Primary percutaneous coronary intervention for acute ST elevation myocardial infarction – first year's experience of a tertiary referral centre in the UK

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ABSTRACT – This study evaluated the first year's experience of a large interventional centre in the UK after a primary percutaneous coronary intervention (PCI) programme that runs 24 hours a day and seven days a week was started. Workload, patient outcome, length of stay, and effect on the remainder of the interventional service were analysed. The primary PCI service for a mainly urban population of 800,000 was started in April 2005. All relevant characteristics, details of procedures, outcome, and other data on quality of care were collected and entered prospectively onto a computerised database. Data were analysed with SPSS (version 13.0). Over a 12-month period, 305 patients were diagnosed with ST elevation myocardial infarction (STEMI), of whom 259 (85%) were accepted for primary PCI. Median door-to-balloon time was 98 minutes, which decreased from 106 minutes in the first six months to 93 minutes in the second six months ($p<0.005$). In-hospital mortality was 4.5% and 30-day mortality was 4.9%. Median length of stay was three days, which was reduced from the six days previously reported after thrombolysis. Waiting times for other acute and elective PCI procedures did not increase after initiation of the primary PCI programme. Primary PCI can be delivered successfully in a setting in the UK with low mortality and reduced length of stay and without a negative impact on other interventional services.

KEY WORDS: acute myocardial infarction, logistics, mortality, primary angioplasty

Introduction

Primary percutaneous coronary intervention (PCI) is superior to thrombolysis for the treatment of acute ST segment elevation myocardial infarction (STEMI). It reduces mortality, reinfarction, recurrent ischaemia, stroke, and composite endpoints.[1,2] Improved outcome with primary PCI has been shown in patients admitted directly to PCI centres and in those who require transportation from a peripheral hospital to the interventional centre.[3,4]

The logistics of providing a primary PCI service that runs 24 hours a day for seven days of the week are challenging,[5] however, and few countries have been able to implement the service for their entire population. Furthermore, the provision of such a service may have adverse effects on other cardiac services. The main arguments put forward by most centres for not providing such a service are:

- timely diagnosis, transportation, and intervention will not be possible in a setting in the UK and hence door-to-balloon times will not achieve the recommended 90-minute target
- results in real-world practice will not match those in randomised controlled trials
- the primary PCI service will have a detrimental effect on other cardiology services, specifically on waiting times for elective PCI and PCI for acute non-STEMI.

First year's experience in providing a primary PCI service 24 hours a day for seven days of the week for a mainly urban population of about 800,000 are reported in this paper. Workload, details of procedures, data on outcomes, and the effect on the remainder of the interventional cardiology service are also discussed.

Methods

Primary PCI service

From 1 April 2005 in Leeds (population about 800,000), all patients with suspected STEMI, irrespective of age and comorbidity, were referred for consideration of primary PCI. Patients were referred via the emergency department in the PCI centre (Leeds General Infirmary) or from the other acute hospital in the area (St James University Hospital). Patients initially assessed at St James' University Hospital were brought for PCI by paramedic ambulance and then transferred back the day after the procedure. Referral was via a dedicated phone line to the catheter laboratory scheduler during office hours

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and the on-call cardiology registrar out of hours. Members of the on-call staff were not resident during the out-of-hours period. Patient pathways were devised before the service started, and there was a period of intensive training that involved ambulance crews, staff from the emergency department, coronary care nurses, and staff from the catheter laboratory.

Follow up

Follow up to determine vital status at 30 days was undertaken in all of the cases. At the same time, it was confirmed by telephone that cardiac rehabilitation had been arranged. If this was not the case, cardiac rehabilitation was offered at this stage on an outpatient basis.

Database management and statistics

Nursing staff dedicated to primary PCI were recruited for data collection and management. Patient and procedural data were entered prospectively into a dedicated database. Quality of data input was assessed by the authors (through random checking and tests for data consistency). The quality of the data was good, with less than 2% data input error. All statistical analysis was performed using SPSS version 13.0. Baseline characteristics for patients who received primary PCI and thrombolytic drugs were compared by unpaired *t* testing for continuous variables and χ^2 testing for categorical variables. Medians were compared using the Mann-Whitney U test.

Results

Population

A diagnosis of STEMI was made in 305 patients, of whom 259 (85%) were accepted for primary PCI (Fig 1). Baseline characteristics are shown in Table 1. The remaining 46 patients were treated with thrombolysis for a number of reasons – most commonly on clinical grounds or because the catheter laboratory was unavailable (Table 2). Patients treated with thrombolysis had more pre-existing coronary artery disease and were more likely to have a history of arterial hypertension than those who underwent primary PCI. Of the 259 patients accepted for primary PCI, one died before reaching the catheter laboratory and 15 underwent diagnostic coronary angiography but not PCI: 11 had essentially normal coronary arteries while four had significant coronary artery disease but no target for primary PCI. Primary PCI therefore was attempted in 243 (94%) patients.

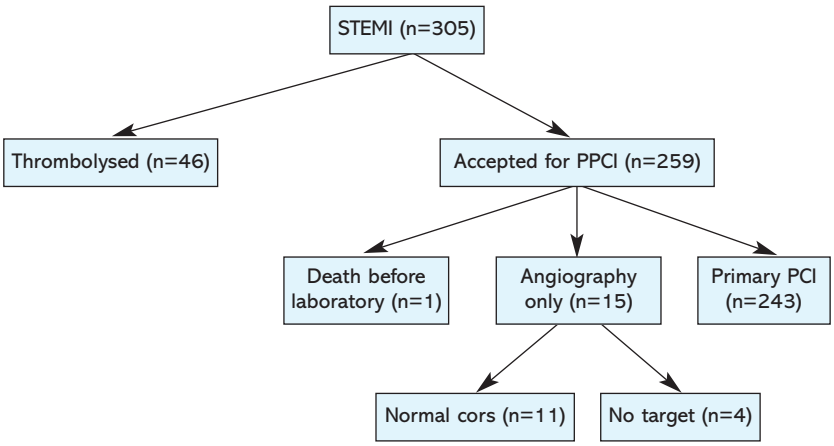

Fig 1. Patient flow diagram. PCI = percutaneous coronary intervention; STEMI = ST segment myocardial infarction.

Table 1. Baseline characteristics of patients who underwent primary percutaneous coronary intervention (PCI) (n=243) or thrombolysis (n=46). Values are number (%) unless otherwise specified.

Characteristic	Primary PCI	Thrombolysis	p value
Mean (sd) age (years)	63 (13)	67 (15)	0.11
Women	79/243 (33)	18/46 (39)	0.39
Pre-existing CAD	47/243 (19)	17/46 (37)	<0.01
Diabetes	22/243 (9)	4/46 (9)	0.94
Hypercholesterolaemia	81/243 (33)	14/46 (30)	0.70
Hypertension	85/243 (35)	24/46 (52)	<0.03
Smoker (current or ex-smoker)	161/243 (66)	31/46 (67)	0.88

CAD = coronary artery disease.

Door-to-balloon time

The median door-to-balloon time was 98 minutes (Table 3). An improvement in service provision occurred over time (Fig 2). Median door-to-balloon time was reduced from 106 minutes in the first six months to 93 minutes in the second six months (p<0.006). Patients who presented to the peripheral hospital had longer door-to-balloon times than those admitted to the PCI centre. In addition, service was quicker during normal working hours (09.00–17.00 Monday to Friday) than out of hours when non-resident staff had to travel from home to the hospital.

Procedural characteristics

Most infarcts were due to occlusion of the left anterior descending or right coronary artery (Table 4). Single-vessel PCI only to the culprit lesion was performed in 87% of patients. The indication for multi-vessel PCI was cardiogenic shock or uncertain culprit lesion. Drug-eluting stents were used in 44 (18%) patients. Six (3%) patients had balloon angioplasty only. A thrombectomy device was used in 26 (11%) patients. Adjuvant pharmacotherapy was standardised: all patients received clopidogrel (600 mg) and unfractionated heparin, 99% received aspirin, and 98% received

abciximab. Thrombolysis in myocardial infarction grade 3 (TIMI3) flow (normal flow) in the infarct-related artery was achieved in 91% of patients.

Mortality

Follow up for in-hospital and 30-day mortality was 100%. Of the patients with STEMI who underwent primary PCI, in-hospital mortality was 4.5% (11/243) and 30-day mortality was 4.9% (12/243). Mortality at 30 days in the thrombolysed patients was 13%. Overall 30-day mortality for all 305 patients who presented with STEMI was 6.6%.

Length of hospital stay

Median length of stay for patients treated with primary PCI was three (range 0–44) days. In our historical control group from 2003, when all patients were treated with thrombolysis, median length of stay was six days. A policy of primary PCI as the default treatment, therefore, led to a saving of around 700 patient bed days over one year.

Out of hours working and impact on the rest of the service

Adoption of a primary PCI programme for a population of 800,000 added an average of 0.7 (range 0–4) procedures per day. Fig 3 gives an overview of the diurnal variation of the caseload. Only 91 (37%) patients presented during normal working hours. A total of 50 (21%) patients presented between midnight and 8 am. Despite increased out-of-hours working, there was no detrimental effect on waiting times for PCI for other patient groups. The median waiting time for elective PCI was seven weeks after the primary PCI service was instituted compared with 12 weeks for the preceding year. During the study period, the median waiting time for inpatient transfer to the PCI centre for patients with non-ST elevation acute coronary syndrome was three days compared with three days for the preceding year.

Discussion

This study shows that primary PCI for STEMI can be delivered successfully in a setting in the UK, with satisfactory door-to-balloon times, low mortality, reduced length of stay, and no adverse effect on other interventional services.

Mortality at 30 days for patients treated with primary PCI was 4.9%. This compares favourably with data from randomised controlled trials. In a meta-analysis of 23 trials, short-term mortality was 7%.[2] Mortality at 30 days in the group who received thrombolytic drugs was significantly higher at 13%. This is higher than in the published thrombolytic trials and may reflect selection bias and the worse cardiovascular risk profile in this small group. Selection bias against high-risk patients is of concern, particularly as patients with STEMI in the highest risk groups may have the most to gain from primary PCI compared with thrombolysis.[6,7] Overall mortality at 30 days in all patients

Table 2. Reasons for administration of thrombolytic drug.

Reason	Number of patients
Medical reasons*	13
Catheter laboratory unavailable	10
Diagnostic difficulties with electrocardiography	5
Too unstable to transfer	4
Failure to refer or delays in contacting primary PCI team	4
Staff fatigue	3
Unknown	7

*Severe peripheral vascular disease, dementia, and inability to lay flat. PCI = percutaneous coronary intervention.

Table 3. Door-to-balloon times.

Variable		Median (min)	p value
Centre *v* referring hospital	Centre	94	<0.003
	Referring	106	
Weekday *v* weekend	Weekday	97	0.11
	Weekend	105	
Weekday in hours *v* out of hours	In hours	86	<0.001
	Out of hours	109	
Months 1–6 *v* months 7–12	Months 1–6	106	<0.006
	Months 7–12	93	

Table 4. Procedural and post-procedural characteristics for patients who underwent primary percutaneous coronary intervention (PCI).

Characteristic	Number (%) n=243
Culprit artery	
Right coronary artery	109 (45)
Left anterior descending artery	98 (40)
Circumflex artery	29 (12)
Left main stem	2 (1)
Saphenous vein graft	5 (2)
Multi-vessel PCI	31 (13)
Drug-eluting stent	44 (18)
Balloon angioplasty only	6 (3)
Thrombectomy	26 (11)
TIMI3 flow after procedure	221 (91)
Adjuvant pharmacotherapy	
Aspirin	240 (99)
Clopidogrel	243 (100)
Unfractionated heparin	243 (100)
Abciximab	237 (98)

TIMI3 flow = thrombolysis in myocardial infarction grade 3 (normal) flow.

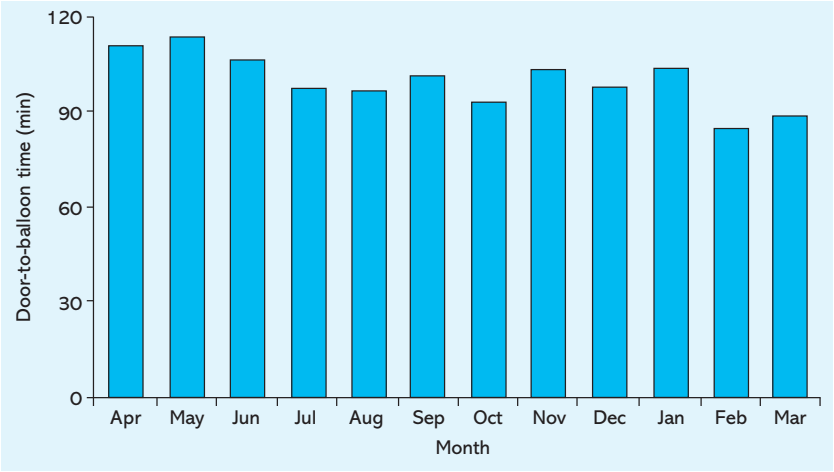

Fig 2. Improvement in the door-to-balloon time over the first year of the primary percutaneous coronary intervention programme.

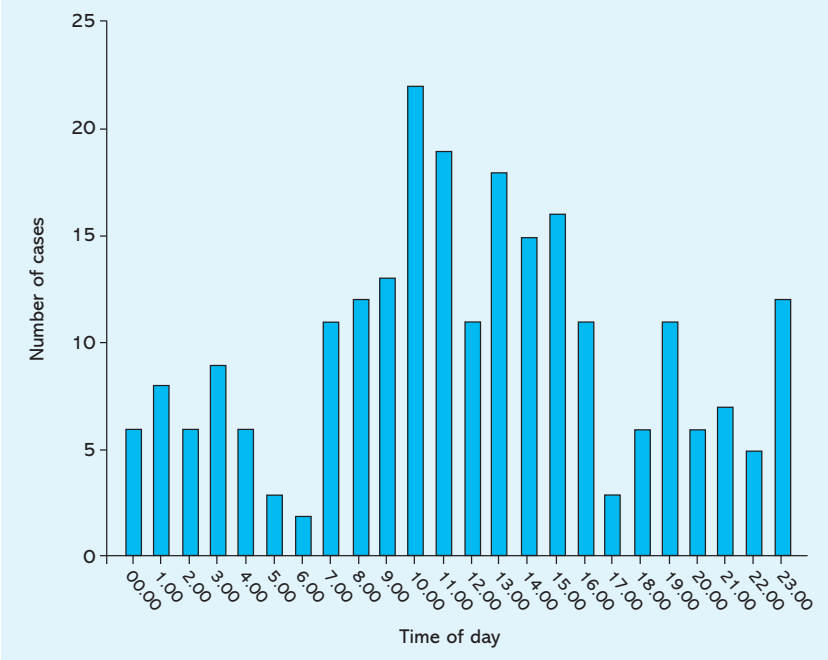

Fig 3. Diurnal variation in presentation of ST segment myocardial infarction (STEMI).

who presented with STEMI was 6.6% compared with 9.1% in the centre in the six months preceding the introduction of primary PCI according to the Myocardial Infarction National Audit Project (MINAP). The data, therefore, are consistent with other studies that suggest that a policy of primary PCI can reduce mortality in patients who present with STEMI in the real-world setting.[8]

The median door-to-balloon time was 98 minutes – just longer than the 90-minute target recommended by the guidelines of the American Heart Association (AHA) and American College of Cardiology (ACC) and the European Society of Cardiology.[9,10] Door-to-balloon times did decrease progressively during the one-year study period, with a median time <90 minutes during the last two months of the study. In fact, recent registry data from 192,509 patients treated by primary PCI or thrombolysis in the USA indicate that the benefit of primary PCI over thrombolysis is preserved as long as the delay to primary PCI is shorter than 114 minutes – equivalent to a door-to-balloon time of 144 minutes.[7]

The additional workload of 0.7 cases/day (equivalent to 0.9 cases/day/million population) was less than 10% of all PCI cases. No elective cases had to be cancelled because of primary PCI commitments, and the waiting time for elective PCI actually decreased over the study period. Similarly, the median waiting time for acute PCI (excluding STEMI) did not change.

Only 21% of patients who underwent primary PCI presented in the hours between midnight and 8 am. On average, therefore, the on-call team was called in once per week between midnight and 8 am. The European Working Time Directive demands a compensatory rest period of 11 hours the following day for work done after midnight. This directive was observed but caused little disruption of scheduled work, probably because the large capacity of our interventional programme allows some flexibility. In smaller interventional centres, however, this could be a significant logistical problem.

Early discharge of selected low-risk patients after primary PCI has been shown to be safe.[11–14] In this study, median length of stay after primary PCI was three days compared with six days for patients who received thrombolysis in the same hospitals during 2003. A full cost-effective analysis of primary PCI is beyond the scope of this paper, however, the saving of about 700 patient bed days per annum is clearly a major benefit of a strategy of primary PCI. Despite the reduced inpatient length of stay, initiation of proved secondary prevention interventions was excellent, and all patients were offered a structured programme of cardiac rehabilitation.

Conclusion

A primary PCI programme that runs 24 hours a day for seven days a week can be performed successfully in a setting in the UK. Mortality is lower than for historical thrombolysis-treated controls and is in line with data from published randomised trials. Target door-to-balloon times can be achieved and we found no evidence that a strategy of primary PCI significantly disrupted other aspects of the cardiology service. Indeed, the shortened

hospital stay after primary PCI resulted in a major saving of hospital bed days.

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