REVIEWS

Should we establish chest pain observation units in the UK? A systematic review and critical appraisal of the literature

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Abstract

***Objectives*—The chest pain observation unit (CPOU) has been developed in the United States to allow rigorous assessment of patients presenting with chest pain, thus expediting their discharge if assessment is negative. This review aims to examine the evidence for effectiveness and economic efficiency of the CPOU and to explore whether data from the United States can be extrapolated to the UK.**

***Method*—Search of the literature using Medline and critical appraisal of the validity of the data.**

***Results*—Five studies comparing outcomes of CPOU care with routine practice showed no significant difference in objective measures including mortality or missed pathology. Eleven studies described outcomes of a cohort of CPOU patients. Follow up was comprehensive and demonstrated no clinically significant evidence of missed pathology. Nine studies comparing CPOU costs with routine care demonstrated impressive cost savings that were more modest when randomised comparisons were made.**

***Conclusion*—CPOU care is safe and costs are well defined. There is no strong evidence that a CPOU will improve outcomes if routine practice is good. Cost savings have been shown when compared with routine care in the United States but may not be reproduced the UK.**

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During the 1980s studies from the United States suggested that approximately 3%–4% of patients attending hospital with acute myocardial infarction (AMI) were discharged from the emergency department,[1 2] and many of those admitted ultimately had a benign cause.[3 4] A similar study from the UK found that 11.8% of patients presenting to the accident and emergency (A&E) department with acute ischaemic heart disease were discharged home,[5] and audit of attendances with chest pain have found that many are discharged by junior staff without recourse to second opinion,[6] and errors of electrocardiogram (ECG) interpretation are frequent.[5 7]

One approach to this problem has been the development of the chest pain observation unit (CPOU).[8 9] Patients presenting with chest pain who are at low risk of AMI undergo a short period of rigorous monitoring with serial ECGs and cardiac enzymes before receiving some form of provocative testing, usually exercise treadmill. If all tests are negative they can be discharged home.

It is now estimated that 22% of emergency departments in the United States have a CPOU[10] and interest is growing in the UK.[11] The rationale for their development is both clinical and economic. Rigorous evaluation is intended to increase diagnostic certainty and prevent inadvertent discharge of patients with AMI or unstable angina, while reducing length of stay should reduce costs. In addition, the very high legal cost in the United States of discharging a patient with unrecognised AMI has been a driving force there, which has yet to fully evolve in the UK.

To be considered effective a CPOU must be demonstrated to improve, or at least match, patient outcomes for normal practice. The outcomes usually measured are: mortality, "missed AMI", reattendance, complications, cardiovascular procedures, and final diagnoses. Mortality is the most objective outcome measure but is fortunately rare. There is little scope for the CPOU to improve this outcome, while increased mortality is a very insensitive measure of CPOU safety.

The purpose of a CPOU is to rule out AMI and detect critical myocardial ischaemia. The latter may be hard to define by objective diagnostic criteria, but the missed AMI rate (the proportion of cases of AMI attending the emergency department who are inadvertently discharged) is an important indicator of effectiveness. However the accuracy of this measurement will depend upon the rigour with which it pursued. The estimates of missed AMI rate quoted above involved reassessment of discharged patients with ECG and enzyme testing at 48–72 hours after discharge.[1 2] Unless those discharged from a CPOU are followed up with equal rigour, estimates of the

missed AMI rate should be considered with caution. The other outcome measures are related to processes of care rather than definitive outcomes. As such their relationship to patient benefit will require interpretation.

Economic evaluation depends upon the evidence of effectiveness. It is anticipated that CPOU outcomes will either match or improve upon routine care and costs will be lower. If this is true then the CPOU is dominant over routine care and there is no need to determine any cost effectiveness ratio. However, claims of cost saving should be scrutinised with the same rigour as claims of effectiveness. In particular, the differences in health service costs and clinical practice that exist between countries mean that cost savings may not be reproduced elsewhere.

The aim of this review is to examine the evidence for both the effectiveness and the economic efficiency of the CPOU and to explore whether data from the US can be extrapolated to the UK.

Method

A computerised search of the literature was undertaken using Medline. Articles were searched for the textwords "chest pain observation", "chest pain evaluation", or "chest pain assessment". The medical subheading (MeSH term) "chest pain" was also searched in combination with MeSH terms: "emergencies", "observation", "myocardial ischaemia", "unstable angina", and "myocardial infarction (diagnosis)". Any article that reported costs or outcomes for patients managed on a CPOU was reviewed. The bibliography of each article was searched for related citations. Articles relating to chest pain clinics[12 13] (rapid access outpatient cardiology services) were not included. Although similar, these services have a different source of referral and tackle a different clinical problem to the CPOU.

The question of effectiveness was addressed in two ways. Firstly studies were selected that compared outcomes of CPOU management with those of routine patient care. The quality of these studies was assessed against standard criteria covering reporting, statistical analysis, internal validity (bias and confounding), and external validity (generalisability).[14 15] Particular attention was directed at determining how subjects were selected and allocated to intervention (CPOU) and control (routine care) groups, how the controls were chosen, how follow up was performed for each group, the completeness of follow up, and the range of outcomes examined.

Secondly, studies were selected that made no comparison but simply described outcomes of CPOU patients. Quality was assessed by determining how subjects were selected, the nature and completeness of follow up, and the range of outcomes examined. Although descriptive studies cannot demonstrate effectiveness on their own, they may be helpful in adding to a body of knowledge that a technology can be safely applied in a variety of settings.

To address the economic question studies were selected that compared CPOU costs with those of a comparison group. Criteria relating to the reporting of economic evaluations have recently been published.[16] Unfortunately most of the literature relating to CPOUs were submitted for publication before this and the reports of economic data are, by comparison, poor. Hence rigorous examination of quality is not possible. Quality assessment was therefore focused upon essential criteria for internal and external validity of the economic comparison, such as the method of allocation to intervention and control groups, the choice of controls, the range of costs included and the costing technique used. As most of the data obtained was observational and non-randomised, no attempt to perform a meta-analysis was made. Instead the various estimates of costs were examined for heterogeneity and explanations for any differences sought.

Results

All the studies found were from the United States. Six studies compared outcomes for patients admitted to a CPOU to a control group.[17–22] One of these, which compared outcomes principally in terms of patient satisfaction,[22] ran alongside a randomised trial of cost effectiveness[18] and will be discussed separately. The results of the five remaining studies are summarised in table 1.

Table 1 Comparative studies of chest pain observation units (CPOUs)

First author	*Subjects*	*Allocation to treatment*	*Controls*	*Outcomes*
Farkouh[17]	Intermediate risk of myocardial ischaemia	Randomised	"Usual care": monitored cardiology bed	No significant difference for in-hospital, 30 day or 6 month event rate. No significant difference for return visits
Roberts[18]	Low risk of MI (<7%) but admission planned	Randomised	Inpatient telemetry unit	At 8 weeks: no deaths, no significant difference in rehospitalization (6.1% *v* 4.5%), fewer indeterminate diagnoses in CPOU group (13% *v* 45%)
Gomez*[19]	Low risk of MI (<7%) but admission planned	Randomised	Routine care: hospital admission	No death, MI or coronary artery disease in either group at 30/7. 6% of CPOU group re-presented, 7% of admitted group required further investigation
Gaspoz[20]	Low risk of MI with anticipated stay <48 hours	Non-randomised	Contemporaneous, eligible for CPOU but either discharged or admitted to hospital	No significant difference in complications, MI or death at 72 hours or 6 months
Kerns[21]	Atypical chest pain, low risk of ischaemia	Non-randomised	Contemporaneous, eligible for CPOU but admitted to hospital	No death, MI or coronary artery disease at 3 or 6 months in either group

*Compared costs with both randomised and historical controls but only randomised controls had outcome data collected.
MI = myocardial infarction.

Table 2 Descriptive studies of cohorts of chest pain observation unit patients

First author	*No*	*% Discharged from CPOU*	*Type of follow up*	*Timing of follow up*	*% Followed up*	*Adverse events detected*
Farkouh[17]	212	46	Outpatient review	72 hour 30 day 6 month	99	In hospital: 5 MI, 1 CCF, 1 death 30 day: 1 death 6 month: 2 MI, 3 CCF, 1 death
Roberts[18]	82	55	Inpatient, telephone, clinic, or HIS*	24 hour 8 weeks	100 85 96	No deaths 6.1% rehospitalised
Gomez[19]	50	82	Telephone, mail or clinic	30 day	98	No death, MI, or coronary artery disease 6% represented
Gaspoz[20]	592	84	Telephone, record review, or BVS†	72 hour 6 month	98 100†	5 MI within 72 hours of discharge 10 MI and 13 deaths (10 cardiac related) within 6 months
Kerns[21]	32	100	Telephone questionnaire	3 month 6 month	Not reported	No death, MI, or coronary artery disease
Gibler[23]	1010	82	Telephone, mail, clinic, or death records	30 day	Not reported	1 return with MI at 3 days 5 deaths (1 admitted with MI, 1 unknown cause, and 3 non-cardiac causes)
Kirk[24]	212	87	Telephone, mail, hospital, or death records	30 day	94	No morbidity or mortality
Graff[25]	6005	76	Evidence of reattendance	72 hour	No formal follow up	3 returns with MI within 72 hours
Mikhail[26]	502	86	Telephone questionnaire	3 or14 day 150 day	94	2 deaths at 2 weeks and 2 months 1 MI 7 PTCA or CABG
Stomel[28]	473	96	Telephone or record review	12 month	93	7 unstable angina on medical treatment, 3 CABG, 1 PTCA
De Leon[27]	495	66	Telephone or mail	Not stated	69	No morbidity or mortality detected in discharged patients

*Hospital information system: records if patient is alive or dead.
†BVS is the Bureau of Vital Statistics: records if patient is alive or dead. CABG = coronary artery bypass graft; CCF = congestive cardiac failure; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty.

Reporting was adequate for all studies. The objectives, interventions, outcomes, main findings, and patient characteristics were well described. All studies included appropriate statistical analysis except that of Kerns *et al*.[21] Regarding validity, blinding of patients and carers was inevitably absent from all the studies and represents a potential source of bias. Three trials were randomised and are therefore the most likely to be valid.[17–19] The non-randomised study by Gaspoz *et al* made appropriate adjustment for confounding,[20] but only random allocation can take into account the influence of unknown confounders. No such adjustment was made by Kerns *et al* and taking into account the small number and lack of statistical analysis,[21] this study can only be considered to represent pilot data. Only the study by Farkouh *et al* described the full details of patients excluded from the trial.[17] Without such details it is impossible to determine whether the trial population is representative of all low risk patients with chest pain and we must be cautious about applying findings to other patient groups.

The AMI rate in the study groups varied from zero to 4.9% and did not differ significantly between CPOU and control groups in any study. Baseline characteristics, in terms of age, sex, type of pain, risk factors, and history of coronary artery disease, did not differ significantly between CPOU and control groups in any of the randomised trials.[17–19] In the study by Gaspoz *et al* the control patients were significantly more likely to be male, have recurrent or atypical pain, have abnormal ECGs, and have a history of ischaemic heart disease.[20] No statistical analysis of baseline characteristics was carried out by Kerns *et al*.[21]

Six studies were found that described outcomes for CPOU subjects without comparison with a control group,[23–25] or used a control group for cost analysis only.[26–28] Hence there were a total of 11 studies reporting follow up of a cohort of CPOU patients. These are outlined in table 2. All studies excluded subjects with an ischaemic ECG and selected those at low risk of AMI. Often this selection involved a subjective element of physician judgment. Most studies achieved high follow up rates.[17–20 24 26 28] This follow up was typically done by mail or telephone and was therefore adequate to exclude major morbidity but not "missed AMI" by the criteria outlined above.

Table 3 Estimates of cost savings per patient managed on a chest pain observation unit

First author	*Cost saving per patient*	*Randomised, contemporaneous, or historical controls*	*Controls admitted or discharged*	*Time period costed*	*Costing technique*
Kerns[21]	$1873*	Contemporaneous	All admitted	In-hospital only	Patient charges
Hoekstra[29]	$1160*	Contemporaneous	All admitted	In-hospital only	Patient charges (excluding physician charges)
	$2030*	Contemporaneous	All admitted	In-hospital only	Patient charges (excluding physician charges)
Rodriguez[30]	$1564*	Contemporaneous	All admitted	In-hospital only	Mean hospital charge
Stomel[28]	$1497	Contemporaneous	All admitted	In-hospital only	Hospital financial data system costing
Mikhail[26]	$1470*	Historical	All admitted	In-hospital only	Hospital financial data system costing
Sayre[31]	$1449*	Contemporaneous	All admitted	In-hospital only	Engineered standards
Gomez[19]	$1165†	Historical	All admitted	In-hospital + 30 day follow up	Charges incurred on patients itemised account
	$624†	Randomised	All admitted	In-hospital only	Charges incurred on patients itemised account
Gaspoz[20]	$698*	Contemporaneous	Admitted + discharged	In-hospital + 6 month follow up	Detailed costing procedure
Roberts[18]	$567*	Randomised	All admitted	In-hospital only	Detailed costing procedure

*Mean cost saving.
†Median cost saving.

Table 4 Diagnostic tests used in the chest pain observation unit protocols

First author	*ST monitor*	*Cardiac enzymes*	*Exercise stress test*	*Others*
Farkouh[17]	Yes	CK-MB	Yes	Nuclear or ECHO stress test†
Roberts[18]	No	CK-MB	Yes	Nil
Gomez[19]	Yes	CK, CK-MB	Yes	ECHO, dobutamine stress ECHO*
Gaspoz[20]	No	CK-MB	Yes	Nil
Kerns[21]	No	Nil	Yes	Nil
Gibler[23]	Yes	CK-MB	Yes	ECHO
Kirk[24]	No	Nil	Yes	Nil
Mikhail[26]	Yes	CK, CK-MB, myoglobin	Yes	Nuclear or ECHO stress test†
De Leon[27]	No	CK, LDH, CK-B	No	Nil
Hoekstra[29]	Yes	CK, CK-MB	Yes	ECHO
Stomel[28]	No	CK-MB	No	Stress ECHO

*Selected patients only.
†If unable to exercise. CK = creatine kinase; CK-MB = creatine kinase MB isoenzyme; ECHO = echocardiogram; LDH = lactate dehydrogenase.

Nine studies comparing costs of a CPOU to routine care were found,[18–21 26 28–31] two of which were only in abstract form.[30 31] Two of the studies consisted of two separate comparisons so there were a total of 11 comparisons to review.[19 29] These are outlined in table 3. One other study was found that compared resource use but no costs.[32] Data from this institution, including costs, has been published elsewhere.[30]

Table 4 outlines the diagnostic tests used in each of the CPOU protocols described in the literature.

Discussion

The effectiveness of the CPOU has been investigated by five comparative studies.[17–21] Despite differences in inclusion criteria, method of allocation to treatment, and follow up there is broad similarity in outcomes. No significant difference in any objective outcome measure has been demonstrated. The main threat to the validity of this conclusion is the small number of deaths, AMI, and complications in these low risk subjects. A larger trial might be needed to detect a small difference in these outcomes, but it appears that the CPOU does not markedly affect hard outcome measures.

More subjective outcomes should be interpreted with caution in view of the inability of researchers to institute blinding. The only significant difference in outcome detected was an increase in diagnostic certainty after CPOU assessment.[18] Two studies recorded a non-significant trend towards higher reattendance rates among CPOU patients (Farkouh *et al*[17]: 8.0% *v* 4.2% and Roberts *et al*[18]: 6.1% *v* 4.5%). These are measures of processes of care and their value to the patient is debatable.

A further study by Rydman *et al* reported improved patient satisfaction among patients referred to a CPOU when compared with routine care,[22] but this may be an example of patient preference bias.[33] Being a randomised controlled trial of a new intervention, patients who have a preference for CPOU care can only obtain it by entering the trial and risking disappointment if they are randomised to the control. While those with a preference for routine care can be sure to obtain their preference by refusing consent. Unless patients have no preferences recruitment will be biased towards those who prefer CPOU care.

It should be noted that all the aforementioned studies compare CPOU patients with those admitted. A more appropriate comparison would also include patients discharged after initial emergency department assessment so as to report the proportion of AMIs discharged. Such a study, particularly if randomised, would present significant logistic and ethical problems but must be considered the only way of providing definitive proof of the relative effectiveness of the CPOU.

Descriptive and comparative studies have now reported large numbers of patients receiving CPOU assessment.[17–21 23–28] Follow up by telephone or mail is reasonably comprehensive and, supported by searches of death registries, is adequate to ensure that significant symptomatic pathology is not being missed. Death and complication rates do not exceed those expected for the study population and it is reasonable to conclude that the CPOU is a safe management strategy for low risk patients. Protocols consisting of continuous ST monitoring, creatine kinase MB isoenzyme measurement, and exercise stress testing seem to be the standard practice. Most result in discharge of around 80% of CPOU patients. The low discharge rates seen in the studies by Farkouh *et al*[17] and Roberts *et al*[18] probably occur because these protocols stipulate admission of those with inconclusive exercise testing.

It is tempting to compare the results of CPOU follow up with the previously reported rates of missed AMI.[1 2] Indeed, this has been done to conclude that the CPOU reduces inadvertent discharge of AMI.[25] This conclusion should be resisted for two important reasons. Firstly, none of the studies of CPOUs report testing for missed AMI with clinical, ECG, and enzyme assessment at 48–72 hours after discharge. Without such rigorous follow up it is impossible to tell if an equivalent number of AMIs are missed. Secondly, estimates of missed AMI rates predate many changes in emergency management of chest pain that may have improved or increased the caution with which patients with chest pain are managed. The use of historical controls is recognised to exaggerate the effects of new interventions,[34 35] and any conclusion of benefit based on such a comparison should be viewed with scepticism. Though it is reasonable to conclude that the CPOU offers a safe alternative to hospital admission, there is no convincing evidence of improved outcome.

Even if the CPOU is no more effective than routine care in ensuring safe discharge of patients with chest pain, surely the evidence of cost saving provides a compelling reason to introduce this form of care to the UK? Before this can be accepted the validity of cost estimates and their applicability to the UK must be reviewed.

Economic evaluations are subject to many of the same threats to validity as clinical trials.[16] The value of concealed, random allocation in preventing known and unknown confounders being over-represented in one or other group is such that for clinical trials and economic evaluations it is considered to be the gold standard.[14]

Non-random allocation may cause bias if subjects with a different prognosis are systematically allocated to one group.[36 37] The CPOU has been investigated by both randomised[18 19] and non-randomised methods[20 21 26 28–31] and it is noticeable that cost savings are less impressive when a randomised method is used (see table 3).

Randomised trials may also be subject to bias. Subjects may be selected for inclusion in a trial on the basis that they are deemed "suitable" for the new intervention. Management decisions may be influenced by awareness that the CPOU patient is under investigation. Patients may refuse consent if they are adverse to any risk associated with discharge and express a preference for more investigation or a longer hospital stay. If only hospital costs are recorded then significant costs incurred as outpatients may be missed. All such factors will tend to exaggerate the potential for the CPOU to reduce costs and must be considered when reviewing claims of cost effectiveness.

The potential for cost saving will also depend upon the proportion of patients normally discharged directly from the emergency department.[25] Most estimates of cost minimisation (even from randomised controlled trials) compare CPOU patients with those admitted.[18 19 21 26 28–31] If the presence of a CPOU leads to enrolment of patients who would normally be discharged, then this comparison will no longer be valid and cost savings reduced. It is noticeable from table 3 that the only trial with a control group that included those discharged directly from the emergency department had a relatively low cost saving per patient.[20]

The costing of all these trials was limited. Only hospital costs were included and only two studies looked beyond inpatient costs.[19 20] If, by facilitating early discharge, a CPOU simply moves investigations from an inpatient to an outpatient setting, then cost savings detected by analysis of inpatient costs only will be an overestimate. The use of patient charges to estimate costs may also introduce inaccuracy. Cross subsidising may mean that charges are a poor reflection of costs.

The application of trial findings to local circumstances must be considered. Protocols for the CPOU are usually well defined and can be transferred from one location to another. However, routine practice for hospital admission may vary greatly. It is important that local practice for patients admitted with chest pain is similar to that of the control population in a trial if cost savings are to be reproduced. For example, some studies report rates of inpatient coronary catheterisation for controls of 20%–25%.[19 29] Such high cost comparisons are unlikely to be found in the UK. The extent to which subsequent costs should be included in the analysis is a matter of debate and depends upon the economic viewpoint. From the A&E viewpoint it may be reasonable to only consider costs incurred in detecting or ruling out acute disease. Given the present low rate of interventional cardiology in the UK, the introduction of a CPOU that increases the detection of cases of coronary artery disease may result in more cardiology referrals and therefore greater costs. Whether this is appropriate or not requires a subjective judgment.

This review takes a critical look at the arguments in favour of the CPOU. We can conclude that CPOU care is safe and that resource use is controlled and well defined. Uncertainty remains regarding whether the CPOU can improve patient outcomes and whether cost savings can be reproduced in the UK. It should be noted that much of this uncertainty relates to a lack of comparative data on present practice in the UK. It would be perverse to use this uncertainty to conclude that there is insufficient evidence to establish CPOUs in the UK.

The problem of chest pain management in the A&E department is unlikely to diminish in the future. The potential benefits of early thrombolysis mean that patients will be encouraged to attend the A&E department early if they experience acute chest pain. We need to have strategies in place to manage these patients if the ECG is non-diagnostic. Bed availability for emergency admissions is unlikely to increase to meet this demand. Meanwhile the potential for litigation if patients with AMI are discharged is likely to increase. All this suggests that we cannot afford to be complacent about our management of patients with chest pain. The evidence base for the CPOU may have its limitations but we have little evidence to support our present approach.

Conclusion

The CPOU offers a safe alternative to routine hospital admission that may be cheaper and more effective. The potential for cost saving depends upon the proportion of patients attending the A&E department who are subsequently admitted, the typical resource use of those admitted, the proportion of those admitted who would be suitable for care on a CPOU, and the ability of the A&E department to support CPOU services in an efficient manner. Further evidence is essential to determine whether this promising new approach can be applied in the UK.

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