ORIGINAL ARTICLE

Structure, process and outcomes of chest pain units established in the ESCAPE Trial

Jane Arnold, Steve Goodacre, Francis Morris, on behalf of the ESCAPE Research Team

Emerg Med J 2007;**24**:462–466. doi: 10.1136/emj.2007.046862

See end of article for authors' affiliations

Correspondence to: J Arnold, Medical Care Research Unit, University of Sheffield, Regent Court, 30 Regent Street, Sheffield S1 4DA, UK; j.a.arnold@sheffield.ac.uk

Accepted 26 March 2007

Background: Chest pain units (CPUs) provide a system of care for patients with acute chest pain that can improve outcomes while reducing health service costs. The Effectiveness and Safety of Chest Pain Assessment to Prevent Emergency Admissions (ESCAPE) multicentre trial was undertaken to determine whether CPUs could be successfully established throughout the National Health Service (NHS).

Aim: To describe the structure, processes and outcomes of patients managed by CPUs in the ESCAPE Trial.

Method: 7 of 14 participating hospitals were randomly allocated to establish CPU care. Each hospital set up a CPU using standardised protocols to provide biochemical cardiac marker and exercise treadmill testing for low-risk patients. Research staff then followed up patients for 30 days to identify any adverse events, defined as chest pain-related readmission to hospital for more than 48 h, non-fatal myocardial infarction and all deaths.

Results: The 7 units managed a total of 1644 patients during their first year of operation. Activity varied from 1 to 7 patients per 1000 adult emergency department attendances. Overall, 1374 (83%) patients were discharged after CPU assessment, with 23 (1.7%) adverse events recorded among those discharged. Some, but not all, of the variation in activity could be attributed to hospital size and patient selection.

Conclusion: CPU care can be instituted in a safe manner at a variety of NHS hospitals, with most patients being discharged after assessment. However, there is variation in the number and type of patients managed by the different units. Further research is required to identify reasons for variation in CPU activity.

Chest pain units (CPUs) are an innovative system of care for patients with acute chest pain. Patients receive up to 6 h of observation, ECG monitoring and cardiac marker testing, followed by an exercise treadmill test (ETT). A recent single-centre randomised trial[1] showed that CPU care reduced hospital admissions, health service costs, and patient anxiety and depression, and improved patient-reported health, quality of life and satisfaction with care.

The Effectiveness and Safety of Chest pain Assessment to Prevent Emergency Admissions (ESCAPE) multicentre trial[2] aimed to determine whether CPUs could be established at a variety of hospitals in the UK and whether this process resulted in improved outcomes for patients with acute chest pain and reduced health service costs. Project findings therefore contribute to the debate about whether CPUs should be established throughout the UK National Health Service (NHS).

The ESCAPE Trial was a cluster randomised controlled trial in which 7 of 14 participating hospitals were randomly allocated to set up a CPU while 7 continue to provide conventional care, typically consisting of admission for 12 h troponin measurement with no formal provision of early exercise testing. Our first aim was to determine whether CPUs could be established and function in a safe and practical manner at a variety of NHS hospitals. Subsequent evaluation will compare the results of CPU and conventional care.

METHODS

Study design

This was a descriptive study of the structure, process and outcomes of CPUs set up in the ESCAPE cluster randomised controlled trial.

Setting

We sought 18 hospitals in the UK that hoped to set up a CPU and were willing to allow the process and timing of commencing CPU care to be determined by random allocation. All participating hospitals had to accept acute medical admissions, including patients arriving by emergency ambulance. Any hospital with an established CPU or a chest pain protocol that too closely resembled CPU care was excluded. No restrictions were made on the basis of hospital size, cardiac intervention facilities or specialties involved in care of patients with chest pain. Ultimately, 14 suitable hospitals agreed to participate within the time frame of the study and 7 hospitals were allocated to establish CPU care between November 2004 and June 2005.

Each hospital was asked to set up a CPU, using standardised protocols and ETT to rule out acute coronary syndrome (ACS) in low-risk patients. Box 1 summarises the protocol, based on that used in the single-centre randomised trial at the Northern General Hospital in Sheffield.[1]

The process of CPU set-up

On the basis of experience with the Sheffield CPU,[1] we anticipated that the CPU should ideally be based in or adjacent to the emergency department, staffed by specialist chest pain nurses, should use biochemical tests in laboratories with a turnaround time of $\leqslant 1$ h and should use a treadmill test immediately following observation, conducted in the emergency department by the chest pain nurses. However, to allow CPU care to be set up in a variety of settings, we accepted that the CPU could be situated in an observation or admissions ward, other staff could cross cover for chest pain nurses, point-of-care biochemical tests could be used, patients could be discharged home between biochemical tests and the treadmill test (but the treadmill test must be performed on the next

Abbreviations: ACS, acute coronary syndrome; CPU, chest pain unit; ESCAPE, Effectiveness and Safety of Chest Pain Assessment to Prevent Emergency Admissions; ETT, exercise treadmill testing; NHS, National Health Service

Box 1 The ESCAPE chest pain protocol

- Serial ECG recording over a period of 2–6 h.
- Measurement of biochemical cardiac markers: creatine kinase MB (CK-MB) (mass) on arrival and at least 2 h later, and troponin at least 6 h after the onset of the worst symptoms.
- Patients with increased markers or with a gradient rise of >0.7 ng/ml between CK-MB samples are admitted for further investigation.
- Exercise treadmill testing immediately after normal cardiac marker testing, unless the patient is unable to perform a treadmill test or is known to have coronary heart disease.
- Patients with early positive treadmill tests are admitted.
- Patients with late positive treadmill tests are either discharged on medication with cardiology follow-up or admitted depending on the speed of recovery from testing.
- Equivocal results are treated in light of the presenting symptoms, either discharged home with no follow-up or reviewed by the cardiologist.
- Patients with negative tests are discharged home.

working day) and the treadmill test could be performed in the cardiac department.

The process of setting up a CPU was led by a local lead investigator and supported by a full-time clinical researcher (JA) and a member of the ESCAPE Research Team (FM). JA had previously worked as a chest pain nurse at the Sheffield CPU and was able to provide expertise in setting up and running a CPU. Two teaching days were also provided at all intervention sites before commencement of the trial. Additional ad hoc training days were arranged as the sites requested or as thought necessary throughout the trial year. Protocols and data collection forms were provided by the researchers. Once the intervention year had commenced, regular visits by the research staff took place to ensure that all hospitals were working safely within the protocol. All hospitals were able to contact a member of the research team by telephone to discuss any problems during working hours. However, the ultimate responsibility for CPU operation and performance was with the participating hospital, rather than with the ESCAPE researchers.

Funding for the initial set-up costs of the CPU had to be found by the individual hospitals. However, it was expected that these costs would be recouped during the trial year by means of a central subvention from the UK Department of Health. Under this arrangement, the hospital was reimbursed £106 (US$212, €156) per patient managed according to the CPU protocol. This sum was estimated from the single-centre trial to be the excess per-patient cost of providing CPU care, not allowing for any potential cost savings from CPU care.

Study participants

Patients were eligible for CPU protocol if they presented with chest pain due to possible ACS. They were excluded if they had (1) new ECG changes diagnostic for ACS (ST deviation >1 mm or T wave inversion >3 mm); (2) known coronary heart disease with prolonged (>1 h) or recurrent cardiac-type pain; (3) suspected serious non-cardiac pathology (such as pulmonary embolus or aortic dissection); (4) comorbidity, such as arrhythmia or heart failure, which prevented discharge home; or (5) an obvious alternative cause for their pain (such as chest wall injury or pneumothorax).

Data collection

We recorded CPU performance over the first year of operation. CPU staff were asked to record presenting details, diagnostic test results and management decisions for all patients managed according to the CPU protocol. Other patients, such as those with acute myocardial infarction or unstable angina, who might have been occasionally or opportunistically managed by CPU staff or using CPU facilities were not routinely recorded.

All patients discharged from the CPUs were checked on the hospital information system by a member of the research staff for any reattendances with a chest pain-related complaint or any adverse event. These events were defined as readmission to hospital for >48 h, deaths or non-fatal myocardial infarction.

Outcomes of interest

We evaluated the safety of the CPU protocol by measuring the proportion of patients discharged after CPU assessment who had experienced an adverse event over the 30 days following initial attendance. We evaluated the practicality of the CPU protocol by measuring the proportion of emergency department attendances who were eligible for the CPU protocol and the proportion of patients who were discharged after CPU assessment.

Data analysis

We report the descriptive characteristics of patients receiving the CPU protocol as proportions or means with a 95% CI, calculated using Confidence Interval Analysis (CIA Software) and SPSS V.10.0, respectively.

Ethical issues

The ESCAPE Trial received ethical approval from the Thames Valley Multicentre Research Ethics Committee. Individual patients managed on the CPUs were not formally ''recruited'' to the trial or asked to provide consent to management in the CPU because CPU care is an accepted, evaluated form of care for acute chest pain that is used at hospitals outside the trial. Their data were managed in accordance with the Data Protection Act (1998). A data monitoring committee reviewed quarterly

Table 1 Structure of the chest pain units

Hospital	Staffing	Opening hours	Location	Blood tests	Exercise test
1	2 Chest pain nurses	5 days/week 07:30–19:30	Emergency department	Laboratory	Cardiology department
2	6 Chest pain nurses	7 days/week 24 h	Heart assessment centre	Laboratory	Cardiology department
3	1 Chest pain nurse	5 days/week 09:00–17:00	Emergency department	Laboratory	Cardiology department
4	2 Chest pain nurses (1 WTE)	5 days/week 08:00–16:00	Emergency department	Laboratory	Emergency department
5	1 Emergency department nurse	5 days/week 09:00–17:00	Emergency department	Laboratory	Cardiology department
6	Overseen by physicians	Ad hoc	Emergency department	Point of care	Cardiology department
7	1 Chest pain nurse	5 days/week 08:00–16:00	Medical assessment unit	Laboratory	Cardiology department

WTE, whole time equivalent.

Table 2 Outcomes of patients managed by the chest pain units

Hospital	Total adult emergency department attendances for trial year	Patients in CPU (n (%) of adult attendances)	Patients in CPU discharged, n (%)	Adverse events, n (%)
1	43 897	91 (0.2)	81 (89)	2 (2.5)
2	83 402	484 (0.6)	381 (79)	4 (1.0)
3	75 588	537 (0.7)	466 (87)	14 (3.0)
4	39 708	201 (0.5)	161 (80)	3 (1.9)
5	58 101	78 (0.1)	67 (86)	0
6	22 196	65 (0.3)	58 (89)	0
7	46 471	188 (0.4)	60 (85)	0

CPU, chest pain units.

reports from each CPU outlining the number and type of patients managed according to the CPU protocol and any adverse events.

RESULTS

All seven hospitals set up a CPU that remained operational for the whole year of the trial. The CPUs varied in location, staffing and operational hours (table 1).

In five of the seven hospitals, the units were based in or adjacent to the emergency department and run by emergency department staff. The other two sites were located away from the emergency department, but suitable patients were identified within the emergency department before moving to a different location. Staffing of the units varied, with five of the seven units using specialist chest pain nurses, although two other units used staff they had currently in post. Operational hours varied, mainly because of the staffing levels. Six units used the hospital laboratories for blood testing. In one hospital, point-of-care testing was used because the laboratories were unable to ensure a 1 h turnaround time. Only one hospital was able to provide ETT by chest pain nurses within the emergency department. The other six provided treadmill testing within the cardiology department on the next working day.

A total of 1644 patients were managed according to the CPU protocol and had their details recorded by CPU staff. The proportion of adult attendances managed on the CPU varied from 1 to 7 per 1000 attendances (table 2).

Overall, 1374 (83%) patients were discharged after assessment. The proportion of patients discharged did not vary substantially between hospitals, ranging from 79% to 89%, whereas the proportion of those experiencing adverse events after discharge varied from 0% to 3%. Overall, there were 23 adverse events among the discharged patients (1.7%) over the 30 days following discharge: 1 cardiac death, 1 non-cardiac death, 3 non-fatal myocardial infarctions and 18 readmissions for >48 h.

Table 3 shows the characteristics of patients managed at each CPU. These suggest that two of the CPUs that managed fewer patients (hospitals 1 and 5) selected younger patients with fewer risk factors and fewer with known coronary heart disease. Conversely, hospitals 3 and 4 managed more patients and included older patients and more patients with risk factors or known coronary heart disease.

Tables 4 and 5, respectively, show the blood tests and ETTs recorded at each hospital. Most patients received two blood samples; however, a proportion who presented late received a single troponin sample. The exception was hospital 7, where most patients received a single troponin sample. Most units performed ETT in about 66% of patients, as in the previous study.[1] The exception was hospital 3, where only 46% received treadmill testing, perhaps reflecting the higher proportion of older patients and those with known coronary heart disease managed by this unit.

DISCUSSION

CPU care can be provided in a safe manner in a wide variety of different hospitals in the UK. All seven hospitals established CPU care and ran the unit for the trial year. The proportion of patients discharged home after assessment was similar across all seven units (79–89%). Adverse events were uncommon among patients discharged after CPU assessment.

The numbers of patients receiving CPU care were relatively low, but this is in keeping with previous studies of CPU care from the UK. Herren *et al*[3] reported managing 383 patients over 1 year at the Manchester Royal Infirmary, the Sheffield CPU reported managing 534 patients over the first year of operation,[4]

Table 3 Characteristics of patients managed in each chest pain unit

Characterstics	1	2	3	4	5	6	7	All
Mean age (years)	47 (44 to 49)	51 (50 to 52)	55 (54 to 56)	58 (56 to 60)	45 (42 to 47)	51 (48 to 55)	53 (51 to 55)	53 (52 to 54)
Male	47/91	266/484	299/537	115/201	46/78	40/65	120/188	933/1644
	52 (42 to 62)	55 (50 to 59)	56 (52 to 60)	57(50 to 64)	59(48 to 69)	62(49 to 72)	64(57 to 70)	57
Known CHD	2/87	24/461	131/534	35/194	0/72	0/62	15/183	207/1593
	2 (0 to 8)	5 (3 to 8)	25 (21 to 29)	18 (13 to 24)	0 (0 to 5)	0 (0 to 6)	8 (5 to 13)	13 (11 to 15)
Diabetes	5/90	17/468	56/522	11/192	1/67	4/63	8/179	102/1581
	6 (2 to 12)	4 (2 to 6)	11 (8 to 14)	6 (3 to 10)	1 (0 to 8)	6 (2 to 15)	4 (2 to 9)	6 (5 to 8)
Hypertension	11/86	129/461	191/521	70/192	9/69	14/62	55/177	479/15 68
	13 (7 to 22)	28 (24 to 32)	37 (33 to 41)	36 (30 to 43)	13 (7 to 23)	23 (14 to 34)	31 (25 to 38)	31 (28 to 34)
Hyper-lipidaemia	12/84	101/449	165/522	78/201	6/62	6/61	43/169	415/14 72
	14 (8 to 23)	23 (19 to 27)	32 (28 to 36)	39 (32 to 46)	10 (5 to 20)	10 (5 to 20)	25 (19 to 33)	28 (26 to 31)
Smoker	29/87	160/459	168/522	48/192	24/66	23/62	49/181	501/15 69
	33 (24 to 44)	35 (31 to 39)	32 (28 to 36)	25 (19 to 32)	36 (26 to 48)	37 (26 to 50)	27 (21 to 34)	32 (30 to 34)
Family history of	25/68	197/426	269/513	73/174	24/64	24/54	56/174	668/14 739
CHD	37 (26 to 49)	46 (42 to 51)	52 (48 to 57)	42 (35 to 49)	38 (27 to 50)	44 (32 to 58)	32 (26 to 39)	45 (43 to 48)

CHD, coronary heart disease; CPU, chest pain units.
Values are n/total and percentage (95% CI) unless otherwise specified.

Table 4 Blood tests performed on patients managed on each chest pain unit

Hospital	Total number of patients seen	Patients receiving first CK-MB only, n (%)	Patients receiving second sample (CK-MB and troponin), n (%)	Patients receiving troponin only, n (%)	Data not recorded, n (%)
1	91	5 (5)	69 (76)	15 (16)	2 (2)
2	484	1 (<1)	461 (95)	12 (2)	10 (2)
3	537	5 (<1)	401 (75)	122 (23)	9 (2)
4	201	6 (3)	163 (81)	28 (14)	4 (2)
5	78	0	54 (69)	11 (14)	13 (17)
6	65	1 (2)	63 (97)	0	1 (2)
7	188	1 (<1)	24 (13)	151 (80)	12 (6)

CK-MB, creatine kinasse MB.

whereas Taylor *et al*[5] reported managing 100 patients over 6 months at the Royal United Hospital in Bath. Although chest pain is a common presenting complaint at the emergency department, a substantial proportion of patients have comorbidities, unstable angina or ECG changes that make them ineligible for CPU care.[1]

Four of the ESCAPE Trial hospitals managed similar numbers to previous studies during their first year of operation, whereas three managed markedly fewer. Previous reports may be subject to a degree of selection and publication bias because their activity could be driven by enthusiasts keen to acquire publishable data, whereas hospitals may have been more likely to submit their data for publication if activity levels were relatively high. The current study could therefore provide a more accurate reflection of CPU activity in more typical NHS hospitals.

However, this study may have underestimated CPU activity at some or even all of the hospitals. We only recorded details for patients who were managed according to the CPU protocol and attracted reimbursement. It is possible that other patients, such as those with unstable angina or myocardial infarction, were managed by CPU staff or using CPU facilities without being recorded. It is also possible that availability of the CPU could have influenced the management of other patients not in CPUs. For example, employment of chest pain nurses, access to short-stay beds, or changes in access to blood or exercise tests may have resulted in unrecorded changes to the care of other patients. It is also possible that, despite our efforts, hospital staff treated the CPU as an experimental intervention and did not use the CPU in the same way that they would in normal practice.

Previous descriptive studies of CPU care are mostly from the US and provide substantial data to show that CPU care is safe and practical.[6–15] Cohorts of patients receiving CPU care were followed up by a variety of methods and generally reported low adverse event rates.[6–15] The proportion of patients discharged after assessment varied from 46%[11] to 88%,[8] but most studies reported discharge rates of around 80%.[6–13] Our study showed similar findings across a variety of different NHS hospitals.

There was substantial variation between hospitals in the number of patients recorded as being managed by the CPU protocol. Some, but not all of this, was explained by differences in the number of new emergency department attendances. The number of CPU patients per 1000 adult attendances varied from 1 to 7. There was a trend towards larger hospitals having more CPU patients per 1000 adult attendances, but some inconsistencies were evident. Some of the variation may reflect differences in patient selection, particularly the inclusion of older patients and those with known coronary heart disease. Variation in CPU activity was not apparently related to CPU location, staffing or opening hours. Further research is therefore required to identify why some of the CPUs managed more patients than others.

It is apparent that the CPU protocol can be run by a variety of different staff in a variety of different locations. Indeed, it might be more appropriate to consider the CPU as a process of care, rather to than a physical entity, because the key elements of CPU care relate to processes rather than structures. We have recently surveyed current practice in the UK[16] and have shown that many hospitals are developing elements of CPU care without establishing a formal CPU. Meanwhile, other hospitals that reported having a CPU seemed to provide care that differed little from conventional non-CPU care. This presents a challenge to one of the aims of CPU care—to provide standardised care for patients with chest pain.

This study has a number of potential limitations. We intended that CPUs should provide care in as normal a manner as possible, to reflect how they would perform in a typical NHS setting, rather than in a research environment. We therefore did not contact discharged patients during follow-up, as this would have required additional intervention and possibly individual patient consent. We therefore could not determine whether some had any additional adverse events that either did not involve hospital attendance or resulted in attendance at another hospital. Furthermore, our assessment of the practicality of CPU care was restricted to measurement of the proportion of emergency department attendances receiving the CPU protocol and the proportion discharged after assessment.

Table 5 Exercise treadmill tests carried out on patients managed on the chest pain units

Hospital	Total number of patients seen	ETTs carried out, n (%)	Not suitable for ETT, or not carried out for other reason, n (%)	Data not recorded, n (%)
1	91	75 (82)	15 (16)	1 (1)
2	484	320 (66)	145 (30)	19 (4)
3	537	246 (46)	274 (51)	17 (3)
4	201	127 (63)	63 (31)	11 (5)
5	78	61 (78)	7 (9)	10 (13)
6	65	52 (80)	7 (11)	6 (9)
7	188	147 (78)	39 (21)	2 (1)

ETT, exercise treadmill test.

More detailed analysis of CPU processes would have been valuable, but was beyond the scope of this study.

CONCLUSION

CPU care can be instituted in a safe manner in a variety of NHS hospitals, with most patients being discharged after assessment. However, there is wide variation in the number and type of patients managed by the different units. Further research is required to identify reasons for these variations.

ACKNOWLEDGEMENTS

We thank Margaret Jane and Sarah Lampard for clerical assistance and the staff at the participating hospitals for their help with this study.

Authors' affiliations

Jane Arnold, Steve Goodacre, Medical Care Research Unit, University of Sheffield, Sheffield, UK
Francis Morris, Sheffield Teaching Hospitals, Sheffield, UK

Funding: The ESCAPE trial was funded by the NHS Service Delivery and Organisation R&D Programme.

Competing interests: None declared.

Contributors: *Project Management Group*: Jane Arnold, Research Fellow, University of Sheffield (Clinical Manager); Simon Capewell, Professor of Clinical Epidemiology, University of Liverpool (North-West Lead); Liz Cross, Research Associate, University of Sheffield (Research Manager); Steve Goodacre, Professor of Emergency Medicine, University of Sheffield (Principal Investigator); Maxine Johnson, Research Associate, University of Sheffield (Qualitative Researcher); Cath Lewis, Research Associate, University of Liverpool (North-West Co-ordinator); Francis Morris, Consultant in Emergency Medicine, Northern General Hospital, Sheffield (Chest Pain Unit Advisor); Jon Nicholl, Director MCRU Policy Research Programme, University of Sheffield (Statistician), Yemi Oluboyede, Research Associate, University of Sheffield (Health Economist); Susan Read, Honorary Research Fellow, University of Sheffield (Nursing Advisor); Angela Tod, Principal Research Fellow, Centre for Health and Social Care Research, Sheffield Hallam University (Qualitative Advisor).

Trial Steering Committee: Phil Adams, Consultant Cardiologist, Newcastle upon Tyne NHS Foundation Trust (Co-applicant); Tim Coats, Professor of Emergency Medicine, University of Leicester; Nicky Cullum, Professor, Centre for Evidence Based Nursing, University of York (Independent Chair); Alasdair Gray, Consultant in Emergency Medicine, Edinburgh Royal Infirmary (Co-applicant); Enid Hirst (Lay member); Jason Kendall, Consultant in Emergency Medicine, Frenchay Hospital, Bristol (Independent member); David Newby, Professor of Cardiology, The University of Edinburgh (Co-applicant); Simon Dixon, Senior Lecturer, University of Sheffield (Health Economist).

Data Monitoring Committee: Jonathan Benger, Consultant in Emergency Medicine, Bristol Royal Infirmary; David Gray, Reader in Medicine and Honorary Consultant Physician, Epidemiology and Health Services Research Unit, Queen's Medical Centre, Nottingham; Robin Prescott, Statistical Advisor, Medical Statistics Unit, Public Health Sciences, The University of Edinburgh.

Principal Trial Staff: University Hospital Aintree: John Hollingsworth (ED Lead), Erwin Rodrigues (Cardiology Lead), Paula McCarten (Cardiac Specialist Nurse); Whiston Hospital: David Roe (ED Lead), Dave Johns (Chest Pain Nurse); Halton General Hospital: Dr Serge Osula (Cardiology Lead), Karen Randles (Cardiac Nurse Specialist); Wythenshawe Hospital: Darren Walter (ED Lead); Warrington Hospital: Steve Crowder (ED Lead), Cindy Lancaster (ED Nurse); West Cumberland Hospital: Charles Brett (ED Lead), Guy Bickerton (ED Lead); Peterborough District Hospital: Rob Russell (ED Lead); Dewsbury and District Hospital: Dean Okereke (ED Lead); Scunthorpe General Hospital: Ajay Chawla (ED Lead), Julia Lindley (Administration/Systems Manager), Julie Housham (Chest Pain Nurse), Sarah McGugan (Chest Pain Nurse); Queen's Medical Centre Nottingham: Frank Coffey (ED Lead), Phil Miller (Emergency Department Research Coordinator); Taunton and Somerset Hospital: Cliff Mann (ED Lead), Andria Haffenden (Chest Pain Nurse), Bridget Capewell (Chest Pain Nurse); Hairmyres Hospital: John Keaney (ED Lead); City Hospital Birmingham: Nigel Langford (MAU Lead); Worcestershire Royal Hospital: Rose Johnson (ED Lead), David Pitcher (Cardiology Lead), Sue Amos (Chest Pain Nurse), Sally Baker (Chest Pain Nurse).

REFERENCES

1 **Goodacre S**, Nicholl J, Dixon S, *et al*. Randomised controlled trial and economic evaluation of a chest pain observation unit compared with routine care. *BMJ* 2004;**328**:254–7.
2 **NHS Service Delivery and Organisation**. *The ESCAPE Multicentre Trial of Chest Pain Units in the NHS, ISRCTN55318418*. London, NHSSDO, 2007; http://www.sdo.lshtm.ac.uk/sdo412003.html (accessed 20 April 2007).
3 **Herren KR**, Mackway-Jones K, Richards CR, *et al*. Is it possible to exclude a diagnosis of myocardial damage within six hours of admission to an emergency department? Diagnostic cohort study. *BMJ* 2001;**323**:372–4.
4 **Goodacre SW**, Morris FM, Campbell S, *et al*. A prospective, observational study of a chest pain observation unit in a British hospital. *Emerg Med J* 2002;**19**:117–21.
5 **Taylor C**, Forrest-Hay A, Meek S. ROMEO: a rapid rule out strategy for low risk chest pain. Does it work in a UK emergency department? *Emerg Med J* 2002;**19**:395–9.
6 **Graff LG**, Dallara J, Ross MA, *et al*. Impact on the care of the emergency department chest pain patient from the chest pain evaluation registry (CHEPER) study. *Am J Cardiol* 1997;**80**:563–8.
7 **Gibler WB**, Runyon JP, Levy RC, *et al*. A rapid diagnostic and treatment center for patients with chest pain in the emergency department. *Ann Emerg Med* 1995;**25**:1–8.
8 **Mikhail MG**, Smith FA, Gray M, *et al*. Cost-effectiveness of mandatory stress testing in chest pain center patients. *Ann Emerg Med* 1997;**29**:88–98.
9 **Gaspoz J-M**, Lee TH, Weinstein MC, *et al*. Cost-effectiveness of a new short-stay unit to ''rule out'' acute myocardial infarction in low risk patients. *J Am Coll Cardiol* 1994;**24**:1249–59.
10 **Roberts RR**, Zalenski RJ, Mensah EK, *et al*. Costs of an emergency department-based accelerated diagnostic protocol vs hospitalization in patients with chest pain. A randomized controlled trial. *JAMA* 1997;**278**:1670–6.
11 **Farkouh ME**, Smars PA, Reeder GS, *et al*. A clinical trial of a chest pain observation unit for patients with unstable angina. *N Engl J Med* 1998;**339**:1882–8.
12 **Gomez MA**, Anderson JL, Karagounis LA, *et al*. An emergency department-based protocol for rapidly ruling out myocardial ischaemia reduces hospital time and expense: results of a randomized study (ROMIO). *J Am Coll Cardiol* 1996;**28**:25–33.
13 **De Leon AC**, Farmer CA, King G, *et al*. Chest pain evaluation unit: a cost-effective approach for ruling out acute myocardial infarction. *South Med J* 1989;**82**:1083–9.
14 **Bholasingh R**, de Winter RJ, Fischer JC, *et al*. Safe discharge from the cardiac emergency room with a rapid rule-out myocardial infarction protocol using serial CK-MB(mass). *Heart* 2001;**85**:143–8.
15 **Stomel R**, Grant R, Eagle KA. Lessons learned from a community hospital chest pain center. *Am J Cardiol* 1999;**83**:1033–7.
16 **Cross E**, How S, Goodacre S. Development of acute chest pain services in the United Kingdom. *Emerg Med J* 2007;**24**:100–2.