REVIEWS

Chest pain evaluation units

Gareth Quin

Chest pain is a common cause of accident and emergency (A&E) presentation. In the United States, it accounts for 5–6% of new emergency department attendances.[1 2] The principal challenge in these patients is to identify those with an acute coronary syndrome (ACS). Early diagnosis allows effective treatment and inadvertent discharge may have disastrous consequences for patient and doctor: in the United States, between 2–5% of acute myocardial infarctions (AMI) are discharged from the emergency department and 20% of malpractice claims against emergency physicians relate to the management of ACS.[3]

The problem with the A&E assessment of these patients lies in the limitations of diagnostic tests for acute coronary ischaemia—initial ECG is diagnostic of AMI in only 40–65% of patients and is even less useful in unstable angina.[4] Despite recent advances, serum markers for myocardial necrosis detect, at best, 66% of AMIs on arrival.[5] Faced with these diagnostic difficulties and the consequences of misdiagnosis, A&E physicians have a low threshold for admitting patients with chest pain in whom the diagnosis is not immediately clear. Some 60–65% of these patients have an eventual diagnosis of non-cardiac chest pain[3] and while serious pathology is diagnosed in a minority, this traditional approach to chest pain is both time consuming and expensive.

It is against this background that the concept of A&E based chest pain evaluation units emerged—the aim being to provide medically equivalent care at a lower cost for A&E chest pain patients with a probability for ACS that is low, but not sufficiently low to allow discharge. The concept originated in, and has been almost exclusively confined to, the United States. The first chest pain evaluation unit was set up in 1981 and, by 1997, 15% of emergency departments in the US had followed suit.[6] The aim of this paper is to review the literature on chest pain evaluation units to answer the following questions:

- How are patients managed on chest pain evaluation units?
- Is there evidence for their clinical effectiveness?
- Are they cost effective?
- Is there evidence for patient satisfaction?

Methods

A literature search was carried out to identify research papers and articles whose principal focus was chest pain evaluation units run by emergency departments for the assessment of chest pain of possible cardiac origin. The following databases were searched—Medline, EMBASE, the Cochrane library and the Database of Abstracts of Reviews for Effectiveness. The following MeSH terms were used—"emergency service, hospital", "myocardial infarction/diagnosis", "myocardial ischaemia/diagnosis", "angina pectoris/diagnosis", "chest pain/diagnosis", "chest pain/therapy" "cost benefit analysis", and "randomised controlled trials". In addition, the reference lists of retrieved articles were searched for papers not identified in the computerised search. Journals were not hand searched and authors were not contacted for unpublished work. Papers were selected if they described patient management or presented evidence for clinical efficacy, cost effectiveness or patient satisfaction. Where appropriate, papers were critically appraised along standard guidelines.[7 8] Conference abstracts were not selected as the brevity of information hinders meaningful critical appraisal.

Results

PATIENT MANAGEMENT

Eight papers were identified, describing the management process in six chest pain evaluation units. These are summarised in table 1. Despite differences in the detail, the overall approach to patient management is similar in the different centres. All are described as being located in, or adjacent to, the emergency department. All centres include patients with non-traumatic chest pain deemed to be at low risk for AMI. In four centres, the ascription of risk is at the discretion of the treating physician, according to local guidelines. In the other two units, risk is determined according to the Goldman algorithm, a validated tool that subdivides patients with chest pain into groups with differing probabilities of AMI, based on history, examination and ECG findings.[15] Patients are eligible for these chest pain evaluation units if they have a probability of AMI that is calculated to be less than 7%.

Exclusion criteria are described for five of the centres. Common exclusion criteria are ECG evidence of acute myocardial ischaemia or the presence of complications of cardiac ischaemia (for example, arrhythmia, hypotension, CCF, pre-hospital cardiac arrest). The identification of a non-cardiac diagnosis is stated as an exclusion criterion in four of the

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Table 1 Management protocols in six chest pain evaluation units

First author	*Duration of protocol (h)*	*ECG*	*Biochemical markers*	*Additional testing*
Zalenski[9]	12	0, 6, 12 hours	CK-MB at 0, 4, 8, 12 hours	ETT
Gibler[10]	9	Continuous ST segment monitor	CK-MB at 0, 3, 6, 9 hours	2-D echo, ETT
Hoekstra[11]	9	Continuous ST segment monitor	CK-MB at 0, 3, 6, 9 hours	Thallium ETT
Doherty[12]	9	0, 3, 6, 9 hours	CK-MB at 0, 3, 6, 9 hours	Cardiology consult, ETT, Thallium ETT, MUGA scan
Mikhail[13]	8	Continuous ST segment monitor	Total CK at 0 hours +/− CK-MB at 0, 4, 8 hours +/− myoglobin at 0, 4 hours	ETT, Stress echo Dobutamine echo, Thallium ETT
Gomez[14]	9	Continuous ST segment monitor	Total CK + CK-MB at 0, 3, 6, 9 hours	ETT, Dobutamine echo

ETT, exercise tolerance test; echo, echocardiogram.

five centres. Two units exclude patients with a history of coronary artery disease, while one specifically includes these patients. Inability to perform an exercise test excludes patients in one centre.

Once admitted to the units, patients are subjected to serial clinical, ECG and biochemical assessment at specified intervals. If evidence of AMI or unstable angina emerges the patient is transferred to critical care unit. Patients with normal results at the end of the testing period undergo exercise stress testing, or an equivalent in those physically unfit for the treadmill. If these tests are positive the patient is admitted for further evaluation. If negative, the patient is discharged home. Follow up is arranged with a cardiologist or family physician.

CLINICAL EFFICACY

An effective chest pain evaluation unit should have a diagnostic protocol that performs as well as standard management. The gold standard for evaluating a new diagnostic test (chest pain evaluation unit) entails its independent, blind comparison with a reference standard of diagnosis (standard inpatient management), the reference being applied irrespective of the new test result.[16] Five published studies have assessed the diagnostic utility of their chest pain evaluation unit's protocol, but only one meets the above criterion. Zalenski *et al*[9] studied 317 patients all of whom were initially admitted to a chest pain evaluation unit. At the end of the testing protocol, all patients were admitted to hospital for the establishment of reference diagnoses according to the standard inpatient examination. Final reference diagnoses were assigned by a physician blinded to the results of the chest pain evaluation unit outcomes. The sensitivity and specificity of the protocol for acute coronary insufficiency were 90% (95% CI 73.4% to 97.9%) and 50.5% (95% CI 44.6% to 56.4%) respectively. Negative and positive predictive values were 98% (95% CI 94.2% to 99.6%) and 16% respectively. The authors assume a sensitivity of 100% for the inpatient protocol.

Four other papers used the incidence of adverse outcomes over a period of follow up as a measure of the diagnostic accuracy of their protocol. Table 2 summarises the results.

The proportion of patients discharged home after the protocol, duration of stay, the frequency with which ischaemic heart disease is diagnosed in all chest pain unit patients and in those admitted with positive results all relate to the effectiveness of the unit. Table 3 summarises the available evidence on these issues.

Table 2 Outcomes of patients discharged from four chest pain evaluation units

First author	*Number of patients**	*Period of follow up*	*Adverse outcomes*
Doherty[12]	176	9 months	Nil
Mikhail[13]	410	5 months	1 AMI at 6 days
Gibler[10]	829	1 month	1 AMI at 3 days 4 non-cardiac deaths at 1 month
Gomez[14]	46	30 days	Nil

AMI, acute myocardial infarction. *Number of patients discharged after negative chest pain unit evaluation.

COST COMPARISONS

Four papers report comparative studies with cost as a primary outcome. Roberts *et al*[18] randomly allocated 166 chest pain evaluation unit eligible patients to either chest pain unit (intervention) or standard inpatient treatment (control). The mean total cost per chest pain unit patient was $1528 compared with $2095 for controls ($p<0.01$). Mean costs for patients admitted after chest pain unit evaluation were $2410, higher than the cost for patients discharged after chest pain unit evaluation ($803, $p<0.001$) and for controls ($2095, $p<0.13$). This study was well designed with robust randomisation, clearly stated sample size calculations, intention to treat analysis and rigorous cost analysis. Blinding was not possible as patients were managed in different areas.

In a second randomised controlled trial, Gomez *et al*[14] reported mean hospital charges of $1297 in the chest pain unit group versus $5719 in the routine care (control) group ($p<0.0001$). Figures are not presented for the cost differences between those admitted from the chest pain unit and those discharged.

Mikhail *et al*[13] report a comparative study using retrospective controls. The mean total cost per case for patients discharged from the chest pain unit was $894. The corresponding figure for controls was $2364.

In another non-randomised trial, Hoekstra *et al*[11] report a cost analysis for chest pain units in two centres. Patients admitted to the hospitals when the chest pain units were full were used as controls. In both centres, mean charges were significantly less for chest pain unit patients

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Table 3 Outcomes of patients admitted to chest pain evaluation units

Author	*Discharged (%)*	*Duration (control)*	*% Admitted with ACS**	*% CPEU patients with ACS†*
Gomez[14] (RCT)	92	15.4 hours (54.6 hours)	25	2
Doherty[12]	78	17.4 hours (52.8 hours)	10	2
Toner[17]	72	6.5 hours	N/S	N/S
Gibler[10]	82.1	N/S	28.1	4.25
Mikhail[13]	86	N/S	66	9

*Percentage of patients admitted from the chest pain evaluation unit with an eventual diagnosis of an acute coronary syndrome. †Percentage of all patients admitted to the chest pain evaluation unit with a final diagnosis of an acute coronary syndrome. N/S, not stated; RCT, randomised controlled trial.

than controls (Centre 1: \$2797 *v* \$3957 (p=0.009); Centre 2: \$1931 *v* \$3961 (p=0.002)). This paper also reports higher mean charges in patients admitted following chest pain unit evaluation than in controls, although these differences were not statistically significant.

PATIENT SATISFACTION

Rydman *at al*[19] report a randomised controlled trial comparing patient satisfaction between chest pain observation unit patients and controls admitted for routine care, using patient interviews to score a number of satisfaction markers from 1 (most dissatisfied) to 4 (most satisfied). The chest pain unit scored higher than inpatient management on all seven satisfaction indices, with the attainment of a statistically significant difference in four of these scores.

Discussion

The management strategy used in chest pain evaluation units represents a condensed form of traditional inpatient management. Protocols differ in some of their components, although no study has compared one with another. Recent evidence on the performance of Troponin T and Troponin I in patients with chest pain and normal ECGs offers the prospect of even shorter testing periods. In a well designed validation study, Hamm and colleagues[5] report that Troponin T and Troponin I tests were positive in 94% and 100% (respectively) of patients with AMI within six hours of pain onset, although this study was not carried out in the context of a chest pain unit.

All units perform some form of provocative testing before discharge. This practice recognises the safety of early exercise testing in chest pain patients with a low risk of ACS[20 21] and the dangers of omitting such testing—Gaspoz et al[22] reported a 1.2% missed MI rate in patients discharged from a cardiology run chest pain observation unit, only 19% of whom had had an exercise test before discharge.

It is clear that the success of these units stands or falls on rapid and extended access to cardiac enzyme assays and stress testing facilities. Most of the reporting US centres can access blood assays 24 hours a day and exercise testing seven days a week. Excluding patients unable to perform exercise tests may simplify the logistics, by obviating the need for rapid access to more sophisticated provocation tests, but would probably limit the usefulness of the unit.

Despite the considerable investment required, chest pain units may have a modest impact on chest pain management in a given department. In a feasibility study, Zalenski *et al*[1] found that only 28% of patients deemed to be at low risk for MI were eligible for the chest pain unit. Characteristics of the study population, protocols used and chest pain unit exclusion criteria all impact on this proportion.

The available evidence suggests that chest pain evaluation units deliver what they promise, providing equivalent clinical outcomes to inpatient management, in a shorter time and for less money. Follow up of discharged patients has demonstrated the safety of the protocols, although given the sensitivity of 90% reported by Zalenski *et al*,[9] and with a disease prevalence of 10%, approximately 1 in 100 tested patients would be wrongly classified as being disease free. The specificities of the protocols are moderate and most patients admitted having had a positive result in the chest pain unit prove ultimately not to have an acute coronary syndrome (table 3). This underscores the limitations of current diagnostic tests.

Two well designed studies have demonstrated the cost-benefits of chest pain evaluation units. The important observation is that patients managed on the unit who are subsequently admitted cost more than those managed in the routine way. Savings can only be made if a majority of those managed on the unit are discharged. Most units achieve this (table 3). It is probable that some patients will be admitted to the unit who would otherwise have been discharged after initial A&E evaluation. This is essential to decrease missed MI rates but will impact on overall cost effectiveness.

There is a potential in chest pain evaluation units for overlooking other causes of chest pain, given the overwhelming focus on excluding cardiac disease. Many of these alternative diagnoses are not readily apparent and some may have serious consequences. In addition, chest pain evaluation units run the risk of downplaying the importance of symptoms other than chest pain in the presentation of myocardial ischaemia. These potential pitfalls have received little attention in the literature, though it seems likely that focused education would lessen the risk.

It is estimated that, since 1991, over 500 chest pain evaluation units have been established in emergency departments across the United States.[23] There are no published reports of such A&E based units from any other country. Retrospective denial of payment for patients admitted with non-cardiac chest pain is not an uncommon occurrence in the US,[3] and it is clear from the literature that financial pressures have had a significant role in the development of chest pain evaluation units. Of the three randomised controlled trials identified, two centre on cost. The clinical benefits are largely reported in observational studies. Whatever their origin, the role of chest pain

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units continues to develop in the US, with the recent publication of the results of a randomised trial reporting the safe, clinically and cost effective use of a chest pain observation unit for the treatment of patients with unstable angina deemed to be at intermediate risk for cardiac events.[24]

Conclusion

Do chest pain evaluation units have a role in UK A&E practice? Experience in the US has demonstrated that such units manage patients at low risk for MI as effectively as inpatient admission, and at less cost. They seem like a good idea. However, all available evidence emanates from the US and may not be generalisable to the UK. Their institution in the UK would require staffing levels and access to diagnostic facilities currently beyond most centres. Feasibility and cost-benefit studies would need to inform any change in local practice. Close collaboration with the cardiology service would be essential.

In the current absence of a clinical or financial imperative to establish chest pain evaluation units, their appearance in UK A&E practice may well reflect local opinion on whether such activity constitutes seizing the initiative or shouldering the burden.

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