[1]	781	40	197	44
Glasgow[1]	823	49	256	49
Oxford[2]	273	39	66	36
Age standardised[b] event rates for men and women 65–79 years				
Oxford[2]	1,350	–	677	–
First event[c] rates for men and women 35–64 years				
Oxford[2]	189	–	58	–
Bromley[3]	125			35

[1] WHO MONICA studies in Belfast and Glasgow.
[2] Oxford Myocardial Infarction Study.
[3] Bromley Coronary Heart Disease Register.
[a] Age-standardised.
[b] Age-standardisation to a world standard population.
[c] First events in Oxford (non-fatal and fatal definite myocardial infarction (MI), fatal possible MI and unclassifiable coronary death) up to 28 days after medical presentation compared to first events in Bromley (sudden cardiac death in the community and non-fatal acute myocardial infarction admitted alive to hospital).

Case fatality rises with age in both men and women. In the MONICA survey, case fatality was the same for new (incident) and recurrent events in both men and women. As these descriptions of acute coronary events in the community do not include non-fatal cases of unstable angina and exertional angina, the overall case fatality for symptomatic coronary disease appears much worse than it actually is. By including all non-fatal manifestations of coronary atherosclerosis, and in particular exertional angina, the proportion who survive their initial symptomatic presentation to be either assessed as an outpatient or admitted to hospital is substantially higher; about four fifths of all incident cases (*see* Figure 2).

The most contemporary national data available on acute coronary syndromes without ST elevation comes from the PRAIS-UK registry.[41] This registry conducted throughout 1998 and 1999 involved 1046 patients enrolled from 56 centres throughout the UK. Centres were originally invited by a geographically stratified method based on intervals of catchment populations. About 40% of those hospitals originally invited were unable to participate due to resource limitations and therefore further suitable replacement hospitals were invited, though not fully geographically balanced. The average duration for recruiting 20 consecutive patients in PRAIS-UK was 14 days. The total catchment population of these centres was 24% of the UK. By extrapolating these data, each centre would annually admit about 520 patients with acute coronary syndromes without ST elevation. In the UK the number of admissions per year would be about 114 000. The range around this figure would be between 94 000 and 133 000 with a rate of about 2000 per million population. The baseline characteristics of these patients are shown in Table 10. The average length of stay for patients in PRAIS-UK was 6 days. In hospital rates of death and death or non-fatal MI were 1.5% and 3.9%. All patients in PRAIS-UK had 6 months follow-up, by which time the rates of death and death or non-fatal MI respectively were 7.3% and 12.5%. These rates are similar to those seen in the earlier international OASIS study and support the observation that most patients admitted with acute coronary syndromes are at high risk of subsequent major adverse cardiac events.

Table 10(a): Baseline characteristics of 1,046 patients admitted with non-ST elevation acute coronary syndromes in PRAIS-UK.

PRAIS-UK

Baseline characteristics	**n = 1,046**
Age (years)	66 ± 12
Gender (% male)	60.8
Diabetes (%)	16.0
Treated hypertension (%)	36.9
Current smoker (%)	22.8
Prior angina (%)	74.6
Prior MI (%)	48.1
Prior PTCA (%)	13.5
Prior CABG (%)	13.4
Prior revascularisation (%)	23.1
Prior coronary disease	81.0

Table 10(b): Outcomes from PRAIS-UK.

Outcomes from PRAIS-UK	In-hospital %	6 months %
Death	1.5	7.6
New MI	4.0	7.7
Refractory/Unstable angina	3.4	17.0
Death/MI	4.9	12.2
Death/MI/RFA/UA*	7.7	30.0
Stroke	0.5	1.0
Death/MI/stroke	5.4	14.8
Heart failure	7.9	12.6
Major bleed	0.9	1.6

Heart failure due to coronary atherosclerosis

Although coronary artery disease is the principal cause of heart failure, there are other pathologies responsible for this clinical syndrome (*see* Table 11).[45] Incidence of new clinical heart failure can only be estimated from special population surveys. Age/sex-specific incidence rates for incident (new) clinical heart failure were estimated in the first London Heart Failure Study, in Hillingdon (*see* Table 12, overleaf).[42] The overall incidence rate (95% CI) for clinical heart failure for all ages was 130 per 100 000/annum (113–148). The incidence rate for men was 141 (117–169) and for women 119 (97–144).

Table 11: Aetiology of incident (first presentation) of heart failure in men and women in the community^{+} (London Heart Failure Study I).

Aetiology	Number (%)
Coronary heart disease	79 (36%)
Acute myocardial thrombosis	*42 (19%)*
Not acute myocardial infarction	*37 (17%)*
Hypertension	30 (14%)
Valve disease	16 (7%)
Atrial fibrillation or flutter	10 (5%)
Cor pulmonale	4 (2%)
Alcohol	4 (2%)
Hypertrophic cardiomyopathy	1 (0.5%)
Restrictive cardiomyopathy	1 (0.5%)
Unknown	75 (34%)

There is little data on ethnic variation in heart failure incidence, although it is likely to parallel variations in the incidence of coronary heart disease.

The commonest aetiology of heart failure was CHD, as assessed mainly from non-invasive tests, which accounted for about a third of all cases (*see* Table 11). CHD frequently co-existed with a history of hypertension, which was found in about half of such cases. In the second London Heart Failure Study, in Bromley, using the same methodology, coronary arteriography was undertaken in unselected incident

Table 12: Incidence (first presentation) of heart failure per 100,000 population per annum in men and women (aged 25 years and over) in the community (London Heart Failure Study I).

	Men		Women		All	
Age	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)
25–	0	–	1	4 (0.1–25)	1	2 (0.05–12)
35–	3	16 (3–47)	3	18 (4–52)	6	17 (6–37)
45–	4	26 (7–65)	1	7 (0.2–38)	5	16 (5–38)
55–	21	170 (105–260)	8	67 (29–132)	29	119 (80–172)
65–	34	388 (269–542)	24	231 (148–343)	58	303 (230–391)
75–	41	982 (705–1,332)	42	592 (427–801)	83	737 (587–913)
85+	15	1,676 (938–2,764)	23	962 (610–1,443)	38	1,156 (818–1,587)
All	118	141 (117–169)	102	119 (97–144)	220	130 (113–148)

cases of heart failure under the age of 75 years.[74,76] CHD was the cause of heart failure in at least one in two of these cases (*see* Table 13) and this shows that clinical assessment without angiography underestimates, in absolute terms by about 20%, the real proportion of patients with CHD as the cause of heart failure.

Table 13: Aetiology of incident (first presentation) of heart failure in men and women < 75 years in the community (London Heart Failure Study II).

Aetiology	Number (%)
Coronary artery disease	71 (52%)
Idiopathic dilated cardiomyopathy	17 (13%)
Valve disease	13 (10%)
Hypertension	6 (4%)
Alcohol	5 (4%)
Atrial fibrillation	4 (3%)
Other (determined)	7 (5%)
Undetermined (no angiographic data)	13 (10%)

The Health Survey for England did not estimate the prevalence of heart failure. A variety of studies have however estimated the prevalence of heart failure suggesting an overall prevalence of 3–16/1000 patients. There is a significant age-related increase in prevalence with rates between 40–60/1000 in those over 70 years.[130] This prevalence (and number of admissions) is increasing and this is presumed due to improved survival from myocardial infarction and improved treatments for heart failure.

Heart failure is associated with substantial morbidity resulting in recurrent hospital admissions. Five per cent of hospital admissions may be due to heart failure.[126] Readmission rates are high, up to 50% in the first 3 months. Importantly some studies suggest up to 50% of these admissions may be preventable.[134]

In a the second London cohort of 332 cases of incident (new) heart failure followed up for a median of 14 months there were 209 hospitalisations in 127 (38%) of these patients.[44] Seventy-eight patients had one subsequent hospital admission and 49 had two or more (maximum of five) hospital admissions.

Ninety-three (44%) of these 209 admissions were related to worsening of heart failure. The average duration of a hospital admission was five days (range 12 to 84 days).

Overall the prognosis of heart failure, based on all incident cases is poor. Six thousand deaths per year are thought to be due to heart failure secondary to coronary heart disease. In the first London heart failure study the one year survival was 62%.[46,130]

The cost to the NHS of heart failure is estimated as 1–2% of the total NHS budget.[128]

While the majority of heart failure is due to left ventricular systolic dysfunction there are cases of heart failure who have preserved systolic function. A proportion of these have abnormalities of diastolic function. The epidemiology of this poorly defined condition has not been established but may represent up to 50% of new heart failure[130] although a much lower figure is more likely.

Future epidemiological trends

In England and Wales the decline in CHD mortality did not start until about 1978, and it has been more age-related than elsewhere.[153] At ages 35–44 the annual rate of decline is around 5%, reducing to around 2% by ages 55 to 64; and at older ages (where most deaths occur) a major fall is still awaited. It is likely that we can now expect a long, continuing decline in CHD mortality of perhaps 3 to 4% per year, involving both sexes and (before long) all regions and all ages.

The decline in CHD mortality is considered to be primarily due to a fall in events (new and recurrent) but a decline in case fatality is also making a contribution. This fall in event rates is secondary to an abatement of underlying causes, some of which are known and some not. The decline in smoking, particularly amongst men and in higher socio-economic groups, is an important contributing factor, as are changes in the national diet reflecting a reduction in saturated fat consumption. However, there are some worrying trends such as teenage smoking, the rising prevalence of obesity and the lack of physical activity in the general population.

The medical and surgical management of patients presenting with coronary atherosclerosis is also contributing to the decline in CHD mortality by reducing case fatality. There are now a number of different medical and surgical interventions which have been shown, in randomised controlled trials, to reduce coronary and total mortality (*see* Section 6, 'Effectiveness of services and interventions').

Data from large multinational registries of patients with acute coronary syndromes demonstrate that about twice as many patients are admitted with unstable angina and myocardial infarctions without ST elevation than with myocardial infarction with ST elevation.[207] The mortality rates for both these groups of patients is similar at 6–12 months. This highlights that, while mortality rates for patients with ST elevation are decreasing, event rates for patients with unstable angina and particularly myocardial infarction without ST elevation are higher than previously realised.

5 Services available

Pre-symptomatic

Screening the healthy population

Screening the healthy population for risk of developing CHD (or other arterial disease) is a prerequisite to identifying and targeting high risk individuals for lifestyle and, as appropriate, therapeutic interventions.

The overall objective of a cardiovascular screening programme is to detect and treat high risk individuals in order to reduce the risk of a first non-fatal or fatal ischaemic event.

The following criteria need to be met before a coronary or cardiovascular risk screening programme can be justified:

Criteria for screening for risk of disease	Criteria met
• Disease is common	Yes
• Relationship between risk factors and the subsequent development of disease is quantified	Yes
• Evidence from randomised controlled trials that modifying risk factors reduces the subsequent risk of developing disease	Yes
• Screening tests for risk factors are valid, precise, reproducible, practical and acceptable	Yes
• Screening and management strategy for risk factors which can replicate (or improve on) the results of randomised controlled trials	Some evidence
• Cost-effective use of resources in primary and secondary care including medical and other health professionals, and the cost of drug treatments	Some evidence

The advantages of screening for high risk individuals are several. First, it focuses on interventions which are appropriate to the individual. Second, it avoids unnecessary medical action being taken in those who are at low risk as defined within a given population. Third, this approach is consistent with the medical model of care between the patient and the doctor. In this way the risk factor blood pressure, which is continuously distributed in the population, becomes the disease called hypertension (which only some people have) and for which the doctor can then legitimately offer treatment. Finally, the benefit to risk ratio improves where benefits of any given intervention in high risk individuals are larger. By the same token it is a cost-effective use of medical resources. However, it must be remembered that the predictive power of screening tests for an individual is low. Although a person may be classified as high risk, only a minority in that risk category will actually develop the disease within 10 years.

At present there is no national policy for cardiovascular screening of the healthy population in primary care although the principle of identifying and treating those at highest risk of disease is widely accepted following the documented limited impact of unselected screening in primary care.[99,100,230,231] Such patients are being detected through new patient checks and opportunistic screening e.g. for hypertension or diabetes, but this serendipitous approach, which is likely to vary considerably in its application both between and within (between partners) general practices, means that a proportion of individuals will go undetected. In the Health Survey for England[160] the prevalence of untreated hypertension (defined as a BP $>160/95$ mmHg) was 9.9% overall, which is about half of all patients with high blood pressure, and the number of individuals will be considerably higher for the new definition of high blood pressure $>140/90$ mmHg. However, not all such patients will necessarily require antihypertensive therapy as treatment of SBP 140–159 mmHg and DBP 90–99 mmHg depends on the clinical context defined by absolute CHD or cardiovascular risk.[107,163,226,233] Opportunistic screening can include some or all of the following:

1 **Lifestyle assessment:** tobacco exposure (current or former cigarette smoker); obesity (height and weight and calculation of body mass index (wt/ht^2) and a measure of central obesity; and physically active or sedentary.

2 **Other risk factors:**
   (i) blood pressure
   (ii) lipids
      (a) random (non-fasting) total cholesterol
      (b) fasting lipoprotein profile (total cholesterol; HDL-cholesterol; triglycerides and calculated LDL-cholesterol)
   (iii) glycosuria; random (non-fasting) glucose; fasting glucose; 2 hour postprandial glucose (but not following a standard glucose load); glucose tolerance test.

3 **Family history:**
   (i) premature CHD: first degree blood relative (men < 55 years and women < 65 years) with non-fatal or fatal CHD
   (ii) premature stroke or other atherosclerotic disease
   (iii) diabetes, hypertension, dyslipidaemia.

4 **Screening of blood relatives:** in a patient with a high cholesterol (say > 8.0 mmol/L) and/or when there is a family history of premature CHD, the systematic screening of first degree blood relatives for familial dyslipidaemia.

At present, no national general practice data on frequency of cardiovascular screening, what it constitutes, and what action is taken on the results are available.

The potential for risk factor reduction in high risk individuals is considerable, both through effective lifestyle intervention and the use of efficacious and safe drug therapies for hypertension (low dose thiazide diuretics or beta-blockers as first line treatment in the absence of contra-indications or compelling indications for other antihypertensive agents) and lipids (statins) as demonstrated in clinical trials with disease end-points. However this potential to reduce risk in primary prevention of CHD and other atherosclerotic diseases is not being realised in practice.

Early detection of asymptomatic coronary artery disease

As sudden cardiac collapse and death is the first and final manifestation of CHD in about 1 in 10 apparently healthy individuals, there is an understandable interest in detecting coronary disease in the asymptomatic phase of its natural history. Sudden death is not the only impetus for a coronary artery disease screening programme. Some patients who survive their first symptomatic presentation may be so disabled by a myocardial infarction that secondary prevention and rehabilitation has little to offer.

For coronary artery disease, magnetic resonance is able to detect and quantify proximal atherosclerotic disease, and ultrafast CT scanning uses coronary calcification as a surrogate for coronary atheroma.

The objective of a coronary artery disease detection programme is to identify amongst apparently healthy individuals in the general population those who have asymptomatic coronary disease in order to slow disease progression, induce regression, and decrease the risk of acute thrombotic complications. In this way risk of a non-fatal or fatal cardiac ischaemic event can be postponed or even prevented.

However, the following criteria need to be met before a coronary artery disease screening programme can be justified:

Criteria for screening for asymptomatic disease	Criteria met
• Disease is common	Yes
• Relationship between asymptomatic disease and the subsequent development of disease is quantified	Some evidence
• Evidence from randomised controlled trials that modifying risk factors for asymptomatic disease reduces the subsequent risk of developing symptomatic disease	No
• Screening tests for asymptomatic disease are valid, precise, reproducible, practical and acceptable	No
• Screening and management strategy for asymptomatic disease	No
• Cost-effective use of resources	No

For the moment, none of the non-invasive techniques currently available to detect coronary artery disease have met all of the above criteria and therefore this remains the subject of research.

Symptomatic

Out of hospital cardiac arrest

Community studies have shown that about three-quarters of cardiac arrests occur outside hospital, 83% in the victim's home, and that the principal witnesses are members of the victims family. About half the cases who die have a medical history of coronary disease. In the UK Heart Attack Study only half the arrests were witnessed and in the others the victim was found dead, having last been seen alive several hours previously.[145,146] Importantly, of those that were witnessed, death was truly sudden in only a small minority (13%). Premonitory symptoms were reported by bereaved relatives in at least a third of deaths, and the commonest was chest pain, but symptoms of 'breathlessness', 'indigestion', or 'feeling unwell' were also reported frequently. A call for help before cardiac arrest is made in very few cases and cardiopulmonary resuscitation is attempted in less than a third of the deaths that are witnessed. Overall survival from out of hospital cardiac arrest remains poor. A total of 111 patients were successfully resuscitated in the UK Heart Attack Study but only half were discharged from hospital alive. Of these, the vast majority had ventricular fibrillation. If the arrest is witnessed the main determinant of survival is the delay from arrhythmia to electrical defibrillation of the heart. There is almost a one in two chance of patients who arrest in the presence of a paramedic equipped with a defibrillator surviving to leave hospital alive. Basic life support performed before the arrival of a defibrillator doubles the survival rate, yet cardiopulmonary resuscitation is attempted by lay persons in less than a third of the deaths they witnessed. Attendance by an ambulance crew fully trained in CPR and equipped with a defibrillator is not guaranteed. Nor does a general practitioner necessarily attend a community collapse, preferring instead to summon an ambulance. The NHS plans to continue the single paramedic response system, prioritising emergency calls and reducing response times for life-threatening emergencies from the present 14 minutes for 95% of calls in urban areas to 8 minutes for 90% of all calls in all areas. So there is potential to treat cardiac arrest in the community more effectively.

Presentation and management of cardiac chest pain in the community

A patient seeking medical advice for chest pain can do so through the general practitioner, or Accident and Emergency. The doctor has to decide is the pain cardiac in origin and, if so, whether it is due to an acute coronary syndrome or exertional angina. The former requires urgent assessment in hospital whereas the latter can be managed as an outpatient. For the GP, the diagnosis can be difficult from the history alone. Options are to perform an ECG, send the patient to casualty, refer for an open access 12 lead ECG (and in some hospitals open access exercise testing is also available) or refer for a cardiology outpatient opinion. Community surveys of angina before the introduction of chest pain clinics found that most patients with 'stable angina' were managed by their GP; only a small minority were referred for specialist opinion and investigations. For those patients presenting directly to casualty, the doctor can admit, refer to cardiology outpatients or back to the GP. The consequence is up to 25% inappropriate admissions of non-cardiac chest pain to hospital 'chest pain – exclude myocardial infarction' and conversely between 2 and 12% of patients being inappropriately discharged from hospital.[141]

Presentation and management of exertional angina in the community

Criteria for referring patients with exertional angina from primary care to hospital outpatients were not defined in most districts, and therefore a large variation in practice existed between districts and between general practitioners within a district. Some GPs referred patients when they first presented, whereas others managed patients medically and only referred if symptoms could not be adequately controlled with medication alone, or for other reasons.

In one community study of prevalent angina, most patients for whom general practitioners prescribed nitrates had not been investigated in detail.[89,138] Only 64% had had an ECG, 7% an exercise test and 4% a coronary angiogram. One in five of these patients attended a hospital medical clinic during the period of the survey, and half of these were seen by a cardiologist. In a seven year follow-up of this group of patients, 20% were admitted urgently with chest pain (although only 14% had a confirmed myocardial infarction) and a further 15% were referred for a medical outpatient appointment because of chest pain. 39% of patients died during this period, of whom two-thirds died from cardiovascular or unknown causes. So if Nottingham was representative of practice elsewhere, then most patients with suspected angina were treated by general practitioners without specialist help.

One model of care for patients with exertional angina, which is now widely available, is a Rapid Access Chest Pain Clinic (RACPC).[48,59,103,141,151] For example, a service in Bromley opened in 1996 provided rapid daily assessment of patients with chest pain which, in the opinion of the referring doctor, could be due to angina. All patients had presented with chest pain for the first time, and none had a past medical history of CHD. The RACPC was open Monday through Friday, 12 midday to 4 p.m., and patients could therefore be rapidly assessed without appointment, either on the day they presented or the next working day. Patients considered by the GP to have unstable angina or an evolving myocardial infarction were referred directly to the Accident and Emergency Department in the usual way. Patients with chest pain who went direct to A&E without consulting their GP, and in whom an acute coronary syndrome had been excluded, were also referred to the RACPC for assessment of angina. Patients were reviewed by a cardiologist in training and had a full history, clinical examination, resting 12 lead ECG, chest X-ray, and for those with angina or possible angina, either a treadmill exercise test (Bruce protocol) and/or a thallium scan if they were unable to use the treadmill. The results of this service are shown in Table 14(a).[190–193] Twenty-nine per cent of patients were considered to have exertional angina and two-thirds non-cardiac pain. One in twenty patients had an acute coronary syndrome despite the advice to refer such patients directly to casualty. These results are almost identical to those of a RACPC at Newham General Hospital in London where the patient referral criteria were almost identical.[104] In the Newham clinic the pain

had to be of recent onset (within 4 weeks) and younger people (men < 30 years and women < 40 years) were discouraged.

These clinics show that the diagnosis of cardiac chest pain can be resolved, those with coronary disease identified and those with non-cardiac pain appropriately reassured. The difficulty in sometimes distinguishing an acute coronary syndrome from exertional angina in the community is also illustrated by the inappropriate referral of a small proportion of such patients to these clinics. These patients may have been inappropriately managed in the past in general practice and thus not received potential life-saving treatments. Although the majority of patients did not have cardiac pain this should not necessarily be seen as a judgement of the GP's ability to diagnose angina because the threshold for referral to a RACPC is likely to be lower than that for referral to cardiology outpatients.

In Bromley this service was set up in the context of the Bromley CHD Register and so it was possible to estimate the impact of the RACPC on the number of new diagnoses of CHD in this district. The number of new exertional angina cases increased by 57% as a result of the RACPC. This increase in the number of angina patients assessed in hospital is consistent with previous reports of a low referral rate of angina patients by GPs to a specialist. When a chest pain clinic opens there will inevitably be an increase in the number of new cases of angina identified by the cardiology service, not previously referred for a specialist opinion.

Unlike Bromley and Newham, the referral criteria for the chest pain clinics in Edinburgh[48,141] (*see* Table 14(b)) were more acute – 'acute or recent onset' or 'new or increasing or chest pain at rest' – and

Table 14(a): Rapid assessment chest pain clinics.

	Bromley Hospital London (n = 1,602)	**Newham Hospital London (n = 2,160)**
Referral criteria	*Chest pain considered to be exertional angina and no history of CHD*	*Recent onset of chest pain (under 4 weeks) and no history of CHD*
Acute coronary syndromes	84 (5%)	[ ] (4%)
Angina	467* (29%)	[ ] (25%)
Non-cardiac chest pain	1,051 (66%)	[ ] (69%)
Other	–	–

* Definite and possible angina combined.

Table 14(b): Rapid assessment chest pain clinics.

	Royal Infirmary Edinburgh (n = 1,188)	**Western General Edinburgh (n = 278)**
Referral criteria	*Suspected cardiac chest pain of acute or recent onset and no history of CHD*#	*New or increasing chest pain, or chest pain at rest, or other chest pain of concern in patients with or without a history of CHD*
Acute coronary syndromes	144 (12%)	51 (18%)
Angina	274 (23%)	89 (32%)
Non-cardiac chest pain	768+ (65%)	
Other	2 (–)	2 (–)

+ Includes 82 patients with chest pain not otherwise specified.
# Patients with suspected myocardial infarction or unstable angina referred directly for hospital admission.

although GPs were instructed to send patients with suspected acute coronary syndromes direct to casualty these referral criteria increased, by up to threefold, the proportion of patients referred to the chest pain clinic with acute coronary disease which may actually delay life-saving treatments. The number of hospitals providing a chest pain clinic facility is rapidly increasing but their impact needs to be evaluated.

In the Edinburgh Royal Infirmary service, GPs were asked to provide an initial diagnosis and an indication of their preferred patient management if the chest pain clinic was not available. An unambiguous referral diagnosis was only made in 29% of cases. The GP diagnosis agreed with that of the clinic physician in just a third of the 27% of cases for which the GP proposed hospital admission. Only a fifth of patients required admission from the chest pain clinic. Conversely, of the three-quarters of patients who would have had a GP-requested outpatient review about 1 in 10 actually required direct admission to hospital. So a positive impact of the chest pain clinic was to reduce intended admissions to hospital by 46%. However, on the negative side, of the 144 patients with an acute coronary syndrome (81% unstable angina), only 26% would have been hospitalised by their GP, thus delaying admission and life-saving treatments for the majority.[141]

Patients with exertional angina assessed in such clinics all have specialist investigations – treadmill exercise testing, radionuclear investigations, etc. – to determine the severity of coronary artery disease and myocardial ischaemia. In the Bromley Rapid Access Chest Pain Clinic, 85% of patients with exertional angina went on to have an exercise test (87%) or a thallium scan (13%). On exercise testing there was objective evidence of myocardial ischaemia in 72% of patients and 74% of patients who had thallium scans had a high probability of coronary artery disease. Forty-eight per cent of patients classified as high risk on the basis of these non-invasive investigations proceeded to coronary arteriography: 60% required revascularisation either in the form of angioplasty ± stent implantation (70%) or CABG (30%), 23% were for medical therapy only, and 17% had normal coronary angiograms. Overall, 29% of all patients presenting with exertional angina required revascularisation.

So, rapid assessment of chest pain resolves the cardiac diagnosis, provides potential life-saving treatments for those with acute coronary syndromes who might otherwise have been managed in the community, prevents unnecessary hospital admissions and risk-stratifies patients for coronary arteriography and revascularisation.

Presentation and management of acute coronary syndromes

A contemporary description of the presentation and hospital management of acute coronary syndromes comes from a UK Survey of Acute Myocardial Infarction and Ischaemia (SAMII).[21] This prospective clinical survey was undertaken in a random sample of 94 district general hospitals at which 1064 consecutive patients aged < 70 years (approximately equal numbers of men and women) with a working diagnosis of acute myocardial infarction or ischaemia were followed up to discharge.

For patients admitted to hospital with an acute coronary syndrome, the majority first seek advice from their GP and around a third call an ambulance or present directly to the casualty department. There is a difference in the source of medical advice by gender; men go directly to casualty more frequently than women, who prefer to seek advice from their GP. The time interval from symptom onset to the start of in-hospital treatment is mainly determined by the patient deciding to seek medical advice. Once such advice is sought, the time to admission is longer if this is done through the GP. Once they reach hospital, the majority of patients (57%) are initially assessed in casualty, but 28% are admitted directly to CCU. For those assessed in casualty, the triaging of patients with chest pain, and a protocol for initiating thrombolytic therapy in the A&E department, are both important determinants of the door to needle time. Sixty-eight per cent of patients who are being managed as an acute coronary syndrome are admitted to a CCU. The others are treated in an acute medical ward. Acute myocardial infarction is more likely to be managed in CCU. Thirty-two per cent of patients are admitted under the care of a cardiologist, and of

those admitted under another speciality about 18% are transferred to a cardiologist prior to discharge. So overall, about one in two patients are ultimately managed by a cardiologist.

Four out of five patients with a working admission diagnosis of acute myocardial infarction were given thrombolytics, and streptokinase was used in a large majority[11,17,70,95,165–167,215] (*see* Table 15(a)). TPA or another agent was used in 13% of cases. The proportion of patients with a final discharge diagnosis of acute myocardial infarction, who received thrombolytic therapy as part of initial management, falls to about two-thirds. This is explained by a number of factors. The diagnosis of an evolving myocardial infarction depends on characteristic symptoms and dynamic ECG changes with or without laboratory evidence of myocardial necrosis. In the absence of characteristic ECG changes, the physician requires serial blood enzymes estimations to make the diagnosis, but these are neither completely sensitive nor specific, though newer more sensitive measures are becoming available such as troponin.[119,122] In those patients with a past history of CHD the initial ECG can be difficult to interpret as there may be residual ST elevation and/or Q waves. A proportion of patients have contra-indications to thrombolytic therapy. The median time interval between hospital arrival and starting thrombolytic therapy in those with an initial diagnosis of acute myocardial infarction was 76 minutes. This interval is almost halved for those initially assessed in CCU compared to casualty. Importantly, of those patients with a final discharge diagnosis of myocardial ischaemia but no infarction, only 4% received thrombolytic therapy inappropriately. The treatments used in acute myocardial ischaemia are shown in Table 15(b).

Table 15(a): Therapeutic management of acute coronary syndromes in district general hospitals in the UK: acute myocardial infarction.[+]

Acute myocardial infarction (n = 447)		
Initial in-hospital (first 24 hours) management		
Thrombolysis		79%
Streptokinase	85%	
TPA	12%	
Others	3%	
Aspirin		93%
< 150 mg	40%	
≥ 150 mg	60%	
Beta-blockers		35%
Intravenous[+]	10%	
Oral	97%	
At discharge		
Aspirin		92%
Beta-blockers		51%
Lipid modification		1.5%
ACE inhibitors		36%
Calcium antagonists		18%
Nitrates		58%
Diuretics		20%
Anticoagulants		2.1%

[+] Bowker TJ *et al.* (SAMII principal results paper *E Heart J* 2000; **21**: 1458–63)

Table 15(b): Therapeutic management of acute coronary syndromes in district general hospitals in the UK: acute myocardial ischaemia.

Acute myocardial ischaemia (n = 614)		
Initial in-hospital (first 24 hours) management		
Aspirin		83%
< 150 mg	54%	
≥ 150 mg	46%	
Intravenous nitrates		39%
Heparin*		62%
Subcutaneous	28%#	
Other	97%	
At discharge		
Aspirin		83%
Beta-blockers		46%
ACE inhibitors		25%
Lipid modification		1.2%
Calcium antagonists		54%
Nitrates		78%
Diuretics		24%
Anticoagulants		7.4%*

* Heparin: 'Subcutaneous' – unfractionated s.c. only; 'other' – unfractionated IV; low molecular weight s.c. or IV.
# Some patients receiving s.c. heparin here subsequently given heparin by another route.

Aspirin is given in almost all patients, although the dose varies from 75 mg to more than 150 mg.[8] 56% of myocardial infarction patients are given a beta-blocker but in only 3% is this first given intravenously.[80,235] 38% are prescribed an ACE inhibitor.[1] Other drug therapy is shown in Table 10.[36]

One in ten patients had exercise electrocardiography prior to discharge and those patients with a final diagnosis of AMI as opposed to myocardial ischaemia were less likely to have this test. Three per cent of patients had coronary angiography at the DGH prior to discharge, and when those booked electively for this procedure are added, the proportion increases to 5%. The median duration of in-hospital stay is about five days, and longer for women than for men. About 13% of patients required bed to bed transfer to a specialist cardiac centre because of recurrent myocardial ischaemia, and this is twice as common in those with an initial diagnosis of myocardial ischaemia as opposed to acute infarction. They are also more likely to have a past history of CHD. Altogether, about one in five patients are referred, either as inpatients, or electively as an outpatient, to a specialist cardiac centre. One in three patients are given a place on a cardiac rehabilitation course, and these places are more likely to be offered to incident (new) cases of myocardial infarction.

For patients admitted with acute coronary syndromes without ST elevation, data from PRAIS-UK provides the following information. Of the 1046 patients recruited from 56 selected centres, 71% were admitted through accident and emergency, while 28% were admitted directly via general practice or chest pain clinics. Less than 2% of patients were transfers from another hospital, but 9% of patients needed subsequent inter-hospital transfers for coronary investigations and procedures. Chest pain was present on admission in 72% of patients and about two-thirds of patients had recently had unstable or increasing

anginal symptoms. The first admission ward was coronary care unit for 38% of patients, and an admission or cardiology ward for 45% of patients. Study co-ordinators were asked to recruit patients from all wards with acute coronary syndromes, regardless of age. About half of all patients had input from a cardiologist or physician with an interest in cardiology at any time. Of the 56 PRAIS-UK centres, about half had access to some form of coronary angiography, while 15% of centres had access to coronary interventions and coronary bypass surgery.

Treatment changes between admission and follow-up demonstrate that there is no increase in prescriptions of most agents including agents such as lipid lowering therapies after discharge. Use of agents such as beta-blockers is markedly low, even allowing for older patients with co-morbidities, and use of agents such as aspirin and statins is lower than other countries in registries performed at the same time such as ENACT.[72] Work is needed to improve the implementation of an evidence-based prescription policy based on available guidelines, for patients with an acute coronary syndrome in the UK.

Coronary revascularisation

Coronary revascularisation by coronary artery surgery or percutaneous angioplasty can both save lives and improve quality of life.[109,111] Patients who are potentially eligible for revascularisation include the following:

1 acute myocardial infarction with evidence following recovery of clinically important reversible myocardial ischaemia
2 acute coronary syndromes (non Q wave MI or unstable angina) following appropriate medical management
3 exertional angina with evidence of clinically important reversible myocardial ischaemia, or whose symptoms cannot be controlled by medical therapy.

Primary angioplasty has a potential role in patients with acute myocardial infarction who are ineligible for thrombolytic therapy, including those in cardiogenic shock.

The chosen revascularisation procedure for an individual depends on a number of factors, including coronary anatomy. Coronary artery surgery is preferred on prognostic grounds in patients with left main stem disease (or left main stem equivalent disease) or three vessel disease, particularly in the presence of impaired LV systolic function.

Coronary artery surgery or percutaneous transluminal coronary angioplasty (with or without stenting) is suitable on symptomatic grounds in patients whose coronary disease does not fall into the above classification.

Since 1980 there has been a fourfold increase in the number of coronary artery bypass graft operations, which totalled 22 160 in 1996/97. Angioplasty and other coronary intervention procedures have increased more rapidly over a shorter time period and in 1996 there were 20 511 procedures reported. Yet revascularisation rates are lower in the UK than many other Western European countries. This may partly reflect the relatively lower cardiologist per population ratio in the UK compared to other countries.[18] The Department of Health in 2001 are aiming for a 30% increase in the number of consultants in the UK by 2004, which may improve this.

Within this country there are marked variations in revascularisation rates. The age-standardised rates (per 100 000 population) for CABG and angioplasties by National Health Authority districts in England show an enormous range, from 4 in Nottingham to 140 for Brent and Harrow; the average for England is 57. This variation in revascularisation rates is not closely correlated with the coronary disease burden for these districts.

Using CHD mortality as a surrogate for disease burden, there should be a direct correlation between age-standardised CHD mortality rates and interventional rates for coronary disease. The revascularisation

rates for a health district should reflect the local burden of clinical disease, and not an arbitrary interventional rate based on clinical practice in other countries.

Presentation and management of heart failure due to coronary artery disease in the community

The majority (67%) of patients developing clinical heart failure for the first time present as an acute medical emergency, most commonly in the context of an acute myocardial infarction.[76] The rest present to their general practitioner and are either diagnosed and managed in the community or referred for specialist investigation (e.g. echocardiography) and a consultant opinion. It is not known what proportion of these patients are managed without a cardiology opinion. The diagnosis of clinical heart failure can sometimes be difficult, in hospital as well as the community, but particularly for the general practitioner without ready access to specialist investigations.[34,75]

A normal ECG and CXR virtually excludes the diagnosis of heart failure but, conversely, abnormalities in either of these investigations are not necessarily diagnostic of clinical heart failure. The accuracy of the diagnosis of heart failure is considerably improved with the addition of echocardiography, which defines cardiac anatomy and assesses left ventricular dysfunction, but the demonstration of impaired systolic function does not necessarily mean the patient has clinical heart failure. More recently, natriuretic peptides are being investigated as diagnostic markers of heart failure, but their application in clinical practice is still the subject of research.[43] Currently, patients in the community are commonly diagnosed on clinical criteria alone, often supported by simple investigations such as the ECG and chest X-ray. In some districts open access echocardiography is offered[29] or the patient is referred to a specialist where all cardiac investigations will be undertaken including, as appropriate, cardiac catheterisation.

There is evidence of underinvestigation of patients with suspected heart failure. In one study, only 31% of patients with suspected or presumed heart failure had undergone echocardiography.[32] This study also confirmed the figure of approximately 50% for the accuracy of diagnosis of heart failure in primary care.

Once the clinical diagnosis of heart failure has been made and the aetiology defined, subsequent management will include diuretics, ACE inhibitors (or AII receptor blockers), beta-blockers and spironolactone in some combination. ACE inhibitors, beta-blockers and spironolactone have all been shown to improve the survival of heart failure patients. Current evidence suggests underuse of these agents. While ACE inhibitors are now used in the majority of patients, beta-blockers are used in less than 10% of patients with heart failure.[222] The way in which these treatments are started, up-titrated and monitored varies considerably with, in some cases, the general practitioner having sole responsibility and in others, ongoing review organised through specialist heart failure clinics. Specialist heart failure nurses are being introduced in some districts to provide liaison care between the hospital and the community with the intention of reducing the need for recurrent hospital admissions.[129] Not all patients are appropriate for aggressive treatment. For many, palliative care may be the aim.[85]

Post-symptomatic: cardiovascular prevention and rehabilitation

After the acute medical/surgical management of patients presenting with acute coronary syndromes, or exertional angina, the clinical strategy is to reduce the risk of recurrent disease, improve quality of life and life expectancy. Traditionally, cardiac rehabilitation has focused on supervised exercise sessions but this is gradually evolving into comprehensive lifestyle programmes – smoking cessation, healthy food choices as well as increased physical activity – based on behavioural models of change. Risk factor management in terms of controlling blood pressure, lipids and diabetes, and the use of prophylactic drug therapies such as aspirin is also becoming an integral part of this approach to reduce cardiovascular disease. And finally, the psychosocial and vocational support required to help patients lead as full a life as possible is also provided.

This evolution in the scope of cardiac rehabilitation might now more appropriately be called *cardiovascular prevention* and rehabilitation.

As the scope of cardiovascular prevention and rehabilitation is evolving it is also embracing a broader group of patients with coronary disease. Rehabilitation was initially restricted to patients recovering from a myocardial infarction and those who had had cardiac surgery. With the emphasis now on favourably influencing the underlying causes of the disease, patients presenting with angina, both stable and unstable, are being included after their initial medical or surgical management.

Although the evidence base for cardiovascular prevention and rehabilitation of coronary patients is now amongst the best of any aspect of clinical medicine, service provision still remains inadequate in many parts of the country, despite a rapid increase in the number of cardiac rehabilitation programmes over recent years, many started by the British Heart Foundation. The British Association of Cardiac Rehabilitation[49] puts the total number of programmes at almost 300, but this still means that many coronary patients still have no access to such a service. There is also wide variation in practice and in the organisation and management of cardiac rehabilitation services. Thus current service provision fails to meet the national guidelines for cardiac rehabilitation. Most programmes are outpatient, hospital-based, concentrating on lower risk patients who have had myocardial infarction, although many also include patients who have had coronary artery surgery or angioplasty. Women are less likely to receive cardiac rehabilitation than men. The majority of programmes are still exercise-centred, although patient education on other aspects of lifestyle and coronary disease is provided in most. A national hospital survey (ASPIRE) of patients with established CHD, undertaken by the British Cardiac Society, still found considerable potential to reduce the risk of recurrent disease through effective lifestyle changes, risk factor management and the appropriate use of proven prophylactic drug therapies.[22] The risk factor management in patients with CHD in Europe is also far from optimal. Surveys of clinical practice such as EUROASPIRE I and II (European Action on Secondary Prevention by Intervention to Reduce Events) have shown that integration of coronary heart disease prevention into daily practice is inadequate and there is considerable potential to further reduce cardiovascular risk in patients with established CHD because many are not achieving these lifestyle and risk factor goals.[65–67]

More recent surveys in general practice have found that nearly two-thirds of patients with CHD have two or more high risk lifestyle factors that would benefit from change and there is considerable variation in prescribing prophylactic drug therapies between one part of the country and another.

Prescribing of aspirin ranged from 81% to 97%, beta-blockers from 32% to 67% and lipid lowering drugs from 4% to 9%. Several models of care have been evaluated to raise the standards of secondary preventive care, including specialist liaison nurses working between hospital and general practice, postal prompts to patients and general practitioners, health promotion by health visitors and secondary prevention clinics run by nurses in general practice. The liaison nurses had no impact on health outcome and health visitors and postal prompts were also unsuccessful. A dedicated nurse, however, improved patients' health and reduced hospital admissions.

Hospital remains an appropriate starting point for cardiovascular prevention and rehabilitation because patients with acute coronary disease present through Accident and Emergency departments, or are admitted directly to Cardiac Care Units. Those with exertional angina are being assessed in increasing numbers through hospital, mainly through casualty but also cardiology outpatients, and in some districts through the development of rapid assessment chest pain clinics.

Patients with exertional angina are at high risk of progressing to an acute coronary syndrome or coronary death. By addressing lifestyle and other coronary risk factors, and by prescribing aspirin and other prophylactic remedies, the risk of disease progression can be reduced. Yet these patients are not usually included in cardiovascular prevention and rehabilitation programmes, and surveys of risk factor management like ASPIRE have shown that those with angina alone are least well managed compared to patients following myocardial infarction or revascularisation.

6 Effectiveness of services and interventions

Pre-symptomatic patients

Individuals at high risk of developing CHD

Cardiovascular screening

The evidence from randomised controlled trials of systematic (unselected) nurse-led multifactorial cardiovascular screening in primary care is disappointing. The British Family Heart Study[231] and OXCHECK[99,100] both demonstrated small but significant reductions in total coronary risk, achieved principally through lifestyle change. There was no change in smoking habit, but small and significant reductions in weight, blood pressure and cholesterol. Overall, the total coronary risk was reduced by about 12%, the greatest reduction occurring in those at highest risk, and importantly, these reductions were sustained in the OXCHECK trial over several years. These results are in contrast to those obtained in unifactorial intervention trials, usually with drug therapies, showing significant benefits in coronary morbidity and mortality for both antihypertensive and cholesterol modification therapies in primary prevention. In addition, antihypertensive therapy reduces the risk of stroke and there is some evidence emerging, at least in the context of coronary patients, that cholesterol modification therapy can also reduce the risk of stroke. So if clear benefit is evident from different unifactorial interventions, then multifactorial intervention should produce at least as great a benefit. And this is so if the multifactorial intervention is accepted. In an analysis of the relationship between compliance with the WHO Factories Study[115,171] intervention programme and CHD incidence, it was shown that the multifactorial prevention programme was effective to the extent that it was accepted. The rationale for multifactorial intervention and its beneficial effect is therefore not in doubt, but such an intervention needs to produce the same changes achieved in each of the single risk factor trials.

Lifestyle interventions

The evidence for lifestyle change – stopping smoking, modifying diet and increasing physical activity – comes from both observational studies and randomised controlled trials. Individuals who chose to stop smoking have a lower risk of subsequent CHD. There has been only one randomised controlled trial of stopping smoking in healthy middle-aged men which showed no evidence of benefit in terms of coronary or total mortality. This result is more a reflection of the limitations of the randomised controlled trial in evaluating lifestyle change rather than any objective assessment of the true impact of stopping smoking on subsequent disease development. The observational data that smokers who quit have lower CHD rates is a much closer approximation to the true impact of stopping smoking, but this relationship is confounded by other lifestyle changes associated with stopping smoking, including favourable dietary changes and an increase in physical activity.[156] (Level of evidence: II-2.)

The principal evidence for diet as a major determinant of CHD comes from epidemiological studies, and no observational studies have reported the effect of dietary change on subsequent disease events. Of the few randomised controlled trials of diet in primary prevention of CHD, most have tested a reduction in fat, principally saturated fat, although some have modified the intake of monounsaturated and polyunsaturated fats as well. These trials have shown no benefit in relation to CHD or total mortality but again, as with the RCTs of stopping smoking, there are a number of important methodological issues in each of these trials, which substantially reduced the chances of obtaining a realistic answer to the dietary hypotheses. There have been many trials of diet in relation to surrogate end-points for CHD; namely, lipoproteins and blood pressure.[33] These trials have provided convincing evidence, particularly those

conducted under metabolic conditions, that modifying dietary components can favourably influence these risk factors for CHD. Therefore, extrapolating from these dietary risk factor trials, the expectation is that such favourable changes will translate into a lower risk of atherosclerotic disease, but this has not been convincingly demonstrated in disease end-point trials. Finally, there have been a number of RCTs of dietary supplements of vitamins and other food nutrients. Interestingly beta-carotene increased cardiovascular mortality in one trial in the healthy population. So there is currently no convincing evidence to support dietary supplementation with vitamins or other nutrients.[30,120,188] (Level of evidence: II-2.)

There have been no randomised controlled trials of increasing physical activity in the primary prevention of CHD. So the evidence comes from epidemiological studies but, unlike diet, this evidence also includes studies which have related change in physical activity to subsequent disease. The adoption of moderate physical activity is associated with a reduced risk of non-fatal coronary disease and both cardiovascular and non-cardiovascular mortality. There is both observational and trial evidence on the favourable impact of physical activity on other risk factors for CHD, principally lipoproteins. Physical activity raises HDL cholesterol, lowers LDL cholesterol and triglycerides. Physical activity also lowers blood pressure. The same caveats about the confounding effects of other lifestyle changes apply to physical activity as they do to smoking and diet.[86,117,172,177] (Level of evidence: II-2.)

Blood pressure

Several large scale randomised controlled trials have convincingly demonstrated that blood pressure lowering by drugs reduces cardiovascular morbidity and mortality. A meta-analysis of these trials comprising a total of more than 40 000 individuals has shown that over an average period of five years a mean diastolic blood pressure difference of 5–6 mmHg between treatment and control groups reduced the risk of stroke by about 40%.[38,39,123] This is only slightly less than the increase in fatal and non-fatal stroke seen in epidemiological studies for a prolonged increase in diastolic blood pressure of 5–6 mmHg. Another meta-analysis comprising a total of about 14 000 individuals showed that blood pressure lowering reduces the development of heart failure by about 50%.[136] However, this meta-analytic approach has also shown that the reduction in risk of coronary heart disease (fatal or non-fatal events) with a five-year reduction of diastolic blood pressure of 5–6 mmHg is about 15%, which is definitely less than the 20–25% increase in coronary heart disease predicted from epidemiology for a prolonged 5–6 mmHg difference in diastolic blood pressure. Thus antihypertensive treatment does result in a substantial reduction in the increased risk of stroke and heart failure associated with hypertension. However, it only incompletely reduces the risk of coronary heart disease.

Hypertension is also a major risk factor in the elderly. A number of randomised controlled trials have shown that antihypertensive drug treatment is clearly beneficial and this benefit extends to the very elderly up to 80 years of age. These trials have also shown that in isolated systolic hypertension, i.e. a form of hypertension common in the elderly population, and which markedly increases cardiovascular risk, blood pressure lowering by drugs results in a clear-cut reduction in the number of cardiovascular fatal and non-fatal events. Cardiovascular complications reduced by drug treatment are stroke, heart failure and coronary heart disease, with a reduction in all-cause mortality, both in individual trials and in a meta-analysis.[186,211] (Level of evidence: I.)

Blood lipids

Clinical evidence of the benefit of lowering blood cholesterol in relation to primary prevention of CHD has been obtained from several RCTs, although until quite recently there was still concern about the benefits of such treatment overall. There have now been two RCTs of cholesterol modification using statins in primary prevention; the West of Scotland Coronary Prevention Study (WOSCOPS)[227] and the Air

Force/Texas Coronary Atherosclerotic Prevention Study (AFCAPS/TexCAPS).[58] In both trials there was a significant reduction in the combined end-point of non-fatal and fatal coronary events. There was no effect on total mortality but neither trial was powered to test the effect of lipid lowering on all causes of deaths. Importantly, there was no evidence of any adverse effects of the statins on non-cardiovascular events and these results are consistent with the three trials of statins in secondary prevention, two of which did show overall benefit in relation to total mortality. Earlier clinical trials of fibrate treatment have not yielded results as clear-cut as those involving other classes of lipid lowering drugs, principally the statins. Continuing long-term surveillance of all classes of lipid modification therapy on clinical events, both cardiovascular and non-cardiovascular, is necessary. (Level of evidence: I.)

Diabetes mellitus

Although both types of diabetes, Type I (insulin-dependent) and Type 2 (non-insulin-dependent), are associated with a markedly increased risk of CHD, cerebrovascular disease and peripheral vascular disease, there has been no evidence from RCTs that glycaemic control had any benefit in relation to these macrovascular complications. The recent UK Prospective Diabetes Study (UKPDS)[219,220] evaluated different treatment modalities (chlorpropamide, glibenclamide, insulin and metformin) in Type 2 diabetes in relation to both microvascular and macrovascular end-points. Glycaemic control reduced the risk of microvascular complications but was not associated with a significant reduction in macrovascular complications. However, lowering blood pressure did significantly reduce coronary events. (Level of evidence: I for anti-hypertensive therapy.)

Individuals with asymptomatic disease

Although non-invasive methods for the detection of asymptomatic coronary artery or other atherosclerotic disease look promising, more research is needed to evaluate their incremental value above that of conventional risk factor measurements in assessing absolute risk of developing cardiovascular disease in healthy people. Randomised controlled trials are also required to evaluate the impact of a non-invasive screening and intervention programme for coronary artery, or other arterial, disease on subsequent morbidity and mortality.

Symptomatic patients

Out of hospital cardiac arrest

Direct current cardioversion for ventricular flutter/fibrillation in the context of acute myocardial ischaemia/infarction is life-saving and therefore a randomised controlled trial has never been conducted because observation provided conclusive proof. In a CCU/ITU, Accident and Emergency Department and other specialised areas of care in a hospital where staff are trained in all aspects of advanced cardiopulmonary resuscitation, the chances of surviving a cardiac arrest are optimal. For out of hospital cardiac arrests this is not so, and the observational evidence shows that only a small minority survive to reach and then be discharged from hospital alive. The central issue is the benefit of different levels of cardiopulmonary resuscitation in the community (paramedical with full resuscitation skills and equipment) through to bystander CPR.[210] (Level of evidence: II-3.)

Despite the present provision of paramedical teams, only 1 in 10 patients are successfully resuscitated, of whom less than half survive to 30 days; about 4% of all cardiac arrests outside hospital. However, only a minority actually has cardiopulmonary resuscitation, about 27%. Paramedical staff have a much higher

success compared to bystander CPR. There is a five-fold increase in the prospect of surviving out of hospital cardiac arrest from 8% with relative or bystander CPR to 40% for paramedics.[145,146]

Chest pain in the community

There is no evidence from randomised controlled trials that rapid assessment of chest pain will favourably modify the natural history of exertional angina. Such clinics resolve the diagnosis and initiate appropriate management but their impact on morbidity and mortality is not known.

Exertional angina

Drug therapy

There is no evidence from randomised controlled trials that any therapeutic drug class used to treat the symptom angina has any survival benefit. This includes nitrates, beta-blockers, calcium channel blockers and other agents. However, there is some trial evidence that prophylactic aspirin and cholesterol-lowering therapy with a statin reduces the risk of subsequent morbidity and mortality and can improve survival.[47,61,77,93,110,189] (Level of evidence I (aspirin) and II-I (statin).)

Coronary revascularisation

Revascularisation of selected patients with stable exertional angina, either by coronary artery surgery or coronary angioplasty, will reduce morbidity and mortality.[13,155,170,201] In an overview of randomised controlled trials comparing coronary artery bypass graft (CABG) surgery with medical therapy in patients with stable angina (not severe enough to necessitate surgery on symptomatic grounds alone, or myocardial infarction), the CABG group had significantly lower mortality than the medically treated group up to 10 years. The odds ratios (95% CI) were 0.61 (0.48–0.77), 0.68 (0.56–0.83) and 0.83 (0.70–0.98) at 5, 7 and 10 years in favour of surgery. The risk reduction was greatest in those with the most prognostically important disease, left main artery and in three vessels. Coronary surgery has also been compared to coronary angioplasty in angina patients. A meta-analysis of randomised trials showed no difference in prognosis between these two initial revascularisation strategies for the combined end-point of cardiac death and non-fatal myocardial infarction; relative risk 1.08 (0.79–1.50). However, 17.8% of patients randomised to percutaneous transluminal coronary angioplasty (PTCA) required additional CABG within a year. The rate of additional non-randomised interventions (PTCA and/or CABG) in the first year of follow-up was 3.37% and 3.3% in patients randomised to PTCA and CABG respectively. The prevalence of angina after one year was considerably higher in the PTCA group (relative risk 1.56 [1.30, 1.83]) although this difference had attenuated by 3 years. Separate analyses for multi-vessel and single vessel disease patients were largely compatible, though the rates of mortality, additional intervention and prevalent angina were slightly lower in single vessel disease.

In this country the Randomised Intervention Treatment of Angina (RITA) trial showed similar results; no difference in the combined end-point of death or definite myocardial infarction (relative risk 0.88 [0.59–1.29]).[168] However, 4% of PTCA patients required emergency CABG before discharge and a further 15% had CABG during follow-up. Altogether, 38% and 11% of the PTCA and CABG groups required revascularisation procedure(s) had a primary event. Repeat coronary arteriography during follow-up was four times more common in the PTCA than in CABG patients. The prevalence of angina during follow-up was higher in the PTCA group (32% vs 11% at 6 months) but this difference became less marked after 2 years and anti-anginal drugs were prescribed more frequently for PTCA patients. The long-term follow-up (median 6.5 years) of RITA-1 continued to show no significant difference in death or non-fatal

myocardial infarction.[94] Altogether, a quarter of patients assigned PTCA also had CABG and a further 19% required additional non-randomised PTCA. The prevalence of angina remained consistently higher in the PTCA group. So these revascularisation procedures for patients with angina are equivalent in terms of subsequent death and myocardial infarction. However, those who have PTCA have a much higher need for repeat angiography and further revascularisation (either CABG or repeat PTCA) and are still more symptomatic than those who had surgery.

The role of PTCA has also been evaluated in comparison to medical therapy in the RITA-2 trial.[169] Unlike the comparison with surgery, there was a significantly higher risk of death or definite myocardial infarction in the PTCA group (6.3% vs 3.3%); an absolute difference of 3% (95% CI: 0.4–5.7%). This difference was mainly due to one death and seven non-fatal myocardial infarctions related to the revascularisation procedures. Almost one in five patients randomised to PTCA required either emergency ($n = 7$) or elective CABG or further non-randomised PTCA. In the medical group, 23% underwent a revascularisation procedure during follow-up, mostly because of worsening symptoms. Relief of angina and exercise time was significantly better in the PTCA group and these benefits were greatest in those with more severe angina at baseline. In patients with angina, which is considered suitable for either medical care or PTCA, the greater symptomatic improvement from this form of revascularisation has to be balanced against the short-term excess hazard, principally myocardial infarction and emergency revascularisation.

Acute coronary syndromes: Q wave MI, non Q wave MI and unstable angina

Patients with acute coronary syndromes – acute ST elevation MI, non-ST elevation MI and unstable angina – require urgent hospital assessment for three reasons. First, the survival benefit for those patients eligible for reperfusion therapies (thrombolytic agent or combination of thrombolytic with either heparin or Gp IIb/IIIa receptor blockers therapy or primary angioplasty) increases the shorter the interval between onset of symptoms and treatment. Second, in the event of ventricular flutter/fibrillation the chances of successful resuscitation are increased fivefold with a trained paramedic crew in attendance, or if the cardiac arrest occurs in casualty or another specialised hospital area. Third, for those patients not eligible for reperfusion therapies, agents such as clopidogrel and Gp IIb/IIIa receptor blockers have been shown to reduce subsequent combined end-points such as death, stroke or myocardial infarction. There are numerous trials that are both recently completed and ongoing dealing with the management of acute coronary syndromes. These have changed the management of acute coronary syndromes substantially with further developments to come.

Anti-ischaemic therapy

Only beta-blockers have clinical evidence of benefit from randomised controlled trials in relation to survival. Intravenous (oral) beta-blockade in acute myocardial infarction lowers early mortality by 10–15%. There are no similar trials in unstable angina. There is no comparable evidence for intravenous nitrates. Calcium antagonists – verapamil and diltiazem – can be used for patients with AMI in whom beta-blockers are contra-indicated, and in the absence of significant LV systolic dysfunction or heart failure. However, a meta-analysis of this class of drugs showed no evidence of benefit in terms of mortality, and may actually increase the risk of dying. Nifedipine, the short acting calcium blocker, is contra-indicated in this context.[106,182,185,235] (Level of evidence for beta-blockers: 1.)

Anti-thrombotic therapy

Anti-platelet therapy

Anti-platelet therapy, principally aspirin, has been shown in randomised controlled trials to reduce the risk of myocardial infarction and death in acute coronary syndromes by up to 70%. Of the second generation platelet inhibitors, clopidogrel is superior to aspirin in one randomised control trial in terms of achieving a significantly greater reduction in clinical events, and is therefore an appropriate alternative to aspirin when the latter cannot be tolerated. The combination of aspirin and clopidogrel for patients presenting with non-ST elevation acute coronary syndromes has recently been shown to reduce the combined end-point of cardiovascular death, myocardial infarction and stroke by 20% at a mean follow-up of 9 months. This reduction in the CURE trial was mainly driven by a reduction in myocardial infarction. In a prospective sub-group analysis of the patients in the CURE study that underwent coronary angioplasty, the benefit seen was even higher despite the placebo arm switching briefly to open label clopidogrel for 1 month.[131,132]

Intravenous glycoprotein IIb/IIIa receptor antagonists are the third generation of platelet inhibitors. Oral agents have been ineffective. There are two distinct types of intravenous agents: monoclonal antibodies (abciximab) and small molecules (tirofiban or eptifibatide). These agents have been evaluated in a number of trials of acute coronary syndromes. Initially these agents were restricted to trials of patients with non-ST elevation acute coronary syndromes, but more recently they have been tried in combination with thrombolytic agents in the context of ST elevation acute coronary syndromes. In randomised control trials of non-ST elevation acute coronary syndrome patients, both small molecule agents have shown a reduction in myocardial infarction and death of up to 25% compared with aspirin and unfractionated heparin alone. The main driver of these reductions has been in the reduction of myocardial infarction. One notable exception of an intravenous agent not being effective was the GUSTO-IV study of non-ST elevation in patients with acute coronary syndromes unlikely to go for revascularisation.[181] While a number of theories of inadequate chronic platelet inhibition or rebound platelet activation have been offered for this result, the impact has been that abciximab is not recommended for medical stabilisation of patients with non-ST elevation acute coronary syndromes. However, in the context of patients going for coronary angioplasty, abciximab was found to be superior to tirofiban in the only head to head Gp IIb/IIIa receptor blocker (TARGET) study to report thus far.[216] It is worth noting that the National Institute of Clinical Excellence have recommended that all high risk patients are given a Gp IIb/IIIa receptor blocker as soon as possible on admission with a non-ST elevation acute coronary syndrome. This guidance has been supported by the recent European and British guidelines on the management of non-ST elevation acute coronary syndromes. Despite these strong, clear recommendations there has not been a widespread uptake of Gp IIb/IIIa receptor blockers except when patients are scheduled to go directly to coronary angiography. However, few patients in the UK are offered urgent angiography due to lack of interventional units.[8,15,25–28,64,73,114,132,158–160,181,208,216] (Level of evidence for aspirin, clopidogrel: I-1; glycoprotein IIb/IIIa receptor antagonists as adjuncts to angioplasty and stenting in the context of acute coronary syndrome: I-1; glycoprotein IIb/IIIa receptor antagonists as medical stabilisation of acute coronary syndrome only : I-1 [last level may be revised in light of GUSTO-IV].)

Acute anticoagulation

A meta-analysis of the use of unfractionated heparin in acute coronary syndromes has shown only marginal benefit in terms of mortality over the use of aspirin alone. Low molecular weight heparin, together with aspirin, is much more effective than aspirin alone and is at least as effective as unfractionated heparin. Low molecular weight heparin is being increasingly used in preference to unfractionated heparin because of ease of administration (subcutaneous) and no need for monitoring.[9,10,36,40,61,62,79,81,82,88,101,113,208] (Level of evidence for unfractionated heparin: 4.)

Thrombolytic therapy

In patients with an evolving myocardial infarction (ST elevation > 0.1mm in two or more contiguous leads, or bundle branch block) seen within 12 hours of the onset of symptoms, aged < 75 years, then thrombolytic therapy will reduce mortality. For those patients with an anterior MI, there is evidence that rtPA confers additional mortality benefit over streptokinase. For older patients and those seen after 12 hours, or with other ECG changes, there is no convincing evidence for thrombolytic therapy. Nor is there any evidence to support the use of thrombolytic therapy in non Q wave MI, or unstable angina, and for the latter this treatment may actually have adverse risks. Combinations of thrombolytic agents and Gp IIb/IIIa receptor blocker are being evaluated. In ASSENT-3, tenecteplase was combined with one of the following: unfractionated abciximab, or enoxaparin.[202] Both the latter arms did significantly and equally better than the unfractionated heparin arm. The convenience of enoxaparin makes it an attractive addition to thrombolytic agents for reducing the combined end-points of death (by 30 days), re-infarction and refractory ischaemia.[11,70,78,102,199,203] (Level of evidence for thrombolytic therapies: 1.)

Long-term anticoagulation

The data for oral anticoagulation in addition to aspirin is contradictory. While the earlier CHAMP study of 5059 patients with acute myocardial infarction showed no benefit of the combination over 10 years with a mean INR of 1.9, the more recent WARIS-II trial showed a benefit. WARIS-II enrolled 3630 acute myocardial infarction patients and randomised them to either aspirin or warfarin or a combination.[98] The mean INR in the combination group was 2.2 and in the warfarin alone arm was 2.8. Both these warfarin arms reduced the rate of combined first events of death, thromboembolic stroke or re-infarction significantly by 29% and 19%, respectively. The combination arm increased the risk of bleeding fourfold above aspirin but with very low absolute numbers (0.15% to 0.58% major bleeds per year). Patients with both Q and non Q wave infarctions were included in that study. How these results will impact on clinical practice remains to be seen in view of the additional resources needed for this approach. An evaluation of aspirin–warfarin and clopidogrel–aspirin–warfarin combinations would be the next logical step to determine benefits and bleeding rates. Anticoagulation would be appropriate in selective coronary patients at high risk of systemic embolisation; atrial fibrillation, large anterior MI, and LV thrombus. (Level of evidence: I-2.)

Statins in the acute phase

The MIRACL trial evaluated the impact of atorvastatin 80 mg started between 24 and 96 hours after admission and continued for 16 weeks, in 3086 patients with a non-ST elevation acute coronary syndromes. There was a significant reduction in the combined end-points of first event of death, myocardial infarction, stroke or recurrent ischaemia/ischaemic readmission. However, this result was almost completely driven by a reduction in recurrent ischaemia/ischaemic readmissions. So the clinical benefit of acute statin therapy remains an open question but there was little difference in adverse events from placebo.[175] (Level of evidence: I-2.)

Hormone replacement therapies in the acute phase of acute coronary syndromes

A variety of hormone replacement therapies are being evaluated in female patients presenting with acute coronary syndromes and results of these are awaited.

Interventional therapy

Primary angioplasty

There is evidence of mortality benefit for primary angioplasty as an alternative to thrombolytic therapy in an evolving myocardial infarction when undertaken by a skilled interventionist. However, at present this therapeutic option is not available in the vast majority of hospitals which manage acute coronary syndromes. Primary angioplasty should be considered for patients with evolving MI (same criteria as for thrombolytic therapy) in whom thrombolysis is contra-indicated, or for cardiogenic shock. (Level of evidence: I-1.)

Early revascularisation

After medical therapy for acute coronary syndromes the benefit of early revascularisation for high risk patients, e.g. non Q wave MI and unstable angina who settle medically, has been compared with a conservative medical approach. In the FRISC II trial, patients with unstable coronary artery disease (verified by electrocardiography or raised biochemical markers) were randomised to an early invasive or non-invasive treatment strategy. There was a reduction in the combined end-point of death or myocardial infarction (risk ratio 0.78 [95% CI: 0.62–0.98]). Myocardial infarction decreased significantly, but not mortality. Symptoms of angina and readmission were halved by the invasive strategy. The differences between previous studies and the FRICS II trial[83,225] are probably explained by the large difference in intervention rates and the timing of interventions. Coronary angiography was done within the first 7 days in 96% and 10%, and revascularisation within the first 10 days in 71% and 9% of patients in the invasive and non-invasive groups. This is in contrast to the intervention rates in the TIMI IIb trial (61 vs 49% at 42 days) and the VANQWISH[19] trial (44 vs 33% after about 1 year). In the context of non-ST elevation acute coronary syndromes, the TARGET trial of 2220 patients also demonstrated the benefits of a routine early aggressive approach compared to an initial conservative approach with all patients covered by Gp IIb/IIIa receptor blockers.[216] The TACTICS trial required all patients randomised to the invasive approach to go for angiography within 4 to 48 hours, with revascularisation if appropriate.[26] Inpatient angiography was provided for patients in the conservative group if they developed refractory ischaemia, cardiac complications or had a positive pre-discharge stress tests. The primary outcome was a combination of death, myocardial infarction or a readmission with an acute coronary syndrome within 6 months. Prior to discharge 51% of patients in the conservative group and 97% in the invasive group had angiography, resulting in respective revascularisation rates of 36% and 60%. By 6 months, revascularisation rates were 44% and 61%, and the primary end-point occurred in 19.4% of the conservative group and 15.9% of the invasive group. The relative risk reduction was 22% ($p = 0.025$), driven mainly by significant reductions in myocardial infarctions and readmission but not mortality.

So the potential of early revascularisation, particularly for high risk patients, in reducing subsequent morbidity (myocardial infarction) requires further evaluation in relation to total mortality. Even if proven, such a policy will require a major increase in resources and manpower. In PRAIS-UK, only 10% of patients had inpatient angiography and another 4% of patients had angiography after inter-hospital transfer. These rates are lower than the conservative arm of the TACTICS trial demonstrating the marked disparity of resources in the UK compared to the US and other European countries and the United States. (Level of evidence: 1.)

Late revascularisation

Patients following a myocardial infarction (Q wave and non Q wave MI) are at high risk of reinfarction and coronary death. In the DANAMI (Danish Trial in Acute Myocardial Infarction)[124] trial, patients following

a myocardial infarction were randomised to an invasive strategy, exercise testing and coronary angiography with revascularisation of those with abnormal exercise tests, or a conservative one. Those randomised to the invasive strategy had a better outcome.

Other therapies

ACE inhibitors

In patients with a myocardial infarction there is evidence of mortality benefit for angiotensin-converting enzyme inhibitors. Patients with symptoms or signs of heart failure at the time of MI, or with echocardiographic evidence of significant LV systolic dysfunction (ejection fraction < 40%) will benefit from ACE inhibitors.[1,103,116,237] When an ACE inhibitor is contra-indicated the combination of nitrates and hydralazine should be considered. (Level of evidence: 1.)

Anti-arrhythmic drugs

There is no single trial evidence for the prophylactic use of anti-arrhythmic drugs, other than beta-blockers, in the management of acute coronary syndromes. An individual patient meta-analysis of amiodarone following myocardial infarction found a 13% reduction in the total mortality. The follow-up period for the studies included varied from 6 months to 4.5 years.[4]

Cardiovascular prevention

The evidence for the long-term use of aspirin (or other platelet-modifying drugs), beta-blockade and cholesterol modification therapy is described under 'Cardiovascular prevention and rehabilitation' below.

Heart failure

Randomised controlled trials of several classes of therapeutic agents have shown survival benefit for patients with clinical heart failure.[180] ACE inhibitors improve survival in all grades of heart failure.[84] This class has largely superseded the use of hydralazine and nitrates (where mortality benefit has been demonstrated in earlier studies) except where renal function precludes ACE inhibitor or AII receptor antagonist therapy. (Level of evidence: I-1.)

AII receptor antagonists are appropriate if ACE inhibitors are not tolerated (e.g. because of cough) but their efficacy in addition to ACE inhibitors (particularly in combination with beta-blockers) is unclear.[37] (Level of evidence: I-1.)

Beta-blockers improve survival in all grades of heart failure but must be initiated and up-titrated cautiously.[31,133,152,229] (Level of evidence: I-1.)

Digoxin therapy for patients whose rhythm is sinus in heart failure does not confer any survival benefit but may be useful for symptoms and to reduce hospitalisation.[203] (Level of evidence: I-1.)

Although there is no clinical trial evidence for diuretic therapy, this treatment was obviously beneficial to patients in heart failure when first used and all therapeutic agents with proven survival benefit are given in combination with diuretics. (Level of evidence: III.)

Spironolactone in low doses (25–50 mg o.d.) improved survival in one trial of patients with severe heart failure although worsening hyperkalaemia and renal failure can occur.[154] (Level of evidence: I-1.)

Cardiac transplantation improves survival.[97] (Level of evidence: II-1.)

LV assist devices may act as a bridge to transplantation. Revascularisation has not been tested in a RCT but case series suggest it is useful in patients with 'viable' myocardium.[74] (Level of evidence: II-1.)

Complex biventricular pacing improves symptoms in highly selected patients.[223] (Level of evidence: I-2.)

Models of care have in the main not been formally evaluated although nurse-led interventions have been shown to reduce hospitalisations.[129] (Level of evidence: I-2.)

There is some evidence of increased exercise capacity from physical training in heart failure.[68] (Level of evidence: I-2.)

There are few reliable data on treatment for the specific clinical syndrome of heart failure with preserved systolic function. NICE have yet to address drug therapies for heart failure or protocols of care, although this is planned.

Post-symptomatic patients

Lifestyle interventions

Smoking

As there are no randomised controlled trials of stopping smoking after developing symptomatic coronary artery disease, evidence of effectiveness comes from observational studies. Patients who choose to quit, and such evidence comes mainly from those who have had a myocardial infarction, have a lower risk of recurrent disease and a longer life expectancy. This benefit is partly a function of stopping smoking but may also reflect other lifestyle changes made by those who quit; namely, healthier food choices, increased physical activity and better compliance with prophylactic drug therapies.[164,221] (Level of evidence: II-2.)

Diet

Three randomised controlled trials have shown benefit from dietary modification following a myocardial infarction by reducing the risk of recurrent disease and improving survival. Dietary supplementation with oily fish (two portions per week) or fish oils capsules in one trial; an alpha linolenic acid-based margarine in a second; and a vegetarian diet rich in fruits and nuts in the third all significantly reduced the frequency of subsequent coronary morbidity and mortality. Although there are methodological concerns about some aspects of these trials, the evidence is sufficiently strong to provide support for the current dietary recommendations following the development of coronary disease and to justify further research.[52,19] (Level of evidence: I.)

Physical activity

There have been a large number of randomised trials of exercise rehabilitation following myocardial infarction and two meta-analyses have shown that such rehabilitation reduces by 20–25% overall cardiovascular mortality. Whilst this evidence is supportive of a beneficial effect of aerobic exercise, changes in physical activity in these programmes have occurred concurrently with other changes in lifestyle, such as smoking cessation and the adoption of a healthy diet. This was examined in one of the meta-analyses which compared the effects of trials of exercise rehabilitation alone with those including other aspects of lifestyle change. The benefits in reducing coronary morbidity and mortality were only evident in the multifactorial intervention trials. Although there was a favourable trend in the exercise-only trials, this did not achieve statistical significance.[24,71,96,118,140,148,149,212] (Level of evidence: I.)

Obesity

There is no evidence, either from clinical trials or observational studies, of the effect of reducing obesity in coronary patients in relation to subsequent morbidity and mortality. However, because of the adverse

effects of obesity on other risk factors, and also because of its adverse haemodynamic consequences, reducing weight is important in obese patients with coronary disease. (Level of evidence: 0.)

Other interventions

Blood pressure

Although blood pressure elevation in patients with myocardial infarction is associated with an increased risk of re-infarction, there is no randomised controlled trial evidence of blood pressure lowering following the development of coronary disease. However, several classes of antihypertensive agents (beta-blockers, ACE inhibitors) given to selected patients following myocardial infarction have reduced subsequent coronary morbidity and mortality. So current clinical practice of using antihypertensive therapy in coronary patients with raised blood pressure is supported by this evidence, and the evidence from randomised controlled blood pressure trials in primary prevention.[162,163]

Blood lipids

In contrast, there is compelling evidence that lipid modification, principally lowering total and LDL cholesterol with statins following the development of coronary disease, is associated with a significant reduction in subsequent morbidity and mortality and an increase in survival. Three randomised controlled trials[173,174,205] have provided consistent evidence of benefit. Whether this benefit is the same across the whole distribution of cholesterol in coronary patients is not clear, particularly for those patients with a total cholesterol < 4.8 mmol/l. There is also more recent evidence of benefit from one trial using a fibrate which showed that a significant reduction in coronary events can be achieved without altering LDL cholesterol. HDL cholesterol was raised and triglycerides lowered in this trial. However, there was no overall survival benefit. The results of another fibrate trial, as yet unpublished, also reported no overall benefit. So the evidence for lipid modification is strongest for the statins and this class of lipid modification therapy also has the best safety record so far.[16,179,187] (Level of evidence: I.)

Diabetes mellitus

Hyperglycaemia after myocardial infarction is associated with a poorer prognosis.[121,135] There has been one randomised controlled trial of aggressive blood glucose management with insulin, compared to usual treatment, following myocardial infarction and one year mortality was significantly reduced by 25% in the insulin treated group.[125] (Level of evidence: I.)

Prophylactic drug therapies

In patients with coronary heart disease the following drugs, or classes of drugs, have been shown in single trials or meta-analyses to reduce total mortality. Therefore, in addition to the use of drugs which may be needed to control symptoms, manage blood pressure, lipids and glucose, the following should also be considered.

(a) **Aspirin and other platelet-modifying drugs:** Aspirin (at least 75 mg) or other platelet-modifying drugs, in virtually all patients with coronary heart disease or other atherosclerotic disease. The meta-analysis of anti-platelet trials following myocardial infarction provides convincing evidence of a significant reduction in all-cause mortality, vascular mortality, non-fatal re-infarction of the myocardium and non-fatal stroke. In the trials which used aspirin, the most widely tested doses

ranged between 75 and 325 mg per day. There was no evidence of any greater clinical benefit for doses of 160–325 mg compared to 75 mg daily. Nor was any other anti-platelet regimen in this overview more effective than daily aspirin in this dose range. Side-effects from aspirin use, principally gastrointestinal bleeding and peptic ulceration, are lowest in those using 75 mg or less daily. Therefore, for secondary coronary heart disease prevention a maintenance dose of 75 mg of aspirin is recommended for all patients following myocardial infarction and those with other clinical manifestations of coronary artery disease: unstable angina and stable angina. Although there is no clinical trial evidence of treatment beyond a few years it would be prudent to continue aspirin therapy for life. When aspirin cannot be tolerated alternative anti-platelet therapies such as clopidogrel should be considered. For patients with stroke or transient ischaemic attacks aspirin at a dose of at least 75 mg daily is recommended and should also be considered for other high risk patients with peripheral arterial disease.[8,14,27,60,112] (Level of evidence: I.)

(b) **Beta-blockers:** Beta-blockers in patients following acute myocardial infarction. In a meta-analysis of beta-blockers following myocardial infarction there was evidence of a significant reduction in all-cause mortality, and in particular sudden cardiac death, as well as non-fatal re-infarction. This clinical benefit was greatest in those patients with left ventricular dysfunction or serious tachy-arrhythmias. Therefore, a beta-blocker should be considered in patients with no contra-indications following myocardial infarction, and particularly for patients at high risk because of mechanical or electrical complications. The evidence for calcium antagonists as a prophylactic therapy following myocardial infarction is not as well established.[80,87,91,92,105,137,150,185] (Level of evidence for beta-blockers: I.)

(c) **ACE inhibitors:** ACE inhibitors in selected patients following acute myocardial infarction. ACE inhibitors in patients with symptoms or signs of heart failure at the time of acute myocardial infarction, those with a large myocardial infarction and in those with chronic left ventricular systolic dysfunction, will significantly reduce all-cause mortality and the risk of progressing to persistent heart failure. In the absence of clinical heart failure, an assessment of left ventricular function by echocardiography is required. Patients following myocardial infarction with an estimated ejection fraction $< 40\%$ would be eligible for treatment with an ACE inhibitor.[1,56,236] The HOPE trial provides further evidence of the benefits of ACE inhibition in patients with coronary disease and preserved left ventricular function. This trial demonstrated a 22% relative risk reduction of the combined end-points death, myocardial infarction and stroke, using ramipril 10 mg once daily.[237] (Level of evidence: I.)

(d) **Anticoagulation:** Anticoagulation following myocardial infarction for selected patients at increased risk of thromboembolic events, including patients with large anterior myocardial infarction, left ventricular aneurysm or thrombus, paroxysmal tachyarrhythmias, chronic heart failure and those with a history of thromboembolic events.[5,183] (Level of evidence: II.)

7 Quantified models of care and recommendations

National models of care

The National Service Framework for Coronary Heart Disease published in 2000 put forward a framework for reducing the burden of CHD in England and modernising CHD services. It set out standards of care (*see* below) for the prevention, diagnosis and treatment of CHD and described the interventions and service models for the delivery of these standards. Health authorities and their partners were required to produce local delivery plans and Long-term Service Agreements.

Standards of care

Standards 1 & 2: Reducing heart disease in the population	1	The NHS and partner agencies should develop, implement and monitor policies that reduce the prevalence of coronary risk factors in the population, and reduce inequalities in risks of developing heart disease.
	2	The NHS and partner agencies should contribute to a reduction in the prevalence of smoking in the local population.
Standards 3 & 4: Preventing CHD in high risk patients	3	General practitioners and primary care teams should identify all people with cardiovascular disease and offer them established comprehensive advice and appropriate treatment to reduce their risks.
	4	General practitioners and primary health care teams should identify all people at significant risk of cardiovascular disease but who have not developed symptoms and offer them appropriate advice and treatment to reduce their risks.
Standards 5, 6 & 7: Heart attack and other acute coronary syndromes	5	People with symptoms of a possible heart attack should receive help from an individual equipped with and appropriately trained in the use of a defibrillator within 8 minutes of calling for help, to maximise the benefits of resuscitation should it be necessary.
	6	People thought to be suffering from a heart attack should be assessed professionally and, if indicated, receive aspirin. Thrombolysis should be given within 60 minutes of calling for professional help.
	7	NHS Trusts should put in place agreed protocols/systems of care so that people admitted to hospital with proven heart attack are appropriately assessed and offered treatments of proven clinical and cost-effectiveness to reduce their risk of disability and death.
Standard 8: Stable angina	8	People with symptoms of angina or suspected angina should receive appropriate investigation and treatment to relieve their pain and reduce their risk of coronary events.
Standards 9 & 10: Revascularisation	9	People with angina that is increasing in frequency or severity should be referred to a cardiologist urgently or, for those at greatest risk, as an emergency.
	10	NHS Trusts should put in place hospital-wide systems of care so that patients with suspected or confirmed coronary heart disease receive timely and appropriate investigation and treatment to relieve their symptoms and reduce their risk of subsequent coronary events.
Standard 11: Heart failure	11	Doctors should arrange for people with suspected heart failure to be offered appropriate investigations (e.g. electrocardiography, echocardiography) that will confirm or refute the diagnosis. For those in whom heart failure is confirmed, its cause should be identified – treatments most likely to both relieve their symptoms and reduce their risk of death should be offered.
Standard 12: Cardiac rehabilitation	12	NHS Trusts should put in place agreed protocols/systems of care so that, prior to leaving hospital, people admitted to hospital suffering from coronary heart disease have been invited to participate in a multidisciplinary programme of secondary prevention and cardiac rehabilitation. The aim of the programme will be to reduce their risk of subsequent cardiac problems and to promote their return to a full and normal life.

Cardiovascular screening in primary care and relationships to specialist (hypertension, lipids and diabetes) hospital clinics

The model of care developed for cardiovascular screening and intervention in primary care needs to achieve the same risk factor changes achieved in unifactorial trials – blood pressure and lipids – which significantly reduced coronary morbidity and mortality. If such risk factor changes are achieved there will inevitably be a corresponding reduction in clinical disease. Despite the compelling scientific evidence for both lifestyle and therapeutic interventions in primary prevention of CHD and stroke, the evidence that this knowledge can be successfully translated into effective multifactorial risk factor reduction in primary care is disappointing. The conclusion of the multifactorial intervention trials, OXCHECK[99,100] and the British Family Heart Study,[231] is that lifestyle interventions and appropriate use of drug therapies should be concentrated on individuals at highest risk.

This emphasis on identifying and managing high risk individuals has been endorsed in the Joint British Societies' recommendations on coronary prevention in clinical practice.[107,233] This new emphasis on multifactorial CHD risk assessment as the principal determinant of how intensively to intervene with lifestyle, and when to consider the use of drug therapies, is an important departure from traditional single risk factor guidance. Beyond lifestyle, the decision to introduce drug therapy for blood pressure or lipids should be strongly determined by the absolute risk of developing CHD or cardiovascular disease. As a general guide, an absolute risk of 15% or greater of developing CHD (equivalent to a cardiovascular risk of $\geq 20\%$) over the next 10 years is considered to be sufficiently high to justify drug treatment, although the physician's final decision about using drug therapy will also be influenced by the patient's age, gender, race, inheritance, coexistent disease and other factors such as life expectancy. In other words, a decision to introduce drug therapy, for example to lower BP, is not simply a function of the BP level alone. It is the whole risk factor context, of which BP is only one contributory factor, which is important. A coronary risk prediction chart is published in the recommendations so that absolute CHD risk (the risk of myocardial infarction and coronary death) over the next 10 years can be estimated. The risk factors used are gender, age, smoking habit, systolic BP, total cholesterol to HDL-cholesterol ratio and diabetes mellitus. There is also a cardiac risk assessor computer programme which can be used to calculate both CHD and cardiovascular (CHD and stroke) risk.

As the identification, investigation and management of everyone at a 15% or higher CHD risk in the population would be hugely demanding on NHS resources, a staged approach to coronary and other arterial disease prevention is recommended. Those at highest risk should be targeted first, and as a minimum, healthy individuals with a 30% or higher CHD risk over 10 years should all be identified and treated appropriately and effectively now. As the scientific evidence clearly justifies risk factor intervention in healthy individuals with a CHD risk lower than 30%, it is entirely appropriate for physicians to progressively expand opportunistic screening and risk factor intervention down to individuals with a 15% CHD risk over 10 years, as long as those at higher levels of risk have already received effective preventive care. Taking a progressive staged approach to coronary prevention in this way ensures that those at highest risk are targeted first and the delivery of care is commensurate with the ability of medical services to identify, investigate and manage patients properly over the long term.

However, not all high risk people as defined will be eligible for blood pressure lowering drug therapy as this also depends on whether the blood pressure, in response to lifestyle advice, remains consistently greater than a systolic > 140 mmHg and/or a diastolic of > 85 mmHg, or there is evidence of target organ damage. The percentages of people with a CHD risk $\geq 15\%$ and a BP > 140 and/or > 85 mmHg are shown in Table 1(b). Similarly, the use of lipid modification therapy also depends on whether the total cholesterol (and LDL cholesterol), in response to lifestyle advice, remains consistently greater than 5 mmol per litre (LDL > 3 mmol per litre). The percentages of people with a CHD risk $\geq 15\%$ and a total cholesterol ≥ 5 mmol per litre are shown in Table 1(b). So, assuming that lifestyle has no effect on the proportion of

people requiring BP and/or lipid lowering therapy, the proportions requiring drug treatment will actually be slightly lower than the 12% and 5% estimated for all risk factors. The therapeutic implication of this multifactorial approach is that lipid lowering therapies are likely to be used in primary CHD prevention as commonly as antihypertensive therapies. There may actually be a reduction in prescriptions for antihypertensive treatment because elevated blood pressure alone (with the important exception of patients with a BP systolic $\geq$ 160 mmHg and/or diastolic $\geq$ 100 mmHg, or evidence of target organ damage at any BP level) will not be sufficient to justify treatment in the absence of other risk factors. In contrast, there will be a considerable expansion in the use of lipid modification therapies, principally statins. Treatment targets in patients whose CHD risk is $\geq$ 15% over the next 10 years, and for all patients who are started on drug therapies for primary CHD prevention, are defined as follows:

(i) BP < 140 mmHg systolic and < 85 mmHg diastolic
(ii) total cholesterol < 5 mmol per litre (LDL cholesterol < 3 mmol per litre)
(iii) diabetes mellitus should be optimally controlled and blood pressure reduced to < 130 mmHg systolic and < 80 mmHg diastolic
(iv) aspirin (75 mg) is recommended in individuals who are older than 50 years and are either well controlled hypertensive patients or men at high risk of CHD.

For some patients a specialist opinion will be required, and there should be agreement on a protocol between general practice and hospital specialist clinics (hypertension, lipid and diabetic) on referral criteria and, conversely, for those assessed in these specialist clinics there should be agreement on the criteria for discharge to continuing care in the community. Auditing the ascertainment of high risk individuals in general practice and their subsequent management is essential.

In the hospital sector the care of high risk patients in hypertension, lipid and diabetic clinics should be co-ordinated between specialists based on agreed protocols to ensure a common approach to multifactorial risk assessment, lifestyle and therapeutic interventions. The care of such high risk patients treated in specialised hospital clinics should be integrated with general practice to ensure, through the use of agreed common protocols, optimal long-term management. Auditing the impact of common clinical protocols for hospital and general practice on the identification and management of high risk individuals is strongly recommended.

Organisation of ambulance services for community resuscitation

A fully equipped paramedical ambulance-based team, trained in advanced cardiopulmonary resuscitation (CPR), is only one of several approaches to sudden cardiac collapse in the community.[144,207] About three-quarters of deaths attributed to CHD in people under 75 years occur outside hospital, and 61% are witnessed, usually by a relative or bystander. Importantly, of those that are witnessed, only a minority (about 13%) are instantaneous. Symptoms precede the arrhythmia causing cardiac collapse, principally chest pain, and therefore the potential to manage these patients more effectively exists if the delay between summoning medical help, arrival of a paramedical crew and transport to an Accident and Emergency Department can be reduced.

If bystander CPR was performed in all cases, assuming limited success in resuscitation, survival at 30 days would increase from 4% to about 5.5%. Overall case fatality for acute coronary events would be reduced from 45% to 44.7%; an absolute reduction of only 0.3%.

Improving the access of trained staff to community arrests could potentially have a larger impact. Overall case fatality for acute coronary events with all cardiac arrests attended by paramedics could be reduced from 45% to 37%; an absolute reduction of 8%, which represents a 27-fold increase in survival

compared to bystander CPR. Based on the most optimistic scenario, in which all community arrests are attended by trained paramedics (or general practitioners), sudden cardiac collapse would still have a high fatality, with 60% or more dying in the community, thus emphasising the priority for primary prevention.

All patients with chest pain who summon an ambulance (or when it is summoned by their GP) should be attended by a paramedical crew trained in advanced cardiopulmonary resuscitation. When the GP has been called, the practitioner should attend the patient as well, even though an ambulance has also been called. In the event of a cardiac arrest, the chances of a successful resuscitation are then maximised. Training the general public in the CPR is a considerable task and the impact of bystander CPR is very small indeed. Therefore, it would be better to focus on the close relatives (and friends) of patients with CHD, particularly those who have already survived a cardiac arrest, as these patients are at highest risk of dying suddenly. Other groups would include the police, fire brigade, transport (bus, rail, boat and plane) staff and a small number of selected staff in work places.

A policy in general practice of summoning an ambulance at the same time as going to see a patient with chest pain is likely to have the greatest impact on reducing the incidence of sudden death and the interval between symptom onset and thrombolysis for acute myocardial infarction.

Chest pain in the community

All patients presenting for the first time with chest pain which is considered to be cardiac in origin, and where there is no medical history of CHD, should be referred to hospital. Where symptoms are likely to be due to an acute coronary syndrome, urgent transfer to Accident and Emergency, preferably in an ambulance with a trained paramedic crew and facilities for cardiopulmonary resuscitation, is essential. Where the symptoms are those of new exertional angina, the patient should be referred for a cardiological opinion, usually through a Rapid Access Chest Pain Clinic, supported by appropriate specialist investigations. For patients with a medical history of CHD whose symptoms become acute or easily provoked or occur at rest, then urgent transfer to Accident and Emergency is required. Those patients who experience a recurrence of exertional angina, or have angina which is no longer adequately controlled with medical therapy, require an outpatient cardiology review and further specialist investigation.

Exertional angina

All patients presenting for the first time with the symptom exertional angina should be referred for a cardiological opinion supported by appropriate specialist investigations.[50,142,147,176,197] A rapid access chest pain clinic is now the preferred way of providing such a clinical service. Referring patients with chest pain for a hospital ECG is a practice which should be abandoned, as it is normal in most patients presenting with new exertional angina. Nor are other open access tests such as exercise testing or radionuclide investigations advised, because they require specialist interpretation in a clinical context. The traditional present practice whereby most patients with angina are managed medically in the community without referral for specialist opinion and appropriate investigations is no longer appropriate. A minority of patients with acute coronary syndromes will be inappropriately managed in this setting and thus deprived of life-saving treatments. Of those with exertional angina, some will require revascularisation on prognostic grounds and they cannot be identified from symptoms alone. In addition, a potentially large number of patients who do not have CHD will be given an unnecessary trial of medical therapy in the community when they could be reassured with no further follow-up required.

Acute coronary syndromes

All patients with cardiac chest pain which may be due to an acute coronary syndrome should be assessed in hospital as quickly as possible.[15,51,196] The ambulance service is usually the best way of achieving this. So when a patient consults general practice with this symptom, if its considered to be severe, the GP should call 999 at the same time as going to assess the patient. Ambulance crews or general practitioners should always administer at least 150 mg of soluble aspirin to these patients immediately.

Although two-thirds of patients with a diagnosis of AMI received thrombolytic therapy, this proportion could be increased by using ECG monitoring for dynamic ST/T wave changes (rather than serial 12 lead ECGs) and more sensitive indices of myocardial necrosis. Triaging the patient quickly through casualty will also increase the proportion of patients eligible for this form of therapy. A written protocol for triage is essential if the door to needle time for thrombolytic therapy is to be the same as that achieved with direct admissions to Cardiac Care Units.

All patients with an acute coronary syndrome should be assessed by a cardiologist within 24 hours of admission and where this is not possible a written protocol devised by the cardiologist for the management of such patients is essential. This should cover the following:

1 Aspirin (at least 150 mg) for all patients.
2 Thrombolysis criteria and the indications for individual thrombolytic agents.
3 Anti-platelet agents: clopidogrel should be recommended on admission for patients admitted with non-ST elevation acute coronary syndromes, Gp IIb/IIIa receptor blockers are recommended for high risk patients with non-ST elevation acute coronary syndromes, particularly if scheduled to go for coronary angiography. Guidance should be provided on the use of both clopidogrel and Gp IIb/IIIa receptor blockers for patients that may need to go to surgery, as they both increase the risk of bleeding, particularly for patients needing to go for coronary artery bypass grafting.
4 Beta-blockade: intravenous on admission for ST elevation MI and oral therapy at the doses prescribed in the clinical trials for all post MI patients, and for at least three years.
5 ACE inhibitors at the doses prescribed in the clinical trials for patients with symptoms or signs of heart failure at the time of myocardial infarction, or in those with persistent LV systolic dysfunction as assessed by echocardiography (ejection fraction $< 40\%$).
6 Anticoagulants for patients at risk of systemic embolisation with large anterior infarctions, severe heart failure, left ventricular aneurysm or paroxysmal tachyarrhythmias.
7 A written record of cardiac risk factors: tobacco exposure, body mass index (including a measure of central obesity), history of hypertension, hyperlipidaemia and diabetes mellitus. Family history of CHD: relatives, age at which disease developed and/or death and nature of the disease (e.g. MI) and whether there was angioplasty or surgery. For women, exposure to oral contraceptives and HRT, age at menopause and gynaecological history (hysterectomy ± oophorectomy). Action on risk factors should also be recorded: advice to quit tobacco, professional dietary advice given together with a target BMI, advice on how to increase physical activity. BP assessment in hospital with the objective of reducing the systolic pressure consistently below 140 mmHg (< 130 mmHg in patients with diabetes mellitus). Measurement of random total cholesterol on the first blood sample drawn for estimation of blood enzymes, or not later than 24 hours after the onset of symptoms, should also be recorded. If the random total cholesterol is > 6 mmol per litre then, in addition to dietary advice, lipid modification therapy should be initiated before discharge. A statin is the drug of first choice at the doses prescribed in the clinical trials. Those with a cholesterol level < 6 mmol per litre should have their fasting lipids checked at six weeks to measure total cholesterol, HDL cholesterol and triglycerides and then calculate LDL cholesterol. If the total cholesterol is > 5 mmol per litre (LDL cholesterol > 3 mmol per litre), then lipid modification therapy should be given as stated above. Blood lipids should be checked again in six

weeks. If the target of a total cholesterol < 5.0 mmol/l (LDL cholesterol < 3 mmol per litre) has not been met, the dose of the statin should be increased. Those with a cholesterol < 5 mmol per litre should be monitored, at least annually, because despite diet there maybe a requirement for lipid lowering therapy at a later date. Younger patients (< 55 years for men and < 65 years for women with CHD and a cholesterol > 5 mmol per litre, or any patient whose blood cholesterol is particularly high (> 8 mmol per litre) should have their first degree blood relatives screened for blood cholesterol. This is because of the possibility of familial hypercholesterolaemia, or another inherited form of hyperlipidaemia, which has a sufficiently high risk of arterial disease to justify drug treatment for primary prevention.

8 Fasting blood glucose should be measured. However, because the level may rise acutely during acute myocardial infarction or ischaemia, any elevation of blood glucose in patients who are not clearly diabetic should be confirmed six weeks after the event. The ADA has redefined diabetes mellitus as a fasting blood glucose of $\geq$ 7 mmol per litre or greater. The WHO has proposed new diagnostic criteria and individuals with a fasting plasma glucose $\geq$ 7 mmol per litre will be designated as having diabetes, those with fasting glucose < 7 mmol per litre but a two-hour value $\geq$ 7 and < 11.1 mmol litre as having impaired glucose tolerance (IGT) and those with fasting plasma glucose $\geq$ 6.1 mmol per litre but < 7 mmol per litre as having impaired fasting glycaemia (IFG). Patients with CHD whose fasting blood glucose is < 7.8 mmol/l but whose two-hour level is > 7.8 mmol per litre and < 11.1 mmol per litre, and particularly in those who have hypertriglyceridaemia (regardless of total cholesterol level), have a higher than expected risk of subsequently developing overt diabetes mellitus and therefore require further fasting blood glucose determinations at annual review.

Rapid assessment chest pain clinics are not part of the assessment and management of acute coronary syndromes. This is because they are primarily intended for patients with exertional angina but with such a service fewer patients are admitted unnecessarily to hospital, and a proportion of patients with acute coronary syndromes are no longer inappropriately managed in the community.

All patients with acute coronary syndromes should be offered a place on a comprehensive cardiovascular prevention and rehabilitation programme.

Heart failure

Patients with heart failure should be investigated and managed according to locally agreed protocols. Examples of these are contained in the NSF for Coronary Heart Disease Chapter 6 and the SIGN guidelines.[139,180] All patients with heart failure, whether diagnosed in hospital or general practice, should be referred to a cardiologist to confirm (or refute) the diagnosis, determine the aetiology and advise on management. This will include appropriate specialist investigations, principally echocardiography, but also cardiac catheterisation in selected cases. When a cardiology opinion cannot be obtained it is essential to have an ECG, chest X-ray and echocardiogram. These investigations are needed to establish the diagnosis and may also identify the aetiology, including those aetiologies which are potentially remediable with cardiac surgery (e.g. aortic stenosis).

All patients with heart failure due to LV systolic dysfunction in whom an ACE inhibitor is not contra-indicated should receive this class of drug at the doses used in the clinical trials.[180,198,206,209] Beta-blockers are indicated in patients with heart failure due to LV systolic dysfunction. For those who are unable to tolerate an ACE inhibitor because of side-effects e.g. cough, then an angiotensin II receptor antagonist is an alternative. When renal function is impaired, or deteriorates with the introduction of an ACE inhibitor, a combination of nitrates and hydralazine should be considered. Spironolactone should be added for selected patients with severe heart failure. Diuretics (thiazides and loop) should be used for fluid retention. Arrhythmias [particularly atrial fibrillation (AF)] should be identified and

treated and patients who may be appropriate for biventricular pacing or AICD implantation similarly identified. Digoxin should be a consideration for rate control in AF and for symptomatic benefit in patients in sinus rhythm. Anticoagulation should be considered for those in atrial fibrillation and with dilated ventricles.

Drugs that may be aggravating heart failure should be identified and if possible eliminated (NSAIDs, short-acting calcium receptor blockers).

The management of heart failure depends on the underlying aetiology and when this is due to CHD then the control of risk factors and revascularisation are both potentially important modalities of treatment.

Patients with heart failure and preserved systolic function should be managed with the aim of symptom control (in the absence of pharmacological trials showing mortality benefits in this particular group). It seems reasonable to treat them with vasodilators and beta-blockers.

Patients should be educated to restrict salt and fluid intake, avoid excessive alcohol consumption and maintain (and if possible improve) activity.

Current underutilisation of investigations and therapies suggests that optimal care of heart failure will increase costs through non-invasive and invasive investigations, drugs and human resources (nurses etc.). However, this may be partially or completely offset by a reduction in costly hospital admissions. Individual trials of drugs and models of care have suggested that optimal treatment result in cost savings.[84,128]

Cardiovascular prevention and rehabilitation from hospital to community

By addressing lifestyle and risk factor management in these patients, including the use of prophylactic drug therapies, the risk of progressing to myocardial infarction and coronary death will be reduced.[23,35,107,143,213,214,232–234] In the Joint British Recommendations on Coronary Prevention, patients with established CHD are deemed to be the top priority for prevention, and an integrated cardiovascular prevention and rehabilitation service should be available for such patients.

All hospitals responsible for the acute management of coronary disease should have a comprehensive cardiovascular prevention and rehabilitation service that is fully integrated with all other aspects of cardiac care. This service should be available to all coronary patients: post myocardial infarction, treated unstable angina, exertional angina and those following revascularisation by angioplasty or coronary artery surgery. For those patients who are to be revascularised electively, every effort should be made to achieve ideal lifestyle and risk factor targets, and compliance with appropriate prophylactic drug therapies, before the procedure or operation. Such a service should embrace all aspects of prevention to reduce the patients risk of subsequent cardiovascular disease, as well as rehabilitation to promote their return to a full and normal life. Integration of care between hospital and general practice through the use of common protocols is essential to ensure optimal long-term lifestyle, risk factor and therapeutic management. Auditing the impact of a such protocols is strongly recommended.

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 < 65 years) is encouraged, and in the context of familial dyslipidaemia is essential.

Cardioprotective drug therapy should be considered and prescribed in selected patients: (i) aspirin for all patients; (ii) beta-blockers at the doses prescribed in the clinical trials following MI, particularly in high risk patients, and for at least 3 years; (iii) cholesterol-lowering therapy (statins) at the doses prescribed in the clinical trials; (iv) ACE inhibitors at the doses prescribed in the clinical trials for patients with symptoms or signs of heart failure in the context of MI, or in those with persistent left ventricular systolic dysfunction (ejection fraction < 40%); and (v) anticoagulants for patients at risk of systemic embolisation.

8 Outcome measures, audit methods and targets

National audits are required in representative samples of hospitals and general practices to evaluate the process and outcome of care in relation to professional guidelines and nationally agreed targets for CHD. Such audits will give a national picture which can be monitored over time and they will also facilitate development and evaluation of methodologies (including measurement instruments) which can then be made available for local audits in health authority districts, hospitals and general practices. An example of such an audit is the national audit of myocardial infarctions (NAOMI) project.

Audits of process and outcome are proposed for the following areas.

Cardiovascular screening

A national sampling frame for general practice is required to audit the identification and management of high risk individuals.

Process of care

a All patients joining a practice are given a new patient check, which includes a cardiovascular risk assessment.
b Absolute risk of CHD or cardiovascular disease is calculated and recorded as well as individual risk factor levels, together with action taken.
c Risk factor advice in relation to lifestyle (smoking, diet including obesity and physical activity) recorded.
d For BP, a record of target organ damage (retinopathy, LVH on ECG, renal impairment) and radial femoral delay.
e For lipids, a record of stigmata: corneal arcus, xanthomata and screening of first degree blood relatives.
f For diabetes mellitus, a record of target organ damage (retinopathy, renal impairment including microalbuminuria and proteinuria, neuropathy and skin care).
g Aspirin prescribed in patients > 50 years who are well controlled hypertensives on anti-hypertensive medication.
h Referral to a specialist: hypertension and/or lipid and/or a diabetic clinic.
i Additional investigations requested for patients with:
    1 hypertension: ECG, echocardiography, renal function, catecholamine metabolites, tests for renal artery stenosis, lipids and glucose
    2 hyperlipidaemia: renal function, thyroid function, liver function and glucose
    3 diabetes mellitus: renal function, lipids.
j Drugs prescribed: generic names and doses for:
    1 hypertension
    2 hyperlipidaemia
    3 diabetes mellitus.
1 Screening of first degree blood relatives.

Outcome of care

a Lifestyle: smoking status, dietary habits (including BMI and central obesity) and physical activity.
b In high risk individuals (CHD risk > 15% over 10 years) all patients with severe hypertension (systolic blood pressure > 160 mmHg and/or diastolic blood pressure > 100 mmHg) or associated target organ

damage, familial hypercholesterolaemia or other inherited dyslipidaemia, or diabetes mellitus with associated target organ damage, have the following risk factor targets been achieved?
1 BP < 140/85 mmHg.
2 Total cholesterol < 5 mmol per litre (LDL cholesterol < 3 mmol per litre).
3 Diabetes mellitus optimally controlled and BP reduced to < 130/80 mmHg.

c Compliance with prophylactic aspirin and prescribed therapies for BP, lipids and diabetes mellitus.
d Quality of life.

Sudden cardiac collapse

A national sampling frame of ambulance services is required, with audit of a random sample of consecutive community collapses.

Exertional angina

A national sampling frame of Rapid Access Chest Pain Clinics is required to audit patients with angina pectoris (but no history of myocardial infarction or revascularisation), by reviewing the GP record.

Process of care

a Referred to a cardiologist or other hospital specialist, or assessment in Accident and Emergency department ± hospital admission.
b ECG and exercise tolerance test (or radionuclide scan if unable to exercise) performed.
c Lifestyle and risk factors recorded (*see* 'Cardiovascular prevention and rehabilitation' below, items (b) to (e)) and action taken.
d Aspirin prescribed.
e Psychosocial interventions.
f Educational interventions.
g Screening of first degree blood relatives and action taken.

Outcome of care

a Lifestyle: smoking status, dietary habits (including BMI and central obesity) and physical activity.
b BP target of < 140/85 mmHg achieved.
c Lipid target of total cholesterol < 5 mmol per litre and LDL cholesterol < 3 mmol per litre achieved.
d In diabetes mellitus, good glycaemic control and BP < 130/85 mmHg achieved.
e Compliance with prescribed prophylactic drug therapy at the doses used in the clinical trials.
f Quality of life.
g Blood relatives screened and action that followed.

Acute coronary syndromes

A national sampling frame of district general hospitals is required to audit consecutive cases of acute coronary syndromes.

Process of care

a Point of contact with the medical services (GP, 999 or direct to casualty) and whether attended by a paramedical crew trained in CPR and/or a GP.
b Aspirin administered prior to admission to hospital.
c Thrombolysis: time from onset of symptoms to thrombolytic therapy, door to needle time, place of initial medical assessment (casualty, CCU, other), triaged in Accident and Emergency, type of thrombolytic agents used.
d Beta-blockade: intravenous and/or oral.
e ACE inhibitor, echocardiography.
f Cholesterol measured, titration in therapy.
g Glucose measured and in diabetes mellitus, insulin therapy used.
h Anticoagulation.
i Exercise tolerance test.
j Referral (emergency or elective) for coronary arteriography with a view to revascularisation (angioplasty ± stenting, CABG).
k Discharge summary to GP, and follow-up arrangements.

Outcome of care

As for exertional angina.

Heart failure

A national sampling frame of district general hospitals is required to audit consecutive cases of heart failure.

Process of care

a Number of patients with a diagnosis of heart failure.
b Specialist who made the diagnosis and whether referred to a cardiologist.
c Aetiology of heart failure recorded.
d % echocardiography obtained.
e % treated with an ACE inhibitor (and dose).
f % prescribed a beta-blocker (and dose).
g Revascularisation; transplantation.
h Family screening for familial cardiomyopathy.
i Use of palliative care services.

Outcome of care

a Quality of life.
b Compliance with prescribed drug therapies at the doses used in the clinical trials.
c Rehospitalisations (inc. reasons) and mortality.

Cardiovascular prevention and rehabilitation

A national sampling frame of district general hospitals is required to audit consecutive cases of acute coronary syndromes, exertional angina and revascularised patients.

Process of care

a Patient offered a place on a cardiovascular prevention and rehabilitation programme.
b Health promotion in relation to lifestyle (smoking, diet and physical activity).
c BP levels.
d Lipid levels
e Glycaemic and BP control in diabetes mellitus.
f Prophylactic drug therapy is prescribed, generic names of drugs and doses: aspirin, beta-blockers, ACE inhibitors, lipid modification therapy and anticoagulation.
g Psychosocial intervention.
h Educational interventions.
i Exercise tolerance test and supervised exercise sessions.
j Screening of first degree blood relatives.
k Report of patient's lifestyle, risk factors and drug therapies, including risk factor targets, to the GP or practice care team.

Outcome of care

As for exertional angina.

Mortality is not an appropriate outcome of care because a comprehensive cardiovascular prevention and rehabilitation programme, which replicates the process of care in the clinical trials which demonstrated mortality benefit, will inevitably reduce mortality.

9 Information and research requirements

Cardiovascular screening

1 The optimal risk factor model for identifying and targeting high risk individuals in general practice needs to be defined.
2 Imaginative approaches to lifestyle change also need to be developed.
3 Compliance with drug therapies requires investigation.

Sudden cardiac collapse

1 The optimal response model for sudden cardiac collapse in the community.

Exertional angina

1 The optimal method for diagnosing, investigating and managing exertional angina presenting for the first time in the community requires evaluation. The rapid assessment chest pain clinic is the preferred model, but this is not necessarily the most cost-effective way of diagnosing and managing angina from the community and needs to be evaluated.

Acute coronary syndromes

1 The role of the general practitioner in the management of chest pain in the community requires evaluation. If a general practitioner summons an ambulance at the same time as he attends a patient with chest pain, will this shorten the interval between onset of symptoms and appropriate medical therapy, and what impact will this have on the ambulance service and Accident and Emergency departments? Will this approach increase the chances of successful community resuscitation?
2 The role of a rapid assessment chest pain clinic also requires evaluation in the context of acute coronary syndromes and whether or not the provision of such a service will increase the identification of such syndromes in the community and thus ensure more appropriate management. Also, does such a service reduce casualty assessments and emergency hospital admissions for chest pain and follow-up appointments for cardiology outpatients? Can such a service delay the appropriate hospital management of patients with acute coronary syndromes?
3 The triaging of patients with chest pain in Accident and Emergency departments requires evaluation in order to develop a model of care which achieves the same standard door to needle time for thrombolytic therapy compared to patients admitted directly to a cardiac care unit.
4 The role of primary angioplasty in the management of acute (anterior) myocardial infarction requires evaluation in a randomised controlled trial in a district general hospital setting.
5 The development of more sensitive and specific assays for myocardial necrosis require evaluation in the context of Accident and Emergency departments, rapid assessment chest pain clinics and other outpatient settings to determine whether patients can avoid an unnecessary hospital admission.
6 The contribution of specialists to clinical outcome in acute coronary syndromes requires evaluation because the majority of patients with this acute presentation are managed by specialists other than cardiologists, and one in two patients are never seen by a cardiologist. In the context of protocol-driven management (with the protocol determined by the cardiologist), is clinical outcome any different if the patient is personally attended by a cardiologist compared to any other specialist?
7 Risk stratification of patients with acute coronary syndromes – unstable angina which responds to medical therapy and non Q wave myocardial infarction – requires evaluation to determine whether those at highest risk of recurrent coronary disease or death are selected out for further investigation.
8 The utility of measuring and acting on a random blood cholesterol measured at the time of admission of patients with acute coronary syndromes, as opposed to delaying such an estimation until a fasting blood sample can be drawn at least six weeks after the acute clinical event, also requires evaluation. In the clinical trials of lipid modification in patients with coronary disease, drug treatment was not started during the acute phase and therefore there is no evidence that such early treatment will confer any additional benefit. It is important to know whether a delay in measuring and acting on blood lipids, given that care often passes from hospital specialist to the general practitioner, results in a lower frequency of evaluation and treatment.

Heart failure

1 The role of the cardiologist in relation to the generalist for the diagnosis, aetiological classification and management of heart failure needs to be evaluated as most patients presenting with heart failure to the hospital service are managed by physicians other than cardiologists.
2 As heart failure is associated with a high frequency of recurrent hospital admissions, many of which are due to worsening of the heart failure, the optimal strategy for managing heart failure in the community needs to be defined.
3 Evaluation of new diagnostic tests for heart failure (e.g. the natriuretic peptides) which can be applied in the community is required, and these tests could also be evaluated in patients admitted to hospital.

Cardiovascular prevention and rehabilitation

1 As rehabilitation has traditionally been offered to patients following cardiac surgery or post myocardial infarction, a formal evaluation of models of care for cardiovascular prevention and rehabilitation in patients with angina (both exertional angina and following medical management of unstable angina) is required.
2 The optimal mix and components of a cardiovascular prevention and rehabilitation programme, and the frequency and duration of the programme require investigation. Several approaches exist for the delivery of cardiovascular prevention and rehabilitation from menu-driven systems, home-based and community-based services and hospital-based programmes. Research is required into the effectiveness of each of these approaches, both separately and together.
3 Lifestyle intervention is the foundation of a cardiovascular prevention programme and research is required to develop more effective ways to help patients stop smoking, make healthy food choices and become physically active over the long term.
4 The integration of care between a hospital-based cardiovascular prevention and rehabilitation programme and the subsequent management of coronary patients in general practice and the community needs to be developed and evaluated. The concept of a cardiac liaison nurse is one approach but there are others and they each need to be evaluated. Other ways of integrating care also need to be considered, such as the common patient-held record.
5 Prescribing drugs at the doses used in the clinical trials which have shown efficacy and safety in relation to prevention of established coronary disease, and ensuring compliance with such treatments over many years, is the only way to replicate the results of the clinical trials. As there are now at least five classes of drugs which can reduce the risk of recurrent disease and improve survival, it is necessary to ensure that appropriate drugs are selected for an individual patient and compliance with such treatments encouraged over the long term. Compliance needs to be monitored and the reasons for non-compliance evaluated.
6 Ethnic minorities pose a particular challenge for cardiovascular prevention and rehabilitation because of cultural and language issues and these groups require research in their own right to ensure that the lifestyle intervention is appropriate to their culture and the instruments used are offered in the patients' own language and not just English.
7 The involvement of the patients partner, and other members of the immediate family sharing the same household, could potentially bring about much more effective and sustained lifestyle change in relation to the use of tobacco, food choices and physical activity. The role of the partner in this process requires evaluation to ensure the most conducive environment for lifestyle change.
8 Women are more reluctant to take up a place on a cardiovascular prevention and rehabilitation programme and the reasons for this need to be investigated and measures put in place to ensure that women are able to enjoy the same benefits of such a programme as men.
9 Social class is also a factor in determining whether a patient participates in a cardiovascular prevention and rehabilitation programme and there is a tendency for response rates to be higher amongst the professional and middle classes, whereas the disease is commonest in working class men and women. The factors influencing the attitude of different social classes to such programmes requires investigation to ensure that all patients take up this service.
10 The elderly are at higher absolute risk of recurrent coronary disease and death and have special requirements in terms of the appropriateness of lifestyle interventions, risk factor management and prophylactic drug therapies. Given competing co-morbidity and life expectancy in this group, research is required into the benefits of a cardiovascular prevention and rehabilitation programme and how this can be most sympathetically delivered.

11 There is some evidence to support exercise-based rehabilitation for patients with heart failure and, when this is due to coronary artery disease, other aspects of lifestyle and risk factor management may be important in determining the quality of life and prognosis of these patients. Research is required in patients with chronic LV systolic dysfunction to determine the optimal components of a rehabilitation programme for heart failure.

10 Appendices

A strategy for sudden cardiac collapse in the community

1 A district-wide protocol agreed between the ambulance service, Accident and Emergency and general practice.
2 All 999 calls for 'collapse' to be attended by an ambulance crew trained and equipped for cardiopulmonary resuscitation.
3 General practitioners to immediately attend all patients reporting chest pain, which could be due to an acute coronary syndrome, and to call an ambulance at the same time.
4 Training of close relatives of patients with established CHD in cardiopulmonary resuscitation.
5 Training of all emergency services in cardiopulmonary resuscitation, and selected sections of the general public.
6 Auditing the impact of the protocol.

A strategy for diagnosing and managing cardiac chest pain in the community

1 A district-wide protocol agreed between secondary and primary care for patients presenting with chest pain, to general practice or Accident and Emergency.
2 Educating people who develop chest pain to seek medical help early through their general practitioner, or by calling 999. This applies particularly to patients with established CHD who experience a recurrence of symptoms, a worsening of symptoms or symptoms at rest.
3 General practitioners to refer all patients who are thought to have new exertional angina to a Rapid Access Chest Pain Clinic, and those who are unstable (acute coronary syndromes) directly to Accident and Emergency.
4 A Rapid Access Chest Pain Clinic for new patient assessments to be available in every DGH with an Accident and Emergency Department.
5 A triage system for patients attending Accident and Emergency with chest pain in order to prioritise those with acute coronary syndromes for immediate treatment, and referral of those with new exertional angina to the RACPC. Patients with established CHD who are not unstable to be referred to cardiology outpatients.
6 Auditing the impact of the protocol.

A strategy for primary prevention of CHD in high risk individuals in primary and secondary care

1 A common district-wide protocol agreed between primary and secondary care for the identification and management of high risk individuals.
2 In primary care systematic identification of all high risk (CHD risk $\geq$ 15% over 10 years) individuals through cardiovascular screening:
   a all new patients registering with a general practice – which will ultimately ensure all patients are screened
   b all patients with an existing diagnosis of hypertension, dyslipidaemia or diabetes mellitus

   c opportunistic screening of all patients attending for a consultation for whatever reason
   d rescreening of all individuals at least once every 5 years and sooner for those whose *projected* 10 year risk is $\geq 15\%$.
3 Nurse-led lifestyle intervention, using a behavioural approach to change, in all high risk individuals with repeat measurements of BP (if $> 140/90$ mmHg) and cholesterol (if > 5.0 mmol/l) and monitoring of glycaemic control (and other risk factors) in patients with diabetes mellitus.
4 General practitioner-initiated drug treatment at the doses used in the clinical trials in high risk individuals for risk factors – blood pressure, blood cholesterol and diabetes mellitus – according to an agreed primary/secondary care protocol in order to meet risk factor targets: BP $< 140/85$ mmHg (BP $< 130/80$ mmHg in diabetes mellitus); and optimal glycaemic control in diabetes mellitus (HbAIC $< 7\%$).
5 Referral of selected patients from primary care requiring specialist investigation or management to hypertension, lipid and diabetes clinics according to an agreed primary/secondary care protocol. Discharge of patients from hospital clinics following appropriate specialist investigation and management to primary care.
6 Nurse-led screening of blood relatives in primary care if there is a family history of premature (men < 55 years, women < 65 years) CHD in one or more close relatives or if familial dyslipidaemia is suspected.
7 Auditing the impact of the district protocol in both general practice and specialised hospital (hypertension, lipid and diabetes) clinics.

A strategy for managing acute coronary syndromes

1 A hospital-wide protocol for management of acute coronary syndromes.
2 Triaging of patients in Accident and Emergency to ensure patients eligible for aspirin, thrombolytic therapy and other acute life-saving treatments are managed as quickly as possible. The following treatments at the doses used in the clinical trials to be given in casualty:
   i aspirin
   ii thrombolytic therapy
   iii intravenous or oral beta-blockade
   iv intravenous nitrates and low molecular weight heparin for unstable angina.
3 Primary angioplasty as an alternative to thrombolysis in patients with an AMI but with a major contra-indication to thrombolysis, or in cardiogenic shock.
4 Transfer of all patients with acute coronary syndromes to CCU managed by cardiologists.
5 Inpatient angiography for patients with recurrent myocardial ischaemia which does not respond to medical therapy.
6 Initiate prophylactic drug therapies at the doses used in the clinical trials:
   i beta-blocker
   ii ACE inhibitor
   iii cholesterol modification therapy
   iv anticoagulation.
7 Inpatient pre-discharge exercise test (or an alternative non-invasive assessment of reversible myocardial ischaemia) to determine priority for coronary angiography.
8 Inpatient recruitment to a cardiovascular prevention and rehabilitation programme.
9 Discharge summary to general practitioner specifying diagnosis; lifestyle, risk factor and therapeutic targets; and drug therapies.
10 Auditing the impact of the hospital protocol.

A strategy for managing heart failure in secondary and primary care

1 A common district-wide protocol agreed between secondary and primary care for heart failure.
2 All patients presenting for the first time in primary care with heart failure to be referred for a cardiological opinion to confirm the diagnosis, determine aetiology and management.
3 Address the causes of the heart failure e.g. treating blood pressure and other risk factors for CHD, revascularisation of the myocardium.
4 Initiate drug therapies at the doses used in the clinical trials and other treatments appropriate to the aetiology:
   i loop diuretics
   ii ACE inhibitor (or ATII receptor blocker if an ACE inhibitor is not tolerated)
   iii hydralazine and nitrate combination where an ACE inhibitor is contra-indicated or not tolerated
   iv beta-blocker
   v spironolactone
   vi warfarin.
5 In primary care general practitioner up-titration of drug treatments and regular assessment for compliance.
6 Auditing the impact of the common clinical protocol for heart failure in secondary and primary care.

A strategy for cardiovascular prevention and rehabilitation of CHD in secondary and primary care

1 A common district-wide protocol agreed between secondary and primary care for cardiovascular prevention and rehabilitation of all patients with CHD.
2 All patients with CHD – acute coronary syndromes, exertional angina and those following coronary revascularisation – to be provided with a hospital-based nurse-led comprehensive cardiovascular prevention and rehabilitation programme which includes the Joint British Societies guidance for lifestyle, risk factor and therapeutic targets, with results summarised in a report to general practice.
3 In primary care, a nurse-led reassessment of patients with CHD following completion of a hospital-based programme, which addresses the same targets for lifestyle, risk factors and compliance with drug therapies. Where risk factor and therapeutic targets have not been met, referral to the patient's general practitioner, to initiate drug therapy at the doses used in the clinical trials.
4 In primary care a nurse-led retrospective review of all patients with an existing medical diagnosis of CHD to ensure the lifestyle, risk factor and therapeutic targets are met. Where these targets have not been met, referral to the patient's general practitioner, to initiate drug therapy at the doses used in the clinical trials.
5 General practitioner-initiated drug treatment for risk factors (blood pressure, cholesterol and diabetes mellitus) and as prophylactic therapy (aspirin, beta-blocker, ACE inhibitors).
6 Nurse-led screening of first degree blood relatives if there is a family history of premature (men < 55 years, women < 65 years) CHD in one or more close relatives.
7 Auditing the impact of the common clinical protocol for cardiovascular prevention and rehabilitation in hospital and general practice.

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