Integration of ambulance staff trained in cardiopulmonary resuscitation with a medical team providing prehospital coronary care

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From Waveney Hospital, Ballymena, Northern Ireland

Summary Ambulance staff with advanced training in cardiopulmonary resuscitation and equipped with monitor/defibrillators were used as the initial responders to collapse calls within a medically based prehospital coronary care system. During 21 months, in a population of approximately 120,000, ambulance staff successfully resuscitated six patients from ventricular fibrillation; there were four long-term survivors. The median response time of emergency ambulances to collapse calls was eight minutes compared with 20 minutes for the medically manned mobile coronary care unit. None of the patients resuscitated by ambulance staff would have survived if they had been dependent on the mobile coronary care unit acting alone. Nineteen other patients with important arrhythmias were referred for earlier medical management which in some cases may have saved lives. An additional eight long-term survivors of out of hospital ventricular fibrillation were resuscitated by medical staff.

The integration of paramedical with medical prehospital coronary care improved survival after out of hospital cardiac arrest.

The beneficial effect of a medically manned mobile coronary care unit on community mortality from myocardial infarction in the Antrim and Ballymena district has already been reported. In addition, the results of equipping general practitioners in this district with portable defibrillators have been encouraging. However, cardiac arrest, often without warning symptoms, may occur when medical attention is not immediately available. Survival is critically dependent on prompt cardiopulmonary resuscitation and delivery of definitive care, in particular defibrillation. The efficacy of a medically manned mobile unit in out of hospital cardiac arrest is limited by its operation from a single despatch centre and by the inevitable delay while the doctor and nurse are collected. Although general practitioners are usually closer to the patient they may not be immediately available or a bystander may initially telephone 999 for an emergency ambulance.

There are obvious advantages in using emergency ambulance staff when a delay of a few minutes may be critical. In this district an ambulance can be despatched from either of two stations situated 13 miles apart or diverted from a less urgent call if it is in the vicinity of a collapsed patient.

Ambulance staff trained in defibrillation techniques can successfully resuscitate patients from cardiac arrest outside hospital. However, the limited capability of paramedical workers to stabilise the patient’s haemodynamic state with appropriate drug treatment after successful defibrillation may contribute to the low long-term survival rates in this group. Some predict that more complete stabilisation by a skilled medical team after defibrillation and before transfer to hospital would improve the outcome.

We decided to train emergency ambulance staff to provide initial definitive resuscitation in patients with cardiac collapse and to back up this team with prompt support from the medical team on a mobile coronary care unit.

Patients and methods

Since 1966 the Antrim and Ballymena district, population 120,000, has been served by a medically staffed mobile coronary care unit operating from the Waveney Hospital coronary care unit, and in 1982 general practitioners were provided with...
defibrillators. In July 1986 we initiated a voluntary two week cardiac training programme for ambulance staff. Volunteers were taken in groups of four. During the first week they had five 75 minute tutorials in basic cardiac anatomy and physiology, myocardial infarction, electrocardiographic interpretation of cardiac rhythm and arrhythmias, and the use of a Hewlett-Packard monitor/defibrillator type 43120A. They practised resuscitation and defibrillation techniques on a training mannequin with cardiac arrhythmia simulator (Laerdal Arrhythmia Anne IV). Subsequently the pairs of trainees spent a week on the coronary care unit watching the emergency management of myocardial infarction, with emphasis on electrocardiographic monitoring and arrhythmia recognition. They were encouraged to use a defibrillator when the opportunity arose. They were also taught to measure systolic blood pressure by radial pulse palpation with an aneroid sphygmomanometer.

When they arrived at a collapsed patient they were advised to define the cardiac rhythm as quickly as possible. If ventricular fibrillation was present, defibrillation was applied immediately and the mobile coronary care unit was summoned. An initial direct current shock of 200 J was delivered followed if necessary by further shocks of 360 J. Additional resuscitative measures were continued as required until medical support arrived. If the initial rhythm was agonal with electromechanical dissociation or asystole, resuscitation was not attempted; a rhythm strip was recorded for documentation and the mobile coronary care unit was not activated. Other arrhythmias were observed, recorded, and assessed and if a coronary event was suspected the mobile unit was summoned. The systolic blood pressure was recorded when possible and oxygen with or without nitrous oxide was administered if chest pain or dyspnoea was present.

On completion of the training course each trainee underwent an oral and practical examination by a panel comprising the authors and a second senior ambulance officer. A high level of accuracy and expertise was demanded and by 1 October 1986, 18 out of 20 volunteers from a total of 28 emergency ambulance personnel employed in the district achieved the required standard. All seven emergency ambulances were then equipped with Hewlett-Packard 43120A monitor/defibrillator units and the duty rosters were arranged so that at least one person in the crew of two had been trained in cardiopulmonary resuscitation. Every two months trained staff attended a one hour refresher course.

We have now a comprehensive system for prehospital coronary care (fig 1). People with chest pain usually summon their general practitioners but, if they are not available the mobile coronary care unit may be requested directly via the 999 system. In the event of a patient's sudden collapse the general practitioner may be able to attend promptly, or alternatively a 999 call alerts the nearest emergency ambulance. When necessary the mobile coronary care unit attends as quickly as possible to stabilise the patient's cardiac rhythm and haemodynamic state before transfer to hospital.

Results

During the first 21 months of this scheme 116 patients with cardiac arrest were attended by the emergency ambulance crews (table 1). In 43 patients the cardiac rhythm was not recorded because they were obviously beyond resuscitation and these individuals were classified as dead on arrival. Ventricular fibrillation was the initial documented rhythm in 18 patients of whom six (33%) had received bystander cardiopulmonary resuscitation compared with 13 (24%) of the 55 in whom there was asystole or agonal rhythm. Defibrillation was attempted in all patients with ventricular fibrillation; when the mobile coronary care unit arrived six had a

<table>
<thead>
<tr>
<th>Cardiac arrests attended by emergency ambulance staff</th>
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<tr>
<td>Dead—rhythm not documented</td>
</tr>
<tr>
<td>Asystole</td>
</tr>
<tr>
<td>Agonal rhythm</td>
</tr>
<tr>
<td>Ventricular fibrillation:</td>
</tr>
<tr>
<td>Survived to medical care</td>
</tr>
<tr>
<td>Discharged alive</td>
</tr>
</tbody>
</table>
Ambulance staff trained in cardiopulmonary resuscitation

Cardiac output—four of them were in sinus rhythm, one had atrial fibrillation, and one had nodal rhythm. One patient died of cardiogenic shock before transfer to hospital and another, who had an acute anterior myocardial infarction, died from cardiac rupture three days after admission to hospital. Of the four patients who survived to discharge two men, aged 40 and 57, had acute transmural myocardial infarction and two, a 66 year old man and a 73 year old woman, had neither electrocardiographic nor biochemical evidence of acute myocardial necrosis but both had previous infarction. None of the survivors had appreciable persistent cerebral impairment.

The median response time from receipt of a collapse call to the arrival of the emergency ambulance at the scene was eight minutes compared with the mobile coronary care unit’s median response time of 20 minutes for 100 consecutive calls documented during this study (fig 2). For the 18 cases of ventricular fibrillation the mean response time for the emergency ambulance was eight (range 1–16) minutes while the mean response time for the mobile coronary care unit to these patients after they were summoned by the emergency ambulance was 18 (range 6–30) minutes. An additional 78 arrhythmias were documented by the emergency ambulance crews in patients without cardiac arrest (table 2). As a result, at least 19 people with haemodynamically important or possibly life threatening arrhythmias (ventricular tachycardia, R on T ventricular extrasystoles, supraventricular tachycardia, and complete heart block) received appropriate therapeutic intervention earlier.

During this study, 21 of those patients who presented with cardiac pain and who were initially attended in the usual way by general practitioners and/or the medically manned mobile coronary care unit developed ventricular fibrillation outside hospital and were defibrillated by general practitioners (six patients) or by the mobile unit team (15 patients). Eight of these 21 patients survived to reach hospital and all eight were discharged alive.

Therefore, within our overall prehospital coronary care scheme, 39 patients were treated for out of hospital ventricular fibrillation, 13 (33%) survived to reach hospital and 12 (31%) were discharged alive.

Discussion

This study shows the benefit of using ambulance staff trained in cardiopulmonary resuscitation in addition to established medically based prehospital coronary care. The response times of the emergency ambulances and the mobile coronary care unit show that the patients resuscitated from ventricular fibrillation by emergency ambulance crews would not have survived if they had been dependent on the mobile coronary care unit acting alone. The greater success rate achieved by general practitioners and the mobile coronary care unit reflects the fact that most of these cardiac arrests occurred in their presence so that defibrillation could usually be applied immediately, while all patients defibrillated by emergency ambulance crews had been in ventricular fibrillation for several minutes. The high recorded incidence of asystole and agonal rhythm also reflects the length of time that had elapsed from the onset of cardiac arrest in many patients, because ventricular fibrillation rapidly deteriorates to these terminal rhythms if no action is taken. The ability of the ambulance crews to recognise arrhythmias other than those associated with cardiac arrest resulted in earlier referral of many patients for possibly life saving medical treatment.

In view of the catchment population the results achieved by our prehospital coronary care scheme

Table 2  Arrhythmias documented by ambulance staff in patients without cardiac arrest

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>No of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricular tachycardia</td>
<td>3</td>
</tr>
<tr>
<td>R on T ventricular extrasystoles</td>
<td>5</td>
</tr>
<tr>
<td>Supraventricular tachycardia</td>
<td>8</td>
</tr>
<tr>
<td>Complete heart block</td>
<td>3</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>19</td>
</tr>
<tr>
<td>Sinus bradycardia</td>
<td>14</td>
</tr>
<tr>
<td>Benign ventricular extra systoles</td>
<td>25</td>
</tr>
<tr>
<td>First degree heart block</td>
<td>1</td>
</tr>
</tbody>
</table>
compare favourably with those reported elsewhere.\textsuperscript{4-12} Prehospital coronary care schemes dependent on paramedical staff acting alone reported survival rates of 36\% to 63\% for patients admitted after out of hospital resuscitation.\textsuperscript{4-12,13} Our high survival rate for patients admitted to the coronary care unit after out of hospital resuscitation (12 of 13) indicates the benefits of prompt stabilisation of the patient’s condition by a skilled medical team before transfer to hospital.

The two week training course for the ambulance staff is similar to those described by Rowley \textit{et al}.\textsuperscript{14} and Jakobsson \textit{et al}.\textsuperscript{15} When skilled medical support is rapidly available training ambulance staff in the administration of parenteral drugs and intubation would yield only marginal, if any, benefit and would increase the cost of the programme by prolonging the training period.

In Seattle it has been found that after a few years the percentage of patients resuscitated from ventricular fibrillation outside hospital tends to plateau, mainly because of the delay in initiating basic life support and defibrillation.\textsuperscript{6} A community training programme in cardiopulmonary resuscitation improves the efficacy of prehospital coronary care.\textsuperscript{6,16} In this study those patients whose initial documented rhythm was ventricular fibrillation were more likely to have received cardiopulmonary resuscitation initiated by a bystander than those whose rhythm was asystolic or agonal, which suggests that bystander cardiopulmonary resuscitation may have maintained some individuals in a condition amenable to resuscitation. However, only 17\% of our cardiac arrest victims received cardiopulmonary resuscitation from bystanders compared with 40\% in Seattle where at least 370,000 citizens have taken part in a community training programme.\textsuperscript{6} Because cardiopulmonary resuscitation training is time consuming and at least half of the victims of out of hospital cardiac arrest have known coronary heart disease,\textsuperscript{17-18} it may be more rewarding to target relatives of cardiac patients for training. Consequently we now offer training in basic life support to relatives of our cardiac inpatients and we expect this policy to yield increasing dividends in the future.

We thank the staff on the emergency ambulances and ambulance controllers for their willing co-operation, enthusiasm, and dedication, also the coronary care unit nursing staff and physiologic measurement technicians for their invaluable help in the training programme.

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\textbf{References}

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