

## ORIGINAL ARTICLES

### Urgent In-Patient Coronary Angiography: a Comparison of Centres With and Without Cardiac Catheter Facilities

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#### ABSTRACT

##### Objectives

To review the referral of patients to a tertiary centre for urgent angiography and to determine if there are differences in invasive treatment strategies for patients with acute coronary syndrome (ACS).

##### Methods

There were 2 parts to the study, a retrospective part over 3.5 years from a computerised cardiac laboratory booking data base and a prospective part over 3 months.

##### Results

There were 1190 urgent in-patient angiograms performed with 499 (42%) admitted initially to the tertiary centre while the remaining 691 (58%) were admitted to district general hospitals (DGH), with no on-site access to a cardiac laboratory, and subsequently transferred to the tertiary centre. Once referred, DGH patients waited longer for their angiogram ( $2.7 \pm 3.2$  vs  $2.0 \pm 2.8$  days,  $p < 0.0001$ ). Interestingly, DGH patients appear to spend an average of 4 days in hospital prior to referral for angiography. DGH patients were more likely to have a higher Thrombosis in Myocardial Infarction (TIMI) risk score at presentation and following angiography were more likely to have coronary artery bypass graft (CABG) or percutaneous coronary intervention (PCI) and less likely to have angiographically normal arteries.

##### Conclusions

Our findings are consistent with previous studies demonstrating that access to coronary angiography varies considerably between hospitals. However, we have demonstrated that patients in DGHs wait on average 4 days before referral for coronary angiography suggesting that there may be triage based on initial responses to medical therapy. Further research is needed to determine whether this has a direct effect on outcomes.

#### Introduction

Scotland currently has 14 cardiac catheter laboratories and there have been calls to increase this number. The widespread use of troponin testing has resulted in a marked increase in the number of patients being referred for urgent in-patient coronary angiography. Variation in geographical distribution of cardiac catheter laboratories and consultant cardiologists leaves the potential for 'postcode' variation in use of and waiting times for this important investigation.

Current guidelines recommend early, inpatient coronary angiography for 'high-risk' acute coronary syndrome

(ACS) patients<sup>1,2</sup> on the basis of trial evidence supporting its use in selected patients.<sup>3,4,5,6</sup> In Scotland, most patients admitted with a suspected ACS are admitted under the care of a non-cardiologist physician to a hospital without cardiac catheter laboratory facilities. This may lead to delays in referral and is likely to result in appropriate patients not being offered angiography. Indeed, geographical variations in coronary angiography rates in Scotland have previously been reported.<sup>7</sup>

The aim of this current study was to review patterns of referral of patients to a tertiary referral centre and to determine if there are differences in treatment strategies for patients with ACS.

#### Methods

##### Patients

There were 2 parts to the study, a retrospective part over 3.5 years (7478 patients) and a prospective part over 3 months (122 patients). In the retrospective part of the study, all patients referred as an inpatient for an urgent coronary angiogram were identified from our computerised cardiac catheter laboratory booking system. This system also stores data for each patient including; referring hospital, provisional diagnosis, the date the patient is added to the waiting list for urgent angiography and the date of the procedure. The admission date for these patients was not recorded. In the prospective part of the study, all patients attending the tertiary referral centre over a 3 month period, for an urgent angiogram were included. Detailed information was collected regarding the referral pathway and the clinical details.

##### Data handling and statistical analysis

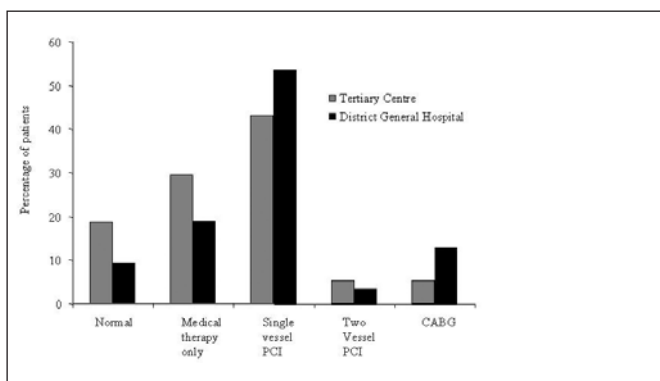
Data were entered into a spreadsheet (Excel 2002, Microsoft®, USA) and presented as average values  $\pm$  SD or range as appropriate. Statistical analysis was performed using Student's unpaired two tailed t-test on continuous data and a chi-squared test on categorical data.

**Table I Patients' Characteristics**

|                        | Tertiary centre<br>Mean (SD) / n (%) | District hospital<br>Mean (SD) / n (%) | p value  |
|------------------------|--------------------------------------|--|----------|
| Number of procedures   | 37                                   | 85                                     |          |
| Age                    | 63.2 (10.3 SD)                       | 61.2 (11.2 SD)                         | 0.36     |
| TIMI Score             | 3.2 (1.3 SD)                         | 4.1 (1.3 SD)                           | 0.002    |
| Chest pain within 24 h | 35 (95%)                             | 73 (86%)                               | 0.41     |
| ECG change             | 16 (43%)                             | 59 (69%)                               | 0.0002   |
| Enzyme rise            | 17 (46%)                             | 46 (54%)                               | 0.27     |
| Current smoker         | 11 (30)                              | 32 (38%)                               | 0.18     |
| Ex smoker              | 13 (35%)                             | 26 (31%)                               | 0.48     |
| Family cardiac history | 6 (16%)                              | 29 (34%)                               | <0.0001  |
| Diabetes               | 5 (14%)                              | 11 (13%)                               | 0.89     |
| Hypercholesterolaemia  | 15 (41%)                             | 43 (51%)                               | 0.15     |
| Hypertension           | 18 (49%)                             | 40 (47%)                               | 0.83     |
| Previous CABG          | 7 (19%)                              | 7 (8%)                                 | 0.02     |
| Previous PCI           | 2 (5%)                               | 8 (9%)                                 | 0.11     |
| Previous MI            | 2 (5%)                               | 19 (22%)                               | <0.00001 |

**Table II Time Differences between Tertiary Centre and District Hospital (days)**

|                                      | Tertiary Centre | District General Hospital | P value |
|--------------------------------------|-----------------|---------------------------|---------|
| Number of procedures                 | 37              | 85                        |         |
| Time between admission and referral  | n/a             | 3.9 (5.3)                 |         |
| Time between referral and angiogram  | n/a             | 1.7 (1.9)                 |         |
| Time waiting at WGH for angiogram    | n/a             | 0.8 (0.9)                 |         |
| Time between admission and angiogram | 2.3 (2.6)       | 6.4 (5.8)                 | <0.0001 |

**Figure 1 Outcome following coronary angiography in patients referred for urgent in patients angiography. (Percutaneous coronary intervention – PCI, Coronary artery bypass grafting – CABG).**

## Results

There were 7478 procedures performed in a single cardiac laboratory over the 3.5 year study period between July 2000 and December 2004. There were 1190 urgent in-patient angiograms performed with 499 (42%) admitted initially to the tertiary centre while the remaining 691 (58%) were admitted to one of 9 district general hospitals (DGH), with no on-site access to a cardiac laboratory, and subsequently transferred to the tertiary centre. The average time between being entered onto the cardiac laboratory computer system and the coronary

angiogram being performed was significantly longer for DGH patients compared with the tertiary centre ( $2.7 \pm 3.2$  vs  $2.0 \pm 2.8$  days,  $p < 0.0001$ ). In the prospective study, more detailed information was obtained. The clinical features and referral times of DGH patients and tertiary centre patients are shown in Table I. Compared with tertiary centre patients, DGH patients were more likely to have ECG changes, raised cardiac enzymes, a previous history of myocardial infarction and thus had a higher Thrombosis in Myocardial Infarction (TIMI) risk score. A lower proportion of DGH patients had previously undergone coronary artery bypass surgery. Referral times are shown in Table II. Patients admitted to a DGH who are subsequently referred for urgent coronary angiography appear to spend on average four days longer in hospital prior to referral for angiography than patients in the tertiary centre. Outcomes following urgent coronary angiography are shown in Figure 1. Compared to tertiary centre patients, patients from the district hospital were more likely to have coronary artery bypass surgery or percutaneous coronary intervention (PCI) following urgent angiography and less likely to have angiographically normal arteries.

## Cost implications

Estimating the cost implications of referrals for coronary angiography is complex. However, over the three and a half year period, 219 patients were transferred to the tertiary centre from one of the district hospitals. Assuming that the provision of a local cardiac catheterisation laboratory could provide urgent angiography, this would potentially save 219 hospital bed days (the wait from referral to transfer to tertiary centre) at a cost of £416 per bed.<sup>8</sup> If the presence of an on-site cardiac laboratory resulted in more rapid referral for coronary angiography then a further 4 hospital bed days per patient could be saved, resulting in a potential additional financial saving of £2,080 per patient. These figures may also apply to unstable cardiac patients who currently do not undergo urgent coronary angiography allowing earlier discharge. These potential cost saving would have to be offset against the cost of providing onsite cardiac catheterisation facilities compared with the costs of tertiary referrals where the average unit costs are £1,200 for a coronary angiogram and £2,600 for a PCI.<sup>8</sup>

## Discussion

Our data provide evidence for differences in waiting times and clinical characteristics of patients undergoing urgent in-patient coronary angiography between centres with and without on-site cardiac laboratory facilities. From the data

collated over three and a half year years patients from DGHs waited, on average, only 1 day longer (after referral for angiography) than patients from the tertiary centre. However, from prospective data, the mean wait for DGH patients was four days prior to referral for urgent angiography with a further two days wait prior to angiography being performed (total six days) whereas patients in the tertiary centre waited a mean of 2.3 days in total between admission and angiography.

Furthermore, there appear to be important differences in the characteristics of patients from the DGHs and tertiary centres. Patients who were referred from DGHs had a higher mean TIMI risk score than patients from the tertiary centre either reflecting a true difference in the cohort of patients or suggesting that the threshold for proceeding to angiography was lower at the tertiary centre. In reality, it is likely that there is triage of patients at DGHs based on their response to initial medical therapy rather than based on their risk status at admission. Whether this strategy alters outcome for patients is uncertain but the findings in this study provide further evidence for geographical variations in the use of coronary angiography. These differences in the patient characteristics are reflected in the outcomes following coronary angiography. More patients from the tertiary centre were reported as having normal coronary arteries and more patients from the DGHs were revascularised by either PCI or Coronary Artery Bypass Graft (CABG). These findings suggest a lower risk threshold for investigation by angiography in tertiary centres.

Risk assessment is central to the treatment of patients with ACS. There have been useful developments in the identification of patients at high risk with the Global Registry of Acute Coronary Events (GRACE)<sup>9</sup> and TIMI risk scores, which have been shown to predict short-term outcome in patients with ACS.<sup>10</sup> However, while these scoring systems can give a measure of absolute risk, they are less proven at identifying patients with 'modifiable' risk by an early invasive strategy. Despite this, evidence suggests that 'high risk' patients with an ACS should be considered for early coronary intervention.<sup>1,2,3,4,5,6</sup>

There are several issues that will affect access to cardiac interventions including the number and location of catheterisation facilities, expertise of operators and the distance patients are from the hospital. These issues are especially important in Scotland with a population dispersed over a large geographical area. While provision of

catheterisation laboratories at more sites may improve access to angiography there will be local issues as to whether these laboratories will be fully funded for PCI. Even if there is a dedicated catheterisation facility and funding, there may not be sufficient local expertise to support to such a service. Thus, even increased numbers of cardiac catheter laboratories may not result in equitable access to PCI. However, it is recognised that the distance to the nearest cardiac laboratory and numbers of cardiologists have a major impact on rates of coronary angiography and PCI.<sup>11,12</sup>

## Conclusion

Our findings are consistent with previous studies demonstrating that access to coronary angiography varies considerably between hospitals.<sup>7</sup> However, we have demonstrated that patients in DGHs wait on average four days before referral for coronary angiography suggesting that there may be triage based on initial responses to medical therapy. Further research is needed to determine whether this has a direct effect on outcomes.

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