The use of coronary angiography and coronary revascularisation procedures in a Glasgow population

Eileen McKnight Kesson, R.G.N.

Master of Science

Department of Public Health
University of Glasgow

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Abstract

Aim: To describe and explain variation in the use of coronary angiography and revascularisation in an urban population, in relation to available measures of need: age, gender, mortality and socioeconomic status.

Methods: A case was defined as an individual aged 35 - 74, residing in the acute catchment area of the Western Infirmary, Glasgow and undergoing coronary angiography. Data concerning angiography in 1990 and revascularisation in 1990 - 1991, were collected from routine and non routine sources from each of the 3 centres where patients in this area may be investigated. Standardised Mortality Rates for coronary heart disease (ICD 410 - 414) were used as a proxy of need. Socioeconomic deprivation in postcode areas was described using the categories of Carstairs and Morris. Rates of investigation per 1000 population were calculated by age and sex. The number of expected and observed angiograms, the proportion of patients proceeding to revascularisation and the number of days between investigation and surgery were calculated for men and women separately in each deprivation category.

Results: 195 men and 95 women aged 35 - 74 were investigated, at a rate of 4.53 and 1.91 per 1000 respectively. No significant difference was demonstrated by age or deprivation category in the number proceeding to revascularisation. The median time between investigation and surgery showed a significant difference; men in the most affluent category waited longer for surgery than men in the middle category. A statistically significant relative excess of coronary investigation was observed in the most affluent category and a significant deficit in more deprived categories.

Conclusions: The differences observed in this investigation could not be explained on the basis of need, as indicated by differences in mortality. The greater length of time between investigation and surgery in the most affluent category may reflect earlier referral of this group for investigation, compared to those from more deprived categories. However, careful inspection and analysis of routine data are unable to sort out competing explanations for the different investigation and treatment rates between men and women, age groups and mortality and socioeconomic groups. Additional research is required to explain the variation in referral and the effectiveness, efficiency and appropriateness of care. Health care purchasing decisions could then be made with a view to reducing variations in care which are not based on need or likely benefit from treatment.

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Preface

In 1991 I was awarded a Scottish Office Home and Health Department Research Training Fellowship. The purpose of the Fellowship was to acquire a range of experience concerning all stages of the research process. This would add to my training as a Registered General Nurse and equip me for further employment within the National Health Service, possibly in health services research or audit related activities. This Master of Science thesis was undertaken concurrently with the Research Training Fellowship.

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Introduction

Current reforms of the National Health Service of Scotland (1) have resulted in the distribution of resources to health boards, based on the size of the populations they serve. Health boards are responsible for assessing the relative health and health care needs of their populations and for allocating resources accordingly.

Greater Glasgow Health Board is responsible for purchasing services for a population characterised by large variations in mortality from coronary heart disease, and featuring some of the highest and lowest coronary mortality rates in Scotland (2,3). The assessment of the relative health care needs of this population in respect of the provision of cardiological services is an important issue for the health board.

This study aims to describe and explain variation in the use of coronary angiography and revascularisation in a Glasgow population, in relation to available measures of need; age, gender, mortality and socioeconomic status. Part I of the following literature review examines these measures of need in the context of the epidemiology of coronary heart disease. Part II describes the utilisation of coronary investigation and revascularisation by these indicators of health need.

Literature Review

Part I The epidemiology of coronary heart disease

Mortality and area of residence

Coronary heart disease (CHD) is a leading cause of morbidity and premature death in western countries (4). In 1984 the World Health Organisation set up the MONICA Project to **MONI**tor the trends and determinants of **CA**rdiovascular disease in defined communities (5,6). Since then, this international, longitudinal 10 year study has collected data on coronary mortality, non-fatal coronary events, risk factors and medical care in 38 populations from 21 countries. The findings of the project may give some indication as to why large differences exist between study populations in different countries, with regards to the relationship between the prevalence of risk factors and the incidence of heart disease and mortality.

In Glasgow, the MONICA Project is centred on a population of men and women aged 35 - 64 years in an area north of the River Clyde (5). Analysis of data relating to events in 1985 - 1987, shows major differences between populations in fatal and nonfatal coronary event rates. The Glasgow male population remains near the top of the league, with an age standardised annual event rate of 823 per 100,000 second only to Finland (915 per 100,000). The lowest rate in men is in Beijing, China, with a rate of 76 per 100,000 population.

While Glasgow women have a rate one third that of Glasgow men, they have the highest annual event rate of women in the MONICA Study - 256 per

100,000. Belfast, Northern Ireland where coronary mortality is similar to that of the west of Scotland, is second to Glasgow with a rate of 197 per 100,000. The lowest rate in women is in Catalonia, Spain with 30 per 100,000.

Within Britain there is evidence of national and regional variations; towns in south-east England have half the coronary mortality rates of towns in the west of Scotland (7,8).

These regional variations can also be found between the east and west of Scotland, the west having a higher coronary mortality than the east. Fulton et al (7) reviewed and analysed mortality data from the Annual Reports of the Registrar General in Scotland and the Registrar General's Statistical Review's of England and Wales. Data on coronary mortality during 1969 - 1973 were reviewed for men and women aged 35 - 64. England and Wales were subdivided into 9 regions and Scotland into 5 regions. North and west Britain were found to have the highest rates for death from ischaemic heart disease, the worst being west central Scotland.

Regional variations in mortality were further investigated in the British Regional Heart Study (BRHS) (8). This study assessed the role of environmental and socioeconomic issues in relation to cardiovascular mortality over 5 years (1969 - 73) in 253 towns in England, Wales and Scotland. Cardiovascular risk factors in middle aged men in 24 of these towns were examined (9). Mean systolic blood pressure, heavy cigarette smoking and heavy alcohol consumption were all positively associated with cardiovascular mortality. A weak association was found between cardiovascular mortality and social class. The authors related this association to differences between towns in smoking, drinking, blood pressure and hardness of water.

A later study by Crombie et al (10), analysed coronary mortality data from the Registrar General of Scotland for 1979-1983, for males and females aged 35-64 years and confirmed these regional variations within Scotland. These findings influenced the design and conduct of the Scottish Heart Health Study which aimed to investigate these geographical variations in coronary mortality (3,11,12).

In this large cross sectional study of 10,359 men and women aged 40 - 59, randomly selected from 21 local government districts in Scotland, three conventional risk factors were measured; serum cholesterol, blood pressure and cigarette smoking. A strong association between male unemployment and CHD mortality was shown. The only risk factor found to be strongly associated with coronary mortality among both men and women was cigarette smoking.

Marked regional variations are also evident within the west of Scotland, the predominantly unemployed and unskilled working populations of Clydeside having high mortality rates and the predominantly professional populations of Bearsden and Milngavie, and Eastwood having very low rates (3).

Geographical variations in mortality rates provide some indication of the relative needs of a population (13,14). However, the assessment of health care needs requires more specific information. The following studies examine indicators of health care need; gender, age, mortality and socioeconomic status.

Gender and age

CHD manifests itself in different ways; acute myocardial infarction, angina and sudden cardiac death. These presentations are affected by gender and age.

i) Acute myocardial infarction

Acute MI is diagnostically the same in both sexes with similar features of chest pain and electrocardiographic (ECG) changes (15). ECG changes of infarction without chest pain are, however more commonly seen in women (16). Women develop angina about 10 years later than men and clinical manifestations of myocardial infarction about 20 years later. The reasons for this are largely unexplained. Women's relative immunity to CHD early in life may be due to the protective influence of oestrogen, the function of which wanes with advancing age. The mechanism of this effect is not yet established. Overall, women are less likely to present with MI but the rate does increase rapidly over the age of 70. Further evidence from the Framingham study suggests that when MI occurs in women, mortality and morbidity rates are worse than those for men (16).

Tofler et al (17) reported mortality rates after MI to be greater in women than men, independent of age, while Dittrich and colleagues (18) concluded that increased mortality in women was due to their greater age at diagnosis. The higher rates observed in women of diabetes mellitus, hypertension and the presence of cardiac failure have also been cited as causes of increased post infarction mortality (18,19). Analysis of survival in the first 6 months following acute MI showed that in the first 30 days following MI, women have a worse prognosis than men (20). This could not be explained by variation in age and co-existing disease. Evidence of less vigorous post infarction treatment of women compared to men led the authors to conclude that until these variations in care are remedied, gender should not be considered an independent determinant of risk.

ii) Angina

Anginal chest pain is a common presenting feature of CHD in both sexes, but the Framingham Heart Study (16) may have fostered the opinion that angina was not such a serious disease in women as it is in men.

The National Heart and Lung Institute's Framingham Heart Study followed the course of 2336 men and 2873 women who were free of clinically manifest CHD at entry to the study. Follow-up was conducted for 26 years at biennial reviews. All evidence of coronary heart disease was recorded which included cardiovascular history, physical examination, blood lipid analysis and glucose level, body weight, vital capacity, chest radiography and 12 lead ECG. A total of 1240 coronary events were recorded during the follow-up. 752 (60%) of these events occurred in men and 488 (40%) in women. It was found that more than half (56%) of all the principal manifestations of coronary events in women were attributable to angina and 29% to MI. This compared with men where the principal manifestations of coronary disease were MI (43%) and angina (34%). Women appeared to develop angina almost twice as commonly as they did MI but with a more favourable prognosis than men.

It is possible that the favourable prognosis of women with angina reflected a substantial prevalence of women in the Framingham Study who did not have CHD. This hypothesis is supported by data from the Coronary Artery Surgery Study (CASS)(21) which examined medical and surgical treatment of coronary artery disease. The findings at coronary angiography revealed that 50% of women referred for coronary angiography had no coronary arterial narrowing compared with 17% of men. This raised the possibility that the definitions of 'chest pain' and 'angina' used in the Framingham Study, may have led to a large number of women being classed as angina sufferers where in fact they had precordial pain simulating angina. Women in the Framingham Study consequently appeared better able to tolerate angina than men.

In addition to finding gender to be an important determinant of disease prevalence, CASS also found that age and the character of chest pain played an important part (22). They found high risk coronary disease to be common in middle aged patients with definite angina and older patients with probable angina, but it was rare in patients with non specific chest pain.

The British Regional Heart Study (9) also investigated the prevalence of CHD by age, although this was limited to men in the age band 40 - 59 years. 7735 men were selected at random from general practices in 24 British towns. 14.2% of men had some evidence of angina on questionnaire, with almost a four fold difference between the youngest (40 - 44) and the oldest (55 - 59) age group. Myocardial ischaemia on ECG showed only a small increase in age from 8.1% in the 40 - 49 age group, to 12.1% in the 50 - 59 age group.

The Renfrew Paisley Midspan Study (23) investigated the prevalence of CHD and unlike other studies, included women in its population. 7137 men and 8262 women aged 45 - 64 took part between 1972 and 1976. The population was characterised by high social deprivation and high mortality rates from CHD.

Cardiovascular symptoms were assessed using the Rose chest pain questionnaire. Cardiovascular screening of participants included blood pressure measurement, ECG, plasma cholesterol and smoking habit (GCM Watt, personal communication, 1994).

Men aged 60 - 64 reported angina at twice the rate of men aged 45 - 59 with an even greater difference in myocardial ischaemia evident from ECG findings (2.5 fold). The prevalence of angina in this study was more than twice that of men in the British Regional Heart Study.

Only small differences were observed between men and women in the Renfrew Paisley Study in the prevalence of angina or myocardial ischaemia. In women, the prevalence of angina rose with age but to a lesser extent than men, rising form 14.4% at age 45 - 59, to 19.3% at age 60 - 64 years. As with men, ECG evidence of myocardial ischaemia more than doubled between these age groups.

The SHHS also reported on the prevalence of CHD in relation to gender (3). A history of myocardial infarction was three times more common in men than women and likewise a history of angina was more common in men. However, the percentage of women who reported less severe angina was slightly higher in women than men. This observation was based on chest pain data from the Rose questionnaire (24) and may reflect some peculiarity of the Rose questionnaire or a difference in the perception or description of chest pain between sexes.

iii) Sudden Death

The third syndrome of CHD is sudden death. About half of deaths due to coronary disease occur outside hospital. Sudden unexpected death (SUD) was examined in the Framingham Study (25). SUD was defined as "any death occurring within one hour of onset of symptoms in a person without prior overt CHD and without other probable cause of death suggested by medical history".

The authors found that established risk factors for CHD in men (cigarette smoking, raised blood pressure and raised cholesterol) were predictive of SUD in men. However, in women these CHD risk factors were unrelated to sudden death. Three variables - haematocrit, vital capacity and raised blood glucose were predictors in women but not in men. Surprisingly, cigarette smoking was not associated with SUD in women and the authors found this difficult to explain.

These documented differences in gender and age in presentation and risk factors suggest that the criteria used to diagnose and prevent heart disease in middle aged men, may not be appropriate when applied to women or to older age groups.

Socioeconomic status

In 1980 a report on the inequalities in health was published by the Department of Health and Social Security (26). The main finding was that there were large differentials in mortality and morbidity between social classes with those from lower social classes being most disadvantaged. Marmot et al (27) reviewed CHD mortality rates between the years 1931 -

1971 and related this difference to increased smoking , higher consumption of sugar and lower consumption of wholemeal bread in lower social classes. The Whitehall study of British male civil servants (28) confirmed these findings and added to the differences already identified between social classes; men in lower social classes exercised less, they were shorter and more overweight and they had higher blood pressures and lower levels of glucose tolerance. The authors concluded however, that most of the differences remained unexplained by conventional risk factors for CHD. Smoking habit (28,29) and fibrinogen levels (30) have shown the strongest association with lower socioeconomic groups.

In a second study 20 years later (Whitehall II) (31), social class differences mirrored those previously observed in mortality rates, with an inverse relationship between employment grade and prevalence of angina and ECG evidence of myocardial ischaemia. Differences in risk factors also persisted, particularly in smoking habit with 8.3 % of men in higher grade employment recorded as current smokers, compared to 33.6 % of men in the lowest employment grade. Overall, women smoked more than men except in the lowest grades.

The British Regional Heart Study (9) showed a weak association between social class and cardiovascular mortality within 24 British towns. This could be explained to some extent by differences between towns in cardiovascular risk factors; mean systolic blood pressure, heavy cigarette smoking and heavy alcohol consumption. The authors concluded that the prevalence of these risk factors may determine to some extent, increased CHD mortality in manual workers.

Social status in Great Britain has traditionally been measured by occupation data from the Office of Population Censuses and Surveys (OPCS) (32). However the use of social class alone, as an indicator of the differences found between different socioeconomic groups has been questioned (33,34). The allocation of social class is dependant on the recording of occupational status. Death certificates and census data provide the numerator and denominator for mortality rates but lack of agreement in recording occupation on both documents introduces bias. This is compounded by lack of data on women, who are frequently not assigned an occupation but are assigned to their husbands occupation.

The SHHS (35) measured social class not only by OPCS classification but also level of education, years of education and housing tenure. They measured conventional risk factors for CHD and several others which were related to social status. Smoking habit and fibrinogen level were found to be the most important confounding variables for men, and body mass index, high density lipoprotein cholesterol and triglyceride levels the most important for women. Of the measure of social status used, not being a home owner was found to be the most discriminatory measure of social status in relation to CHD.

Geographical variation in standardised mortality ratios (SMR) and socioeconomic status has become increasingly important to health boards and districts as they attempt to address the relative needs of their populations. SMRs have been used as a proxy measure of morbidity (and health need) by the Resource Allocation Working Party (RAWP) Report (36). The 1976 report of RAWP was criticised for the use of mortality data as an indicator of morbidity. Forster claimed that SMRs did not accurately measure the relative need for health care and that it was not a valid measure on which to base resource allocation (37). However as there are currently no accurate measures of morbidity available, RAWP continues to use SMRs as a proxy of need on which to base resource allocation. Further claims that the use of SMRs ignores other factors which affect the health of a deprived community such as poor housing and unemployment have resulted in the development of composite deprivation scores (34,38,39).

The Jarman index (38) was originally devised for use in allocation of resources in primary care by identifying areas of high workload for general practitioners. It was not designed as a measure of deprivation but has been adopted as such in England and Wales (40). It has been criticised for its use of census data, its use of demographic categories such as the elderly and ethnic minorities which may only be at risk of being deprived (41) and also for its poor correlation with measures of morbidity, when compared with other deprivation measures (42).

Other deprivation scores have been developed which rank higher in respect of correlation with measures of morbidity (42). Towsend's index of material deprivation is constructed from variables representing absence of material resources; not owning the home, unemployment, lack of access to a car and overcrowding (39). In Scotland, the Scottish Development Department devised different methods of classifying social deprivation. One was based on 12 indicators of social deprivation divided into 3 categories; housing, economic and sociodemographic and the other was used to classify individual households (43).

More recently, Carstairs and Morris have developed an alternative method of classifying social status of populations (34,44,45). Their analysis refers to the proportion of people in a defined population rather than individuals. This deprivation measure was applied to all postcode sectors in Scotland and wards in England and Wales. It consists of a combination of four variables: the percentage of males unemployed, residents with an economically active head in social class 4 or 5, residents in households overcrowded (> 1 person per room) and residents in households with no car. The deprivation scores are recoded into a categorical variable ranging from 1 (most affluent) to 7 (most deprived). Like the social class basis for measuring deprivation, this area based method can be criticised for its use of census and mortality data. However the widespread national use of postcodes as a basis for area classification means that most events can be allocated geographically.

This measure of deprivation correlates strongly with the standardised mortality ratio (SMR) for ages 0 - 64 and also with the census measure of the percentage of the population (in private households) reporting themselves as unable to work due to permanent sickness (45). Carstairs and Morris examined SMRs for CHD by deprivation category and found that for the 0 - 64 year old age group, SMR ranged from 63 in the most affluent category to 123 for the most deprived. This provides strong evidence of a gradient for ages 0 - 64 year. A less steep gradient was evident for over 64 years, ranging from 82, most affluent to 110 most deprived (44).

These composite scores of material deprivation have been criticised (42,46). The rational behind using a composite deprivation score has been that the more variables used the more representative the score will be of the multidimensional nature of deprivation. Campbell et al (42) propose that simple percentage unemployment is a single variable that does not need standardisation or require weighting before it can be used as a measure. In Scotland, Crombie et al (47) investigated the relationship between standardised mortality ratios for coronary death and a range of socioeconomic factors in 56 local government districts. Strong associations were seen with several measures of social disadvantage, the strongest being male unemployment. Sheldon et al (46) also criticise the use of composite deprivation scores on the grounds that they are statistically complex, not easily updated such as unemployment rates and are of no additional value to SMRs as a proxy of morbidity.

In the 1990's, the effects of social deprivation on health, initially highlighted by the report from the Department of Health and Social Security (26) have been further researched (48,49,50). While not specific to coronary heart disease, these studies emphasise the need for health boards to assess the relative health care needs within their populations, in order that resources may be allocated in the most effective, efficient and equitable manner.

Part II Coronary investigation and revascularisation

Exercise Tolerance Testing (ETT) is a non-invasive investigation performed routinely on patients with symptoms of chest pain. While the sensitivity and specificity of this test has been demonstrated in men, it has been shown to be a less reliable predictor of CHD in women (51,52). This results in a larger proportion of coronary angiography investigation being performed in women who are found to have normal coronary arteries but who have exhibited abnormal ETT (51). Sullivan et al (52) found that women were 5 times more likely to have normal coronary arteries than men at coronary angiography, concluding that ETT was of limited value in predicting CHD in women.

Coronary angiography is considered the "gold standard" for decision making in the diagnosis of patients with symptoms of chest pain and the management of patients with CHD; it is equally accurate in women and men. If revascularisation is indicated, the patient will proceed to percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG).

PTCA is the procedure of choice for many patients with symptomatic single vessel disease and increasingly many patients with multivessel disease are now successfully treated (53). CABG has been shown to be lifesaving (54) and of benefit to patients with high or medium risk from cardiac death (55) and for many others it reduces angina (56).

The differences observed in CHD mortality and morbidity by age, gender and socioeconomic status, give some indication of the relative need for investigation and revascularisation. Recent studies have shown variation in the use of cardiac procedures which suggest that bias may be occurring in the selection of patients for investigation and subsequent referral for revascularisation (57-64).

Age

A report from the Royal College of Physicians (57) recommended that elderly patients should have better access to cardiological services. It also noted that the facilities available were inadequate to provide for the patients of all ages who could benefit from these procedures. This implies that some rationing of services is required but if equity is defined as equal access for equal need then age should not necessarily be a discriminating factor. The increasing number of elderly people in the population (58) has resulted in an increase in the prevalence of age related disease such as angina and increasing demand for the finite resources available for cardiac investigation and intervention.

A study carried out in Edinburgh aimed to establish and compare the characteristics of patients aged 70 years and over with younger patients selected for coronary angiography and to assess the value of coronary angiography for older patients with chest pain (59). It showed that older patients undergoing coronary angiography generally had more severe symptoms and were taking more intense antianginal treatment than younger patients.

After angiography, the same proportion of older patients and younger patients proceeded to CABG, but elderly patients required more urgent intervention. Although operative mortality was higher in elderly patients, the similar symptomatic benefit in both groups led the authors to conclude that earlier referral and investigation of elderly patients might reduce the operative risk.

Montague and colleagues also evaluated the risk and practice patterns in acute MI in 402 patients, comparing clinical investigation of patients over 70 years with patients aged less than 70 years. Coronary angiography was performed less often in those aged 70 and over but the authors were unable to find an explanation (60).

The short term outcome of PTCA in patients with post infarction angina was assessed by Iniguez et al (61). The results of PTCA in patients aged 65 and over was compared with those under 65 years. They found that PTCA was successful in 89% of both groups. No patients required emergency coronary surgery, 2% of the elderly group reinfarcted and 3% of the young group, 1 elderly and 1 young patient died. The authors concluded that PTCA for post infarction in the elderly patients provides a high clinical success rate similar to results in young patients. However, other than the presence of recent infarction, the selection criteria was not specific and careful selection of older patients may have influenced the outcome.

Gender

The differences observed between men and women in the presentation of CHD may have led clinicians to believe that it is not such a serious disease in women, even though it is the leading cause of death.

Several American studies have examined the use of coronary procedures in patients hospitalised for CHD and found gender related differences (62,63). Ayanian and Epstein (62) found that men were more than twice as likely as women to undergo coronary angiography even after adjusting for age and co-existing disease. However, although they controlled for some confounding factors, they did not consider the severity of patients' coronary artery disease or their response to previous treatment of angina. Steingart et al (63) controlled for age and co-existing disease, left ventricular ejection fraction, previous infarction and disability following index myocardial infarction and found men were investigated at twice the rate of women.

These studies and others (64,65) have explored variations in investigation rates but are limited by their application to patients who have been hospitalised with suspected or definite coronary heart disease. The undemanded and unrecognised needs of the population who may have unreported coronary symptoms are therefore excluded from analysis.

The decision to proceed to coronary angiography indicates that if clinically indicated, revascularisation will be considered. It is possible that the observed differences in the use of coronary angiography relate to clinical perceptions of the reduced effectiveness of these procedures in the elderly and in women. Gender related differences in referral for PTCA were examined by the National Heart Lung and Blood Institute(NHLBI) (66). The women in this study were older and had a higher prevalence of severe and unstable angina and hypertension. Men more often had multivessel disease, previous bypass surgery and ejection fractions less than 50 percent. Despite the more advanced disease diagnosed by angiography in men, women had a lower clinical success rate and higher in-hospital mortality.

However Eysnam and Douglas (67) cited a meta-analysis of 212 published reports on angioplasty and demonstrated that gender was not significantly correlated with post-PTCA restenosis. The favourable long term outcome suggested that PTCA may be an excellent therapeutic option in women. The precise reasons for women's increased morbidity at the time of angioplasty require further study.

It is generally believed in clinical practice that women undergoing CABG have a higher risk of mortality and morbidity than men. This may account for the lower number of women undergoing CABG but research studies addressing these assumptions are equivocal and sparse. Of the 3 most cited studies examining the role of CABG in atherosclerotic CHD, the Veterans Administration (68) and the European Coronary Surgery Study (56) include only men, while the population of the Coronary Artery Surgery Study (CASS) (69) was only 19% female.

CASS was a large study of the medical and surgical treatment of CHD which reported higher mortality rates for women following surgery than men; 4.5% women versus 1.0% men undergoing CABG in the same institution. However they concluded that the excess operative risk in women was due to smaller stature and smaller diameter of coronary arteries rather than their sex, i.e. the smaller patient, woman or man, face heightened risk of operative mortality after allowing for differences in other risk factors. Loop et al (70) criticised this study stating their belief that the coronary artery diameter as measured by numerous surgeons was inaccurate and that vessel diameter itself does not take into context the effect of diffuse atherosclerosis, graft stenosis or early graft closure. Their findings paralleled those of CASS in relation to age and mortality. Both studies found women younger than 60 years had a significantly higher mortality than men in the same age group. After 60 years of age, mortality increased in men and differences between sexes became insignificant.

More recently, King et al (71) suggested that women are referred for CABG later in the course of their disease than men and that later referral may increase their chances of death.

Ayanian and Epstein (62) found that women were significantly less likely to undergo revascularisation then men, while Steingart et al (63) found that once women had undergone angiography, they were as likely to proceed to surgery as men.

In a further study examining referral for CABG, Bickell et al (72) found women to be at least as likely as men to be referred for CABG among more symptomatic and more severely diseased patients in whom surgery offers the greatest survival benefits. Patients with a low risk of cardiac death gain little or no survival benefit by undergoing surgery rather than medical treatment; Bickell et al found that women in this category were less likely than men to be referred for CABG, concluding that women were receiving more appropriate treatment than men.

These studies examining gender differences and the use of coronary procedures have all been carried out in the USA. It was comparatively recently that Petticrew et al (73) in South West Thames and North West Thames Regional Health Authorities set out to determine whether the sex differences in access to cardiac surgery observed in the USA exist also in the United Kingdom. A retrospective analysis of routinely collected data was performed. The authors found that in all age groups and among patients with a principal diagnosis of either angina or chronic ischaemia, men were significantly more likely then women to undergo revascularisation in both regions and they concluded that there appeared to be systematic differences in the treatment received by men and women. The reasons for this are unclear. In using routine hospital data the accuracy of these results may be questioned but as the authors point out, it seems unlikely there is a systematic difference in data capture between the sexes. The study was limited by lack of data on severity of disease and the omission of data from the large private health care sector of South West Thames. In addition, Petticrew et al claim that these differences reflect differences in the UK. The investigation and revascularisation rates of Thames Regional Health Authority may not reflect clinical practice in other parts of the UK.

Gender differences in utilisation rates of coronary catheterisation and angiography in a Northern Ireland population have been investigated by Kee et al (74). While acknowledging that further clinical data would be required to make a judgement about gender bias, they found utilisation rates in men to be twice the rate of women.

Area of residence

Kee also investigated socioeconomic status and referral for coronary angiography in Northern Ireland (14). No significant difference was found between investigation rates in areas of varying socioeconomic status. Electoral wards were ranked by a deprivation score but variation in mortality rates within these districts was not considered. Routine statistics were used to determine the numerator and denominator. The authors estimated that 7 - 10% of their numerator could not be assigned to an electoral ward, which may have introduced a numerator-denominator bias.

In Scotland, socioeconomic status was further explored by Findlay et al (75) They compared the use of coronary angiography between the 15 area health boards, only four of which had facilities for coronary angiography; Greater Glasgow, Lothian, Tayside and Grampian. Using Standardised Mortality rate for CHD as an indicator of need, variations in the rate of coronary angiography between the health boards were examined. They found that while Dumfries and Galloway had comparable mortality rates with Lothian, the rate of coronary angiography in Lothian was more than twice the rate in Dumfries and Galloway. The rates for coronary angiography were highest in those four health boards with angiographic facilities, concluding that ready access to services rather than need may be determining investigation.

In a subsequent study, they compared the angiography rate with a social deprivation score (SCOTDEP) and standardised mortality ratio for CHD (76). A relative excess of referral for coronary angiography in patients from areas of low social deprivation was shown. This was particularly evident in women. They concluded that a significant need was not being met in patients from areas of high social deprivation.

The Clinical Standards Advisory Group (77) aimed to describe the availability of and access to CABG and PTCA purchased by the NHS and the variation that exists within the UK. It did not investigate the use of coronary angiography. The study was carried out in 3 English Regions and 3 Scottish Health Boards, Greater Glasgow, Lanarkshire and Ayrshire and Arran. The use of revascularisation procedures was investigated in 10 NHS hospitals, 2 of which were in Glasgow - the Western Infirmary and the Royal Infirmary. Data were also included from Ross Hall Hospital, a private hospital in Glasgow which had provided services for NHS funded patients. Data were collected for the financial years between 1987 and 1992 and the first half of 1993. Results for the year 1991/2 revealed huge interegional variations in rates of PTCA and CABG from 190 per million in East Anglia to 453 per million in Greater Glasgow. A four fold difference in the rate of PTCA was observed, from 54 per million in East Anglia to 222 per million in South East Thames. These results could not be explained on the basis of the availability of regional services. Utilisation rates were found to be associated with the availability of consultant and non-consultant staff in regional centres.

Marked differences were also evident between the 3 Scottish Health Boards. Age standardised rates were calculated for the population over

24 years of age. The rates per million for CABG were 857, 578 and 475 for Greater Glasgow, Ayrshire and Arran and Lanarkshire respectively. District rates of utilisation of PTCA and CABG plus PTCA correlated with the availability of a local cardiologist and the proximity of a regional centre. Revascularisation rates were inversely associated with low SMRs, meaning that those with less need were utilising the services at a higher rate.

Variations in referral, investigation and revascularisation by gender and age should be expected and should reflect relative need; lower rates of referral and investigation in younger women compared with men of the same age, and similar rates of investigation in women and men aged 65 and over when CHD is equally common.

The large differentials in mortality from CHD between socioeconomic groups should also be reflected in referral and investigation rates; lower rates in more socioeconomically affluent areas with lower SMR, and higher rates in more deprived areas, with higher SMR.

Study aim and objectives

This literature review has highlighted the relative health care needs of populations and current utilisation of coronary procedures. This study aims to describe and explain variation in the use of coronary angiography and revascularisation in a Glasgow population, in relation to available measures of need; age, gender, mortality and socioeconomic status.

The specific objectives of the study were to:

1 determine the most accurate and complete source of data

2 identify cases undergoing coronary angiography

3 identify cases undergoing percutaneous transluminal coronary angioplasty or coronary artery bypass surgery within 12 months of coronary angiography

4 describe the cases by age, gender and socioeconomic status

5 describe differences in the use of coronary angiography and revascularisation by age, gender and socioeconomic status

6 relate these differences to the known variation in mortality

Methods

Study population

The study area was the acute catchment area of the Western Infirmary, Glasgow (WIG). This contains 33 postcode sectors, 19 within the City of Glasgow and 14 outside (Figure 1). The number of men and women aged 35-74, residing in each of the 33 postcode sectors was determined from 1991 Population Census data. The widely reported under counting of the Glasgow population in the 1991 Census has been identified predominantly in men aged 18 - 34 years of age. Due to low coronary mortality and coronary investigation rates, the population under 35 years of age were excluded from this study, thus reducing the denominator bias which may have occurred had this age group been included.

Socioeconomic deprivation of the area was described using the deprivation scores of Carstairs and Morris based on 1991 census data (Figure 2). They calculated deprivation scores for each postcode sector in Scotland based on four variables associated with lack of material wealth: overcrowding, male unemployment, low social class and car ownership. These are calculated as a proportion within each postcode sector and assigned a deprivation score. Scores are calculated into a categorical variable ranging from 1, most affluent to 7, most deprived. The 33 postcodes were grouped by deprivation category.

The area of residence of each patient was determined by:

a) identifying the postal address from the hospital computerised records system (COMPAS).

GGHB:- ACUTE CATCHMENT AREA OF WESTERN INFIRMARY GLASGOW

POSTCODE SECTOR LEVEL

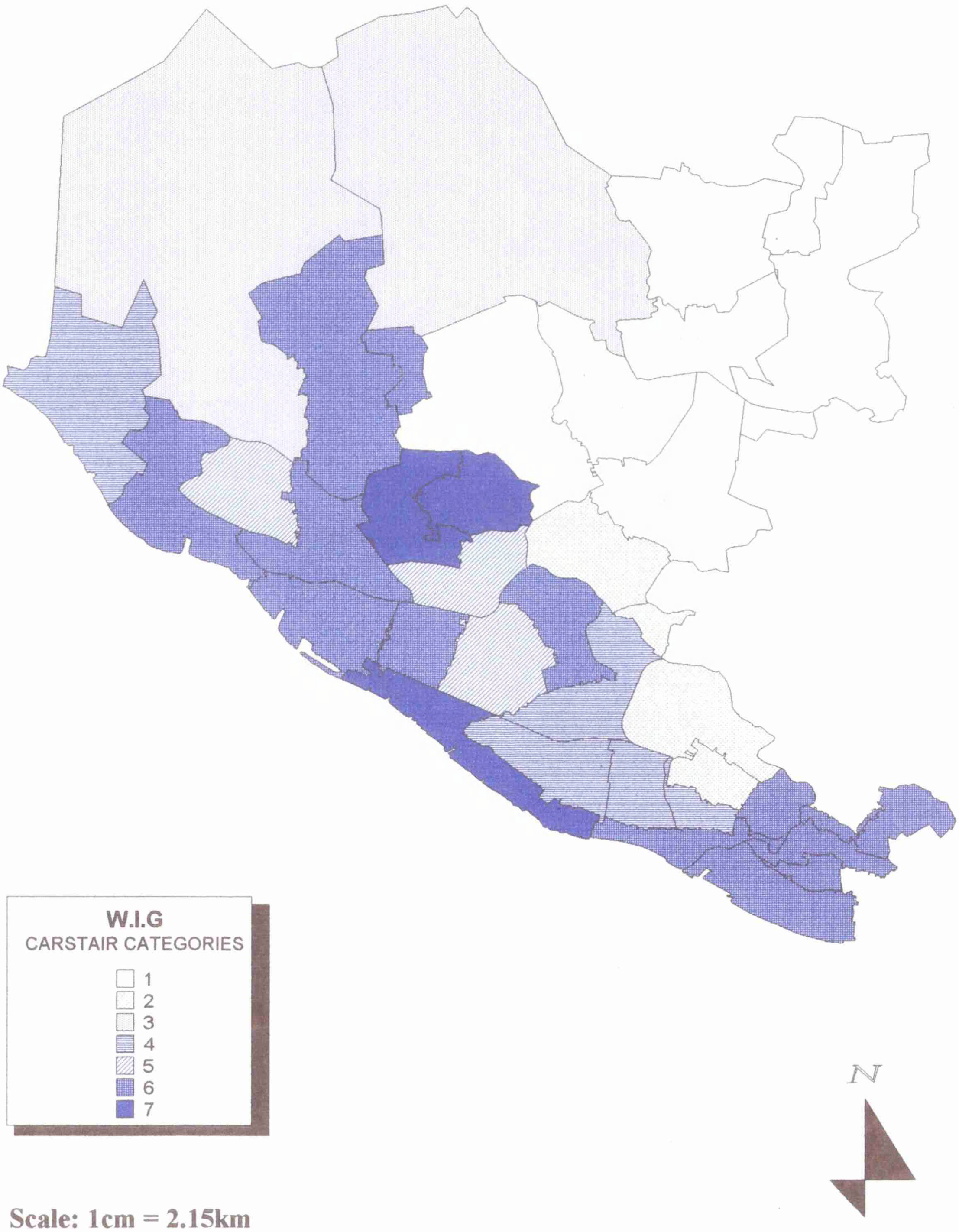
Figure 1

Scale: 1cm = 4.4km

GGHB:- ACUTE CATCHMENT AREA OF WESTERN INFIRMARY GLASGOW

1991 CARSTAIR CATEGORIES

Figure 2



Scale: 1cm = 2.15km

b) assigning the postcode from the Post Office Publication of addresses and postcodes.

The patients were grouped by postcode sector and then by deprivation category.

Case Definition

A case was defined as an individual aged 35-74, residing in the WIG acute catchment area and undergoing coronary angiography in 1990. Since only 7 angiograms were performed on patients under 35 years of age (Table 1) and 6 on patients over 74 (Table 2), the investigation was limited to the 35-74 year old age group.

Ascertainment of cases

There are 3 centres where patients from this area may be investigated; the Western Infirmary Glasgow, Glasgow Royal Infirmary whose catchment area borders the Western Infirmary and a private hospital, Ross Hall which receives cases from the West of Scotland. Data on the use of coronary angiography were collected from each centre for the year 1990.

The Scottish Morbidity Record 1 (SMR1) system would have been the ideal source of data from NHS hospitals. This provides information (including major diagnostic and therapeutic procedures) on patients discharged from Scottish NHS hospitals (excluding psychiatric and obstetric wards). However a study which I carried out in the Western Infirmary, Glasgow (1991) to determine the accuracy and completeness of SMR1 data showed large discrepancies, making it an unreliable source of data (Appendix 1).

Table 1 Excluded from investigation

Patients under 35 years of age investigated by coronary angiography in 1990.

Age	Sex	Deprivation Category	Revascularisation
33	1	6	no
33	1	4	no
34	1	7	yes
32	2	7	no
29	1	6	no
30	2	4	no
32	1	3	yes

Sex 1 = male, 2 = female

Table 2 Excluded from investigation

Patients over 74 years of age investigated by coronary angiography in 1990.

Age	Sex	Deprivation Category	Revascularisation
77	1	4	yes
80	1	5	no
83	2	3	no
82	1	4	no
76	1	3	yes
75	1	1	yes

Sex 1 = male, 2 = female

Consequently, data were collected from each centre, in the following manner (Table 3):

1 Western Infirmary, Glasgow (WIG)

Most patients had angiography at the WIG. The cardiac catheter theatre log book was used to identify all patients who had been investigated by coronary angiography and those who proceeded to percutaneous balloon angioplasty (PTCA) within one year of investigation. The name, unit number and age of patients fulfilling the selection criteria were identified from the theatre log book.

2 Glasgow Royal Infirmary (GRI)

Only a small number of patients residing in the WIG catchment area would be expected to attend GRI for investigation. The time required to perform a similar exercise in GRI to that performed in the WIG could not be justified. However, a two month sample of GRI cardiac catheter theatre log book showed that all patients identified as residing in the WIG area were included in SMR1 data, thus making it a reliable source of identification in GRI.

3 Ross Hall Hospital (RHH)

Routine data from RHH are not included in the SMR1 data. Accordingly, patients undergoing cardiac investigation were identified from the RHH cardiac theatre log book in a similar manner to that used in the WIG.

Exclusions

The WIG provides cardiac services for an area much larger than it's acute catchment area (Table 4). 1494 patients attended the cardiac catheter

Table 3 Sources of Cases

Hospital	Coronary Angiography & PTCA*	CABG**
Western Infirmary, Glasgow	cardiac catheter theatre log book	SMR20
Glasgow Royal Infirmary	SMR1	SMR20
Ross Hall Hospital	cardiac catheter theatre log book	general theatre log book

PTCA* = Percutaneous transluminal coronary angioplasty

CABG** = Coronary Artery Bypass Graft

Table 4 Postcodes of patients attending the Western Infirmary Glasgow Cardiac Catheter Theatre in 1990

Postcode	**Number attending WIG* Cardiac Catheter Theatre**	**Percentage %**
G (*)	746	50
KA	328	22
PA	189	13
FK	104	7
DG	31	2
IN	15	1
Other	59	4
Postcode unknown	22	1
TOTAL	1494	100

Postcodes:

G (*) Glasgow (all Glasgow postcodes including Western Infirmary acute catchment area)

KA Kilmarnock, Ayrshire & District

PA Paisley

FK Falkirk & District

DG Dumfries & District

IN Inverness

theatre in 1991. 1040 patients residing outside the acute catchment area were excluded. The postcode of 22 patients could not be determined because of inaccurate, incomplete or missing data and were therefore excluded.

78 patients, investigated for reasons not relevant to coronary heart disease such as right heart catheter, insertion of pacemakers, generator change or respiratory tests were also excluded.

67 patients admitted on more than one occasion for the same procedure, were counted once.

13 patients under 35 or over 74 years were excluded.

The postcode of all patients attending GRI and RHH was available.

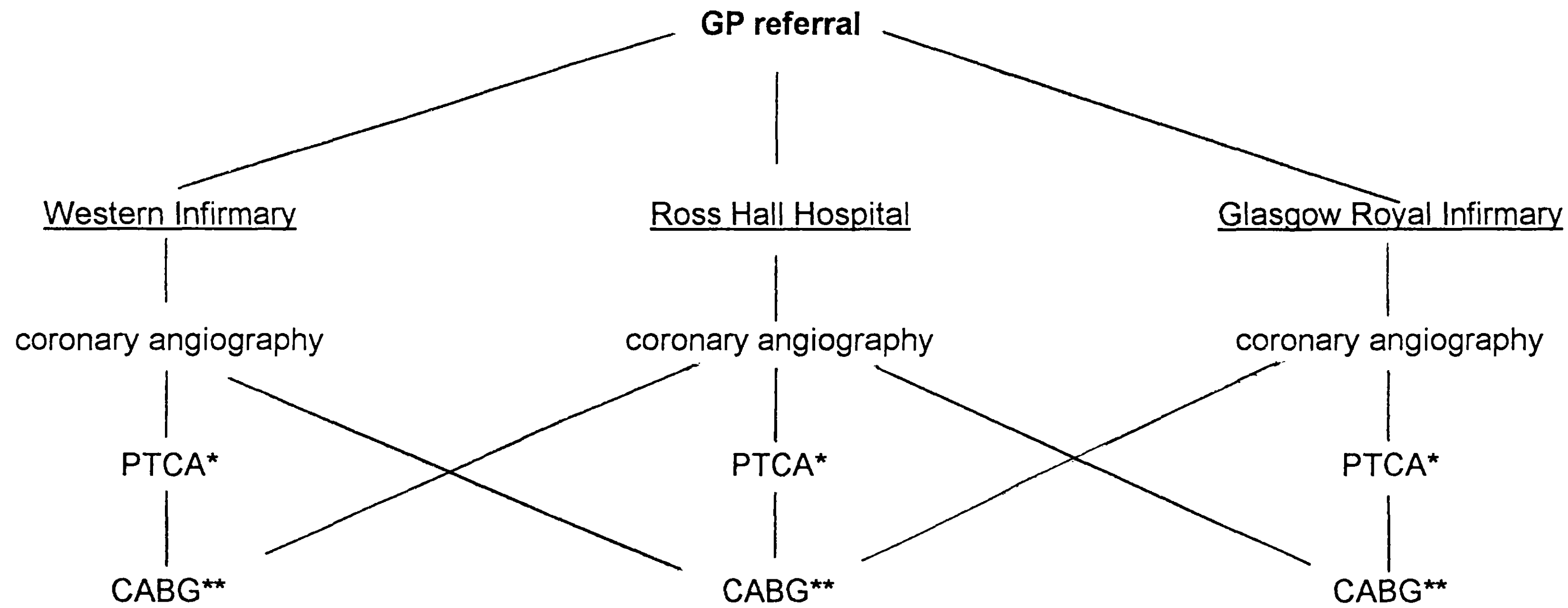
Revascularisation

Information on cardiac surgery in Scotland is stored and analysed by the Information and Statistics Division of the Common Services Agency. To establish which patients proceeded to coronary artery bypass grafting (CABG) following coronary angiography, permission was obtained from consultant cardiac surgeons to link demographic details of patients from the WIG and GRI, with Cardiac Surgery (SMR20) data for the years 1990 and 1991.

In RHH, the names and dates of birth of patients were linked with the main general theatre logs for 1990 and 1991 to determine the number of patients proceeding to surgery.

Data from each hospital were cross linked to identify patients who had been investigated in one hospital but operated on in another (Figure 3).

Figure 3 General Practitioner referral patterns for investigation and revascularisation



PTCA* = Percutaneous Transluminal Coronary Angioplasty

CABG** = Coronary Artery Bypass Graft

The date of coronary artery bypass surgery was subtracted from the date of coronary angiography to determine the number of days between investigation and surgery for each patient. The exact date of coronary angiography was not known for patients investigated at RHH so this analysis excludes patients receiving private treatment. However it could be assumed that patients attending privately would undergo bypass surgery within a shorter time interval than those receiving NHS treatment, therefore their inclusion may have biased the result. The number of patients proceeding from investigation to CABG within each deprivation category was too small to take account of the effects of age.

Mortality

Coronary heart disease mortality data were supplied by Greater Glasgow Health Board (GGHB) for 1989-1990, aged 0-64 ICD Ninth revision (International Classification of Diseases, Codes 410 - 414. Figure 4). The standardised mortality ratio (SMR) for coronary heart disease was calculated in 3 stages for each deprivation category and for men aged 0 - 64 and over 64 years, and for women aged 0 - 64 years, in the following way:

1 The number of observed and expected deaths within each postcode sector were determined from GGHB data. Expected deaths were calculated for ages 0 - 64 and over 65 years for men and women separately, by applying Scottish age- and sex-specific mortality rates to the population in the postcode sectors.

Figure 4 International Classification of Diseases

International Classification of Diseases, version 9 (ICD 9) is a classification of diseases, standardised by the World Health Organisation. It groups together similar conditions or diseases under one heading. The following is the grouping for Coronary Heart Disease:

ICD code	Disease
410	Acute myocardial infarction
411	Other acute and subacute forms of CHD
413	Angina pectoris
414	Other forms of chronic CHD

2 Postcode sectors were grouped by deprivation category

3 The total number of observed deaths was divided by the total number of expected at standard rates (i.e. 100, the standard for Scotland as a whole during that period).

Statistical analysis

Data was entered and stored using Paradox 3.5 and transferred to Epi-Info for some of the analysis. Analysis not performed on Epi-Info was performed manually.

The rate of angiography per 1000 population was calculated for men and women. In order to examine the data in 10 year age bands the deprivation categories were collapsed into 3; 1 and 2 most affluent, 3,4,5 middle, 6 and 7 most deprived. The rate of angiography was calculated separately in 10 year age bands, in each group of deprivation category and for men and women separately.

The proportion of men and women proceeding to surgery in each of the grouped categories was calculated as a percentage of those having undergone angiography. This calculation was performed on the assumption that once angiography had been performed, a similar proportion of patients in each deprivation category would proceed to revascularisation.

The statistical significance of the number of investigations performed by grouped deprivation category and age group was tested for using Chi Square Test and for men and women separately.

The mean number of days between investigation and revascularisation was calculated for the total number of patients undergoing revascularisation. The statistical significance of the median number of days between investigation and revascularisation was tested in each group of deprivation categories and for men and women separately using the Kruskall-Wallis H non-parametric test. The median number of days was used because a wide variation was expected in the number of days between investigation and revascularisation.

In order to take account of differences in coronary mortality between deprivation areas, the number of angiograms expected in each individual deprivation category was estimated: the overall angiography rate was adjusted according to the SMR calculated for each deprivation category and the age- and sex-specific population in that category. The number expected was then compared with the number observed. 95% confidence intervals were calculated for the observed (O)/expected (E) ratio as follows:

$$= \frac{O}{E} - 1.96 \times \frac{\sqrt{O}}{E} \quad \text{to} \quad \frac{O}{E} + 1.96 \times \frac{\sqrt{O}}{E}$$

Calculating confidence intervals defined the range of values within which the true population would lie and therefore took account of the relatively small numbers within each category.

In order to look for different patterns in age groups the calculation was performed for men aged 35 - 74 years and in 10 year age bands. Separate calculation was performed for men aged 35 - 74 attending the 2 National Health Service hospitals.

Due to small numbers of women, this observed/expected ratio was calculated in age group 45 - 74 years only.

This calculation was also performed for men aged 45 - 74 years to estimate the number of revascularisation procedures expected in each deprivation category, and compared with the number of observed. 95% confidence intervals were calculated as described previously. Due to small numbers proceeding to revascularisation, this calculation was not performed for women.

Chapter 6 RESULTS

290 patients (195 men and 95 women) aged 35 -74 years, residing in the acute catchment area of the Western Infirmary Glasgow were investigated by coronary angiography in 1990 (Table 5).

Age and sex

Only 10 men and 3 women aged 35-44 were investigated (Table 6). The highest rate of investigation in both men and women was observed in the 55-64 year old age band. Men were investigated at over twice the rate of women aged 45-64 years. The rate in men rose to more than 3 times the rate in women in the 65-74 year old age band.

Sex and deprivation categories

Coronary angiography utilisation by sex and deprivation category does not reveal an obvious pattern (Table 7).

Deprivation categories and age

In order to examine the data in 10 year age bands, deprivation categories were grouped as 1 and 2, most affluent; categories 3,4, and 5 middle; and categories 6 and 7, as most deprived. The highest age specific rate in men is in the middle category in age band 55 - 64 (Table 8). The highest rate in the most deprived category is also in this age band, while the highest rate in the most affluent category is in age band 65 - 74. No statistically significant

Table 5 Source of confirmed cases residing in the acute catchment area of the Western Infirmary Glasgow Men and women aged 35 - 74.

Hospital	Number of men	Number of women	Total Coronary Angiography
Western Infirmary Glasgow	181	93	274
Glasgow Royal Infirmary	7	0	7
Ross Hall Hospital	7	2	9
Total	**195**	**95**	**290**

Table 6 Coronary angiography rate by age per 1000 population (1991 Census data)

Men and women aged 35 -74

	Men			Women		
Age	population	no. coronary angiograms	rate per 1000	population	no. coronary angiograms	rate per 1000
35-44	13256	10	0.75	13600	3	0.22
45-54	10780	53	4.92	11377	24	2.11
55-64	10405	80	7.68	12421	44	3.54
65-74	8620	52	6.03	12282	24	1.95
Total	**43061**	**195**	**4.53**	**49680**	**95**	**1.91**

Table 7 Age standardised coronary angiography rates by deprivation category

Men and women aged 35 - 74

		MEN			Women		
	Deprivation category	population	no. coronary angiograms	rate per 1000	population	no. coronary angiograms	rate per 1000
most	1	6652	32	4.81	7348	9	1.22
affluent	2	4962	16	3.22	5214	6	1.15
	3	3100	14	4.52	3336	2	0.59
	4	6851	25	3.65	8213	15	1.83
	5	5531	33	5.97	7044	23	3.26
most	6	12069	59	4.89	14151	33	2.33
deprived	7	3896	16	4.10	4374	7	1.60

Table 8 Age specific coronary angiography rates by deprivation category. Men aged 35-74.

Coronary angiography rates expressed per 1000 population. Number of coronary angiographies shown in brackets

	Deprivation Categories			
	most affluent		**most deprived**	
Age	**1 & 2**	**3,4,5**	**6 & 7**	$\chi2$, 2 df
35 - 44	0.24 (1)	0.66 (3)	1.29 (6)	$\chi2$ not applicable numbers too small
45 - 54	3.56 (11)	4.78 (18)	6.10 (24)	$\chi2 = 2.32$ $p = 0.31$
55 -64	7.77 (20)	8.70 (33)	8.68 (27)	$\chi2 = 1.04$ $p = 0.59$
65 -74	8.59 (16)	5.29 (18)	5.36 (18)	$\chi2 = 2.60$ $p = 0.27$
Total 35 - 74	**4.13 (48)**	**4.65 (72)**	**4.69 (75)**	$\chi2 = 0.56$ $p = 0.75$

difference was demonstrated between deprivation categories or between age band and deprivation categories .

The highest age specific rate in women is also in the middle category, age band 55 - 64 years, which is more than three times the rate in the most affluent category in that age band. The highest rate in the most deprived category is also in this age band and the highest rate in the most affluent category is in the age band 65 - 74. No statistically significant difference was demonstrated between deprivation categories or between age band and deprivation categories (Table 9).

Revascularisation

Men

102 men (52%) proceeded to revascularisation; 32 to PTCA and 70 to CABG. Only 6 patients under 45 underwent revascularisation; 2 to PTCA and 4 to CABG, so these results concern the 45-74 year old group only (Table 10).

The numbers proceeding to PTCA and CABG were combined to give the total number proceeding to revascularisation in each deprivation category. No statistically significant difference was demonstrated between deprivation categories in the number proceeding to revascularisation and the number not proceeding to revascularisation (Table 11). No statistically significant differences were revealed by age and deprivation category in men undergoing revascularisation (Table 12).

Table 9 Age specific coronary angiography rates by deprivation category. Women aged 35-74

Coronary angiography rates expressed per 1000 population. Number of coronary angiographies shown in brackets.

	Deprivation Categories			
	most affluent		most deprived	
Age	**1 & 2**	**3,4,5**	**6 & 7**	**$\chi 2$, 2 df**
35-44	0.00 (0)	0.42 (2)	0.62 (1)	$\chi 2$ not applicable numbers too small
45-54	1.23 (4)	1.98 (8)	2.03 (12)	$\chi 2 = 2.54$ $p = 0.28$
55-64	1.43 (4)	4.38 (21)	3.94 (19)	$\chi 2 = 4.72$ $p = 0.09$
65-74	2.82 (7)	1.80 (9)	1.66 (8)	$\chi 2 = 1.23$ $p = 0.54$
Total 35 -74	**1.19** **(15)**	**2.15** **(40)**	**2.15** **(40)**	$\chi 2 = 4.54$ $p = 0.10$

Table 10 Percentage proceeding to PTCA* or CABG** by age and deprivation category.

Men aged 45-74. Number of procedures shown in brackets.

	PTCA* Deprivation categories			CABG** Deprivation categories		
AGE	1 & 2	3, 4, 5	6 & 7	1 & 2	3,4,5	6 & 7
45 - 54	9.0 (1)	16.7 (3)	25.0 (6)	54.5 (6)	38.8 (7)	25.0 (6)
55 - 64	15.0 (3)	12.1 (4)	25.0 (7)	30.0 (6)	42.4 (14)	33.3 (9)
65 - 74	18.7 (3)	11.1 (2)	16.6 (3)	31.2 (5)	44.4 (8)	50.0 (9)
Total 45-74	**14.9 (7)**	**13.0 (9)**	**23.1 (16)**	**36.1 (17)**	**42.0 (29)**	**34.7 (24)**

PTCA* Percutaneous Transluminal Coronary Angioplasty

CABG** Coronary Artery Bypass Graft

Deprivation categories 1 & 2 = most affluent, 3,4,5 = middle, 6 & 7 = most deprived.

Table 11 Number of patients proceeding to revascularisation (PTCA* or CABG**) by deprivation category

Men aged 45 -74.

	Deprivation Category			
	most affluent		most deprived	
	1 & 2	3,4,5	6 & 7	Total
revascularisation	24 (51 0%)	38 (55.0%)	40 (57.9%)	102 (55.1%)
no revascularisation	23 (48.9%)	31 (44.9%)	29 (42.0%)	83 (44.8%)
Total coronary angio.	47 (100%)	69 (100%)	69 (100%)	185 (100%)

$\chi 2$, = 0.54, df = 2, p = 0.76

PTCA* Percutaneous Transluminal Coronary Angioplasty

CABG** Coronary Artery Bypass Graft

Table 12 Percentage proceeding to revascularisation (PTCA* or CABG**) by age and deprivation category. Men aged 45-74. Number of revascularisation procedures in brackets.

	Revascularisation			
	most affluent	Deprivation Categories	most deprived	
Age	1 & 2	3,4,5	6 & 7	χ^2, 2 df
45 - 54	63.6	55.5	50.0	$\chi^2 = 0.40$
	(7)	(10)	(12)	$p = 0.81$
55 - 64	45.0	54.5	59.2	$\chi^2 = 0.63$
	(9)	(18)	(16)	$p = 0.73$
65 - 74	50.0	30.3	44.4	$\chi^2 = 0.65$
	(8)	(10)	(12)	$p = 0.72$
Total 45-74	**50.0**	**48.1**	**58.8**	$\chi^2 = \mathbf{0.62}$
	(24)	**(38)**	**(40)**	$p = \mathbf{0.73}$

PTCA* Percutaneous Transluminal Coronary Angioplasty

CABG** Coronary Artery Bypass Grafting

Women

No women under 45 years proceeded to revascularisation. 34 (36.9%) women aged 45 - 74 proceeded to revascularisation; 11 to PTCA and 23 to CABG (Table 13). The small number limits further analysis of these data.

No statistically significant difference was demonstrated between deprivation categories in the number proceeding to revascularisation and the number not proceeding to revascularisation (Table 14). Examination of the data by deprivation category and age (Table 15) reveals no obvious pattern. Numbers were too small for statistical analysis.

Comparing the rate of revascularisation procedures performed in men with the rate for women, reveals a significant difference ($p = 0.004$), with 55% of men aged 45 - 74 undergoing revascularisation and 37% of women (Table 16).

Number of days between coronary angiography and surgery.

The mean number of days from coronary angiography to surgery was 177 for men. Because the data were highly skewed with a range of 0 - 365 days from investigation to surgery the median number of days in each category was compared. A statistically significant difference was observed ($p = 0.04$) (Table 17). The median number of days was significantly longer in the most affluent category compared with the middle category ($p = 0.01$).

The mean number of days from coronary angiography to revascularisation was 185 for women. No significant difference was demonstrated between the

Table 13 Number of women proceeding to PTCA* or CABG** by age and deprivation category.

Women aged 45-74.

	PTCA* Deprivation categories			**CABG** Deprivation categories**		
AGE	1 & 2	3, 4, 5	6 & 7	1 & 2	3,4,5	6 & 7
45 - 54	0	2	3	0	2	1
55 - 64	0	3	2	1	4	5
65 - 74	0	0	1	5	3	2
Total 45-74	**0**	**5**	**6**	**6**	**9**	**8**

PTCA* Percutaneous Transluminal Coronary Angioplasty

CABG ** Coronary Artery Bypass Graft

Deprivation categories 1 & 2 = most affluent, 3,4,5 = middle, 6 & 7 = most deprived.

Table 14 Number of patients proceeding to revascularisation (PTCA* or CABG**) by deprivation category

Women aged 45 -74.

	Deprivation Category			
	most affluent		most deprived	
	1 & 2	3,4,5	6 & 7	Total
revascularisation	6 (40%)	14 (36.8%)	14 (35.9%)	34 (36.9%)
no revascularisation	9 (60%)	24 (63.1%)	25 (64.1%)	58 (63.0%)
Total coronary angios	**15 (100%)**	**38 (100%)**	**39 (100%)**	**92 (100%)**

$\chi 2 = 0.08$, $df = 2$, $p = 0.96$

PTCA* Percutanous Transluminal Coronary Angioplasty

CABG ** Coronary Artery Bypass Graft

Table 15 Percentage proceeding to revascularisation (PTCA* or CABG**) by age and deprivation category. Women aged 45-74. Number of revascularisation procedures shown in brackets.

	Revascularisation		
	most affluent	Deprivation Categories	most deprived
Age	1 & 2	3,4,5	6 & 7
45 - 54	0.0(0)	50.0(4)	33.3(4)
55 - 64	25.0(1)	33.3(7)	36.8(7)
65 - 74	71.4(5)	33.3(3)	37.5(3)
Total 45-74	**40.0(6)**	**36.8(14)**	**35.8(14)**

PTCA* Percutaneous Transluminal Coronary Angioplasty

CABG** Coronary Artery Bypass Graft

Table 16 Number of men and women undergoing revascularisation. Aged 45 -74.

	revascularisation	no revascularisation	Total
Men	102	83	185
Women	34	58	92
Total	136	141	277

$\chi 2 = 8.12$, $p = 0.004$*

Table 17 Median days from coronary angiography to coronary artery bypass surgery by deprivation category. Men aged 45 - 74 years. NHS patients (n = 63)

Deprivation Category		number of patients	median number of days investigation to surgery	Range min max
most affluent	1 & 2	15	246	10 - 363
	3,4,5	27	140	3 - 365
most deprived	6 & 7	21	217	1 - 355

Kruskall Wallis H 6.32, df 2, p = 0.04*

median number of days in each deprivation category, from investigation to surgery (Table 18).

Coronary mortality, social deprivation and coronary procedures

The SMR for each deprivation category was calculated for 0 - 64 years and over 64 years for men and women separately (Tables 19,20).

CORONARY ANGIOGRAPHY

The number of expected and observed angiograms performed were compared in each deprivation category. In men in the age group 35 - 74 years (Table 21), a statistically significant relative excess of investigation was observed in deprivation category 1. A relative deficit of investigation was observed in categories 4 and 7. These results were also statistically significant after removing private patients from the equation (Table 22). No significant observations were made in age group 35 - 44 (Table 23). A significant relative deficit in the age group 45 - 54 was evident in deprivation category 7 (Table 24). No significant observations were made in age group 55 - 64 (Table 25) or 65 - 74 (Table 26).

In women in the age group 45 - 74 years (Table 27), a statistically significant relative excess of investigation was observed in category 1 and a significant relative deficit of investigation in category 7.

REVASCULARISATION

A statistically significant relative excess of revascularisation was observed in deprivation category 1 (Table 28).

Table 18 Median days from coronary angiography to coronary artery bypass surgery by deprivation category

Women aged 45 - 74 years.

Deprivation Category	Number of patients	median number of days investigation to surgery	range min max
most affluent 1 & 2	6	74	21 - 344
3,4,5	9	150	80 - 300
most deprived 6 & 7	8	242	142 - 299

Kruskall-Wallis H = 4.5, df = 2, p = 0.10

Table 19 Standardised Mortality Ratios for deprivation categories.

Men aged 0 - 64 years and over 64 years, ICD codes 410 - 414

Deprivation Category	SMR 0 - 64	SMR over 64
1	50	82
2	68	87
3	83	108
4	107	95
5	119	103
6	110	110
7	152	96

Table 20 Standardised Mortality Ratio for deprivation categories.

Women 0 - 64, ICD codes 410 - 414

Deprivation Category	SMR 0 - 64
1	24
2	56
3	82
4	77
5	111
6	138
7	177

Table 21 Comparison of expected and observed number of coronary angiograms by deprivation category. Men aged 35-74.

Deprivation category	SMR(0-64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio Observed/ expected	Excess	Deficit	95% confidence interval (significant *)
1	50	15	32	2.13	17		1 39 - 2.87*
2	68	16	16	1.0	0	0	0
3	83	12	14	1.17	2		0.56 - 1.78
4	107	34	22	0.65		12	0.38 - 0.92*
5	119	30	36	1.2	6		0.81 - 1.59
6	110	61	59	0.97		2	0.72 - 1.22
7	152	27	16	0.59		11	0.30 - 0.88*

Deprivation categories: 1, most affluent to 7, most deprived.

Table 22 Comparison of expected and observed number of coronary angiograms by deprivation category.

Men aged 35 - 74. NHS patients only n = 188.

Deprivation category	SMR(0-64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed/ expected	Excess	Deficit	95% confidence interval (significant*)
1	50	15	28	1.87	13		1.18 - 2.56*
2	68	15	14	0.93		1	0.44 - 1.42
3	83	11	13	1.18	2		0.54 - 1.82
4	107	33	22	0.66		11	0.38 - 0.93*
5	119	29	36	1.24	7		0.84 - 1.64
6	110	59	59	0	0	0	0
7	152	26	16	0.61		10	0.30 - 0.90*

Deprivation categories: 1, most affluent to 7, most deprived.

Table 23 Comparison of expected and observed number of coronary angiograms by deprivation category. Men aged 35-44.

Deprivation category	SMR(0-64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed/ expected	Excess	Deficit	95% confidence interval (significant*)
1	50	1	1	1.0	0	0	0.96 - 2.96
2	68	1	0	0.0		1	0
3	83	1	1	1.0	0	0	0.96 - 2.96
4	107	2	1	0.5		1	-0.48 - 1.48
5	119	1	1	1.0	0	0	0.96 - 2.96
6	110	3	5	1.67	2		0.21 - 3.13
7	152	1	1	1.0	0	0	0.96 - 2.96

Deprivation categories: 1, most affluent to 7, most deprived.

Table 24 Comparison of expected and observed number of coronary angiograms by deprivation category. Men aged 45-54.

Deprivation category	SMR(0-64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed/ expected	Excess	Deficit	95% confidence interval (significant*)
1	50	5	7	1.4	2		0.37 - 2.43
2	68	4	4	1.0	0	0	0.02 - 1.98
3	83	4	6	1.5	2		0.3 - 2.7
4	107	9	3	0.33		6	-0.05 - 0.71*
5	119	7	9	1.28	2		0.44 - 2.12
6	110	16	20	1.25	4		0.7 - 1.8
7	152	8	4	0.5		4	0.01 - 0.99*

Deprivation categories: 1, most affluent to 7, most deprived.

Table 25 Comparison of expected and observed number of coronary angiograms by deprivation category. Men aged 55-64.

Deprivation category	SMR(0-64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed/ expected	Excess	Deficit	95% confidence interval (significant*)
1	50	6	13	2.17	7		0.99 - 3.35
2	68	5	7	1.4	2		0.37 - 2.43
3	83	5	7	1.4	2		0.37 - 2.43
4	107	13	12	0.92		1	0.40 - 1.44
5	119	14	14	1.0	0	0	0
6	110	27	20	0.74		7	0.42 - 1.06
7	152	10	7	0.7		3	0.18 - 1.22

Deprivation categories: 1, most affluent to 7, most deprived.

Table 26 Comparison of expected and observed number of coronary angiograms by deprivation category. Men aged 65-74.

Deprivation category	SMR(>64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed/ expected	Excess	Deficit	95% confidence interval (significant*)
1	82	5	11	2.2	6		0.95 - 3.5
2	87	4	5	1.25	1		0.16 - 2.34
3	108	3	0	0		3	0
4	95	8	9	1.12	1		0.38 - 1.85
5	103	10	9	0.9		1	0.32 - 1.48
6	110	17	14	0.82		3	0.39 - 1.25
7	96	5	4	0.8		1	0.02 - 1.58

Deprivation categories: 1, most affluent to 7, most deprived.

Table 27 Comparison of expected and observed number of coronary angiograms by deprivation category.

Women aged 45-74.

Deprivation category	SMR(<64) ICD 410-414	Expected coronary angiograms	Observed coronary angiograms	Ratio observed / expected	Excess	Deficit	95% confidence intervals. (significant*)
1	24	3	9	3.0	6		1.04 - 4.96*
2	56	5	6	1.2	1		0.24 - 2.16
3	82	5	2	0.4		3	-0.15 - 0.95
4	77	12	14	1.17	2		0.56 - 1.78
5	111	16	22	1.38	6		0.77 - 1.97
6	138	38	32	0.84		6	0.55 - 1.13
7	177	13	7	0.54		6	0.15 - 0.93*

Deprivation categories: 1, most affluent to 7, most deprived.

Table 28 Comparison of expected and observed number of revascularisation procedures by deprivation category. Men aged 45-74.

Deprivation category	SMR(0-64) ICD 410-414	Expected revascularisation	Observed revascularisation	Ratio observed / expected	Excess	Deficit	95% confidence intervals (significant*)
1	50	8	16	2.0	8		1.02 - 2.98 *
2	68	7	8	1.14	1		0.35 - 1.93
3	83	7	8	1.14	1		0.35 - 1.93
4	107	15	13	0.87		2	0.4 - 1.34
5	119	18	17	0.94		1	0.5 - 1.38
6	110	33	31	0.94		2	0.61 - 1.27
7	152	14	9	0.64		5	0.22 - 1.06

Deprivation categories: 1, most affluent to 7, most deprived.

Discussion

The results of this study show differences in the use of coronary angiography and revascularisation procedures between sexes, age groups and areas of residence.

Gender

The incidence of CHD between sexes is documented at a ratio of 3:1, men:women (6,10). In this study, men were investigated at twice the rate of women and a larger proportion of men proceeded to revascularisation. The limited value of ETT in predicting CHD in women (52) could explain the higher than expected rate of investigation in women and the lower rate of revascularisation. However without clinical information on severity of disease, diagnoses and co-morbidity, assumptions should not be made that these variations represent gender bias.

Kee et al (74) also found that women admitted with CHD underwent coronary angiography at half the rate of men, but likewise concluded that further clinical information was required. Ayanian and Epstein (62) and Steingart et al (63) found similar differences in patients with proven CHD which persisted even after adjustment for age and coexisting disease.

Neither these studies nor others which have reported variations in utilisation of cardiac services have been able to determine if the differences represent over investigation in men, under investigation in women or if investigation rates are appropriate and reflect relative need.

Age and social deprivation

CORONARY ANGIOGRAPHY

Differing rates of coronary angiography were observed by age and deprivation category. Although not statistically significant, the highest rate of investigation in more affluent categories is in older men aged 55 - 64 and 65 - 74, whereas the highest rate in more deprived categories occur at an earlier age, 45 - 54 and 55 - 64. The higher rates of angiography at a later age in more affluent categories may reflect social bias in referral for angiography or it may reflect differences in the pattern of disease shown in previous studies, with the population in more socioeconomically deprived areas exhibiting onset of disease at an earlier age (78, 79).

In women, the crude rates of investigation appear higher in the less affluent categories of 3,4,5 and 6 and 7 but this was not statistically significant. A pattern of investigation similar to that seen in men is apparent, with higher rates of investigation in younger age groups in the most deprived category, and higher rates in older patients in the most affluent categories.

REVASCULARISATION

Revascularisation in men showed variations which are of interest. In the age group 45 - 54 years, the most affluent category has the lowest angiography rate of 3.56 per 1000 but the highest proportion (63.6%) proceeding to revascularisation. Only 50% of patients in the most deprived category proceed to revascularisation despite a higher investigation rate of 6.10 per 1000.

In the age group 55 - 64 years, the angiography rate in the most affluent category is 7.77 per 1000, with 45% proceeding from angiography to revascularisation. This compares with an angiography rate of 8.68 per 1000 in the most deprived category, 59.2% of whom proceeded to revascularisation.

In the age group 65 - 74 years, the most affluent category has one of the highest angiography rates, but only 50% proceed to revascularisation. The most deprived category with a lower angiography rate, proceed to revascularisation at the highest rate of 70.6%.

Different revascularisation rates may reflect referral for different severities of angina by deprivation category. However the lower proportion of elderly patients undergoing revascularisation relative to the rate of investigation in the most affluent category could be reflecting GP referral rather than severity of disease.

The small number of women proceeding to revascularisation precludes any meaningful analysis by age band and deprivation categories.

No data is available from other studies on the relative rates of investigation and revascularisation by age group and socioeconomic status.

Days between coronary angiography and surgery

Data on the number of days between coronary angiography and revascularisation were highly skewed because the number of days from investigation to revascularisation ranged from 1 to 365 days. The significant difference observed in the median number of days to surgery may reflect referral for angiography of patients with less severe disease, and therefore in less urgent need of revascularisation. Some of the delay may not actually reflect a delay in surgery. A patient may be kept under review for some time before surgery is indicated.

The report of the Clinical Standards Advisory Group (CSAG) on the access to and availability of revascularisation procedures in 1992 - 93 (77), found the mean waiting time from coronary angiography to CABG in the WIG to be 245.5 days for men and women combined. The mean waiting time in this study for men and women combined, in 1990-91 was 181 days. However, only patients undergoing surgery within one year of angiography were included in this analysis while the CSAG included all patients proceeding to surgery, irrespective of the duration between investigation and surgery. As indicated earlier, the use of the mean is not appropriate due to the data being highly skewed.

Coronary mortality, social deprivation and coronary procedures

Mortality data are only a rough guide to the level of CHD in the population. It gives little indication of the actual prevalence or incidence of disease and may not reflect changes or trends. However, SMR's have been shown to be a reliable proxy of morbidity and in addition, the measure of social deprivation used in this study correlates strongly with the SMR for ages 0 - 64 (45).

The relative excess of investigation in men aged 35 - 74 from the most affluent category and relative deficit in the middle and most deprived category cannot be explained by differences in SMR. This excess is apparent even when patients investigated in the private hospital are excluded. Similarly, a relative excess of investigation in women aged 45 - 74 from more affluent categories was shown. A larger dataset would be required to show whether the findings are part of a continuous trend between affluent and deprived categories.

Although several research studies document variations in the use of coronary procedures by age (59-61) and gender (62-65, 70-73), less information is available on utilisation of procedures by socioeconomic status (74-77).

The findings in this study are similar to those of Findlay et al (75). They compared the angiography rate with the social deprivation score and SMR for CHD and found the most marked relative excess of investigation in the least deprived categories of women. Kee et al (74) found no such difference in their investigation of a Northern Ireland population.

The Clinical Standards Advisory Group (77) did not examine the use of coronary angiography but they found a significant negative correlation between SMR and revascularisation, leading them to conclude that "provision and utilisation of health care are inversely related to the populations need for care".

Weaknesses of the study

The numerator and denominator in this study were carefully defined in order to determine true rates of utilisation of procedures in men and women, and in different age and socioeconomic groups. Unfortunately, this resulted in relatively small numbers within each category which limits the analysis of the data, particularly in women.

The findings of this study are relevant to the defined population. They may not reflect referral and investigation practice in geographical areas with different rates of CHD, and differences in supply and access to cardiological services.

Results of this study cannot be fully explained without additional data.

Additional data needed to explain the findings

Clinical information regarding patient's presenting symptoms, severity of disease, co-morbidity and diagnosis is required. These variables influence GP's decisions to refer for specialist opinion and specialist's decisions to refer for revascularisation.

Additional data are required to explain the patient's progress from his or her decision to seek advice, the GP's decision to treat and refer for specialist opinion and the hospital clinician's decision to investigate and treat.

The patient's perception of his or her symptoms and the demand for services from the GP will be influenced not only by the GP's advice but also by variables such as social and educational background and media coverage of health issues.

The GP's perception of need for further investigation will be influenced by his or her knowledge of cardiology and approach to diagnosis and treatment, the presenting complaint, risk factors for CHD and past medical history. Demands from the patient and availability of services may also influence the decision to refer.

The hospital clinician's decision to investigate will be influenced by his or her specialist expertise and by the results of non-invasive investigation. They may also be subject to demands from patients or GP's. Hospital clinicians however, can select patients for investigation only from those referred for their specialist opinion.

Further research

These data are required in order to explain the findings of this study. Further research is required to provide an understanding of the variations in effectiveness, efficiency and appropriateness of care.

While considerable research has been carried out in the USA (80-82) on the appropriateness of care, the variations in health care provision and health care needs which occur not only between countries but within countries, indicates that local research is required.

The Rand Corporation and the University of California, Los Angeles, have developed a method of measuring appropriateness of care which they define as follows:(80)

> Appropriate (care) means that the expected health benefit (i.e. increased life expectancy, relief of pain, reduction of anxiety, improved functional capacity) exceeds the expected negative consequences (i.e. mortality, morbidity, anxiety of anticipating the procedure, pain produced by the procedure, misleading or false diagnoses, time lost from work) by a sufficiently wide margin that the procedure is worth doing.

Based on a review of medical literature, appropriateness ratings of possible indications for the use of coronary angiography were developed (80). Using a modified Delphi technique a panel of expert clinicians rated all possible indications as appropriate, uncertain and inappropriate. They found 17% of elderly in the United States (81) had been investigated inappropriately by coronary angiography. In another study of randomly selected groups of hospitals in the western United States, the proportion of CABG that was inappropriate or equivocal varied among hospitals from 23% to 63% (82).

In the USA the fee for service system and different expectations of patients may partly explain these findings. But this cannot be true of the Trent region of Great Britain where a similar study was performed (83). Around 50% of coronary angiographies and CABG were retrospectively considered to have been performed for inappropriate or equivocal reasons. A similar study is required in a Glasgow population.

Another type of study which could be relevant in examining the appropriate use of diagnostic angiography was carried out by Naji et al (84). This retrospective study, carried out in Aberdeen, examined the use of elective upper gastrointestinal endoscopy. Naji et al found that although only 69% of endoscopies were positive, 82% were retrospectively classified as helpful in the diagnosis and management. The value of a negative endoscopy or any other diagnostic procedure should not be underestimated. The authors suggest that decisions about the most appropriate use of diagnostic tests should be based on investigations which influence management and those which do not, rather than distinguishing between results which were positive or negative, normal or abnormal. The methodology in this study could be used to examine the appropriate use of diagnostic coronary procedures.

The provision of health care could be radically changed by using ratings designed to measure appropriateness. Brook (85) suggests that purchasers could buy services only from clinicians who agreed to operate within agreed guidelines based on appropriateness. Indeed within Britain, it is possible that contracts between purchasers and providers will incorporate clinical guidelines (86). Practice guidelines have emerged in an attempt to improve quality of care while effectively managing the finite resources of the health service. Guidelines may define when it is appropriate or inappropriate to perform a diagnostic test. However careful development, dissemination and implementation of guidelines is essential if they are to be successful in influencing clinical decision making (87,88).

I propose that further research such as the type undertaken by the Rand Corporation and Naji et al is necessary in order to address the effective, efficient and appropriate use of diagnostic and revascularisation procedures.

Conclusion

This study provides useful detailed information on the use of cardiac investigation and revascularisation procedures in a defined geographical area.

Differences were observed in the use of procedures between men and women, age groups and socioeconomic categories. Careful inspection and analysis of routine and non-routine data are unable to sort out competing explanations for these variations such as severity of disease, patients' wishes, GP referral rates and clinical criteria for investigation and revascularisation. Further information is required on these confounding factors. The differences could not be explained on the basis of need, as indicated by differences in mortality. The observations in this study were based on a small dataset; greater numbers might show whether the observations are part of a continuous trend between social deprivation categories.

Implications for the health service

In order that policy and planning decisions will direct resources to those in need or most likely to benefit from care, health care purchasers and providers need to understand why the variations in referral and investigation observed in this study have occurred. Further research into the appropriateness of care is essential in order that purchasing decisions are based on quality and equity of care as well as cost. Purchasers of health care must be aware that further research may identify underuse of services by populations at greatest risk and not overuse by those at least risk; the possible increased cost of providing appropriate care cannot be ignored.

Appendix

Recording cardiac investigations: a comparison of routine and non routine data.

Background

Medical audit provides a systematic method for evaluating standards of patient care including the use of diagnostic and therapeutic procedures. Audit requires reliable routine data for which the main source is the Scottish Morbidity Record 1 (SMR1) system. This provides information on hospital discharges including diagnoses, surgical procedures and major diagnostic and therapeutic procedures. However the reliability of these data is questionable. A preliminary review of SMR1 data for 1990 for the number of coronary procedures performed in the 2 main teaching hospitals in Glasgow revealed marked discrepancies; 4 coronary angiograms and 18 percutaneous transluminal coronary angioplasties (PTCA) were reported as having been performed at the Western Infirmary Glasgow, compared with 1569 coronary angiograms and 248 PTCAs at Glasgow Royal Infirmary.

In light of these differences, this study investigated the accuracy and completeness of SMR1 data from the Western Infirmary Glasgow (WIG).

Aim

To assess the quality of routine SMR1 information available from the Greater Glasgow Health Board Medical Information Statistics Department as a means of monitoring the number of cardiac investigations and procedures performed in the Department of Cardiology, Western Infirmary, Glasgow.

Objectives

* To identify cases recorded in the SMR1 data as having been discharged from the WIG, following major diagnostic or therapeutic cardiological procedures.

* To identify cases recorded in the cardiac theatre log books as having undergone major diagnostic or therapeutic cardiological procedures at the WIG.

* To identify from a sample undergoing percutaneous transluminal angioplasty (PTCA) potential sources of error in the process of producing discharge data.

Methods

Computer print-outs of SMR1 data provided by the Medical Statistics Information Department (GGHB) were reviewed in order to identify all cases discharged from the Western Infirmary, Glasgow following a coronary investigation or procedure. The cases comprised those with any of the following procedure codes for the year 1990:

Procedure Code (OPCS*)	Investigation
K49.0 - 9	Precutaneous Transluminal Angioplasty
K63.0 - 9	coronary angiography
K65.1 - K65.3	right and/or left heart catheterisation

*OPCS = Office of Population Censuses and Surveys (Fourth Revision)

In order to assess the completeness of ascertainment of cases by SMR1 recording, cases were cross-referenced with the theatre log book in which all procedures carried out in the cardiac catheter theatre are recorded.
Further investigation was based on a sample of cases identified in the theatre log books as having undergone percutaneous transluminal coronary angioplasty (PTCA - OPCS code K49). For these patients the following information was recorded from the theatre log book:

* name
* date of birth/age
* hospital number
* type of procedure performed
* date of procedure

As a check of completeness of information in the theatre log book, these cases were cross referenced with the PTCA folder which is a separate register of all cases which have this investigation carried out in the cardiac theatre.

Discrepancies between SMR1 data and the PTCA folder were investigated by:

1. Reviewing copies of the admission/discharge data forms which are held in the hospital's medical records data department and which are the basis of the SMR1 data.
2. Interviewing the secretarial and clerical staff responsible for recording and keying the discharge data.

Results

1. Completeness of SMR1 data

From the information collected there were large discrepancies between sources of data (Table 1).

Coronary arteriography and left/right angiocardiography (which come under the umbrella code K63.0-9) was recorded 1130 times in the theatre log book but appeared on only 4 occasions on the SMR1 printout.

Catheterisation of the heart (K65.1.2.3) had been performed on 156 occasions (16 times as right heart catheter and 140 times in conjunction with coronary angiography) according to the theatre log book. However, SMR1 data recorded 1133 cardiac catheterisations.

PTCA was performed on 130 occasions during 1990 according to the hospital log book, but on only 18 occasions according to the SMR1 printout.

2. Recording of percutaneous transluminal coronary angioplasty

The total number of PTCAs performed in the Western Infirmary in 1990 was 130, compared to 18 identified on the SMR1 printout.

These 130 procedures were compared with the original SMR1 forms held in the medical records department (Table 2). Two patients had PTCA performed twice during one admission and in both cases this was recorded once on the SMR1 form. 18 had been assigned an incorrect code (6 had coronary artery bypass grafting performed, 12 forms showed cardiac

Table 1.

Number of cases by source of ascertainment (WIG 1990).

Source	**K63**	**K65**	**K49**
SMR1	4	1133	18
Discharge forms	*	*	23
Theatre log book	1130	156	130
PTCA folder	**	**	130

Not Investigated *

Irrelevant **

K49 Percutaneous Transluminal Coronary Angioplasty

K63 coronary angiography

K65 right/left heart catheterisation

Table 2.

Coding translations of PTCA.

Theatre log book	Medical records	SMR1 data
	6 CABG **18** incorrect code **12** cardiac catheterisation	
130 procedures (**128** patients)	**3** no code **23** PTCA **2** no code	**18**
	87 no procedure code	

catheterisation to have been performed) and 23 recorded PTCA (3 with no SMR1 code, 2 with an incorrect code and 18 were verified with the SMR1 printout). However 87 (67%) of the 130 procedures performed had no procedure detailed at all.

The 5 cases recorded on the SMR1 form as having had PTCA but not recorded on the SMR1 printout are explained as follows:

a) 2 patients were entered on computer by the data processing department (WIG) as cardiac catheterisation (OPCS K65)

b) 3 patients were not given a procedure code by the data processing department and therefore did not appear on the SMR1 printout.

The case notes of the 6 patients recorded on the hospital discharge forms as undergoing coronary bypass grafting were reviewed and it was found that PTCA had been performed in addition to bypass grafting. These patients may have been assigned an alternative SMR code for coronary artery bypass grafting (SMR20) but this has not been ascertained.

Interpretation and discussion

Interviews conducted with the clerical and secretarial staff regarding the documentation of cardiac procedures on the discharge forms revealed the source of some of the problems. A typist completes the SMR1 form by reviewing the case-note and recording the diagnosis from the most recent letter, previous letters or nursing notes. Procedures may appear as a list or as a heading on the discharge letter but are more often ascertained for coding purposes from the text of the letter. Any letter which states the procedure as coronary angiography, PTCA, left ventricular angiography or right and left heart catheterisation is translated to the SMR1 form as "cardiac catheterisation". SMR1 forms are sent to medical records (data processing) where the text of diagnoses and procedures are typed into the computer system and automatically coded - as cardiac catheterisation K65. This explains why SMR1 data showed 1133 procedures with code K65 while only 156 were performed. As has been shown (Table 1), the hospital theatre log indicates that 1130 coronary angiographies were performed while only 4 were recorded on SMR1 data. The conclusion must be that the majority of cases recorded as cardiac catheterisation should have been recorded as coronary angiography.

In addition, 12 PTCA procedures were recorded in the SMR1 data as cardiac catheterisation - not as PTCA. Neither this anomaly, nor the omission from SMR1 data of 87 (67%) PTCA cases can be explained. No discrepancy was found between the number of PTCAs recorded in the theatre PTCA folder and the cardiac theatre log book indicating that the theatre log can be considered as the "gold standard".

Dissemination

The results were discussed with consultant cardiologists of the Western Infirmary, Glasgow. They recognised the need for more explicit guidelines for the recording and coding of procedures which would improve the quality of SMR1 data. Accordingly, some alterations in the recording procedure have been suggested (eg. a clearer description on the discharge letter of the procedure performed and assignment of the correct OPCS code on the discharge form). Commencing in April 1992, Greater Glasgow Health Board will be implementing a training programme for key staff who are responsible for the coding of SMR1 data. This study should be repeated following training of clerical staff to determine what changes have occurred in the quality of data recording and processing.

Relevance to the health service

The findings of this study are relevant to clinicians and other service providers, to managers and policy makers and for future research.

The information generated by SMR1 data has always been considered an important gauge of hospital activity in Scotland. Only if SMR1 data is accurate and complete can it be confidently used to aid clinical audit or guide policy decisions on allocation of resources within the health service.

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