Prognosis of patients with ventricular fibrillation in out-of-hospital cardiac arrest in Hong Kong: prospective study

Objective. To determine the prognosis of patients with ventricular fibrillation in out-of-hospital cardiac arrest in Hong Kong and examine its relationship with the other links in the chain of survival.

Design. Prospective descriptive study.

Setting. Three accident and emergency departments, Hong Kong.

Participants. Patients older than 18 years with non-traumatic out-of-hospital cardiac arrest who were transported to the hospitals by ambulance between 15 March 1999 and 15 October 1999.

Main outcome measures. Demographic data, characteristics of the cardiac arrest and the response times of the emergency medical service according to the Utstein style, and survival to hospital discharge rate.

Results. Three hundred and twenty patients were included. The incidence of ventricular fibrillation in this group of patients was 14.1%. The chance of survival to hospital discharge was significantly higher for patients with ventricular fibrillation than those with other rhythms of cardiac arrest (4.4% versus 0.7%). Approximately 40.0% of all cardiac arrests were witnessed. The bystander cardiopulmonary resuscitation rate was low at 15.6%. The median intervals for recognition to activation of the emergency medical service, time to cardiopulmonary resuscitation, time to defibrillation, and time to advanced life support were 1, 8, 9, and 27 minutes, respectively.

Conclusion. Patients with ventricular fibrillation in out-of-hospital cardiac arrest have a better chance of survival than those with other cardiac rhythms. Further improvement requires simultaneous strengthening of all four links in the chain of survival.

Introduction

Since the landmark study by Zoll et al1 in 1956, it has been known that electrical defibrillation is the only effective means to terminate ventricular fibrillation (VF). Among the many factors that influence the effectiveness of
defibrillation, time is the most crucial one. The chance of success drops by 7% to 10% per minute delay. After 15 minutes, success is unlikely. To optimise the chance of survival, however, all four links in the chain of survival—early access to emergency medical service (EMS), early cardiopulmonary resuscitation (CPR), early defibrillation, and early advanced life support (ALS)—have to be strengthened simultaneously. In Hong Kong, the EMS is a one-tier system. The first training programme for ambulance crews on the operation of an automated external defibrillator (AED) began in 1990. By 1999, all ambulances in Hong Kong were equipped with an AED. Because of the lack of data on survival of patients with VF before the implementation of the AED programme, an assessment of its effect on VF resuscitation is not possible. This study aims to determine the prognosis of VF in out-of-hospital cardiac arrest (OOHCA) and its relationship with the other links in the survival chain in the presence of an ambulance AED programme.

Methods

A prospective descriptive study was conducted in the accident and emergency (A&E) departments at Queen Mary Hospital, Pamela Youde Nethersole Eastern Hospital, and Tang Shiu Kin Hospital from 15 March 1999 to 15 October 1999. The three A&E departments serve Hong Kong Island and the outlying islands. The population is approximately 1.4 million.

The study population included all patients older than 18 years with non-traumatic OOHCA who were transported to the A&E departments by ambulance. Patients from the outlying islands were excluded. Data collected included patient characteristics, cardiac rhythm at the scene, whether the arrest was witnessed, whether bystander CPR was performed, and survival status. The EMS response with regard to the time to EMS activation, CPR, defibrillation, and ALS provision was recorded. Data were reported according to Utstein style guidelines. Data were primarily analysed by descriptive statistics. Two-tailed P values for comparison between patients with and without VF were provided by Chi squared test for categorical variables and Wilcoxon-Mann-Whitney test for continuous variables.

Results

Three hundred and twenty patients with OOHCA were enrolled during the study period. Forty-five patients had VF and constituted 14.1% of the study population. The majority (75.6%) had asystole (Table 1).

Table 1. Electrocardiogram rhythm at scene (n=320)

<table>
<thead>
<tr>
<th>Electrocardiogram rhythm</th>
<th>Patients No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asystole</td>
<td>242 (75.6)</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>45 (14.1)</td>
</tr>
<tr>
<td>Pulseless electrical activity</td>
<td>24 (7.5)</td>
</tr>
<tr>
<td>Others</td>
<td>9 (2.8)</td>
</tr>
</tbody>
</table>

Table 2. Outcomes of prehospital defibrillation (n=41)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Patients No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead at accident and emergency department</td>
<td>35 (85.4)</td>
</tr>
<tr>
<td>Survival to hospital admission</td>
<td>6 (14.6)</td>
</tr>
<tr>
<td>Survival to hospital discharge</td>
<td>2 (4.9)</td>
</tr>
</tbody>
</table>

Of the 45 patients with VF, 41 received defibrillation by the ambulance crews in the prehospital phase. Two survived to hospital discharge. The cause for not giving electrical defibrillation to the remaining four patients was uncertain. The outcomes of prehospital defibrillation are shown in Table 2. When compared with patients with rhythms other than VF, patients with VF were more likely to have a history of ischaemic heart disease (IHD), and have their arrests witnessed. Their chances of survival were also significantly higher than patients with other rhythms (4.4% versus 0.7%) [Table 3].

Table 4 shows the response times of the EMS. For the group with VF, the median intervals for EMS activation, CPR, defibrillation, and ALS provision were 1, 8, 9, and 27 minutes, respectively. Only the time to CPR interval was significantly different between patients with and without VF.

Discussion

The incidence of VF in OOHCA varies markedly in different studies, ranging from 12% to 70%. This study revealed a relatively low incidence of VF in patients with OOHCA. This can probably be explained by two facts: a high ratio of...
unwitnessed cardiac arrests and low rate of bystander CPR. More than 50% of cardiac arrests were not witnessed in this study. For these patients, the time interval before EMS attention was unknown. With time, the initial VF would degenerate into asystole for an increasing number of patients. This is reflected by the high percentage of patients with asystole as the initial rhythm recorded by the EMS. Bystander CPR, if properly performed, maintains the heart in VF for a short period of time. With the low rate of bystander CPR (15.6%), it is not surprising to find asystole as the predominant rhythm.

This study suggests a better prognosis for patients with VF. When compared with patients in other cardiac arrest rhythms, there were statistically significant differences in the prevalence of IHD, witness status, and time to CPR interval. These differences may partly explain the better prognosis of VF. Patients with IHD, who had their arrests witnessed and who received CPR earlier, may be more likely to be in VF when they were attended by the EMS.

Worldwide, there is much variation in the survival rate of patients with VF, ranging from 4% in New York City to 30% in Seattle. Despite the differences in the structure of EMS, experience with prehospital resuscitation, and patient characteristics, the chance of survival of VF patients in this locality remains poor when compared with major cities in the rest of the world. One of the possible causes may be the delay in defibrillation. It has been shown that survival is closely related to the delay in first defibrillation. The faster it is delivered, the better is the prognosis. For instance, in Seattle, where the survival rate is high, the time delay to defibrillation was only approximately 4 minutes. In Hong Kong, with a median time to defibrillation interval of 9 minutes, survival is expected to be low.

To achieve the 5-minute time to defibrillation interval advocated by the American Heart Association is not easy. It involves minimising delay in the chain of events leading to delivery of defibrillation. The chain starts with the recognition of dangerous symptoms by patients or bystanders leading to EMS activation, followed by the EMS call receipt, arrival at the scene of the cardiac arrest, and first defibrillation. Continuous health education to the public is essential to maintain a short recognition to activation interval. On the other hand, shortening the phase after EMS activation depends on a number of factors such as the location of the cardiac arrest, traffic conditions, and the deployment of emergency vehicles. In the current situation, concerted efforts by various government departments are required to achieve a better result.

Public access defibrillation (PAD), which allows trained laypersons to operate an AED, is an important move in OHCA resuscitation. This move is intended to shorten the collapse to defibrillation interval. There are three potential levels of responders. The first level is the non-traditional responders such as the police and firefighters. Level two targets the responders in public facilities such as staff working at the airport. The third level of responders comprises relatives and friends of people at risk of sudden cardiac death. Although the idea of PAD appears to be attractive, evidence of its effectiveness in improving the outcome of OHCA is not always positive. For instance, while White et al found a higher survival rate from OHCA after equipping police officers with AED when compared to historical controls, Kellermann et al found no significant difference after providing AED to firemen. Until more definitive evidence is available, attention should probably be focused on other more pressing issues such as strengthening the other links in the survival chain. Moreover, early defibrillation alone is not enough to improve the chances of survival of patients with VF. New York City and Hong Kong have comparable survival rates for patients with VF. Yet the median time elapsed for first defibrillation in New York was 12.4 minutes, which is 3 minutes longer than in Hong Kong. Further analysis reveals that there is a higher bystander CPR rate (32%) in New York, and a shorter ALS interval (15 minutes). This difference highlights the importance of the other links in the chain of survival in resuscitation of patients with VF.

Limitation of study

The major limitation of this study is the small sample size. It is not possible to perform multivariate analysis to identify any favourable prognostic factors because of the small number of survivors. From this study, significant differences in IHD prevalence, witness status, and time to CPR interval between patients with and without VF were noted. These may contribute to the different outcomes of the two groups. Owing to the study design, the reasons leading to the differences in these three aspects cannot be identified. It is, however, hoped that this study may provide some background information on OHCA in this locality.

Table 4. Response times of the emergency medical service

<table>
<thead>
<tr>
<th>Event</th>
<th>Ventricular fibrillation, n=45</th>
<th>Non–ventricular fibrillation, n=275</th>
<th>P value (ventricular fibrillation vs non–ventricular fibrillation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median time of recognition to activation of emergency medical service (interquartile range) [minutes]</td>
<td>1.0 (1.0-1.0)</td>
<td>1.0 (1.0-2.0)</td>
<td>0.175</td>
</tr>
<tr>
<td>Median time to cardiopulmonary resuscitation (interquartile range) [minutes]</td>
<td>8.0 (7.0-10.0)</td>
<td>9.0 (7.0-12.0)</td>
<td>0.042</td>
</tr>
<tr>
<td>Median time to defibrillation (interquartile range) [minutes]</td>
<td>9.0 (8.0-15.0)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Median time to advanced life support (interquartile range) [minutes]</td>
<td>27.0 (22.5-30.0)</td>
<td>27.0 (23.0-32.0)</td>
<td>0.470</td>
</tr>
</tbody>
</table>
Conclusion

Patients with VF in OOHCA have a better prognosis than those with other heart rhythms. The survival rate of 4.4% in Hong Kong is, however, low in comparison with other cities. While shortening the time to defibrillation is an important consideration, implementation of a PAD programme in Hong Kong needs further evaluation. Instead, resources should be allocated to public education on health issues, for example, enhancing public awareness of the signs and symptoms of IHD. In particular, knowledge and practice of CPR should be disseminated and encouraged on a territory-wide scale. Measures to shorten the delay to arrival in the A&E department for ALS initiation are also important. By combining all these efforts, hopefully, the survival rate of patients with VF in OOHCA can be improved.

Acknowledgements

The authors wish to thank Dr CB Lo, Dr HK Tong, Dr TW Wong, and Dr PG Kan for their guidance and comments. Thanks are also due to the staff of the three accident and emergency departments involved as well as the ambulance crews of the Fire Services Department.

References