MEDICAL PRACTICE

Contemporary Themes

Importance of patient selection in evaluating a cardiac ambulance service

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All patients brought to hospital by a special cardiac ambulance were followed up and compared with patients carried by routine ambulances to assess the effectiveness of a cardiac ambulance service. The overall mortality of patients with heart attacks was 51% among those carried by an ordinary ambulance and 40% among those carried by the cardiac ambulance. The apparently low mortality in the latter group was balanced, however, by a high mortality (68%) among patients carried by ordinary ambulances when the cardiac ambulance was available but not used; these patients tended to have a short duration of symptoms and heart attacks away from home, and their ambulance was more often called by a member of the public than by a general practitioner. It seems therefore that low-risk cases were inadvertently selected for transport by the cardiac ambulance; such unintentional selection makes it difficult to evaluate a cardiac ambulance service.

Introduction

The results of any new form of treatment depend partly on the treatment and partly on the type of patient selected for treatment. Thus the effectiveness of a special ambulance for transporting patients suspected of having heart attacks will depend

partly on the performance of its crew and partly on the type of patient carried. Several "cardiac" ambulance services have been described,¹⁻⁵ and, clearly, such services can be very efficient and some lives can be saved. What is less clear, however, is whether these special services handle the full spectrum of patients with heart attacks. Little information is available on the patients carried by routine ambulance services in towns where a cardiac ambulance service has been established, and unless it can be shown that low-risk cases are not selected for the cardiac ambulance claims of reduced mortality are invalid.

In Nottingham a cardiac ambulance manned by trained ambulance crews was set up experimentally in 1973, and all patients with heart attacks brought to Nottingham hospitals by this vehicle and by routine vehicles were followed up to find out whether mortality was reduced in patients carried by the special ambulance and whether there was any evidence of selection in the type of patient carried by the cardiac ambulance.

Methods

Crew selection and training—Two ambulance training officers worked for one month with the nursing staff of the coronary care unit at Nottingham General Hospital and had daily tutorials on all aspects of the care of patients with heart attacks, particularly the recognition of arrhythmias. These training officers then became responsible for about three-quarters of the training of the crews who manned the cardiac vehicle. The ambulance crews received training for two hours a week for 12 weeks and then were assessed with a test of recognition of arrhythmias, an oral examination, and a practical test in resuscitation. The successful crews continued their training throughout the year of the study.

Selection of patients to be transported by cardiac ambulance—General practitioners within the area were informed about the cardiac ambulance and told that they should specifically ask for it whenever they wanted to admit a patient to hospital whom they suspected of having a heart attack. Although priority was given to calls for the ambulance from general practitioners, the special vehicle was also sent in response to calls from the public when there was a reasonable chance

that the patient had had a heart attack.⁶ A routine vehicle was sent in response to an emergency (999) call from the public if it was much nearer the patient than the cardiac vehicle.

Evaluating the cardiac ambulance—Manning the cardiac ambulance continuously would have meant an unacceptable reduction in the routine service as the city ambulance department was below its establishment at the time of the study. We therefore manned the cardiac ambulance only on some shifts and those patients who were transported by the routine ambulance when the cardiac ambulance was not available formed a "control" group. Different shifts throughout the 24-hour period were manned each week, and general practitioners were not informed of the times that the special service was available. Patients with heart attacks brought in by the county ambulance service, for whom no special vehicle or crew training had been provided, were also studied. This service covers a large population in suburban Nottingham and also the surrounding country, which has a lower population density.

Heart attacks—Follow-up of all patients who might have had a heart attack was performed daily by a medical secretary, and the completed record forms, together with copies of all electrocardiograms (ECGs) and the discharge summaries, were reviewed. The patients were either excluded from the study because some alternative diagnosis had been established or were classified as having had one of the following categories of heart attack: (a) definite myocardial infarction: the patient had a typical history, unequivocal ECG changes, and raised serum enzymes (usually hydroxybutyric dehydrogenase); (b) probable infarction: the patient had a typical history and either characteristic ECG or enzyme changes; (c) possible infarction: the patients had a convincing story, with an ECG that was abnormal but did not fulfil the criteria for recent infarction and marginal enzyme changes; (d) ischaemic heart disease: the patient had a clear story of a previous infarction or angina with an abnormal ECG but no evidence of recent infarction; (e) chest pain: the patient was admitted because of chest pain, for which no adequate diagnosis was made; (f) heart disease at necropsy: the patient was dead on arrival and had had either a recent myocardial infarction, an old infarction with coronary artery disease and no other cause of death, or coronary artery disease alone and no other cause of death.

Results

During the study 881 patients with heart attacks were brought to the Nottingham Hospitals. Of the 373 patients not brought by Nottingham city ambulances (see table I) 325 were brought by county ambulances, 23 by other ambulances, and 25 by private car. During the year the cardiac ambulance was despatched in response to 502 calls, of which 112 (22%) concerned patients with heart attacks. Among the remainder, 31 were for patients with heart failure and seven for patients with arrhythmias due to causes other than a heart attack. Altogether 72 patients were carried by an ordinary city ambulance even though the cardiac vehicle was available because either the cardiac vehicle was already busy or the ambulance controller could not obtain the necessary evidence from the caller to make him send out the special vehicle.

MORTALITY

The overall mortality (patients dead on arrival in hospital plus patients dying in hospital; table I) was 40% in patients carried by the cardiac ambulance compared with 51% in those carried by ordinary ambulance when the cardiac vehicle was not available ($P < 0.05$). This difference seems to indicate that patients transported by the special vehicle fared better than those brought in by the routine

ambulance. But the mortality among patients brought to hospital by ordinary ambulance when the cardiac vehicle was available but not used was 68%, and many of these patients were dead on arrival at hospital. Thus the combined mortality rate for all patients brought to hospital in the shifts when the cardiac vehicle was available (whether or not it was used) was 51%—a rate identical to that in patients brought in by the routine service when the cardiac vehicle was not available.

Since ordinary ambulances were manned by the same people and had the same equipment whether the cardiac service was available or not it seems most unlikely that the crews' performances were significantly worse when the cardiac vehicle was available, as appears from these figures. The only logical explanation of these results is that when the cardiac vehicle was available there was an unintentional partition of patients, those with a relatively low-risk being carried by the cardiac ambulance and those with a relatively high-risk being carried by the routine service. The data were therefore examined to see what differences there were between the groups of patients.

ANALYSIS OF PATIENTS CARRIED BY CITY AMBULANCES

Clinical data—The groups of patients brought in by the different types of ambulance (cardiac, routine when cardiac ambulance was available, and routine when cardiac ambulance was not available) were similar in mean age (61.8, 60.3, and 64.4 years respectively); the proportion of men; the numbers of patients with breathlessness, a cold periphery, raised jugular venous pressure, basal lung crepitations, heart rate greater than 100 beats/min, and a systolic blood pressure of under 100 mm Hg; mean peak serum enzyme levels; and the proportion with anterior or inferior infarctions on ECG. Among the patients who were alive on arrival the same proportions in each group were eventually diagnosed as having definite or probable myocardial infarction (78–81%), possible infarction or ischaemic heart disease (13–19%), and chest pain of unknown cause (0–9%).

Onset of symptoms—Table II shows the intervals from the onset of symptoms to the call for the ambulance. The time taken for the ambulance to reach the patient was similar in all groups—about 45% of patients were reached within five minutes and 90% within 10 minutes of the call. Thirty-five per cent of the patients carried by routine ambulance when the cardiac ambulance was available had their attacks away from home compared with only 19% carried by

TABLE II—Duration of symptoms in patients brought to hospital by routine and cardiac ambulances. Results are percentages

Duration of symptoms (min):		<30	30–90	–150	>150	Unknown
Routine ambulance sent		29	17	6	34	44
Cardiac vehicle available:						
Cardiac ambulance sent		30	18	9	38	5
Routine ambulance sent		37	15	8	28	12

TABLE III—Relation between place where attack occurred and duration of symptoms before ambulance was called (all patients). Results are percentages

Duration of symptoms (min):		<30	30–90	>90	Unknown
% with attack at home		19	17	53	11
% with attack away from home		59	15	21	5

routine ambulance when it was the only vehicle available and only 17% carried by cardiac ambulance ($P < 0.01$). When the attack occurred away from home the duration of symptoms before the ambulance was called tended to be shorter than when the attack occurred at home (table III). Patients brought in by ordinary ambulance when the cardiac vehicle was available were significantly ($P < 0.05$) less likely to have called for help from a general practitioner in the first instance (only 18% had done so compared with 41% when patients were carried by cardiac ambulance and 32% when they were carried by a routine ambulance when only it was available), and as might be expected there was a correlation between the attack occurring away from home and a direct call for an emergency ambulance. In 56% of cases when a relative or bystander had called an ambulance symptoms had persisted for less than 30 minutes, but only 5% of the patients who first called their general practitioner had had symptoms for less than 30 minutes before an ambulance was called.

TABLE I—Outcome in patients carried to hospital by routine and cardiac ambulances

	No of patients carried	No (%) dead on arrival	No of patients admitted	No (%) of deaths in hospital	No of patients discharged	Overall mortality (%)
Routine ambulance sent	324	137 (42)	187	29 (16)	158	51
Cardiac vehicle available:						
Cardiac ambulance sent	112	24 (21)	88	21 (24)	67	40
Routine ambulance sent	72	45 (63)	27	4 (15)	23	68

Deaths—The higher mortality rate among patients carried by the routine service when the cardiac vehicle was available was due entirely to the high proportion of patients who were dead on arrival in hospital, and clearly it is extremely important to know exactly when each patient died. Ambulance staff cannot pronounce a patient dead, however, and there was therefore no accurate record of the time of death. Ambulance crews do, however, record any attempted resuscitation, and it is reasonable to assume that an experienced crew will attempt resuscitation only when they consider that death has occurred recently.

Resuscitation—Among patients dead on arrival at hospital resuscitation attempts had been made in 10 (42%) of the 24 patients carried by cardiac ambulance, 28 (20%) of the 137 brought by ordinary ambulance when it was the only vehicle available, and seven (16%) of the 45 carried by ordinary ambulance when the cardiac ambulance was available. In addition, seven patients with ventricular fibrillation and three with asystole carried by cardiac ambulance reached hospital alive, and four survived. The crews of ordinary ambulances diagnosed cardiac arrest and applied external cardiac massage and assisted ventilation in two cases; on arrival at hospital the patients were found to be in ventricular fibrillation and were successfully resuscitated; both survived. The higher rate of attempted resuscitation by cardiac ambulance crews may indicate that they more often carried patients who had cardiac arrest just before the ambulance arrived or in transit or it may merely reflect their increased enthusiasm because of their extra training and equipment. The six patients who were initially resuscitated by cardiac ambulancemen but who died in hospital largely accounted for the higher hospital mortality rate among patients brought in by cardiac ambulance.

PATIENTS CARRIED BY COUNTY AMBULANCES

To assess more accurately the influence that different types of patients might have had on the overall effectiveness of the cardiac ambulance service we studied the types of patients brought in by county ambulances. In the areas covered by the county service the population is more scattered, many people commute to the city, and attitudes to general practitioners and the emergency services may be different from those in the city.

The overall mortality among this group was the lowest of all (37% of the 325 patients carried; 82 (25%) were dead on arrival in hospital, and 15% of those alive on arrival in hospital did not survive). This low mortality rate was unlikely to be due to ambulance crew performance, for none of the crews had been specially trained and no special vehicles were available; more probably patient selection accounted for the difference. The county patients were similar to those living in the city in age, sex, number of previous infarctions, and in the clinical, biochemical, and ECG state of those who arrived at hospital alive. But symptoms had tended to last longer in patients from the county than in those from the city (only 24% had histories shorter than 30 minutes), the attack was more likely to have occurred at home (88%), and a general practitioner was more likely to have called the ambulance (61%).

Discussion

When any new form of treatment is introduced it is self-evident that patients who are still treated in the traditional manner should not fare worse than they did before the new treatment appeared. The studies of anticoagulants in patients with acute myocardial infarction and the subsequent controversy about the value of this treatment provides a warning of the danger of forgetting this crucial point.⁷

The apparent reduction in mortality among patients carried by a cardiac ambulance was balanced by an increased mortality among patients carried by the routine vehicles when the special vehicle was available but not used. The only logical explanation is that there must have been inadvertent selection of low-risk patients for the cardiac vehicle, and undoubtedly there were differences between the patients carried by this vehicle and those carried by ordinary vehicles when the cardiac ambulance was available but not used. The group with the highest mortality included more patients with short histories, more whose attack occurred away from home, and more whose ambulance had been called by a member of the public rather than a general

practitioner. The importance of patient selection as opposed to ambulance crew performance is confirmed by results from the county ambulance service, whose patients had usually had a long duration of symptoms before the ambulance was called, had their attack at home, and called their general practitioners; this group showed the lowest overall mortality.

The ambulance controller sent the cardiac vehicle in response to a call from either a general practitioner or member of the public if he believed that the patient might have had a heart attack.⁶ The controllers were, however, instructed always to send the nearest available ambulance in response to a 999 call, and for this reason the cardiac vehicle was sometimes not used when it otherwise might have been; sometimes the controller could not despatch the special vehicle because it was already being used. The main problem, however, seems to have been that of identifying patients with heart attacks from calls made by members of the public; it was not practicable to send the cardiac vehicle to all patients who were said to have "collapsed," for the commonest cause of "collapse" is being drunk and incapable.⁶

This study suggests that, while it may save some lives, a single cardiac ambulance is unlikely significantly to reduce the mortality from heart attacks. Clearly the type of patient carried influences the results more than the type of vehicle or crew used; any claims that a special ambulance service reduces mortality can be considered valid only if the experience of the routine service in that area can also be taken into account.

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A widely used dietary fibre supplement is reported to contain 1.7 g of phytic acid per 100 g. Should people eating bran supplement have additional calcium in their diet?

Although possible, reduced calcium absorption has not been shown as a result of eating bran. Eating 900 g of wholemeal bread a day for 11 days did induce a negative calcium balance in six volunteers.¹ This is equivalent, however, to 150-200 g bran/day, whereas the usual therapeutic "dose" of bran is 20-40 g/day. Moreover, short-term experiments may be misleading because in the long term man seems well able to adapt to low intakes of calcium. Plasma calcium concentrations were unaffected when 19 young men changed for five months from white to wholemeal bread, eating about 200 g/day.² Epidemiologically, metabolic bone disease is less, not more, common in populations with lower calcium intakes.³ An authoritative review³ of calcium requirements concluded "there is no firm evidence that calcium deficiency exists in humans." On present evidence, therefore, the answer to this question is no; but there is a need for more research on the metabolic effects of bran and of fibre in general.

¹ McCance, R A, and Walsham, C M, *British Journal of Nutrition*, 1948, 2, 26.

² Heaton, K W, Manning, A P, and Hartog, M, *British Journal of Nutrition*, 1976, 35, 55.

³ Walker, A R P, *American Journal of Clinical Nutrition*, 1972, 25, 518.