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*For Debate . . .*

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**The coronary care controversy**

J M RAWLES, A C F KENMURE

Five years ago a joint working party of the Royal College of Physicians of London and the British Cardiac Society recommended that the Department of Health and Social Security and the Scottish Home and Health Department should encourage the development of mobile coronary care, preferably manned by doctors or, if this was not practicable, by trained ambulancemen or other paramedical staff.<sup>1</sup> No action has resulted from these recommendations. Indeed, the prevailing medical opinion is that hospital care for myocardial infarction offers no advantage over home care and that mobile coronary care is ineffective in reducing mortality from myocardial infarction.

The Department of Health and Social Security sponsored some studies in Nottingham on home versus hospital treatment for myocardial infarction and on mobile coronary care which have been influential in forming this medical opinion. We re-examine the findings in these and other studies and the arguments for and against coronary care.

**The problem**

Ischaemic heart disease is the commonest single cause of death. Each year in the United Kingdom some 150 000 people, 55 000 of them aged under 70 years, die from coronary heart disease. About two-thirds of these deaths take place outside hospital and most are sudden, occurring within one hour of the onset of symptoms. Any treatment applied late in the course of a coronary attack is therefore unlikely to alter the mortality substantially, the only hope being early coronary care.

**Early coronary care in Belfast**

Since 1966 a mobile coronary care unit has operated from the Royal Victoria Hospital in Belfast.<sup>2</sup> The ambulance is driven by an ambulanceman and staffed by a doctor and a nurse from the coronary care unit. The median time from the onset of symptoms to the arrival of the mobile coronary care unit is 1 hour 40 minutes.

During its first 39 months the mobile unit admitted 794 patients with acute myocardial infarction, 126 of whom had had a cardiac arrest,<sup>3</sup> and 27 (3.4%) of these survived to leave hospital. When ventricular fibrillation complicated myocardial infarction within four hours of the onset of the symptoms and the patient survived to leave hospital the three-year survival rate was 80%.<sup>4</sup> In the first five years of operation there were 3861 calls and 42% of the patients carried had myocardial infarction. The prehospital mortality was 8%.

The rapid mobilisation of the Belfast unit has resulted in an experience of myocardial infarction seen within one hour of the onset of symptoms which is unsurpassed in the UK.<sup>5</sup> In a prospective study 294 such patients were seen and ventricular fibrillation occurred in 55 of them. In 23 cases cardiac arrest occurred before the mobile team arrived so the arrhythmia could not have been induced by anxiety associated with its attendance or travel to hospital. Since the mobile unit has all the equipment and drugs it needs to institute effective coronary care wherever the patient has his attack he is not moved to hospital until his pain is relieved and his rhythm and blood pressure are stable. Deaths in transit are virtually unknown.

An unexpected finding in Belfast was that if coronary care was started within three hours of the onset of symptoms the subsequent hospital death rate was 10%, whereas if it was started after three hours the hospital death rate was 19%.<sup>6</sup> A similar reduction of hospital mortality was shown in the East Belfast Hospital, where at every level of the coronary prognostic index the hospital mortality was lower in patients admitted by the mobile coronary care ambulance than in those admitted conventionally.<sup>7</sup> An overall mortality of 10% in Belfast when coronary care was started within one hour of onset compares with a mortality of 26% in a study from south-west England of 117 patients aged under 70 with myocardial infarction who were seen within one hour by general practitioners.<sup>8</sup> The difference in mortality was even more striking when the systolic blood pressure was less than 100 mm Hg: in Belfast it was 16%; in the south-west it was 49%.<sup>5</sup>

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University of Aberdeen, Department of Medicine, Foresterhill, Aberdeen AB9 2ZD

J M RAWLES, BSC, MRCP, senior lecturer in medicine

Aberdeen Royal Infirmary, Foresterhill, Aberdeen AB9 2ZD

A C F KENMURE, MD, FRCP, consultant cardiologist

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Early coronary care as practised in Belfast leads to the resuscitation of patients who would otherwise have died from ventricular fibrillation and also reduces the hospital mortality by reducing the incidence of cardiogenic shock and pump failure. These observations have not been confirmed by controlled clinical trials—indeed such a trial would be impossible or unethical—but the results are consistent with what is known about myocardial infarction. Early relief of pain, correction of autonomic disturbances, and restoration of blood pressure, could limit the size of infarction and reduce the late mortality from pump failure and cardiogenic shock.

## Home versus hospital treatment

### SOUTH-WEST STUDY

Set against this achievement of immediate coronary care in Belfast is a study from Bristol comparing home and hospital care for patients with myocardial infarction.<sup>9</sup> Only men under 70 who had suffered an infarction within the previous 48 hours took part: "Women were excluded because home care for most would be difficult for social reasons." Altogether 1895 men with definite or probable myocardial infarction were studied but 1445 patients were excluded, most of them being admitted to hospital. Only 24% of the patients admitted to the study were randomly allocated between home and hospital treatment. In all, 80% of patients with definite or probable myocardial infarction were treated in hospital and only 20% at home. The interval between the onset of the attack and the time of first medical examination, when the decision on randomisation was usually made, was known for only 64% of the randomised patients, and only 47% of these patients were seen within three hours. The mortality at 28 days was 12% for the random home group and 14% for the random hospital group.

This study shows that in a minority of patients seen several hours after the onset of myocardial infarction there is no particular advantage in hospital admission. For women and the majority of men there are medical or social reasons for hospital admission, so home treatment is not a genuine alternative.

### TEESSIDE CORONARY SURVEY

The results from the Teesside coronary survey<sup>10</sup> have also been used to support home treatment for the patient with acute myocardial infarction. In this community survey nearly 2000 definite or probable cases of myocardial infarction were identified; 42.8% of patients died before seeing a doctor. Of the remainder, roughly one-third were treated at home, one-third were admitted to a general medical ward, and one-third were admitted to a coronary care unit.

The fatality rate at 28 days was 50.5%, and 70% of the deaths occurred within three hours, highlighting the importance of immediate coronary care. The crude fatality rates for definite myocardial infarction appear to indicate that the risk of death was much less at home than in hospital, and this difference was maintained even when the results were adjusted for age. Furthermore, at every level of a modified Peel prognostic index and at comparable concentrations of serum aspartate aminotransferase there was a lower mortality in the patients kept at home. This was not, however, a randomised controlled trial and there were subtle but definite differences between the groups. Those patients who were going to be treated at home called their doctors on average one-and-a-half hours after the onset of symptoms, whereas those who were going to be treated in hospital summoned the doctor half an hour earlier. In the home-treated cases the doctor took about an hour to arrive but in the hospital-treated group only half an hour. These differences in behaviour may indicate differences of severity of infarction which cannot be measured by the relatively crude prognostic index or even by enzyme values. In this survey 65% of the patients who survived long enough to see a doctor were treated in hospital, and the median time for reaching hospital or coming under the care of the general practitioner if being treated at home was nearly three hours in each case.

### NOTTINGHAM STUDY

An influential paper on home versus hospital treatment was a report of a randomised trial in Nottingham in which a hospital-based team

responded to calls from general practitioners when myocardial infarction was suspected.<sup>11</sup> The team went to the patient's home, made its own assessment, excluded some patients on predetermined medical and social grounds, and remained with the others for two hours after which it allocated them to home or hospital treatment. For patients with suspected myocardial infarction there was no significant difference in the mortality at home (13%) and in hospital (11%).

Although not mentioned in the final paper, the population covered was 100 000 and the study ran for four years from 1973 to 1977.<sup>12 13</sup> Applying the Teesside figure for attack rate to the Nottingham population we would expect 1200 cases of myocardial infarction to survive long enough to need medical attention. Of the 500 calls for suspected myocardial infarction, 207 were to definite or probable myocardial infarction and only 150 cases were randomised, a mere 12% of the estimated total number of coronaries and a smaller percentage than in the much criticised south-west study.

There were 132 patients with suspected myocardial infarction randomly allocated to home treatment, but 26 were later admitted to hospital. We are not told whether these failures of home management occurred in those with definite or only suspected infarcts. Most probably they occurred in those with definite infarctions. The existence of this high proportion of patients with failed home management weakens the argument for keeping such patients at home initially.

Although not explicitly mentioned three deaths occurred among 114 patients without definite or probable myocardial infarction who were randomly allocated between home and hospital treatment. This death rate in ill patients without a definite diagnosis is surely a powerful argument for admission to hospital.

The six-week mortality in randomised patients with definite or probable myocardial infarction was 20% for those kept at home and 18% for those admitted to hospital—an insignificant difference. Not showing a difference, however, is not the same thing as showing that there is no difference, and the 95% confidence limits for this 2% advantage for home treatment are  $\pm 13\%$ . Even if there were a 50% difference in mortality between home and hospital treatment in these patients there would be at least an even chance of not detecting it.<sup>14</sup> A very much larger trial would be needed to confirm that there is no difference between hospital and home treatment.

An examination of the time it took for patients to be randomised to hospital or home treatment shows that half the randomised patients had called their general practitioner by 90 minutes after the onset of symptoms but a further one-and-a-half hours elapsed before half of them came under the care of the coronary care team. Without comment the text states "14 patients were dead when the team arrived." The team then stayed with the patients for two hours until randomisation, which on average was five hours after treatment of symptoms.

This trial is therefore stating the obvious. In a highly selected group constituting about 12% of patients with myocardial infarction and randomised between home and hospital treatment five hours after the onset of symptoms no significant difference between home and hospital treatment was shown. Seventy-nine patients with definite or probable myocardial infarction were randomly allocated to home treatment, but 26 had to be admitted to hospital later. Three deaths occurred in patients without definite or probable myocardial infarction in the random group.

### IRRELEVANT DEBATE

The debate about home versus hospital treatment is irrelevant. In every study that has been carried out in Britain a substantial majority of patients with myocardial infarction are admitted to hospital for social or medical reasons. This should be the starting point of any endeavour to see whether these patients can be brought under coronary care at an earlier stage to try to reduce the formidable pre-hospital mortality rate.

Hospital care started late after the onset of symptoms is unlikely to reduce the mortality substantially, and randomised trials with small numbers are unlikely to show any advantage for hospital treatment. The main advantage in hospital admission is organisational. When patients with myocardial infarction are collected together and monitored in a coronary care unit there is a higher chance of successful resuscitation than in a general ward.<sup>15</sup> Medical, nursing, and paramedical staff rotating through this unit have an intensive experience of coronary care, including resuscitation, and the unit therefore has an important training role. The third function of a hospital coronary care unit is to act as a base for mobile coronary care.

**Mobile coronary care**

NOTTINGHAM

In Nottingham a cardiac ambulance manned by trained ambulance crew was set up experimentally in 1973.<sup>16</sup> All patients with heart attacks brought to Nottingham hospitals by this vehicle and by routine vehicles were followed up to find out whether the cardiac ambulance reduced mortality and whether there was any selection of the patients carried by it.

The cardiac ambulance could not be manned throughout the week, and when it was not available a routine ambulance took cardiac patients to hospital. The overall mortality for patients with myocardial infarction who came by the routine ambulance when it alone was available was 51%. When the cardiac ambulance was sent the overall mortality was 40%. The mortality in patients with myocardial infarction carried by ordinary ambulance at times when the cardiac ambulance was available, however, was 65%, mortality for the two modes of transport combined being unchanged. Thus when there were alternative forms of transport for patients with myocardial infarction the cardiac ambulance tended to carry relatively low risk cases. If acute myocardial infarction leads to sudden collapse with bystanders ringing 999 for an ambulance, the ambulance controller may not be able to identify such a patient as having had an infarct and may send an ordinary ambulance although the patient is at greater risk than those identified as having had myocardial infarction and carried by the cardiac ambulance.

## MOBILE CORONARY CARE FOR ALL EMERGENCIES

A further study was therefore conducted to assess the value of sending a mobile coronary care unit to all emergency calls other than those for children or for patients injured in road traffic accidents or brawls.<sup>17</sup> A group of 1164 patients was randomly allocated to transport via the mobile coronary care unit and 1676 patients to routine transport. No patient survived resuscitation attempts long enough to leave hospital and the authors concluded that mobile coronary care units would not appreciably affect mortality from heart attacks. The

*Success of resuscitation in patients with acute myocardial infarction in various studies*

	No of patients in whom resuscitation was attempted (and % of total group)	No (%) resuscitated who:	
		Survived to hospital	Were discharged
Nottingham MCCU <sup>17</sup>	47 (36)	3 (6)	0
Nottingham routine <sup>17</sup>	33 (25)	4 (12)	0
Brighton (71% admitted) <sup>18</sup>	356 (16)	101 (28)	40 (11)
Belfast <sup>19</sup>	104 (13)	39 (38)	27 (26)
Charlottesville, Virginia <sup>21</sup>	26 (10)	17 (65)	8 (31)
Columbus, Ohio <sup>22</sup> :			
Medic	61	32 (52)	15 (25)
Heartmobile	71	34 (48)	16 (23)
Seattle <sup>23</sup> :			
Technician	223	42 (19)	15 (7)
Technician and paramedic	349	117 (34)	60 (17)

conclusion should have been that in Nottingham mobile coronary care did not appreciably affect mortality—how could it if successful resuscitation was never carried out?

The Nottingham experience should not be extrapolated to mobile coronary care units elsewhere. Indeed, in the same issue of the *British Medical Journal* there is an account of the long-term survival of 40 patients with cardiac arrests who were resuscitated by Brighton ambulancemen.<sup>18</sup> These men had been trained to recognise common arrhythmias, use a defibrillator, and give patients intravenous or intramuscular drugs to combat arrhythmias. A comparison of these two sets of results suggests that the training of the Nottingham ambulancemen was less effective than in Brighton.

This suggestion is supported by the effects of adding a doctor to the crew of the Nottingham cardiac ambulance.<sup>19</sup> The authors concluded that the presence of a doctor did not reduce the mortality of patients with heart attacks. Though this was strictly true, there were three long-term survivors from 19 attempts at resuscitation with a doctor present and only two long-term survivors out of 46 attempts by cardiac ambulancemen alone. This result was not statistically significant, but failing to show a difference is not the same thing as showing

no difference.<sup>20</sup> A longer study would probably have shown an improved long-term survival when a doctor helped with resuscitation since the number of short-term survivors was significantly better with a doctor present ( $p < 0.05$ ). Nine out of 19 patients when resuscitated by a doctor survived to reach hospital but only 8 out of 46 cases resuscitated by ambulancemen personnel alone.

The table compares the success rate of resuscitation carried out in Nottingham, Brighton, Belfast, and three North American cities. The striking differences are the greater number of cases in Brighton and Belfast and the much higher short-term and long-term survival rate in these places compared with Nottingham. The varying success rates will be partly explained by differences in patient populations, delay in calling for help, and journey times, but the obvious explanation of the poor results from the Nottingham mobile unit is the ambulancemen's training: they seem to do no better than the crew of the routine ambulances.

The important point to emerge from the Nottingham studies is that the cardiac ambulance may carry a relatively low-risk group of patients with myocardial infarction.<sup>16</sup> Even in this relatively low risk group, however, the overall mortality was 40% with a prehospital mortality of 21%, which could be reduced with effective mobile coronary care.

In Belfast when a routine ambulance arrives at a collapse call to find that the patient has a cardiac arrest the crew start cardiopulmonary resuscitation and summon the cardiac ambulance. In this way the benefits of mobile coronary care are available to all patients carried by the ambulance service.

**Benefits of mobile coronary care units**

## COST EFFECTIVENESS

In the United Kingdom there have been no studies to show the effect on community mortality of introducing mobile coronary care, though community mortality has been reduced in some North American cities.<sup>21-24</sup> The medical profession seems to be demanding proof of cost effectiveness and in particular of the ability of mobile coronary care to reduce community mortality rates before introducing it on a wide scale. This catch 22 situation ensures that no action is taken. The question should be asked: What reduction of mortality from ischaemic heart disease would justify the introduction of mobile coronary care? Since myocardial infarction is so common a small reduction in mortality will mean that many lives are saved: a reduction of community mortality from 50% to 49% could lead to a saving of 1100 lives a year of patients under 70 in the UK.

A reduction of this magnitude should be easily obtainable with an efficient and comprehensive mobile coronary care service<sup>25</sup> but would be difficult to measure except with a very large-scale survey. Yet this is at least as many lives as are saved by the whole of the dialysis and transplant programme for renal failure and the costs are unlikely to be greater.<sup>26</sup> In Charlottesville, USA, the cost:benefit ratio of mobile coronary care has been calculated to be 1:32.<sup>25</sup>

## INTERVENTION VERSUS PREVENTION

There need be no conflict of interests between immediate coronary care and preventive cardiology. The publicity that surrounds the running of a cardiac ambulance in a community has a valuable effect on public education and is tangible evidence that the medical profession is taking the problem seriously. This considerably increases the impact of preventive advice.

## IMMEDIATE CORONARY CARE IS HUMANE

There are important humane reasons for providing immediate coronary care. In many other areas where life is in danger—coastal waters, holiday beaches, mountains, and ski slopes—rescue services have been set up and every effort is made to save



individual life, which has often been put at risk voluntarily. If a man collapses with a pain in his chest in a public place in a British city his life is in greater danger at that moment than at any other time, but there is no appropriate rescue service he can call on to help him. He cannot even be certain of having relief of pain since over half the patients admitted to coronary care units with myocardial infarction had not been given analgesics before referral to hospital.<sup>27 28</sup>

The provision of immediate coronary care is not only humane but would reduce mortality from heart attacks. The evidence that mobile coronary care is not effective does not bear critical scrutiny. The responsibility of physicians who are now looking after the survivors of myocardial infarction in hospital extends into the community, where the main slaughter from heart attacks is taking place.

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## CHANCE, COINCIDENCE, SERENDIPITY

### The lost cord

When George Wright (then a student at the London Hospital and now a fellow of Clare College, Cambridge) drew my attention to an abnormal electrocardiogram which he had discovered by chance in a patient with Friedreich's ataxia in the London Hospital, it ended with a joint paper on the subject in 1942. In it we said that, although custom had regarded this disease as one that affected the central nervous system, examination of the electrocardiogram in 38 cases had convinced us that the heart, too, was commonly affected.

Perusal of published work confirmed that only rarely had heart failure been recorded since Newton Pitt published a case in 1887, and it is of this case that I write here. Oliver, the patient who suffered from Friedreich's ataxia, was an inmate of a home for incurables in East London, but from time to time, especially at Christmas, he would be admitted for a term to either Guy's Hospital or the London Hospital. This gave rise to friendly rivalry, sometimes acrimony, between physicians at the London and Dr Newton Pitt at Guy's because both parties were anxious to gain access to the patient's spinal cord when he eventually died. We were able to examine the voluminous clinical notes on Oliver during his many admissions to the London hospital from 1890 onwards, which included the statement that he had died in Guy's. We applied to Guy's for permission to consult the clinical notes, but we were informed that all patients' notes for that period had been destroyed.

Two years ago I was presented with a copy of the autobiography of Sir Arthur Hurst, a physician of Guy's Hospital, who died in August

1944. Hurst had been a house physician to Newton Pitt and had dealt with Oliver during his later admissions to hospital. During one such stay, Hurst received a complaint from the sister of the ward that Oliver was behaving badly, and that her nurses disliked looking after him. Accordingly, Hurst informed Oliver that he must mend his ways—otherwise he would be obliged to discharge him from hospital before Christmas. Oliver replied, "You can't do that to me. I have an understanding with Pitt that I get a holiday in his ward over Christmas, and Pitt gets my spinal cord when I die." His next hospital admission was to the London, but later still, chance determined that Oliver should be admitted to Guy's when he was dying. He appeared quite happy, declaring that he was glad that at last Pitt was to get his spinal cord as a reward for his kindness to him through the years. Newton Pitt delayed his annual holiday for a fortnight in order to be at the hospital when the necropsy on Oliver took place.

Chance was still to play her final card. When the intact spinal cord was displayed on the necropsy table, and a tap was turned on to clean the table, a sudden gush of water carried the cord to the mouth of the pipe that drained the table. A frantic attempt was made to grab it, but it failed, and the precious specimen disappeared down the drain. The hospital's plumbers were summoned urgently to the scene, but to no avail; Oliver's spinal cord had been lost. Newton Pitt was in great anguish and could not be comforted. Both hospitals had, through mischance, been denied the prize which they had so much coveted, and the detailed examination of the spinal cord in Friedreich's ataxia had to await another day.—WILLIAM EVANS.