Are Rapid Access Chest Pain Clinics effective and fair?
Characteristics and outcomes of patients from six centres

Report for the National Co-ordinating Centre for NHS Service Delivery and Organisation R & D (NCCSDO)

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prepared by

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Glossary of key terms and acronyms

Term or acronym	Definition
ACRE	Appropriateness of Coronary Revascularisation study.
ACS	Acute coronary syndrome: encompasses both unstable angina and MI.
Angina	Symptom of chest pain or discomfort brought on by exercise (or stress) and relieved by exercise.
ARIA	Appropriateness of Referral and Investigation of Angina study.
CABG	Coronary artery bypass graft: involves opening the patients chest under general anaesthetic and bypassing the narrowed arteries with vessels from elsewhere in the same patient (e.g. leg veins, internal mammary artery).
CAD	Coronary artery disease: the narrowing and irregularities of the blood supply to the heart, which are demonstrated by coronary angiography and underlie Coronary Heart Disease (CHD).
CHD	CHD: a spectrum of clinical disorders including stable and unstable angina and acute MI.
Coronary angiography	X-ray in which dye is injected into the coronary arteries in order to identify areas of narrowing of the arteries.
Coronary revascularisation	Invasive, physical means of reversing the narrowing in coronary artery disease. There are two kinds: CABG and PTCA.
Resting ECG	Electrocardiography: non-invasive investigation to test heart function measuring electrical currents of the heart at rest.
ETT	Electrocardiography: non-invasive investigation to test heart function measuring electrical currents of the heart while exercising on a treadmill.
MI	Myocardial infarction: patient notices prolonged chest pain at rest; caused by a thrombosis (blood clot) causing a blockage in the coronary artery

Morbidity	Suffering from disease, short of death (mortality).
MREC	Multi-centre research ethics committee (now replaced by REC).
NSF	National Service Framework
PTCA	Percutaneous transluminal coronary angioplasty: a local anaesthetic procedure in which a balloon is inserted and inflated to dilate the narrowed coronary artery. Re-stenosis (re-narrowing) of this artery is a problem, hence stents are increasingly deployed. Percutaneous coronary intervention (PCI) is the generic term for PTCA with or without stent.
RAND	("R and D") US research institute which developed method of measuring appropriateness with panels of experts.
Secondary prevention	Medication to prevent death or further heart disease events in patients with established CHD: aspirin, beta-blockers, ACE inhibitors and lipid lowering agents.
Stent	A metal tube inserted across the narrowed coronary artery to hold it open, can be drug-eluding (coated with drugs inhibiting intimal proliferation.
Unstable angina	Chest pain with increased frequency or duration, or at rest, with or without resting electrocardiogram changes or pulmonary oedema, usually resulting in hospitalisation.
NCCP	Non-cardiac chest pain- chest pain other than stable angina, unstable angina or myocardial infarction.

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Executive Summary

Are rapid access chest pain clinics effective and fair: characteristics and outcomes of 8762 patients from six centres

Rapid access chest pain clinics (RACPCs), a key part of the national service framework for coronary heart disease, are now established in nearly all acute trusts in England and Wales. They aim to eliminate delay in the cardiological assessment of patients with chest pain and to distinguish those with angina from those with other causes of chest pain. We have undertaken a multi-centre cohort study of 11,082 consecutive patients attending RACPCs. Data were electronically recorded from 2 January 1996 to 31 December 2002 using identical databases in each of the six participating centres.

The aims of the study were:

- to determine whether RACPCs are appropriately targeted towards patients with chest pain of cardiac origin;
- to analyse populations using RACPCs, equity of access to the clinics and referral for subsequent cardiac procedures and their appropriateness;
- to compare different models of care across centres;
- to determine whether RACPCs act in addition to or as a substitute for other services.

AIM 1: To determine whether RACPCs are appropriately targeted towards patients with chest pain of cardiac origin

Objectives

(1a) determine contemporary prognosis of patients with angina

(1b) measure potential differences in outcomes between angina and non-cardiac chest pain patients

Background

The incidence of angina in primary care populations is increasing but its prognosis is unknown. The assumption that one-stop assessment in RACPCs can successfully separate patients with stable chest pain into those with and without angina is unproven and the extent to which the differential diagnosis accurately predicts risk is unknown.

The external validity of claims made by trialists that cardiovascular risk in stable angina has been reduced to 'normal levels' is hard to gauge.

Methods

The study group comprised patients diagnosed with either incident angina without prior myocardial infarction (n=2366) or non-cardiac chest pain (n=6396).

Median follow-up was 2.57 (interquartile range 1.96-4.15) years.

Mortality (ONS) and hospital admissions (NWCS) were compared with the general population and the participants (placebo groups) of recent randomised trials.

Results

All outcomes were more frequent for patients diagnosed with angina compared with patients with non-cardiac chest pain. Annual rates of coronary death and non-fatal myocardial infarction were 2.3% (95% CI 1.9-2.7%) in patients with angina versus 0.4% (95% CI 0.3-0.5%) in patients with non-cardiac chest pain.

Cumulative probabilities of these events at three years were 4.84% (95% CI 3.92-5.96) in patients with angina versus 0.90% (95% CI 0.67-1.23) in patients with non-cardiac chest pain. Differences persisted after multivariate adjustment. Out of 203 patients with coronary death or non-fatal myocardial infarction, 72 (36%) had been diagnosed with non-cardiac chest pain. They were younger, less likely to have typical symptoms, and more likely to have a normal resting ECG compared with patients with angina who had coronary death or non-fatal myocardial infarction.

Compared with the general population, standardised mortality ratios for death due to CHD were higher in men (2.03, 95% CI 1.49-2.56) and women (2.13, 95% CI 1.29-2.96) with angina. We identified no randomised trials recruiting incident cases of angina, but compared with trials that have recruited secondary and tertiary care patients, most with prior myocardial infarction, fatal and non-fatal event rates were higher in our patients with incident angina.

Conclusions

Patients with previously undiagnosed angina, uncomplicated by prior myocardial infarction, are at higher coronary risk compared with both the general population and the participants in recent clinical trials. RACPCs effectively identify patients at increased risk but fail to correctly diagnose all patients. We need to improve the diagnosis and treatment of ambulatory patients when they first present with chest pain in order to reduce mortality rates in this high risk but neglected group.

(1c) Relate quantitative probability of coronary artery disease to prognosis

Background

In the patient with chest pain, the diagnosis of coronary artery disease is a probability judgement based on disease prevalence in the population group to which the patient belongs and the clinical presentation. Quantitative analysis of the probability of coronary disease in an individual patient was provided by Diamond and Forrester (DF) who devised a CAD score based on that patient's age, gender and typicality of symptoms.

This analysis was based on post-mortem data in US populations and has not been tested in RACPC populations. Its prognostic validity against hard clinical end-points has never been tested.

Methods

The CAD score was calculated within the database, using Diamond and Forrester's algorithm. This is based on the physician's coding of chest pain (typical, atypical, non-specific), age and gender of the patient. A modified CAD score calculated retrospectively from the individual chest pain descriptors provided an objective measure of diagnostic probability, devoid of physician's intuition.

The relation between CAD scores, rated low (<20%), intermediate (20-80%) and high (>80%), and prognosis was determined in the 7426 patients aged 30 to 69 in whom the DF algorithm could be applied.

Results

Median CAD scores in patients with angina were 90.6% (IQ range 67.1-92.0%) compared with 32.4% (IQ range 14.1-54.4%) in patients with non-cardiac chest pain. Corresponding figures for modified CAD scores were 67.1% (46.1%-90.6%) and 18.6% (8.4-32.4%).

Coronary death or non-fatal myocardial infarction occurred in 0.6% of patients with low CAD scores, 1.5% of patients with intermediate CAD scores and 5% of patients with high CAD scores. Corresponding figures for modified CAD scores were 0.5%, 2.0% and 5.5%, respectively.

Cumulative incidences of coronary death or non-fatal myocardial infarction at three years were 0.64% (95% CI 0.33-1.27), 1.13% (95% CI 0.82-1.56) and 4.19% (95% CI 3.00-5.83) for patients with low, intermediate and high probabilities of CAD and 0.53% (95% CI 0.30-0.92), 1.72% (95% CI 1.29-2.30) and 4.37% (95% CI 2.91-6.52) for patients with low, intermediate and high probabilities of modified CAD respectively.

Relations between CAD scores and the cumulative incidences of death or non-fatal myocardial infarction were similar for south Asian and white patients.

Conclusions

In patients with previously undiagnosed chest pain the calculated probability of CAD by the DF algorithm accords not only with diagnosis but also with prognosis, effectively stratifying patients into high, intermediate and low risk groups.

In terms of risk assessment the physician's intuitive assessment of the typicality of symptoms is as good, if not better than objective methods for risk stratification.

Although the DF algorithm for quantifying the probability of coronary artery disease was based on a primarily White US population, its validity for risk stratification in Asian patients with chest pain is confirmed.

(1d) Identify additional baseline clinical variables that may predict outcome

Background

A diagnosis of angina is independently associated with coronary death and non-fatal myocardial infarction. In this section the additional contribution of other baseline clinical variables to adverse outcomes is explored.

Methods

The study population comprised the 8762 patients previously described.

Cox regression was used to estimate hazard ratios for the association of angina with coronary death or non-fatal myocardial infarction initially by adjusting for age. Those age-adjusted covariates which showed significant association ($p<0.05$) were included in the fully adjusted models.

Results

In the fully adjusted model, the hazard ratio for the effect of angina on coronary death or non-fatal myocardial infarction was 2.16 (95% CI 1.40-3.34). Additional baseline variables that contributed to the hazard included abnormal resting ECG (HR 1.95, 95% CI 1.44-2.64), male gender (HR 1.89, 95% CI 1.40-2.55), increase in age (HR 1.57, 95% CI 1.38-1.80), symptom duration >4 weeks (HR 1.32, 95% CI 1.00-1.76), smoking (HR 1.48, 95% CI 1.08-2.05) and diabetes (HR 1.51, 95% CI 1.06-2.15). South Asian ethnicity increased (HR 1.20, 95% CI 0.86-1.68) and black ethnicity reduced (HR 0.37, 95% CI 0.16-0.84) the hazard of coronary death or non-fatal myocardial infarction.

Conclusion

Multiple factors contribute to the hazard of adverse outcomes in patients with angina. Those factors amenable to correction may help improve prognosis. Symptoms for >4 weeks increased the hazard of adverse outcomes, re-inforcing the need for rapid assessment of the patient with chest pain. The added hazard of adverse outcomes for patients with an abnormal ECG justifies the routine recordings obtained in all patients attending RACPCs. In patients with chest pain, the increased hazard for South Asians, and reduced hazard for blacks is confirmed.

AIM 2: To analyse populations using RACPCs, equity of access to the clinics and referral for subsequent cardiac procedures and their appropriateness

Objectives:

(2a) Characterise populations using RACPCs

Background

Identifying demographic characteristics of patients using RACPCs is an important starting point but precludes a judgement about equity because the incidence of heart disease varies among different demographic groups.

Methods

For this analysis, 9390 patients with complete data and follow-up were identified, in which the cohort was characterised by age, gender, ethnicity and RACPC centre.

Results

Age

Relatively more patients aged <65 yrs attended the RACPC than did older patients. The proportion of patients diagnosed with angina increased with age. Rates of coronary death and non-fatal myocardial infarction increased from <1% in patients aged <45 yrs to eight percent in patients aged ≥75 years.

Gender

Men comprised 54% of the cohort. They tended to be younger than women and 32% were diagnosed with angina compared with 26% of women. Rates of coronary death and non-fatal myocardial infarction were 4% in men and 2% in women.

Ethnicity

South Asians were younger than whites (50.78 (±11.61) versus 56.71 (±13.24) years), and less likely to be diagnosed with angina (23% versus 34%), although rates of coronary death and non-fatal myocardial infarction were 3% in both groups. In black patients, angina was

diagnosed in only 14% of cases, and the rate of coronary death and non fatal myocardial infarction was only 1%.

Centre

Newham, the oldest RACPC, comprised 51% of the cohort. Rates of angina varied from 25% (Newham) to 46% (Blackburn). Rates of referral for angiography varied from 6% (Burnley) to 48% (Oldchurch). Annual rates of CHD death or non-fatal myocardial infarction among patients with angina varied from 1.63% (95% CI 1.30-2.03%) in Newham to 3.45% (95% CI 1.49-6.79) in Burnley.

Conclusion

Unsurprisingly, diagnostic categories and outcomes vary systematically with demographic characteristics. Centres vary in relation to: diagnosis; management and outcomes; (probably reflecting differences in catchment populations) referral criteria; local management policy; frequency of clinics; and local availability of cardiac investigations.

(2b) Analyse variation in access to RACPCs by age, gender, ethnicity and deprivation

Background

There is conflicting evidence in the UK of inequitable access to cardiac services and to specific interventions, such as revascularisation, for older people, women, ethnic minority groups and those from more deprived areas. On the whole this research has not adequately taken into account individual or population need. No previous research has investigated access to or referral from rapid access chest pain clinics.

Methods

For analysis of equity of access to the clinics, 8322 patients with undiagnosed chest pain and first attendance at RACPCs and complete data were used.

With a relatively small number of black patients, analyses of ethnic differences were confined to whites and South Asians.

The denominator population for the RACPCs was identified by the catchment area for each clinic, which in turn was defined by the PCTs served by the respective hospitals. The 2001 census was the source for ward level data on age, gender and ethnicity.

Need was defined by the ward coronary mortality data (ONS), adjusted to conform to PCT boundary changes in 2002.

The Townsend deprivation index calculated at ward level by using census 2001 data of percentages unemployed, with no car, not owner occupier and overcrowding was used.

Univariable and multivariable Poisson regression models were fitted to estimate attendance rates by age group, gender, ethnic group and deprivation status and similar models were fitted to estimate population CHD mortality rates.

Results

Attendance rate ratios for older patients (aged ≥ 65 years) were similar to the younger age group, although their population CHD mortality rates were nearly 15 times higher. For those most deprived (quintile five), visit rates were 13 percent lower than those less deprived (quintile one to four) but the population CHD mortality rates were highest in the most deprived quintile. South Asians had higher attendance rates compared to the white ethnic group and a high standardised mortality ratio for CHD based on national data. Women had lower visit rates and also lower population CHD mortality ratios compared to men. Hospitals which ran clinics four to five times a week had higher attendance rates.

Conclusions

We have found evidence for inequity of access to rapid access chest pain clinics for older people and those from more deprived areas, but none for women or South Asian patients.

(2c) Rates of referral for coronary angiography in relation to age, gender, ethnicity and deprivation

Background

There is considerable evidence from the UK and internationally of under-investigation of heart disease in older people, women, some ethnic minority groups and people from socio-economically deprived areas. A major purpose of rapid assessment of chest pain is that it should provide access to invasive investigation equitably for all patients in whom it is indicated, regardless of demographic characteristics, to prevent or postpone coronary events.

Methods

For this analysis 8446 patients, 2270 diagnosed with angina and 1554 with pre-test CAD score >80%, were identified.

The independent contributions of age, gender, ethnicity and deprivation towards use of exercise tolerance tests and referral for angiography were analysed by logistic regression. Sensitivity testing for the analysis of referral for angiography included sub-group analyses of patients with angina and those with a CAD score >80 percent.

Results

The RACPC directly referred 544 patients (6%) for coronary angiography and a further 936 patients (11 percent) during follow up. A diagnosis of angina was the major factor associated with coronary angiography (OR 198.07, 95% CI 46.44-844.83).

Every 10 year increase in age reduced the odds of referral for coronary angiography (OR 0.72, 95% CI 0.65-0.80), as did south Asian ethnicity (OR 0.30, 95% CI 0.21-0.42), and socio-economic deprivation (OR 0.42, 95% CI 0.28-0.62) for most deprived (quintile five) of the Townsend deprivation score versus less deprived (quintile one to four). Being male increased the odds, OR 1.89, 95% CI 1.48-2.41. These associations persisted in the angina and high coronary risk subgroups. Once referred for angiography, the cumulative probability of undergoing the procedure was unaffected by age, gender, ethnicity or deprivation.

Conclusion

Among patients attending RACPCs, there were significant inequities in referral for coronary angiography for older people, women, south Asians and those from more deprived wards.

(2d) Analyse appropriateness of cardiac investigation in RACPCs by applying appropriateness ratings validated in a previous study to answer questions of over-use and under-use according to age, gender, ethnicity and deprivation

Background

In analysing cardiac investigation and its effect on outcomes, a more precise judgement of equity (and under-use/over-use) is possible with retrospective ascription of appropriateness of the investigation to individual patients. In a previous study we have developed appropriateness ratings (RAND-Delphi method) for stress testing (ETT) and coronary angiography.

Methods

We had available 7201 patients for matching against the previously developed appropriateness ratings for ETT and coronary angiography.

Definition of under-use: appropriate investigation not performed.

Definition of over-use: inappropriate investigation performed.

Results

Of the 7201 patients, 67% were appropriate for ETT, 11% were appropriate for coronary angiography. There were 26% of patients' who were appropriate for ETT but who did not receive it (under-use). In logistic regression underuse was more likely in women than men (OR 0.47, 95% CI 0.41-0.53), in South Asians than whites (OR 0.77, 95% CI 0.65-0.91), and patients older than 75 years (OR 2.16, 95% CI 1.21-3.88). At the time of consultation in the RACPC or during follow-up 46% of patients appropriate for coronary angiography did not receive it (under-use). In patients appropriate for coronary angiography, cumulative rates were similar in men and women, but lower in South Asians and older people. In spite of a higher referral rate, those patients from the least deprived areas had a lower uptake of angiography, which may reflect access to private sector investigations. Patients appropriate for coronary angiography who did not receive it were more likely to die during follow-up than patients appropriate for coronary angiography who did receive it.

Conclusions

- There is considerable under-use of ETT and coronary angiography in RACPCs.
- Under-use of coronary angiography is associated with adverse outcomes.
- There is inequity in the use of ETT for women, south Asians and older patients.
- Under-use of coronary angiography is greater for older and south Asian patients.

AIM 3: To compare different models of care in RACPCs

(3a) An overview of models of care in RACPCs in England and Wales

Background

The RACPC we established at Newham University Hospital was the model of care proposed within the NSF for coronary heart disease.

Inevitably however as RACPCs have developed, models of care in different centres have evolved to meet local need within the constraints imposed by local facilities.

Methods

A postal survey of 135 RACPCs in England, to characterise models of care currently being used was done.

Results

The response rate was 75%, which was conservative as some non-responders included centres without established RACPCs. About 50% of the RACPCs were set up in response to the NSF framework for CHD, 69% had a computerized database, 97% operated with an appointment system, 53% accepted referrals only from primary care, most provided service 3-4 times a week seeing 15-16 patients per week, and 48% saw patients within 14 days. Of the 102 responders, 62 were staffed solely by doctors, 37 by both doctors and nurses and 3 by nurses. Doctors were responsible for making the final diagnosis in 93% of the RACPCs and referral for an angiogram in 95%.

Conclusions

There was wide variation in the way the RACPCs are configured, differences presumably reflecting resource allocation and perceptions of local need.

(3b) To compare waiting times in the six participating centres
(3c) To analyse organisational factors,

particularly the roles of doctors and nurses, in different participating centres

Background

A major purpose of RACPCs is to eliminate delay in the cardiological assessment of chest pain. RACPCs represent a new service within cardiology departments that has significant impact on workload. Efficient organisation, therefore, is an important priority.

Methods

A senior member of staff in the 6 participating RACPCs was interviewed using a structured topic guide to provide qualitative information about the organisation of the clinic.

Results

5 RACPCs met the NSF waiting time target of <14 days for all referrals. Attendance rates for all clinics plateaued after 3-4 months at a level that reflected the frequency with which clinics were held. Most clinics operated an appointment system but one was open access, increasing the potential for misuse through inappropriate referral, but having the advantage of no waiting time. This was much valued by patients.

Nurses participated in 3 clinics with roles that varied from administration, through history taking, to diagnosis and management decision making. There was a universal view that while nursing input was desirable, the doctor should be responsible for making the final diagnosis and management plan. All participants agreed that RACPCs provide a good way to overcome delay in assessment of chest pain that is beneficial to the patient. But almost all expressed frustration at the number of inappropriate referrals received despite clearly stated referral guidelines

Conclusions

No single model of care best serves the main purpose of RACPCs to see patients with undifferentiated chest pain within 14 days of referral and to diagnose and initiate appropriate treatment in those with angina. Models of care must take account of local need and local facilities, but clear referral guidelines are essential if referrals are to be both appropriate and manageable.

AIM 4: To determine if RACPCs act in addition to or as a substitute for other services

Objectives

(5a) Quantify the number of patients with incident chest pain who continue to be referred to the outpatient cardiology clinic (OPCC)

(5b) Compare the distribution of cardiac and noncardiac chest pain in RACPC versus OPCC

(5c) Analyse waiting times for assessment of chest pain in OPCC

(5d) Compare demographic characteristics of patients with chest pain in OPCC with patients attending RACPC

(5e) Compare rates of referral and determinants of referral for cardiac catheterisation in RACPC versus OPCC

Background

RACPCs have been established to provide cardiological assessment of chest pain within 2 weeks of referral for all patients who fulfil criterion. RACPCs should substitute for existing services and reduce to zero referrals to OPCCs who fulfil criteria. It is not known if effective substitution has been achieved.

Methods

Prospective study at Newham University Hospital comparing all patients referred to the RACPC over a 2 year period with those referred to the OPCC with new onset chest pain

Similar data, collected in 1382 RACPC patients and 228 OPCC patients, were stored in the same electronic database permitting direct comparison of the 2 groups.

Results

Angina was diagnosed in 26% of the group seen in OPCC compared with 23% of the group seen in the RACPC Mean waiting time for an OPCC appointment was 97± 43 days. Patients in the RACPC were seen the same day or the first working day after the referral. Only 2% of the OPCC group had had symptoms for <4 weeks at the time they were seen, compared with 67% of the RACPC group. After adjustment for the clinic waiting time

and referral guidelines for the RACPC, there remained 30 patients with symptoms <4 weeks who were referred to OPCC.

South Asians comprised 53% of the group seen in OPCC but 45% of the group seen in RACPC. Of patients diagnosed with angina, 33% were referred for angiography from the OPCC, but only 19% from the RACPC. The adjusted odds of referral fro angiography from OPCC compared with RACPC were 3.82 (95% CI 1.85-7.90)

Conclusion

For assessment of new onset chest pain, the RACPC at Newham University Hospital has largely, but not completely, substituted for the OPCC. The RACPC fulfils its aim of rapid assessment with negligible waiting times compared with the OPCC There is an unexplained tendency for south Asians being referred to the OPCC rather than the RACPC. Also unexplained is the higher rate of cardiac catheterisation for patients with angina seen in the OPCC compared with the RACPC.

Variation from stated objectives in the proposal

(Aim 2 b) Analyse rates of referral to angiography and revascularisation in relation to age, gender and ethnicity. Patients were referred for revascularisation following coronary angiography and not directly from the RACPC. Data on reasons for individual patient referral for revascularisation were not captured by the RACPC and NWCS database.

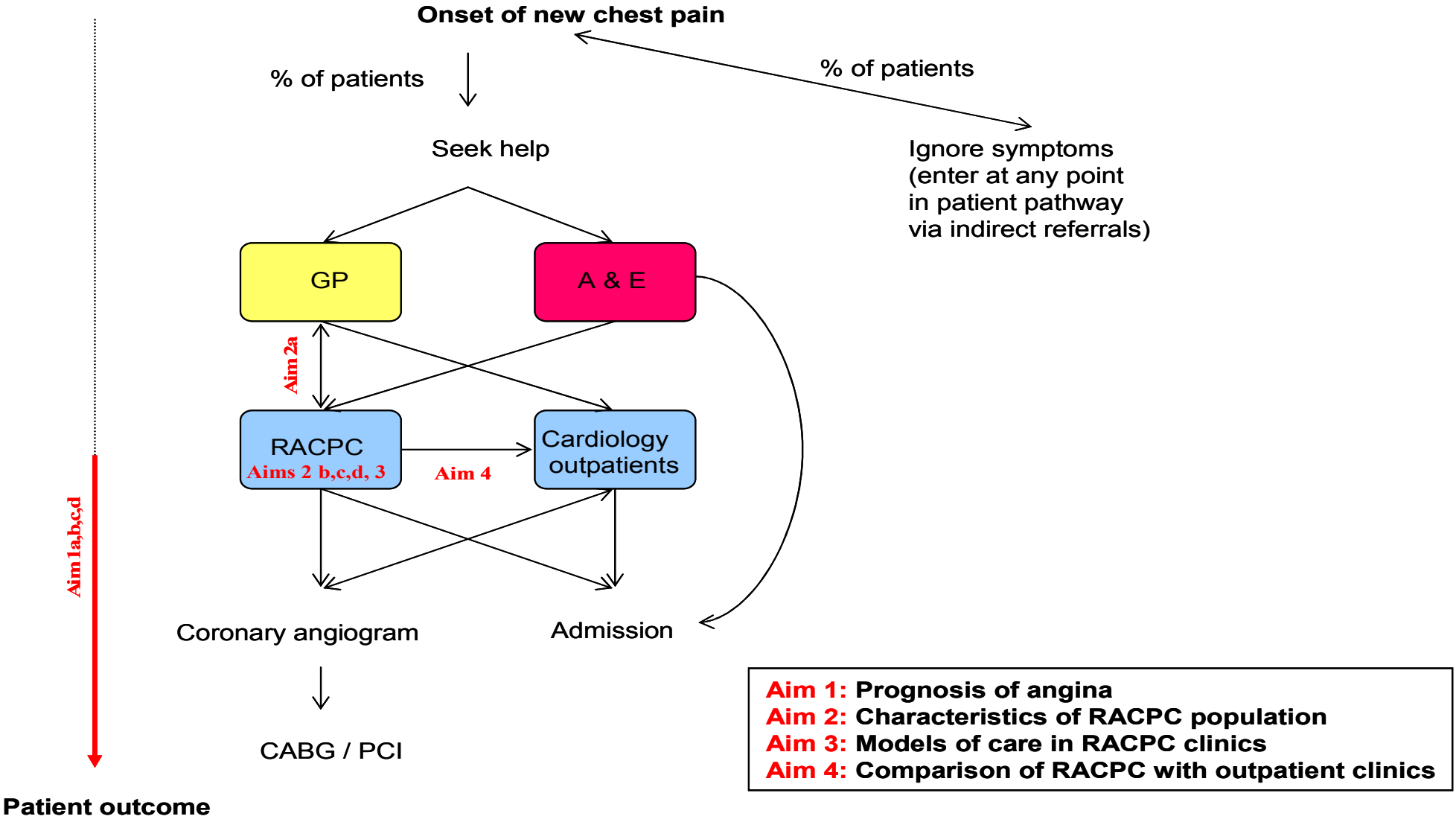
(Aim 2e) Assess access to RACPCs with comparison of proportions of patients referred to the clinics from different age groups, gender, and ethnic groups who are appropriate for referral to a cardiologist. We did not have appropriateness ratings to assess referral of patients to the chest pain clinic.

For both objectives we have analysed variation in access to rapid access chest pain clinics by age, gender, ethnicity and deprivation and rates of referral to exercise stress testing and angiography in relation to age, gender, ethnicity and deprivation.

(Aim 3b) Relate organisational factors, particularly the roles of doctors and nurses, in different participating centres to rates of non-invasive

investigation, outpatient re-attendance and clinical outcomes. Personal interviews with clinicians in the participating centres revealed that for the study period all had doctors providing clinical support. In the four clinics staffed by nurses, independent decisions were not made by them. The data from each centre reflected the doctor's assessment. **We therefore carried out an additional questionnaire survey of RACPCs in England.**

Figure 1: Flow chart of aims and objectives in relation to the patient pathway



The Report

Section 1 Background

1.1.1 Chest pain

Chest pain is a non-specific common symptom with up to 25% of the general population experiencing it in some form during their lifetime (Kroenke, 1992). It encompasses a wide range of medical conditions which range from benign musculoskeletal chest pain, for which simple reassurance and analgesia may suffice, to conditions like stable angina requiring ambulatory care and immediately life threatening disorders such as aortic dissection, myocardial infarction or pulmonary embolism needing emergency admission.

Chest pain due to angina is the most common initial manifestation of coronary heart disease (Kannel and Feinleib, 1972; Sutcliffe *et al*, 2003; Kentsch *et al*, 2003) and accounts for an estimated one percent of annual health expenditure in the UK (Kentsch *et al*, 2003). There are no long-term follow up studies in this group of patients with new onset of chest pain.

2.1.2 Definition of angina

The term angina is commonly used to describe pain syndromes arising from presumed myocardial ischemia most often as a result of reduced blood supply due to atherosclerotic plaques, but without myocardial necrosis. Medical interest in chest pain syndromes stems from first descriptions of angina pectoris, over 200 years ago (Eslick, 2001). Though several physicians had described symptoms suggestive of angina, it was William Heberden (1710 to 1801) who emphasised the role of proper history taking and recording (Heberden, 1772). His initial description of chest discomfort as conveying a sense of 'strangling and anxiety' is still pertinent, and other adjectives frequently used are 'vice-like', 'constricting', 'suffocating', 'crushing', 'heavy' and 'squeezing' (Rutherford and Braunwald, 1992).

Angina is defined as a clinical syndrome characterised by discomfort in the chest, jaw, shoulder, back or arm. It is generally precipitated by exertion or emotion and commonly relieved by rest or nitroglycerine

(Gibbons *et al*, 1999). Figure shows a patient pathway following assessment of chest pain for diagnosis of angina.

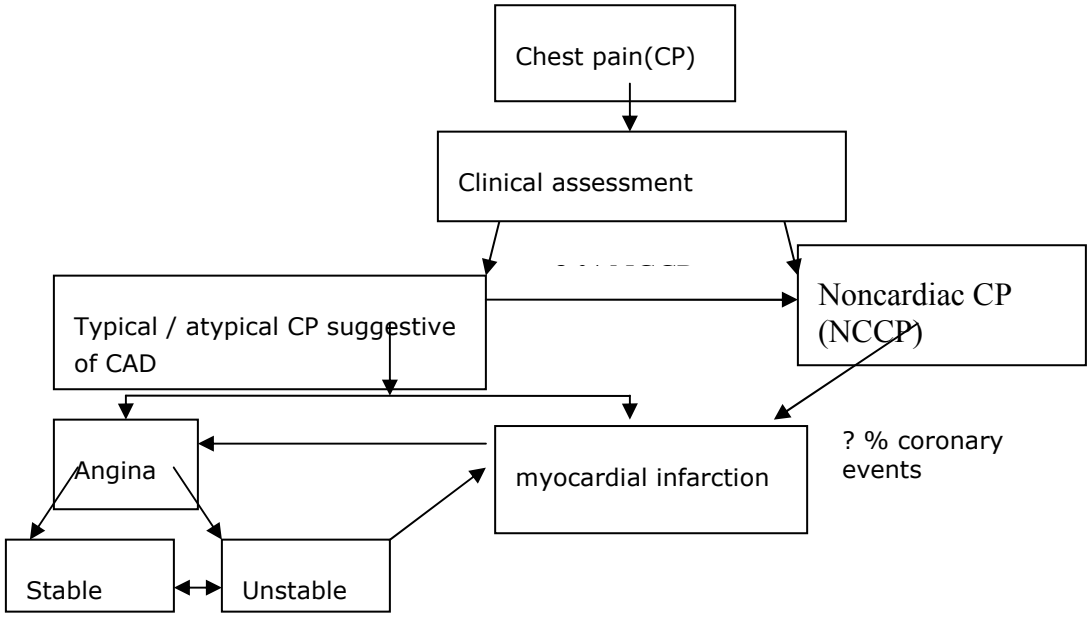


Figure 2: patient pathway

1.1.3 Clinical assessment of patients with chest pain

Discomfort from angina varies considerably among patients and its overlap with other entities can make the differential diagnosis of chest pain difficult (Christi and Conti, 1981; Constant, 1983). A detailed description of the symptom complex is the most important step in the clinical evaluation of the patient with chest pain, allowing the clinician to estimate the likelihood of coronary artery disease (CAD) (Rutherford and Braunwald, 1992; Gibbons *et al*, 1999b). The extent of work up required to exclude a cardiac cause needs to be individually determined. The diagnosis is informed by the clinicians' intuition, experience, interviewing skills supported by investigations like resting electrocardiogram, stress tests (exercise stress tests, stress echocardiograms, myocardial perfusion scans) and coronary catheterisation that aid diagnosis.

There are five important components of chest pain that help classify it into three groups i.e. typical, atypical or non-cardiac chest pain. These

are location, quality, duration of pain, factors that provoke the pain and those that relieve it.

Table 1: Description of chest pain

Typical angina
1) substernal discomfort with a characteristic quality and duration that is 2) provoked by exertion or emotional stress and 3) relieved by rest or GTN spray
Atypical angina
Meets 2 of the above characteristics
Non-cardiac chest pain
Meets one or none of the typical angina characteristics

ACC/AHA/ACP-ASIM chronic stable angina guidelines

Modified from Diamond, JACC, 1983 (Diamond, 1983).

1.1 Distinguishing stable and unstable angina

Angina needs to be further assessed in terms of stability of symptoms, which is highly correlated with prognosis. Unstable angina has a much higher short-term risk of an acute coronary event (Patel *et al*, 1998). Angina is unstable if the pain has started recently, is more easily provoked, or occurs with increased frequency, severity or duration. Stable angina lacks these worrisome features, and is precipitated by activities increasing myocardial oxygen demand such as exercise, eating, and/or stress and is relieved with rest. Importantly stable angina symptoms are reproducible and predictable in onset and can be assessed in an outpatient setting in contrast to unstable angina, which if accompanied by rest or nocturnal chest pain, signs or symptoms of heart failure or ischaemic changes on electrocardiogram, needs inpatient assessment (Gibbons *et al* 1999a).

1.2 Epidemiology of coronary artery disease

Worldwide ischaemic heart disease remains the leading cause of death (Murray and Lopez, 1997). Coronary artery disease (CAD) is the leading cause of mortality among the US population, causing more than 710,000 deaths per year (Minino, Arias, Kochanek, Murphy, Smith, 2000). In the UK cardiovascular diseases are the most common cause of death and coronary artery disease accounts for almost half of all deaths from cardiovascular causes, with a similar picture elsewhere in Europe (Petersen, Peto, Rayner, 2004). Angina pectoris is the most prevalent manifestation of CAD (Gibbons *et al*, 1999), occurring as an initial presentation in almost half of the patients (Sutcliffe *et al*, 2003). Using morbidity statistics data from general practice, new cases of angina are estimated to be about 178,500 in all men living in the UK and about 159,500 in women giving a total of approximately 338,000 (Petersen, Peto and Rayner, 2004). Patients with angina have a threefold increased risk of developing unstable angina, myocardial infarction or cardiac death within two years of first presentation (Murabito, Anderson, Kannel, Evans, Levy, 1990). The incidence of angina in primary care population continues to increase (Lampe, Morris, Walker, Shaper, Whincup, 2005).

Therefore it is important to recognise angina as a prodromal symptom of myocardial infarction and for patients with recent onset exertional chest pain to receive prompt diagnosis and risk stratification with a shift in the treatment paradigm from damage control/salvage of the myocardium to preventive intervention with anti-platelet agents, (BMJ, 1994) statins, (*Lancet*, 1994a) betablockers, (Rehnqvist *et al*, 1995; Lancet, 1994b; Savonitto *et al*, 1996; Pepine *et al*, 1994; Dargie, Ford, Fox, 1996) and angiotensin converting enzyme inhibitors (Yusuf, Sleight, Pogue, Bosch, Davies, Dagenais, 2000; Fox, 2003).

1.3 Management options for patients with new onset chest pain

Most patients with angina initially present to their general practitioner (GP) (Cannon, Connell, Stockley, Garner, Hampton, 1988). Others may directly attend the Accident and Emergency department (A&E) and some may choose to ignore their symptoms. A survey of a health authority based coronary register found that nearly than 87 percent of patients with

first presentation of coronary heart disease presented alive to the medical services, 51 percent of whom were diagnosed with new onset exertional angina (Sutcliffe, Fox, Wood, Stock, Wright *et al*, 2003). This re-inforces the need for measures which can delay and reduce progression of coronary heart disease at an early stage.

1.4 General practice setting

The GP has a variety of management options for the patient presenting with chest pain, the choice depends largely on the clinical presentation and urgency. Referral to secondary care may be chosen, either directly to the local A&E department, or to a cardiology outpatient clinic. Alternatively, the GP may directly request additional diagnostic tests such as a resting electrocardiogram (ECG) or an exercise stress test (ETT), where they have direct access to facilities, before deciding whether to refer the patient to secondary care or to supervise continuing management in the primary care setting. These options however, have important limitations.

Referral to an emergency department (ED) may be viewed as unjustified for non-acute symptoms and junior ED staff may not be sufficiently experienced to make an adequate assessment (Lee, Rouan, Weisberg, Brand, Acampora, Stasiulewicz *et al* 1987).

Waiting lists for outpatient appointments can result in diagnostic delay in patients with possible CAD, delaying diagnosis in some resulting in adverse outcomes (Nilsson, Scheike, Engblom, Karlsson, Molstad, Akerlind *et al*, 2003) and prolonging anxiety in others including those with non-cardiac symptoms. Moreover, further outpatient visits are usually necessary to have investigations performed or to discuss results. This adds to additional diagnostic delay.

The resting ECG, although useful for certain cardiac conditions like arrhythmias and for estimating cardiovascular risk, has a limited role in the diagnosis of angina. It is known that stable angina patients with resting ECG abnormalities are at a greater risk than those with normal ECG, (Hammermeister, DeRouen, Dodge, 1979) but a normal resting ECG (in patients with chest pain of recent onset) cannot exclude either stable or unstable CAD and may be normal in over 90 percent of new angina patients (Sulke, Paul, Taylor, Roberts, Norris, 1991).

Open access ETT has been advocated as a useful method of confirming suspected CAD in the community, but about 80 percent of GPs do not feel sufficiently confident to interpret the results of an ETT and a cardiology

opinion is often needed (McClements, Campbell, Cochrane, Stockman, 1994; Ghandi, Lampe, Wood, 1995b).

Diagnosing the presence of CAD can be difficult in the GP surgery if the patient presents with non-specific symptoms, with only the clinical history and examination to rely on, as ischemic heart disease may have vague symptoms or even be silent (Hedblad, Juul-Moller, Svensson, Hanson, Isacsson, Janzon *et al*, 1989). In one study (Newby, Fox, Flint, Boon, 1998) only about one third of diagnoses of chest pain made in general practice were concordant with the diagnoses made in secondary care where a range of diagnostic measures in addition to specialist experience were available.

A Swedish study (Nilsson, Scheike, Engblom, Karlsson, Molstad, Akerlind *et al, 2003)* in primary care showed that new episodes of chest pain accounted for 1.5% of the total consultations during a 21 month study period. Of these, non-cardiac chest pain was diagnosed in half the patients based on clinical assessment alone, while the other half in whom coronary artery disease(CAD) was suspected needed referral to secondary care either for an exercise stress test (36%) or for emergency admission(12%) with suspected acute coronary syndrome. Further assessment in secondary care excluded CAD in another 30% of patients, 17% of all the chest pain patients had definite or probable angina.

1.5 Emergency department setting

Chest pain is a potentially ominous symptom that provokes anxiety in both doctor and patient and the distinction between cardiac and non-cardiac chest pain can be subtle. A study (Emerson, Russell, Wyatt, Crichton, Pantin, Morgan *et al*, 1989) reported inappropriate discharge of 11.8% of patients with acute ischaemic chest pain who presented to the ED department and an audit of attendances with chest pain found that many such decisions are taken by junior staff without guidance from a more experienced clinician (Fothergill, Hunt, Touquet, 1993). Low thresholds for hospital admission have been adopted and many patients with atypical chest pains are unnecessarily admitted. There is a need to rapidly distinguish patients at higher and lower risk of an acute event and to limit admissions to high risk patients.

1.6 Specialist assessment units: two models

In an attempt to overcome the limitations of conventional referral pathways, rapid assessment units have evolved both in the US and the UK. The focus is on specialist (cardiologist) assessment of chest pain to facilitate the early diagnosis of angina and grading of its severity to inform future treatment and management. The concept of providing a

chest pain assessment service is not new either in the US or the UK, but they vary in their structure and operations.

1.6.1 Chest pain centers (CPC) - US

In the US the first chest pain centre (CPC) was set up in 1981 and the numbers have grown significantly to over 1200. These centres (Graff, Joseph, Andelman, Bahr, DeHart, Espinosa *et al*, 1995) developed as part of a strategy to reduce mortality and morbidity from myocardial infarction. The initial primary aims were to provide rapid thrombolysis and to reduce the rate of inappropriate discharges of missed acute myocardial infarction from the emergency department (Pope, Aufderheide, Ruthazer, Woolard, Feldman, Beshansky, *et al*, 2000). But it was increasingly realised that although management had improved for myocardial infarction, patients with less acute coronary syndromes were at significant risk of adverse outcomes upon discharge (Lee, Rouan, Weisberg, Brand, Acampora, Stasiulewicz *et al,*1987; Tierney, Fitzgerald, McHenry, Roth, Psaty, Stump *et al*, 1986; Rouan, Hedges, Toltzis, Goldstein-Wayne, Brand, Goldman, 1987). In addition about 70 percent of patients admitted to coronary care were discharged with detection of no significant disease (Pozen, D'Agostino, Selker, Sytkowski, Hood, 1984; Bahr, 1997; Bahr, 1995; Tatum, Jesse, Kontos, Nicholson, Schnidt, Roberts *et al*, 1997; Puleo, Meyer, Wathen, Tawa, Wheeler, Hamburg, *et al*, 1994).

As a result of this, the role of these centers has evolved from facilitating rapid treatment of myocardial infarction to evaluating an important subset of patients, who may or may not have angina and who may present with typical, atypical or non-diagnostic symptoms, for whom the conventional management strategies have major shortcomings both in terms of clinical outcomes and economics (Farkouh, Smars, Reeder, Zinsmaster, Evans, Meloy *et al*, 1998; Bahr, Copeland, Strong, 2002). Other studies evaluating the cost of heart attack care claim significant cost savings by reducing hospital admissions for non-cardiac chest pain (Gomez, Anderson, Karagounis, Muhlestein, Mooers, 1996) and it is felt that careful screening allows approximately 80 percent of patients with low to moderate ischemia to be discharged (Graff, Dallara, Ross, Joseph, Itzcovitz, Andelman *et al*, 1997; Gibler, Runyon, Levy, Sayre, Kacich, Hattemer *et al*, 1995). However most cost estimates were limited to inpatient care and with the difference in health care systems, it is unlikely to find similar cost savings in the UK (Goodacre, 2000). The long-term outcome for this group of patients with moderate to low probability of disease discharged from such specialised centers is not known.

1.6.2 Rapid access chest pain clinics - UK

In the UK, the earliest mention of such clinics, now called rapid access chest pain clinic (RACPCs) is from 1976 (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976). In contrast to the CPCs, the RACPCs focus mainly on ambulatory chest pain patients. These clinics potentially provide quick, efficient communication between primary care (GP) and secondary care (hospital) and facilitate rapid assessment of patients with symptoms suggestive of new onset angina by a cardiologist. They are a form of outpatient clinic and do not encourage referral of patients with suspected myocardial infarction or unstable angina, which require emergency treatment and hospital admission. First established to support epidemiological research, (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976; Gandhi, Lampe, Wood, 1995a) their potential to improve cardiac services was recognised and found expression in the national service framework (NSF) for coronary heart disease(CHD) (Department of Health, 2000). In March 2000, the NSF for CHD, the blueprint for action to reduce incidence of CHD, was published and the RACPCs were designated as the service model of choice. These clinics received official backing and a financial boost with the NSF and the immediate priority was to set up 50 RACPCs by April 2001, another 50 by April 2002, with a nationwide roll-out thereafter. Such was the uptake of this service that it outpaced policy and there were more than 175 such clinics by January 2003. Now every acute trust in the UK has an RACPC (The National Service Framework for Coronary Heart Disease, 2004).

1.7 Aims, potential advantages and disadvantages of RACPCs

The RACPC is a service primarily 'to help ensure that people who develop new symptoms that their GP thinks might be due to angina can be assessed by a specialist within two weeks of referral' (Department of Health, 2000). The clinic has several aims listed below.

- To establish rapid 'same-day' referral and discharge policy. If not 'same-day' then to ensure that the waiting time for appointment does not exceed the set '14 day' target.
- To provide a diagnosis with risk stratification, treatment and follow up plan.
- Thus, by implication, optimising the use of hospitalisation for appropriate patients for example, those with acute coronary syndromes.

1.7.1 Potential advantages of RACPCs

- RACPCs provide a specialist cardiology opinion to help identify patients with CAD and their categorisation into three groups. Those at high risk may need immediate hospitalisation, those with intermediate risk may not need to be admitted, but require outpatient treatment, while those at low risk of having significant CAD may benefit from general lifestyle advice, and therapy to modify reversible risk factors. By implication, RACPCs reduce hospitalisation of patients with non-cardiac chest pain and provide re-assurance for them (Davie, Caesar,Caruana, Clegg, Spiller, Capewell *et al*, 1998).
- RACPCs are a good setting for initiation of secondary prevention with drug therapies: aspirin, statins, angiotensin enzyme inhibitors, beta blockers.
- The 'one-stop' element of the RACPCs is particularly helpful for older people or those with reduced mobility, who may find repeat visits to the hospital difficult. It also helps prevent administrative and communication delays.
- Maintenance of a computerised database facilitates audit and research, ensures uniformity of approach in assessment of every patient and improves communication between primary and secondary care (Ray, Archbold, Preston, Ranjadaylan, Suliman, Timmis, 1998).

1.7.2 Potential disadvantages of RACPCs

- Patients with acute coronary syndromes may get referred, causing potential delay in their emergency management.
- There is potential for inappropriate referrals of patients with other cardiac disorders such as arrhythmias and valve abnormalities, of patients with clinically obvious non-cardiac chest pain. The service may be seen as a shortcut for an expert opinion to avoid long outpatient waiting lists, in particular for patients already diagnosed with CAD. In an ideal world these patients would have recourse to rapid medical attention but at present the clinics do not have the resources to fulfil that need.

1.8 Review of literature on RACPC

A recently conducted systematic review on the evidence for rapid access chest pain clinic was identified (Mant, McManus, Oakes, Delaney, Barton, Deeks *et al*, 2004) and was supplemented by citation tracking of the key papers. Ten studies have so far been identified, all of which are more descriptive than evaluative in nature.

1.8.1 What do we know from previous research?

These studies have recruited 90 to 1001 patients for assessment of chest pain and importantly all have confirmed the feasibility of this approach to outpatient care. The clinics differed in their set-up according to the available resources and were staffed by either cardiologists or cardiology registrars. All but two of these clinics saw patients within 24 hours of referral (other than weekends or bank holidays). One (McGavigan, Begley, Moncrieff, Hogg, Dunn, 2003) saw patients by appointment but had difficulty keeping to the 14 day target and the other (Byrne, Murdoch, Morrison, McMurray, 2002) audited attendances at both a weekly and a daily clinic. The daily clinic had more referrals for patients with acute coronary symptoms and those with low risk/non-coronary chest pain compared with the weekly clinic, which had more patients with stable coronary diseases referred to it, despite a similar set of referral guidelines. All clinics discouraged referral of patients with suspected acute coronary syndrome except for one, (Norell, Lythall, Coghlan, Cheng, Kushwaha, Swan *et al*, 1992) where the exclusion criteria were not clearly specified.

A resting 12 lead ECG was done on all patients but the rate of exercise stress testing (ETT) varied, from 7 to 58 percent depending on the group of patients being studied. For instance, in one study ETT was performed on all possible patients with angina, (Ghandi, Lampe, Wood, 1995) while another exercised patients only if there was a doubt in diagnosis (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976). Four studies made comparison with control groups (Newby, Fox, Flint, Boon, 1998; McGavigan, Begley, Moncrieff, Hogg, Dunn, 2003; el Gaylani, Weston, Shandall, Penny, Buchalter, 1997; O'Toole and Channer, 1995) none of which were randomised.

An important finding of these studies was that treatment strategies for angina patients should be introduced promptly, as most adverse events (CHD related death, non-fatal MI) occur within six months of diagnosis (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976; Ghandi, Lampe, Wood, 1995; Davie, Caesar,Caruana, Clegg, Spiller, Capewell *et al*, 1998). Two studies (Newby, Fox, Flint, Boon, 1998; el Gaylani, Weston, Shandall, Penny, Buchalter, 1997) suggested that these clinics may reduce unnecessary admissions, comparing the clinic diagnosis with the respective GP's hypothetical plan for further management had the clinic not existed. Only four studies (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976; Ghandi, Lampe, Wood, 1995; Davie, Caesar,Caruana, Clegg, Spiller, Capewell *et al*, 1998; Byrne, Murdoch, Morrison, McMurray, 2002) provided follow-up data but numbers were small (616,110,278,633) follow-up short (6 to16 months) and recruitment in one of these studies was limited to men aged less than 70 years (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976) and in

another (Ghandi, Lampe, Wood, 1995) to men and women aged 70 or less identified with typical angina in the clinic, without reference to those with non-cardiac pain.

1.8.2 What is not known about RACPCs? The prognosis of angina and non-cardiac chest pain

The 'one-stop' clinic concept is not new and is appealing, but we do not know the reliability of a single specialist assessment of patients with chest pain to distinguish between those whose pain is due to significant heart disease and those who have another cause, not requiring further cardiological management. There is a large body of evidence about long-term outcomes in patients admitted with acute coronary syndrome but little is known about the contemporary prognosis of stable angina or non-cardiac chest pain, particularly in the setting of RACPCs. Past studies (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976; Ghandi, Lampe, Wood, 1995; Davie, Caesar,Caruana, Clegg, Spiller, Capewell *et al*, 1998) had low event rates and insufficient power to test the differences in outcomes between different groups of patients. Most current data are from drug trials based on secondary and tertiary care population and is thus prone to selection bias. Studies (el Gaylani, Western, Shandall, Penny, Buchalter, 1997; Eslick, Coulshed, 2002) have suggested that patients with non-cardiac chest pain may not have as benign an outcome as is commonly believed. This has raised concern about the outcome of patients diagnosed with non-cardiac chest pain in one-stop clinics, where 60 to 70 per cent of patients emerge with this diagnosis (Sutcliffe, Steven, de Belder, Kumar, Fox, Wood *et al*, 2002). Despite the proliferation of these clinics, the assumption that RACPCs effectively distinguish between cardiac and non-cardiac origins of chest pain allowing early identification and management of high risk patients has not been tested.

Mant and colleagues concluded (Mant, McManus, Oakes, Delaney, Barton, Deeks *et al*, 2004) that there was little evidence in the available literature about the impact of RACPC for reducing inappropriate hospital admissions with chest pain and in a broader sense about the effectiveness of these clinics. The comparative groups in their study were hypothetical and no data prior to the introduction of the RACPC were available.

There are not enough data to assess the effect of RACPCs on already stretched revascularisation services and routine cardiology outpatient work. Norell *et al* (Norell, Lythall, Coghlan, Cheng, Kushwaha, Swan *et al*, 1992) concluded from their experience that referral for coronary angiogram or angioplasty from their RACPC accounted for almost five percent of the annual catheter laboratory workload.

Another important aspect of health service provision is to ensure equity of access to the services. Despite provision of a service, if it is not accessible by all potential beneficiaries, outcomes will be suboptimal. Studies (Chaturvedi, Rai, Shlomo, 1997; Dong, Shlomo, Colhoun, Chaturvedi, 1998; Richards, Reid, Watt, 2002; Gardner, Chapple, Green, 1999) have shown inequities exist with reduced access to cardiac services for some ethnic minority groups, women and older people. Barriers to access may start with the patient and may include language, culture, socio-economic status (SES) and health seeking behaviour. A questionnaire survey (Adamson, Shlomo, Chaturvedi, Donovan, 2003) with two clinical vignettes relating to 'chest pain' and 'lump in the armpit' to determine patients' response in seeking immediate medical opinion found no inequalities in patients self reporting to primary care or ED by ethnicity, SES or gender. Another study found that older people had low expectations of treatment, were less informed about the latest advances, feared hospitals and saw doctors as busy (Gardner, Chapple, Green, 1999). Barakat *et al* (Barakat, Wells, Ramdhany, Mills, Timmis, 2003) showed that both Bangladeshi and white patients recognised symptoms of MI and attended the ED in time, but initiation of treatment was delayed in the ethnic group who had more atypical features. Socio-economic status has for long been known as a confounder for CAD (Sundquist, Malmstrom, Johansson, 2004; Hemingway, Shipley, Macfarlane, Marmot, 2000). As yet there is no information about the ability of RACPCs to deliver appropriate and equitable investigation and treatment in vulnerable groups particularly those with poor socio-economic status, females, certain ethnic groups and older people.

1.8.3 Further research to fill the gaps in knowledge

Variation in the design of these clinics across the country makes data collection difficult. The rapid proliferation of these clinics has outpaced policy decisions and it is too late to carry out randomised controlled trials to address questions about clinical outcomes in patients with angina or with non-cardiac chest pain, equity of access by age, gender, ethnicity and SES and the impact of this service on other cardiology services. Our solution was a cohort study which would provide answers to some of the questions outlined above. Prospective data on mortality and morbidity would roughly estimate accuracy of the clinic diagnosis, risk stratification and prognosis in the angina and non-cardiac chest pain groups but not completely address issues of effectiveness in the absence of a comparative group. The biggest advantage of carrying out this cohort study is that consecutive patients attending the clinic have already been recruited. However the time lapse to outcome measurement in a rapidly advancing medical specialty means that it does not completely represent current clinical practice, but remains contemporary nevertheless.

1.8.4 Aims and objectives of our study

Although there has been widespread proliferation of RACPCs, outstanding questions about effectiveness of these clinics regarding prognosis, equity of access by age, gender, ethnicity and SES, impact on other cardiology outpatient services, differences in models of care, remain. The aims and objectives of this study are outlined below.

Aim 1 To determine whether RACPCs are appropriately targeted towards patients with chest pain of cardiac origin.

Aim 2 To analyse populations using RACPCs, equity of access to the clinics and subsequent cardiac procedures (exercise stress tests and coronary angiography) and their appropriateness.

Aim 3 To compare different models of care across the participating centres.

Aim 4 To determine whether RACPC act in addition to, or as a substitute for, other services.

1.9 Objectives

1.10.1 Aim1: appropriate targeting and outcome

a) Determine contemporary prognosis for patients with cardiac chest pain.

b) Measure potential differences in outcomes between patients diagnosed with cardiac and non-cardiac chest pain.

c) Relate the quantitative probability of coronary artery disease (calculated prospectively according to a simple algorithm based on age, gender and typicality of symptoms) to outcomes.

d) Identify additional baseline clinical variables that may predict outcome.

1.9.2 Aim2: populations using RACPCs and equitable access to tertiary investigation and intervention

a) Characterise the populations using RACPCs

b) Analyse variation in access to rapid access chest pain clinics by age, gender, ethnicity and deprivation.

c) Analyse rates of referral to exercise stress testing and angiography in relation to age, gender, ethnicity and deprivation.

d) Analyse the appropriateness of cardiac investigation in RACPCs by applying appropriateness ratings validated in a previous study to answer questions of over and under-use in different population subgroups (by age, gender, ethnicity and deprivation).

e) Compare rates of referral of patients with chest pain to cardiology outpatients and a RACPC by age, gender and ethnicity.

1.9.3 Aim 3: models of care in RACPCs

a) Questionnaire survey of RACPCs - cross sectional survey of rapid access chest pain clinics as a prologue to detailed interview of the six participating centres.

b) Compare waiting times in different participating centres.

c) Conduct structured personal interviews: descriptive analysis assessing the role of doctors and nurses, methods of working and set-up of service in different participating centres.

1.9.4 Aim 4: addition or substitution of services

To achieve this aim (and objective 2e) a prospective sub-study was planned, comparing patients attending the RACPC at Newham with those attending the weekly cardiology outpatient clinic for assessment of chest pain.

a) Measure proportions of patients with chest pain who are referred to the regular outpatients clinic and to the RACPC.

b) Analyse the distributions of cardiac versus non-cardiac chest pain in cardiology outpatients and the RACPC.

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Section 2 Centre selection, ethical approval, data collection

2.1 Multi-centre setting of this study

The RACPC at Newham General Hospital (now University Hospital) in East London was established in January 1996. It was one of the first nationally and four years later became the service model for the NSF (Department of Health, 2000). At the time the RACPC was established, an electronic database was developed in which registry baseline data on consecutive patients' attendances were recorded. The success of the database led to its utilisation in five other RACPCs around the country, all of which have recorded data in identical fields to those used at Newham. Registry data on a total of 11,082 (n=448 revisits) patients was available, representing a unique resource for evaluating RACPCs in a variety of hospital settings.

The participating centres:

- Newham General Hospital, London (now Newham University Hospital)
- Oldchurch Hospital, Romford, Essex
- Manchester Royal Infirmary, Central Manchester (MRI)
- Blackburn Royal Infirmary (BRI), Blackburn
- Burnley general Hospital, Blackburn
- Kingston General Hospital, Kingston-upon-Thames.

Figure 3: Geographical location of the six study centres

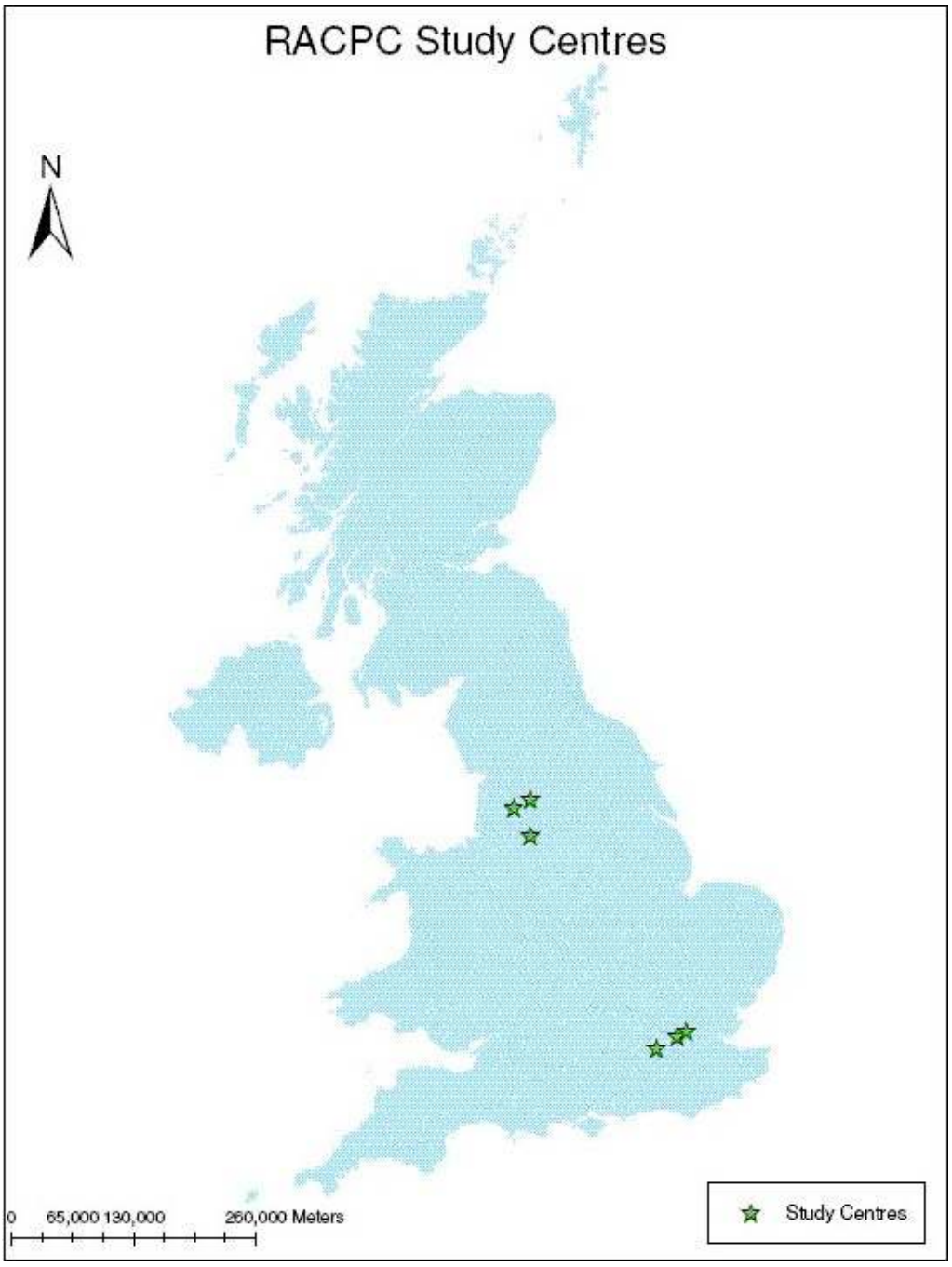


Table 2: Participating centres

Hospital	*Number of patients*	*Date clinic started*	*Clinics per week*	*Patients per clinic*	*Initial patient contact*	*Waiting time (days)*	
						past	**present**
Newham	**5385**	**2/1/96**	**5**	**varies**	**doctor**	**0**	**0**
Oldchurch	**2699**	**3/4/00**	**4**	**6**	**doctor**	**9**	**≤ 14**
Manchester	**755**	**29/11/00**	**3**	**8**	**doctor**	**14**	**≤14**
Blackburn	**681**	**28/11/00**	**2**	**5**	**nurse**	**> 14**	**≤ 14**
Burnley	**476**	**26/3/01**	**2**	**5**	**Doctor & nurse**	**35 days**	**22-28**
Kingston	**638**	**28/6/01**	**2**	**3-5**	**Doctor (now nurse)**	**14 days**	**14 days**

2.2 Ethical approval and sources of external data

The initial plan for the study involved just one centre, namely Newham General Hospital for which LREC approval was obtained in April 2002.

To make the findings more generalisable in the context of the SDO funded study, five other centres were identified based on availability of similar registry datasets. All agreed to collaborate by sharing data on their rapid access chest pain clinic databases.

We aimed to get multi-centre research ethical committee approval before the start of our grant in February 2002

2.2.1 Multi-centre Research Ethics Committee (MREC)

The application was submitted for MREC approval in September 2002 and the earliest available date for consideration was the 7 November 2002 by the Trent MREC. The reply by the Trent MREC was favourable but ethical approval was conditional to getting approval by the Patient Information Advisory group (PIAG) as the research involved use of identifiable patient data without patient consent. The final MREC approval was obtained in September 2003 (ref number MREC/02/4/095).

2.2.2 Patient Information Advisory group (PIAG)

This Patient Information Advisory Group (www.advisorybodies.doh.gov.uk/piag) was established to provide advice on issues of national significance involving the use of patient information and to oversee arrangements created under Section 60 of the Health and Social Care Act 2001. This act ensures that patient identifiable information needed to support essential NHS activity can be used without the consent of patients in the wider public interest. It is intended largely as a transitional measure while consent or anonymisation procedures are developed. The application was submitted to PIAG on 13 February 2003. This being the first application of our group to a relatively new body, satisfying all criteria took an exceedingly long time and final approval was obtained in August 2003.

2.2.3 Office for National Statistics (ONS)

Application to the Office for National Statistics (www.bized.ac.uk) for flagging patients for mortality data was sent in August 2003 and approval was obtained in October 2003, following which contact was made with the ONS office in Southport to make available mortality data.

2.2.4 NHS-wide clearing system (NWCS)

Application was submitted to the NWCS (www.connectingforhealth.nhs.uk/nwcs/) to obtain morbidity data in March 2004 while awaiting a list of NHS numbers for all the patients in the cohort being supplied by the ONS. NWCS approval to process the information was confirmed in April 2004 but the first part of the data was made available only by July and in intervals thereafter. After a process of cleaning, it was available for analysis by September 2004.

2.2.5 Mortality data for CHD at ward level by (ONS)

Data for death due to CHD (ICD 10 I20-I25) by age and gender were obtained for each ward for the years 2000 to 2003 from the Office for National statistics (ONS) (www.bized.ac.uk). The ward mortality data was adjusted to conform to PCT boundary changes in 2002. This was available by October 2004.

2.2.6 Deprivation score

The Townsend index of deprivation was used which has been calculated using census 2001 variables of the percentage of unemployed, percentage with no car, percentage not owner occupier and percentage of overcrowding. This was made available by the South West Public Health Observatory in October 2004.

Table 3: Gantt chart showing reasons for delay in start of the study

Events till December 2003	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
SDO confirms grant – 4 Sep 2002 MREC application submitted – 13 Sep 2002																
TRENT MREC review – 7 Nov 2002 TRENT MREC reply – 19 Nov 2002 requesting PIAG approval & clarifications																
TRENT MREC response – 18 Dec 2002 giving conditional approval pending PIAG approval *Meeting with the SDO in Dec 2002 – extending cohort till 31.12.2002.*																
PIAG application submitted – 13 Feb 2003 PIAG meeting held on - 25 Mar 2003 Reply from PIAG requesting additional info on data security – 8 May 2003 Response to PIAG queries by us 23 May 2003 Further queries from PIAG – 26 Jun 2003 *Continuous flow of email correspondence regarding clarifications* Reply to PIAG sent on 17 Jul 2003																
Final approval for section 60 by PIAG received on 19 Aug 2003																
Application to ONS submitted on the 22 Aug 2003																
ONS approval obtained on the 2 October 2003 and data processing begun																

2.3 Database

2.3.1 Baseline data collection

In all participating centres, baseline data for the first clinic visit have been systematically collected on an identical electronic database. The following information is available.

- *Demographic data* including age, sex, ethnic group, full postcode.
- *Clinical history* including duration of symptoms, risk factors (family history, diabetes, smoking, hypertension, hypercholesterolaemia), previous coronary events - Myocardial infarction (MI) unstable angina (UA), revascularisation procedures-percutaneous transluminal coronary angioplasty (PTCA), coronary artery bypass graft (CABG), pre-coded descriptors of chest pain (location, radiation, provocation, quality, duration) and any associated symptoms (dyspnoea, dizziness, palpitations and their combinations).
- *Physical findings including* pulse rate, systolic and diastolic blood pressure, presence of peripheral pulses and arterial bruits, auscultatory findings (murmurs, added sounds), signs of heart failure.
- *Results of cardiac investigations* including ECG (rhythm, axis, bundle branch block, AV block, Q waves, ST segment changes), stress testing (reasons for doing/not doing test, symptom limiting exercise, result) the chest x-ray (heart size, lung fields).
- *Details of diagnosis* including the probability of coronary artery disease automatically calculated from a pre-programmed algorithm, the dose and timing of all cardiac drugs and disposal information.
- *Uniformity and completeness of data* within the database (used by all participating centres in this study) by selecting categorical variables from drop-down menus ensures uniformity of data entry. Because the computerised report for submission to the GP is not generated unless entries are made into all relevant fields, (Ray, Archbold, Preston, Ranjadayalan, Suliman, Timmis, 1998) the data were 95 percent complete from all centres.

2.3.2 Data management

All data was received by the database manager and master copies stored at Westminster PCT. The clinical coding of the data was carried out by the investigators and it was linked with the anonymised database for the purpose of the analysis and copies given to the research fellow and the statisticians.

Section 3 AIM 1: Are RACPCs appropriately targeted towards patients with chest pain of cardiac origin?

3.1 Objectives

(1a) Determine contemporary prognosis for patients with cardiac chest pain.

(1b) Measure potential differences in outcomes between patients diagnosed with cardiac and non-cardiac chest pain.

(1c) Relate the quantitative probability of coronary artery disease (calculated prospectively according to a simple algorithm based on age, gender and typicality of symptoms) to outcomes.

(1d) Identify additional baseline clinical variables that may predict outcome.

(1a) Determine contemporary prognosis for patients with cardiac chest pain.

(1b) Measure potential differences in outcomes between patients diagnosed with cardiac and non-cardiac chest pain.

3.2 Introduction (objective 1a &1b)

Angina is the most common initial manifestation of coronary heart disease (Kannel, Feinleib, 1972; Sutcliffe, Fox, Wood, Stock, Wright *et al*, 2003; Kentsch, Rodemerk, Gitt, Schiele, Wienbergen, Schubert *et al*, 2003) and accounts for an estimated one percent of annual health expenditure in the UK (Stewart, Murphey, Walker, McGuire, McMurray, 2003). The incidence of angina is increasing, judged by presentation in primary care (The Office of Population Census and Surveys and The Department of Health, 1995), and its early diagnosis and treatment has become a priority for prevention of myocardial infarction and coronary death. Rapid access chest pain clinics (RACPCs) are available in most UK centres (The National Service Framework for Coronary Heart Disease, 2004) and in the United States chest pain assessment units (CPAUs) have extended their role to include diagnosis and treatment of stable chest pain syndromes (Farkouh, Smars, Reeder, Zinsmeister, Evans, Meloy *et al*, 1998; Bahr, Copeland, Strong, 2002).

A key assumption underpinning the development of CPAUs and RACPCs is that one-stop cardiological assessment can successfully separate patients with stable chest pain into those with and without angina. This assumption is unproven and the extent to which the differential diagnosis accurately predicts risk is not known. Based on selected patients recruited to a randomised trial, it has been claimed that cardiovascular risk in patients with stable angina has been reduced to 'normal levels' with contemporary therapy (Pitt, 2004). The external validity of trial outcomes is hard to gauge in the absence of large multi-centre registries which define long-term outcomes for consecutive patients with angina (Rothwell, 2005). Recruiting consecutive patients into registries provides a less biased estimate of prognosis than that provided by 'voluntary' registries (Terkelsen, Lassen, Norgaard, Gerdes, Jensen, Gotzsche *et al*, 2005). Registries in acute coronary syndromes (Fox, 2004), heart failure (Ezekowitz, McAlister, Armstrong, 2003) and non-cardiovascular disorders (SEER, 1973) may play an important role in the interpretation of randomised trials, but there are no large registries of patients from initial presentation with angina. Previous observational studies are limited by small size (accruing less than 20 events on follow up) (Ghandi, Lampe, Wood, 1995), lack of women (Spertus, Jones, McDonell, Fan, Fihn, 2002), and recruitment antedating the recent trials (Orencia, Bailey, Yawn, Kottke, 1993).

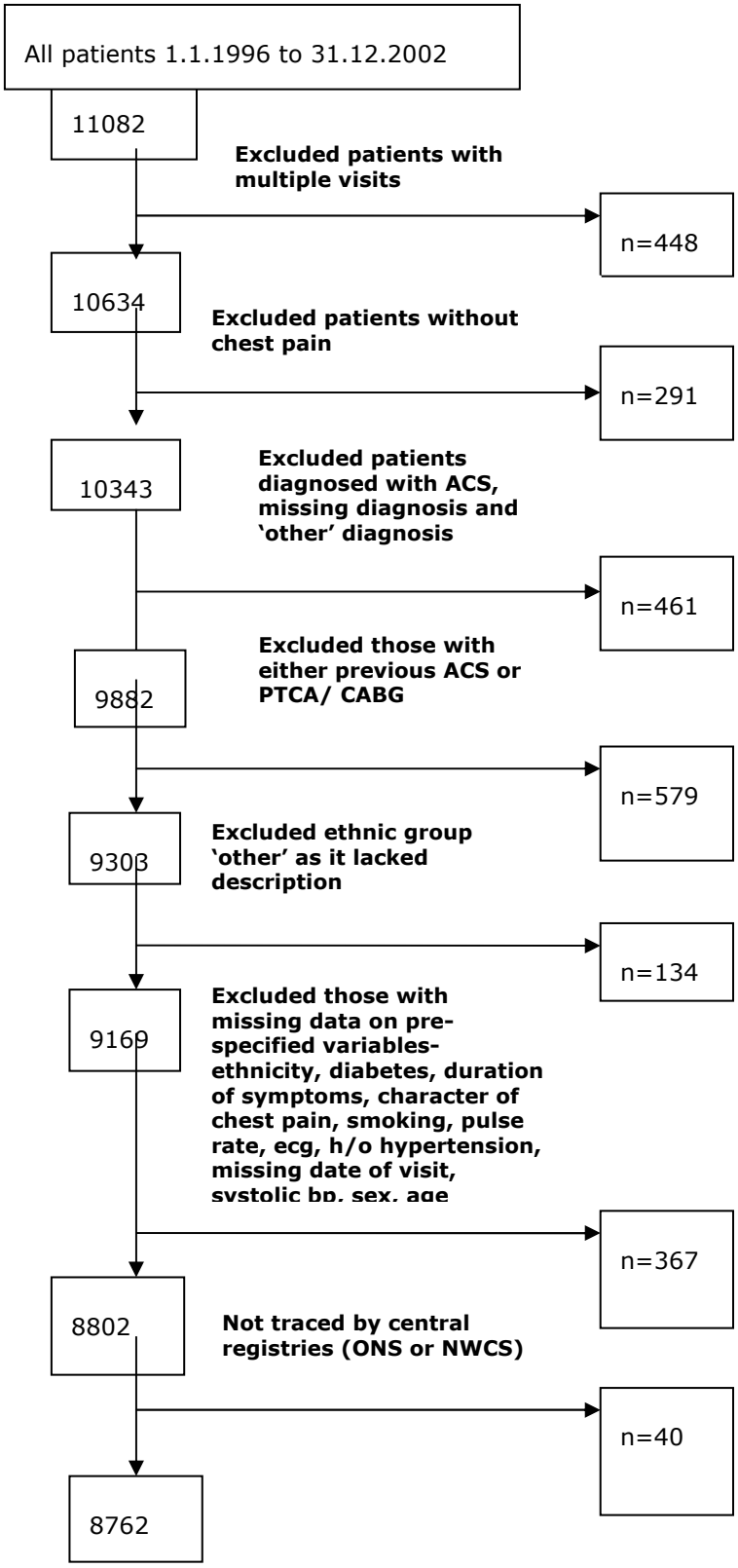
We report the prognosis of a large cohort of patients referred from primary care for rapid assessment of previously undiagnosed chest pain. Our objectives were to compare the prognosis of patients diagnosed with angina with (i) those diagnosed with non-cardiac chest pain, in order to assess the predictive validity of the diagnosis, (ii) mortality rates in the general population, in order to assess the claim that cardiovascular risk has been returned to normal, (iii) mortality and event rates in recent clinical trials in order to gauge their applicability.

3.3 Methods (objective 1a &1b)

Patients Figure 3 – Consecutive patients attending six rapid access chest pain clinics in which cardiological consultation was provided within two weeks of referral from primary care according to the imperatives of the UK national service framework for coronary heart disease (Department of Health, 2000). The purpose of the clinics was to identify patients with angina in order to initiate appropriate treatment, including secondary prevention with aspirin and beta-blockers, and to arrange cholesterol measurement with a view to statin therapy, according to contemporary guidelines (Joint British recommendations on prevention of coronary heart disease in clinical practice, 1998). Data on 11,082 patients were electronically recorded from 2 January 1996 to 31 December 2002 using

identical databases, details of which have been reported previously (Ray, Archbold, Preston, Ranjadalan, Suliman, Timmis, 1998). We excluded re-attendances during the study period (n=448), patients without chest pain (n=291), patients diagnosed with acute coronary syndromes (n=246), patients who reported previously diagnosed coronary heart disease (CHD) or revascularization procedure (n=579), patients for whom a diagnosis was either not entered (n=132) or not identified as angina or non-cardiac chest pain (n=83), those with undefined ethnic group (n=134), patients with missing data (n=367), and those who were not traced by the Office for National Statistics (ONS) (www.bized.ac.uk) or the NHS-wide clearing system (NWCS) (n=40) (www.connectingforhealth.nhs.uk/nwcs/). The remaining 8762 patients with complete data and follow up constituted the study group.

Figure 4: Study population for Aim 1



3.3.1 Data collection

Clinical data included age, sex, ethnicity, duration of symptoms, character of chest pain, smoking status, history of hypertension, diabetes, pulse rate, systolic blood pressure, drugs and follow-up plan on discharge. Twelve lead resting electrocardiograms (ECGs) were recorded as normal or abnormal respectively depending on assessment of rhythm, conduction and the absence or presence of regional ST segment or T wave changes, left ventricular hypertrophy and Q waves. Exercise ECG treadmill tests were performed at the discretion of clinicians in 58 percent of patients. Diagnosis of the cause of chest pain (angina or non-cardiac chest pain) was recorded by the clinician at the end of the consultation.

3.3.2 Follow-up

Patients were flagged for mortality with the ONS (to 25/04/2004), and for hospital admissions and procedures with NWCS (to 23/12/2003). Successful matching was achieved in 99.5 percent of the cohort. Causes of death were defined by the World Health Organisation international classification of diseases (ICD 10 codes). Among patients undergoing hospital admission during the follow-up period, the primary discharge diagnosis was used to define events.

3.3.3 Definition of endpoints

The primary endpoint was death due to coronary heart disease (ICD10 I20-I25) or non-fatal myocardial infarction (ICD10 I21-I23). Secondary endpoints were cardiovascular death (ICD10 I00-I99) or non-fatal myocardial infarction or non-fatal stroke (I60-I69), all cause mortality, and hospital admission with unstable angina (ICD I20, I24.0, I24.8, I24.9).

3.3.4 Clinical trials

We searched the National Library of Medicine with PubMed (search terms: randomised controlled trial, angina, stable coronary artery disease) and performed citation tracking to identify angina trials that recruited during the same period as our study (1996 onwards) and reported fatal and non-fatal coronary endpoints. We only included trials in which greater than 50 percent of participants had angina. We compared the annual rate of endpoints (expressed as total rate divided by years of follow-up) with the annual rate for the angina group in our cohort.

3.3.5 Statistical analysis

Patients with angina and non-cardiac chest pain were compared using chi square and t-tests for proportions and distributions, respectively. We calculated Kaplan-Meier product limits for the cumulative probability of reaching an endpoint and used the log rank test for evidence of a statistically significant difference between the groups. Time was measured from the first clinic visit to the outcome of interest. Cox regression was used to estimate hazard ratios for the effect of angina on outcome in age-adjusted and fully adjusted models, based on covariates associated ($p<0.05$) with the outcome of interest.

3.3.6 Standardised mortality ratios (SMRs)

SMRs for all-cause mortality were calculated for each year of the study taking into account the exact time each patient was in the study and using one year age bands. The reference death rates were for England for the same year, except for 2003 and 2004 where the death rates were not available and 2002 death rates were used. The reference death rates for CHD death and other disease groups are given in 10 year age blocks, so we used linear interpolation to derive death rates for each year of age. SMRs for CHD and other disease groups were calculated using the same method as for all cause mortality.

3.4 Results (Objective 1a &1b)

3.4.1 Patients (Table 4)

Patients diagnosed with angina were older and more likely to be male than patients diagnosed with non-cardiac chest pain. Diabetes and hypertension, but not smoking, were recorded more frequently in patients with angina. Patients with angina were more likely to have cholesterol measurement recommended and to receive treatment with aspirin, beta-blockers and statins. There were 58 percent of patients with angina who were referred for further outpatient cardiological assessment, with a total of 35 percent undergoing angiography during follow-up, of whom 43 percent had a revascularisation procedure. After a single clinic attendance, 89 percent of patients diagnosed with non-cardiac chest pain were referred back to their primary care physician.

3.4.2 Prognosis of angina versus non-cardiac chest pain (Figure 5)

During a median follow-up of 2.57 (interquartile range 1.96-4.15) years, all outcomes were more frequent for patients with angina compared with patients with non-cardiac chest pain. The annual rates of coronary death and non-fatal myocardial infarction were 2.3% (95% CI 1.9-2.7%) in patients with angina versus 0.4% (95% CI 0.3-0.5%) in patients with non-cardiac chest pain. Cumulative probabilities of these events at three years were 4.84% (95% CI 3.92-5.96) in patients with angina versus 0.90% (95% CI 0.67-1.23) in patients with non-cardiac chest pain. Cumulative probabilities for cardiovascular death or non-fatal myocardial infarction or stroke were 7.42% (95% CI 6.29-8.74) versus 1.69% (95% CI 1.36-2.10), respectively, and for hospital admission with unstable angina were 13.0% (95% CI 11.5-14.62) versus 2.11% (95% CI 1.73-2.58), respectively. These associations persisted after multivariate adjustment. In the 501 patients with missing baseline data, rates of coronary death and non-fatal myocardial infarction were not significantly different from the main cohort. (Figure 4)

3.4.3 Predictive accuracy of diagnosis for the primary endpoint

Of the 203 patients with coronary death or non-fatal myocardial infarction, 72 (36 percent) had been diagnosed with non-cardiac chest pain. Compared with patients with angina who reached the primary endpoint, those with non-cardiac chest pain were younger, less likely to have typical symptoms, more likely to be south Asian and more likely to have a normal resting ECG.

3.4.4 Comparison with the general population

Angina among patients aged less than 65 years was associated with an increased rate of all-cause death (SMRs of 1.83 (95% CI 1.26-2.39) in men and 1.78 (95% CI 1.00-2.56) in women) and coronary death (SMRs of 3.52 (95% CI 1.98-5.07) in men and 4.39 (95% CI 1.14-7.64) in women). Angina in older patients was not associated with increased all cause mortality, but remained associated with an increased risk of coronary mortality. The coronary SMRs for non-cardiac chest pain among patients under 65 years were 1.15 (95% CI 0.57-1.73) in men and 1.96 (95% CI 0.68-3.24) in women.

3.4.5 Comparison with clinical trials (Table 8)

We found no trials among patients with new angina as the first manifestation of coronary disease. We identified four randomised trials recruiting patients with angina meeting our eligibility criteria: PEACE (Braunwald, Domanski, Fowler, Geller, Gersh, Hsia *et al*, 2004), ACTION (Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin *et al*, 2004), IONA (Lancet, 2002), TNT (Larosa, Grundy, Waters, Shear, Barter, Fruchart *et al*, 2005). The majority of participants in each trial had a history of myocardial infarction or coronary revascularisation. Despite this, annual rates of coronary death and non-fatal myocardial infarction, cardiovascular mortality, and all cause mortality were consistently higher in our patients with angina than in PEACE (Braunwald, Domanski, Fowler, Geller, Gersh, Hsia *et al*, 2004), ACTION (Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin *et al*, 2004),and TNT (Larosa, Grundy, Waters, Shear, Barter, Fruchart *et al*, 2005). All cause mortality was only slightly lower than in IONA (Lancet, 2002) which selected high risk patients based on older age, high rate of previous infarction, and abnormal exercise ECG in the presence of major additional risk factors, including impaired left ventricular function or left ventricular hypertrophy.

Table 4: Baseline characteristics of the cohort n=8762

	Angina group n=2366		Non-cardiac group n=6396	
	With 1º endpoint * n=131 (6%)	without 1º endpoint* (94%)	With 1º endpoint* n=72 (1%)	without 1º endpoint* (99%)
		n=2235		n=6324
Age (years)	67 (±11)	62(±11)	58(±13)	51 (± 12)
Males	91 (70%)	1263 (57%)	49 (68%)	3191(51%)
Ethnicity				
White	103 (79%)	1707 (76%)	36 (50%)	3939 (62%)
South Asian	26 (20%)	435 (20%)	32 (44%)	1746 (28%)
Black	2 (1.5%)	93 (4%)	4 (6%)	639 (10%)
Risk Factor				
Current smoker	33 (25%)	510 (23%)	23 (32%)	1529 (24%)
Hypertension	64 (49%)	1050 (47%)	32 (4%)	1899 (30%)
Diabetes	31 (24%)	362 (16%)	13 (18%)	512 (8%)
Duration of chest pain				
< 4 weeks	53 (41%)	881 (39%)	40 (56%)	3220 (51%)
1 to <=6 months	52 (40%)	872 (39%)	21 (29%)	2007 (32%)
>6 to12 months	11 (8%)	155 (7%)	3 (4%)	324 (5%)
> 1 year	15 (11%)	327 (15%)	8 (11%)	773 (12%)
Character of chest pain				
Typical	97 (74%)	1597 (72%)	7 (10%)	301 (5%)
Atypical	33 (25%)	629 (28%)	45 (63%)	4372 (69%)
Nonspecific	1 (1%)	9 (0.4%)	20 (27%)	1651 (26%)
Resting Electrocardiogram				
Normal	59 (45%)	1456 (65%)	55 (76%)	5721 (90%)
Abnormal	72 (55%)	779 (35%)	17 (24%)	603 (10%)
Exercise treadmill test				
Positive	49 (37%)	817 (37%)	0 (0%)	891 (10%)
Non-diagnostic	8 (6%)	237 (11%)	3 (4%)	117 (2%)
Negative	16 (12%)	453 (20%)	36 (50%)	3320 (53%)
Not done-not indicated	1 (1%)	35 (2%)	25 (35%)	2256 (36%)
Not done- other reason	57 (44%)	693 (31%)	8 (11%)	605 (10%)
Systolic blood pressure (mm Hg)	148(±22)	147 (±21)	145 (±25)	138 (±20)
heart rate (beats per minute)	79 (±13)	76 (±12)	78 (±12)	77 (±12)
	110 (84%)	1887 (84%)	10 (14%)	630 (10%)
Medication on discharge	69 (53%)	1204 (54%)	9 (13%)	483 (8%)
Aspirin	32 (24%)	628 (28%)	2 (3%)	407 (6%)
Beta blockers	86 (92%)	1403 (89%)	46 (73%)	3387 (65%)
Statin				
Cholesterol measured ‡	0 (0%)	0 (0%)	1 (1%)	12 (0.2%)
Disposal †	72 (57%)	1288 (58%)	9 (13%)	690 (11%)
Admitted	32 (25%)	536 (24%)	0 (0%)	2 (0.03%)
Cardiac Outpatients	23 (18%)	386 (18%)	61 (86%)	5577 (89%)
Angiography				
Discharged to Primary care	52 (40%)	772 (35%)	20 (28%)	135 (2%)
Intervention	13 (10%)	189 (9%)	16 (22%)	17 (0.3%)
Angiogram	25 (19%)	204 (9%)	7 (10%)	13 (0.2%)
PTCA	37 (28%)	382 (17%)	22 (31%)	30 (0.5%)
CABG				
PTCA/ CABG				

1º (Primary) endpoint= death due to coronary heart disease + nonfatal MI Data are number of patients (%); age, systolic blood pressure, pulse = mean (±SD) † Data available for 8689 patients ‡ % of patients not prescribed a statin but in whom cholesterol check was recommended. (Data available for 7810 patients)

Table 5: Number of events (n=8762)

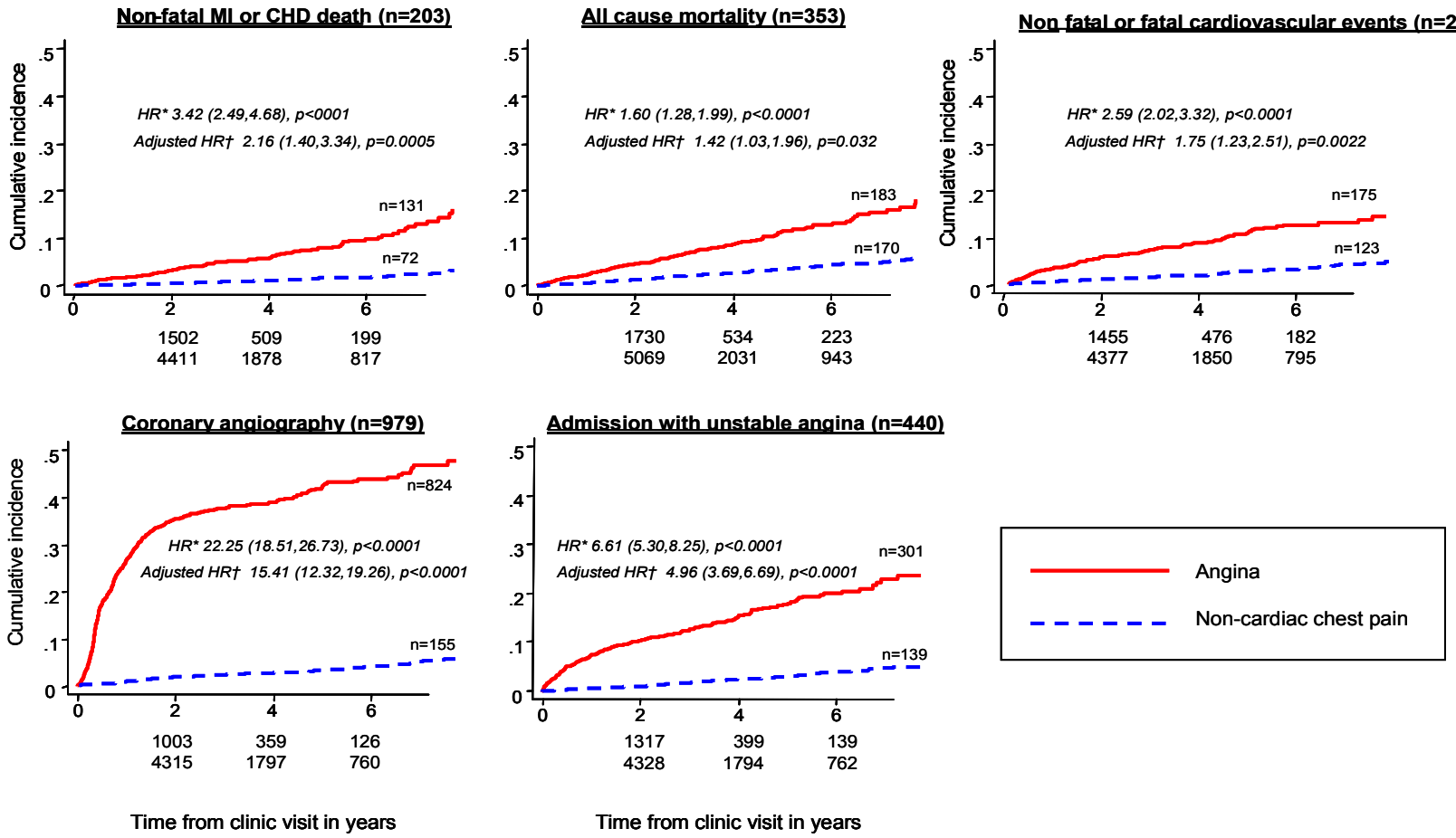
Endpoints	**Angina N=2366 (27%)**	**Non-cardiac chest pain N=6396 (73%)**
Primary endpoint		
CHD or non-fatal MI	131 (6%)	72 (1%)
Secondary endpoints		
Cardiovascular death or non-fatal MI or stroke	175 (7%)	123 (2%)
Deaths (up to April 2004)	183 (8%)	170 (3%)
All cause	104 (4%)	61 (1%)
Cardiovascular cause (I00-I99)	80 (3%)	38 (1%)
Coronary heart disease (I20-I25)	79 (3%)	109 (2%)
Non-cardiovascular causes		
Deaths (matching NWCS FU date)	171 (7.2%)	151 (2.4%)
All cause	95 (4%)	54 (1%)
Cardiovascular cause (I00-I99)	72 (3%)	35 (1%)
Coronary heart disease (I20-I25)	76 (3%)	97 (2%)
Non-cardiovascular causes		
Nonfatal events	301 (13%)	139 (2%)
Admission with unstable angina (I20, I24.0, I24.8,I24.9)	74 (3%)	43 (1%)
Non-fatal myocardial infarction (I21-I23)	31 (2%)	37 (1%)
Non-fatal stroke (I61-I69)		
Procedures	824 (35%)	155 (2%)
Diagnostic angiograms (K63 or K65)	202 (9%)	33 (1%)
PTCA (K49-K50.9)	229 (10%)	20 (0.3%)
CABG (K40-K46.9)		

Table 6: Numbers of events by hospital

Hospital	Total patients n (% of N*)	Angina	Non-cardiac	Primary endpoint (CHD death / MI)
Newham	4412 (50.4%)	987 (22%)	3425 (78%)	108
Oldchurch	2424 (27.7%)	624 (26%)	1800 (74%)	50
Kingston	455 (5.2%)	170 (37%)	285 (63%)	12
Blackburn	573 (6.5%)	251 (44%)	322 (56%)	14
Burnley	292 (3.3%)	126 (43%)	166 (57%)	8
MRI	606 (6.9%)	208 (34%)	398 (66%)	11

* N=8762, total number of patients included in the analysis

Figure 5: Probability of endpoints by type of chest pain



Numbers at risk at beginning of each year of follow up displayed on bottom of each graph: top row-angina, bottom row-noncardiac chest pain

n represents number of events

*HR adjusted for age only

† HR adjusted for gender, age, ethnicity, diabetes, smoking status, heart rate, character of chest pain, resting ECG

Figure 6: Probability of CHD/MI comparing patients included in the analysis with those excluded

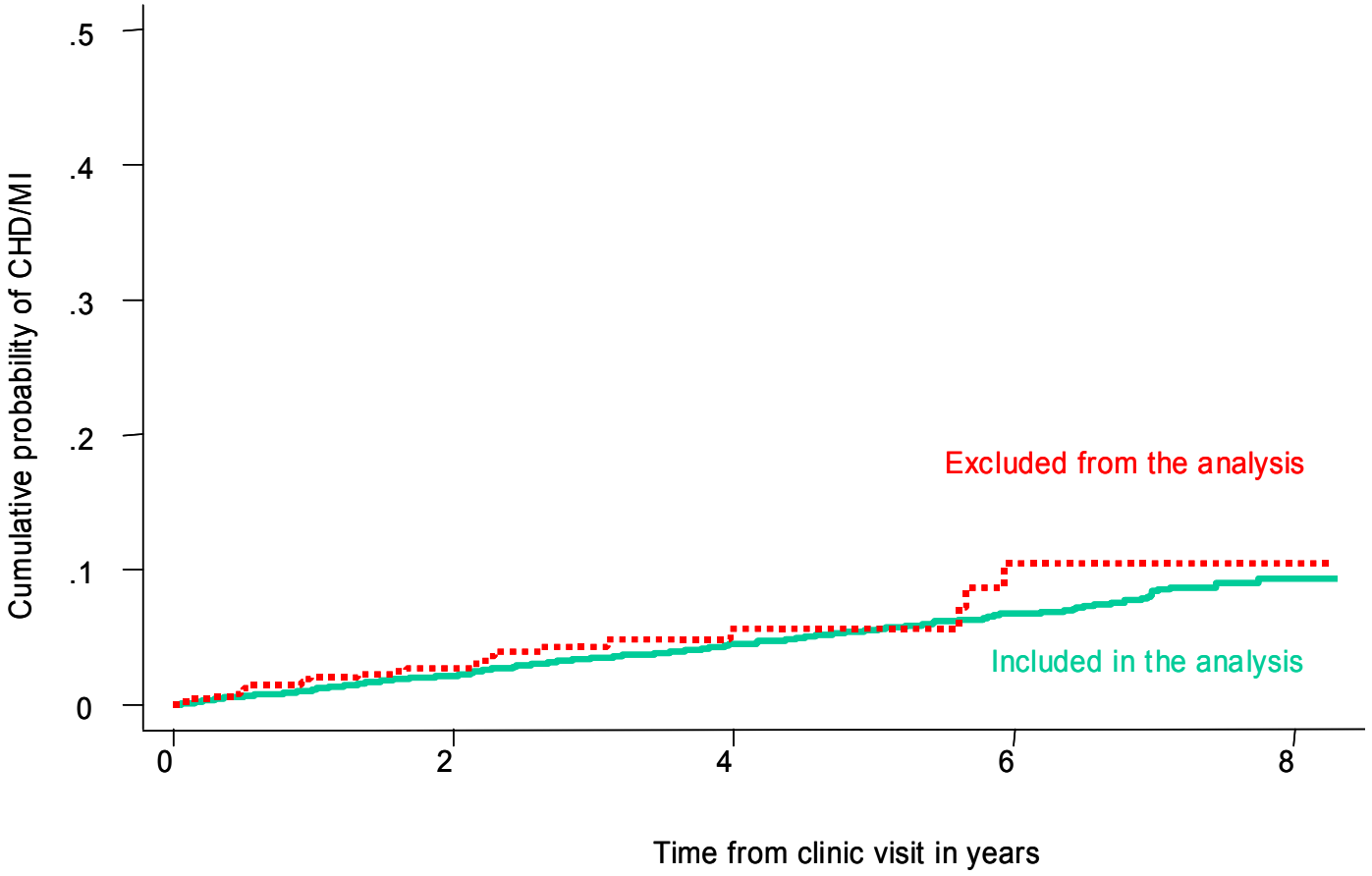


Table 7: Standardised mortality ratios (SMR) (to April 2004) in patients diagnosed with angina and non-cardiac chest pain (n=8762)

	Angina group				Non-cardiac group			
	Male		Female		Male		Female	
	O/E	SMR (95% CI)	O/E	SMR (95% CI)	O/E	SMR (95% CI)	O/E	SMR (95% CI)
All cause mortality								
Under 65	40 / 23	1.83 (1.26-2.39)	20 / 11	1.78 (1.00-2.56)	54 / 54	1.00 (0.73-1.26)	44 / 36	1.21 (0.85-1.57)
65 and over	79 / 91	0.87 (0.68-1.05)	45 / 53	0.85 (0.60-1.09)	46 / 63	0.73 (0.52-0.94)	26 / 51	0.51 (0.32-0.71)
All ages	119 / 113	1.05 (0.86-1.24)	65 / 64	1.01 (0.76-1.25)	100 / 117	0.85 (0.68-1.02)	70 / 88	0.80 (0.61-0.98)
CHD								
(ICD 10 I20-I25)								
Under 65	20 / 6	3.52 (1.98-5.07)	7 / 2	4.39 (1.14-7.64)	15 / 13	1.15 (0.57-1.73)	9 / 5	1.96 (0.68-3.24)
65 and over	35 / 27	1.62 (1.09-2.16)	18 / 10	1.76 (0.95-2.58)	11 / 16	0.71 (0.29-1.12)	3 / 10	0.31 (0.00-0.65)
All ages	55 / 28	2.03 (1.49-2.56)	25 / 12	2.13 (1.29-2.96)	26 / 26	0.92 (0.57-1.28)	12 / 15	0.85 (0.37-1.32)
Non-cardiovascular causes								
Under 65	15 / 14	1.04 (0.77-1.31)	10 / 8	1.19 (0.81-1.57)	31/ 35	0.88 (0.72-0.83)	26 / 28	0.92 (0.74-1.10)
65 and over	33 / 53	0.62 (0.51-0.73)	22 / 34	0.64 (0.50-0.78)	30 / 36	0.83 (0.68-0.98)	18 / 32	0.56 (0.43-0. 69)
All ages	48 / 68	0.70 (0.60-0.80)	32 / 40	0.79 (0.65-0.93)	61 / 75	0.81 (0.71-0.91)	48 / 63	0.76 (0.65-0.87)

O - Observed mortality; E - Expected mortality; CHD - coronary heart disease.

Table 8: Comparison of RACPC angina patients and placebo groups of recent RCTs on stable CHD populations

Baseline risk factors	**RACPC angina (n=2366) 1996 -2002**	**PEACE (n=4132) 1996 - 2000**	**ACTION (n=3840) 1996 - 1998**	**IONA (n=2561) 1998 - 2000**	**TNT(n=5006) 1998-1999**
Age	62 (±11)	64 (±8)	63.4 (±9.3)	67 (±9)	61 (±9)
Females	43%	17%	21%	24%	19%
Non-White ethnicity	24%	7% of cohort	2% of cohort	-	6%
Diabetes	17%	16%	14%	9%	15%
Current smoker	23%	15%	17%	17%	13%
Systolic blood pressure	147 (±22)	133 (±17)	138 (±19)	138 (±19)	131 (±17)
Cardiac history					
Angina	100%	71%	92%	100%	81%
MI	0%	56%	50%	66%	58%
PTCA	0%	41%	20%-25%†	15%	54%
CABG	0%	40%	-	23%	47%
Drugs					
Beta blockers	54%	60%	80%	56%	-
Statins	28%	70%	62%	58%	-
Aspirin	84%	91%	86%	87%	-
Annual endpoint comparisons					
All cause mortality (95% CI) *	3.1% (2.6-3.5)	1.7% (1.5-1.9)	1.5% (1.4-1.7)	3.1% (2.7-3.6)	1.1% (1.0-1.3)
Cardiovascular mortality (95% CI)*	1.8% (1.4-2.1)	0.8% (0.6-0.9)	0.8% (0.7-0.9)	-	-
CHD death + nonfatal MI (95% CI) *	2.3% (1.9-2.7)	1.9% (1.6-2.0) ‡	1.8% (1.6-2.0) §	3.3% (2.7-3.8)	1.7% (1.5-1.9)

** Annual incidence = total incidence of events / follow up time.*

† Range between those without and with history of MI who had PTCA

‡ Figures are for annual cardiovascular death + nonfatal MI, so the actual figures for the endpoint are likely to be lower.

§ extracted from primary endpoint for safety (fatal + nonfatal cardiovascular events)

MI- myocardial infarction; PTCA-percutaneous transluminal coronary angioplasty; CABG-coronary artery bypass graft; CHD-coronary heart disease

3.5 Discussion (objective 1a &1b)

We have shown that patients with incident angina have coronary event rates higher than the general population and angina patients currently represented in randomised controlled trials (Braunwald, Domanski, Fowler, Geller, Hsia, *et al*, 2004; Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin *et al*, 2004; Lancet, 2002; Larosa, Grundy, Waters, Shear, Barter, Fruchart *et al*, 2005). We studied ambulatory patients with recent onset of symptoms who had suspected coronary disease but no history of prior myocardial infarction. This patient group is missing from current trials. The high event rates we identified justify the priority given for rapid assessment of chest pain, but highlight the need for improved diagnosis and treatment.

This is the first large, multi-centre consecutive series of ambulatory patients with new, undifferentiated chest pain, allowing estimates of prognosis in women and men. Angina was diagnosed in 27 percent and independently predicted coronary death and non-fatal myocardial infarction, which occurred at an annual rate of 2.3 percent. Rates of admission with unstable angina were higher still. Patients diagnosed with non-cardiac chest pain had a lower event rate, but accounted for one third of all observed coronary deaths or non-fatal myocardial infarctions. This is cause for concern, because this group had been through a screening process for coronary disease and might, therefore, be expected to exhibit a lower coronary mortality compared with the general population. Instead we found that among patients less than 65 years of age, diagnosed with non-cardiac chest pain the SMR point estimates were greater than unity.

It is likely that most of these patients, who were told they did not have angina, but then had a coronary event, were misdiagnosed at the initial assessment. They were usually younger with atypical symptoms and normal resting ECGs. These findings highlight the relationship between diagnosis and prognosis (Knottnerus, 2002) and the need for research to identify methods for improving diagnostic precision. This may involve better understanding of existing measures (for example, by development and validation of risk scores in this population) as well as consideration of the incremental prognostic or diagnostic value of serological testing (Kragelund, Gronning, Kober, Hildebrandt, Steffensen, 2005) and non-invasive coronary imaging (Mollet, Cademartiri, Nieman, Saia, Lemos, McFadden *et al*, 2004; Schmermund, Denktas, Rumberger, Christian, Sheedy, Bailey, *et al*, 1999). Unlike myocardial infarction (The Joint European Society of Cardiology/American College of Cardiology

Committee, 2000), there is no internationally agreed standard for defining the presence or absence of angina.

In the patient diagnosed with angina, the goal of treatment is to reduce the risk of adverse outcomes to that of the general population. Our findings show that this has not been achieved, and throw into doubt the ACTION (Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin *et al*, 2004) investigators' assertion that 'stable angina has a good prognosis.' Despite ongoing specialist management in >80 percent of our patients with angina, many of whom underwent invasive investigation, SMRs for coronary death in both men and women were substantially higher than the general population. SMRs for all cause mortality were also higher in men and women aged <65 years, but in older patients were more comparable to the general population. This is consistent with findings in acute myocardial infarction and other disease groups, and probably reflect the inevitable increase in population mortality with age (Barakat, Wilkinson, Deaner, Fluck, Ranjadayalan, Timmis, 1999).

We identified no randomised trials that have recruited patients with newly diagnosed angina. The majority of patients in the four recent trials that recruited contemporaneously with our own study had a history of myocardial infarction, and the duration of angina was not specified. Yet the patients in our study, many of whom were within four weeks and most within six months of symptom onset, had a less favourable prognosis than those in three of the trials (Braunwald, Domanski, Fowler, Geller, Hsia, *et al*, 2004; Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin *et al*, 2004; Larosa, Grundy, Waters, Shear, Barter, Fruchart *et al*, 2005), and only a slightly lower all cause mortality than those in the fourth (Lancet, 2002) who had been explicitly selected as being at high risk. These differences are likely to reflect the selection bias in trial populations (Gross, Mallory, Heiat, Krumholz, 2002) and raise important questions about the extent that prognostic data from trial populations can be generalised (external validity). Population based studies have shown that chest pain, without a diagnosis of angina, may have an adverse prognosis (Bodegard, Erikssen, Bjornholt, Thelle, Erikssen, 2004; Hemingway, Shipley, Britton, Page, Macfarlane, Marmot, 2003). We propose that trials should be conducted in patients with new onset angina, with minimal exclusion criteria in order to ensure external validity and enhance the implementation of findings into practice.

Rates of aspirin and beta-blocker therapy in our patients diagnosed with angina were similar to those reported in the Euro Heart Survey (Daly, Clemens, Sendon, Tavazzi, Boersma, Danchin *et al*, 2005). Cholesterol measurement was recommended, in accordance with contemporary guidelines (Joint British recommendations on prevention of coronary heart disease in clinical practice, 1998), in 90 percent of patients diagnosed with angina and 28 percent were already prescribed statins at this first

cardiological consultation. This is lower than entry treatment rates for angina trial participants, many of whom had prior myocardial infarction and full cardiological work-up over many visits. The majority of our patients with angina did undergo further cardiological follow-up and it is a limitation of our study that we do not know what proportion came to be treated with a statin.

We found low SMRs for non-cardiovascular deaths, particularly in those aged greater than 65 years, consistent with a referral bias. However, this 'selection by fitness' would tend to reduce rather than exaggerate adverse outcomes within our study population, and would not therefore affect our main conclusion about the high cardiovascular risk of patients with incident angina.

In our study, patients with previously undiagnosed angina, uncomplicated by prior myocardial infarction, are at higher coronary risk compared with both the general population and the participants in recent clinical trials. These findings have confirmed the importance of rapid access chest pain clinics for identifying patients at increased risk but have also exposed misdiagnosis in a minority of cases who are not appropriately treated. We need to improve the diagnosis and treatment of ambulatory patients when they first present with chest pain in order to reduce mortality rates in this high risk but neglected group.

(1c) Relate the pre-test quantitative probability of coronary artery disease to outcomes

3.6 Background

In the patient with chest pain, the diagnosis of coronary artery disease is a probability judgement based on clinical presentation and disease prevalence in the population group to which the patient belongs. Quantitative analysis of the probability of coronary disease in individual patients was provided by Diamond and Forrester (DF) who devised a CAD score based on that patient's age, gender and typicality of symptoms. This analysis was based on angiographic and post-mortem data in US populations and has not been tested in RACPC populations with their heterogeneity of ethnicity and clinical presentation. Its prognostic validity against hard clinical endpoints has never been tested.

3.7 Method

3.7.1 Pre-test probability of coronary artery disease: The Diamond and Forrester CAD score (Table 9)

The Diamond and Forrester (DF) pre-test CAD score (Diamond, Forrester, 1979) (Table 9) was calculated automatically within the database and is available for all patients, together with the clinical diagnosis (angina or non-cardiac chest pain) recorded at the time the patient was seen.

Table 9: Probability of coronary artery disease (%) by age, gender and typicality of symptoms

Age	**Non specific chest pain**		**Atypical chest pain**		**Typical angina**	
Year	Men	Women	Men	Women	Men	Women
30 - 39	5.2 ± 0.8	0.8 ± 0.3	21.8 ± 2.4	4.2 ± 1.3	69.7 ± 3.2	25.8 ± 6.6
40 - 49	14.1± 1.3	2.8 ± 0.7	46.1± 1.8	13.3 ± 2.9	87.3 ± 1.0	55.5 ± 6.5
50 - 59	21.5 ±1.7	8.4 ± 1.2	58.9 ± 1.5	32.4 ± 3.0	92.0 ± 0.6	79.4 ± 2.4
60 - 69	28.1 ±1.9	18.6 ± 1.9	67.1 ± 1.3	54.4 ± 2.4	94.3 ± 0.4	90.6 ± 1.0

3.7.2 Patients

The DF algorithm excludes patients aged <30 years or those aged >69. For this analysis, therefore, we included all RACPC patients included in the prognostic outcome analysis (Figure 4) who fell within the age range 30 to 69 (n=7426). The pre-test clinician coded CAD score (CCAD) was available for all patients based on the individual's age, gender and clinician's interpretation of symptoms (typical, atypical, non-specific).

3.7.3 Modified pre-test CAD score

The RACPC database provides detailed descriptions of chest pain by location, quality, radiation, duration of episode, provocation and associated symptoms. (see appendix). In order to assess the character of symptoms more objectively, the symptoms were scored to devise a new measure of typicality.

- Location - central or L sided score=1
- Duration - <15 minutes score =1

- Provocation - exercise score=1
- Quality - constricting score=1

Score=4 typical angina, score= 2 or 3 atypical angina, score= 1 or 0 non-specific chest pain. Based on these scores, the pre-test probability of CAD was recalculated using the DF algorithm to provide the modified CAD score (MCAD).

3.7.4 Statistics

Descriptive analysis was used to compare baseline characteristics stratified by pre-test CAD scores (< 20%, 20-80% and > 80%). The Kaplan-Meier product of cumulative probability for the primary endpoint of death due to coronary heart disease or non-fatal MI and secondary endpoint of all cause death was calculated for the clinician-based and modified CAD scores using log rank test for significance testing.

3.8 Results (objective 1c)

Clinician coded (CCAD) and modified (MCAD) probability scores in patients with angina and non-cardiac chest pain (Table 10)

In patients with angina, symptoms were classified typical in 71% of cases by the clinicians and 43% of cases by the recoded character description. In the non-cardiac group, symptoms were classified non-specific in 25% of cases by the clinicians and 57% of cases by the re-coded character description. Thus, for the angina group the median CCAD score was 90.6 (interquartile range 67.1- 92.0) and the median MCAD score was 67.1 (interquartile range 46.1 - 90.6). For the non-cardiac group the median CCAD was 32.4 (interquartile range 14.1 – 54.4) and the median MCAD was 18.6 (interquartile range 8.4 - 32.4).

Table 10: CAD score and character symptoms by diagnostic groups

		Angina group n=1708 (23%)	**Non-cardiac group n=5718 (77%)**
Age	mean	57 (± 8)	50 (± 10)
Males		997 (58%)	2931(51%)
Ethnicity			
White		1231 (72%)	3446 (60%)
South Asian		393 (23%)	1681 (29%)
Black		84 (5%)	591 (10%)
Character of chest pain (clinician coded)			
Typical		1212 (71%)	273 (5%)
Atypical		488 (28%)	3991 (70%)
Non specific		8 (1%)	1454 (25%)
Character of chest pain (recoded character)			
Typical		737 (43%)	228 (4%)
Atypical		843 (49%)	2235 (39%)
Non specific		128 (8%)	3255 (57%)
CAD score (CCAD)			
mean		77.48 (±20.00)	36.83 (±23.24)
median		90.6 (67.1-92.0)	32.4 (14.1- 54.4)
CAD score (MCAD)			
mean		63.54 (±25.90)	25.31 (±22.24)
median		67.1 (46.1-90.6)	18.6 (8.4,32.4)

Mean (SD), Median (interquartile range)

3.8.2 Patient characteristics by probability of coronary artery disease: < 20% (low), 20-80% (intermediate), > 80% (high) CCAD and MCAD coding

Clinician coded – CCAD score (Table 11): There was an increase in mean age, proportion of men and white patients with increasing probability of CAD. Patients with high pre-test probability of CAD were more likely to have an abnormal resting 12 lead electrocardiogram and positive exercise treadmill test (ETT). Risk factors (smoking, hypertension and systolic blood pressure, diabetes) were more prevalent in those with high probability of CAD, who also had higher rates of referral for coronary angiogram and intervention. Those with 91% of low probability of CAD were discharged home. Only 0.6% of those with low probability of CAD reached the primary endpoint of death due to coronary heart disease or non-fatal myocardial infarction (CHD death/MI) compared to 1.5% in the intermediate group and 5% in the high risk group. But 50% of the total events (65/131) occurred in those with 20-80% pre-test likelihood of disease.

Recoded - MCAD score (Table 12): Recoding by more objective analysis of chest pain characteristics reduced numbers in the high probability group and increased numbers in the intermediate and low probability groups. This increased event frequency in the low and intermediate probability groups and decreased event frequency in the high probability group.

Non-invasive testing by probability of coronary artery disease: < 20% (low), 20-80% (intermediate), > 80% (high)

Exercise stress testing was recorded as 'not indicated' in 61% of patients with low CCAD scores, 21% of patients with intermediate CCAD scores and only 2% of patients with high CCAD scores. Corresponding data for MCAD scores were 48%, 15% and 1%, respectively.

Table 11: CCAD: Analysis of cohort by CAD probability (clinician)

	< 20% **(n=1808)** **24%**	**20 – 80%** **(4492)** **61%**	**> 80%** **(n=1126)** **15%**
Age mean	44 (±9)	53 (±9)	59 (±8)
Males	1775 (98%)	3782 (84%)	161 (14%)
Diagnosis			
angina	33 (2%)	710 (16%)	965 (86%)
non-cardiac chest pain	430 (24%)	2687 (60%)	811 (72%)
Ethnicity			
White	922 (51%)	2913 (65%)	842 (75%)
South Asian	632 (35%)	1213 (27%)	229 (20%)
Black	254 (14%)	366 (8%)	55 (5%)
Risk Factor			
current smoker	398 (22%)	1208 (27%)	313 (28%)
hypertension	394 (22%)	1537 (34%)	494 (44%)
diabetes	111 (6%)	470 (10%)	181 (16%)
Duration of chest pain			
< 4 weeks	967 (53%)	2222 (50%)	428 (38%)
1 to ≤ 6 months	543 (30%)	1456 (32%)	450 (40%)
>6 to ≤12 months	93 (5%)	255 (6%)	78 (7%)
> 1 year	205 (11%)	559 (12%)	170 (15%)
Character of chest pain			
typical	2 (0.1%)	357 (8%)	1126 (100%)
atypical	666 (37%)	3813 (85%)	---
non-specific	1140 (63%)	322 (7%)	---
Electrocardiogram			
normal	1675 (93%)	3907 (87%)	791 (70%)
abnormal	133 (7%)	585 (13%)	335 (30%)

Exercise treadmill test			
positive	12 (1%)	296 (7%)	393 (35%)
non-diagnostic	21 (1%)	178 (4%)	93 (8%)
negative	562 (31%)	2535 (56%)	374 (33%)
not done-not indicated	1098 (61%)	932 (21%)	17 (2%)
not done-unable to do	115 (6%)	551 (12%)	249 (22%)
Systolic blood pressure (mm Hg)	133 (±20)	140 (±19)	145 (±21)
Heart rate beats per minute	78 (±12)	77 (±12)	76 (±12)
Disposal ‡			
admitted	5 (0.3%)	6 (0.1%)	---
outpatient appointment	159 (9%)	838 (19%)	542 (49%)
referral for angiogram	5 (0.3%)	156 (4%)	295 (27%)
discharged back to GP	1627 (91%)	3459 (78%)	272 (25%)
Drugs on disposal	111 (6%)	990 (22%)	859 (76%)
aspirin	104 (6%)	668 (15%)	622 (55%)
beta blockers	73 (4%)	442 (10%)	350 (31%)
statin	11 (0.6%)	65 (1.5%)	55 (5%)
CHD death + MI §	8%of 131	50% of 131	42% of 131
Intervention	35 (2%)	348 (8%)	405 (36%)
angiogram	7 (0.4%)	125 (3%)	236 (21%)
PTCA/CABG†			

** ACS- acute coronary syndrome. † PTCA/CABG- percutaneous coronary angiogram/coronary artery bypass graft. ‡disposal information was only available for 7364 patients. §primary endpoint of death due to coronary heart disease or non fatal myocardial infarction (n=131)*

Table 12: MCAD: Analysis of cohort by CAD probability (modified)

	< 20% (n=3159) 43%	**20 – 80% (3563) 48%**	**> 80% (n=704) 10%**
Age mean	46 (±9)	55 (±9)	59 (±8)
Males	999 (32%)	2386 (67%)	543 (77%)
Diagnosis			
angina	138 (4%)	1006 (28%)	564 (80%)
non-cardiac chest pain	3021 (96%)	2557 (72%)	140 (20%)
Ethnicity			
White	1787 (57%)	2386 (67%)	504 (72%)
South Asian	1000 (32%)	916 (26%)	158 (22%)
Black	372 (12%)	261 (7%)	42 (6%)
Risk Factor			
current smoker	751 (24%)	988 (28%)	180 (26%)
hypertension	789 (25%)	1338 (38%)	298 (42%)
diabetes	239 (8%)	419 (12%)	104 (15%)
Duration of chest pain			
< 4 weeks	1621 (51%)	1719 (48%)	277 (39%)
1 to ≤ 6 months	999 (32%)	1171 (33%)	279 (40%)
>6 to ≤12 months	156 (5%)	223 (6%)	47 (7%)
> 1 year	383 (12%)	450 (13%)	101 (14%)
Character of chest pain			
typical	0 (0%)	261 (7%)	704 (100%)
atypical	539 (17%)	2539 (71%)	---
non-specific	2620 (83%)	763 (21%)	---
Resting electrocardiogram			
normal	2888 (91%)	2969 (83%)	516 (73%)
abnormal	271 (9%)	594 (17%)	188 (27%)

Exercise treadmill test			
positive	58 (2%)	407 (11%)	236 (34%)
non-diagnostic	64 (2%)	173 (5%)	55 (8%)
negative	1260 (40%)	1962 (55%)	249 (35%)
not done-not indicated	1512 (48%)	527 (15%)	8 (1%)
not done-unable to do	265 (8%)	494 (14%)	156 (22%)
Systolic blood pressure (mm Hg)	135 (±19)	142 (±20)	145 (±21)
Heart rate beats per minute	77 (±11)	77 (±12)	76 (±12)
Disposal ‡			
admitted	6 (0.2%)	5 (0.1%)	---
outpatient appointment	357 (11%)	866 (25%)	316 (46%)
referral for angiogram	29 (1%)	256 (7%)	171 (25%)
discharged back to GP	2748 (88%)	2403 (68%)	207 (30%)
Drugs on disposal			
aspirin	298 (9%)	1146 (32%)	516 (73%)
beta blockers	239 (8%)	779 (22%)	376 (53%)
statin	190 (6%)	472 (13%)	203 (29%)
CHD death + MI §	17 (0.5%)	75 (2%)	39 (5.5%)
	13%of 131	57% of 131	30% of 131
Intervention			
angiogram	94 (3%)	450 (13%)	244 (35%)
PTCA/CABG†	22 (0.7%)	199 (6%)	147 (21%)

** ACS- acute coronary syndrome. † PTCA/CABG- percutaneous coronary angiogram / coronary artery bypass graft. ‡disposal information was only available for 7364 patients.§ primary endpoint of death due to coronary heart disease or non fatal myocardial infarction (n=131)*

Prognosis by character of chest pain (Table 13, Figure 7)

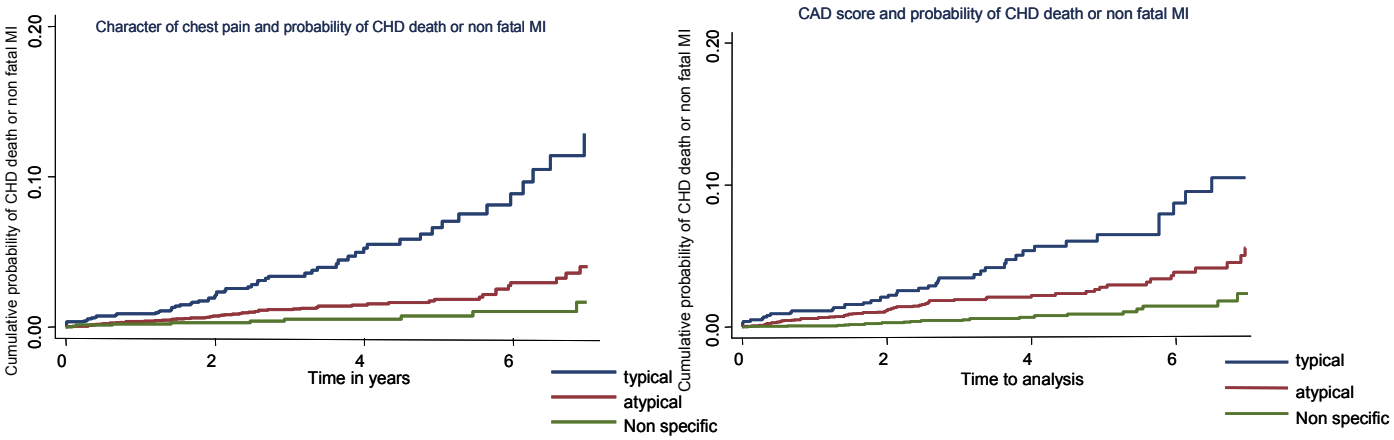
Character of chest pain stratified patients into high medium and low risk groups, the clinician coding of typical chest pain providing a better categorization of patients at high risk of CHD death or non-fatal myocardial infarction than the recoding.

Table 13: Probabilities of CHD death or nonfatal MI by character of chest pain

	Typical		Atypical		Non-specific	
	clinician	**recoded**	**clinician**	**recoded**	**clinician**	**recoded**
1	0.88 (0.51-1.50)	1.14 (0.63-2.05)	0.38 (0.24-0.61)	0.62 (0.39-0.97)	0.21 (0.07-0.63)	0.09 (0.03-0.27)
2	2.14 (1.48-3.10)	2.12 (1.36-3.32)	0.73 (0.51-1.05)	1.22 (0.87-1.71)	0.28 (0.11-0.75)	0.31 (0.16-0.59)

Figure 7: Clinician coded (LR test p<.0001)(Left panel)

Recoded character (LR test p=0.0001)(Right panel)

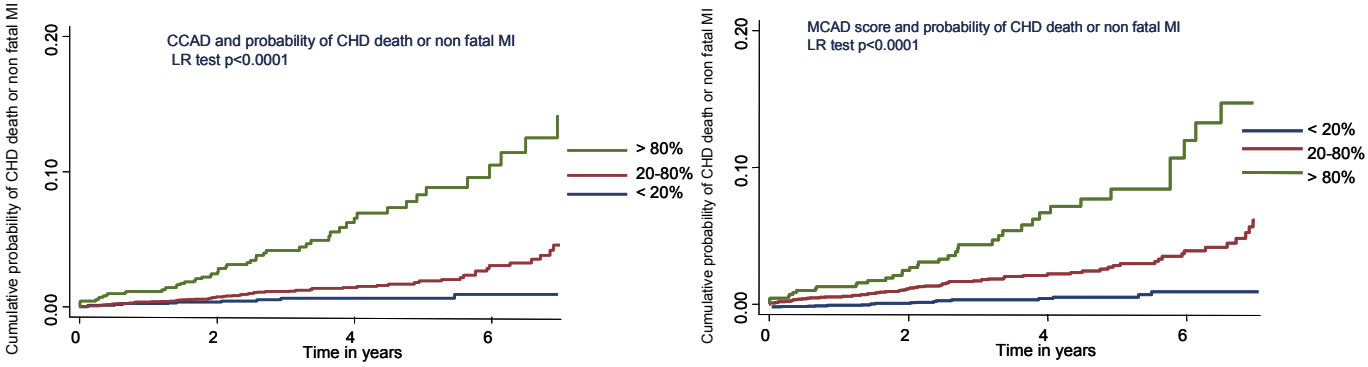


Prognosis by probability of CAD (Figure 8)

Both CCAD and MCAD stratified patients by risk of CHD death and non-fatal myocardial infarction. Categorisation of patients at high risk of CHD death or non-fatal myocardial infarction was similarly effective for both scoring systems but MCAD showed better discrimination than CCAD between groups at intermediate and low risk.

Figure 8: Clinician coded (LR test p<.0001)(left panel)

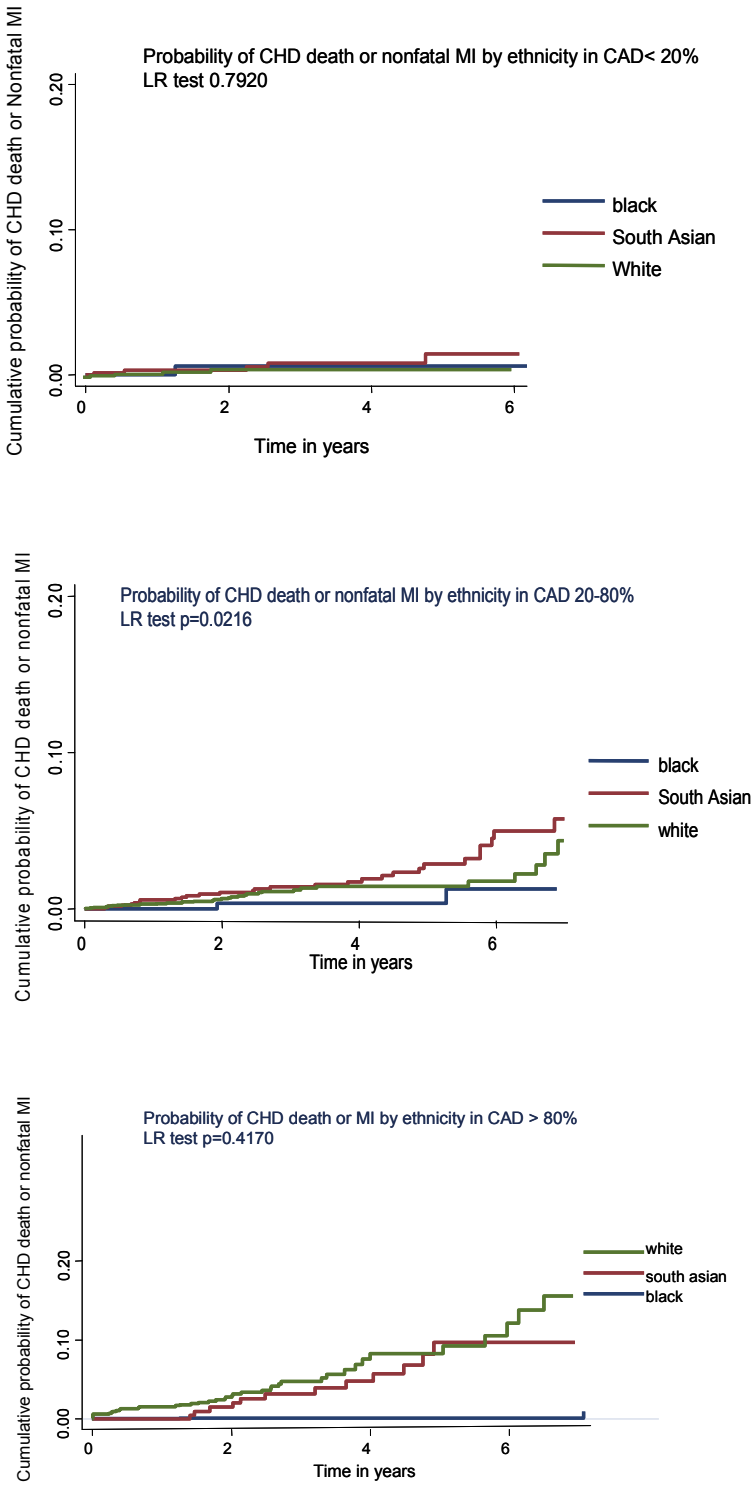
Recoded character (LR test p=0.0001)(Right panel)



Prognosis by probability of CAD: effect of ethnicity

Relations between CAD scores and the cumulative incidences of death or non-fatal myocardial infarction were similar for south Asian and white patients.

Figure 9: Probabilities of CHD death/MI by ethnicity and CAD score



3.9 Discussion (objective 1c)

This is the first study in which probability estimates of coronary artery disease by the Diamond and Forrester (DF) algorithm have been applied to patients with previously undiagnosed chest pain referred for outpatient cardiological assessment. The major findings were:

1 probability of CAD accords not only with diagnosis but also with prognosis, effectively stratifying patients into high, intermediate and low risk groups

2 in terms of risk assessment, the physician's intuitive assessment of the typicality of symptoms is as good if not better than more objective assessment

3 the validity of the DF algorithm for risk stratification in south Asian patients with chest pain is confirmed.

Pre-test probability estimates of coronary artery disease devised by Diamond and Forrester were based on relations between simple clinical factors (age, gender, typicality of symptoms) and angiographic and post-mortem findings in a largely white US population. The clinical purpose of the estimates was provision of quantitative estimates of the probability of disease in individual patients as a guide to diagnosis and further management, particularly the indications for non-invasive testing by applying Bayesian principles. This study confirms that in patients with undifferentiated chest pain, probability estimates of CAD are not only higher in patients diagnosed with angina, but also have prospective validity, effectively stratifying patients into high, medium and low risk groups. The data make clear, however, that a careful clinical history of the descriptors of chest pain precludes the need for formal probability analysis and is as effective in identifying the high risk patient, particularly when combined with the global assessment of the cardiologist.

The application of probability judgements of disease to indications for non-invasive testing is particularly important as the probability of disease with a positive test increases substantially for patients in whom the pre-test probability is intermediate (20-80%), but much less for patients with a high or low pre-test probabilities of disease. This is reflected to some extent by our data, which show relatively low rates of non-invasive testing when the pre-test probability of disease is <20%, particularly when the clinician-coded score (CCAD) is analysed, but much higher rates when it is between 20% and 80%. Rates of non-invasive testing were also high when the pre-test probability of disease was >80%, but although a positive test does not add appreciably to diagnostic power in this group, it may provide important prognostic information (Gibbons, Balady, Beasley,

FAAFP, Bricker, Duvernoy, *et al*, 1997), probably accounting for this apparent anomaly. There is no suggestion that cardiologists consult quantitative probability estimates of disease before making their decisions about non-invasive testing, but the data are consistent with the application of Bayesian principles in the decision making process.

Although the probability scores of Diamond and Forrester were based on data from a largely white US population, this study has shown that the prospective validity of the scores in our UK population of patients with undiagnosed chest pain was similar regardless of ethnic group. The cumulative incidence of coronary death and non-fatal infarction in whites and south Asians was similar in groups with low, intermediate, and high probabilities of disease. This is the first time that the validity of the DF algorithm for risk stratification in Asian patients with chest pain has been demonstrated.

In conclusion, the probability scores of Diamond and Forrester in RACPC populations appear to be applied intuitively by cardiologists in the selection of patients for non-invasive investigation, and have prospective validity for risk stratification in whites and south Asians in this country.

(1d) Identify additional baseline clinical variables that may predict outcome

3.10 Introduction

There is extensive literature on the interplay of risk factors in predicting the outcome of patients with coronary heart disease (Robson, Feder, 2001; Yusuf, Hawken, Ounpuu, Dans, Avezum, Lanas *et al*, 2004). It is well known that age, diabetes, hypertension, smoking, family history and certain ethnic minority groups are at high risk of developing coronary heart disease. This risk is additive and magnified by the presence of multiple risk factors. The aim of this analysis was to identify factors in our RACPC population that increased the risk of coronary death or non-fatal myocardial infarction and the risk of all cause death.

3.11 Method

The 8762 RACPC patients identified in Figure 4 were used for this analysis, which is an extension of objectives a) and b). The hyperlipidaemia and family history of premature coronary heart disease fields on the database did not have sufficient detail for inclusion in the analysis.

3.11.1 Statistics

Cox regression was used to estimate hazard ratios for the age-adjusted effect of angina. Those covariates associated ($p<0.05$) with the outcome of interest (death due to coronary heart disease or nonfatal MI, all cause death) were included in the fully adjusted models.

3.12 Results

3.12.1 Coronary death or non-fatal myocardial infarction (Table 14, Table 15)

With age adjustment, factors associated with coronary death or non-fatal myocardial infarction were: diagnosis of angina, presence of an abnormal resting electrocardiogram, male gender, increasing age, current smoker, diabetes, south Asian ethnicity, typical symptoms and symptom onset >4 weeks previously. In the fully adjusted model, diagnosis of angina more than doubled the hazard of coronary death or non-fatal myocardial infarction [HR 2.16 (95% CI 1.40-3.34]). Other factors included abnormal resting electrocardiogram, male gender, increasing age, south Asian ethnicity, symptom onset >4 weeks previously, smoking and diabetes. Black ethnicity was protective in both the age adjusted and fully adjusted models. Addition of treadmill test results as a covariate showed significance for the age-adjusted model, but failed to reach significance in the full model.

3.12.2 All cause mortality (Table 14,Table 15)

With age adjustment, factors associated with all cause mortality were: male gender, diagnosis of angina, typical symptoms, abnormal resting electrocardiogram, resting heart rate, diabetes and smoking. In the fully adjusted model, increasing age, male gender, abnormal resting electrocardiogram, angina, smoking, diabetes, and resting heart rate were retained as predictive factors. Black and south Asian ethnicity were protective in both the age adjusted and fully adjusted models. Addition of treadmill test results to the fully adjusted model showed that inability to exercise for whatever reason increased the hazard of all cause mortality (HR 2.41 (95% CI 1.72,3.36)).

Table 14: Factors associated with the probability of all cause death and CHD death or non-fatal MI in stable angina and patients with non-cardiac chest pain

	All cause mortality (n=353)				**CHD or non-fatal MI (n=203)**			
Covariates	Age adjusted** HR (95% CI)	p	Adjusted* HR (95% CI)	p	Age adjusted** HR (95% CI)	p	Adjusted*HR (95% CI)	p
Angina diagnosis	1.60 (1.28,1.99)	<0.0001	1.42 (1.03,1.96)	0.032	3.42 (2.49,4.68)	<0.0001	2.16 (1.40,3.34)	0.0005
Male sex	1.65 (1.33,2.04)	<0.0001	1.55 (1.25,1.93)	0.0001	2.17 (1.61,2.93)	<0.0001	1.89 (1.40,2.55)	<0.0001
Age per 10 year increase*	2.27 (2.07,2.49)	<0.0001	2.08 (1.88,2.31)	<0.0001	1.90 (1.70,2.13)	<0.0001	1.57 (1.38,1.80)	<0.0001
Ethnicity		0.018		0.019		0.001		0.005
Black vs White	0.64 (0.41,1.00)		0.66 (0.42,1.04)		0.31 (0.14,0.71)		0.36 (0.16,0.83)	
SA vs White	0.72 (0.54,0.97)		0.70 (0.52,0.94)		1.19 (0.86,1.64)		1.20 (0.86,1.68)	
History of hypertension	1.08 (0.88,1.34)	0.460	N/A	N/A	1.21 (0.91,1.60)	0.187	N/A	N/A
Systolic blood pressure	1.00 (1.00,1.01)	0.635	N/A	N/A	1.00 (0.99,1.01)	0.646	N/A	N/A
Current smoking	1.91 (1.50,2.42)	<0.0001	1.70 (1.33,2.17)	<0.0001	1.62 (1.18,2.21)	0.004	1.48 (1.08,2.05)	0.018
Diabetes vs none	1.35 (1.02,1.78)	0.043	1.40 (1.04,1.87)	0.031	1.79 (1.28,2.51)	0.001	1.51 (1.06,2.15)	0.027

Symptoms		0.004		0.055		<0.0001		0.354
Atypical vs Non-specific	0.77 (0.57,1.04)		0.67 (0.49,0.92)		1.23 (0.76,1.99)		0.88 (0.53,1.46)	
Typical vs Non-specific	1.13 (0.82,1.54)		0.67 (0.44,1.02)		3.01 (1.86,4.88)		1.13 (0.61,2.09)	
Duration of symptoms								0.052
>1 m vs ≤ 1 month	1.01 (0.82,1.25)	0.915	N/A	N/A	1.44 (1.08,1.90)	0.011	1.32 (1.00,1.76)	
Heart rate in 10 beats per minute	1.18 (1.09,1.26)	<0.0001	1.15 (1.07,1.23)	0.0003	1.08 (0.98,1.20)	0.134	N/A	N/A
Abnormal ECG result	2.18 (1.75,2.72)	<0.0001	1.82 (1.44,2.30)	<0.0001	2.64 (1.97,3.53)	<0.0001	1.95 (1.44,2.64)	<0.0001

**age is univariable*

***adjusted for all variables in the table apart from duration of symptoms, history of hypertension or systolic blood pressure for all cause mortality*

***adjusted for all variables in the table apart from heart rate, history of hypertension or systolic blood pressure for CHD death or non-fatal MI*

Table 15: Factors associated with the probability of CHD death/ non-fatal MI in stable angina patients and patients with non-cardiac chest pain

	All cause mortality (n=353)				**CHD or non-fatal MI (n=203)**			
Covariates	Age adjusted** HR (95% CI)	p	Adjusted* HR (95% CI)	p	Age adjusted** HR (95% CI)	p	Adjusted*HR (95% CI)	p
Angina diagnosis	1.60 (1.28,1.99)	<0.0001	1.07 (0.74,1.55)	0.73	3.42 (2.49,4.68)	<0.0001	1.87 (1.13,3.10)	0.015
Male sex	1.65 (1.33,2.04)	<0.0001	1.62 (1.30,2.02)	<0.0001	2.17 (1.61,2.93)	<0.0001	1.85 (1.37,2.50)	<0.0001
Age per 10 year increase*	2.27 (2.07,2.49)	<0.0001	2.00 (1.80,2.21)	<0.0001	1.90 (1.70,2.13)	<0.0001	1.57 (1.37,1.80)	<0.0001
Ethnicity		0.02		0.01		0.001		0.006
Black vs White	0.64 (0.41,1.00)		0.65 (0.41,1.03)		0.31 (0.14,0.71)		0.37 (0.16,0.84)	
SA vs White	0.72 (0.54,0.97)		0.68 (0.51,0.92)		1.19 (0.86,1.64)		1.21 (0.86,1.69)	
History of hypertension	1.08 (0.88,1.34)	0.46	N/A	N/A	1.21 (0.91,1.60)	0.19	N/A	N/A
Systolic blood pressure	1.00 (1.00,1.01)	0.64	N/A	N/A	1.00 (0.99,1.01)	0.65	N/A	N/A
Current smoking	1.91 (1.50,2.42)	<0.0001	1.73 (1.35,2.20)	<0.0001	1.62 (1.18,2.21)	0.004	1.49 (1.08,2.05)	0.02
Diabetes vs none	1.35 (1.02,1.78)	0.04	1.38 (1.03,1.85)	0.04	1.79 (1.28,2.51)	0.001	1.50 (1.05,2.14)	0.03

Symptoms		0.004		0.35		<0.0001		0.33
Atypical vs non-specific	0.77 (0.57,1.04)		0.77 (0.54,1.10)		1.23 (0.76,1.99)		0.84 (0.47,1.50)	
Typical vs non-specific	1.13 (0.82,1.54)		0.82 (0.52,1.30)		3.01 (1.86,4.88)		1.09 (0.55,2.15)	
Duration of symptoms								0.05
>1 m vs <= 1 month	1.01 (0.82,1.25)	0.92	N/A	N/A	1.44 (1.08,1.90)	0.01	1.32 (1.00,1.76)	
Heart rate in 10 beats per minute	1.18 (1.09,1.26)	<0.0001	1.13 (1.06,1.22)	0.001	1.08 (0.98,1.20)	0.13	N/A	N/A
Abnormal ECG result	2.18 (1.75,2.72)	<0.0001	1.61 (1.26,2.05)	<0.0001	2.64 (1.97,3.53)	<0.0001	1.96 (1.43,2.68)	<0.0001
ETT results		<0.0001		<0.0001		<0.0001		0.84
Positive vs Negative	2.16 (1.51,3.08)		1.74 (1.14,2.65)		2.94 (1.97,4.38)		1.31 (0.81,2.12)	
Equivocal vs Negative	1.42 (0.77,2.62)		1.20 (0.64,2.25)		2.01 (1.05,3.86)		1.19 (0.60,2.35)	
Not done, as not indicated vs Negative	1.69 (1.22,2.35)		1.69 (1.17,2.45)		0.77 (0.48,1.24)		0.95 (0.55,1.64)	
Not done (reasons) vs Negative	2.95 (2.19,3.98)		2.41 (1.72,3.36)		2.08 (1.41,3.06)		1.14 (0.73,1.78)	

**age is univariable, **adjusted for all variables in the table apart from duration of symptoms, history of hypertension or systolic blood pressure for all cause mortality, **adjusted for all variables in the table apart from heart rate, history of hypertension or systolic blood pressure for CHD death or non-fatal MI*

3.13 Discussion

The main finding in this analysis was that for patients with undifferentiated chest pain attending RACPCs, a diagnosis of angina is significantly associated with adverse coronary outcomes. This association is independent of a range of other risk factors including advanced age, male gender, smoking and diabetes, all of which have well established associations with coronary events in the general population. As discussed earlier in this chapter, the association of angina with adverse coronary outcomes provides prognostic validation of the diagnosis obtained at one-stop cardiological assessment within RACPCs.

This analysis has confirmed angina as an important independent predictor of coronary events, with other well-established risk factors making additional independent contributions. Patients with symptoms that had started >4 weeks prior to attending the RACPC were also at greater risk than their counterparts with more recent symptom onset. This finding lends powerful support to the NSF for CHD (Department of Health, 2000) directive that all patients with recent onset of chest pain should be seen within two weeks of referral by the specialist.

Patients attending RACPCs routinely have a resting ECG recorded, additional investigation being limited to an exercise stress test that is usually undertaken in selected cases according to clinical indication. The value of the resting ECG for risk stratification in RACPC populations has not previously been evaluated. Our data show that an abnormal recording is not only more common among patients with angina but also predicts adverse outcomes, almost doubling the risk of coronary death or non-fatal myocardial infarction and increasing the risk of all cause mortality. An abnormal stress test nearly always led to a diagnosis of angina (see previously), just as an abnormal resting recording was associated with adverse outcomes in the age adjusted analysis. With multiple adjustment, however, this association was lost which, interpreted literally, questions the independent prognostic value of the exercise ECG. A more thoughtful interpretation, however, recognises that an abnormal stress test was a major driver of diagnosis and showed close correlation with angina, ensuring that both could not be retained in the multivariate model.

The tendency towards greater coronary risk among south Asians with chest pain, despite adjustment for their younger age and higher prevalence of diabetes compared with whites, is consistent with their known propensity to coronary heart disease. Similarly, the lower coronary risk for blacks is well recognised. These data confirm the need for intensive investigation and treatment of south Asians with suspected

coronary artery disease, although data provided elsewhere in this report show that this need is not adequately fulfilled in RACPCs.

As discussed before, the major purpose of RACPCs is to diagnose and treat angina at an earlier stage thereby reducing the risk of myocardial infarction and CHD death. Non-cardiac causes of death are unlikely to be affected, making all cause mortality an inappropriate outcome measure for evaluating the efficacy of RACPCs (Pocock, 1997). Out of the total deaths, 53 percent (188/353) were non-cardiac, most due to cancer. Independent multivariate predictors of all-cause mortality were age, male gender, smoking, resting heart rate, diabetes, diagnosis of angina and abnormal electrocardiogram, but inability to perform an ETT (immobility, anaemia, other, medical problems, resting ECG abnormalities) was associated with the highest hazard.

In conclusion, multiple factors contribute to the hazard of adverse outcomes in RACPC patients diagnosed with angina. Treating risk factors amenable to correction may help improve prognosis in this high risk group. Based on our observation of worse outcomes in patients with symptoms for longer than four weeks, we conclude that early referral for cardiological assessment is essential. Also essential is provision of equitable access to RACPCs for south Asian patients and others at increased risk to provide them with appropriate cardiological investigation and treatment.

Section 4 AIM 2: Is access to and referral from rapid access chest pain clinics and referral equitable?

4.1 Objectives

(2a) Characterise the populations using RACPCs.

(2b) Analyse variation in access to RACPCs by age, gender, ethnicity and deprivation.

(2c) Analyse rates of referral to exercise stress testing and angiography in relation to age, gender, ethnicity and deprivation.

(2d) Analyse the appropriateness of cardiac investigation in RACPCs by applying appropriateness ratings validated in a previous study to answer questions of over and under-use in different population subgroups (age, gender, ethnicity and deprivation).

(2e) Compare rates of referral of patients with chest pain to cardiology outpatients and a RACPC by age, gender and ethnicity (see *Predictors for referral for coronary arteriography*).

4.2 Background (Aim 2)

Equitable access to health services is a key principle of the National Health Service (Department of Health, 1997) and a central aim of the National Service Framework for Coronary Heart Disease (Department of Health, 2000). There is consistent evidence from north America that older age, lower socio-economic status (Alter, Naylor, Austin, 1999) and membership of ethnic minority groups (Smedley, Stith, Nelson, 2002) is associated with reduced access to coronary angiography and revascularisation, whereas the existence of inequity by gender is less clear, when clinical need is taken into account (Rathore, Chen, Wang, Radford, Vaccarino, Krumholz, 2001; Ghali, Faris, Galbraith, Norris, Curtis, Saunders *et al*, 2002). In the United Kingdom, more than 100 studies have been published from 1995 to 2003 investigating potential inequalities in access to cardiac services, the majority uncontrolled observational studies (Jones, McDaid, Hartley, Orton, Glanville, Forbes, 2004). There is evidence for inequitable access by older people to non-

invasive testing and coronary angiography (Bond, Bowling, McKee, Kennelly, Banning, Dudley *et al*, 2003). Lower socio-economic status in the UK is associated with lower use of angiography and revascularisation in some studies (Payne and Saul, 1997; MacLeod, Finlayson, Pell, Findlay, 1999) but not others (Jones, Ramsay, Feder, Crook, Hemingway, 2004; Britton, Shipley, Marmot, Hemingway, 2004). There is a similar heterogeneity, not fully explained by type of cardiac service, study design and quality, with regards to access of south Asians to coronary investigation and revascularisation. A systematic review in 2000 suggested that there was inequity in access to angiography and revascularisation (Feder, 2000) although the studies were underpowered and prone to confounding, without adjustment for need or appropriateness. Overall, better quality studies, that adjust for potential confounders, found that no gross inequity in access to investigation (Jones, Ramsay, Feder, Crook, Hemingway, 2004; Britton, Shipley, Marmot, Hemingway, 2004) and there is continuing conflicting evidence about access to coronary artery bypass grafting comparing whites to south Asian patients who are appropriate for that intervention (Feder, 2000; Feder, Crook, Magee, Banerjee, Timmis, Hemingway, 2002) systematic review of potential gender bias across different specialties found that women were less likely to undergo non-invasive investigations but that there were no differences in coronary angiography and revascularisation (Raine, 2000). There has been no previous study on equity of access to or referral from rapid access chest pain clinics by age, socio-economic status, ethnicity or gender.

The incidence of symptomatic heart disease varies in different groups. It is higher in older people, lower socio-economic groups and south Asian populations within the UK, with people of Pakistani and Bangladeshi origin having higher rates than those of Indian origin (Bholpal, Unwin, White, Yallop, Walker, Alberti *et al*, 1999). Although the prevalence is lower in women then men, their survival after a coronary event is at least as poor as men (Murabito, Evans, Larson, Levy, 1993). The differential incidence of heart disease between age, socio-economic and ethnic groups means that judging equity of access to rapid access chest pain clinics cannot be based simply on a comparison of proportions of people from different groups using the clinics with the proportion of the groups in the local population that constitutes the catchment area of the clinics. Nor can a judgement about equity of referral from a rapid access chest pain clinic for further investigation and treatment be based simply on a comparison of proportions of different groups referred. Judgements about equity or inequity of clinic use and investigations or treatments are potentially misleading without the use of population data to estimate need or individual patient data to determine appropriateness for further investigation and treatment. A parallel study to this one, also funded by the SDO, has included the development of appropriateness criteria for referral of patients with chest pain for exercise tolerance testing and

angiography. We have used these criteria to judge appropriateness of referral of patients in our cohort. Analyses also need to adjust for the correlation between demographic factors and between demographic factors and individual cardiovascular risk factors. For example, there is a strong correlation between Bangladeshi ethnicity, deprivation and smoking (Bush, White, Kai, Rankin, Bhopal, 2003). An additional confounder that needs to be taken into account is distance from a service, as there is evidence from the United States (Gregory, Malka, Kostis, Wilson, Arora, Rhoads, 2000) and the United Kingdom (Crook, Knorr-Held, Hemingway, 2003) that this is independently associated with use of cardiac procedures.

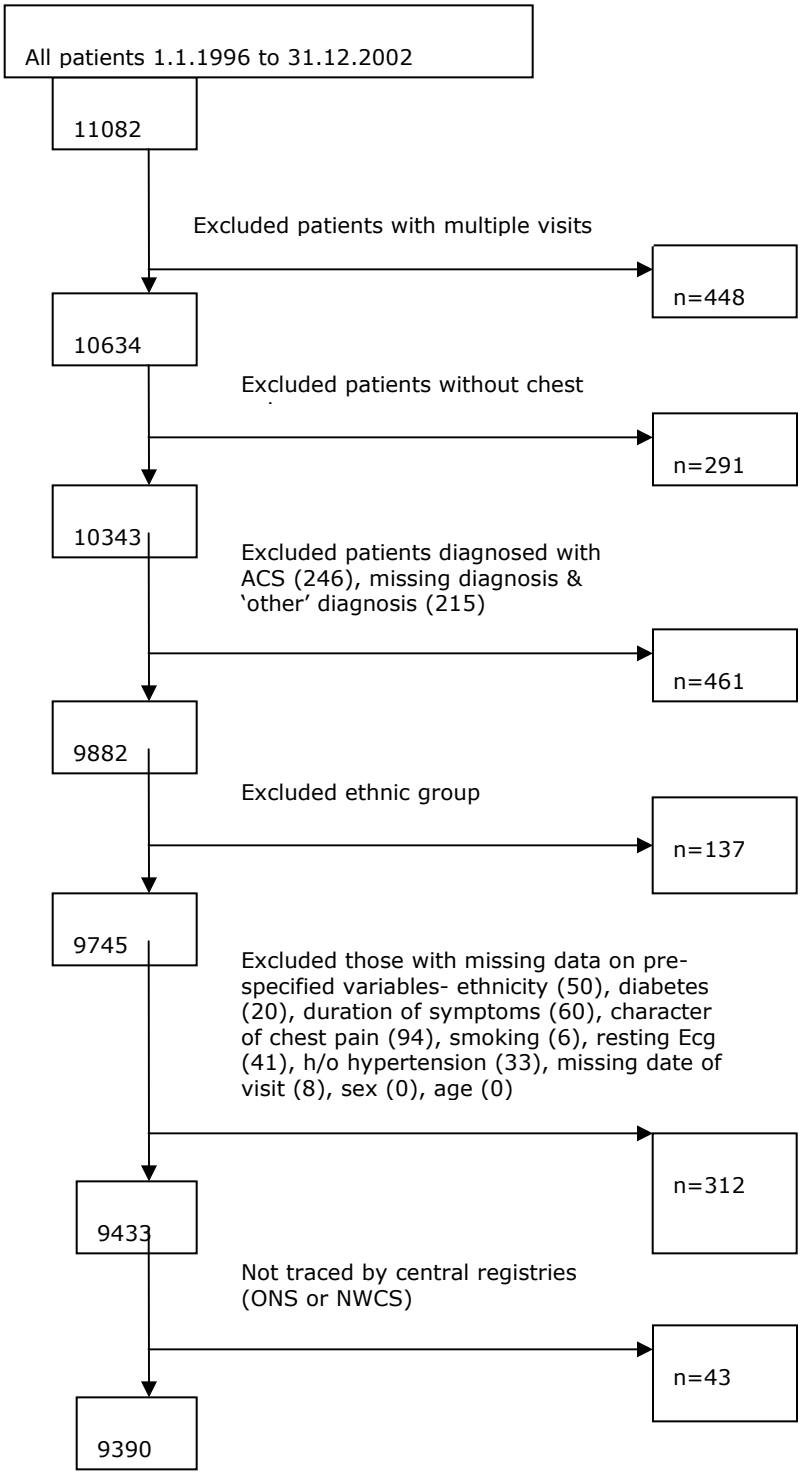
(a) Characteristics of the rapid access chest pain clinic populations

4.3 Methods (objective 2a)

4.3.1 Study population (Figure 10)

For this analysis we started with the 11,802 consecutive patients on which data had been entered from 2 January 1996 to 31 December 2002 in the six RACPCs that participated in this study. Figure 10 shows patients we excluded for this analysis. We have characterised the cohort by age, gender, ethnicity and by different RACPC centres.

Figure 10: Study population for objective 2a



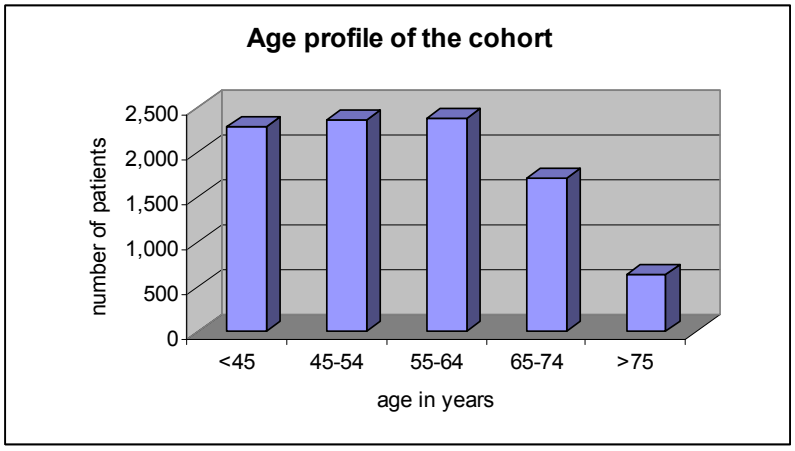
4.4 Results (objective 2a)

4.4.1 Age

Attendance (Figure 11)

In our study, 74 percent of the cohort was aged under 65. In each age band, more than half the patients were white and the proportion increased with age, comprising 90 percent of those aged more than 75. There was an increase in the proportion of patients with hypertension, abnormal resting electrocardiogram and past history of acute coronary syndrome with age.

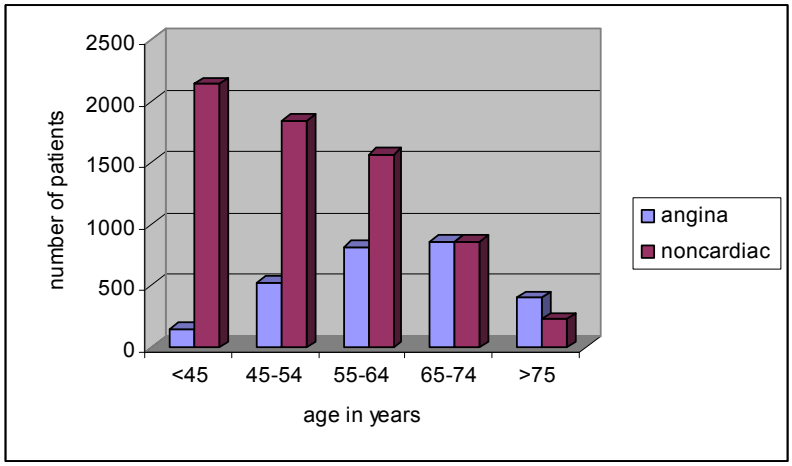
Figure 11: Age profile of the cohort



Diagnosis and discharge (Table 16)

Predictably the diagnosis of angina and presence of typical chest pain increased with age, while the majority of those aged less than 45 were diagnosed with non-cardiac chest pain. (Figure) Nearly half of those aged more than 75 were given cardiology outpatient appointments while 87 percent of patients less than 45 were discharged back to their general practitioners.

Figure 12: Distribution of diagnosis by age



Outcome

The number of events increased with age (Table 16). The highest proportion of CHD deaths or non-fatal MI [32 percent (82/260)] occurred in patients aged between 65 to 74, followed by 28 percent (72/260) in patients aged between 55 to 64. (Figure 13)

Figure 13: Proportion of total events by age group

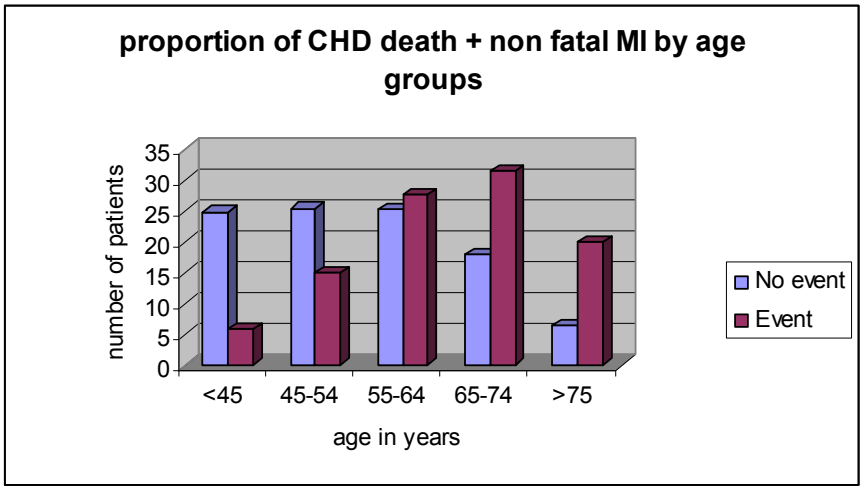


Table 16: Characteristics of cohort by age group (n=9390)

	45 years (n=2287) 24%	**45-54 years (n=2364) 25%**	**55-64 years (n=2384) 25%**	**65-74 years (n=1722) 18%**	**>75 years (n=633) 7%**
Diagnosis					
angina	150 (7%)	525 (22%)	816 (34%)	859 (50%)	402 (64%)
non-cardiac chest pain	2137 (93%)	1839 (78%)	1568 (66%)	863 (50%)	231 (36%)
Males	1365 (60%)	1240 (52%)	1208 (51%)	912 (53%)	313 (50%)
Ethnicity					
White	1227 (54%)	1468 (62%)	1630 (68%)	1319 (77%)	572 (90%)
south Asian	796 (35%)	734 (31%)	549 (23%)	290 (17%)	45 (7%)
black	264 (12%)	162 (7%)	205 (9%)	1319 (77%)	16 (3%)
Risk Factor					
current smoker	670 (29%)	655 (28%)	559 (23%)	257 (15%)	55 (9%)
hypertension	374 (16%)	755 (32%)	1022 (43%)	830 (48%)	325 (51%)
diabetes	129 (6%)	272 (12%)	306 (13%)	267 (16%)	82 (13%)
Cardiac history					
ACS*	15 (1%)	60 (3%)	123 (8%)	133 (8%)	66 (10%)
PTCA/CABG†	11 (1%)	48 (2%)	82 (3%)	95 (5%)	27 (4%)
Duration of chest pain					
< 4 weeks	1218 (53%)	1182 (50%)	1075 (45%)	752 (44%)	269 (43%)
1 to ≤ 6 months	716 (31%)	772 (33%)	810 (34%)	622 (36%)	242 (38%)
>6 to ≤12 months	113 (5%)	125 (5%)	154 (6%)	105 (6%)	35 (6%)
> 1 year	240 (11%)	285 (12%)	345 (14%)	243 (14%)	87 (14%)
Character of chest pain					
typical	177 (8%)	481 (20%)	669 (28%)	670 (39%)	321 (51%)
atypical	1334 (58%)	1506 (64%)	1374 (58%)	863 (50%)	251 (40%)
non-specific	776 (34%)	377 (16%)	341 (14%)	189 (11%)	61 (10%)

Electrocardiogram				
Normal 362(57%)	2096 (92%)	2078 (88%)	1890 (79%)	1197 (70%)
abnormal 271 (43%)	191 (8%)	286 (12%)	494 (21%)	525 (30%)
Exercise treadmill test				
positive 86 (14%)	*67 (3%)*	*205 (9%)*	*335 (14%)*	*313 (18%)*
non-diagnostic 35 (6%)	28 (1%)	113 (5%)	120 (5%)	99 (6%)
negative 118(19%)	956 (42%)	1241 (53%)	1079 (45%)	632 (37%)
not done (unable / not indicated) 393 (62%)	1236 (54%)	805 (34%)	850 (36%)	678 (39%)
Systolic blood pressure *(mm Hg)* 150 (±21)	130 (±17)	138 (±19)	144 (±20)	149 (±20)
Disposal ‡				
admitted 2 (0.3%)	5 (0.2%)	2 (0.1%)	3 (0.1%)	1 (0.1%)
outpatient appointment 306 (49%)	237 (10%)	466 (20%)	671 (28%)	646 (38%)
referral for angiogram 54 (9%)	47 (2%)	147 (6%)	213 (9%)	191 (11%)
discharged back to GP 266 (42%)	1984 (87%)	1726 (74%)	1472 (62%)	869 (51%)
CHD death + MI § 52 (8%)	15 (0.6%)	39 (2%)	72 (3%)	82 (5%)

** ACS- acute coronary syndrome. † PTCA/CABG- percutaneous coronary angiogram / coronary artery bypass graft. ‡ disposal information was only available for 9308 patients. § Primary endpoint of death due to coronary heart disease or non fatal myocardial infarction.*

4.4.2 Gender

Men, comprising 54 percent of the cohort, were on average younger than women, and a larger proportion had typical chest pain and a diagnosis of angina. Coronary risk factors were more common in women, while men were more likely to be smokers, have more abnormal resting electrocardiograms, positive exercise treadmill tests and a previous history of documented coronary heart disease. Consistent with these factors, men had higher prescription rates for anti-anginal drugs and referral for a coronary angiogram.

4.4.3 Ethnicity

Two-thirds of the cohort was identified as white (66 percent), south Asians (26%) and blacks (eight percent comprised the remaining one third. South Asians were younger, followed by blacks and had a higher proportion of non-specific symptoms and a lower proportion with a diagnosis of angina compared to whites. There were more men than women in all ethnic groups especially among blacks. As expected, smoking was more common among whites, diabetes among south Asians and hypertension among blacks. The rate of exercise stress testing, referral for coronary angiogram and prescription of anti-anginal drugs was higher among whites.

Table 17: Characteristics of cohort by gender

	Male n=5038 (54%)	Female n=4352 (46%)
Age mean	54 (±13)	56 (±13)
Diagnosis		
angina	1633 (32%)	1119 (26%)
non-cardiac pain	3405 (68%)	3233 (74%)
Ethnicity		
White	3331 (66%)	2885 (66%)
south Asian	1372 (27%)	1042 (24%)
black	335 (7%)	425 (10%)
Cardiac history		
ACS *	289 (6%)	108 (3%)
PTCA/CABG †	213 (4%)	50 (1%)
Risk Factor		
current smoker	1418 (28%)	778 (18%)
hypertension	1603 (32%)	1703 (39%)
diabetes	588 (12%)	468 (11%)
Duration of chest pain		
< 4 weeks	2466 (49%)	2030 (47%)
1 to ≤ 6 months	1675 (33%)	1487 (34%)
>6 to ≤12 months	272 (5%)	260 (6%)
> 1 year	625 (12%)	575 (13%)
Character of chest pain		
typical	1345 (27%)	973 (22%)
atypical	2785 (55%)	2543 (58%)
nonspecific	908 (18%)	836 (19%)

Resting electrocardiogram		
normal	3972 (79%)	3651 (84%)
abnormal	1066 (21%)	701 (16%)
Exercise Treadmill test		
positive	714 (14%)	292 (7%)
negative	205 (4%)	191 (4%)
non-diagnostic	2249 (45%)	1777 (41%)
not done- not indicated	1090 (22%)	1313 (30%)
not done- other reason	780 (15%)	779 (18%)
Systolic blood pressure (mm Hg)	139 (±20)	142 (±22)
Disposal from clinic (n=9308)		
Admitted	7 (0.1%)	6 (0.1%)
OP appointment	1238 (25%)	1088 (25%)
referred for angiogram	488 (10%)	164 (4%)
discharged back to GP	3256 (65%)	3061 (71%)
Drugs on discharge		
Aspirin	1809 (36%)	1287 (30%)
beta blockers	1195 (24%)	852 (20%)
statin	774 (15%)	521 (12%)
CHD death or nonfatal MI §	167 (4%)	82 (2%)

* ACS- acute coronary syndrome. † PTCA/CABG- percutaneous coronary angiogram / coronary artery bypass graft.

‡ disposal information was only available for 9308 patients. § 1º endpoint- CHD death or nonfatal MI

Table 18: Characteristics of cohort by ethnicity (n=9390)

		White (n=6216) 66%	south Asian (2414) 26%	Black (n=760) 8%
Age	mean	57 (±13)	51(±12)	51 (±13)
Diagnosis				
angina		2084 (34%)	561 (23%)	107 (14%)
non-cardiac chest pain		4132 (67%)	1853 (77%)	653 (86%)
Males		3331 (54%)	1372 (57%)	335 (86%)
Risk Factor				
current smoker		1725 (28%)	387 (16%)	84 (11%)
hypertension		2137 (34%)	821 (34%)	348 (46%)
diabetes		451 (7%)	506 (21%)	99 (13%)
Cardiac history				
ACS*		281 (5%)	105 (4%)	11 (2%)
PTCA/CABG†		191 (3%)	66 (3%)	6 (1%)
Duration of chest pain				
< 4 weeks		2631 (42%)	1414 (59%)	451 (59%)
1 to ≤ 6 months		2315 (37%)	652 (27%)	195 (26%)
>6 to ≤12 months		388 (6%)	113 (5%)	31 (4%)
> 1 year		882 (14%)	235 (10%)	83 (11%)
Character of chest pain				
typical		1772 (29%)	446 (19%)	100 (13%)
atypical		3565 (57%)	1353 (56%)	410 (54%)
nonspecific		879 (14%)	615 (25%)	250 (33%)
Electrocardiogram				
normal		4976 (80%)	2045 (85%)	602 (79%)
abnormal		1240 (20%)	369 (15%)	158 (21%)

Exercise treadmill test			
positive	766 (12%)	214 (9%)	26 (3%)
non-diagnostic	298 (5%)	84 (4%)	14 (2%)
negative	2762 (44%)	983 (41%)	281 (37%)
not done-not indicated	1291 (21%)	782 (32%)	330 (43%)
not done-unable to do	1099 (18%)	351 (15%)	109 (14%)
Systolic blood pressure (mm Hg)	142 (±20)	137 (±21)	142 (±22)
Disposal ‡			
admitted	10 (0.2%)	3 (0.1%)	0 (0%)
outpatient appointment	1802 (29%)	418 (18%)	106 (14%)
referral for angiogram	575 (9%)	71 (3%)	6 (1%)
discharged back to GP	3770 (61%)	1901 (79%)	646 (85%)
Drugs on disposal			
aspirin	2253 (36%)	698 (29%)	145 (19%)
beta blockers	1489 (24%)	455 (19%)	103 (14%)
statin	1042 (17%)	215 (9%)	38 (5%)
CHD death + MI §	181 (3%)	71 (3%)	8 (1%)

** ACS- acute coronary syndrome. † PTCA/CABG- percutaneous coronary angiogram / coronary artery bypass graft. ‡ disposal information was only available for 9308 patients. § primary endpoint of death due to coronary heart disease or non fatal myocardial infarction*

4.4.4. Variation between RACPCs (Table 19, Table 20)

The clinic populations varied demographically and clinically and in length of follow up. Newham was the oldest RACPC of the six centres and comprised 51% of the cohort followed by Oldchurch, comprising 27% of the cohort. The proportion of patients with a diagnosis of angina was highest in Blackburn (46%). Oldchurch RACPC had the highest referral rate for coronary angiograms. All centres had higher proportion of white than south Asian or black patients except Newham. Follow up for the primary endpoint of death due to coronary heart disease and non-fatal myocardial infarction ranged from 1.67 (95% CI 1.35-2.03) years in Burnley to 4.27 (95% CI 2.66-5.88) years in Newham.

The event rate of CHD death or non-fatal myocardial infarction was lowest in the Newham angina group 1.63 (95% CI 1.30-2.03) and for all cause mortality was lowest in Kingston RACPC 1.50 (95% CI 0.55-3.27) with overlapping of confidence intervals across centres.

Table 19: Follow-up and endpoints by centre (RACPC) [A-angina, NCCP – non cardiac chest pain)

Hospital characteristics	**Blackburn** (n=604) 6% of the cohort		**Burnley** (n=313) 3% of the cohort		**Kingston** (n=489) 5% of the cohort		**MRI** (n=646) 7% of the cohort		**Newham** (n=4775) 51% of the cohort		**Oldchurch** (n=2563) 27% of the cohort	
	A -275 (46%)	**NCCP** - 329 (54%)	**A** -139 (44%)	**NCCP** - 174 (56%)	**A** -192 (39%)	**NCCP** - 297 (61%)	**A** -237 (37%)	**NCCP** - 409 (63%)	**A** - 1190 (25%)	**NCCP** - 3585 (75%)	**A** -719 (28%)	**NCCP** -1844
Age mean (SD)	60 (±9)	52 (±9)	62 (±11)	52 (±12)	66 (±11)	52 (±13)	58 (±11)	53 (±13)	62 (±11)	50 (±12)	66 (±10)	53 (±13)
Males	188 (68%)	195 (59%)	95 (68%)	107 (61%)	124 (65%)	167 (56%)	119 (50%)	199 (49%)	648 (54%)	1853 (53%)	459 (64%)	884 (48%)
Ethnicity												
White	255 (93%)	277 (84%)	132 (95%)	154 (89%)	171 (89%)	250 (84%)	186 (79%)	309 (76%)	648 (55%)	1432 (40%)	692 (96%)	1710 (93%)
south Asian	18 (6%)	48 (15%)	7 (5%)	19 (11%)	21 (11%)	46 (16%)	40 (17%)	65 (16%)	453 (38%)	1588 (44%)	22 (3%)	87 (5%)
black	2 (1%)	4 (1%)	--	1 (1%)	--	1 (0.3%)	11 (5%)	35 (9%)	89 (8%)	565 (16%)	5 (1%)	47 (3%)
HTN	101 (37%)	88 (27%)	57 (41%)	49 (28%)	93 (48%)	88 (30%)	75 (32%)	112 (27%)	613 (51%)	1119 (31%)	338 (47%)	573 (31%)

Diabetes	33 (12%)	19 (6%)	15 (11%)	11 (6%)	25 (13%)	18 (6%)	35 (15%)	41 (10%)	284 (24%)	393 (11%)	97 (13%)	85 (5%)
Current smoker	60 (22%)	97 (29%)	32 (23%)	53 (30%)	22 (11%)	52 (18%)	70 (30%)	137 (34%)	279 (23%)	832 (23%)	136 (19%)	426 (23%)
Cardiac history												
ACS	21 (8%)	3 (1%)	9 (7%)	5 (3%)	14 (7%)	7 (2%)	14 (6%)	5 (1%)	155 (13%)	74 (2%)	63 (9%)	27 (2%)
PTCA / CABG	4 (2%)	5 (2%)	6 (4%)	2 (1%)	11 (6%)	3 (1%)	21 (9%)	9 (2%)	79 (7%)	57 (2%)	42 (6%)	24 (1%)
Resting ECG												
normal	160 (58%)	274 (83%)	85 (61%)	138 (79%)	99 (52%)	246 (83%)	150 (63%)	372 (91%)	768 (65%)	3207 (89%)	427 59%)	1697 (92%)
abnormal	115 (42%)	55 (17%)	54 (39%)	36 (21%)	93 (48%)	51 (17%)	87 (37%)	37 (9%)	422 (35%)	378 (11%)	292 (41%)	147 (8%)
ETT												
positive	124 (45%)	8 (2%)	62 (45%)	3 (2%)	58 (30%)	3 (1%)	52 (22%)	-- --	379 (32%)	14 (0.4%)	299 (42%)	4 (0.2%)
non-diagnostic	36 (13%)	6 (2%)	22 (16%)	3 (2%)	61 (32%)	18 (6%)	31 (13%)	299 (73%)	92 (8%)	77 (2%)	29 (4%)	21 (1%)
negative	75	286	40	160	41	263	75	104	232	1730	86	739

	(27%)	(87%)	(29%)	(92%)	(21%)	(89%)	(32%)	(25%)	(20%)	(48%)	(12%)	(40%)
not done-NI	--	1 (0.3%)	2 (1%)	3 (2%)	1(0.5%)	1 (0.3%)	4 (2%)	6 (2%)	44 (4%)	1405(39	--	838 (45%)
not done-reason	40 (15%)	28 (9%)	13 (9%)	5 (3%)	31 (16%)	12 (4%)	75 (32%)		443 (37%)	359 (10%)	305 (42%)	242 (13%)
Medication												
aspirin	246 (90%)	94 (29%)	41 (30%)	8 (5%)	165 (86%)	58 (20%)	210 (89%)	60 (15%)	1054 (89%)	353 (9%)	617 (86%)	208 (11%)
beta blocker	230 (84%)	63 (19%)	73 (53%)	10 (6%)	101 (53%)	23 (8%)	103 (44%)	47 (12%)	643 (54%)	202 (6%)	352 (49%)	200 (11%)
statin	256 (93%)	69 (21%)	61 (44%)	17 (10%)	67 (35%)	22 (7%)	96 (41%)	58 (14%)	203 (17%)	144 (4%)	134 (19%)	168 (9%)
Disposal												
admitted	--	--	--	--	--	1 (0.4%)	--	--	--	10 (0.3%)	--	2 (0.2%)
out patient	160 (59%)	44 (13%)	110 (88%)	19 (11%)	102 (56%)	65 (23%)	120 (51%)	15 (4%)	715 (60%)	179 (5%)	370 (52%)	427 (23%)
angiogram	66 (24%)	1 (0.3%)	7 (6%)	--	75 (41%)	1 (0.4%)	73 (31%)	-- 387(96%)	85 (7%)	--	344 (48%)	-- 1415 (77%)
discharged to GP	47 (17%)	284 (86%)	8 (6%)	150(89%)	5 (3%)	221 (77%)	44 (19%)		383 (32%)	3368(95%)	5 (1%)	

Table 20: Endpoints by centre (A-angina, NCCP – non cardiac chest pain)

	Blackburn (n=604)		**Burnley** (n=313)		**Kingston** (n=489)		**MRI** (n=646)		**Newham** (n=4775)		**Oldchurch**(n=2563)	
	6% of the cohort		3% of the cohort		5% of the cohort		7% of the cohort		51% of the cohort		27% of the cohort	
Median FU	2.26 (IQR 1.72-2.73)		2.01 (IQR 1.65-2.36)		2.08 (IQR 1.69-2.40)		2.18 (IQR 1.75-2.62)		4.48 (IQR 2.85-6.09)		2.55 (IQR 1.96-3.27)	
All cause death'04	1.92 (IQR 1.40-2.38)		1.67 (IQR 1.35-2.03)		1.75 (IQR 1.34-2.06)		1.86 (IQR 1.44-2.33)		4.27 (IQR 2.66-5.86)		2.24 (IQR 1.67-2.95)	
CHD death /MI'03												
	A	**NCCP**	**A**	**NCCP**	**A**	**NCCP**	**A**	**NCCP**	**A**	**NCCP**	**A**	**NCCP**
	n=275 (46%)	n=329 (54%)	n=139 (44%)	n=174 (56%)	n=192 (39%)	n=297 (61%)	n=237 (37%)	n=409 (63%)	n=1190 (25%)	n=3585 (75%)	n=719 (28%)	n=1844 (72%)
Annual mortality'03												
All cause	1.70% (0.78-3.23)	0.32% (0.14-1.14)	3.02% (1.21-6.38)	0.69% (0.08-2.48)	1.79% (0.65-3.89)	0	2.04% (0.93-3.87)	0.79% (0.29-1.72)	2.62% (022-3.10)	0.83% (0.69-0.99)	3.72% (2.84-4.80)	0.80% (0.55-1.12)
CHD / MI	2.65% (1.45-4.45)	0.47% (0.10-1.39)	3.45% (1.49-6.79)	0	2.68% (1.23-5.08)	0.96% (0.31-2.25)	1.82% (0.78-3.58)	0.66% (0.21-1.53)	1.63% (1.30-2.03)	0.39% (0.30-0.50)	3.17% (2.36-4.17)	0.34% (0.19-0.57)
Annual mortality'04	1.77% (0.88-3.17)	0.27% (0.03-0.97)	2.87% (1.23-5.64)	0.86% (0.18-2.51)	1.50% (0.55-3.27)	0.32% (0.04-1.17)	1.94% (0.93-3.56)	0.67% (0.25-1.46)	2.59% (2.17-3.06)	0.88% (0.74-1.04)	3.6% (2.78-4.58)	0.76% (0.54-1.06)

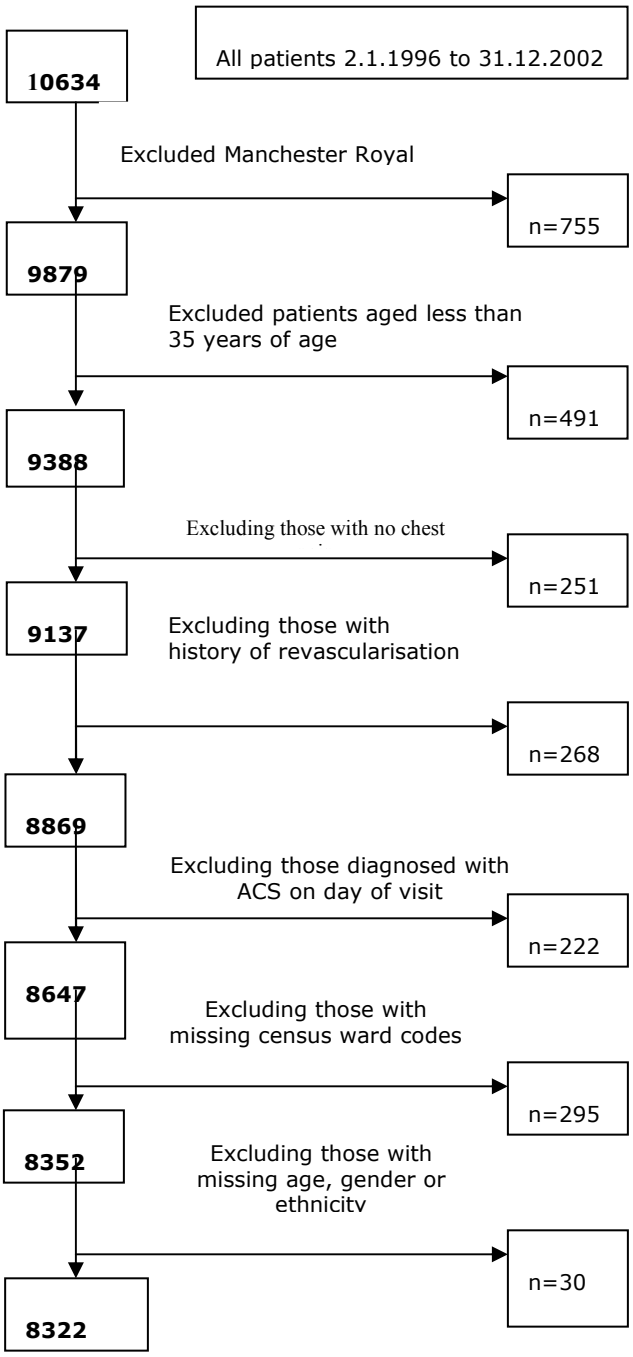
(2b) Analyse variation in access to rapid access chest pain clinics by age, gender, ethnicity and deprivation

4.5 Methods (objective 2b)

4.5.1 Patients (Figure 14)

Data on 8322 consecutive patients attending five different RACPCs were used for this analysis. The catchment area of these clinics was determined by the PCTs they served (Table 21). Manchester Royal Infirmary (a tertiary referral centre) did not have a clearly defined catchment area and was excluded from the analysis (n=755). All clinics had similar referral guidelines discouraging referral of younger patients and of those with known CHD.

Figure 14: Study population for objective b



4.5.2 Classification of ethnicity

The clinician assessing the patient in the rapid access chest pain clinic ascribed 'Asian', 'White', 'black' or 'other' ethnic identity during the consultation, choosing between those four categories. There were no explicit criteria for ascribing ethnicity; the category 'Asian' was used for patients of Indian, Pakistani, Sri Lankan and Bangladeshi origin and we have referred to this category as 'south Asian' in this report. The main comparison of interest is between white and south Asian patients.

4.5.3 Distance (in kilometers) for each ward from its respective RACPC

The distance for each patient from their respective clinic was calculated from their postcode recorded at attendance. Distance of each ward from the RACPC was calculated by averaging the distance of all the included patients from a given ward who visited that particular clinic. For wards with no attendees the distance from the geographic centre of the ward to the clinic was calculated. The median distance was 4.4 km (IQR 2.7-7.7km).

4.5.4 Denominator population (Table 21)

The denominator population for the RACPCs was identified by the catchment area for each clinic, which in turn was defined by the PCTs served by the respective hospitals. The identity of the PCTs constituting the catchment area of each RACPC was established by communication with administrative departments of the respective hospitals and matched to 2001 census ward boundaries.

Table 21: Catchment area for the five RACPCs

PCT	PCT CODE	HOSPITAL (RACPC)
Newham PCT	L5C5	Newham
Havering PCT	L5A4	Oldchurch
Dagenham & Barking PCT	L5C2	Oldchurch
Burnley, Pendle & Rosendale PCT	L5G8	Burnley
Blackburn with Darwen PCT,	L5CC	Blackburn
Hyndburn & Ribble Valley PCT	L5G7	Blackburn
Kingston PCT	L5A5	Kingston
Richmond & Twickenham PCT	L5M6	Kingston

4.5.5 Census wards data for catchment areas

The 2001 census was the source for ward level data on age, gender and ethnicity (proportion of south Asians, white and black). We aggregated these data for each census ward and used them as the denominator for each RACPC in the analysis.

4.5.6 Defining need: Matching of CHD mortality data to clinic catchment areas

We obtained data on deaths due to CHD (ICD 10 I20-I25) by age and gender for each census ward for the years 2000 to 2003 from the Office for National statistics (ONS) and adjusted the areas to conform to PCT boundary changes in 2002. Mortality data from 2000 were based on the ICD 9 code and for the subsequent years on the ICD 10 code with comparability ratios for ICD 10 I20-I25 between the two coding systems of 1.007 for men and 1.005 for women (www.statistics.gov.uk). The mortality data does not provide information on ethnicity and thus standardised mortality ratios (SMRs) from a cross-sectional analysis of

CHD mortality by country of birth in England and Wales (Wild, McKeigue, 1997) were used as measures.

4.5.7 Deprivation score

The Townsend index of deprivation calculated with census 2001 variables of the proportion of the ward population unemployed, with no car, not owner occupiers and in overcrowded housing. (2001 Townsend Index, South West Public Health Observatory, 2004)

4.5.8 Analysis (objective 2b)

The unit of analysis was the census ward. All analyses were performed with STATA version eight.

Data on 8322 patients were collapsed to census ward level by age group, gender, ethnicity and deprivation status which resulted in a dataset with 1608 counts (201 census wards x 2 age groups x 2 gender x 2 ethnicities). The Townsend score for a census ward was ecologically related to all patients with the same ward code. Person years for each census ward by age, gender and ethnicity combination were calculated by multiplying the category denominator by the time since establishment of the respective chest pain clinic. For age, patients were divided into two age bands- those aged 35 to 64 and those more than 65. Deprivation quintiles for Townsend score were calculated and quintile one to four was grouped together and is described as less deprived and quintile five as most deprived. Univariable and multivariable Poisson regression models were fitted to estimate attendance rates by age group, gender, ethnic group and deprivation status, controlling for distance and clinic. Similar Poisson regression models were fitted to estimate CHD mortality rates with person years calculated as the number in each ward by age, gender combination multiplied by four, the number of years for which CHD mortality data were available. For ethnicity, standardised mortality ratios from a previous study (Wild, McKeigue, 1997) as discussed above were used as a marker of need. A sensitivity analysis was done by excluding Newham chest pain clinic which contributed 55 percent of the total cohort and had a large proportion of south Asian patients, and people from deprived wards, which is not generalisable across the UK.

4.6 Results (objective 2b)

4.6.1 Attendance rate ratios by age (Figure 10 Table 22)

The univariable and multivariable attendance rate ratios for patients aged more than 65 were similar to the younger age group (35 to 64), despite the population CHD mortality rate ratios being nearly 15 times higher in the older age group.

4.6.2 Attendance rate ratios by gender (Table 2)

Women had lower attendance rate ratios, both adjusted and unadjusted, but also had proportionally lower population CHD mortality rate ratios compared to men.

4.6.3 Attendance rate ratios by ethnicity (Table 22)

South Asians had higher attendance rates (adjusted rate ratio of 1.67, 95 percent CI 1.57, 1.77) compared to whites and a higher standardised CHD mortality ratio, based on national data (Wild, McKeigue).

4.6.4 Attendance rate ratios by deprivation (Table 22)

Higher Townsend score corresponds to more deprivation. Univariable analysis showed the most deprived patients (quintile five) having an attendance rate twice that of less deprived quintiles (one to four), but the adjusted analysis showed their attendance rate to be 13 percent lower (0.87, 95 percent CI 0.81, 0.94) compared to the less deprived. Population CHD mortality rates are highest among the most deprived quintile.

4.6.5 Attendance rate ratios by clinic (Table 22)

Newham had the highest attendance rates followed by Oldchurch and are among the RACPCs which ran the clinic more frequently, five and four clinics a week respectively.

Table 22: Clinic attendance rate ratios and population CHD mortality rate ratios and CHD standardised mortality rate

Variable	***Baseline comparator***	***Univariable attendance RR (95% CI)***	***Multivariable attendance RR (95% CI) ****	***Univariable CHD mortality RR (95%CI)***	***Multivariable CHD mortality RR (95% CI) ****
Age (years)					
≥65	35-64	1.01 (0.96, 1.06)	1.10 (1.05, 1.16)	15.25 (14.47, 16.08)	15.79 (14.97, 16.65)
Gender					
Females	Males	0.82 (0.78, 0.86)	0.81 (0.77, 0.84)	0.74 (0.71, 0.76)	0.61 (0.59, 0.63)
Deprivation					
Most deprived	Less deprived	2.04 (1.95, 2.14)	0.87 (0.81, 0.94)	1.26 (1.21, 1.31)	1.25 (1.19, 1.30)
Distance (Km)		0.85 (0.84, 0.86)	0.93 (0.92, 0.94)	1.00 (0.99, 1.01)	0.99 (0.98, 1.00)
Clinic					
Oldchurch		0.57 (0.54, 0.60)	0.58 (0.54, 0.63)	1.28 (1.20, 1.36)	1.10 (1.02, 1.17)
Blackburn	Newham	0.29 (0.27, 0.32)	0.35 (0.32, 0.39)	1.24 (1.16, 1.33)	1.19 (1.10, 1.28)
Burnley		0.25 (0.22, 0.27)	0.30 (0.26, 0.34)	1.28 (1.19, 1.37)	1.22 (1.13, 1.31)
Kingston		0.22 (0.20, 0.24)	0.22 (0.19, 0.25)	0.81 (0.76, 0.87)	0.88 (0.80, 0.96)

Ethnicity					**CHD SMR (95% CI) †**
South Asian	White	2.54 (2.41, 2.68)	1.67 (1.57, 1.77)	--	1.46 (1.41,1.51)

*Attendance and CHD mortality rate ratios adjusted for age, gender and deprivation, distance and clinic. ** Less deprived group contains wards in deprivation quintiles 1-4. Most deprived group contains wards in deprivation quintile 5 †SMR from a cross-sectional analysis of CHD mortality by country of birth in England and Wales129*

In summary, multivariable analysis for attendance rates with adjustment for interaction between age, gender, ethnicity, deprivation, distance and clinic, showed lower rates for women and those in the most deprived quintile, but not for older people or south Asians. Population CHD mortality rates and, for ethnicity, CHD national standardised mortality ratios, used as proxy measures of need were much higher for older people, higher for people in wards with the lowest deprivation quintile and south Asians but lower for women.

A sensitivity analysis excluding Newham RACPC patients from the cohort resulted in similar results in the multivariable analysis. (data not shown).

(2c) Analysis of rates of referral to exercise tolerance testing, angiography in relation to age, gender, ethnicity and deprivation

4.7 Methods (objective 2c)

4.7.1 Patients

Referral for exercise stress test in patients with 20 to 80 percent pre-test probability of CAD

The same 11082 patients were the starting point for this analysis as in objectives a and b. We included 4251 patients in this analysis, after excluding those who were unable to exercise as shown in Figure

Referral and receipt of angiography: in the entire cohort, patients with angina and in those with pre-test probability of CAD >80%

The study population is displayed in Figure 15. Our main analysis was in 8446 patients. We also performed sub-group analysis in patients diagnosed with angina (n=2370) and in patients with a pre-test probability of coronary artery disease > 80% (n=1554).

Figure 15 : Study population for objective c (ETT)

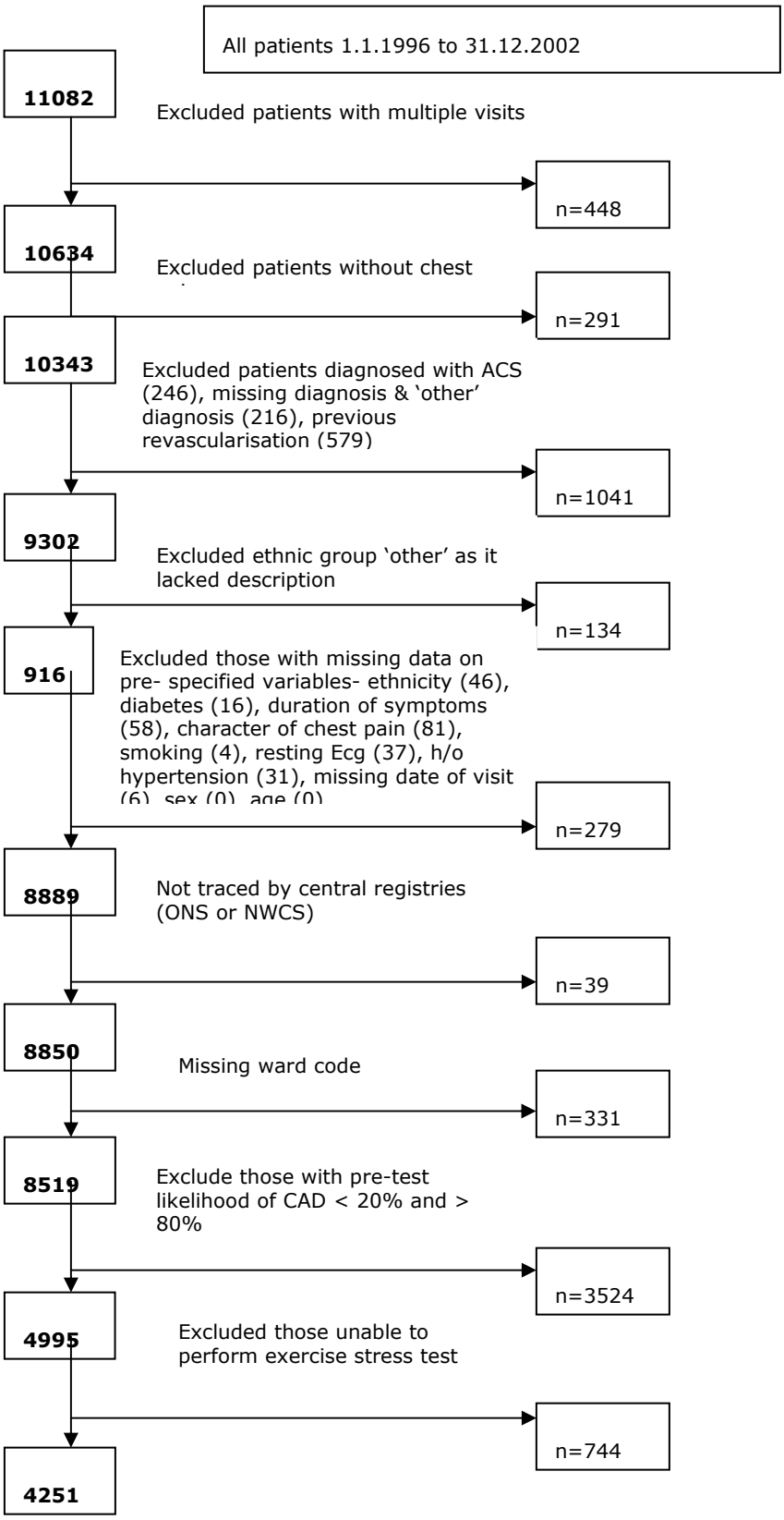
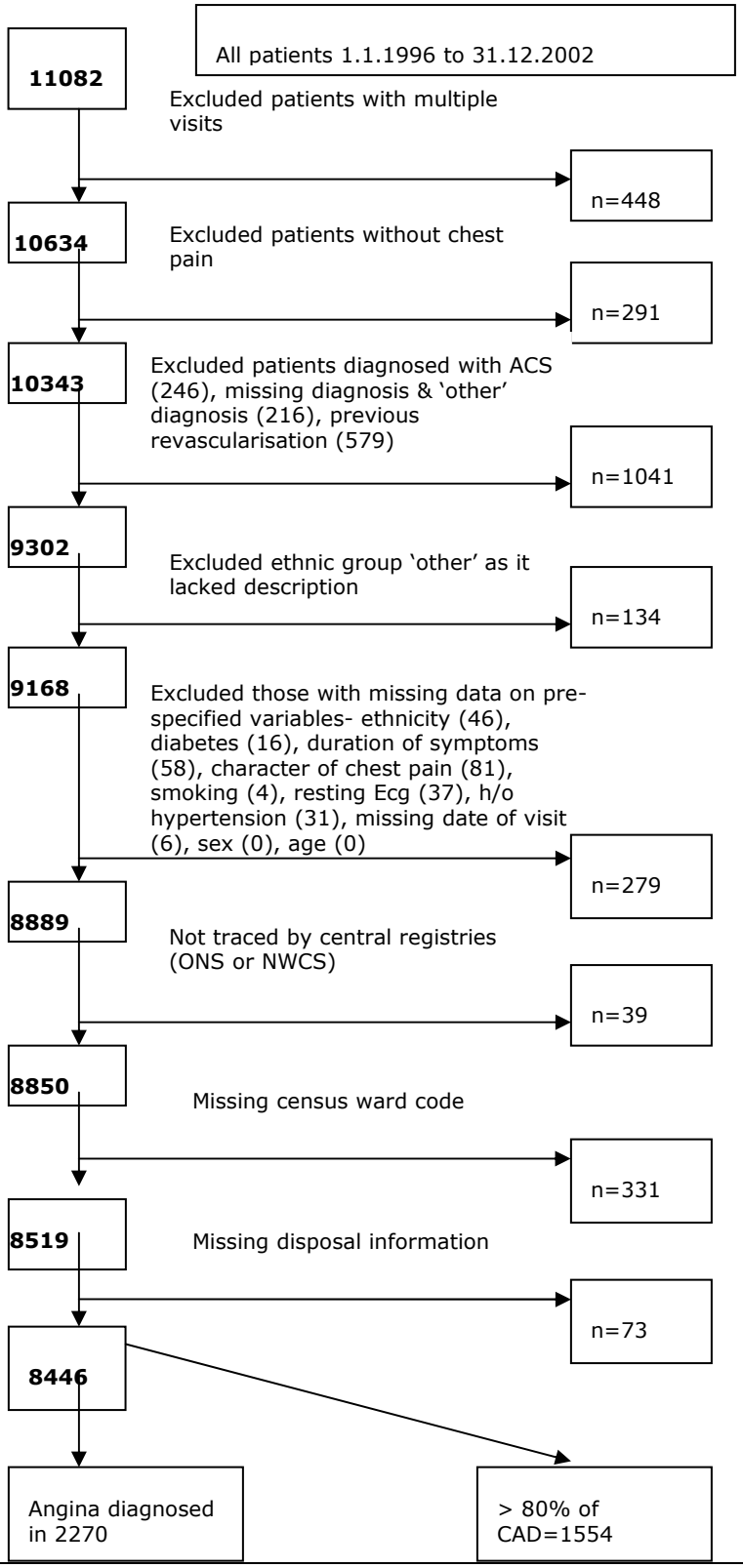


Figure 16: Study population for objective c (angiography)



4.7.2 Analysis

We used logistic regression for the endpoints of referral for an exercise stress test and coronary angiogram in the univariate and multivariate analyses. We included covariates that were significant at the five percent level in the multivariate model. Subgroup analysis to determine factors influencing referral for coronary angiogram was done for patients diagnosed with angina and for those with a pre-test likelihood of coronary artery disease of >80%. We used Kaplan Meier products for cumulative probability to determine the likelihood of undergoing a coronary angiogram by age, gender, ethnicity and deprivation after being referred from the clinic and also for the cumulative probability by age, gender, ethnicity and deprivation for reaching the endpoint of death due to coronary heart disease or non-fatal myocardial infarction. We used the log rank test to check for significant differences. A sensitivity analysis was performed with patients referred after 2000 to control for a secular trend in referral for angiography.

4.8 Results (objective 2c)

4.8.1 Referral for exercise stress test in patients with 20 to 80% probability of CAD

Factors associated with referral for an exercise stress test (Table 23, Table 24)

We found 4251 patients with intermediate probability of CAD were referred for an exercise stress test following their clinical assessment on the day of visit. Age and deprivation did not influence referral for an exercise stress test. Character of chest pain (typicality), was the most important reason for performing an exercise stress test with adjusted OR 83.76 (95% CI 39.44, 177.90) and 6.89 (95% CI 5.39, 8.81) respectively. Presence of risk factors (hypertension, diabetes, smoking), being male and presenting with longer duration of symptoms were other contributing factors. The high rates of referral for an exercise test by centre were dependent upon the clinic policy or clinician preference of exercising all patients presenting with chest pain as was evident on adding centre as a covariate. Despite this, south Asians were less likely to be referred for an exercise stress test, OR 0.58 (95% CI 0.46, 0.72).

4.8.2 Referral for coronary angiogram (Table 25, Table 26)

Factors associated with referral for coronary angiogram (n-8446)

Of the 8446 patients, 544 (6%) were referred for a coronary angiogram directly from the clinic and 936 patients (11%) in all underwent the procedure during follow up. Diagnosis of angina, presence of typical chest pain and a positive exercise stress test were among the most important factors associated with the decision to refer for a coronary angiogram, both in the univariable and multivariable analysis. In addition, men and patients with duration of symptoms longer than four weeks were also more likely to be referred while those identified as south Asian were less likely to be referred for invasive investigation. Increasing age was associated with raised odds of referral in the univariate analysis, OR 1.46 (95% CI 1.37, 1.57) but was inversely associated in the multivariate analysis, OR 0.72 (95% CI 0.65, 0.80). Diabetes, hypertension, smoking and an abnormal resting electrocardiogram did not make an independent contribution to the referral decision in the adjusted analysis. There appeared to be a strong centre effect influencing referral for angiography. Deprivation appeared to influence referral in the univariate analysis, with most deprived being less likely to be referred for an angiogram and also in the multivariable analysis if centre was not added as a covariate. When centres were added as a covariate to the model, deprivation was no longer a predictor of referral for coronary angiogram.

The analysis was repeated using data on patients referred after 31.12.2000 (4759) but the centre difference in odds of referral for angiogram remained. (data not shown).

Table 23: Logistic regression of factors potentially influencing referral of patients for an exercise stress test

Variable	Comparator	Univariate		Multivariate	
		Odds ratio (95% CI)	**P**	**Odds ratio 95% CI**	**P**
Age per 10 year increase		1.05 (0.99,1.12)	0.1196	NA	NA
Male	*Female*	0.86 (0.74,0.99)	0.0405	1.56 (1.32,1.84)	<0.0001
Ethnicity					
Black	*White*	0.58 (0.45,0.75)		0.64 (0.49,0.84)	0.0007
South Asian		0.74 (0.63,0.87)	<0.0001	0.78 (0.65,0.93)	
H/o hypertension	*None*	1.39 (1.19,1.63)	<0.0001	1.51 (1.28,1.79)	<0.0001
H/o diabetes	*none*	1.41 (1.09,1.82)	0.0078	1.53 (1.15,2.04)	0.0026
Current smoker	*None or ex-smoker*	1.31 (1.11,1.55)	0.0012	1.31 (1.09,1.57)	0.0033
Character of symptoms					
Typical	*Non-specific*	59.73 (28.64,124.56)	<0.0001	83.76 (39.44,177.90)	<0.0001
Atypical		5.82 (4.62,7.32)		6.89 (5.39,8.81)	
Duration of symptoms					
> 4 weeks	*< 4 weeks*	1.35 (1.17,1.55)	<0.0001	1.22 (1.05,1.42)	0.0106
Resting electrocardiogram					
Abnormal	*normal*	1.27 (1.01,1.61)	0.0373	1.27 (0.99,1.63)	0.0602
Townsend deprivation score					
Most deprived (quintile 5)	*Less deprived (quintile 1-4)*	1.00 (0.84,1.20)	0.9650	NA	NA

Table 24: Logistic regression of factors potentially influencing referral of patients for an exercise stress test in patients with 20-80 per cent CAD probability (n=4251) with hospital as covariate

Variable	comparator	Univariable		Multivariable	
		Odds ratio (95% CI)	**P**	**Odds ratio 95% CI**	**P**
Age per 10 year increase		1.05 (0.99,1.12)	0.1196	NA	NA
Male	*Female*	0.86 (0.74,0.99)	0.0405	1.42 (1.19,1.68)	0.0001
Ethnicity					
Black	*White*	0.58 (0.45,0.75)		0.53 (0.39,0.71)	<0.0001
South Asian		0.74 (0.63,0.87)	<0.0001	0.58 (0.46,0.72)	
H/o **hypertension**	*None*	1.39 (1.19,1.63)	<0.0001	1.65 (1.38,1.98)	<0.0001
H/o **diabetes**	*none*	1.41 (1.09,1.82)	0.0078	1.55 (1.15,2.09)	0.0033
Current smoker	*None or ex-smoker*	1.31 (1.11,1.55)	0.0012	1.26 (1.04,1.53)	0.0160
Character of symptoms					
Typical	*Non-specific*	59.73 (28.64,124.56)	<0.0001	106.44 (48.75,232.42)	<0.0001
Atypical		5.82 (4.62,7.32)		13.91 (10.26,18.86)	
Duration of symptoms					
> 4 weeks	*< 4 weeks*	1.35 (1.17,1.55)	<0.0001	1.23 (1.04,1.46)	0.0161

Resting electrocardiogram					
abnormal	*normal*	1.27 (1.01,1.61)	0.0373	0.95 (0.73,1.25)	0.7408
Hospital					
Blackburn		76.38 (10.69,545.85)		126.10 (17.20,924.33)	
Burnley	*Newham*	26.53 (6.56,107.37)		22.40 (5.34,94.02)	<0.0001
Kingston		87.53 (12.25,625.20)	<0.0001	55.44 (7.68,400.32)	
MRI		2.21 (1.49,3.28)		2.86 (1.76,4.67)	
Oldchurch		0.57 (0.49,0.66)		0.32 (0.26,0.40)	
Deprivation status					
Most deprived	*Less deprived*	1.00 (0.84,1.20)	0.9650	NA	NA

Table 25: Logistic regression of factors potentially influencing referral of patients for an angiogram (n=8446)

Variable	Comparator	Univariable		Multivariable	
		Odds ratio (95% CI)	**P**	**Odds ratio (95% CI)**	**P**
Angina diagnosis	*Non-cardiac diagnosis*	968.26 (241.31,3885.24)	<0.0001	279.57 (64.26,1216.28)	<0.0001
Age per 10 year increase		1.46 (1.37,1.57)	<0.0001	0.60 (0.53,0.68)	<0.0001
Male	*Female*	2.61 (2.15,3.17)	<0.0001	2.08 (1.57,2.76)	<0.0001
Ethnicity					
Black	*White*	0.07 (0.03,0.18)	<0.0001	0.29 (0.10,0.87)	0.0277
South Asian		0.30 (0.23,0.39)		0.74 (0.48,1.12)	
H/o **hypertension**	*None*	1.61 (1.35,1.92)	<0.0001	1.28 (0.98,1.68)	0.0737
H/o **diabetes**	*none*	1.45 (1.13,1.87)	0.0048	1.18 (0.81,1.71)	0.3979
Current smoker	*None or ex-smoker*	1.06 (0.86,1.29)	0.5969	NA	NA
Character of symptoms					
Typical	*Non-specific*	464.99 (65.26,3313.00)	<0.0001	8.18 (0.62,106.95)	<0.0001
Atypical		42.85 (5.98,306.86)		3.16 (0.24,41.19)	
Duration of symptoms		2.48 (2.05,3.00)	<0.0001	1.23 (0.91,1.65)	0.1745
> 4 weeks	*< 4 weeks*				

Resting electrocardiogram		2.73 (2.26,3.30)	<0.0001	1.12 (0.84,1.50)	0.4309
abnormal	*normal*				
Exercise treadmill test					
Positive	*negative*	133.80 (87.61,204.34)		33.39 (20.19,55.22)	
Non-diagnostic		16.30 (9.55,27.84)	<0.0001	3.23 (1.75,5.96)	<0.0001
Not done (unable to/ for medical reason/not indicated)		3.88 (2.47,6.11)		2.68 (1.59,4.53)	
Townsend deprivation score					
Most deprived (quintile 5)	*Less deprived (quintile 1-4)*	0.30 (0.22,0.43)	<0.0001	1.30 (0.80,2.10)	0.2935

Table 26: Logistic regression of factors potentially influencing referral of patients for an angiogram (n=8446) with hospital as covariate

Variable	Comparator	Univariable		Multivariable	
		Odds ratio (95% CI)	**P**	**Odds ratio (95% CI)**	**P**
Angina diagnosis	*Non-cardiac diagnosis*	968.26 (241.31,3885.24)	<0.0001	279.57 (64.26,1216.28)	<0.0001
Age per 10 year increase		1.46 (1.37,1.57)	<0.0001	0.60 (0.53,0.68)	<0.0001
Male	*Female*	2.61 (2.15,3.17)	<0.0001	2.08 (1.57,2.76)	<0.0001
Ethnicity					
Black	*White*	0.07 (0.03,0.18)	<0.0001	0.29 (0.10,0.87)	0.0277
South Asian		0.30 (0.23,0.39)		0.74 (0.48,1.12)	
H/o **hypertension**	*None*	1.61 (1.35,1.92)	<0.0001	1.28 (0.98,1.68)	0.0737
H/o **diabetes**	*none*	1.45 (1.13,1.87)	0.0048	1.18 (0.81,1.71)	0.3979
Current smoker	*None or ex-smoker*	1.06 (0.86,1.29)	0.5969	NA	NA
Character of symptoms					
Typical	*Non-specific*	464.99 (65.26,3313.00)	<0.0001	8.18 (0.62,106.95)	<0.0001
Atypical		42.85 (5.98,306.86)		3.16 (0.24,41.19)	
Duration of symptoms		2.48 (2.05,3.00)	<0.0001	1.23 (0.91,1.65)	0.1745
> 4 weeks	*< 4 weeks*				
Resting electrocardiogram		2.73 (2.26,3.30)	<0.0001	1.12 (0.84,1.50)	0.4309

abnormal	*normal*				
Blackburn					
Burnley		7.03 (4.89,10.10)		3.04 (1.82,5.08)	
Kingston	*Newham*	1.16 (0.46,2.89)	<0.0001	0.44 (0.16,1.22)	<0.0001
MRI		10.88 (7.66,15.47)		20.44 (11.46,36.45)	
Oldchurch		7.30 (5.10,10.43)		14.11 (8.24,24.15)	
		8.85 (6.79,11.54)		29.04 (18.31,46.06)	
Townsend deprivation score					
Most deprived (quintile 5)	*Less deprived (quintile 1-4)*	0.30 (0.22,0.43)	<0.0001	1.30 (0.80,2.10)	0.2935
Exercise treadmill test					
Positive	*negative*	133.80 (87.61,204.34)		33.39 (20.19,55.22)	
Non-diagnostic		16.30 (9.55,27.84)	<0.0001	3.23 (1.75,5.96)	<0.0001
Not done (unable to/ for medical reason/not indicated)		3.88 (2.47,6.11)		2.68 (1.59,4.53)	
Exercise treadmill test					
Positive	*negative*	133.80 (87.61,204.34)		33.39 (20.19,55.22)	
Non-diagnostic		16.30 (9.55,27.84)	<0.0001	3.23 (1.75,5.96)	<0.0001
Not done (unable to/ for medical reason/not indicated)		3.88 (2.47,6.11)		2.68 (1.59,4.53)	

Exercise treadmill test					
Positive	negative	133.80 (87.61, 204.34)		33.39 (20.19,55.22)	
Non-diagnostic		16.30 (9.55, 27.84)	<0.0001	3.23 (1.75,5.96)	<0.0001
Not done (unable to/for medical reasons/not indicated)		3.88 (2.47, 6.11)		2.68 (1.59, 4.53)	
Hospital					
Blackburn		7.03 (4.89, 10.10)		3.04 (1.82, 5.08)	
Burnley	Newham	1.16 (0.42, 2.89)	<0.0001	0.44 (0.16, 1.22)	<0.0001
Kingston		10.88 (7.66, 15.47)		20.44 (11.46,36.45)	
MRI		7.30 (5.10, 10.43)		14.11 (8.24, 24.15)	
Oldchurch		8.85 (6.79, 11.54)		29.04 (18.31, 46.06)	
Townsend deprivation score					
Most deprived (quintile 5)	Less deprived (quintile 1-4)	0.30 (0.22, 0.43)	<0.0001	1.30 (0.80, 2.10)	0.2935

Sub-group analysis - patients with angina (n=2270)

Both in the univariate and adjusted analysis (data not shown), angina patients who were male, white, had typical or atypical symptoms, had abnormal exercise stress test results or symptoms for more than four weeks were more likely to be referred for an angiogram while older patients and patients from deprived areas were less likely to be referred. These associations persisted after adjustment for cardiac risk factors.

Sub group analysis: Patients with pre-test probability of coronary artery disease>80% (n=1554)

Pre-test probability of coronary artery disease was calculated for all patients using the Diamond and Forrester algorithm (0 Aim1 objective c) and the factors associated with referral for a coronary angiogram were studied in patients with a high probability of coronary disease. Unadjusted and adjusted analysis showed that older people, women, south Asian patients and those from more deprived wards were less likely to be referred for a coronary angiogram.

For these 1554 patients, a similar analysis was repeated by using coronary angiogram procedure data provided by the NWCS as the outcome variable to compare the result of the analysis based on referral data from the clinics. Unadjusted and adjusted analysis showed that patients who underwent a coronary angiogram were likely to be younger, male, white, have an abnormal stress test result, longer duration of symptoms and from less deprived areas. (data not shown)

4.8.3 Survival analysis by subgroups

Survival analysis in the angina group (n=2379)

Kaplan Meier plots showed that the cumulative probability of CHD death or non-fatal MI in this subgroup was higher in men compared to women (log rank test p=0.01) but there was no significant difference between white and south Asian patients.

Survival analysis in patients with pre-test probability of CAD > 80% (n=1554) Figure 18

In the group of patients judged to have a high risk of coronary disease, there was no difference in the probability of CHD death or non-fatal

myocardial infarction among men and women. The difference in outcome between white and south Asian patients and between patients from deprived and affluent wards was not significant.

Figure 17: Cumulative probabilities of CHD death or non fatal MI in patients with angina (n=2270)

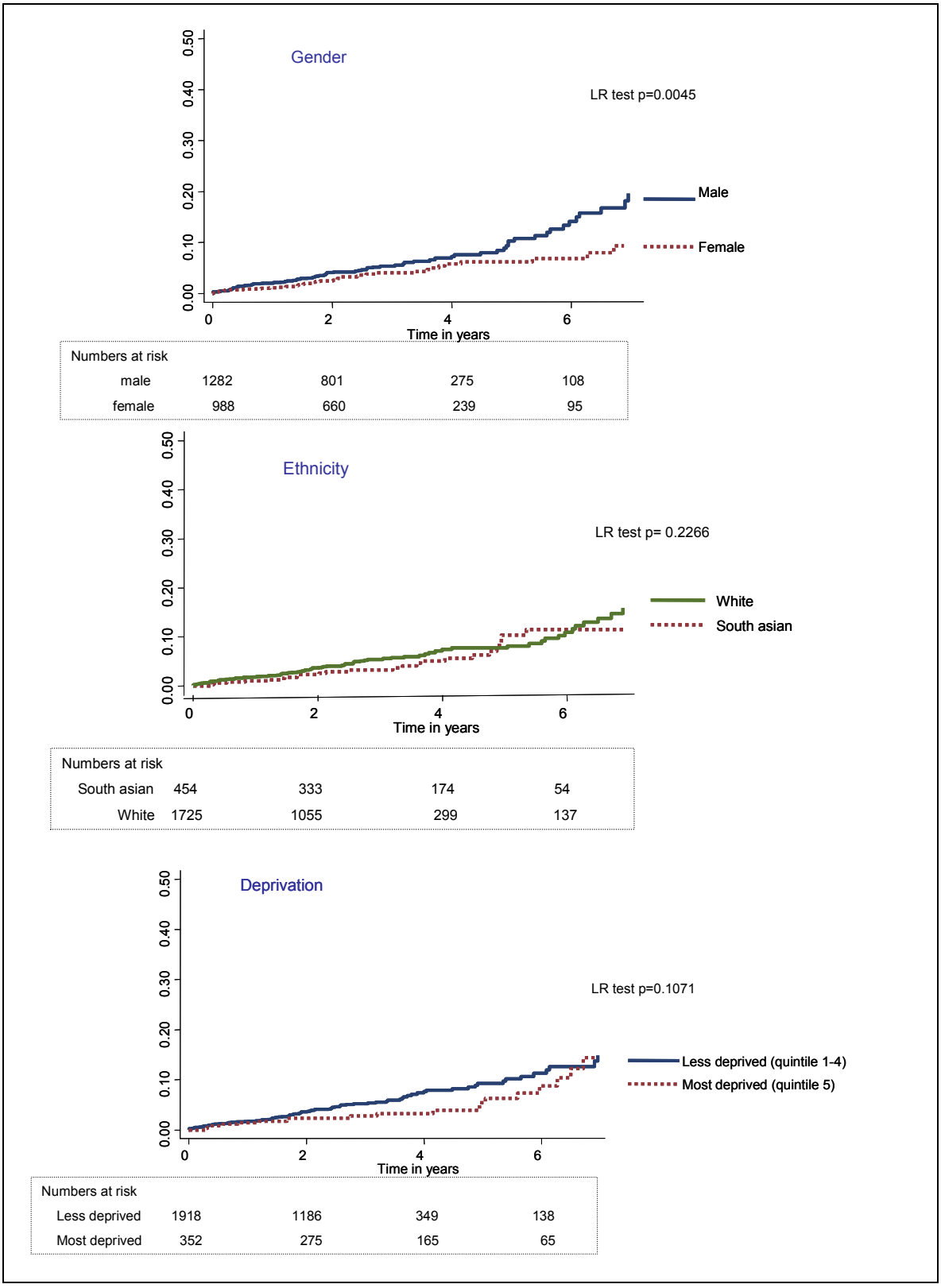
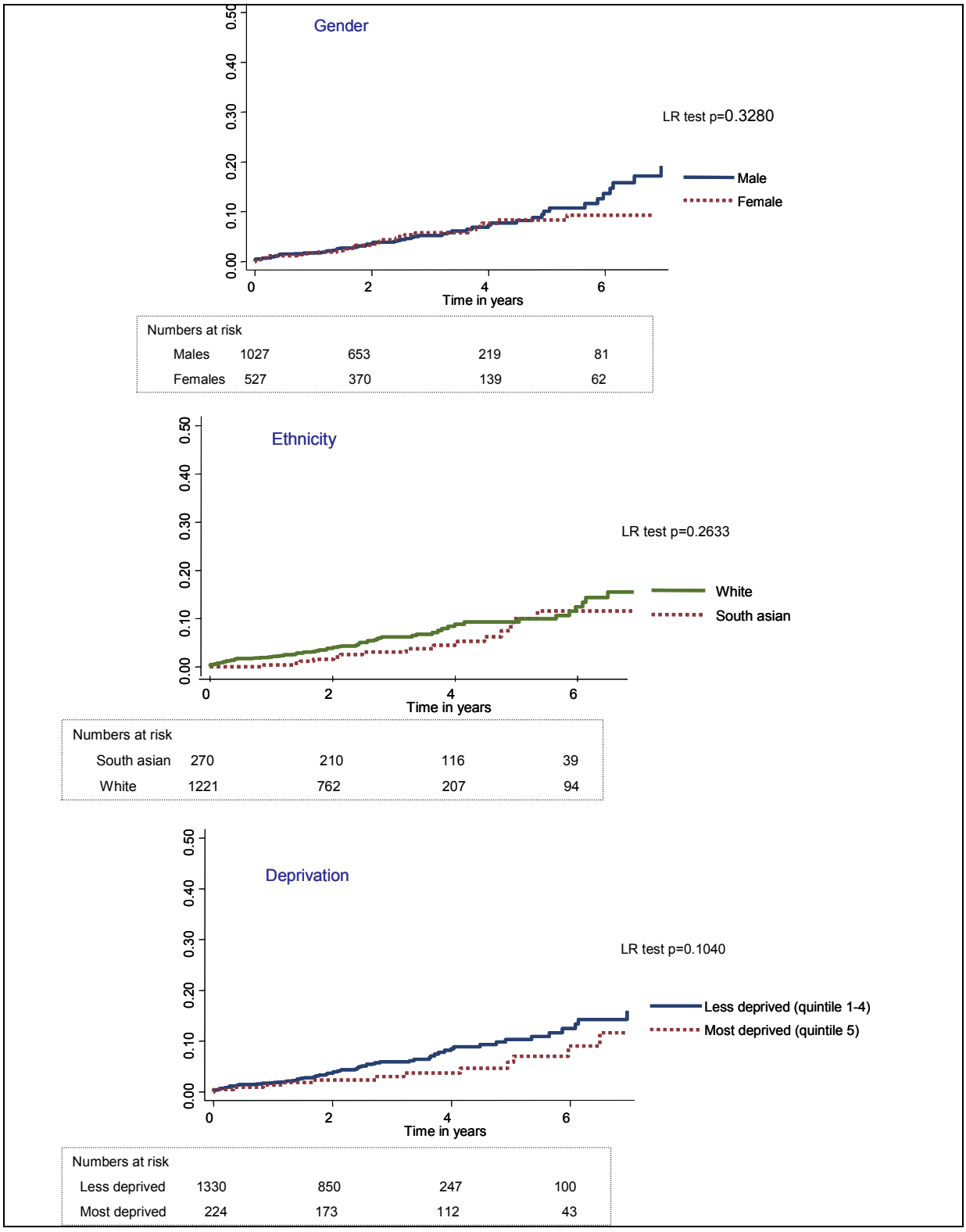


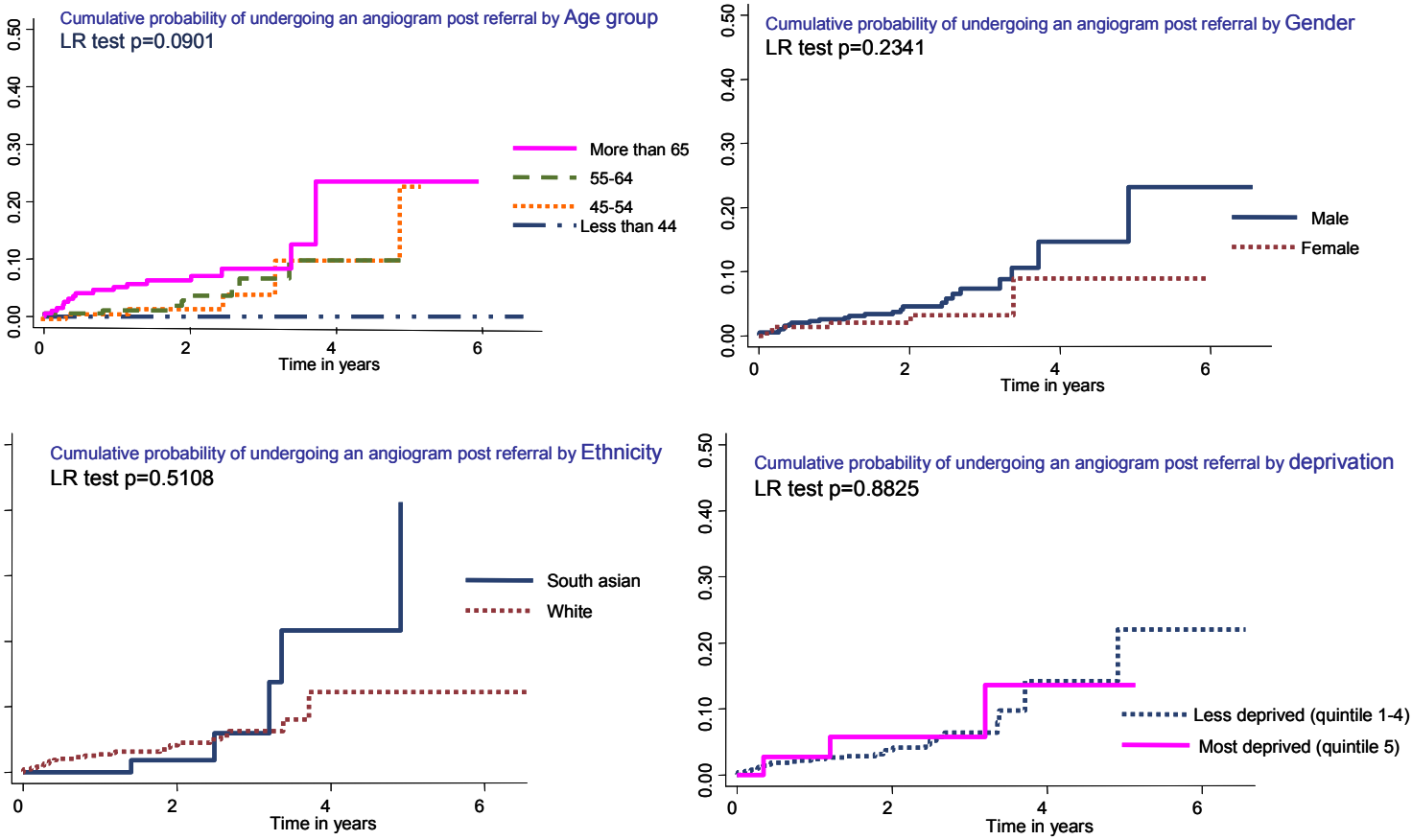
Figure 18: Cumulative probabilities for CHD death/ non-fatal MI in patients with CAD>80% (n=1554)



4.8.4 Probability of undergoing an angiogram after being referred from the RACPC (n=544) (Figure 19)

After being referred for an angiogram from the RACPC, the Kaplan Meier product of cumulative probability shows that both men and women, white and south Asian patients, younger and older patients, most deprived and less deprived, were equally likely to receive it.

Figure 19: Probability of undergoing the procedure after being referred for coronary angiogram



(2d) To analyse the appropriateness of cardiac investigation in RACPCs by applying appropriateness ratings to answer questions of over and under-use in different population groups. (Ref SDO/33/2002)

4.9 Methods (objective 2d)

The ARIA (Appropriateness of Referral and Investigation in Angina) ratings were developed according to the RAND-Delphi method. Individual panellists rated 3072 unique indications (unique combinations of clinical and patient characteristics), initially independently and, subsequently, with the results of the first round, at a meeting of all panellists in 2003. The two independent expert panels consisted of 11 members comprising five general practitioners, five cardiologists and one cardiothoracic surgeon each. Clinicians were drawn from nine towns: Panel A (England and Scotland): London, Bristol, Southampton, Nottingham, Birmingham, Dundee and Panel B (England and Ireland): London, Newcastle, Oxford and Galway. Each panellist received a personalised report containing their own first round ratings, and the median and range of ratings from the whole panel. Areas of disagreement were discussed at the panel meeting. Panellists had the opportunity to change their ratings if they were persuaded by the evidence and discussion, but were under no obligation to do so.

Appropriateness is defined by a nine point scale, with one to three denoting inappropriate, four to six uncertain and seven to nine appropriate. The most appropriate management step (rated nine) is defined as one in which benefit so clearly outweighs harm that it would always be carried out or it would be wrong not to do it. For an investigation to yield benefit, it must change the pre-test probability of diagnosis or prognosis by sufficient margin to change subsequent management. The most inappropriate management step (rated one) is defined as one in which harm so clearly outweighs benefit that it would never be carried out or it would be wrong to do it.

Ratings are made in the context of a health service without waiting lists; and exercise ECG and angiography can be ordered directly by generalists. This was done to ensure that the ratings truly reflect clinical need regardless of health service factors and can be applied to various settings and over time. The panellists also assumed that all patients are treated with secondary prevention medication where indicated, have identified angina or chest pain as a significant symptom from which they are actively seeking relief and are without a strong preference for a particular investigation, absolute indication or contra-indication or significant co-morbidity. The latter was done because withholding or carrying out a

procedure in these cases might be the right thing to do independent of the clinical appropriateness or inappropriateness of the investigation.

The indications (or hypothetical patients) were structured into six broad clinical presentations: previous abnormal coronary angiogram, previous normal coronary angiogram, previous history of acute coronary syndrome, typical angina symptoms, atypical angina symptoms, non-specific chest pain. Ten clinical descriptors define specific patient indications within some, or all of these presentations: previous revascularization, time of previous angiogram (if relevant), time of acute coronary syndrome (if relevant), age, gender, severity of symptoms, Canadian Cardiovascular Society (CCS) angina class, cardiovascular risk factors, resting ECG result, exercise ECG result (if relevant), medication for symptoms.

For each patient indication, panellists were asked for their rating on a nine point scale of the appropriateness of an exercise ECG (ETT) and of coronary angiography.

4.9.1 Ascribing appropriateness ratings to patients in the cohort (Figure 20)

For these analyses we used ratings of panel A, which rated in agreement with pre-test probabilities of coronary artery disease and was in closer agreement with current guideline recommendations. We attempted to match every patient with chest pain recorded at the time of the clinic (n=8672 & 7201) to an appropriateness rating for exercise ECG and for coronary angiography respectively.

(We are planning further detailed multivariable analysis using both panel ratings).

4.9.2 Angiography

We excluded fifty-six patients as they did not have a resting ECG result, which is part of each rating and a further 1411 patients for whom we did not have a Townsend deprivation score. Finally, we excluded 204 patients with acute coronary syndrome at the time of the RACPC visit for the analysis of referral, as acute coronary syndrome at the time of the clinic was not included in the ratings on the basis that for these patients immediate medical attention is always paramount. Follow up (deaths from ONS and admissions/procedures from NWCS) was complete for the remaining 8672 patients included in this analysis but none could be matched to the first two presentations (previous normal angiogram, previous abnormal angiogram) as data on previous angiograms and their results was not available. It was therefore assumed that none of the patients who were referred to the clinics had previously received these

investigations. This is a reasonable assumption, as absence of previous investigation is a requirement for RACPC referral from primary care.

4.9.3 For exercise stress test

For the analysis of appropriateness of ETT a further 1471 people were excluded as they were unable to exercise. Main outcome measure: receipt of ETT on a three point scale of appropriateness (inappropriate, uncertain, and appropriate). Under-use was defined as patients not receiving an investigation deemed appropriate by the expert panel (rated seven to nine); overuse was defined as patients receiving an investigation that was deemed inappropriate (rated one to three).

4.9.4 Analysis (objective 2d)

Definitions

Age was categorized into five levels: <45, 45 to 54, 55 to 64, 65 to 74 and >=75 and the Townsend score was categorised into quintiles.

Definition of under-use: appropriate investigation not performed.

Definition of over-use: inappropriate investigation performed.

Angiography

We calculated Kaplan Meier curves of receipt of angiography after the chest pain clinic in patients who were appropriate for the procedure to test for potential differences by age, gender, socio-economic status and ethnicity. Time was measured from the time of the clinic visit to the time of angiography or last follow-up. Patients deemed inappropriate by the panel who had a subsequent ACS were censored at the time of the ACS because their baseline appropriateness level has changed. Analyses were truncated at two years after clinic visit, as this was deemed the maximum waiting time for an angiogram, and to limit the effect of potential changes in appropriateness over time. We used univariable analyses to examine differences in patient characteristics and access as the appropriateness ratings already adjust for clinical need. In this analysis all patients were considered homogeneous in terms of clinical need as they were all appropriate for investigation.

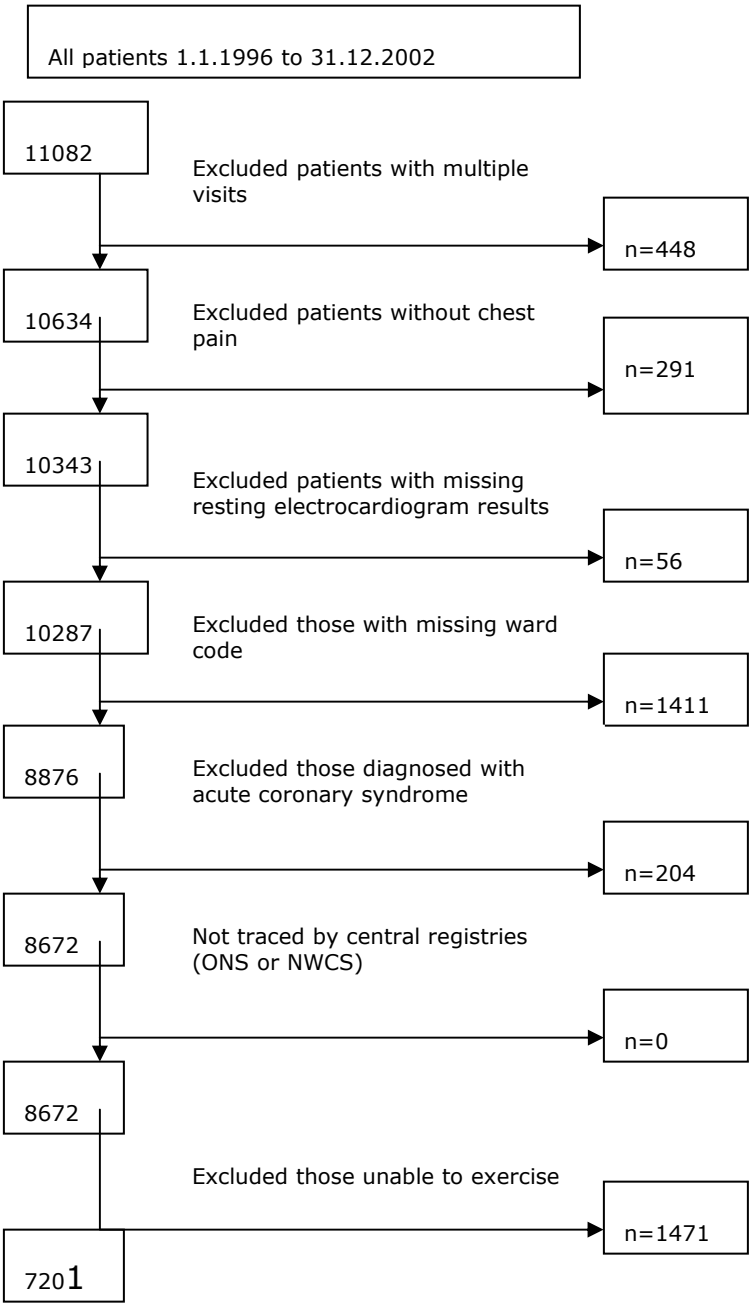
Exercise ECG

Survival analysis could not be performed for the analysis of under-use and over-use of exercise ECG, as there was no time dimension (exercise ECGs were performed at the time of the clinic visit). We therefore used logistic regression to investigate the association of having an exercise ECG at the time of clinic visit according to appropriateness criteria in patients appropriate for an exercise ECG according to the expert panel.

Impact of inequalities on outcome: Cumulative probabilities of all-cause mortality were calculated by appropriateness and actual management for age, gender, ethnicity and deprivation. We were unable to use CHD death or non-fatal MI as an outcome measure due to the small number of events.

(We are planning further analysis with composite endpoint of CHD death, non-fatal Mi and hospital admission with unstable angina).

Figure 20: Patients included for analysis of appropriateness ratings



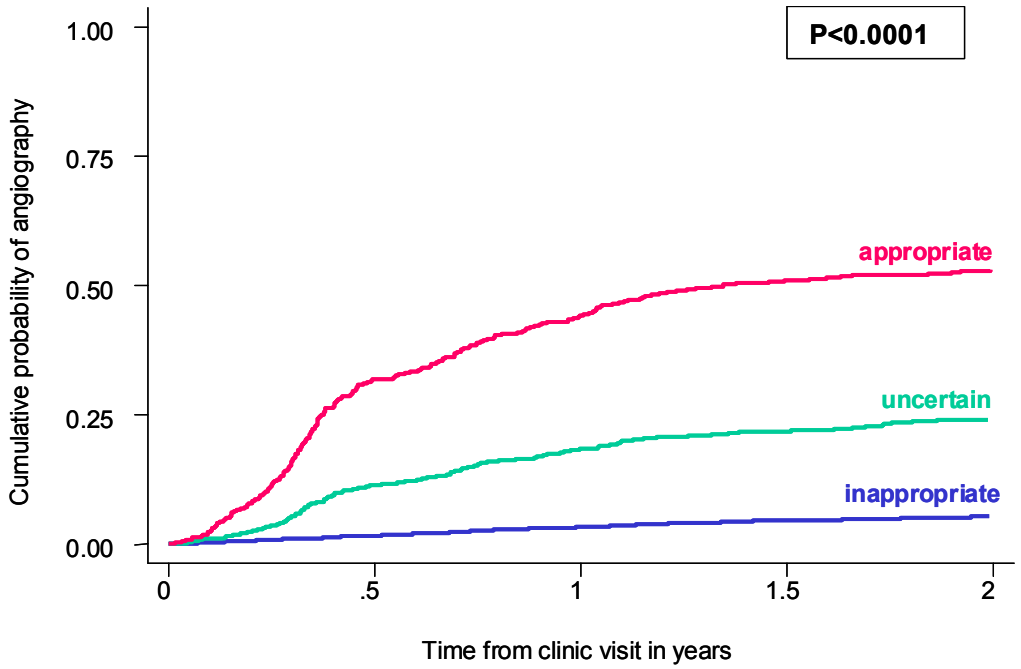
8672 patients were included for analysis of angiography appropriateness ratings

7201 patients were included for analysis of Exercise stress test (ETT) appropriateness ratings

4.10 Results (objective 2d)

The appropriateness ratings were predictive of receipt of angiography after the index visit to the clinic. (Figure) Almost half of all patients who were appropriate for angiography had received an angiogram by two years from the time of clinic visit, while less than 25 percent of those deemed uncertain and less than two percent of patients deemed inappropriate had received an angiogram by that time.

Figure 21: Cumulative probability of receiving an angiogram by appropriateness



The majority of patients seen at the clinic were appropriate for exercise ECG (67 percent), but only 11 percent were appropriate for angiography. More women than men were appropriate for exercise ECG, but more men than women were appropriate for angiography (Table , Table). With regard to ethnicity, the majority of white patients were appropriate for exercise ECG and a greater proportion of White patients were also appropriate for angiography compared to south Asian patients. Up to 74 years of age patients were increasingly appropriate for exercise ECG and angiography. Fewer patients aged over 75 years were appropriate for either of these investigations. Distributions of appropriateness by centre revealed three to 16 percent of patients inappropriate for ETT and 61 to 83% inappropriate for angiography, whereas 64 to 75% of patients were appropriate for ETT and 7 to 21% for angiography. Manchester, Newham and Oldchurch clinics had a higher proportion of patients inappropriate for these investigations than the other three centres.

Table 27: Distribution of appropriateness by selected patient characteristics

Characteristics	**ETT (n=7201)**		
	Inappropriate	Uncertain	Appropriate
All	798 (11.1%)	1617 (22.5%)	4786 (66.5%)
Men	493 (12.7%)	1173 (22.5%)	2203 (66.5%)
Women	305 (9.2%)	444 (13.3%)	2583 (77.5%)
South Asian	313 (18.2%)	480 (29.7%)	929 (53.9%)
Caucasian	388 (8.1%)	963 (20.1%)	3435 (71.8%)
Other or missing	97 (14.0 %)	174 (25.1%)	422 (60.9%)
Age			
<40	367 (35.0%)	591 (56.3%)	91 (8.7%)
40 - 49	341 (18.8%)	330 (18.2%)	1145 (63.1%)
50 - 59	41 (2.1%)	401 (20.2%)	1543 (77.7%)
60 - 74	38 (1.8%)	120 (5.8%)	1901 (92.3%)
75 +	11 (3.8%)	175 (59.9%)	106 (36.3%)
Blackburn	50 (9.7%)	84 (16.3%)	381 (74.0%)
Burnley	19 (5.6%)	76 (22.4%)	245 (72.1%)
Kingston	15 (3.0%)	113 (22.8%)	367 (74.1%)
Manchester	106 (18.3%)	124 (21.5%)	348 (60.2%)
Newham	477 (13.7%)	846 (24.4%)	2152 (61.9%)
Oldchurch	131 (7.3%)	374 (20.8%)	1293 (71.9%)
Townsend score (median, IQR)	8.91 (5.04,10.43)	8.52 (1.22,10.36)	6.70 (0.29,9.99)
ETT received	210 (4.5%)	917 (19.6%)	3550 (75.9%)
ETT not received	588 (23.3%)	700 (27.7%)	1236 (49.0%)

Table 28 Distribution of appropriateness by selected patient characteristics

Characteristics	Angiogram (n=8672)		
	Inappropriate	Uncertain	Appropriate
All	6817 (78.6%)	1076 (12.4%)	779 (9.0%)
Men	3528 (76.6%)	545 (11.8%)	532 (11.6%)
Women	3289 (80.9%)	531 (13.1%)	247 (6.1%)
South Asian	1696 (84.0%)	171 (8.5%)	151 (7.5%)
Caucasian	4410 (75.5%)	837 (14.3%)	597 (10.2%)
Other or missing	711 (87.8%)	68 (8.4%)	31 (3.8%)
Age			
<40	1087 (98.1%)	14 (1.3%)	7 (0.6%)
40 - 49	1811 (90.5%)	102 (5.1%)	88 (4.4%)
50 - 59	1826 (78.7%)	260 (11.2%)	234 (10.1%)
60 - 74	1702 (63.2%)	547 (20.3%)	444 (16.5%)
75 +	391 (71.1%)	153 (27.8%)	6 (1.1%)
Blackburn	367 (63.0%)	101 (17.3%)	115 (19.7%)
Burnley	272 (69.2%)	71 (18.1%)	50 (12.7%)
Kingston	396 (72.3%)	106 (19.3%)	46 (8.4%)
Manchester	496 (74.9%)	123 (18.6%)	43 (6.5%)
Newham	3494 (83.2%)	409 (9.7%)	294 (7.0%)
Oldchurch	1792 (78.3%)	266 (11.6 %)	231 (10.1%)
Townsend score (median, IQR)	8.13 (1.03, 10.24)	5.48 (0.46,9.50)	4.81 (-0.32,9.20)
Angiogram received	411 (36.9%)	280 (25.2%)	422 (37.9%)
Angiogram not received	6406 (84.7%)	796 (10.5%)	357 (4.7%)

Under-use

At the time of the clinic visit 74% of patients appropriate for an ETT had one. Only 54% of patients who were deemed appropriate by the expert panel received an angiogram at any time after the clinic visit. Six percent of those deemed inappropriate for angiography received an angiogram while a considerable proportion of those deemed uncertain underwent angiography (26%).

Potential inequities in access

Exercise ECG

Logistic regression showed that women compared to men appropriate for an ETT were less likely to receive it (OR 0.47; 95%CI 0.41-0.53). Compared with white patients who were appropriate for an exercise ECG, south Asian patients were less likely to receive an exercise ECG (OR 0.77; 95%CI 0.65-0.91). There were significant differences across age groups in all patients deemed appropriate for an exercise ECG: compared with the youngest patients (<40), all patients were more likely to receive an exercise ECG. The patients aged 50 to 74 were approximately three times as likely to receive an exercise ECG compared with patients aged less than 40. The difference was less pronounced in patients aged 75 or older (OR 2.16; 95% CI 1.21-3.88).

Angiography

When examining patients who were appropriate for angiography (n=779), figures 28 to 31 (left-sided) show probabilities (univariable analysis) of receiving angiography by age, gender, ethnicity and deprivation. Although men appeared to be more likely than women to receive angiography this difference was not statistically significant (log rank test p=0.22). White patients who were appropriate for angiography were more likely to receive it than south Asian patients (p=0.0083). Similarly, patients aged less than 55 or those aged more than 64 who were deemed appropriate for angiography by the expert panel, were less likely to receive angiography than patients in other age groups. Patients between 55 and 64 were most likely to receive an angiogram when appropriate (p=0.049). Those from more deprived areas were less likely to receive an angiogram.

4.10.2 Clinical impact of appropriateness and actual management

Figure shows the clinical impact of the actual management broken down by appropriateness. Patients who were appropriate for an angiogram but did not receive it were most likely to die from all causes by four years of follow-up. Patients who were appropriate for an angiogram and received it as well as patients who were inappropriate for angiography were least likely to die from all causes.

(We are planning further analysis with composite endpoint of CHD death, non-fatal Mi and hospital admission with unstable angina).

Figure 22: Association of appropriateness and actual management with all cause mortality

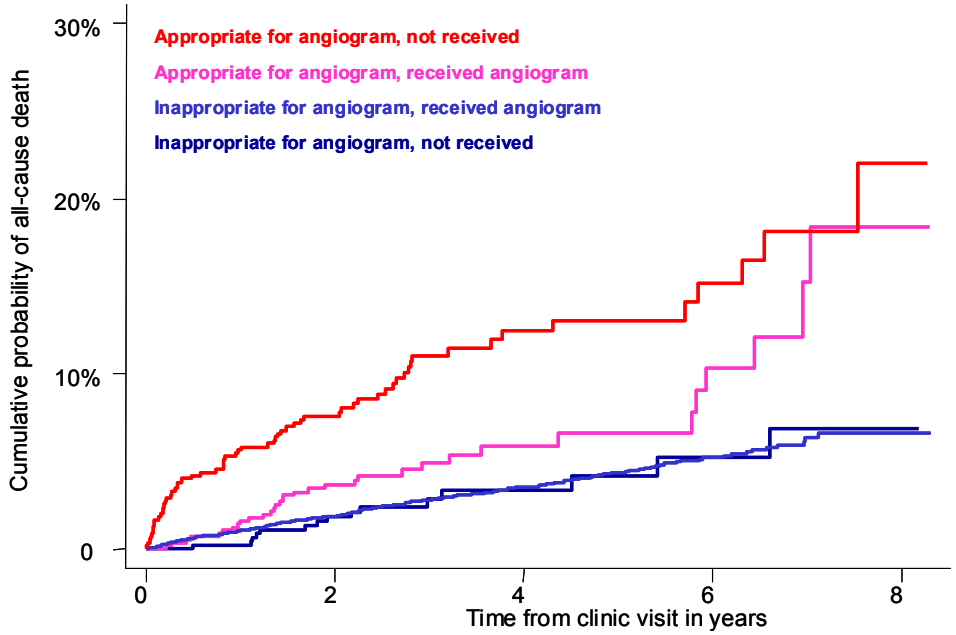


Figure 23, Figure 24, Figure 25,

Figure 26 (right panel) show the probability of dying from any cause among those who were appropriate for angiography (n=779) by age, gender, ethnicity and deprivation (AGED). Patients above the age of 64 were more likely to die (p=0.0019), but the probability of all cause death was almost the same in men and women (p=0.29) as between south Asians and white (p=0.73) and those in different deprivation quintiles (p=0.41).

Figure 23: Probability of angiogram (left) and all-cause mortality (right) by age

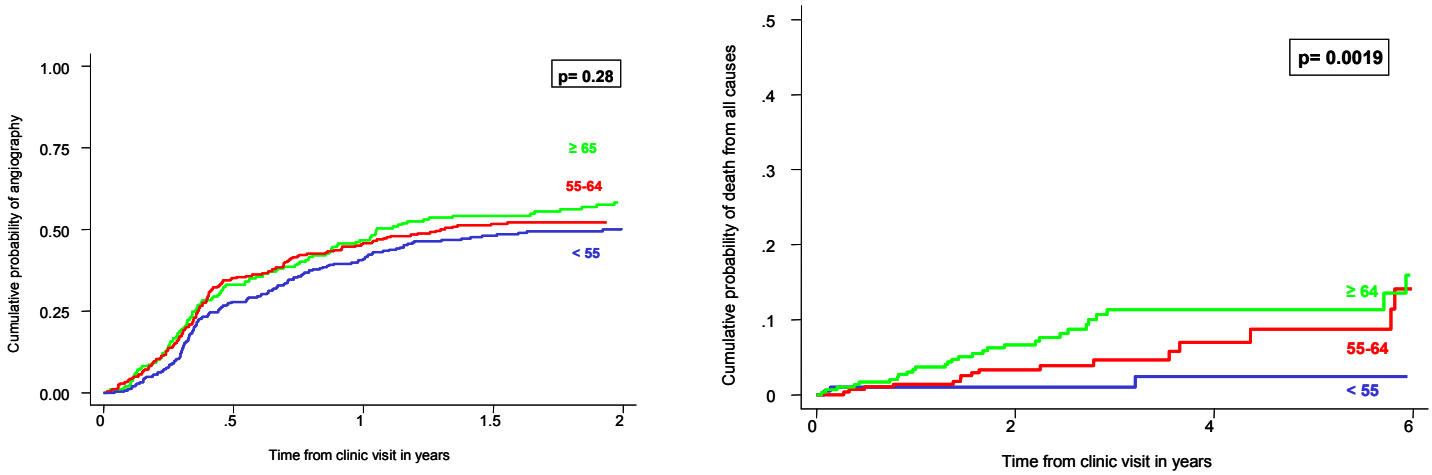


Figure 24: Probability of angiogram (left) and all-cause mortality (right) by gender

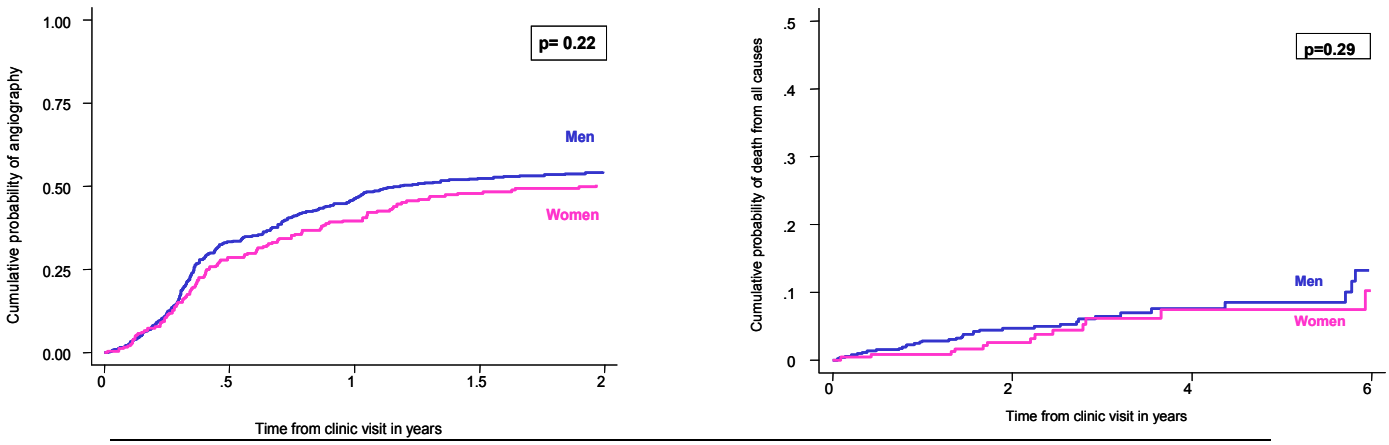


Figure 25: Probability of angiogram (left) and all-cause mortality (right) by ethnicity

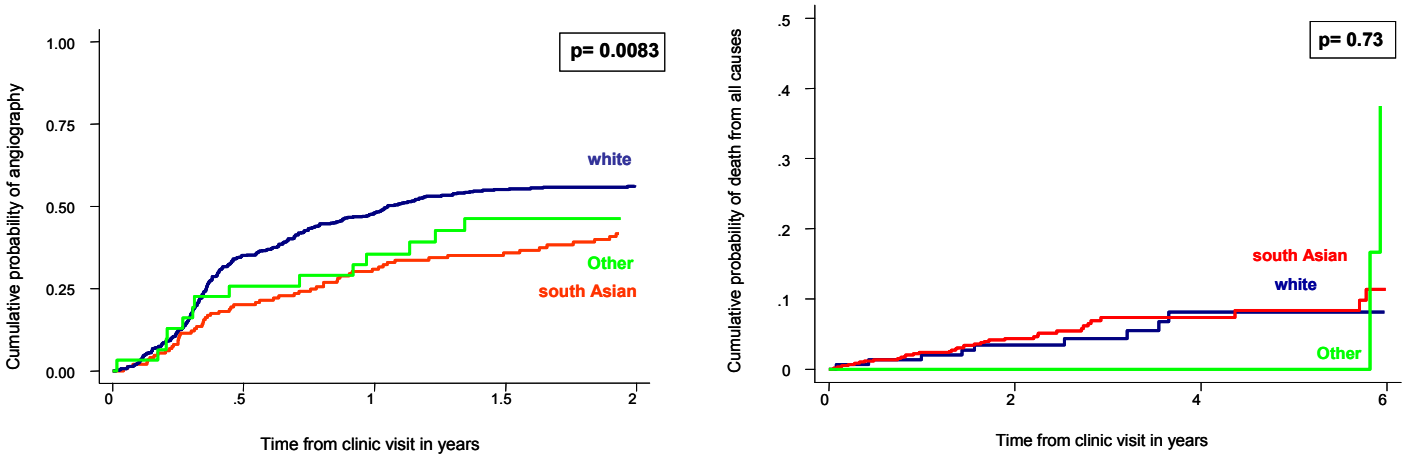
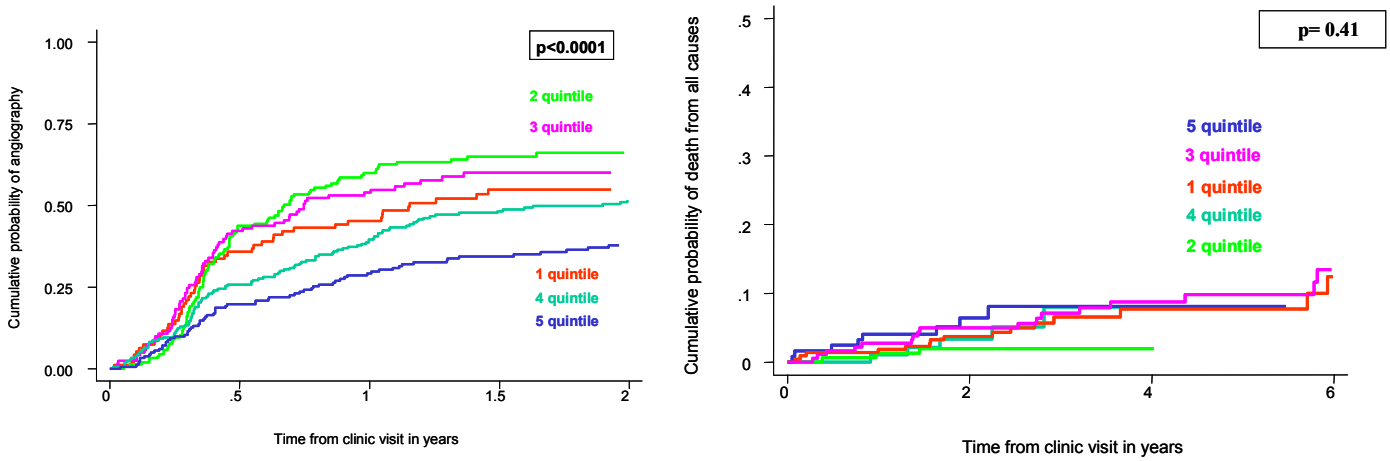


Figure 26: Probability of angiogram (left) and all-cause mortality (right) by deprivation



4.11 Discussion (Aim 2)

4.11.1 Access to rapid access chest pain clinics

Our results are consistent with equitable access to rapid access chest pain clinics for south Asians and women, but not for people from more deprived areas and older people when *need* (ward level CHD mortality) (Black, Langham, Petticrew, 1995), is taken into consideration.

Using census ward as the unit of analysis and ecologically relating the ward deprivation score (after matching with their postcode) to patients attending the RACPC, we found that those most deprived were 13 percent less likely to attend the clinic; this association of visit rates with deprivation persisted even when Newham, the centre contributing the most deprived wards and highest proportion of south Asian patients, was excluded from the analysis. The population CHD mortality rates calculated for those most deprived were high and a similar association was found by Lawlor and colleagues (Lawlor, Ebrahim, Davey, 2005).

South Asian patients had the highest attendance rates in this study, which is consistent with equity of access given the increased coronary risk of people in India, Pakistan and Bangladesh (Wild, McKeigue, 1997).

Women have significantly lower attendance rate, consistent with a lower catchment area population CHD mortality rate for female gender compared to men.

Centres like Newham and Oldchurch in which the rapid access chest pain clinic was held more than four times a week had a higher visit rate, even after adjustment for age, gender, ethnicity and deprivation. This partly reflects the common observation that use of a service is associated with its availability.

The increased risk of coronary disease with age is reflected in the increased population CHD mortality rates for older people. Despite this, the older people had similar attendance rates to those aged less than 65 which is a suggestion of inequity.

4.11.2 Use of exercise stress tests

There may be inequity in use of ETT by gender (Bowling, Bond, McKee, McClay, Banning, Dudley *et al*, 2001) and ethnicity (Lear, Lawrence, Burden, Pohl, 1994), although a recent analysis from the Whitehall II cohort did not find a difference in use of ETT between south Asians and whites. Analysis of patients with a CAD score of 20 to 80 percent showed that age and deprivation were not associated with differential use of this

test, although white patients were more likely to have the test even when we adjusted for other demographic and clinical factors in the multivariate model.

We adjusted more accurately for clinical need with a sub-group analysis of patients deemed appropriate for ETT using ARIA panel criteria. We found that women appropriate for ETT were less likely to receive it than men, south Asian patients were less likely to receive it than white patients, and patients aged over 75 were less likely to receive it than patients aged 50 to 74.

The lower use of ETT by south Asian patients conflicts with the findings of Britton and colleagues (Britton, Shipley, Marmot, Hemingway, 2004) in their analysis of civil servants in the Whitehall II study. Our cohort was more representative of the population of patients with angina nationally.

4.11.3 Referral for angiography from rapid access chest pain clinic

Angiography referrals were, not surprisingly, strongly associated with the diagnosis of angina. The increased likelihood of referral of patients less than 65 years, whites, men and people from less deprived wards in the univariate analyses persisted in the multivariable analysis in which angina diagnosis, ETT results and cardiovascular risk factors were included. This is consistent with inequity of referral for invasive investigation in older people, women, south Asian and black patients and those from more deprived areas. Increasing age was associated with increased referral for an angiogram in univariable analyses, but inversely correlated in the multivariate analysis. This suggests that taking into account other demographic factor and clinical assessment, there may be inequity in referral of older people to angiography from the clinics.

The robustness of these results was further tested with subgroup analyses of those patients diagnosed with angina and those with a pre-test probability of CAD >80%. We still found lower odds of referral for older patients, women, south Asians and those from most deprived areas. Additional univariable analysis of *receipt* of coronary angiography, based on patients deemed appropriate for referral according to the ARIA panel, confirmed the findings in relation to ethnicity and deprivation, but not gender and age. Appropriateness for a procedure, on the assumption that the ARIA panel's judgment is valid, is a more precise ascription of need at the individual patient level.

After referral for an angiogram from the clinic, age, gender and ethnicity did not influence the probability of undergoing catheterisation.

A striking finding, independent of the issue of equity of access to further investigation by different groups, is that almost half of patients deemed

appropriate for angiography by ARIA panel ratings had not undergone an angiogram over the follow-up period. This is of concern, especially as patients classified as appropriate who did not receive an angiogram, had worse outcomes.

4.11.4 Coronary events

The analyses of CHD death or non-fatal MI in patients with angina and those with a probability of CAD > 80% conflict: the former found more events in men; the latter found no differences between genders, ethnic groups and deprivation. The relatively small number of events in each sub-group makes these results unreliable and an insufficient basis for interpretations about the consequences of inequity in referral for further investigation from the clinics. Further analysis by appropriateness ratings showed no differences in cumulative events between demographic sub-groups (gender, ethnicity and ward-based deprivation score), but these comparisons are underpowered. Furthermore, the decision to do a coronary angiogram is driven as much, if not more, by need to improve morbidity, particularly symptoms, as by the potential reduction in mortality.

4.11.5 Strengths of equity analyses

This analysis of equity of access to and referral from rapid access chest pain clinics is multi-centred and based on an unselected clinical population with uniformly collected patient-level data, including a broad classification of ethnicity. There are sufficient numbers of patients having exercise tolerance tests and referrals for angiography for comparison of demographic and clinical sub-groups. We used several methods to take into account clinical need or appropriateness in the analysis of ETT use and referral for/receipt of angiography, to test the robustness of the findings of potential inequity.

4.11.6 Limitations of equity analyses

These findings are based on a non-random sample of five clinics out of more than 175 nationally; therefore we need to be cautious about extrapolating them to the generality of rapid access chest pain clinics. The deprivation measure we used for both the analysis of access and for referral for angiography, the Townsend score, is based on census ward level, not individual socio-economic status and therefore the analysis is less precise and prone to the ecological fallacy (ascription of average deprivation across a ward to an individual who lives in that ward). Another limitation is the broad classification of ethnicity and its source in the labelling of the patient by the clinician who put the information on the database. Although it is likely that the label of '(south) Asian' corresponds

to the broad census category of south Asian, the latter is based on self-ascription. The validity of this category, whatever its source, depends on the research question (Bhopal and Donaldson, 1998). In this study we are able to answer questions about inequity relating to a broad ethnicity category. It is justified to pose these questions because previous research in the United Kingdom suggests inequitable access to some cardiac services using broad ethnicity categories (Institute of Community Health Sciences research group, 2001) and also because discrimination by clinicians against ethnically heterogeneous minority groups may be an explanation for inequity (Schulman, Berlin, Harless, Kerner, Sistrunk, Gersch *et al*, 1999; King, 1996).

Ward-based CHD mortality rate is a relatively crude proxy for clinical need (Black, Langham, Petticrew, 1995) in our analysis. Like the Townsend score, it is an area measure ascribed to individuals in the cohort. Ward-based hospital admission rates with ischemic heart disease would have given us a more accurate picture of need for the clinics, but data linkage problems meant that we were unable to use Hospital Episode data for this purpose. The other important limitation of CHD mortality as a measure of need for rapid access chest pain clinics is that they are targeted at new onset angina.

4.11.7 Conclusion

We have found evidence for inequity of access to rapid access chest pain clinics for older people and those from more deprived areas, but none for women or south Asian patients. The gross discrepancy between the attendance rate for people aged greater than 64 and the CHD mortality of older people in the catchment areas of the clinics, means that this is a robust result and needs to be addressed in terms of policy. Without individual clinical and detailed ethnicity data from general practices of patients who are and are not referred to rapid access chest pain clinics, we cannot be completely confident that access to the clinics by different ethnic groups is equal. These data should be routinely available from electronic medical records in the future, as long as they are prioritised by the Quality Management and Analysis (QMAS) framework which determines what data are systematically recorded by general practices.

There is no evidence of inequity of use of exercise tolerance tests between different types of analyses, based on the sub-group of patients with intermediate risk of CAD and those appropriate by ARIA criteria. To the extent that the appropriateness criteria are valid, the analysis based on these are likely to be more robust, suggesting that there is relative under-use for women, south Asians, and older people. This potential inequity needs to be investigated with data from other clinics, more detailed case studies (capturing more clinical data that may account for this variation)

and qualitative studies of the consultation process in rapid access chest pain clinics.

South Asians, older people, and people from more deprived areas were less likely to be referred for coronary angiography taking the cohort as a whole, as well as those with >80% probability of CAD, those diagnosed with angina or those who were deemed appropriate by the ARIA criteria. The same holds for women in the first two analyses. This is a robust finding and also requires further investigation, including replication in other clinics and more detailed clinical data, complemented by interviews with clinic staff and observation of consultations in clinics.

In parallel with further research, our findings and previous studies (Feder, Crook, Magee, Banerjee, Timmis, Hemingway, 2002) should inform policy to deal with sources of inequity in the provision of cardiological investigation and treatment.

Section 5 Aim 3: models of care

The national roll out of rapid access chest pain clinics (RACPCs) was set as one of the immediate priorities by the NSF for CHD, in order to allow prompt cardiological assessment of patients with first presentation of symptoms suggestive of angina.

5.1 Specific aims of RACPCs

- Specialist assessment within two weeks of referral by the GP.
- 'One stop' service providing diagnosis, risk stratification, treatment and a follow-up plan.

Although the NSF provided illustrative service models, RACPCs, have inevitably evolved systems of care that reflect local resources, local needs and the priorities set by individual consultants, hospitals and Trusts. Despite many reports on setting up of RACPCs no clear directives exist (Department of Health, 2000).

We have obtained summary information about models of care employed in RACPCs throughout the country to provide a background for a comparative analysis of the six RACPCs in our study. Specific aims were to determine:

- volume of patients seen, and how patient flows have changed with time
- proportion of patients seen within two weeks
- the most appropriate skill mix for the running of the clinic.

5.2 Method

Data already available within the RACPC database provided a detailed account of the volume of patients seen, and the change with time in the six individual centres. These data were supplemented by national data (questionnaire) and local data for the six centres (interview) to answer questions about the proportion of patients seen within two weeks and the models of care that have evolved.

5.2.1 Questionnaire survey of RACPCs in England (Appendix 2: Questionnaire survey of RACPCs in England)

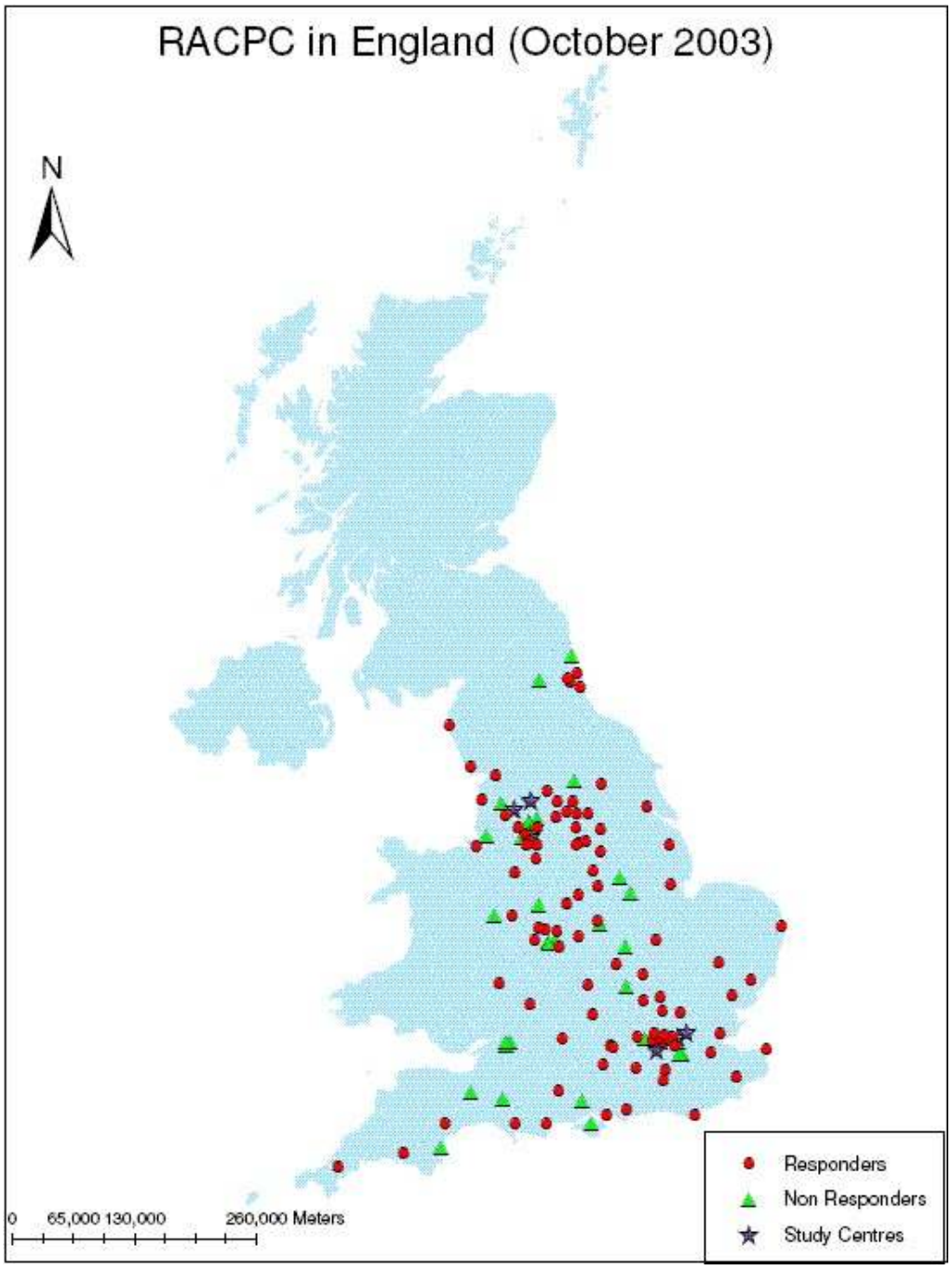
In September 2003, a list of 173 RACPCs in England was obtained from the Department of Health. The list included the six study centres but was not comprehensive and did not take into account Trust mergers. Of the listed NHS Trusts, 15 did not have a RACPC and contact details were not always available. A brief questionnaire was circulated to obtain the following information about RACPCs in individual centres: set up date, use of a computerized database, sources of referral, clinic frequency, waiting times, patients seen per week, staffing, exercise treadmill testing (ETT).

5.2.2 Detailed interviews with personnel involved in running the six RACPCs (Appendix 3 Topic guide for comparison of different models of RACPC)

A structured topic guide was prepared in order to document the operating characteristics of each of the six centres in the study. This included details about clinic structure, referral guidelines, appointment systems, methods of communication with primary care (phone, fax, modem, post), clinic facilities (waiting areas, consulting rooms), access to simple investigations (ECG, CXR, Exercise ECG, biochemistry), waiting times for tertiary investigation and revascularisation, staffing arrangements (technicians, nurses, doctors), and interaction of doctors and nurses in assessing patients and organising investigations.

Dr Sekhri conducted interviews with key staff members involved in the daily running of the RACPC at each of the six centres in our study. These were recorded and analysed.

Figure 27: Map of RACPCs survey



Responders- hospitals which had RACPCs and responded

Non responders- hospitals that did not respond, some of which may not have RACPCs

Study centres- Manchester, Blackburn, Burnley, Newham, Oldchurch, Kingston

5.2.3 Analysis

Descriptive statistics were used for baseline information (number of patients seen per week, waiting time per patient, proportion of patient seen within 14 days of referral, and number and type of non-invasive tests undertaken). Data from the structured interviews were grouped into identifiable themes.

Results

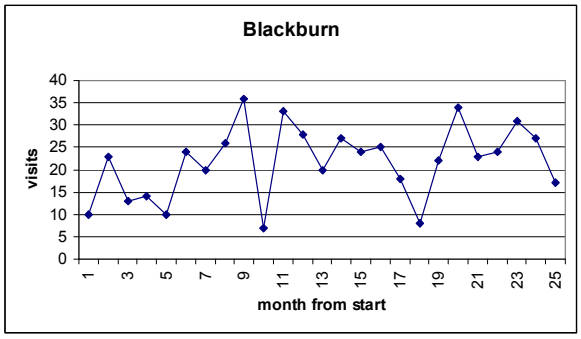
(a) Volume of patients seen and changes with time

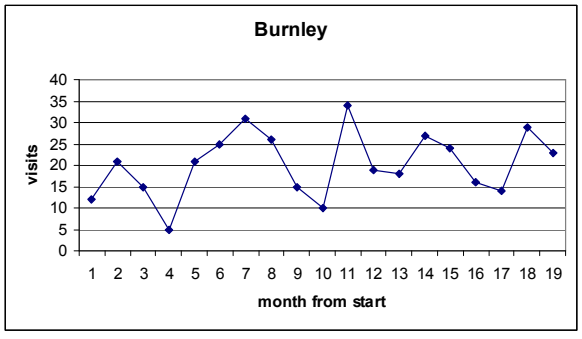
All RACPCs showed the same pattern, with a low but increasing visit rate over the first three or four months, plateauing thereafter with variation within set limits.

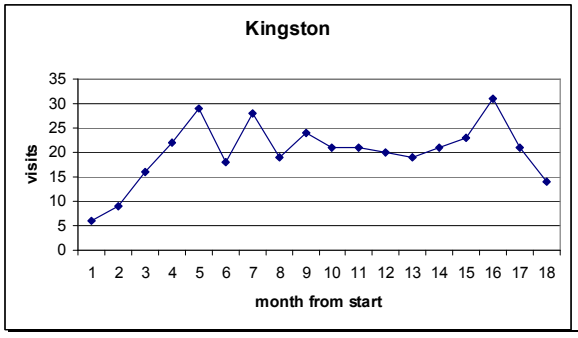
Table 29: Average no. of visits per month

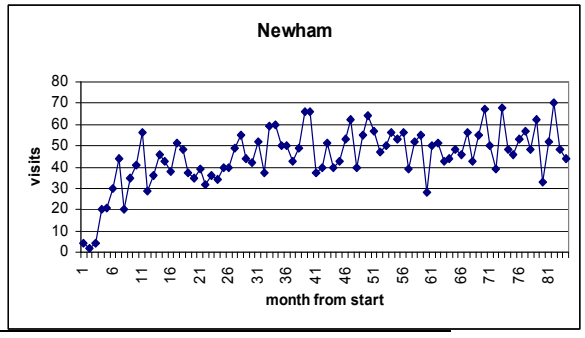
	Blackburn	MRI	Burnley	Kingston	Newham	Oldchurch
Average monthly no of visits	21.8	29.0	20.3	20.9	45.0	62.4

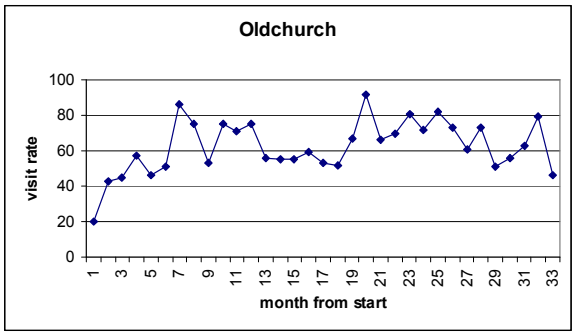
Figure 28: Number of visits per month from start of the clinic

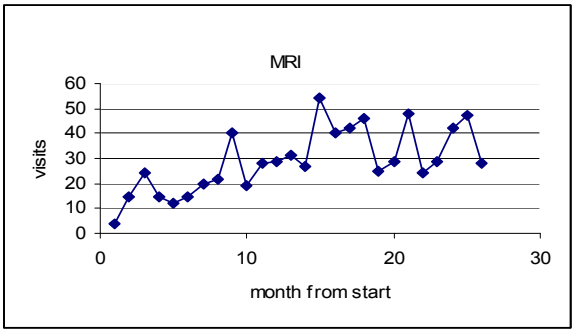












(b) Proportion of patients seen within two weeks

See below

(c) Descriptive analysis of models of care

5.3.1 A survey of RACPCs in England (n=RACPCs for which data were available)

Response rate

The first round of questionnaires, addressed to 'The consultant cardiologist' was sent to 146 hospitals. The response rate, excluding 11 centres that had no RACPC, was 75 percent (102/135), with 60 percent in the first round and 37 percent in the second round. This is a conservative measure of the response rate because it does not take account of sharing of RACPCs between hospitals, and some responders did not identify the name of their hospitals.

RACPC set-up date (n=98)

The first RACPC was set-up in 1986 and by March 2000, 32 percent of the hospitals had a RACPC. Nearly half the RACPCs started in 2001.

Staffing (n=102)

There were 62 RACPCs staffed solely by doctors, including senior house officers, specialist registrars, staff grades, associate specialists, GPs with special interest and consultant cardiologists. Forty of the RACPCs had both nurses and doctors with nursing staff providing initial clinical assessment, although all but three obtained a doctor's opinion during or after the clinic for advice about diagnosis, investigation or both.

Database (n=101)

A computerised database was available in 69 percent of the clinics.

Referral source (n=102)

Fifty-three percent of RACPCs accepted primary care referrals only, the remainder in-hospital referrals as well.

Appointment or open access (n=102)

97 RACPCs saw patients by appointment only, but three operated an open access policy. Two RACPCs had hybrid open access and appointment systems.

Clinic frequency (n=102)

Most centres had three to four RACPCs per week with 10 centres providing ≥6 RACPCs per week (Table 30).

Table 30: Clinic frequency, waiting times

Number of clinics per week	Number of RACPCs	Median (IQR) patients per week	Waiting days (range)**
1	6	4 (4, 5)	6 – 14
2	19	8 (8, 12)	5 – 20
3	25	*15 (12, 15.5)	0 – 25
4	23	16 (13, 22)	5 – 16
5	19	18 (15, 22)	0 – 21
6	2	18 (16, 20)	6 – 9
7	3	40 (20, 42)	1 – 40
8	1	25 (25, 25)	10
9	1	50 (50,50)	14
10	1	38 (38, 38)	3
17	1	25 (25, 25)	14
20	1	50 (50, 50)	5

***data for 95 RACPC only, *data for 24 RACPC only*

Patient attendance (n=101) Table 30

Numbers seen in the RACPCs ranged between two to 50 patients per week, the majority seeing eight to 20 patients per week (median 15, interquartile range 10 to 20). Patient attendance increased with the clinic frequency.

Waiting time in clinics (n=95)

Only 48 percent of the RACPCs managed to see all referrals within 14 days of referral. There was no clear relationship between waiting time and clinic frequency (Table).

Exercise stress test (n=102)

Fifty-nine percent of RACPCs performed ETT routinely on all patients, except those unable to exercise. The remainder were selective according to the decision of the attending doctor. In only four RACPCs was the decision the responsibility of a nurse. Same-day ETT facilities were available at 62% of RACPCs (51 of 83 that provided information).

Final Diagnosis (n=102)

This was made by a doctor in 93%, a nurse in 5%, and jointly in 2% of RACPCs.

Decision to refer for coronary arteriogram (n=98)

This was made by a doctor in 95%, a nurse in 3%, and jointly in 2% of RACPCs.

B. Structured interviews with six participating RACPCs

5.3.2 Date RACPC started

The Newham RACPC started in 1996 and four years later became the service model for the NSF for CHD. The other five RACPCs were set up in response to the NSF, in local recognition of the long waiting times for outpatient cardiology appointments.

Table 31: Clinic set-up and staff in the six study centres

Hospital	Date clinic started	Initial staff in the clinic	Current staff for the clinic	Initial patient contact	Final diagnosis	Involvement of Primary care in set up
Newham	2/1/96	C*	C, SG, AS,RF	doctor	doctor	yes
Oldchurch	3/4/00	C	C, SG*, AS	doctor	doctor	unsure
MRI	29/11/00	AS	C*, CR, AS	doctor	doctor	unsure
Blackburn	28/11/00	C* + NH	2 C, CR, NF	nurse	doctor	unsure
Burnley	26/3/01	C + NH	(C ,SG*) + NH	doctor with nurse	doctor	unsure
Kingston	28/6/01	R, SHO,C	NG*, NH*	nurse	nurse	unsure

*Consultant – C Staff grade-SG Nurse (grade F,G, H)- NF, NG, NH Associate specialist-AS Registrar- R Senior house officer- SHO Research fellow – RF Cardiac Technicians- CT Clinic coordinator- CR * Individuals interviewed at each centre*

5.3.3. RACPC base

Accessibility All RACPCs, except Oldchurch, were readily accessible to patients, being located on the ground or first floor of the main hospital. In Oldchurch access was made difficult by location of the RACPC on the ground floor of a building separate from the main hospital.

Selected interview quotes (doctors):

> *'…should be near the main hospital ….'*
>
> *'Ideal to have in the cardiac department….gives doctor the flexibility to continue with other work, reporting, dictating while waiting for the patients or investigations… disadvantage is that it can lead to shortage of space…'*

Waiting area and consultation room All RACPCs had adequate waiting area and consultation space except Burnley where one of the two clinic locations required patients to wait in the main hospital corridor and the consulting room was small and overcrowded.

Access to cardiac investigations All clinics were based near or within the cardiac department with easy access to non-invasive cardiac investigation like ETT, echocardiogram and pulmonary function testing.

5.3.4 Clinic data

RACPC frequency There was general consensus among the informants that RACPCs should offer a daily service but this was achieved in only two, the remainder citing lack of medical staff as the reason for <5 clinics per week.

RACPC waiting times Five RACPCs met the NSF waiting time target of <14 days, seeing 100 percent of the referrals within the two week period; Burnley had a waiting time of three to four weeks. If clinics were cancelled for any reason (lack of medical cover, public holidays) this inevitably had adverse knock-on effects on waiting times.

Table 32: Clinic data for the six centres

Hospital	Clinics per week	Waiting time (days)	Patients seen / week	Timing of clinics	Reason for timings chosen	Type of clinic**	Referral source	Referral mode	Vetting of referrals
Newham	5	0	10-20	12:00 - 14:00	Availability of CT, suit GP	O	GP	Fax directly to clinic	no
Oldchurch	4	14	24	14:00 - 17:00	Availability of CT	A	GP	Fax directly to clinic	yes
MRI	3	14	24	9:00 - 12:00	Availability of doctor and CT	A	GP+ cardiology referrals	Fax directly to clinic	yes
Blackburn	3	14	15	13:00 - 17:00	Availability of doctor and CT	A	GP + in-hospital	Fax directly to clinic	yes
Burnley	2	21-28	10	Morning and afternoon	Availability of CT and room	A	GP	Fax to appointments	no
Kingston	5	6-8	25	Morning and afternoon	Availability of CT	A	GP +in-hospital	Fax to appointments	no

** CT- cardiac technicians GP- general practitioner*

*** O- open access A- appointment based*

RACPC patients seen per week This was influenced by the number of RACPCs per week. Those with an appointment system (all except Newham) booked five to eight patients per clinic.

RACPC timings These were largely determined by i) availability of cardiac technicians to provide investigational support ii) the need to integrate RACPCs with other inpatient and outpatient work. Clinical staff preferred morning clinics, especially on Fridays, and often felt rushed without control over the selection of timings.

Selected interview quotes:

doctor…'easier to sort out patients in the morning…..'

nurse…'few staff around in the evening to help with investigations…..'

5.3.5 Referral procedure

Referral source Three RACPCS had extended the service from primary care referrals to include in-hospital referrals but reported inappropriate referrals by non-cardiological physicians and emphasised the need for strict inpatient referral criteria. The remainder recognised as desirable an extended service but were concerned this would increase referrals beyond their ability to cope. There was disagreement about the wisdom of accepting stable chest pain referrals from ED, some feeling that this would lead to misuse of the service by overworked ED departments.

Selected interview quotes

> *doctor…. 'looking to see into ways of seeing troponin negative patients discharged from A&E but there are staffing issues ' doctor… 'A&E have benefited with RACPC' nurse ….'clinic receives inpatient referrals…as a dumping ground'…..*

Referral medium All RACPCs received referrals from primary care via fax and one had recently been provided with a web link (to date unused). Four RACPCs used dedicated fax machines, the remainder using machines located in the central appointments department. All participants agreed that direct referral to the RACPC was vital for preventing administrative delay. All RACPCs had structured referral *proforma*s, but these were often ignored by primary care physicians when incomplete contact details unnecessarily delayed RACPC appointments.

Selected interview quotes

> *nurse…referrals get appointment by admission clerks and if we could get involved with the process could vet the inappropriate.. nurse.. .would help if patient's current telephone numbers are added to the referral…*

Appointment versus open access All RACPCs except Newham used an appointment system, preferring it to open-access because, despite the added administrative involvement and the longer waiting times, it allowed better planning of workload and vetting of referrals. The open access system at Newham makes workload planning more difficult and may increase misuse through inappropriate referral, but has the advantage of no waiting list. This is much valued by patients.

Selected interview quotes:

> *Appointment good… doctor..planned workload….prefer to increase the number of clinics… doctor..get enough inappropriate referrals as it is and open access without vetting would make it worse…nurse…unsure how it would run… do not have the infrastructure to cope with open access system..*
>
> *doctor.. Open access…the main success of this clinic is because it is open access and patients are seen within 24 hours. …..quality of referrals varies and can be an unreliable source of urgency ….have concerns about vetting.. chest pain is a cause for concern and patients should not wait weeks for appointment..*

5.3.6 Staffing (Table 31)

Doctor versus nurse led RACPCs All centres initially used a doctor-led service, two employing senior cardiac nurses in a supportive role. After the first three years, Kingston RACPC incorporated nurses and in the last six months has become a fully nurse led service with little input from doctors.

Variation in the role of nurses Each of the three RACPCs now supported by nurses use them in different ways. In one, patients are first seen by the nurse who takes a structured history on a *proforma*, checks blood results and orders an ETT and an echocardiogram before presenting the patient to the consultant cardiologist, who is responsible for making the final diagnosis and management plan. In another, both

nurse and the doctor sit together in the clinic, with the doctor taking the clinical history and the nurse providing administrative support. Both these RACPCs see the roles of doctor and nurse as complementary, unlike the third where senior cardiac trained nurses are responsible for diagnosis and referral for non-invasive and invasive investigation without cardiological input from doctors. An advantage cited for this latter system is that it provides for continuity of care which rarely occurs if junior medical staff are involved in seeing patients.

Selected interview quotes

> *nurses ..' I'm pretty sure about the symptoms in my mind but the doctor has to make the diagnosis... would not mouth the words before doctor.. .. we are nurses, we do not make diagnosis... Previously the Registrar or SHO was responsible for the clinic and if they could not cover, the clinic was cancelled.....no one person responsible .these are focused clinics and we have protocols and guidelines never had the need to contact a doctor.... doctor...Maybe with training could run the clinic but would definitely want a doctor present'*

Doctor led service Three RACPCs had a doctor led service without nurse involvement. Participants in two of these clinics felt that clinical assessment and diagnosis was ultimately the responsibility of doctors and should not be devolved to nurses. Referrals may be inappropriate and involve pathologies that a nurse trained in chest pain assessment could not be expected to diagnose. It was also felt that the seniority of the cardiologist assessing the patient contributed to diagnostic accuracy and patient reassurance, with nurses having complementary roles promoting lifestyle changes, perhaps through cardiac rehabilitation services, for primary and secondary prevention. Participants in the third doctor led RACPC expressed a different view, feeling that with strict protocols and guidelines, trained nurses could run the clinic which would free the cardiologist to concentrate on invasive cardiology procedures.

Other support staff Two study centres had clinic co-ordinators who helped organise referrals, re-arrange clinic lists to meet waiting time targets, and provide other administrative support. It was widely agreed that administrative support could greatly assist the organisation and running of the clinic.

Selected interview quotes - doctors:

> *'Doctor would still be needed to troubleshoot…..they may help with dealing with risk factors which I feel gets neglected in this clinic.. nurses can be trained but clinical signs too need to be recognised…have picked up quite a few cases of cancer, thyrotoxicosis…... Also patient satisfaction needs to be assessed..'*

5.3.7 Referral guidelines

In most RACPCs referral guidelines were drawn up by the consultant cardiologist. Guidelines across the six RACPCs were remarkably similar to those originally devised (with GP consultation) at Newham, probably because of the prominence given to them in the NSF. Discouragement of very young patients was commonplace, but one RACPC discouraged referral of patients aged >75 years, a decision now revoked. Most RACPCs also discourage referral of patients with known CHD, although there is variable flexibility.

Table 33: Referral guidelines for each study centre

Hospital	**Include patients with recent onset of chest pain** **Time specified**	**Exclude patients with known coronary artery disease***	**Exclude young men and women**	**Exclude- patients with acute symptoms**
Newham	Yes (2-4 weeks)	Yes	exclusion (men <30 & women <40)	Yes
Oldchurch	Yes	Yes	exclusion (men <30 & women <35)	Yes
MRI	Yes	Yes	No age exclusion	Yes
Blackburn	Yes (< 6 weeks)	Yes	exclusion (men <35 & women <40)	Yes
Burnley	Yes (< 3 months)	Yes	No age exclusion	Yes
Kingston	Yes	Yes	No age exclusion	Yes

* all centres have a flexible approach for seeing this group of patients

Table 34

All RACPCs routinely performed resting ECGs but only two (both of which used nurses) performed ETTs on all clinic attendees. There was disagreement on the value of ETT for reassuring patient and doctor. In all RACPCs the decision to refer for coronary angiography was made by doctors, except Kingston where now, the nurses made the decision to refer.

Selected interview quotes:

doctor..*'best to exercise them ..nobody believes clinical judgement doctor... blood results are helpful for starting treatment and advising on prevention. doctor...want to look into a way, so that blood results are available at the time of the clinic exercise test done the same day...nurse.. Surely that is the purpose of having a one-stop clinic'.*

Table 34: Investigations done in the clinics

Hospital	Resting 12 lead electrocardiogram	Exercise treadmill test (ETT)	echocardiogram	Height and weight measure	Blood tests for all patients
Newham	All patients	Selective	Selective	No	No
Oldchurch	All patients	Selective	Selective	No	No
MRI	All patients	Selective	Selective	Yes	No
Blackburn	All patients	All patients	All patients	Yes	Yes
Burnley	All patients	Selective	Selective	No	No
Kingston	All patients	All patients	Selective	Yes	No

5.3.9 Database

All hospitals used the computerised database originally designed at Newham. Its value for audit and generating a structured clinic letter was generally acknowledged. The nurse-led clinic at Kingston has recently reverted to maintaining paper records, finding it difficult to enter data at the time of the clinic visit.

Selected interview quotes:

doctor….'computer takes away the stress of dictating letters'…

5.3.10 Communication with primary care

All were of the opinion that in a RACPC the referring physicians should be informed of the consultation outcome as soon as possible. Most faxed the computer-generated letter after the clinic, but in some centres where the data was entered by the nurse co-ordinator, there was delay of about two to three days in communication with primary care. The nurse-led clinic at Kingston dictated letters which reached the GPs in about a week but said that it conveyed more information than a computerised letter.

5.3.11 Overall impression of the service and way forward

All the participants agreed that RACPCs provide a good way to overcome delay in assessment of chest pain that is beneficial to the patient. But almost all expressed frustration at the number of inappropriate referrals received despite clearly stated referral guidelines.

Selected interview quotes:

doctor…'I enjoy the clinic, talking to the patients, carrying out all the investigations the same day… there is positive feedback from them'..

doctor…'Key to the success of this service is to stress to the GPs…improve quality of referrals'…

doctor…'Nurses supplement clinical assessment by advising on lifestyle measures and secondary prevention'…

5.4 Discussion

This study has shown that the volume of patients attending RACPCs usually reaches a plateau within about four months of establishing the service. The numbers seen bear a close relation to the frequency of clinics, those centres with daily clinics being the busiest. The proportion of RACPCs able to see patients within two weeks varied, the target being achieved in five of the six centres included in our study but only about 50 percent of centres nationwide.

We undertook a general survey of RACPCs in England and also a detailed analysis of the six RACPCs participating in our multicentre study. Those centres unable to meet the 14 day target for seeing referrals usually cited staff shortages, logistical problems in running

the clinics, and an excess of inappropriate referrals as the main reasons for their failure.

Staffing issues The staffing requirements for RACPCs were not detailed within the NSF which stated that patients should be seen by a specialist but did not specify whether this should be a consultant cardiologist, more junior member of the cardiology team, general practitioner with special interest in cardiology, a cardiology nurse specialist, or other trained staff. The choice that is made has both cost and clinical implications as reflected in the doctor versus nurse-led model of care. It is less expensive to employ a nurse for this purpose, yet only a handful of RACPCs are reliant on only nurses to run the service. There was a widely held view that while nursing input was desirable for a variety of purposes including administrative support, history taking, and lifestyle support, the doctor (ideally a consultant cardiologist) must be responsible for making the final diagnosis and management plan. In addition to considerations of clinical responsibility, many felt that the experience of a consultant cardiologist provides important re-assurance for patients and is likely to reduce unnecessary investigation.

If a doctor-led, or hybrid doctor-nurse, system is adopted it has important cost implications because RACPCs represent a new clinical service for most cardiology departments and 'efficiency savings' within these departments will never be sufficient to cover new staffing costs. Indeed it was lack of funding for new staff that was identified in many centres as the main cause of failure to meet the 14 day waiting time target. An overview of the survey responses suggests that an 'average' RACPC seeing up to 10 new patients might require the following staff.

Consultant cardiologist: supervise the RACPC and make final decisions about diagnosis and further investigation.

Junior doctor: history and examination (entered on *proformas*), initial diagnosis and management plan.

Cardiac nurses: may substitute for junior doctor's role, and also counsel patients, deliver lifestyle advice, assist cardiac technician and provide administrative duties as required.

Cardiac technician: ECG recording, stress testing (one-stop service).

Administrator: Organise appointments (if not open access), patient waiting, medical notes etc.

Logistics There was general agreement that the site of RACPCs should be adjacent to the cardiology department to provide ready access to investigation, particularly ETT, and also resuscitation on the rare occasions it is required. Because RACPCs represent a new service, the timing has to be consonant with the other duties of staff. This is often difficult and without sufficient new staff (see above) is an important reason for limiting the frequency of clinics to the point that local need cannot be met, as partly reflected in the relatively low

numbers of patients seen per month at Blackburn, Burnley, and Kingston. Fax provides the most efficient contemporary means of rapid communication between primary care and the RACPC (until email links are reliably used) enabling same-day referral and reciprocal transmission of clinic letters after the consultation.

Whether an open access or appointment system has been adopted depends in a large part on local facilities. Appointments, it was stressed in our survey, allow referrals to be vetted for guideline adherence and provide more administrative control over the size of the clinic and the number that are held per week. The logic of open access, on the other hand, is that it requires a daily clinic seeing as many patients as are referred. This imposes important stresses on cardiac departments and probably accounts for the preference expressed for appointment systems in our survey. Nevertheless open access RACPCs can operate successfully, as evidenced by Newham, particularly if staffing levels are adequate, referral guidelines are explicit and are adhered to by local primary care physicians. This requires the involvement of primary care physicians in establishing the guidelines – a requirement not often fulfilled in our six centre study – and regular auditing of referrals with results fed back to primary care through regular meetings.

Database There is no doubt that a computerised database, as used by all six centres in the multi-centre study and by many other centres in our national survey, facilitate the running of RACPCs. Not only do they simplify the audit process, but they standardise history taking and cardiac examination and usually permit instant generation of a clinic letter to keep the referring primary care physician fully informed of the diagnosis and management of his/her patient. Nevertheless it was salutatory to note that of the 69 percent of RACPCs with a computerised database in our national survey, four were unable to give details on waiting times and 12 on the proportion of patients who undergo ETT. This emphasises the need for a standardised RACPC database with a core dataset for national audit similar to the MINAP process.

Inappropriate referrals A major area of concern both in the national survey and the centre analysis was the high proportion of inappropriate patients that are referred to RACPCs. We have already shown that patients with non-cardiac chest pain have an excellent prognosis compared to patients with angina, and given the difficulties many RACPCs have in meeting the 14 day waiting target, it is important that referrals are carefully considered by primary care physicians and that referral criteria are strictly adhered to. However, respondents to our questionnare survey commented that *'No one takes any notice of the guidelines on who not to refer… (The RACPC) is perceived as a quick way to see a consultant for almost any cardiological problem…'* There is a clear need for dialogue between

primary care and RACPC cardiologists to devise ways for judicious use of clinic time.

Cardiac investigation There was a range of different views on the appropriate use of ETT in the RACPC, perhaps reflecting the lack of evidence for non-invasive investigation in patients with undifferentiated chest pain. Some felt that ETT should be restricted to patients in whom there was diagnostic uncertainty, others were in favour of including patients with typical cardiac symptoms, while others felt that all RACPC attendees should have an ETT, for re-assurance of both the patient and the referring primary care physician. Elsewhere in this report we describe significant under-use of non-invasive investigation and also referral for coronary angiography which plausibly contribute to the adverse outcomes among patients diagnosed with angina. While a policy of ETT for all attendees at RACPCs would be difficult to justify in terms of resource utilisation, it seems clear that thresholds for ETT should be lowered to include all patients in whom the probability of coronary disease is intermediate (20 to 80 percent) and probably most patients in whom the probability of disease is >80%. Thresholds for coronary angiography should also be lowered, to include a higher proportion of patients with angina, particularly those whose age, ethnicity and diabetic status puts them at very high risk. This recommendation is based on the proven symptomatic benefit of revascularisation with prognostic benefit in selected groups.

In conclusion, the national questionnaire and the more detailed interview of staff in the six RACPCs participating in our study show that there is no single model of care that best serves the main purpose of RACPCs to see patients with undifferentiated chest pain within 14 days of referral and to diagnose and initiate appropriate treatment in those with angina. Models of care must take account of local need and local facilities, but clear referral guidelines worked up in conjunction with primary care colleagues are always essential if referrals are to be both appropriate and manageable. Where facilities are available, daily clinics should be aimed for, ideally open access, and staffed by cardiologists and trained nurses, with the support of at least one administrative assistant and also cardiac technicians to provide one stop non-invasive assessment with resting ECGs and ETTs where appropriate. The RACP should be audited by electronic data collection with feedback to primary care, in order that continuing refinements to the service can be applied as necessary to meet local needs.

Section 6 AIM 4: Do RACPCs act in addition to or as a substitute for other services?

6.1 Introduction

The National Service Framework (NSF) for coronary heart disease Department of Health, 2000) (CHD) recommended RACPCs to provide prompt cardiological assessment of new onset chest pain, within two weeks of referral by the GP. Assessment as early as this cannot usually be achieved in the conventional outpatient cardiology clinic (OPCC) which also has referrals for a wide range of other cardiac conditions (valvular diseases, cardiomyopathies, established coronary heart disease, heart failure, arrhythmias etc). This often results in long waiting times for specialist assessment of new onset chest pain, putting these patients at risk of acute coronary events that might be prevented with timely cardiological management, including referral for cardiac catheterisation.

Implicit in the recommendation for RACPCs is that they should substitute for existing services and reduce referrals to OPCC of patients who fulfil criteria for rapid assessment of new onset chest pain. The NSF for CHD encouraged local hospitals and primary care trusts (PCTs) to agree on detailed local protocols for assessing such patients, but it is not known if effective substitution has been achieved. One study suggests that RACPCs have produced a three-fold increase in referrals for assessment of chest pain (Sutcliffe, Steven, de Belder, Kumar, Fox, Wood, *et al*, 2002) but there has been only one small prospective study from Scotland, investigating their effect on chest pain referrals to OPCCs over a four week period (McGavigan, Begley, Moncrieff, Hogg, Dunn, 2003). The investigators found that almost 50 percent of patients who fulfilled local guidelines for the RACPC continued to be referred to the OPCC, despite waiting times of 22 (±5.5) days and about three months, respectively. They expressed concern that the RACPC was potentially diverting resources and contributing to further delay in conventional outpatient assessment.

Retrospective data to allow comparison of the number of OPCC chest pain referrals before and after introduction of the RACPC were not available. Also, with the widespread establishment of RACPCs and the documented risks of delayed assessment of chest pain, it would not be feasible to conduct a randomised controlled trial, to test the effectiveness of this service. We therefore undertook a prospective comparison of chest pain attendances to the RACPC and the OPCC of Newham General hospital over a two year period. Our specific aims were to:

- quantify the number of patients with incident chest pain who continue to be referred to the OPCC
- compare the distribution of cardiac and non-cardiac chest pain in RACPC versus OPCC
- measure waiting times for assessment of chest pain in OPCC
- compare demographic characteristics of patients with chest pain in OPCC with patients attending RACPC
- compare rates of referral and determinants of referral for cardiac catheterisation in RACPC versus OPCC.

6.2 Methods

A prospective study at Newham General Hospital comparing patients attending the weekly OPCC and the daily RACPC. Both clinics are staffed by the ***same*** clinicians.

6.2.1 Rapid access chest pain clinic (RACPC)

Local family physicians were the only source of referral to the RACPC and referral guidelines to the clinic were agreed following discussions between their representatives and the department of cardiology.

Inclusion criterion:

- Patients with recent onset of chest pain in the previous two to four weeks

Exclusion criterion.

- Patients who have previously been seen for assessment of chest pain either in the ED or outpatients department or as inpatients should not be referred to the RACPC. These patients should be referred to the outpatient cardiology clinic in the normal way.
- Patients suspected of having an acute myocardial infarction or unstable angina, should be referred to the ED department.

Except in exceptional circumstances, women under 40 and men under 30 should not be referred to the RACPC, because the probability of coronary disease in these groups is very low.

Referrals for the RACPC were made on specially designed referral forms and faxed to a dedicated line within the cardiology department. Clinics were held Monday to Friday between 12:00 to 2:00pm and all patients were seen within 24 hours of referral or the next working day in the case of weekends and public holidays. No appointments were made, and patients were seen in order of attendance. Patient data were entered onto a database with drop down menus to simplify data completion. Clinics were led by a consultant cardiologist and their team of doctors. The setting of the clinic within the cardiology department facilitated easy access to diagnostic tests including 12 lead

ECG, exercise stress test, transthoracic echocardiograms and chest X-ray.

6.2.2 Outpatient Cardiology Clinic (OPCC)

The OPCC was held once a week between 9:00 to 12:00 and appointments were made by the central appointments office which took referral letters from primary care The referrals were vetted by a cardiologist and categorised as urgent (within four weeks), soon (one to three months) or routine (next available slot). Almost all requests for chest pain assessment were booked as urgent.

6.2.3 Patients (Figure 29)

During a two year period (1 September 2002 to 31 August 2004) data on consecutive patients attending the RACPC (1549) and OPCC (276) with new onset chest pain were recorded. In both groups, we included only the first visit during the study period and excluded patients without chest pain, patients diagnosed with acute coronary syndromes, patients who reported previously diagnosed coronary heart disease or revascularisation procedure, patients for whom a diagnosis was not identified as angina or non-cardiac chest pain, and patients with missing data. The remaining 1382 (RACPC) and 228 (OPCC) patients comprised the study groups.

Data collection

For both groups data were entered on identical databases, details of which have been reported previously (Ray, Archbold, Preston, Ranjadayalan, Suliman, Timmis, 1998) and detailed in Appendix 1.

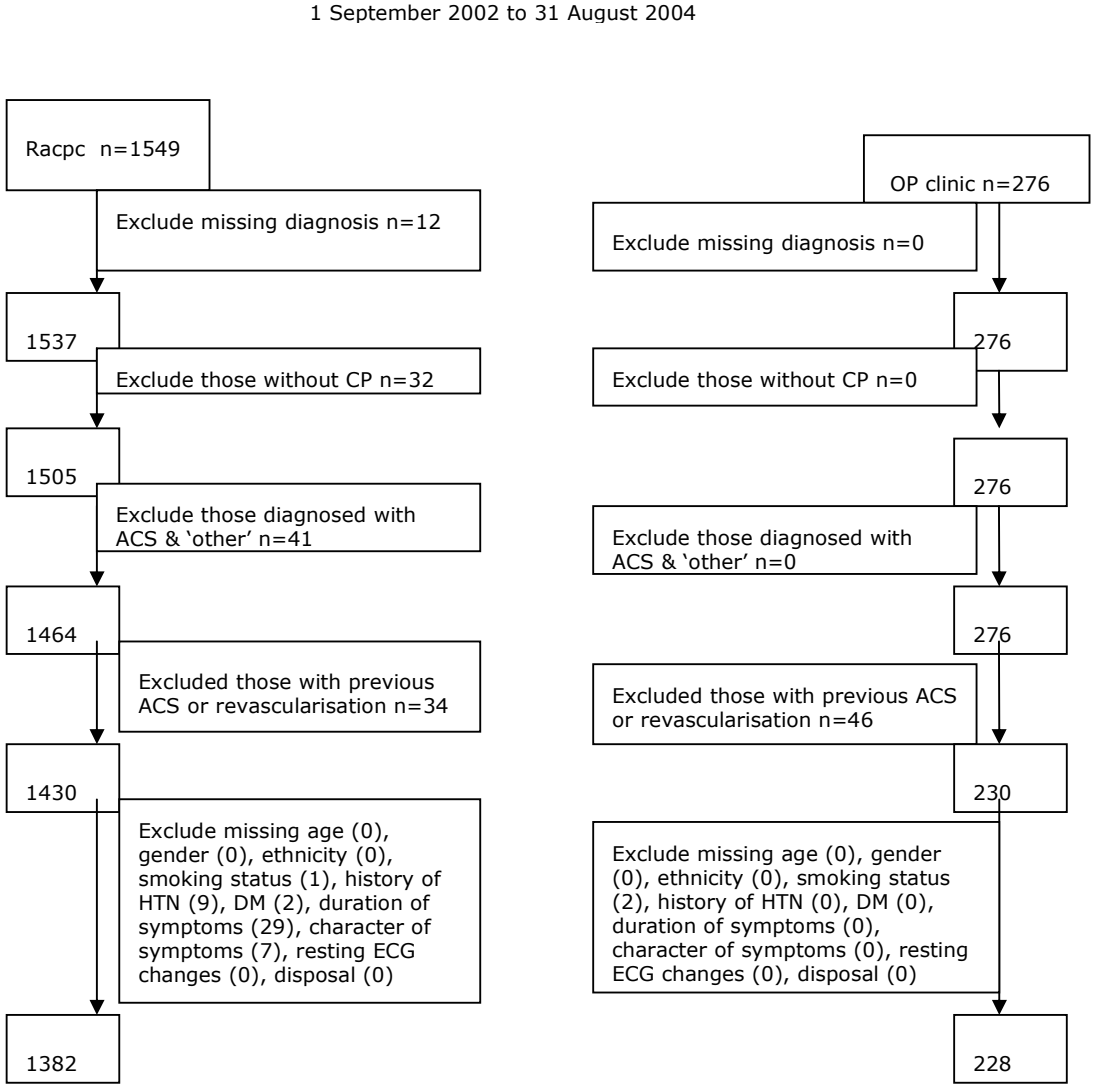
Clinical data included: age, sex, ethnicity, duration of symptoms, character of chest pain, smoking status, history of hypertension, diabetes, pulse rate, systolic blood pressure, drugs and follow-up plan on discharge. Twelve lead resting electrocardiograms (ECGs) were recorded as normal or abnormal depending on the absence or presence of any abnormalities of rhythm, conduction, regional ST segment or T wave change, left ventricular hypertrophy or Q waves. Exercise treadmill tests were performed at the discretion of clinicians in 54 percent of RACPC patients and 50 percent of OPCC patients. Diagnosis of the cause of chest pain (angina or non-cardiac chest pain) was recorded by the clinician at the end of the consultation.

Statistical analysis

Patients in the RACPC and the OPCC were compared using chi square and t-tests for proportions and distributions, respectively. Logistic regression was used to estimate the odds of being referred for an angiogram in univariate and fully adjusted models, based on covariates associated ($p<0.05$) with the outcome of interest. These

included diagnosis of angina, age, gender, ethnicity, hypertension, diabetes, current smoking, typicality and duration of symptoms, resting electrocardiograms, exercise treadmill test results and the clinic setting.

Figure 29: Flow chart for sub study patients



Racpc- rapid access chest pain clinic, *OP* clinic- weekly outpatient cardiology clinic

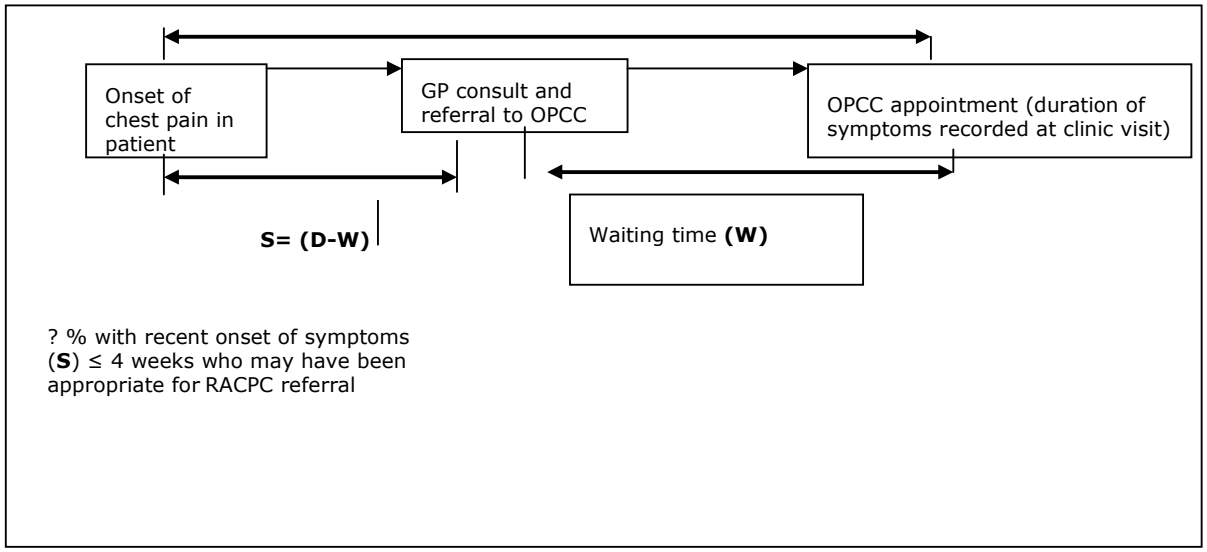
CP- chest pain, *ACS*- acute coronary syndrome, CHD- coronary heart disease, *HTN*- hypertension, *DM*- diabetes, *ECG*- electrocardiogram.

6.2.5 Waiting time calculation

Calculation of symptom duration for patients in the OPCC

We defined substitution as the proportion of patients eligible for the rapid access chest pain clinic who instead attended the outpatient cardiology clinic. Inherent in the outpatient setting are the administrative delays which contribute to the longer waiting times. To adjust for this, the waiting time for the OPCC was calculated as the difference in days between the date on the referral letter to the date of the clinic appointment for each patient attending the OPCC. The *waiting time (**W**)* recorded for OPCC patients was subtracted from the *duration of symptoms (**D**)* recorded at the time of the outpatient clinic visit, to determine whether the RACPC criterion for *recent onset of symptoms (**S**)* (Two to four weeks) was fulfilled at the time of referral by the family physician. The field entries for duration of symptoms were quantified as follows: < 2 weeks= 14 days, two to four weeks= 28 days, one to three months= 90 days, three to six months=180 days, six to 12 months or more= 360 days.

Figure 30: Flow chart for patients included in the analysis



6.3 Results

6.3.1 Patient characteristics

OPCC patients tended to be younger, were more commonly south Asian and all but two percent had had symptoms for >4 weeks at the time they were seen. There were 26 percent of OPCC patients diagnosed with angina compared with 23 percent of RACPC patients. Among those diagnosed with angina, rates of prescription of aspirin

(81% vs 68%) and beta blockers (58% vs 52%) were higher in RACPC patients but the rate of prescription of statins (32% vs 53%) was higher in the OPCC. Also direct referral for coronary angiography was lower from the RACPC compared to the OPCC (19% vs 33%), but 50% of the angina patients seen in the RACPC received further follow-up appointment.

6.3.2 Waiting times

All RACPC patients were seen within 24 hours of referral, except those referred on Friday afternoons, or the day before national holidays who were seen the next working day. The mean waiting time for OPCC appointments (data available in 208 patients) was 97 (± SD 43) days.

6.3.3 Substitution

Over the study period 228 patients, representing 14 percent of all referrals with previously undiagnosed stable chest pain attended the OPCC. Of the 208 for whom waiting time data were available, 33 (16%) had had symptoms for <4 weeks at the time of referral, all but three of whom fulfilled age and gender criteria for the RACPC. Thus 14 percent (30/217) of OPCC patients fulfilled RACPC criteria compared with 67 percent (926/1382) of patients seen in the RACPC. The RACPC, therefore, substituted for the OPCC in 97 percent (926/956) of new chest pain referrals during the study period.

6.3.4 Predictors for referral for coronary arteriography

Among patients diagnosed with angina, rates of referral for coronary angiography were higher in the OPCC than the RACPC (33% versus 19%). Despite multiple adjustment, the odds of referral for coronary angiography were 3.82 (95% CI 1.85-7.90) from the OPCC relative to the RACPC. Examination of the local catheter registry showed that additional referrals for angiography were made after the index OPCC and RACPC consultations, such that by 17.10.2005 48% of the OPCC patients and 35% of the RACPC patients had been referred for coronary angiography.

6.4 Discussion

We have reported a prospective comparison of chest pain referrals to the outpatient cardiology clinic and the rapid access chest pain clinic at Newham general hospital over a two year period. The major findings were: i) waiting times for the RACPC were substantially shorter than waiting times for the OPCC, and ii) among patients fulfilling eligibility criteria, the RACPC substituted for the OPCC in all but three percent of cases.

It is a major requirement of RACPCs that patients with undiagnosed chest pain should receive cardiological assessment within two weeks of referral, a target rarely achieved in conventional OPCCs. Our study shows that waiting times have been reduced below this target in the RACPC at Newham University Hospital, while waiting times in the OPCC during the study period were approximately three months, even though patients with chest pain are typically pre-classified as urgent in expectation of a four week waiting time. The extent to which these findings can be extrapolated to RACPCs elsewhere will depend on the way services are configured. If there are daily clinics and an open access policy for accepting referrals, with no waiting lists or other administrative delays, our study shows that cardiological assessment within 24 hours can be achieved in the large majority of patients.

In most centres, RACPCs have been set up in addition to existing OPCCs. The provision of a 'new' service will inevitably attract additional work and this was confirmed by Sutcliffe for RACPC (Sutcliffe, Steven, de Belder, Kumar, Fox, Wood, *et al*, 2002). Additional chest pain referrals for cardiological assessment are desirable if more at-risk cases are to be treated. The fact that the proportion of those diagnosed with angina in RACPCs and OPCC are similar, suggests that the RACPC is genuinely catering for unmet need rather than just seeing large numbers of low risk patients. But if the effect of RACPCs is to address previously unmet need, this will not in itself reduce outpatient attendance or waiting times for patients with new onset of chest pain, unless all these patients are re-directed to the RACPC, allowing effective substitution for the existing outpatient cardiology service.

Our study shows that our RACPC which currently sees about 800 patients per year has effectively substituted for the OPCC in the assessment of new onset chest pain with 97 percent of all eligible patients now attending the RACPC. However substitution of the OPCC chest pain service has not been complete and while it is clear that provision of daily RACPCs successfully attracts more patients with recent onset chest pain for cardiological assessment, there remains a minority of patients appropriate for the RACPC who are referred to the OPCC, delaying their specialist assessment and treatment. If the RACPC referral criterion for chest pain of less than four weeks duration is ignored, as occurred with 33 patients in our study, then substitution by the RACPC becomes less complete. Opening up the RACPC to all patients, regardless of chest pain duration, would permit more referrals but require more resources.

The RACPC with its structured approach offered more evidence based therapy as seen by the higher rates of prescription of aspirin and beta blockers although this did not apply to statin therapy. Patients referred to the RACPC often do not have their lipid levels performed prior to clinical assessment, which may partly explain the low statin prescription rate on discharge. But nearly 70 percent of the RACPC

angina patients underwent further cardiology follow-up and although it is likely that most came to receive statins, it is a limitation of our study that we do not know what proportion remained untreated. The finding of a higher referral rate for angiography from the OPCC is hard to explain since both clinics were staffed by the same doctors and the patients to both clinics came from the same catchment area. It may reflect longer waiting times and more established clinical symptoms among OPCC patients compared with RACPC patients. Further support to this explanation comes from findings of the Euro Heart Survey of stable angina (Daly, Clemens, Sendon, Tavazzi, Boersma, Danchin *et al*, 2005) which reported higher rates of referral for angiogram among patients with longer symptom duration. This is unlikely to provide a complete explanation, however, since the local catheter registry showed that the difference persisted in the longer term. Also hard to explain is the small excess of south Asian patients continuing to be referred to the OPCC, although this may reflect the referral practice of certain family physicians. An important way of improving the efficiency of the RACPC service must be to improve the quality of referrals to best utilise available resources. This highlights the need for regular audits and contact with the primary care providers, to ensure optimum care is provided to the patients.

This is the first study to show the impact of rapid access chest pain clinics on reducing the number of referrals of patients with new onset chest pain to routine outpatient cardiology clinics. Its strength lies in its prospective design and capturing of parallel clinical data on consecutive patients in two different settings. Another unique aspect of this study is that the same clinicians were involved in patient assessment, both in the outpatient cardiology clinic and the rapid access chest pain clinic, exposing both sets of patients to same level of observer bias. The limitation of this study is that all the data are from a single centre and the findings may not be generalisable. This study was not designed to capture clinician and patient responses and preferences, to answer some of the qualitative aspects of the impact of this service.

In conclusion, we have shown that an RACPC can largely take over the task of assessing new onset chest pain, with almost complete substitution of the existing OPCC chest pain service for patients fulfilling referral criteria.

Table 35: Patient characteristics by diagnostic groups and clinic settings

	RACPC n=1382		**Out patient group n=228**	
	angina n=313 (23%)	**non-cardiac n=1069 (77%)**	**angina n=60 (26%)**	**non-cardiac n=168 (74%)**
Age (mean)	60 (±11)	52 (±12)	58 (±11)	47 (± 13)
Males	158 (51%)	535 (50%)	34 (57%)	84 (50%)
Ethnicity				
Black	35 (11%)	167 (16%)	4 (7%)	26 (16%)
South Asian	135 (43%)	492 (46%)	33 (55%)	88 (52%)
White	131 (42%)	355 (33%)	20 (33%)	40 (24%)
Others	12 (4%)	55 (5%)	3 (5%)	14 (8%)
Risk Factor				
Current smoker	69 (22%)	192 (18%)	11 (18%)	36 (21%)
Hypertension	179 (57%)	391 (37%)	37 (62%)	56 (33%)
Diabetes	97 (31%)	159 (15%)	16 (27%)	21 (13%)
Duration of chest pain				
< 4 weeks	179 (57%)	747 (70%)	2 (3%)	2 (1%)
≥ 4weeks- ≤6 months	113 (36%)	207 (19%)	19 (32%)	83 (49%)
> 6 months-≤ *12 months*	13 (4%)	31 (3%)	13 (22%)	31 (19%)
> 1 year	8 (3%)	84 (8%)	26 (43%)	52 (31%)
Character of chest pain				
Typical	189 (60%)	14 (1%)	39 (65%)	1 (1%)
Atypical	122 (39%)	558 (52%)	21 (35%)	91 (54%)
Non specific	2 (1%)	497 (47%)	0 (0%)	76 (45%)
Electrocardiogram	219 (70%)	922 (86%)	38 (63%)	138 (82%)

Normal	94 (30%)	147 (14%)	22 (37%)	30 (18%)
Abnormal				
	138 (±20)	131 (±19)	140 (±20)	131 (±20)
Systolic blood pressure				
	78 (±14)	78 (±13)	76 (±13)	75 (±12)
heart rate *(beats per minute)*				
Exercise stress test	82 (26%)	5 (1%)	6 (10%)	0 (0%)
Positive	49 (16%)	528 (49%)	8 (13%)	81 (48%)
Negative	42 (13%)	35 (3%)	11 (18%)	8 (5%)
Non diagnostic	140 (45%)	501 (47%)	35 (58%)	79 (47%)
Not done				
Drugs on admission	77 (25%)	131 (12%)	29 (48%)	25 (15%)
Aspirin	51 (16%)	111 (10%)	18 (30%)	19 (11%)
Beta blockers	87 (28%)	149 (14%)	24 (40%)	35 (21%)
Statin				
Drugs on discharge	253 (81%)	134 (13%)	41 (68%)	36 (21%)
Aspirin	181 (58%)	72 (7%)	32 (53%)	16 (10%)
Beta blockers	99 (32%)	89 (8%)	31 (52%)	30 (18%)
Statin				
	214 (68%)	426 (40%)	40 (67%)	62 (37%)
Cholesterol check planned				
Disposal	0 (0%)	3 (0.3%)	0 (0%)	0 (0%)
Admitted	157 (50%)	41 (4%)	20 (33%)	12 (7%)
Out patient appointment	60 (19%)	0 (0%)	20 (33%)	1 (1%)
Referred for angiogram	96 (31%)	1025 (96%)	20 (33%)	155(92%)
Discharged to GP				

Table 36: Logistic regression of factors influencing referral of patients for an angiogram both in the RACPC and OP cardiology clinic

Variable	Comparator	Univariate		Multivariate	
		Odds ratio 95% CI	P	Odds ratio 95% CI	P
Angina *diagnosis*	Non-cardiac diagnosis	337.47 (46.77,2435.26)	<0.0001	106.93 (5.51,2075.35)	<0.0001
Age *per 10 year increase*		1.52 (1.27,1.82)	<0.0001	1.02 (0.78,1.33)	0.8832
Male	Female	2.77 (1.68,4.57)	<0.0001	2.02 (1.07,3.81)	0.0283
Ethnicity					
Black	White	0.23 (0.08,0.65)	0.0075	0.55 (0.17,1.80)	0.2123
South Asian		0.62 (0.39,0.99)		0.55 (0.29,1.05)	
Others		0.65 (0.23,1.87)		1.36 (0.33,5.63)	
H/o **hypertension**	None	1.75 (1.12,2.74)	0.0146	0.98 (0.54,1.80)	0.9607
H/o **diabetes**	None	1.85 (1.12,3.05)	0.0210	1.32 (0.67,2.59)	<0.0001
Current smoker	None or ex-smoker	1.62 (0.98,2.69)	0.0710	NA	NA
Character of symptoms					
Typical	Non-specific	218.51 (30.12,1585.44)	<0.0001	1.67 (0.08,35.24)	<0.0001

Atypical		9.58 (1.25,73.44)		0.37 (0.02,7.75)	
Duration of symptoms					
> 4 weeks	< 4 weeks	1.50 (0.96,2.35)	0.0741	NA	NA
Resting electrocardiogram		2.10 (1.29,3.43)	0.0046	0.85 (0.45,1.60)	0.6188
Abnormal	Normal				
Exercise treadmill test					
Positive	Negative	85.81 (34.82,211.49)	<0.0001	10.14 (3.57,28.83)	<0.0001
Non-diagnostic		9.16 (3.11,26.99)		2.04 (0.60,6.95)	
Not done (unable to/ for medical reason/not indicated)		3.88 (1.59,9.49)		1.92 (0.68,5.45)	
Group					
Outpatients clinic	RACPC	2.24 (1.33,3.75)	0.0042	3.82 (1.85,7.90)	0.0003

Section 7 Summary of background, findings, conclusions and implications

7.1 Background

Chest pain is a non-specific common symptom with up to 25 percent of the general population experiencing it in some form during their lifetime (Kroenke, 1992). Chest pain is also the most common initial manifestation of coronary heart disease (Sutcliffe, Fox, Wood, Sutcliffe, Stock, Wright, *et al*, 2003) angina accounting for an estimated one percent of the annual health expenditure in the UK (Stewart, Murphy, Walker, McGuire, McMurray, 2003). The incidence of angina in primary care populations is increasing but its prognosis is unknown. Conventional outpatient clinics for assessment of chest pain can result in delayed diagnosis caused by the long waiting times and this in turn can increase the risk of adverse events in patients with coronary disease.

The rationale of RACPCs is to provide prompt cardiological assessment of new onset chest pain in patients without known coronary disease. The focus is on ambulatory patients, not those with acute coronary syndromes needing the high intensity monitored environment of the emergency department. RACPCs provide a platform for dialogue between primary and secondary care, with the referring doctor, usually a general practitioner, acting as a gatekeeper for onward referral.

First established to support epidemiological research (Duncan, Fulton, Morrison, Lutz, Donald, Kerr, *et al*, 1976; Ghandi, Lampe, Wood, 1995) their potential to improve cardiac services was recognised and found expression in the national service framework for CHD (Department of Health, 2000). The immediate priority was to set up 50 RACPCs by April 2001, another 50 by April 2002, with a nationwide roll-out thereafter. Such was the uptake of this service that it outpaced policy and there were more than 175 such clinics by January 2003. Now every acute trust in the UK has an RACPC (The National Service Framework for Coronary Heart Disease, 2004).

7.1.1 Why this study was undertaken: Gaps in knowledge

There is a large body of evidence about long term outcomes in patients admitted with acute coronary syndrome, but little is known about the contemporary prognosis of new onset chest pain, particularly in the setting of RACPCs. Past studies (Duncan, Fulton, Morrison, Lutz, Donald, Kerr *et al*, 1976; Ghandi, Lampe, Wood, 1995; Davie, Caesar, Caruana, Clegg, Spiller, Capewell *et al*, 1998) had low event rates, short follow-up (six to 16 months) and insufficient power to test differences in outcomes between different groups of patients. Most current data are from drug trials based on secondary and tertiary care populations and are prone to selection bias. Studies (Wilhelmsein, Rosengren, Hagman, Lappas, 1998; Eslick and Coulshed, 2002) have suggested that patients with non-cardiac chest pain may not have as benign an outcome as is commonly believed. This has raised concern about the outcome of patients diagnosed with non-cardiac chest pain in one-stop clinics, where 60 to 70 percent of patients emerge with this diagnosis (Sutcliffe, Steven, de Belder, Kumar, Fox, Wood, *et al*, 2002). Despite the proliferation of RACPCs, the assumption that they effectively distinguish between cardiac and non-cardiac origins of chest pain allowing early identification and management of high risk patients has not been tested.

The diagnosis of coronary artery disease is a probabilistic judgement based on clinical presentation and the disease prevalence in the population group to which the patient belongs. Quantitative analysis of the probability of coronary disease in an individual patient by Diamond and Forrester (Diamond and Forrester, 1979) based on age, gender and typicality of symptoms was based on post-mortem findings in US populations, and has not been tested in RACPC populations nor has its prognostic validity been tested against clinical end-points.

Another important aspect of health care provision is equity of access to services. If access to effective interventions is not equitable, groups with poorer access will have worse outcomes. Studies (Chaturvedi, Rai, Ben Shlomo, 1997; Dong, Ben Shlomo, Colhoun, Chaturvedi, 1998; Richards, Reid, Watt, 2002; Gardner, Chapple, Green, 1999) have shown inequities exist with reduced access to cardiac services for some ethnic minority groups, women and older people. Barriers to access may start with the patient and may include language, culture, socio-economic status (SES) and health seeking behaviour. As yet there is no information about the ability of RACPCs to deliver appropriate and equitable investigation and treatment in vulnerable groups, particularly those with poor socio-economic status, women, certain ethnic groups and older people.

The central focus in rapid access chest pain clinics is a one stop clinical assessment supported by non-invasive investigations. They are resource

dependent, their functioning requiring well trained clinical and technical staff. With the NSF directive, RACPCs have been set up throughout England and Wales, but no studies have addressed their clinical effectiveness, particularly the extent that they are universally available to patients with recent onset chest pain, their ability to identify patients with angina whose risk is increased, the effectiveness and equity with which they utilise non-invasive and invasive investigations, and the extent to which they have substituted for conventional outpatient assessment of patients with chest pain.

Concerns have been voiced over the need and impact of this new service over existing traditional outpatient assessment, but only one study (McGavigan, Begley, Moncrieff, Hogg, Dunn, 2003), based in Scotland focused on this issue, concluding that the RACPC may in fact be diverting resources from outpatient services by ineffective substitution

7.2 Aims of this study

These were the main aims of our study.

1 To determine whether RACPCs are appropriately targeted towards patients with chest pain of cardiac origin by comparing prognostic outcomes in subgroups.

2 To analyse populations using RACPCs, equity of access to the clinics and subsequent cardiac procedures (exercise stress tests and coronary angiography) and their appropriateness.

3 To compare different models of care across the participating centres.

4 To determine whether RACPC act in addition to, or as a substitute for, other services.

7.3 Data

We pooled and analysed data on patients attending six rapid access chest pain clinics, namely Newham General Hospital (now Newham University Hospital), Oldchurch Hospital, Manchester Royal Infirmary (MRI), Blackburn Royal Infirmary (BRI), Burnley General Hospital, and Kingston General Hospital.

Other data sources were the Office for National Statistics (www.bized.ac.uk), National Health Wide Clearing System (www.connectingforhealth.nhs.uk/nwcs/) and national census 2001.

7.4 Summary of findings integrating results from all four objectives

We found that adverse coronary outcomes were more frequent for patients diagnosed with angina compared with patients with non-cardiac chest pain. Diagnosis of angina, abnormal resting ECG, male gender, increase in age, symptom duration >4 weeks, smoking, diabetes and being south Asian were associated with increased risk of coronary death or non-fatal myocardial infarction. There was a suggestion of under treatment both in the use of statins and onward referral for coronary angiograms.

Nearly one-third of the total coronary events occurred in patients diagnosed with noncardiac chest pain. These patients were younger, less likely to have typical symptoms and more likely to have a normal resting ECG compared with patients with angina who had coronary events. We have shown that the calculated probability of CAD by the Diamond Forrester algorithm (Diamond and Forrester, 1979) accords not only with diagnosis but also with prognosis and confirmed its validity for risk stratification in south Asian patients.

Attendance rates at RACPCs by population 'need' (based on coronary mortality rates) provided evidence of inequity for older patients and those from the most deprived wards. There was no evidence of inequity of access by gender or ethnicity.

Referral for ETT was analysed for patients with intermediate (20 to 80 percent) pre-test probability of CAD and for those considered appropriate for an ETT by an independent panel. In both analyses women and south Asians were less likely to be referred, when adjusted for symptoms, risk factors for CHD, age and deprivation.

Referral for coronary angiogram was analysed in the whole cohort, those diagnosed with angina, those with a CAD score > 80% and those considered appropriate by the ARIA panel. Patients aged over 65 years, women, south Asians and those from the most deprived wards, were less likely to be referred for coronary angiography.

Our questionnaire survey on existing RACPCs throughout England has informed us of the wide variation in the organisational set up of this service. Detailed interviews with staff in the six centres highlighted problems of resource and staffing within these clinics. Centres have adapted their service to available resources and data from a single centre has shown that an RACPC can significantly reduce waiting time and largely substitute for traditional outpatient cardiology clinics.

7.5 Study limitations

7.5.1 Centre selection

The six clinics were not a random sample, but selected because they all used the same electronic database.

They were similar in that all functioned as one-stop clinics, but varied in organisation, length of follow up and demographics of the catchment populations. For this reason, detailed analysis by centre was underpowered and not carried out.

7.5.2 Clinical data

Because of the one-stop nature of this clinic, detailed follow up on discharge medication was not captured. Ethical constraints made it impossible to retrieve this information from general practices or patients. Blood test results were not always entered on the database and we were unable to adjust our outcome data for lipid profile, or serum creatinine or haemoglobin concentrations. Ethnicity was ascribed by physicians, and no measures of deprivation, such as education level, income, housing and lifestyle were recorded. Our ascription of socio-economic status was ecological, based on census ward codes derived from patient postcodes.

7.6 Strengths

This the first long-term study looking at prognostic outcomes in patients attending RACPCs. It is a multicentre study involving six hospitals from different parts of the country, making the findings more generalisable.

All data collection was prospective and was recorded electronically at the time of the clinic visit with 95 percent completeness.

Endpoints for outcomes were obtained from national registries - ONS, NWCS.

7.7 Implications

7.7.1 Clinical implications

It is no surprise that multiple factors contribute towards adverse outcomes in patients with angina. Those factors amenable to correction may help improve prognosis.

Diagnosis made at this one-stop clinic was the most important prognostic factor. The increased risk of a coronary event in patients with symptoms

for more than four weeks emphasises the need for rapid assessment of chest pain. However, our finding that one-third of all coronary events occurred in patients diagnosed with non-cardiac chest pain highlights the need to reduce misdiagnosis and identify all who might benefit from secondary prevention.

Our findings pointed to inequity in referral for non invasive tests (exercise ETT) by gender and ethnicity and for invasive tests (coronary angiogram) by age, gender, ethnicity and deprivation. There was also the added concern of patients who despite being referred for an angiogram, were not found to have undergone the procedure. Clinics and clinicians vary in their use of diagnostic tests, and resources and access to invasive investigations might influence referral patterns. These findings call for greater effort to ensure timely referral of appropriate patients for appropriate investigations.

Our data show that an abnormal ECG recording is not only more common among patients with angina but also predicts adverse outcomes, almost doubling the risk of coronary death or non-fatal myocardial infarction and increasing the risk of all cause mortality. Despite this an abnormal ECG did not influence referral for a coronary angiogram. Perhaps cardiologists should pay more heed to resting ECG findings which are always available for patients attending RACPCs.

An important way of improving the efficiency of the RACPC service is to improve the quality of referrals to best utilise the resources. There is need for regular audits and contact with the primary care providers, to ensure optimum care is provided to the patients

7.7. 2 Implications for patients

Among patients attending RACPCs, we identified increased risk for the older people those with diabetes, south Asians and those with longer duration of symptoms. Attendance rates were lower for the older people who, together with women, south Asians and the most deprived, had lower rates of cardiac investigation. These observations indicate that important inequities continue to stalk provision of cardiac services. Efforts must be redoubled to ensure that all those at risk are assessed promptly, and treated optimally in order to improve health outcomes.

7.7.3 Policy implications

National directives play an important role in establishment of services and our survey of RACPCs showed that over half were set up as a direct response to the NSF framework for CHD.

Guidelines for referral to RACPC based on symptom duration

The finding of heightened risk for patients with symptoms for more than four weeks lends powerful support to the NSF for CHD directive that all patients with recent onset of chest pain should be seen within two weeks of referral by the specialist. Most RACPCs discourage referral of patients with new onset chest pain who have had symptoms for more than four weeks possibly explaining the fact that that 97 percent of patients diagnosed with angina in the outpatient cardiology clinic had had symptoms for many months. Whether this was a deciding factor in their referral to the outpatient clinic is unclear, but the NSF directive takes no account of delays inherent in the referral process. These include the time it takes for the symptomatic patient to seek medical attention, the GP assessment and consideration for onward referral, the requirements of RACPC guidelines and finally the time for an appointment in the clinic.

More rapid assessment of patients with chest pain, therefore, might require increasing levels of awareness among the general population about the significance of new onset chest pain, further education of general practitioners about factors that should encourage immediate onward referral, perhaps opening up the RACPCs to all patients regardless of chest pain duration, and either streamlining appointment procedures or abolishing them with introduction of a truly open-access service. Clearly these interventions would result in more referrals and with only 48 percent of the existing RACPCs being able to meet the 14-day target for assessment of all referrals, policy analysis needs to take into consideration the extra resources both in terms of staff and provision of cardiac investigations that would be needed.

Prescription of secondary prevention drugs

The rate of prescription of secondary prevention drugs was low, especially for statins that were prescribed in only 28 percent of the cohort on the day of visit, although recommendation for cholesterol measurement, in accordance with contemporary guidelines (Joint British recommendations on prevention of coronary heart disease in clinical practice, 1998), was made in 90 percent of patients diagnosed with angina. Supported by evidence from trials like the Heart Protection Study (Collins, Armitage, Parish, Sleigh, Peto, 2003), TNT (Larosa, Grundy, Waters, Shear, Barter, Fruchart, *et al*, 2005) and newer policy directives, it is now clear that all

patients diagnosed with angina should receive statins, which should also be considered for some high risk sub-groups (people with diabetes) among patients with non-cardiac chest pain.

Inequities in health care

Visit rates to the clinic were lower among older people and those from the most deprived quintile of wards, a classic example of the inverse care law (Tudor Hart, 2000) since both groups are at increased risk of CHD compared to the general population. Among patients seen in the clinics, rates of referral for coronary angiography were low among the older people, women, south Asians and the most deprived. These inequities in the provision of care must be addressed through training and monitoring.

Without detailed ethnicity data from general practices of patients who are and are not referred to rapid access chest pain clinics, we cannot be completely confident that access to the clinics by different ethnic groups is equitable. These data should be routinely available from electronic medical records in the future, as long as they are prioritised by the Department of Health's Quality Management and Analysis System.

Models of RACPC-resource implications

The staffing requirements for RACPCs were not detailed within the NSF and the choice that is made has both cost and clinical implications as reflected in the doctor versus nurse-led model of care. Indeed it was lack of funding for new staff that was identified in many centres as the main cause of failure to meet the 14-day waiting time target. It is less expensive to employ a nurse for this purpose, yet only a handful of RACPCs are reliant on nurses alone to run the service. Our survey responses suggests that an 'average' RACPC seeing up to 10 new patients might require the following staff: *consultant cardiologist, junior doctor, cardiac nurses, cardiac technician and clinic administrator.*

Models of care must take account of local need and local facilities, but clear referral guidelines developed in conjunction with primary care colleagues are essential if referrals are to be both appropriate and manageable. Where facilities are available, daily clinics should be the target , ideally open access, and staffed by cardiologists and trained nurses, with the support of at least one administrative assistant and also cardiac technicians to provide one-stop non-invasive assessment with resting ECGs and ETTs where appropriate. The RACPC should be audited by electronic data collection with feed-back to primary care, in order that continuing refinements to the service can be applied as necessary to meet local needs.

7.8 Future research

We have shown that patients with *incident angina* have coronary event rates higher than the general population and this patient group is missing from current trials. We identified no randomised trials that have recruited patients with newly diagnosed angina.

Conclusion by recent trialists that stable angina has a good prognosis (Poole-Wilson, Lubsen, Kirwan, van Dalen, Wagener, Danchin, *et al*, 2004), with risk reduced to 'normal levels' with contemporary therapy (Pitt, 2004) may partly reflect selection bias in trial populations, which usually comprise stable patients in secondary or tertiary care settings. Similarly 75 percent of patients in the Euro Heart survey (Daly, Clemens, Sendon, Tavazzi, Boersma, Danchin, *et al*, 2005) of stable angina had had symptoms for over six months prior to their first cardiological assessment and are different from our patients with incident angina, many of whom were within four weeks and most within six months of symptom onset, suggesting recent plaque instability and predisposition to ischaemic events (Abrams, 2005; Shah, 2003). We propose that trials should be conducted in patients with new onset angina, with minimal exclusion criteria in order to have high external validity and enhance the implementation of findings into practice.

Registries in acute coronary syndromes (Fox, 2004), heart failure (Ezekowitz, McAlister, Armstrong, 2003) and non-cardiovascular disorders (SEER, 1973) have played an important role in understanding disease prognosis but there are no large registry date of patients presenting with new onset chest pain. These are urgently needed and we would strongly recommend the establishment of a national clinical database of patients with new onset chest pain attending RACPCs. The success of the MINAP (Birkhead, Walker, Pearson, Weston, Cunningham, Rickards, 2004) data collect ion process indicates that such large longitudinal databases are technically feasible and have the power to answer important questions about the epidemiology of coronary heart disease

Although clinical factors signal heightened risk among sub-groups diagnosed with non-cardiac chest pain, there is now a need for research to identify methods for improving diagnostic precision. This may involve better understanding of existing measures, for example by development and validation of risk scores in this population, as well as consideration of the incremental prognostic or diagnostic value of serological testing and non-invasive coronary imaging.

The findings of potential inequity in access to the clinic, use of exercise treadmill tests, referral for coronary angiogram and lower rates of receipt of angiogram among those referred for the same needs to be investigated with data from other clinics, more detailed case studies (capturing more

clinical data that may account for this variation) and qualitative studies of the consultation process in rapid access chest pain clinic. We are planning further detailed analysis using ARIA panel results.

7.9 Conclusion

The high event rates we identified among patients with new onset chest pain, justify the priority given for rapid assessment of chest pain in the NSF, but highlight the need for improved service provision, diagnosis and treatment to improve prognosis. The biggest advantage of carrying out this cohort study is that consecutive patients attending the clinic have been recruited. Although the time lapse to outcome measurement in a rapidly advancing medical speciality means that our data do not completely represent current clinical practice, our findings are nevertheless still highly relevant for cardiac service policy.

Section 8 Lay summary

8.1.1 Background

Chest pain is a non-specific common symptom with up to 25 percent of the general population experiencing it in some form during their lifetime (Kroenke, 1992). Chest pain is also the most common initial manifestation of coronary heart disease (Sutcliffe SJ, Fox, Wood, Sutcliffe A, Stock, Wright, *et al*, 2003) angina accounting for an estimated one percent of the annual health expenditure in the UK (Stewart, Murphey, Walker, McGuire, McMurray, 2003). The incidence of angina in the general population is increasing but its prognosis is unknown. Conventional outpatient clinics for assessment of chest pain can result in delayed diagnosis caused by the long waiting times and this in turn can increase the risk of adverse events in patients with coronary disease.

Rapid access chest pain clinics (RACPCs), modelled on the service we had originally introduced at Newham University Hospital, were recommended for all hospitals in England and Wales in the government's National Service Framework (NSF) six years ago (Department of Health, 2000) The immediate priority was to set up 50 RACPCs by April 2001, another 50 by April 2002, with a nationwide roll-out thereafter. Such was the uptake of this service that it outpaced policy and there were more than 175 such clinics by January 2003. Now every acute trust in the UK has an RACPC (The National Service Framework for Coronary Heart Disease, 2004).

The rationale of RACPCs is to provide prompt cardiological assessment of new onset chest pain in patients without known coronary disease. The focus is on ambulatory patients, not those with heart attacks needing the high intensity monitored environment of the emergency department. RACPCs provide a platform for dialogue between primary and secondary care, with the referring doctor - usually a general practitioner -acting as a gatekeeper for onward referral.

Why this study was undertaken

There is a large body of evidence about long term outcomes (prognosis) in patients admitted with heart attacks, but little is known about the contemporary prognosis of new onset chest pain, particularly in the setting of RACPCs. Past studies (Duncan, Fulton, Morrison, Lutz, Donald, Kerr, *et al*, 1976; Ghandi, Lampe, Wood, 1995; Davie, Caesar, Caruana, Clegg, Spiller, Capewell, *et al*, 1998) were unable to test differences in prognosis between different groups of patients. Most current data are from drug trials based on selected hospital-based populations and are

prone to bias. Studies (Wilhelmsein, Rosengren, Hagman, Lappas, 1998; Eslick and Coulshed, 2002) have suggested that patients with non-cardiac chest pain may not have as benign an outcome as is commonly believed. This has raised concern about the prognosis of patients diagnosed with non-cardiac chest pain in RACPCs, where 60 to 70 percent of patients emerge with this diagnosis (Sutcliffe, Steven, de Belder, Kumar, Fox, Wood, *et al*, 2002). Despite the proliferation of RACPCs, the assumption that they effectively distinguish between cardiac and non-cardiac origins of chest pain allowing early identification and management of high risk patients has not been tested.

Another important aspect of health care is providing equal access to services. If access to effective interventions is not equal, groups with poorer access will have worse outcomes. Studies (Chaturvedi, Rai, Ben Shlomo, 1997; Dong, Ben Shlomo, Colhoun, Chaturvedi, 1998; Richards, Reid, Watt, 2002; Gardner, Chapple, Green, 1999) have shown inequal access to cardiac services for some ethnic minority groups, women and older people. Barriers to access may start with the patient and may include language, culture, socio-economic status (SES) and health seeking behaviour. As yet there is no information about the ability of RACPCs to deliver appropriate and equitable investigation and treatment in vulnerable groups, particularly those with poor socio-economic status, women, certain ethnic groups and older people.

The central focus in RACPCs is a one-stop clinical assessment supported by simple (non-invasive) investigations. They are resource dependent, their functioning requiring well trained clinical and technical staff. With the NSF directive, RACPCs have been set up throughout England and Wales, but no studies have addressed their clinical effectiveness, particularly their ability to identify patients with angina whose risk is increased, the extent that they are universally available to patients with recent onset chest pain, their use of non-invasive and invasive investigations, and the extent to which they have substituted for conventional outpatient assessment of patients with chest pain.

Concerns have been voiced over the need and impact of this new service over existing traditional outpatient assessment, but only one study (McGavigan, Begley, Moncrieff, Hogg, Dunn, 2003), based in Scotland focused on this issue, concluding that RACPCs may in fact be diverting resources from outpatient services by ineffective substitution.

Aims of this study

The main aims of our study were:

1 to compare the outcomes in subgroups attending the RACPCs

2 to analyse populations using RACPCs, their access to the clinics and subsequent cardiac procedures (exercise stress tests and coronary angiography) and their appropriateness

3 to compare different models of RACPC across the participating centres

4 to determine whether RACPC act in addition to, or as a substitute for, other services.

Data

We pooled and analysed data on patients attending six rapid access chest pain clinics, namely Newham General Hospital (now Newham University Hospital), Oldchurch Hospital, Manchester Royal Infirmary (MRI), Blackburn Royal Infirmary (BRI), Burnley General Hospital, and Kingston General Hospital.

Other data sources were the Office for National Statistics (www.bized.ac.uk), National Health Wide Clearing System (www.connectingforhealth.nhs.uk/nwcs/ and national census 2001.

Summary of findings integrating results from all four objectives

We found that coronary events (death due to coronary heart disease, non fatal myocardial infarction and unstable angina) were more frequent in patients diagnosed with angina compared with patients with non-cardiac chest pain. Diagnosis of angina, abnormal resting ECG, male gender, increase in age, symptom duration >4 weeks, smoking, diabetes and being south Asian were associated with increased risk of coronary events.

Nearly one-third of the total coronary events occurred in those diagnosed with noncardiac chest pain. These patients were younger, less likely to have typical symptoms and more likely to have a normal resting ECG compared with patients with angina who had coronary events.

The attendance rates for older patients and those from most deprived wards were lower when compared to population 'need' based on coronary mortality rates for the area. Gender or ethnicity did make any difference to attendance rates. This suggested some inequality in access by age and deprivation.

Referral for invasive investigations for different subgroups showed reduced referral rates for older people, women, south Asians and those most deprived.

Our questionnaire survey on existing RACPCs throughout England has informed us of the wide variation in the organisational set up of this service. Detailed interviews with staff in the six centres highlighted problems of resource and staffing within these clinics. Centres have

adapted their service to available resources and data from a single centre has shown that an RACPC can significantly reduce waiting time and largely substitute for traditional outpatient cardiology clinics.

Study limitations

Centre selection

The six clinics were selected because they all used the same electronic database. They were similar in that all functioned as one-stop clinics, but varied in organisation, length of follow up and demographics of the catchment populations.

Clinical data

Because of the one-stop nature of this clinic, detailed follow up on discharge medication was not captured and blood test results were not always entered on the database. Ethical constraints made it impossible to retrieve this information from general practices or patients. Ethnicity was ascribed by physicians, and no measures of deprivation, such as education level, income, housing and lifestyle were recorded. Patient postcodes were matched to the census wards and ward socio-economic status ascribed to them.

Strengths

This is the first long-term study looking at outcomes in patients attending six RACPCs from different parts of the country, making findings generalisable.

All data collection was prospective and was recorded electronically at the time of the clinic visit with 95 percent completeness. Endpoints for outcomes were obtained from national registries - ONS, NWCS.

Implications

Clinical implications

It is no surprise that multiple factors contribute towards adverse outcomes in patients with angina. Those factors amenable to correction may help improve prognosis. Diagnosis made at this one-stop clinic was the most important prognostic factor. The increased risk of a coronary event in patients with symptoms for more than four weeks emphasises the need for rapid assessment of chest pain. However, our finding that one-third of all coronary events occurred in patients diagnosed with non-cardiac chest pain highlights the need to reduce misdiagnosis and target those who would benefit with preventive medication.

Our findings pointed to unequal access in referral for invasive tests (coronary angiogram) by age, gender, ethnicity and deprivation. There was also the added concern of patients who despite being referred for an angiogram, were not found to have undergone the procedure. Clinics and clinicians vary in their use of diagnostic tests, and resources and access to invasive investigations might influence referral patterns. These findings call for greater effort to ensure timely referral of appropriate patients for appropriate investigations.

Our data show that an abnormal ECG recording is not only more common among patients with angina but also predicts adverse outcomes, almost doubling the risk of coronary death or non-fatal myocardial infarction and increasing the risk of all cause mortality. Despite this an abnormal ECG did not influence referral for a coronary angiogram. Perhaps cardiologists should pay more heed to resting ECG findings which are always available for patients attending RACPCs.

An important way of improving the efficiency of the RACPC service is to improve the quality of referrals to best utilise the resources. There is need for regular audits and contact with the primary care providers, to ensure optimum care is provided to the patients.

Implications for patients

Among patients attending RACPCs, we identified increased risk for the older people those with diabetes, south Asians and those with longer duration of symptoms. Attendance rates were lower for the older people who, together with women, south Asians and the most deprived, had lower rates of cardiac investigation. These observations indicate that important inequities continue to stalk provision of cardiac services. Efforts must be redoubled to ensure that all those at risk are assessed promptly, and treated optimally in order to improve health outcomes.

Policy implications

National directives play an important role in establishment of services and our survey of RACPCs showed that over half were set up as a direct response to the NSF framework for CHD.

Guidelines for referral to RACPC based on symptom duration

The finding of heightened risk for patients with symptoms for more than four weeks lends powerful support to the NSF for CHD directive that all patients with recent onset of chest pain should be seen within two weeks of referral by the specialist. Most RACPCs discourage referral of patients with new onset chest pain who have had symptoms for more than four weeks possibly explaining the fact that 97 percent of patients diagnosed with angina in the outpatient cardiology clinic had had symptoms for many months. Whether this was a deciding factor in their referral to the outpatient clinic is unclear, but the NSF directive takes no account of delays inherent in the referral process. These include the time it takes for the symptomatic patient to seek medical attention, the GP assessment and consideration for onward referral, the requirements of RACPC guidelines and finally the time for an appointment in the clinic.

More rapid assessment of patients with chest pain, therefore, might require increasing levels of awareness among the general population about the significance of new onset chest pain, and further education of general practitioners about factors that should encourage immediate onward referral. This may include opening up the RACPCs to all patients regardless of chest pain duration, and either streamlining appointment procedures or abolishing them with introduction of a truly open-access service. Clearly these interventions would result in more referrals and with only 48 percent of the existing RACPCs being able to meet the 14-day target for assessment of all referrals, policy analysis needs to take into consideration the extra resources both in terms of staff and provision of cardiac investigations that would be needed.

Prescription of secondary prevention drugs

The rate of prescription of drugs was low, especially for statins that were prescribed in only 28 percent of the cohort on the day of visit, although recommendation for cholesterol measurement, in accordance with contemporary guidelines (Joint recommendations on prevention of coronary heart disease in clinical practice, 1998), was made in 90 percent of patients diagnosed with angina. Supported by evidence from trials like the Heart Protection Study (Collins, Armitage, Parish, Sleigh, Peto, 2003), TNT (Larosa, Grundy, Waters, Shear, Barter, Fruchart, *et al*, 2005), and newer policy directives, it is now clear that all patients diagnosed with

angina should receive statins, which should also be considered for some high risk sub-groups (people with diabetes) among patients with non-cardiac chest pain.

Inequalities in healthcare

Visit rates to the clinic were lower among older people and those most deprived, despite both groups being at increased risk of CHD compared to the general population. Among patients seen in the clinics, rates of referral for coronary angiography were low among the older people, women, south Asians and the most deprived. These inequalities in the provision of care must be addressed through training and monitoring.

Without detailed ethnicity data from general practices of patients who are and are not referred to rapid access chest pain clinics, we cannot be completely confident that access to the clinics by different ethnic groups is equal. These data should be routinely available from electronic medical records in the future, as long as they are prioritised by the Department of Health's Quality Management and Analysis System.

Models of RACPC-resource implications

The staffing requirements for RACPCs were not detailed within the NSF and the choice that is made has both cost and clinical implications as reflected in the doctor versus nurse-led model of care. Indeed it was lack of funding for new staff that was identified in many centres as the main cause of failure to meet the 14-day waiting time target. It is less expensive to employ a nurse for this purpose, yet only a handful of RACPCs are reliant on nurses alone to run the service. Our survey responses suggests that an 'average' RACPC seeing up to 10 new patients might require the following staff: *consultant cardiologist, junior doctor, cardiac nurses, cardiac technician and clinic administrator.*

Models of care must take account of local need and local facilities, but clear referral guidelines developed in conjunction with primary care colleagues are essential if referrals are to be both appropriate and manageable. Where facilities are available, daily clinics should be the target, ideally open access, and staffed by cardiologists and trained nurses, with the support of at least one administrative assistant and also cardiac technicians to provide one-stop non-invasive assessment with resting ECGs and ETTs where appropriate. The RACPC should be audited by electronic data collection with feed-back to primary care, in order that continuing refinements to the service can be applied as necessary to meet local needs.

Future research

We have shown that patients with new onset angina have higher coronary events than the general population and this patient group is missing from current trials. We identified no randomised trials that have recruited patients with newly diagnosed angina.

We propose that trials should be conducted in patients with new onset angina, with minimal exclusion criteria which would make the findings widely applicable.

Disease databases (Fox, 2004; Ezekowitz, McAlister, Armstrong, 2003; SEER, 1973) have played an important role in understanding disease prognosis but there are no large registry date of patients presenting with new onset chest pain. These are urgently needed and we would strongly recommend the establishment of a national clinical database of patients with new onset chest pain attending RACPCs.

Although clinical factors signal heightened risk among sub-groups diagnosed with non-cardiac chest pain, there is now a need for research to identify methods for improving diagnostic precision. This may involve better understanding of existing measures, serological testing and non-invasive coronary imaging.

The findings of potential reduced access to the clinic and investigations, needs to be investigated with data from other clinics and detailed studies of the consultation process in rapid access chest pain clinic.

Conclusion

The high event rates we identified among patients with new onset chest pain, justify the priority given for rapid assessment of chest pain in the NSF, but highlight the need for improved service provision, diagnosis and treatment to improve prognosis. The biggest advantage of carrying out this study is that unselected patients attending the clinic have been recruited. Although the time lapse to outcome measurement in a rapidly advancing medical speciality means that our data do not completely represent current clinical practice, our findings are nevertheless still highly relevant for cardiac service policy.

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Appendices

Appendix 1 details of data collected in the RACPC

Pt label

Date of GP referral / hospital referral: **Ethnicity**

Date seen in clinic

Cardiac history*(year)*

MI UA CABG PTCA none

Risk factors	Hyperlipidemia- Y / N,	Unknown	Family history - father
	Smoker – Y / N	Ex-smoker,	Mother
	HTN – Y / N		Both parents
Chl level -		sibs	
Diabetes –	N ,	Type 1	Father with sibs
		Type 2	Mother with sibs

Cardiac drugs on presentation

None or as under

Aspirin	– Y / N	Nitrate – Y / N	
B-blocker	– Y / N	GTN –	Y –helpful, Y – not helpful, N
Ca blocker	– Y / N	Statin –	Y / N

Chest Pain Y / N

Duration

< 1 week	1-3 month	> 1 year
1-2 week	3-6 month	
2-4 week	6-12 month	

Character Typical Atypical Noncardiac

Location Central L sided R sided L submammary Epigastric

Quality Aching Constricting Stabbing Nondescript

Radiation None L shoulder L arm R shoulder R arm Back Throat Jaw

Duration Seconds < 5 mins 5-15 mins 15-30 mins hours variable

Provocation Nothing in particular Exercise Exercise& rest Stress eating

Associated symptoms None SOB & palpitation SOB Dizziness & palpitation Dizziness SOB & dizziness palpitations

Examination Corneal arcus- Y/N xanthelasma- Y/N Chest wall tendernes- Y/N

Pulse rhythm SR AF

Pulse rate

Carotid upstoke Normal Slow Rapid Jerky

BP

Auscultation Normal or Specify the murmur

Signs of CCF Y / N

Peripheral pulses full or absent

Arterial bruit Y / N

ECG Normal or else

Axis normal, LAD / RAD Rhythm SR AF ectopics
ST/ T change Y / N Q waves Y / N

LVH Y / N BBB none LBBB RBBB

AV block none 1st degree 2nd degree(type1) 2nd degree (type 2)
CHB (narrow complex CHB (broad complex)

Cardiac investigations Cholesterol needs measuring No Yes by us Yes by GP

ETT done Y No (low probability of CAD)No (unable to exercise) No (LBBB)
No (arrhythmia) No (resting ST change) No (paced rhythm)

ETT Stopped by SOB chest pain Fatigue leg pain

Result Negative positive Equivocal

CXR done Y / N Heart size Y / N Lung fields normal / congested

Echo Y / N Isotope scan requested Y / N

Diagnosis Noncardiiac angina MI Pericarditis

Treatment: please specify if any (names and dose)

Nitrates	Statin
B- blocker	Aspirin
Ca blocker	GTN
Nicorandil	

Disposal Discharged to GP cardiac OP admitted catheter list

Appendix 2: Questionnaire survey of RACPCs in England

Hospital name: Consultant cardiologist: Dr.

Tel: contact no. Person completing form:

1) Date the clinic was set-up: month.....year.....

2) Do you have a computerised database for the chest pain clinic?

YES ☐

NO ☐

3) Are patients seen On the same day of referral (open access) ☐

or

Is there an appointment system (rapid access)? ☐

Please tick one box only.

4) Referrals accepted from

General Practitioners ☐

In-hospital referrals (A&E and clinics) ☐

5) Currently how many clinics do you hold per week? ☐

6) On average how many patients are seen per week? ☐

7) If seen by **appointment** system ,
   - what is the average waiting time for the clinic? ☐
   (Jan 2003 to Aug 2003)
   (in days)
   - What percent of patients are seen within 14 days of referral? ☐
   (Jan 2003 to Aug 2003)

8) Who usually makes the **initial clinical** assessment of the patient?

Please tick one box only

Nurse (grade) ☐

SHO ☐

SpR / Registrar ☐

Staff grade ☐

Associate specialist ☐

Consultant ☐

If other please specify .....

9) If **initial assessment** is made by a **nurse**, are all patients seen by a doctor as well?

YES ☐

NO ☐

10) If nurse led clinics, are the nurses able to prescribe drugs?

YES ☐

NO ☐

If yes please specify which drugs……..

11) Do **all** patients attending the clinic undergo exercise stress testing? (*excluding those who are physically or clinically unable to)*

YES	☐
NO	☐

- If **No**, who makes the decision whether to exercise the patient?- *please specify*

.....

- What percentage of patients would undergo exercise test on the same day?

…….

12) Who decides whether patient needs an angiogram? *Please specify*

.....

13) If nurse led clinic, who makes the final diagnosis? *Please specify*

.....

- ***Please attach a copy of your clinic referral guidelines and proforma.***
- ***Kindly return the completed form by 10th Nov 2003 please.***
- ***If there are any additional comments / suggestions, please add on the next page.***

Are Rapid Access Chest Pain Clinics effective and fair?

Additional Comments:

……

……

……

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……

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……

Thank you for your cooperation.

Appendix 3 Topic guide for comparison of different models of RACPC

Background:

- When was the clinic set up / when did you start working in the clinic Have you been with the clinic since its set up
- Why was it set up *Response to need, NSF, policy decision* *Do you feel it is needed.*
  Any other suggestions?
- Who was involved in the decision making process *GP, cardiologist, trusts*
- Funding for the clinic *How is your clinic funded*

Base:

- Where is the clinic based as respect to the other departments. *How accessible is it? Are you happy with the setting/where do you think it should be based*
- Clinic facilities *availability of waiting room, consultation room Is there adequate space*

Are Rapid Access Chest Pain Clinics effective and fair?

- How often is the clinic held. *How often do you feel it should be held.*
- How are the timings of the clinic chosen? *Coincide with GP surgeries* *Are there any changes you would like to make*
- Are ETT, ECHO based in the vicinity of the clinic? *Do you feel they should be easily accessible*

Are Rapid Access Chest Pain Clinics effective and fair?

FACTS	PROBE	QUESTION
Running of the clinic:		
• Is it nurse/ doctor led clinic (grade of each)	*Who is the initial contact*	*Who do you think should run this clinic*
• If nurse led,	*Are doctors available easily if needed*	*Do you think the doctors should be present*
• Referral guidelines	*Who decided them? Are they adhered to*	*Would you like to suggest any alterations to them*
• Who refers to the clinic (GP, A&E, Other deptts)		*Are you happy with the referral sources*
• Referral procedure to the clinic	*How is it done-fax, phone, post*	*What do you think is the best way to refer in an ideal world?*
• Appointment based/ open access		*What in your opinion is good/bad about the system*
• Are all patients who are referred seen.	*Are the referrals vetted and a sort of triage for urgent cases done.*	*Do you think some pts miss out with this?*
• Waiting time for the clinic.	*On average how long does a pt wait to be seen*	*Do you feel adequately staffed?*
• Percentage of patients seen within 14 day target.		*How easy is it to keep to the NSF target-difficulties?*

Are Rapid Access Chest Pain Clinics effective and fair?

FACTS	PROBE	QUESTIONS
• How many patients are seen per week		Is it easy to cope with the number.
• Who is the first contact for the patient (nurse/doctor)		*Do you feel this is appropriate*
• Who takes the history		
• What investigations are carried out for each patient ie ECG, Bloods-? which, height, weight, CXR		*Do you feel they are needed*
• Are all patients seen by a doctor? Grade?	same day or OP appt made	*Do you think they need to be seen by a doc same day or later*
• Who makes the final decision to exercise the patient,	Perform echo Thallium test Angiogram	
• Who performs the ETT- nurse, technicians, doctors		
• If needed is it possible to do ETT, Echo's on the same day		*Do you think they need to be done on the same day?*
• Are the tests supervised by a doctor		*do you think it is needed*

Are Rapid Access Chest Pain Clinics effective and fair?

FACTS	PROBE	QUESTIONS
• Are the technicians ALS trained.	*Do you think they should be.*	*Are there any provisions for them to be*
• How many people involved with the clinic on the day to day bases.	*Do you feel there is adequate level of staffing? Any suggestions*	
• Who is responsible for making the final diagnosis?	*If made by a nurse, are you happy about it/ Nurse- how do you feel about the responsibility*	
• Is there a computerized data system	*Do you feel computerized system helps*	*What problems do you face, time, training*
• Who enters the data?		
• Is the GP informed the same day – fax/ post/ phone	*Do you feel it is necessary to inform GP the same day*	
• Can nurses prescribe- if yes,? which drugs *prescribe…antianginals*	*Does this provide more efficiency*	*Do you feel that they should be able to*
• Referral for angiograms	*Is there a cath lab onsite* *If no, where are the pts referred to* *Any idea of the waiting times for angio, revasc*	

Any particular anectodote you can tell me about – a grateful patient
What is your overall impression of this clinic.- because of what….

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Addendum

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