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

香港心室纖維性顫動患者在醫院外心動停止的預後：預期研究

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.

目的：確定香港心室纖維性顫動患者在醫院外心動停止的預後，並研究在存活鏈中與其他部份的關係。
設計：預期描述性研究。
安排：香港的三間急症室。
參與者：1999年3月15日至10月15日期間由救護車送到醫院，無外傷而心動停止的18歲以上患者。
主要結果測量：人口統計學數據，心動停止的特徵和根據Utstein模式量度的急救服務反應時間，以及出院時的存活率。
結果：本研究包括了320名患者。其中心室纖維性顫動患者佔14.1%；他們出院時的存活率大大高於其他心動停止的患者(4.4%比0.7%)。約40.0%的病例在病發時有人在場。有人在場的病例中，心肺復蘇率只有15.6%。通知並動員急救的中值時間、進行心肺復蘇的時間、除纖顫的時間及高級生命支持的時間分別為1、8、9、和27分鐘。
結論：心室纖維性顫動患者在醫院外心動停止的存活機會高於其他心臟病患者。要進一步改善患者的存活率，需要同時加強存活鏈中所有四個環節的效率。

Key words:
Heart arrest;
Prognosis;
Ventricular fibrillation

關鍵詞：
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Introduction

Since the landmark study by Zoll et al[1] 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.[2] 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.[3] 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.[4]

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.[5] 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.

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

Electrocardiogram rhythm	Patients No. (%)
Asystole	242 (75.6)
Ventricular fibrillation	45 (14.1)
Pulseless electrical activity	24 (7.5)
Others	9 (2.8)

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

Outcome	Patients No. (%)
Dead at accident and emergency department	35 (85.4)
Survival to hospital admission	6 (14.6)
Survival to hospital discharge	2 (4.9)

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).

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 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%.[6] 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

Table 3. Characteristics of cardiac arrest

Characteristic	Patients, n=320 No. (%)	Ventricular fibrillation, n=45 No. (%)	Non–ventricular fibrillation, n=275 No. (%)	P value (ventricular fibrillation vs non–ventricular fibrillation)
Median age (interquartile range) [years]	73 (60.0-80.0)	74 (53.3-81.0)	74 (65.0-81.0)	0.153
Sex				
Male	180 (56.3)	30 (66.7)	150 (54.5)	0.146
Female	140 (43.8)	15 (33.3)	125 (45.5)	-
History of IHD*	68 (21.3)	17 (37.8)	51 (18.5)	0.003
Arrest witnessed	136 (42.5)	26 (57.8)	110 (40.0)	0.025
Bystander CPR†	50 (15.6)	8 (17.8)	42 (15.3)	0.668
Survival to hospital discharge	4 (1.3)	2 (4.4)	2 (0.7)	0.037

* IHD ischaemic heart disease
† CPR cardiopulmonary resuscitation

Table 4. Response times of the emergency medical service

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

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.[7] 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.[8,9] 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.[10,11] 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.[12,13] 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.[11] 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.[14] 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 OOHCA resuscitation. This move is intended to shorten the collapse to defibrillation interval. There are three potential levels of responders.[14] 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 OOHCA is not always positive. For instance, while White et al[15] found a higher survival rate from OOHCA after equipping police officers with AED when compared to historical controls, Kellermann et al[16] 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.[10] 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 OOHCA in this locality.

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.

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References

1. Zoll P, Linenthal A, Gibson W, Paul M, Norman L. Termination of ventricular fibrillation in man by externally applied electric countershock. N Engl J Med 1956;254:727.
2. Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993;22:1652-8.
3. Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. Circulation 1991;83:1832-47.
4. Hong Kong 1999. Hong Kong: HKSAR Government; 1999.
5. Cummins RO, Chamberlain DA, Abramson NS, et al. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein Style. A statement for health professionals from a task force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Circulation 1991;84:960-75.
6. Eisenberg MS, Horwood BT, Cummins RO, Reynolds-Haertle R, Hearne TR. Cardiac arrest and resuscitation: a tale of 29 cities. Ann Emerg Med 1990;19:179-86.
7. Cox SV, Woodhouse SP, Weber M, Boyd P, Case C. Rhythm changes during resuscitation from ventricular fibrillation. Resuscitation 1993; 26:53-61.
8. Herlitz J, Ekstrom L, Wennerblom B, Axelsson A, Bang A, Holmberg S. Effect of bystander initiated cardiopulmonary resuscitation on ventricular fibrillation and survival after witnessed cardiac arrest outside hospital. Br Heart J 1994;72:408-12.
9. Waalewijn RA, de Vos R, Koster RW. Out-of-hospital cardiac arrests in Amsterdam and its surrounding areas: results from Amsterdam resuscitation study (ARREST) in 'Utstein' style. Resuscitation 1998; 38:157-67.
10. Lombardi G, Gallagher J, Gennis P. Outcome of out-of-hospital cardiac arrest in New York City. The Pre-Hospital Arrest Survival Evaluation (PHASE) study. JAMA 1994;271:678-83.
11. Eisenberg MS, Hallstrom AP, Copass MK, Bergner L, Short F, Pierce J. Treatment of ventricular fibrillation. Emergency medical technician defibrillation and paramedic services. JAMA 1984;251:1723-6.
12. Cobbe SM, Redmond MJ, Watson JM, Hollingworth J, Carrington DJ. "Heartstart Scotland"—initial experience of a national scheme for out-of-hospital defibrillation. BMJ 1991;302:1517-20.
13. Herlitz J, Ekstrom L, Wennerblom B, Axelsson A, Bang A, Holmberg S. Survival in patients found to have ventricular fibrillation after cardiac arrest witnessed outside hospital. Eur Heart J 1994;15: 1628-33.
14. Part 4: the automated external defibrillator: key link in the chain of survival. European Resuscitation Council. Resuscitation 2000;46: 73-91.
15. White RD, Asplin BR, Bugliosi TF, Hankins DG. High discharge survival rate after out-of-hospital ventricular fibrillation with rapid defibrillation by police and paramedics. Ann Emerg Med 1996;28: 480-5.
16. Kellermann AL, Hackman BB, Somes G, Kreth TK, Nail L, Dobyns P. Impact of first-responder defibrillation in an urban emergency medical services system. JAMA 1993;270:1708-13.