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Effectiveness and safety of chest pain assessment to prevent emergency admissions: ESCAPE cluster randomised trial

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RESEARCH

Effectiveness and safety of chest pain assessment to prevent emergency admissions: ESCAPE cluster randomised trial

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doi:10.1136/bmj.39325.624109.AE

ABSTRACT

Objective To determine whether introducing chest pain unit care reduces emergency admissions without increasing reattendances and admissions over the next 30 days.

Design Cluster randomised before and after intervention trial.

Setting 14 diverse acute hospitals in the United Kingdom.

Participants Patients attending the emergency department with acute chest pain during the year before and the year after the intervention started.

Intervention Establishment of chest pain unit care compared with continuation of routine care.

Main outcome measures Proportion of chest pain attendances resulting in admission; reattendances and admissions over the next 30 days; daily emergency medical admissions (all causes); and proportion of emergency department attendances with chest pain.

Results The introduction of chest pain unit care was associated with weak evidence of an increase in emergency department attendances with chest pain (16% *v* 3.5%; P=0.08); no change in the proportion of chest pain attendances resulting in admission (odds ratio 0.998, 95% confidence interval 0.940 to 1.059; P=0.945); small increases in the proportion reattending (odds ratio 1.10, 1.00 to 1.21; P=0.036) or being admitted (1.30, 0.97 to 1.74; P=0.083) over the next 30 days; and evidence of increased daily medical admissions (1.7 per day, 95% confidence interval 0.8 to 2.5; P<0.001). However, this last finding was highly sensitive to changes in the method used to handle missing data.

Conclusion The introduction of chest pain unit care did not reduce the proportion of patients with chest pain admitted and may have been associated with increased emergency department attendances with chest pain.

Trial registration Current Controlled Trials ISRCTN55318418.

This is version 2 of the paper. The abstract of version 1 incorrectly stated that the introduction of chest pain unit care was associated with weak evidence of an increase in the proportion of [rather than an increase in] emergency department attendances with chest pain.

INTRODUCTION

Rising numbers of emergency medical admissions have caused concerns for more than a decade.[1] Acute chest pain is responsible for approximately 700 000 emergency department attendances a year in England and Wales and for around a quarter of all emergency medical admissions.[2] The NHS Institute for Innovation and Improvement has ranked chest pain as the number one clinical scenario by volume of admissions with potential for outpatient management and estimated that 30-60% of patients admitted with chest pain could be treated outside hospital.[3]

Chest pain units have been developed to reduce admissions and improve care by providing rapid and accurate diagnostic assessment for acute coronary syndrome with a short period of observation and testing of biochemical cardiac markers, followed by an exercise treadmill test.[4-6] A previous trial that randomised days of the week at a single hospital to chest pain unit care or routine care showed that chest pain unit care reduced admissions by 17% among selected low risk patients, with non-significant decreases in discharges with acute coronary syndrome (14% *v* 6%).[7]

We aimed to determine whether introducing a chest pain unit, or the elements of care provided by such a unit, at a variety of hospitals would reduce the proportion of emergency department attendances with chest pain resulting in admission, without increasing reattendances and admissions over the next 30 days.

METHODS

We planned to randomise 18 hospitals to either establish chest pain unit care or continue providing routine care and then to measure outcomes before and after the intervention to determine the effect of chest pain unit care compared with routine care, adjusting for baseline differences between the two groups of hospitals. Eligible hospitals had to be able to establish chest pain unit care, not currently provide the key elements of such care, and be willing to allow the intervention to be determined by random allocation.

Intervention

On recruitment, hospitals had to set a date on which they would establish chest pain unit care if randomised to do so. This date would also act as a notional intervention date at control hospitals for determining pre-

intervention and post-intervention time periods. An independent researcher randomised hospitals in pairs, as soon as two consecutive hospitals were recruited (one to establish chest pain unit care and one to continue routine care).

The hospital led the process of establishing chest pain units, supported by two members of the research team. The hospital met initial set-up costs, but the Department of Health provided £106 reimbursement of costs for each patient recorded as receiving the full chest pain unit protocol. The chest pain unit protocol was applied to selected patients with no definite evidence of acute coronary syndrome or alternative pathology. The protocol consisted of two to six hours of observation and biochemical testing (creatine kinase MB (mass) on arrival and at least two hours later and troponin at least six hours after worst pain) followed by an exercise treadmill test. We ideally expected the chest pain unit to be based in or adjacent to the emergency department, staffed by specialist chest pain nurses, using laboratory biochemical tests with a rapid turnaround time and providing immediate treadmill testing in the emergency department. However, to allow care to be set up in a variety of settings, we accepted that the chest pain unit could be based on an admissions ward, cross covered by non-specialist staff, could use point of care biochemical tests, and could allow discharge home between biochemical tests and a treadmill test on the next working day based in the cardiology department.

Hospitals allocated to continue with routine care were asked to not set up a chest pain unit or introduce any of the specific elements of this care, such as short stay observation with biochemical testing or rapid exercise treadmill testing. However, they were free to continue with development of normal services, such as interventions to improve thrombolysis times and staff development.

To avoid interfering with provision of health care we used routine data sources to measure outcomes. We retrospectively identified all adult patients recorded at reception as presenting with chest pain or a related complaint (such as angina or suspected heart attack) during the year before and the year after the intervention began and then identified repeat attendances by the same person in each year. For each attendance, we recorded whether it resulted in admission or discharge. The primary outcome was the proportion of attendances resulting in admission. For each patient, we recorded whether their first attendance was followed by reattendance at the emergency department within 30 days and whether reattendance resulted in admission. We also asked each hospital to provide details of the daily number of emergency medical admissions over the study period.

Analysis

We used a random effects multilevel model to estimate the effect of chest pain unit care, compared with routine care, on each outcome in the post-intervention year, adjusting for pre-intervention differences between the two groups of hospitals. We included the hospital attended as a random effect and age, sex, hospital allocation (chest pain unit or control), and time (before or after intervention) as covariates. We made the decision to use age and sex as covariates a priori. We did the analysis on an intention to treat basis, coding attendances or patients according to the initial allocation of the hospital, regardless of whether patients actually received chest pain unit care. We used a nested analysis of variance in the logits of the proportions to test the hypothesis that the change in the proportion of

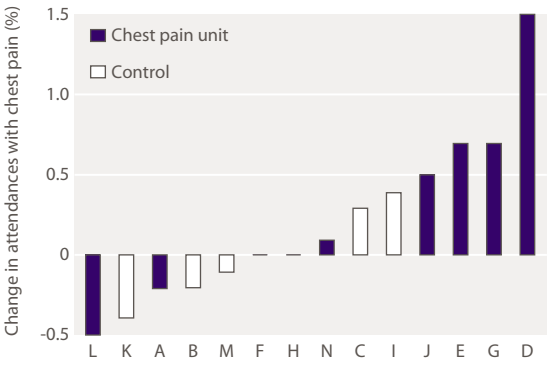
Table 1 | Characteristics of recruited hospitals

Hospital and allocation	Annual emergency department attendances (adults)	Teaching hospital?	Location
Chest pain unit:			
A	41 734	No	Industrial town
D	77 121	Yes	Urban
E	73 862	No	Urban
G	37 189	No	County town
J	54 449	No	Industrial town
L	20 884	No	Rural
N	43 875	No	County town
Control:			
B	42 102	No	Industrial town
C	53 516	No	Industrial town
F	94 470	Yes	Urban
H	55 786	Yes	Urban
I	38 898	No	Industrial town
K	23 550	No	Industrial town
M	113 878	Yes	Urban

Table 2 | Proportion of adults attending emergency department with chest pain

Hospital and allocation	% with chest pain (No with chest pain/all attendances)	
	Pre-intervention	Post-intervention
Chest pain unit:		
A	5.8 (2409/41 734)	5.5 (2410/43 897)
D	6.2 (4815/77 121)	7.7 (6423/83 402)
E	7.0 (5134/73 862)	7.7 (5803/75 588)
G	5.1 (1907/37 189)	5.8 (2312/39 708)
J	4.6 (2511/54 449)	5.1 (2992/58 101)
L	7.1 (1492/20 884)	6.6 (1460/22 196)
N	5.7 (2516/43 875)	5.8 (2701/46 471)
Control:		
B*	5.5 (1643/29 873)	5.3 (2005/37 830)
C	4.2 (2237/53 516)	4.5 (2334/52 224)
F	4.9 (4638/94 470)	4.9 (4644/94 985)
H	9.1 (5095/55 786)	9.1 (5368/59 232)
I	4.9 (1918/38 898)	5.3 (2209/41 769)
K	6.8 (1596/23 550)	6.4 (1386/21 692)
M	5.0 (5731/113 878)	4.9 (5720/117 265)

*Data available for only 10 months of each year.



Change from before to after intervention at each hospital in proportion of emergency department attendances presenting with chest pain. Absolute change reported: positive value indicates increase; negative value indicates decrease

emergency department attendances with chest pain differed between chest pain unit and control hospitals.

We anticipated that each hospital would see approximately 4200 attendances a year with chest pain or a related complaint. Using standard sample size calculations, we estimated that 890 attendances in each hospital before the intervention and 890 after the intervention would provide 80% power to detect an absolute difference of 5% in the proportion resulting in admission (α=0.05). We therefore allowed for potential clustering in the primary outcome with a design effect of up to four.

RESULTS

Of the 82 hospitals that expressed an interest in participating in the trial, 11 decided to set up a chest pain unit outside the trial, 17 decided that they would not be able to set up a unit if randomised to do so, two raised concerns about research aspects of the trial, and 36 gave either other reasons or no specific reason for declining to participate. We therefore recruited 14 hospitals between October 2004 and June 2005. Table 1 outlines the characteristics of these hospitals. Control hospitals tended to be slightly larger and more urban. All seven hospitals randomised to the intervention group successfully set up a chest pain unit that remained operational for the whole year of the trial. The characteristics of these units have been detailed in a previous paper.[8] The units varied in location, staffing, opening hours (from 9 am to 5 pm weekdays only to 24 hours a day seven days a week), and patient throughput. All hospitals provided complete data, except that hospital F was able to provide emergency medical admissions data for only 75 days before and after the intervention and hospital I could not break down admissions by route.

Overall, 37 319 patients made 43 642 attendances with chest pain in the pre-intervention year, and 40 951 patients made 47 767 attendances in the post-intervention year. Mean age was 54.2 (range 16-105) years; 41 656 (53.2%) patients were male, 32 520 (41.5%) patients were female, and sex was not recorded for 4094 (5.3%) patients. Patients attending intervention hospitals were slightly older (55.5 years *v* 52.8 for control), but similar proportions were male (55.8% *v* 56.5%). Table 2 shows the number of chest pain related emergency department attendances at each hospital. Chest pain related attendances increased by 3.5% at control hospitals (from 22 858 to 23 666) and by 16.0% at intervention hospitals (from 20 784 to 24 101), compared with increases in all adult attendances of 2.4% at control hospitals (from 422 200 to 432 319) and 5.8% at intervention hospitals (from 349 113 to 369 363).

The figure shows the change in the percentage of total emergency department attendances presenting with chest pain for each hospital. We found some weak evidence (P=0.08) that the proportion of attendances with chest pain had increased more at

Table 3 | Outcome of chest pain attendances at each hospital. Values are numbers (percentages)

	Pre-intervention			Post-intervention		
Hospital and allocation	Admitted	Discharged	Unknown	Admitted	Discharged	Unknown
Chest pain unit:						
A	1494 (62)	903 (37)	12 (1)	1455 (60)	936 (39)	19 (1)
D	3075 (64)	1740 (36)	0	4029 (63)	2394 (37)	0
E	3115 (61)	1800 (35)	219 (4)	3291 (57)	2206 (38)	306 (5)
G	1290 (68)	601 (31)	16 (1)	1507 (65)	791 (34)	14 (1)
J	1677 (67)	782 (31)	52 (2)	2165 (72)	808 (27)	19 (1)
L	1243 (83)	248 (17)	3 (<1)	1116 (76)	343 (24)	1 (<1)
N	1407 (56)	983 (39)	126 (5)	1636 (61)	915 (34)	150 (6)
Control:						
B	906 (55)	664 (40)	73 (4)	1080 (54)	923 (46)	2 (<1)
C	1058 (47)	1171 (52)	8 (<1)	1194 (51)	1135 (49)	5 (<1)
F	2543 (55)	2036 (44)	59 (1)	2685 (58)	1937 (42)	22 (<1)
H	2537 (50)	2223 (44)	335 (7)	2791 (52)	2241 (42)	336 (6)
I	1489 (78)	423 (22)	6 (<1)	1557 (71)	648 (29)	4 (<1)
K	1106 (69)	490 (31)	0	990 (71)	396 (29)	0
M	2025 (35)	3687 (64)	19 (<1)	1958 (34)	3751 (66)	11 (<1)

Table 4 | Reattendances and admissions over 30 days after initial attendance

Hospital and allocation	Pre-intervention			Post-intervention		
	Total patients	Reattendances (% of total)	Admissions (% of total)	Total patients	Reattendances (% of total)	Admissions (% of total)
Chest pain unit:						
A	2026	205 (10.1)	105 (5.2)	2025	215 (10.6)	126 (6.2)
D	4097	468 (11.4)	277 (6.8)	5457	629 (11.5)	369 (6.8)
E	4365	499 (11.4)	283 (6.5)	5004	528 (10.6)	307 (6.1)
G	1656	135 (8.2)	72 (4.3)	1932	186 (9.6)	101 (5.2)
J	2216	218 (9.8)	133 (6.0)	2532	255 (10.1)	177 (7.0)
L	1206	103 (8.5)	79 (6.6)	1199	115 (9.6)	77 (6.4)
N	2223	158 (7.1)	66 (3.0)	2397	204 (8.5)	115 (4.8)
Control:						
B	1421	133 (9.4)	60 (4.2)	1738	161 (9.3)	68 (3.9)
C	1889	215 (11.4)	88 (4.7)	2032	187 (9.2)	73 (3.6)
F	3872	426 (11.0)	219 (5.7)	3944	364 (9.2)	193 (4.9)
H	4335	420 (9.7)	202 (4.7)	4577	420 (9.2)	199 (4.3)
I	1711	157 (9.2)	103 (6.0)	1968	183 (9.3)	108 (5.5)
K	1394	117 (8.4)	84 (6.0)	1222	105 (8.6)	68 (5.6)
M	4908	621 (12.7)	194 (4.0)	4924	652 (13.2)	201 (4.1)

intervention hospitals than at control hospitals. However, this was not a consistent finding across all intervention hospitals.

Table 3 shows the proportion of chest pain attendances admitted at each participating hospital. Overall, this proportion increased at control hospitals from 52.2% (11 664/22 358) to 52.6% (12 255/23 278) but decreased at intervention hospitals from 65.4% (13 304/20 356) to 64.4% (15 199/23 592). Although chest pain unit care seemed to be associated with a small decrease in the odds of admission (unadjusted odds ratio 0.942, 95% confidence interval 0.892 to 0.994; P=0.029), the inclusion of age and sex in the analysis (as planned a priori) produced a non-significant result (adjusted odds ratio 0.998, 0.940 to 1.059; P=0.945).

Table 4 shows the proportion of patients reattending and the proportion admitted over the 30 days after initial attendance. Chest pain unit care was associated with some evidence of small increases in reattendance (unadjusted odds ratio 1.10, 1.00 to 1.21; P=0.044) and admission at reattendance (1.28, 0.95 to 1.72; P=0.101). Inclusion of age and sex as covariates did not alter these findings (adjusted odds ratio 1.10, 1.00 to 1.21; P=0.036 for reattendance and 1.30, 0.97 to 1.74; P=0.083 for admission).

Mean daily emergency medical admissions (all), those through the emergency department, and those through other routes were 36.1, 21.5, and 14.6 in the pre-intervention year and 37.8, 23.7, and 14.1 in the post-intervention year. At control hospitals, these values were 29.6, 20.6, and 10.5 in the pre-intervention year and 29.7, 21.8, and 9.4 in the post-intervention year. The sum of emergency department and other values does not equal the total value for the control hospitals because hospital I could not identify the route of admission. Table 5 shows these data for the individual hospitals. Availability of a chest pain unit was associated with a mean increase in all admissions of 1.7 (95% confidence interval 0.8 to 2.5; P<0.001) a day, in emergency department admissions of 1.0 (0.4 to 1.5; P=0.001) a day, and admissions through other routes of 0.6 (−0.1 to 1.3; P=0.078) a day.

However, these findings are sensitive to changes in the way missing data from hospital F are handled. Exclusion of all data from hospital F changed the estimated effect of chest pain unit care on all admissions and those through the emergency department to increases of 2.0 (1.3 to 2.8) and 1.4 (0.9 to 1.9) admissions a day, whereas weighting data from hospital F so that they carry equal weight to other hospitals changed these estimates to an increase of 0.4 (−0.5 to 1.2) for all

Table 5 | Mean number of daily emergency medical admissions at each hospital

Hospital and allocation	Pre-intervention			Post-intervention		
	Total	Through emergency department	Through other routes	Total	Through emergency department	Through other routes
Chest pain unit:						
A	38.5	22.2	16.2	39.5	23.9	15.6
D	44.9	41.4	3.5	55.1	52.1	3.1
E	45.4	34.0	11.4	42.4	30.5	11.8
G	48.4	11.8	36.6	54.3	17.1	37.2
J	24.1	18.3	5.8	24.9	18.9	6.0
L	19.7	9.3	10.4	16.1	7.7	8.4
N	31.6	13.7	17.9	32.6	15.5	17.1
Control:						
B	30.8	11.8	19.0	31.7	13.1	18.6
C	22.4	17.1	5.3	22.4	17.7	4.7
F	85.3	57.0	28.3	96.8	69.0	27.8
H	35.4	29.1	6.3	37.3	32.1	5.3
I*	21.8	–	–	21.5	–	–
K	17.5	6.3	11.1	16.5	6.9	9.6
M	38.2	31.2	7.0	34.6	29.4	5.1

*Admissions not broken down by route.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Emergency medical admissions are progressively rising, and approximately one in four admissions are due to chest pain

Low risk patients with undifferentiated chest pain are less likely to be admitted if they are managed on a chest pain unit

Establishing chest pain units throughout the NHS might therefore substantially reduce emergency admissions

WHAT THIS STUDY ADDS

Implementation of chest pain unit care does not reduce the proportion of patients with chest pain admitted and may be associated with increased emergency department attendances with chest pain

Chest pain unit care may lead to an overall increase in emergency medical admissions

admissions and a decrease of 0.5 (−0.1 to 1.1) a day for emergency department admissions. The estimated effect of chest pain unit care on admissions through other routes was unaffected.

DISCUSSION

Our multicentre study is the first to compare the effect of implementing chest pain units with that of continuing routine practice at a "whole system" level across a variety of hospitals. It provides the most reliable estimate of the effect of widespread implementation of chest pain units on hospital admissions. Implementation of chest pain unit care across diverse hospitals did not reduce the proportion of attendances with chest pain admitted to hospital. Furthermore, it may have been associated with increased emergency department attendances with chest pain and overall emergency hospital admissions.

This conflicts with previous studies showing that chest pain unit care was associated with decreased admissions with chest pain.[7 9-11] However, these studies either compared chest pain unit care with historical practice without a concurrent control group or evaluated the effect of chest pain unit care on the selected low risk patients who are most likely to benefit.[7 9-11] The first approach carries the risk of bias from differential patient selection or confounding by concurrent changes in practice, whereas the latter may reliably show benefit in selected groups but miss knock-on effects on the wider population.

New services aimed at reducing the need for hospital care may increase demand for services and thus not reduce overall admissions,[12] although there are few robust data showing this phenomenon. One recent example evaluated case management of elderly people by using a controlled, before and after design and measured emergency admission rates at practice level.[13] This showed that case management introduced an additional range of services into primary care without an associated reduction in hospital admissions and concluded that this may have been because of identification of additional cases.

Although service level evaluation provides the best way of estimating effects on the whole service, it has several limitations that could lead to an erroneous conclusion that chest pain unit care is ineffective. We were unable to institute detailed follow-up to identify whether chest pain unit care led to more appropriate admission of patients with acute coronary syndrome or whether patients benefited from admission. We cannot therefore draw conclusions about the value of a potential increase in admissions. Most patients with chest pain do not receive chest pain unit care, so beneficial effects may be "diluted" in the study population. The structure, processes, and activity of the chest pain units,[8] and outcomes at individual hospitals, varied substantially, so drawing conclusions about a general effect of chest pain units may be inappropriate.

Conclusions

The limitations outlined above mean that we cannot exclude the possibility that individual chest pain units had beneficial effects in selected groups of patients. However, we can reasonably conclude that setting up chest pain unit care throughout the National Health Service would not reduce, and could paradoxically increase, emergency medical admissions.

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

Contributors: SG, JN, and SC conceived and designed the study; EC and CL collected the data; SG and JN analysed the data. All authors contributed to writing the article and approved the final draft. SG is guarantor.

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Funding: The ESCAPE trial was funded by the NHS Service Delivery and Organisation R&D programme. The funders played no role in developing the study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.
Competing interests: None declared.
Ethical approval: Thames Valley research ethics committee.
Provenance and peer review: Not commissioned; externally peer reviewed.

The chest pain unit protocol and data collection form are available as extras on bmj.com.

1 Capewell S. The continuing rise in emergency admissions: explanations and responses must be properly evaluated. *BMJ* 1996;312:991-2.
2 Goodacre S, Cross E, Arnold J, Angelini K, Capewell S, Nicholl J. The health care burden of acute chest pain. *Heart* 2005;91:229-30.
3 NHS Institute for Innovation and Improvement. *Directory of emergency ambulatory care for adults*. Coventry: NHS Institute for Innovation and Improvement, 2007.
4 Roberts RR, Zalenski RJ, Mensah EK, Rydman RJ, Ciavarella G, Gussow L, 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.
5 Farkouh ME, Smars PA, Reeder GS, Zinsmeister AR, Evans RW, Meloy TD, et al. A clinical trial of a chest pain observation unit for patients with unstable angina. *N Engl J Med* 1998;339:1882-8.
6 Gomez MA, Anderson JL, Karagounis LA, Muhlestein JB, Mooers FB. 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.
7 Goodacre S, Nicholl J, Dixon S, Cross E, Angelini K, Arnold J, et al. Randomised controlled trial and economic evaluation of a chest pain observation unit compared with routine care. *BMJ* 2004;328:254-7.
8 Arnold J, Goodacre S, Morris F, on behalf of the ESCAPE Research Team. The structure, processes and outcomes of chest pain units established in the ESCAPE trial. *Emerg Med J* 2007;24:462-6.
9 Graff LG, Dallara J, Ross MA, Joseph AJ, Itzcovitz J, Andelman RP, 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.
10 Shah SS, Noor H, Tokarski G, McCord J, Khoury N, McCabe KB, et al. Clinical effectiveness evaluation of an emergency department cardiac decision unit. *Br J Clin Governance* 2001;6:40-5.
11 Abbott BG, Abdel-Aziz I, Nagula S, Monico EP, Schriver JA, Wackers FJ. Selective use of single-photon emission computer tomography perfusion imaging in a chest pain center. *Am J Cardiol* 2001;87:1351-5.
12 Henscher M, Fulop N, Coast J, Jefferys E. Better out than in? Alternatives to acute hospital care. *BMJ* 1999;319:1127-30.
13 Gravelle H, Dusheiko M, Sheaff R, Sargent P, Boaden R, Pickard S, et al. Impact of case management (Evercare) on frail elderly patients: controlled before and after analysis of quantitative outcome data. *BMJ* 2007;334:31-4.

Accepted: 30 July 2007