The limited potential of special ambulance services in the management of cardiac arrest

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Abstract

For six months a survey was made of all the patients in the Nottingham District Health Authority who died or who were brought to hospital after a cardiac arrest outside hospital. During this period just under half of the emergency ambulance shifts were covered by specially trained crews with defibrillators. During the study period the ICD coding of death certificates indicated that 894 (25%) of the 3575 deaths were due to ischaemic heart disease. During this period the ambulance service received 17 749 emergency calls, which included 445 patients who had cardiac arrests outside hospital. One hundred and forty seven of these patients were carried by ambulances equipped with defibrillators and resuscitation was attempted in 83. Seven patients survived to leave hospital.

The special ambulance service was cost effective—a simple calculation suggests that the cost per life saved was approximately £2600, but it seems unlikely that special ambulance services will materially affect community fatality rates from ischaemic heart disease.

Special ambulance services for the transport and treatment of patients with a cardiac arrest have been in operation in the United Kingdom for more than twenty years. Different approaches have been used[1-4] but widespread acceptance of the need to extend the skills of ambulance personnel has not been accompanied by equally widespread attempts to investigate either the effectiveness of ambulance personnel with advanced training or the overall potential benefit to the community. The benefit to an individual who is successfully resuscitated from cardiac arrest is obvious[5] and perhaps because of this it has been suggested that community mortality from ischaemic heart disease may be significantly reduced by the introduction of resuscitation by paramedical services.[6]

In 1983 the Nottinghamshire Ambulance Service began advanced training in resuscitation skills for ambulance personnel on the accident and emergency shifts. We have described elsewhere both the training programme and the results from the first 403 cardiac arrests suffered outside hospital in the county of Nottinghamshire and attended by our crews.[7 8] Now that nearly half of our emergency ambulance shifts have crews with advanced training we decided to investigate the extent to which our ambulance service is involved with deaths and cardiac arrests that occur outside hospital so that we could estimate the potential of our new service for saving lives.

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Patients and methods

METHODS

We reviewed all the patients who suffered a cardiac arrest outside hospital and for whom an emergency ambulance was summoned. Some of these patients were found dead and had clearly been dead for some time, while others were seen to collapse or were found in circumstances that suggested that cardiac arrest had occurred recently. We excluded those patients with a death certificate issued by a general practitioner.

The Nottingham District Health Authority serves a population of 617 000 and there is a single accident and emergency department at University Hospital to which ambulances bring all those who suffer a cardiac arrest outside hospital. During the six month period 1 January to 30 June 1988 the records of the accident and emergency department were inspected daily to identify the patients who had been certified dead on arrival at hospital or who had died after admission to hospital after a cardiac arrest. Such deaths are usually reported to the coroner and the cause of death was identified from coroner's records. We excluded patients found to have died of causes other than coronary disease.

Death certificate returns to the district health authority from registrars of births, deaths, and marriages for this six month period were inspected to identify the number of deaths within the area. Death certificate entries were coded according to the 9th revision of the *International Classification of Diseases* to identify the deaths that were attributed to ischaemic heart disease (ICD codes 410-414).

All patients who had been carried on an ambulance equipped with a defibrillator by a trained crew were identified from records submitted to one of us (JMR) by the ambulance personnel. These records were completed for all patients in whom resuscitation had been attempted, whether successful or not. Crews were also encouraged to complete forms to identify patients who had been certified dead on arrival without any attempt at resuscitation. Any patient who was successfully resuscitated and admitted to hospital was followed until death or hospital discharge.

To simplify comparison with data from death registration this investigation was confined to cardiac arrests managed by ambulance crews based at the eight ambulance stations within the Nottingham District Health Authority, though records are maintained of all cardiac arrests managed by

specially trained crews throughout the county of Nottinghamshire.[8]

The records of the Nottingham ambulance stations were analysed to identify the proportion of accident and emergency shifts for which a defibrillator and a trained crew were available. The working day of the emergency ambulance service is divided into a variable number of shifts and a variable number of ambulances are available at different times of the day and on different days of the week. For the purposes of this study, therefore, an "ambulance shift" was defined as the usual work period of an individual ambulance manned by two people.

Results

For the six month period from 1 January 1988 to 30 June 1988 3575 deaths were reported within the Nottingham District Health Authority; on the basis of the death certificates (mainly issued by general practitioners) 894 (25%) of these deaths were coded as being due to ischaemic heart disease. The ambulance service as a whole received 17 749 emergency calls during this period and transported to University Hospital 445 patients who suffered cardiorespiratory arrest outside hospital.

Figure 1 summarises the overall pattern of deaths within the community and the involvement of the ambulance service. The study period was covered by a total of 5736 emergency ambulance shifts, 2760 (46.5%) of which were worked by a crew trained and equipped to use a defibrillator. Of the 445 victims of cardiac arrest brought to the accident and emergency department 298 (67%) were transported by crews who had not been trained in defibrillation and these patients were either certified dead on arrival or after a period of attempted resuscitation in the accident department. No patient survived who had a cardiac arrest outside hospital and who was transported by a crew without special training or a defibrillator. One hundred and forty seven patients (33% of those with a cardiac arrest) were brought to hospital by a crew able to attempt defibrillation: in 64 of these patients no attempt at resuscitation had been made and they were certified dead on arrival at hospital; an attempt had been made by the ambulance crew to resuscitate 83 patients.

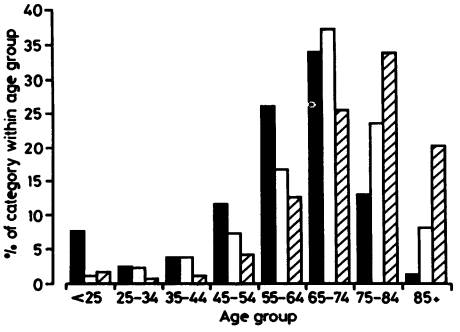

Figure 2 Age structure of the group of 83 patients in whom resuscitation was attempted (black bars), of the 64 patients who were brought to hospital by special crews without resuscitation attempt (open bars), and of the 3575 patients who died in the Nottingham District Health Authority during the study period (hatched bars).

Ventricular fibrillation was the observed cause of the cardiac arrest in 45 (54%) of the 83 patients in whom resuscitation was attempted and defibrillating shocks administered. Nine of these patients were admitted to the coronary care unit and six were discharged alive. Four patients resuscitated from cardiac arrest due to rhythms other than ventricular fibrillation were admitted but only one of these survived.

Figure 2 shows the age distribution of the patients who died in the Nottingham District Health Authority during the study period. The median age of death for the whole group was 76. The median age of patients transported to hospital by ambulance without any attempt at resuscitation was 70 but the median age at death in the group in which resuscitation was attempted by a trained crew was 64.

Figure 3 shows the cumulative percentage of response times in the 17 749 emergency calls

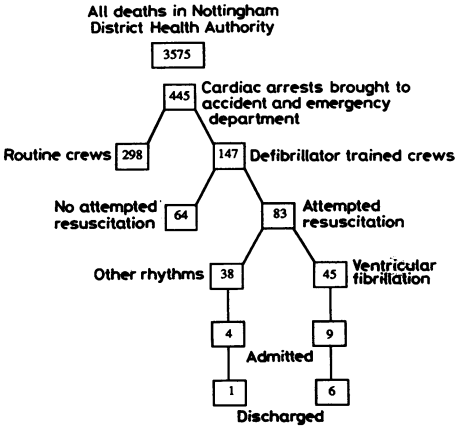

Figure 1 Management and outcome of patients with cardiac arrests outside hospital in the Nottingham District Health Authority during a 6 month period.

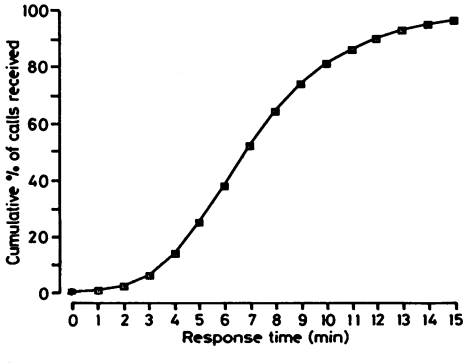

Figure 3 Cumulative frequency (%) of time intervals from the call for an emergency ambulance to its arrival at the patient.

for an ambulance during the study period. The median response time was 7 minutes, and was the same for all types of emergency ambulance, whether or not they had a specially trained crew.

Discussion

This survey was conducted during the first half of 1988, and at that time our extended training scheme for ambulance personnel had been in operation for five and a half years. We had trained sufficient crews for nearly half of the emergency ambulance shifts to have specially trained crews equipped with defibrillators. Only 12.6% of the total deaths in the community involved a call to the ambulance service, though ambulances were involved in half of the deaths due to ischaemic heart disease.

Although half of the ambulance shifts were covered by special crews, such personnel attended only one third of the patients who died. The cause of this discrepancy is not clear, but it may reflect information given to the ambulance controllers. The controllers had no specific protocol for selecting a routine emergency ambulance or one equipped with a defibrillator for response to a particular type of call; they used their judgment. It seems likely that when a call was received concerning a patient who had been found dead and who had probably been dead for some time a routine ambulance was dispatched. Such patients are probably more common than those seen to collapse, so routine vehicles may well have carried a higher proportion of patients who fall within our definition of "cardiac arrest".

Even if all our emergency ambulances had specially trained crews with defibrillators, it is clear that there would be little impact on community fatality rates from heart attacks and that previously published estimates of the effect of such services[6] have been over-optimistic. Many of the patients described as having a cardiac arrest outside hospital might be better described as "found dead". Our specially trained crews, who might be expected to be enthusiastic about resuscitation, only attempted this in just over half the patients they attended with cardiac arrest; in the remainder a resuscitation attempt was clearly too late. The use of automatic defibrillators could reduce training time and thus increase the number of trained crews, but there is no reason to suppose that the proportion of successful resuscitations would increase. If we make the optimistic assumption that complete cover of our emergency ambulance service with defibrillator equipped ambulances would be associated with the same rate of attempted and successful resuscitation demonstrated by the crews we have at present, then we can calculate that in our population of 617 000 at best between 30 and 40 lives would be saved in a full year. While this saving of lives is vital to the individuals who benefit it must be seen in the context of nearly 2000 deaths each year from coronary disease, and a total of over 7000 deaths in our community.

There are many ways in which it might be possible slightly to improve the number of survivors of cardiac arrest outside hospital but few have been critically evaluated. In some communities it might be more appropriate for general practitioners to have their own defibrillators[9] but this will only help where patients tend in the first instance to call their general practitioner rather than the emergency services. It might be possible to educate potential patients to call for help more quickly or to call the emergency ambulance service rather than their general practitioner, though our experience of this has had only limited success.[10] It seems unlikely that our median ambulance response time of 7 minutes can be much improved, but it might be useful to concentrate special ambulance services where there are large crowds.[11]

Public education programmes in cardiopulmonary resuscitation may lead to a higher proportion of resuscitation attempts by special ambulance services having a successful outcome.[12] The presence of a doctor on the emergency vehicle should improve the success rate of a resuscitation, but when we compared an ambulance manned by a doctor with an ambulance with a specially trained crew the results were very similar.[13] Further extension of the skills of the ambulance crew to include intubation and intravenous fluid and drug administration[14] may lead to a higher proportion of successful resuscitations but training of all emergency crews to this standard will take several years. It is also difficult to evaluate the effects of skills other than defibrillation. While any or all of these measures might save a few extra lives it seems unlikely that they will make a significant impact on community mortality.

We made a simple estimate of the cost of saving lives with our special ambulance service by adding the salaries of the staff required for the service to the cost of purchasing and maintaining equipment. The staff required include a training officer and one additional trained ambulance crew to allow for the time needed for training. The ten defibrillators provided mainly from charitable sources for the Nottingham-based crews cost £4500 each. If we assume that the present rate of discharge from hospital is maintained over a seven year period (the projected life of the defibrillators) then with our present level of staffing 84 patients will be discharged from hospital at a cost of £45 000 for defibrillators plus £23 000 for their maintenance and approximately £150 000 for the salaries of the training officer and the additional ambulance staff. The cost per life saved is therefore approximately £2600—this calculation takes no account of the quality of life of the survivors nor of the balance of costs and benefits in terms of loss of income and taxes or the payment of social benefits. In simple terms, however, our advanced training scheme for ambulance crews seems to be highly cost effective.

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