Out-of-hospital cardiac arrest in a teaching hospital in Hong Kong: descriptive study using the Utstein style

使用厄特斯泰因形式在香港一所教學醫院作院前心搏停止的描述性研究

AKC Wai 衛家聰, P Cameron, CK Cheung 張志騏, P Mak 麥小娟, TH Rainer 譚偉恩

Objective: To describe, using the Utstein template, the characteristics of patients presenting with out-of-hospital cardiac arrest to a university teaching hospital in the New Territories of Hong Kong, and to evaluate survival. *Design:* Prospective study. *Setting:* The emergency department of a teaching hospital in the New Territories, Hong Kong. *Participants:* Patients older than 12 years with non-traumatic out-of-hospital cardiac arrest who were transported to the hospital between 1 July 2002 and 31 December 2002. *Main outcome measures:* Demographic data, characteristics of cardiac arrest and response time intervals of the emergency medical service presented according to the Utstein style, and also survival to hospital discharge rate. *Results:* A total of 124 patients were included (49.2% male; mean age 71.9 years). The majority of cardiac arrests occurred in patients' home. The overall bystander cardiopulmonary resuscitation (CPR) rate was 15.3% (19/124). The most common electrocardiographic rhythm at scene was asystole, whilst pulseless ventricular tachycardia (VT)/ventricular fibrillation (VF) was found in 18.0%. The overall survival was 0.8% (1/124), and survival to hospital discharge was significantly higher for patients with VF or pulseless VT than those patients with other rhythms of cardiac arrest (11.1% versus 0%). The median witnessed/recognised collapse to defibrillation time was 14 minutes. The median prehospital time interval from collapse/recognition to arrival at hospital was 33 minutes. *Conclusion:* The prognosis of out-of-hospital cardiac arrest in Hong Kong was poor. Major improvements in every component of the chain of survival are necessary. (*Hong Kong j.emerg.med.* 2005;12:148-155)

目的：使用厄特斯泰因樣板，描述在香港新界一所大學教學醫院呈現院前心搏停止病者的特徵，並評估其生存率。**設計：**前瞻性研究。**設定背景：**香港新界一所教學醫院的急症室。**參與者：**於二零零二年七月一日至十二月三十一日期間因非創傷性院前心搏停止而被送院的十二歲以上病者。**主要結果量度：**根據厄特斯泰因形式描述病人統計數據、心搏停止的特徵、緊急醫療服務反應的間距，與及生存出院率。**結果：**研究包括 124 名病者（男性佔 49.2%；平均年齡 71.9 歲）。大部份心搏停止個案發生在病者家中，整體上，旁觀者施行心肺復甦法佔 15.3%（19/124）。現場最常見的心電圖心率為心搏靜止，而無脈膊的心室心率過速或心室纖維性顫動者只佔 18.0%。整體生存率為 0.8%（1/124），心室纖維性顫動或無脈膊的心室率過速病者的生存出院率顯著地高於心搏停止的其他心率（11.1% 對 0%）。由目擊或識

Correspondence to:
Timothy Hudson Rainer, MD, FHKAM(Emergency Medicine)
Prince of Wales Hospital, Accident & Emergency Medicine Academic Unit, The Chinese University of Hong Kong, Room 107, Trauma and Emergency Centre, Shatin, N.T., Hong Kong
Email: thrainer@cuhk.edu.hk

Wai Ka Chung, Abraham, MBChB
Peter Cameron, MD, FACEM
Cheung Chee Kay, MBChB, BSc(Leeds)
Paulina Mak, RN

別昏倒的時刻至施行去顫術的時間中位數為 14 分鐘。由目擊或識別昏倒至抵院的院前間距中位數為 33 分鐘。**總結：**香港院前心搏停止個案的預後很差，生存鏈中的每一個部份需要重大的改善。

Keywords: Ambulances, cardiopulmonary resuscitation, emergency medical services, heart arrest, ventricular fibrillation

關鍵詞：救護車、心肺復甦法、緊急醫療服務、心搏停止、心室纖維性顫動

Introduction

Uniform reporting of data from out-of-hospital cardiac arrest (OHCA) in the Utstein style was introduced in 1991,[1] and since then it has been used to evaluate and to compare emergency medical services at different stages of development throughout the world.[2-11] In Hong Kong, there is no territory-wide registry to collect and to analyse outcome data for patients suffering from OHCA although a few multi-centre reports have been published.[12] The objective of this study was to describe, using the Utstein template, the characteristics of patients presenting with out-of-hospital cardiac arrest to a university teaching hospital in the New Territories of Hong Kong, and to evaluate survival.

Materials and methods

Data were collected prospectively on all patients transported to the Emergency Department of the Prince of Wales Hospital (PWH), New Territories, Hong Kong from 1st July to 31st December 2002. All data were collected and recorded according to the Utstein style template. PWH is a regional referral centre serving a population of approximately 1.5 millions. The emergency department receives about 200,000 new cases a year and admits about 24% of the cases. All emergency ambulances have a defibrillator. Ambulance personnel completed a patient record form and handed this to emergency personnel for reference. The data were used to capture ambulance times. In general, three ambulance personnel would attend each cardiac arrest.

Results

A total of 124 non-traumatic patients with mean age 71.9 years (SD 16.6; range 14 to 97; 49.2% male) were admitted to the resuscitation room with out-of-hospital cardiac arrest. Table 1 shows the patient demographics, site of collapse, type of ambulance responding to the call, and witness personnel. Bystander cardiopulmonary resuscitation (CPR) was

Table 1. Patient demographics, site of collapse, ambulance type and witness personnel in 124 patients presenting with cardiac arrest

	Variable*
Mean age [SD] - years	72 [17]
Male sex	61 (49.2%)
Site of collapse	
Home	85 (68.5%)
Old age home	19 (15.3%)
Public place	9 (7.3%)
Street	7 (5.6%)
Other	4 (3.2%)
Transfer to the Emergency Department	
By Ambulance	
EMA II (intermediate level)	68 (54.8%)
EMA I (basic with defibrillator)	51 (41.1%)
Not by Ambulance	5 (4.0%)
Personnel witnessed/recognised the arrest	
Relatives	83 (66.9%)
Ambulancemen/Nurse	8 (6.5%)
Police	1 (0.8%)
Others	32 (25.8%)

*Values in brackets are percentages unless stated otherwise

EMA=emergency medical assistant

performed in 19 (15.3%) patients. Figure 1 presents data according to the Utstein template. Among these patients, 70 (56.5%) were considered to have cardiogenic (primary) cardiac arrest, and 54 (43.5%) patients had cardiac arrest of presumed non-cardiac (as identified from patients' history of past and present illness) aetiology.

Figure 2 shows that of the 50 patients with witnessed OHCA of primary cardiac origin, asystole and pulseless electrical activity [unshockable rhythms] were noted in 41 (82.0%), and ventricular fibrillation (VF)/ pulseless ventricular tachycardia (VT) [shockable rhythms] in 9 (18.0%). The rate of return of spontaneous circulation (ROSC) and discharge rate in patients suffering a cardiogenic witnessed OHCA was 32.0% and 2.0% respectively. The discharge rate in patients with a witnessed VF/pulseless VT was 11.1% (1/9, Figure 2). The 54 patients with cardiac arrest of non-cardiac causes are presented in Table 2. The commonest associated diagnoses were cancer and hypoxia due to pulmonary causes.

Only one patient survived. This was a young patient with chest pain who collapsed in a taxi on the way to hospital. He reached the emergency department within 10 minutes. He did not have any premorbid medical conditions that impaired his survival and recovery. His initial presenting rhythm was pulseless VT. One series of shock and aggressive resuscitation were given before spontaneous circulation returned.

Table 3 shows the time intervals that are critical for the chain of survival. The median time between witnessed/recognised collapse to ambulance control receiving the call was 4 minutes. The median ambulance response time (from when the ambulance control received the call to when the ambulance stopped at the street level) was 6 minutes. The ambulance responded within 11 minutes in 90% of

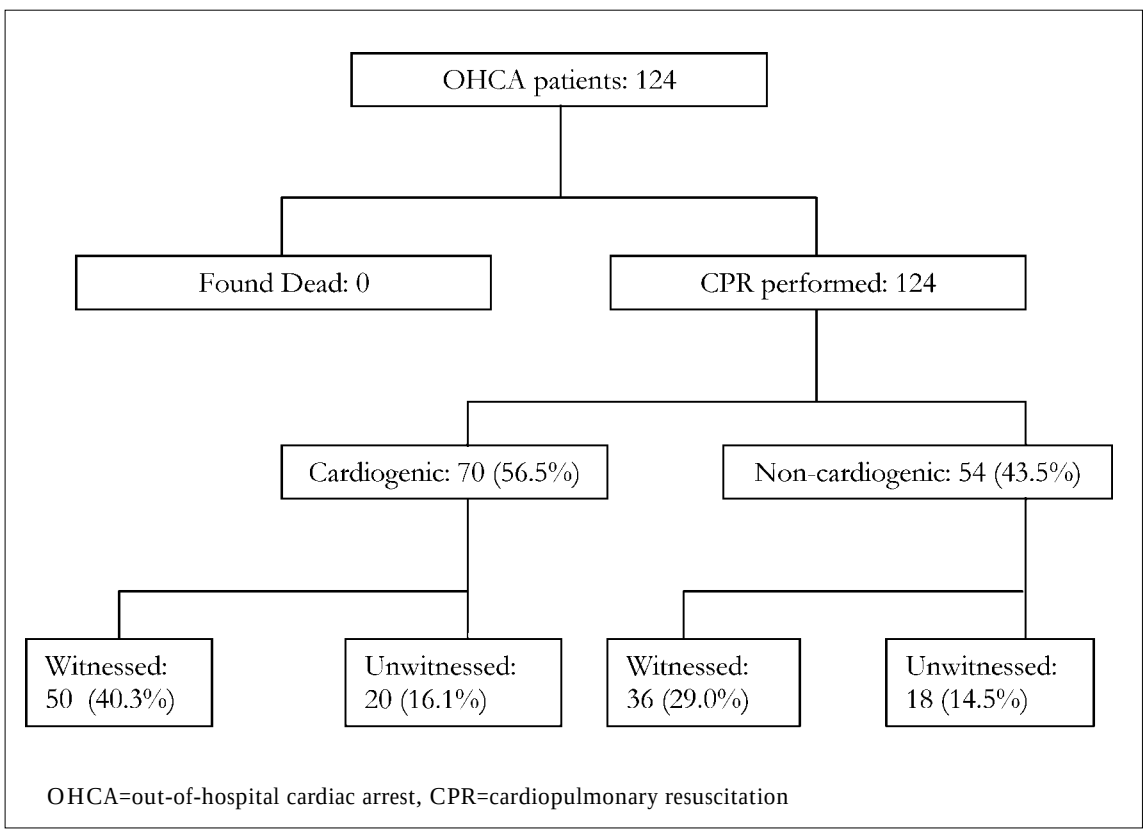
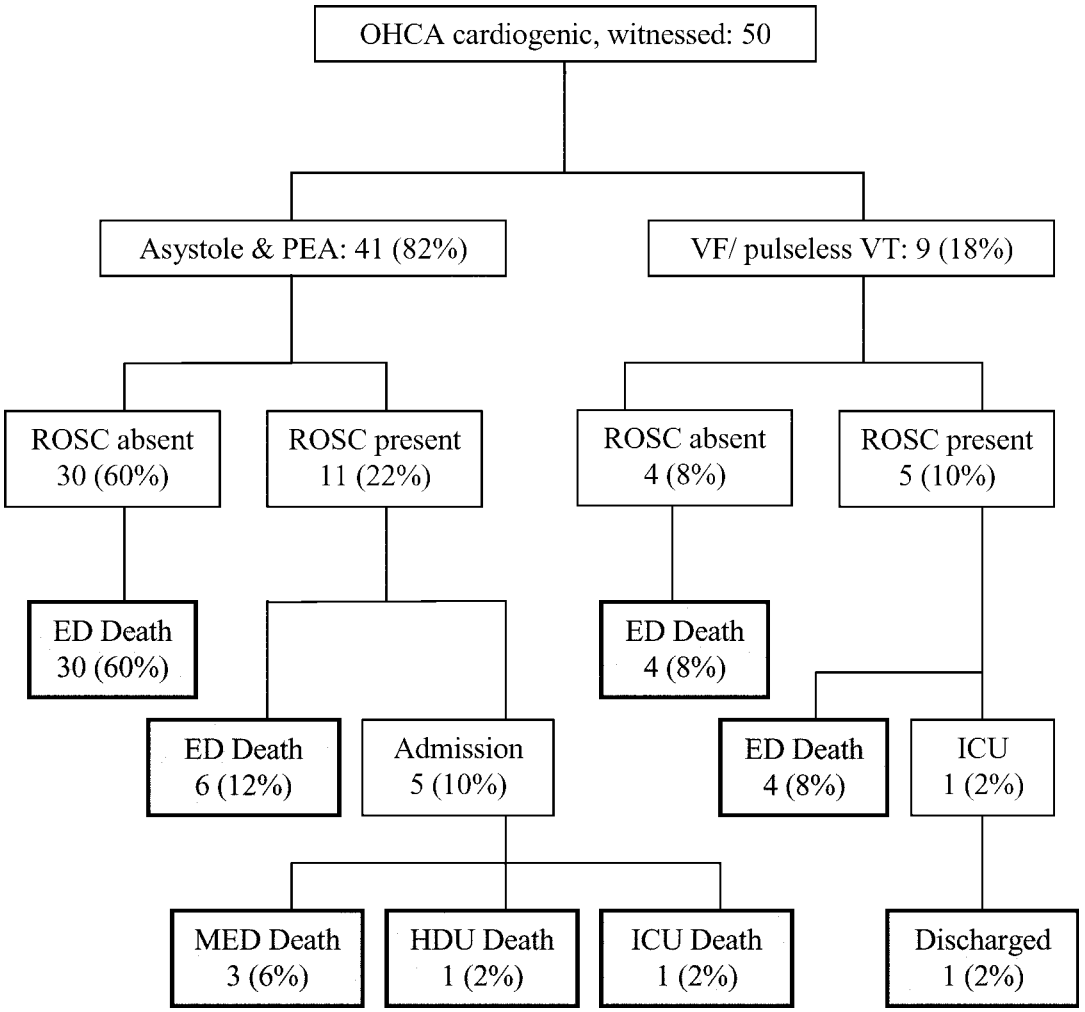


Figure 1. Overall data of 124 OHCA patients using the Utstein template.



ED=emergency department; HDU=high dependency unit; ICU=intensive care unit; MED=general medical ward; OHCA=out-of-hospital cardiac arrest; PEA=pulseless electrical activity; ROSC=return of spontaneous circulation; VF=ventricular fibrillation; VT=ventricular tachycardia.

The darkened boxes indicate the final outcome of each group of patients.

Figure 2. Outcome of cardiogenic, witnessed OHCA .

Table 2. Non-cardiac causes of cardiac arrest in 54 patients

	Number of patients	%
Airway obstruction	6	11.1
Drowning	1	1.9
Haemorrhage - non trauma	4	7.4
Hypoxia by pulmonary disease	9	16.7
Intoxication	6	11.1
Intracranial - non trauma	7	13.0
Cancer	17	31.5
Pulmonary embolism	3	5.6
Others	1	1.9
TOTAL	54	100

Table 3. Response and other times (minutes)

Time interval	Median	IQR
From call to bystander CPR	0	0 - 1
From witnessed/recognised collapse to call receipt	4	2 - 10
From call receipt to vehicle arrival at street level	6	5 - 8
From vehicle arrival at street level to patient's side	2	0 - 2
From patient's side to first shock delivered	2	1 - 4
From witnessed collapse to defibrillation	14	8 - 22
From patient's side to departure from scene	12	8 - 15
From witnessed collapse to arrival at emergency department	33	25 - 41
Witnessed collapse to ROSC	23	16 - 26
Defibrillation to ROSC	10	4 - 15
Witnessed/recognised collapse to death certification	60	42 - 79

ROSC=return of spontaneous circulation

cases. The median delay between ambulance arrival at the street level and getting to the patient's side was 2 minutes. There was a further median 2-minute delay between the time when the ambulance personnel reached the patient's side and the first defibrillation. Only 75% of the patients received defibrillation within 4 minutes. Therefore, the overall median reported witnessed/recognised collapse to defibrillation time delay was 14 minutes. Ambulance personnel spent a median of 12 minutes with the patient before the ambulance left the scene, but on occasions it could take up to 18 minutes or longer. The median time interval from reported witnessed/recognised collapse to presentation at the emergency department was 33 minutes.

Discussion

This study showed that the overall survival to discharge after prehospital cardiac arrest in Hong Kong was poor. The main reasons for the poor outcomes resulted from major weaknesses in the chain of survival.

The median time from witnessed/recognised collapse to receipt of call by the ambulance control centre was 4 minutes. The importance of early recognition and access to the emergency medical service has to be stressed to the general public. Eighty-five (68.5%) collapses occurred in the patients' home and 83 (66.9%) were found by relatives. Although 86 (69.4%) of the cardiac arrests were witnessed, only 19 received bystander CPR. Therefore, training relatives of high-risk cases to recognise cardiac arrest, to initiate CPR and to call for emergency medical services remains a high priority.

Ambulance response times were within their performance targets, but the time from ambulance stopping at the street level to arriving at the patient's side took about 2 minutes more. The commonest initial rhythm noted was asystole, suggesting that any effort by trained ambulance personnel was likely to have little effect. It took a median of 14 minutes from the time of witnessed collapse to the first defibrillation - possibly too long to be effective. In any patient presenting in a shockable rhythm, the single greatest determinant of survival would be the time from collapse to the first defibrillation.[13] Time is critical as survival from cardiac arrest caused by VF/pulseless VT declines by 7-10% per minute. For sudden cardiac arrest, survival was constant if the defibrillation response time interval had been less than 6 minutes, but decreased as the interval increased from 6 to 11 minutes, and levelled off after 11 minutes.[14,15] When over 12 minutes after collapse, the survival from cardiac arrest would be only 2-5%.[13] Thus, even though Hong Kong ambulances achieved their response time performance target (12 minutes for ≥92.5% of all calls), the overall survival was still poor. Shorter response times were significantly associated with increased probability of receiving defibrillation and survival to discharge among those

defibrillated. In the UK, one study showed that reducing the 90th percentile for response time to 8 minutes increased the predicted survival to 8%, whilst reducing it to 5 minutes increased survival to 10-11%.[16]

Among those non-cardiogenic cardiac arrests, about 1/3 of them were patients with cancer, raising questions regarding the appropriateness of resuscitation and the need for 'do not resuscitate' orders. The next highest causes were hypoxia due to pulmonary disease and airway obstruction, the latter being potentially preventable or even reversible. To become more efficient in treating airway obstruction patients, a population-based education programme on the early management of choking by foreign bodies may enhance the chance that the patients will receive prompt and appropriate treatment.

It took a median of 60 minutes from witnessed/ recognised collapse to death certification with a few cases exceeding 3 hours. Whilst prolonged resuscitation might be appropriate in some cases, it was likely that in many cases this was a waste of resources. Medical personnel may need to be more prudent in terminating resuscitation.

An earlier study from Hong Kong found that the majority of cardiac arrests occurred at patients' homes and that in 57.5% of cases the arrest was not witnessed.[12] The bystander CPR rate was 15.6% and the most common electrocardiographic (ECG) rhythm at scene was asystole. Similar to the current study, the average call to dispatch interval was 1.04 minutes, average call to CPR interval was 9.82 minutes and the average total prehospital interval was 27.55 minutes. The overall immediate survival rate was 14.1% and the rate of survival to hospital discharge was 1.25%. Patients with ventricular fibrillation in out-of-hospital cardiac arrest had a better chance of survival than those with other cardiac rhythms. These findings were similar to our study and suggest that over the three years there has been little improvement - the weakness in the Hong Kong system was still the first three links of the survival chain, including delay in health care access, low bystander CPR rate and long witnessed/recognised collapse to defibrillation time, which was far longer than the 5 minutes recommended by the American Heart Association (AHA).[17]

Table 4 compares the discharge rates of patients suffering witnessed VF/pulseless VT from a variety of international centres and includes our data for comparison. The best outcomes were from Germany followed by King County and Helsinki, where the emergency medical services in these cities were able to provide a rapid and effective chain of resuscitation. However, the King County study may not be representative of the situation in the United States. These centres also provide a high level of medical involvement and control. All these factors might contribute to improving the outcome in resuscitation of these OHCA patients. Although we have a 11.1% discharge rate for patients with witnessed VF/pulseless VT, the number of cases in this study was extremely

Table 4. Comparison of discharge rates for patients suffering from a witnessed VF/pulseless VT in other centres.

Nation	City or county, year [reference]	Rate (%)
USA	King County 1991 [2]	34.0
Canada	Ottawa 1999 [3,4]	5.2
	Ottawa 2004 [5]	5.1
England	Nottingham 1999 [6]	11.7
Germany	Heidelberg 1999 [7]	37.7
Finland	Helsinki 1996 [8]	32.5
New Zealand	Auckland 1995 [9]	16.3
Denmark	Copenhagen 2000 [10]	20.5
Japan	Major metropolitan areas 2000 [11]	11.4
China	Hong Kong 2001 [12]	1.25
	Hong Kong 2002 [this study]	11.1

VF=ventricular fibrillation, VT=ventricular tachycardia

small and only a single hospital was studied. Therefore this could not be representative of Hong Kong in general.

With reference to the successful experiences in those cities with high VF/pulseless VT discharge rate, we may improve the quality of prehospital care by enhancing the key elements of the "Chain of Survival". Defibrillation and Basic Life Support (BLS) of patients with OHCA is associated with an increase in survival compared to BLS and no defibrillation.[18,19] Currently in Hong Kong, lay persons can learn the skills mainly by classes organised by St. John Ambulance and the Red Cross. A certificate, which is valid for 2-3 years, will be awarded upon passing both practical and written examinations. Certificate holders must renew the status by re-sitting the examination after taking a refresher course. An even more effective means may be to put BLS into the local school curriculum.

Automated external defibrillators (AED) play an important role in cardiac arrest resuscitation. The principle is that the most common adult primary arrhythmia is VF/pulseless VT and minimal delay in the provision of a countershock improves survival.[20] The invention of the AED simplifies the training of defibrillation because it can identify the shockable rhythms and prompt actions by itself, saving time in training on skills such as ECG interpretation and the steps of the procedure. The simplicity, accuracy, and safety of these devices markedly expand the range of people who can deliver early defibrillation, which include minimally trained emergency personnel, lay and community responders, and family members of high-risk patients.[21] Public access defibrillation has been suggested to solve the problem because the local emergency medical service cannot respond fast enough. We need to note that there is evidence that installing AED as an isolated measure, without any supportive measure, does not improve survival.[22,23] Instead, early defibrillation is the single most important factor for survival after out-of-hospital cardiac arrest. Firemen, police officers, frontline civil servants, airline crew, school teachers and students should receive adequate training so that they can function as effective first responders if necessary, as recommended by AHA at the second Public Access Defibrillation Conference.[24]

However, an economic modelling exercise revealed that the more widespread is the provision of public place defibrillators, the higher is the cost per quality adjusted life year (QALY).[25] This is probably another point for consideration with the current budgetary cuts in public health services in Hong Kong.

Conclusion

Survival from cardiac arrest in Hong Kong has improved little in the last 10 years, despite it being a major world city and financial centre. Better survival figures should be possible if major links in the chain of survival are strengthened.

Acknowledgements

We pay tribute to the staff of the emergency department and ambulance service who dedicate their time and effort to improving the quality of life of members of our society.

References

1. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the 'Utstein style'. Prepared by a Task Force of Representatives from the European Resuscitation Council, American Heart Association, Heart and Stroke Foundation of Canada, Australian Resuscitation Council. Resuscitation 1991; 22(1):1-26.
2. Eisenberg MS, Cummins RO, Larsen MP. Numerators, denominators, and survival rates: reporting survival from out-of-hospital cardiac arrest. Am J Emerg Med 1991;9(6):544-6.
3. Stiell IG, Wells GA, Spaite DW, Nichol G, O'Brien B, Munkley DP, et al. The Ontario Prehospital Advanced Life Support (OPALS) study Part II: Rationale and methodology for trauma and respiratory distress patients. OPALS Study Group. Ann Emerg Med 1999; 34(2):256-62.
4. Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. JAMA 1999;281(13):1175-81.
5. Stiell IG, Wells GA, Field B, Spaite DW, Nesbitt LP,

De Maio VJ, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. N Engl J Med 2004;351 (7):647-56.
6. Soo LH, Gray D, Young T, Huff N, Skene A, Hampton JR. Resuscitation from out-of-hospital cardiac arrest: is survival dependent on who is available at the scene? Heart 1999;81(1):47-52.
7. Bottiger BW, Grabner C, Bauer H, Bode C, Weber T, Motsch J, et al. Long term outcome after out-of-hospital cardiac arrest with physician staffed emergency medical services: the Utstein style applied to a midsized urban/ suburban area. Heart 1999;82(6):674-9.
8. Kuisma M, Maatta T. Out-of-hospital cardiac arrests in Helsinki: Utstein style reporting. Heart 1996;76(1): 18-23.
9. Crone PD. Auckland Ambulance Service cardiac arrest data 1991-3. N Z Med J 1995;108(1004):297-9.
10. Rewers M, Tilgreen RE, Crawford ME, Hjortso N. One-year survival after out-of-hospital cardiac arrest in Copenhagen according to the 'Utstein style'. Resuscitation 2000;47(2):137-46.
11. Mashiko K, Otsuka T, Shimazaki S, Kohama A, Kamishima G, Katsurada K, et al. An outcome study of out-of-hospital cardiac arrest using the Utstein template--a Japanese experience. Resuscitation 2002;55 (3):241-6.
12. Leung LP, Wong TW, Tong HK, Lo CB, Kan PG. Out-of-hospital cardiac arrest in Hong Kong. Prehosp Emerg Care 2001;5(3):308-11.
13. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care - an international consensus on science. Adult Basic Life Support. Resuscitation 2000;46(3):29-71.
14. Nichol G, Detsky AS, Stiell IG, O'Rourke K, Wells G, Laupacis A. Effectiveness of emergency medical services for victims of out-of-hospital cardiac arrest: a metaanalysis. Ann Emerg Med 1996;27(6):700-10.
15. Nichol G, Stiell IG, Laupacis A, Pham B, De Maio VJ, Wells GA. A cumulative meta-analysis of the effectiveness of defibrillator-capable emergency medical services for victims of out-of-hospital cardiac arrest. Ann Emerg Med 1999;34(4 Pt 1):517-25.
16. Pell JP, Sirel JM, Marsden AK, Ford I, Cobbe SM. Effect of reducing ambulance response times on deaths from out of hospital cardiac arrest: cohort study. BMJ 2001;322(7299):1385-8.
17. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 4: the automated external defibrillator: key link in the chain of survival. The American Heart Association in Collaboration with the International Liaison Committee on Resuscitation. Circulation 2000;102(8 Suppl):I60-76.
18. Auble TE, Menegazzi JJ, Paris PM. Effect of out-of-hospital defibrillation by basic life support providers on cardiac arrest mortality: a metaanalysis. Ann Emerg Med 1995;25(5):642-8.
19. Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. N Engl J Med 2004;351(7):637-46.
20. Liddle R, Davies CS, Colquhoun M, Handley AJ. ABC of resuscitation. The automated external defibrillator. BMJ 2003;327(7425):1216-8.
21. Cummins RO. From concept to standard-of-care? Review of the clinical experience with automated external defibrillators. Ann Emerg Med 1989;18(12): 1269-75.
22. Becker LB, Ostrander MP, Barrett J, Kondos GT. Outcome of CPR in a large metropolitan area--where are the survivors? Ann Emerg Med 1991;20(4):355-61.
23. 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(9):678-83.
24. Nichol G, Hallstrom AP, Kerber R, Moss AJ, Ornato JP, Palmer D, et al. American Heart Association report on the second public access defibrillation conference, April 17-19, 1997. Circulation 1998;97(13):1309-14.
25. Walker A, Sirel JM, Marsden AK, Cobbe SM, Pell JP. Cost effectiveness and cost utility model of public place defibrillators in improving survival after prehospital cardiopulmonary arrest. BMJ 2003;327(7427):1316.