

Planning a pre-hospital cardiac resuscitation programme: an analysis of community and system factors in London

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The value of pre-hospital advanced cardiac life support (ACLS) schemes remains controversial in this country. Studies of British schemes in the late 1960s and 1970s reported both favourable [1,2] and equivocal [3] results. The release of the National Health Service Training Authority (NHSTA) guidelines for extended training of ambulance staff in 1987 [4] seemed to confer official approval to the concept of advanced pre-hospital care. It is likely that more services will now develop pre-hospital resuscitation schemes, although immediately prior to the publication of these guidelines a study carried out in Scotland once again questioned whether advanced training would always be justified [5].

The NHSTA guidelines advocate training of ambulance staff in all ACLS skills (intravenous infusion, intubation, defibrillation, cardiac monitoring, drug administration). Successful programmes using this approach have been reported [2,6]. However, the relevance of this work to other communities wishing to implement schemes must be carefully considered. If community and system factors are not conducive to survival, introduction of a 'paramedic' type of ambulance service alone may be of little benefit. An important stage in planning a pre-hospital resuscitation scheme involves assessment of these factors.

To investigate whether the full paramedic approach would be beneficial in London, the effects of training a number of ambulancemen in ACLS skills were evaluated and community and system factors assessed.

Method

Seventeen ambulance staff from three London stations were trained in ACLS skills in 1985. On successful completion of the course, staff were able to treat asystole and ventricular fibrillation (VF) according to set protocols (Fig. 1). Each of the ambulance staff was equipped with drugs and a Simonsen & Weel DMS 600 defibrillator. The advanced trained crews were not selectively deployed. Ambulance service documentation, hospital records and/or post-mortem reports on all patients treated

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by the cardiac trained staff between 1985 and 1987 were sought, in order to obtain the following information:

1. Incidence of witnessed arrest
2. Incidence of bystander cardiopulmonary resuscitation (CPR), ie basic life support
3. Initial cardiac rhythm
4. Response time (ie time from receipt of 999 call to ambulance arrival)
5. Approximate time from collapse to CPR and collapse to ACLS (if times are unknown for unwitnessed arrests, time of 999 call is taken as time of arrest)
6. Treatment administered by ambulance staff
7. Age of patient
8. Outcome
9. Disease aetiology

Resuscitation was deemed successful if patients regained consciousness following ACLS procedures.

Statistical analysis. Associations between individual variables and successful resuscitation were computed using Fisher's exact test.

Fig. 1. *Treatment protocols for ventricular fibrillation and asystole.*

VF protocol	
↓	Precordial thump
	DC shock 200 J
	DC shock 200 J
	DC shock 400 J
	Intubation carried out
	Lignocaine 200 mg (endotracheal)
	DC shock 400 J
	Adrenaline 20 ml 1/10,000 (endotracheal)
↓	DC shock 400 J
Asystole protocol	
↓	Atropine 2 mg (endotracheal)
	Adrenaline 20 ml 1/10,000 (endotracheal)
↓	Isoprenaline 100 µg (intravenous)

Table 1. Characteristics of patients attended. (Numbers of patients are given in parentheses. Since total number of patients is 99, the figures are approximately percentages.)

Age:	18-44 (8)	45-74 (68)	75 + (20)	Unknown (3)
Location:	Home (55)	Public place (33)	Other (11)	
Alerted by:	Friend/relative (51)	GP (4)	Stranger (44)	
Witnessed:	Yes (41)	Yes, by crew (9)	No (49)	
Bystander* CPR:	Yes (25)	No (65)		
Initial ECG:	VF/VT (45)	Asystole (43)	Pulseless rhythm (10)	No record (1)

*Cases not witnessed by ambulance crew.

Table 2. Time intervals from collapse to CPR and ACLS.

Time from collapse to CPR:	7.7 ± 7.9 min (N = 60)
Time from collapse to ACLS:	11.5 ± 7.8 min (N = 54)
Patients receiving CPR within 4 min:	33.7% (N = 86)
Patients receiving ACLS within 8 min:	22% (N = 83)

N = number of cases where times known
Total cases = 99

Results

Over a period of 24 months, 99 patients in cardiac arrest were treated. Excluding the ambulance instructors, who were not continuously involved in emergency duties, each individual treated an average of seven patients (range 1-18).

Table 1 shows the characteristics of those patients attended. 96% of calls were 999 calls. The call-out time was 8.5 minutes (SD 2.7 min; range 4-17 min). This time includes an average of 2 minutes (SD 1.3 min) for the call

to be processed and dispatched, and a mean journey time of 6.2 minutes (SD 2.4 min; range 2-14 min). 50% of patients were reached within 7 minutes of receipt of a 999 call.

Table 2 shows time intervals between collapse and CPR/ACLS. Figure 2 shows the outcomes of the patients treated. A summary of pre-hospital treatment administered and patient outcome can be found in Table 3. In 8 patients treated with defibrillation only, pulses were restored in 5 patients at the scene, and 3 were eventually discharged. In 91 patients, several interventions were used (combinations of intubation and drugs or defibrillation). In 9 (12%) of these patients, pulses were restored at the scene but none survived or regained consciousness.

One patient treated with intubation and drugs did survive but the history of this patient is unclear. The initial rhythm documented by the ambulance crew was asystole but the patient was reported to be breathing spontaneously. Hospital records state that the rhythm on arrival at hospital was ventricular fibrillation which was successfully defibrillated with no additional intervention.

A summary of the characteristics of the patients resuscitated with no neurological deficit can be found in Table 4. Statistical analysis using Fisher's exact test showed an association between successful resuscitation and treatment with defibrillation only ($p = 0.0001$), a time to defibrillation of less than 8 minutes ($p = 0.0058$), arrest witnessed ($p = 0.035$), and arrest witnessed by crew ($p = 0.0049$).

Fig. 2. Outcome of patients attended.

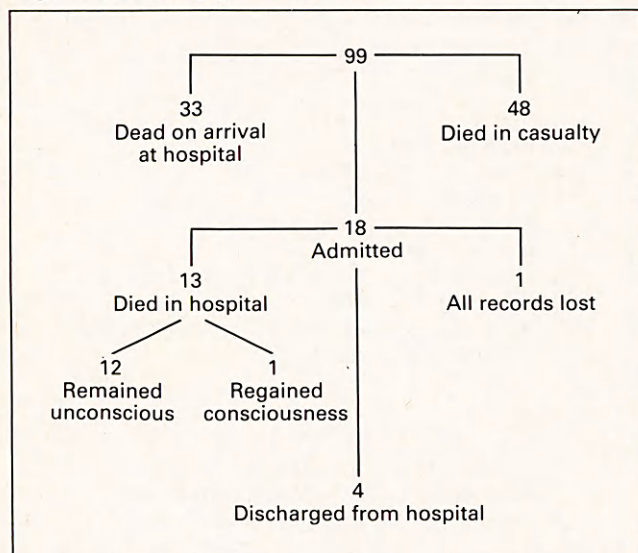


Table 3. Treatment administered and patient outcome.

	Treatment involving intubation + I.V. drugs + defibrillation	Defibrillation only
Number of patients treated	91	8
Number initially in VF	33 (36%)	8 (100%)
Number with pulse on arrival at hospital	9 (9.8%)	5 (62.5%)
Number discharged	1 (1%)	3 (37.5%)

Table 4. Summary of the characteristics of the patients resuscitated with no neurological deficit.

Patient outcome	Initial ECG	Pulse O/A hospital	Neurological status	Aetiology	Witnessed?	Bystander CPR	Time to definitive care	Crew intervention
Alive at 6 months	VF	Yes	Normal	MI	By crew	N/A	< 1 min	Defibrillation
Died at 6 months	Unknown	No (in VF on arrival)	Slight impairment	MI	Yes	No	?	Intubation Drugs
Alive at 6 months	VF	Yes	Normal	Ventricular dysrhythmia	Yes	No	< 10 min	Defibrillation
Alive at 6 months	VF	Yes	Normal	MI	By crew	N/A	< 1 min	Defibrillation
Died after 1 day	VF	Yes	Normal	MI	By crew	N/A	< 1 min	Defibrillation

Documentation of the cause of cardiac arrest was obtained from post-mortem reports or hospital records for 87/99 patients. Cardiac causes were identified in 62 patients (71%) and non-cardiac causes in 25 (29%).

Discussion

The best way of evaluating a pre-hospital ACLS programme is by randomised controlled studies or well organised cohort studies. Results from such studies in Seattle [6,7] have shown that four factors are associated with maximum chances of survival from pre-hospital cardiac arrest: witnessed arrest, bystander CPR within 4 minutes, ECG of VF and ACLS within 8 minutes. Our findings will be discussed with reference to these factors.

It has been well documented that the chances of survival from unwitnessed arrests are poor (3%) [7]. Half of the arrests documented in our study were unwitnessed. Scrutiny of report forms also revealed that, when arrests were witnessed, bystanders would often seek neighbours or telephone relatives before contacting the ambulance service. This indicates a lack of public knowledge and is reinforced by the observation that only 25% of victims received bystander CPR, which is less than reported in recent British studies (Nottingham 46% [8]; Stockport 38% [9]). Possibly, voluntary citizen CPR training and community education programmes have had less of an impact in London than in other areas; alternatively, citizens who volunteer for training are not those most likely to witness a cardiac arrest.

Although more than half of all patients suffered arrest at home (56%), only one quarter of the patients who received bystander CPR (6/25) were at home. Similarly, in 51% of all cases the ambulance was alerted by a friend or relative, but in only 10/25 cases did this person provide CPR. A lower incidence of witnessed arrests and bystander CPR in the home has been documented in Washington [10]. This was explained by the observation that, although 40% of the public are trained in CPR, only 7% of those live with victims of heart disease.

Time intervals from collapse to CPR and collapse to ACLS were available for 86 and 83 patients respectively. Only 34% of patients received basic CPR and 22%

received ACLS within the optimum time intervals (4 min and 8 min respectively). A decrease in the time taken by bystanders to alert the ambulance service and commence CPR, and a decrease in ambulance response time, would improve these figures. At present these results suggest that patients may only have a good chance of survival if they arrest after the 999 call has been made. This was thought to have happened in 18% of the cases, half of whom (9 patients) arrested in the presence of the ambulance crew, and 3 of these were successfully resuscitated.

Given that VF is the primary arrhythmia associated with sudden cardiac death [11], comparatively few patients in our study were found to be in VF or VT (45%). In recent British studies a higher incidence of VF has been reported (Stockport 57% [9]; Nottingham 63% [8]). This finding can be related to the lack of bystander CPR and the longer interval between collapse and definitive care in London. In 8 cases VF required treatment with defibrillation only, which resulted in the highest proportion of survivors in any treatment group. Of 32 patients found in VF who required drugs and/or intubation in addition to DC shock, none survived. The contribution of drugs to restoring perfusing rhythms in long-term survivors (when DC shock alone has been unsuccessful) has not been proven in previous trials. In some areas [2,6] drugs are administered routinely as prophylaxis to patients who have been successfully defibrillated. Whether the use of drugs in this situation reduces mortality is uncertain. Our ambulance staff were not able to administer drugs prophylactically, and none of the patients who were defibrillated into perfusing rhythms refibrillated before reaching hospital.

Fifty-eight patients with asystole or electromechanical dissociation were treated with drugs and/or intubation. One patient survived but, as the initial documentation of asystole was almost certainly incorrect, the contribution of medication to this patient's survival is questionable. Appreciable numbers of survivors from asystole or electromechanical dissociation have not been previously documented even in those communities where call-out times are short, bystander CPR is common, and an established paramedic service is in operation [12].

Whether selective deployment of the specially trained

crews would have increased the number of patients treated or the degree of success is debatable. Studies in Nottingham [13] found that the description of the patient's complaint received from the general public often bore little resemblance to the actual problem, and patients referred by GPs tended to be lower risk cases. It is also unlikely that a two-tier system would be effective (where basic crews summon help from advanced trained crews once a case of cardiac arrest has been verified) unless the first tier are able to respond to a call within 4 minutes of collapse and the second tier within 8 minutes [7]. In London the average response time was 8.5 minutes, and only 50% of patients were reached within 7 minutes of the 999 call. At present, ambulance control is being computerised and one hopes that this will help to reduce the time taken to receive and dispatch calls.

It is difficult to achieve optimum response times for dealing with pre-hospital cardiac arrest in London because of the relatively high number of emergency calls with which the London Ambulance Service has to deal (68.9 patients/1000 population/year in London, compared with 41.7 in Nottingham and 24.6 in Surrey [14]) together with other less quantifiable influences (eg traffic density, large number of high-rise estates where addresses are difficult to locate) which are also likely to hinder a fast response. These issues require a separate study.

One way of increasing the number of patients treated would be to train more ambulance staff in full ACLS skills, but training enough of them to make an impact may take several years owing to the length and cost of the training programme. It could be argued that ambulance staff in London require the additional skills of intubation and drug therapy to deal with the larger number of patients who are asystolic and/or hypoxic as a result of being in cardiac arrest for some time before definitive care can be given. Our results do not support this argument. Defibrillation was the only advanced skill associated with survival. A better alternative would be to teach defibrillation skills alone, requiring a shorter training. This approach has been advocated in Nottingham [8]. Since 1987, in the London Ambulance Service, training in defibrillation only has replaced training in full ACLS skills. Our study supports this strategy.

Community and system factors are not conducive to survival from pre-hospital cardiac arrest in London. It is believed that many patients were beyond resuscitation by the time the ambulance arrived, but 4 patients survived who may not have done so without pre-hospital treatment. Before embarking on a programme of pre-hospital care for victims of cardiac arrest, individual community

and system factors should be investigated. The findings will highlight areas which need attention if survival rates are to be improved, and more rational decisions can be made about the organisation of pre-hospital cardiac care.

Acknowledgements

We gratefully thank Marks & Spencer plc and the Peel Medical Research Trust for funding this research, Miss Susan Smith for preparing the manuscript, Dr D. D'Auria and Mr K. G. Smith of the London Ambulance Service for allowing access to records, and the staff of the Computer Unit of King's College School of Medicine and Dentistry.

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