Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital

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Management of out-of-hospital cardiac arrest is a major task of the accident and emergency department. The aim of this study is to evaluate the efficacy of prehospital resuscitation of out-of-hospital cardiac arrest in Hong Kong and identify areas for improvement. It was a prospective descriptive study of adults with non-traumatic out-of-hospital cardiac arrest who were admitted to the Accident and Emergency Department of Queen Mary Hospital by the ambulance service from March 15, 1999 to October 15, 1999. Patient characteristics and the response times of the ambulance service were recorded according to the Utstein style. One hundred and thirty patients were included. The overall immediate survival rate was 14.6% and the overall survival to discharge rate was 1.54%. The outcome of out-of-hospital cardiac arrest is poor. Every link in the chain of survival has to be improved. (*Hong Kong j. emerg.med.* 2000;7:191-196)

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Introduction

Resuscitation of out-of-hospital cardiac arrest (OHCA) is an important issue in Emergency Medicine. Although cardiopulmonary resuscitation (CPR) with closed chest compression has been practised for nearly 40 years,[1] survival of patients with OHCA as reported by various studies remains poor.[2-4] The American Heart Association has proposed the concept of the chain of survival in order to optimise the outcome.[5] The chain consists of early access to the emergency medical service (EMS), early CPR, early defibrillation and early advanced life support (ALS). The first three elements are clearly related to prehospital care. Any improvement in prehospital care should in theory improve the outcome of OHCA.

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Methods

This was a prospective descriptive study undertaken at the Accident and Emergency Department (A&E) of Queen Mary Hospital. The objectives were to evaluate the efficacy of prehospital resuscitation of OHCA and identify areas of improvement. The study period was from March 15, 1999 to October 15, 1999. Patients older than 18 years with non-traumatic OHCA occurring in the catchment area of Queen Mary Hospital and who were transported to the A&E by ambulance were included. Data including patient characteristics, the circumstances in which the arrest occurred, the ECG rhythm at scene and in A&E, outcome in A&E and the response times of the ambulance service based on the Utstein style was collected.[6] Except for those cases obviously dead before arrival, all patients were resuscitated by A&E staff using ACLS guidelines of the American Heart Association.[7] Records of

patients admitted were reviewed to determine the final outcome. Descriptive statistics were used for analysis of the outcome.

Results

During the study period, one hundred and thirty patients were included. There was a male predominance (61.5%). The mean age was 71 years (range 28-98 years). Diabetes mellitus, ischaemic heart disease and hypertension were the three commonest known underlying medical illnesses. (Table 1)

The majority of incidents of cardiac arrest occurred at patient's home (68.5%). In most cases, the scenes were accessible by lifts, however in about 2/3 of these cases, the lifts were not big enough to allow the ambulance crews to place their stretchers horizontally. More than half of the arrests were not witnessed (55.4%). It was usually the family members of patients who called for the EMS. In 86.2% of cases, the EMS was immediately summoned on recognition of the arrest. Delay occurred when other relatives were contacted first for their opinion. Before the arrival of the ambulance crews, only 17 patients received bystander CPR. Among these, one patient received basic life support (BLS) of both external chest compression and artificial ventilation. For the other cases, only either external chest compression or artificial ventilation was performed. (Tables 2a & 2b)

The commonest ECG rhythm at scene was asystole (76.2%). Ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) constituted 14.6%. In

Table 1. Patient characteristics (number in brackets).

Age (years)	Mean 71.08	Range 28-98
Gender	Male 61.5% (80)	Female 38.5% (50)
Medical disease	Yes	No
IHD	20.8% (27)	79.2% (103)
DM	21.5% (28)	78.5% (102)
HT	20.8% (27)	79.2% (103)
COAD	6.9% (9)	93.1% (121)
Malignancy	10% (13)	90% (115)
Others	25.4% (33)	74.6% (97)

Table 2a. Circumstance of arrest.

Location		Access		Stretcher accommodation	
Home	68.5% (89)	Lift	70% (91)	Yes	34.1% (31)
Old age home	13.1% (17)	Stairs	16.2% (21)	No	65.9% (60)
Street	6.2% (8)	Escalator	2.3% (3)		
Others	12.3% (16)	Slope	0.8% (1)		
		Others	10.8% (4)		

Table 2b. Circumstance of arrest.

Witness available		Caller		Call stat		Bystander CPR	
Yes	44.6% (58)	Family	70.8% (92)	Yes	86.2% (112)	Yes	13.1% (17)
No	55.4% (72)	Passer-by	4.6% (6)	No	13.8% (18)	No	86.9% (113)
		Officers	16.9% (22)				
		Others	7.7% (10)				

A&E, asystole continued to be the commonest initial ECG finding. Resuscitation was carried out in 68 patients (52.3%). Nineteen patients were successfully resuscitated and admitted to the in-patient wards of Queen Mary Hospital. The overall immediate survival rate was 14.6%. Among these 19 patients, eight presented with VF or pulseless VT at scene, nine out of these 19 survivors had already achieved return of spontaneous circulation on arrival at A&E. Thirteen of these survivors were admitted to the general ward, the rest to either CCU or ICU. Eleven were dead on the same day and fifteen patients died within 5 days of admission. One patient survived 14 days and another for 39 days before succumbing. Of these 130 OHCA patients, only 2 survived to discharge. One patient, nevertheless, remained in vegetative state. The other one returned to pre-arrest status. This only successful survivor was an 82 years old male with history of ischaemic heart disease. His arrest was not witnessed and occurred in the street. His presenting rhythm at scene was VF which was converted to VT with a pulse. He was treated in the CCU and then the general ward for about a month before discharge. (Tables 3a & 3b)

Table 3a. ECG rhythm.

ECG	At scene	At A&E
Asystole	76.2% (99)	78.5% (102)
VF/pulseless VT	14.6% (19)	3.1% (4)
PEA	4.6% (6)	7.7% (10)
Others	4.6% (6)	10.8% (14)

Table 3b. Putcome.

Attempted resuscitation		Outcome	
Yes	52.3% (68)	DBA	46.2% (60)
No	47.7% (62)	DOA	39.2% (51)
		ROSC	14.6% (19)

Table 4 shows the response times of the ambulance service. The average call to dispatch time was 1.03 minutes. The time elapsed before patients were treated by the ambulance crews was on average 8.95 minutes. The mean prehospital time was 28.44 minutes.

Discussion

The results of this study displayed a very gloomy picture of patients with OHCA in our community. During the study period, only 1 out of 130 patients could be revived to pre-arrest status. All the more discouraging is that despite advances in the practice of Emergency Medicine in Hong Kong in the last decade, not much improvement has occurred in the outcome of OHCA. A study of resuscitation outcome during 1992-1993 in Princess Margaret Hospital demonstrated a less than 2% survival rate.[8] The result of our study was no better. The outcome was even worse when compared with other major cities in the world.

The question that now stands out is: what is wrong with our system? The outcome of OHCA depends on many factors. To aid analysis, two groups of factors, namely the fate and the system factors, can be identified.[9] Fate factors describe features specific to the patient e.g. age, gender and past medical history. System factors, on the other hand, refer to the characteristics of the EMS e.g. the various response times after the occurrence of cardiac arrest.

The average age of patients in our study was 71 years.

Table 4. Response times.

Time	Range (minutes)	Mean (minutes)
Recognition-activation	1.0-48	3.85
Call-dispatch	1.0-2.0	1.03
Call-arrival	2.0-18	6.54
Call-patient side	3.0-21	8.95
Scene interval	1.0-22	9.98
Call-CPR	3.0-24	9.68
Call-shock	8.0-21	11.67
Call-ROSC	8.0-25	15.38
Call-A&E	9.0-45	28.44

The only successful survivor was 82 years old. Age by itself did not seem to be related to the outcome. This was also true for gender.[9] It was more difficult to evaluate the influence of underlying medical illness on the outcome, as the extent to which patient's health was affected was usually unknown and one patient might have more than one disease. In our group of patients, diabetes mellitus, ischaemic heart disease and hypertension were most prevalent. All of them, directly or indirectly, affected pre-arrest cardiac function. It was reasonable to assume that cardiac event was a significant cause of arrest in our patients. In that case, only the rhythm was related to outcome. It was well known that VF had the best prognosis whereas that of asystole was the worst. Whether the arrests were witnessed contributed significantly to the chance of survival. Over half of cardiac arrests in our study were not witnessed. Survival in this group of patients was rare because of the unknown period of time that patients had to wait before being resuscitated. Another concern was the delay in activation of the EMS. The average recognition to activation interval was 3.85 minutes. Without any resuscitative support, irreversible cerebral damage occurred after cessation of circulation for 3-4 minutes. This also explains why asystole was the commonest rhythm. Among the system factors, the time to CPR, defibrillation and ALS were important. To achieve the shortest time to CPR, initiation of CPR by a bystander was critical. It has been demonstrated in various studies that bystander CPR improved survival.[10] The quality of CPR also matters. Research showed that good CPR was better than those poorly performed.[11,12] If CPR was either done as external cardiac massage or artificial ventilation, survival was better in the former.[13] In our patients, the rate of bystander CPR was low. The average interval that BLS was provided by the ambulance crews was 9.68 minutes which was unacceptably long. The quality of bystander CPR was also doubtful and in only one case was CPR performed with both manoeuvres. Another remarkable finding in our study was the problem associated with patient transport. In a significant number of occasions, the stretchers could not be placed flat in lifts. This means that CPR could not be performed properly for a certain period of time during patient transport. This shortcoming, in combination with the low rate and poor quality of bystander CPR and delay in BLS, inevitably led to the poor outcome of OHCA in our study.

The second important system factor was time to defibrillation. This was based on the fact that almost all survivors of OHCA were in VF and the only effective treatment of VF was defibrillation. The earlier the defibrillation was performed the greater the likelihood of success. It was estimated that the chance of success dropped by 7% per minute.[14] At the end of 10 minutes, the chance was near to zero. In our study, the mean call to shock interval was 11.67 minutes. Though bystander CPR will slow the decline of success rate over time, our patients seldom received it. Therefore, a low success rate of defibrillation and in turn, a poorer outcome was expected.

The third factor that may contribute to the poor outcome was the delay in provision of ALS. Our EMS was basically a one-tier system providing BLS with defibrillation as the only ALS intervention. Looking at our figures, one could find that the average prehospital time, that is the time to A&E where ALS was provided, was about 29 minutes. This surely undermined the fourth link in the survival chain.

In 1994 and 1995, Wong[8] and Wong[15] had already observed the need for improving OHCA resuscitation in Hong Kong. With reference to our findings, there are certain aspects worth discussing. To improve the first link, i.e. early access, the recognition to activation interval must be shortened. The prerequisite is prompt recognition of the warning symptoms just before collapse. Patients knowledgeable about the symptoms of, say, a heart attack, have the shortest delay in asking for help.[16] Improvement is possible through public education, but this should also involve the physicians of the internal medicine specialty who treat most of these patients. Another phenomenon in Hong Kong worthy of note is the increasing number of elderly people who live alone. They belong to the high risk group for sudden cardiac arrest. Subsidies for installation of safety alarms connected to the EMS at their homes should be considered.

The area that requires urgent attention is bystander CPR. The proportion of the local population that

has been trained in CPR is unknown, but experience tells us that the proportion is small. Improvement is difficult without a well designed territory-wide program. Perhaps it is more feasible to conduct targeted CPR training. Persons with a high chance of witnessing a cardiac arrest and being called to rescue should be given priority of training. These include, for instance, old age home staff, employees of public transport companies and relatives of high risk patients. One particularly trainable group is the younger generation.[17] They, in general are more eager to learn and able to pick up the knowledge and skills. To derive the biggest benefit of CPR, it has to be performed properly. As noted earlier, stretcher accommodation in lifts poses a difficult problem. Better building design, perhaps with legislation controlling the desired floor area of lifts, is essential to overcome this problem.

Speedy defibrillation is a major determinant of OHCA outcome. To ensure victims in VF can be defibrillated as soon as possible, the availability of defibrillators and the number of operators should be increased. Currently, our ambulances are equipped with automated external defibrillators (AED) and the ambulance crews are trained in their operation. Promotion of public access to defibrillators was discussed at a conference in 1994 in the United States.[18] Two strategies were suggested. One strategy is to integrate AEDs into the existing public safety system including the police and the fire service. The second strategy is to involve the lay public as first responders in defibrillation provided AEDs are widely distributed. With regard to the local setting, the first strategy appears more practicable. Involvement of the lay public probably would take a very long time to achieve.

Improving the last link i.e. early ALS, means upgrading the skills and equipment of our ambulance crews. This unavoidably requires more resources in terms of time, money and manpower. In order to have speedy access to ALS, our ambulance crews should adopt a scoop and run approach except when defibrillation is required. This is because for the time being, A&E is the only place where ALS is delivered. A prehospital time of nearly 29 minutes is definitely far from ideal.

In conclusion, the outcome of OHCA patients is dismal. It is related to the high percentage of unwitnessed arrest, low rate of bystander CPR, delay in defibrillation and ALS. All links in the survival chain have to be strengthened. Otherwise, any effort in OHCA resuscitation will continue to be futile.

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