Clinical Research

Continuation of cardiopulmonary resuscitation in a Chinese hospital after unsuccessful EMS resuscitation

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Objective To evaluate the efficacy of the continuation of cardiopulmonary resuscitation (CPR) following transportation to the emergency department in a Chinese hospital after unsuccessful emergency medical services (EMS) CPR. **Methods** From January 2002 to December 2007, emergency records of non-traumatic patients who were transported to a tertiary teaching hospital after unsuccessful EMS CPR were reviewed. **Results** Eigty-five patients were included, and 13 patients (15%) accomplished restoration of spontaneous circulation in our emergency department. Resuscitative possibility reached zero at around 23 minutes. One patient was discharged with a favourable neurologic outcome. **Conclusions** This study shows that the continuation of CPR is not futile and may improve outcomes. The outcomes should be re-evaluated in the future when prehospital information can be combined with in-hospital information **(*J Geriatr Cardiol* 2009; 6:142-146)** .

Key words cardiac arrest; cardiopulmonary resuscitation (CPR); emergency medical services (EMS); advanced cardiac life support (ACLS)

Introduction

Out-of-hospital cardiac arrests (OHCA) are at least twice as frequent as in-hospital cardiac arrests.[1, 2] When OHCA occurs, emergency medical services (EMS) should be initiated so that professional cardiopulmonary resuscitation will be provided as early as possible. However, return to spontaneous circulation occurs in only 16%-35% of patients with OHCA.[3-5] Some of the remaining patients are transported to in-hospital emergency departments where cardiopulmonary resuscitation (CPR) is continued. Few data are available on the efficacy of prehospital resuscitation or continued CPR in China. We reviewed the resuscitative process and hospital course of the patients who were transported to the emergency department of a Chinese tertiary hospital after unsuccessful EMS CPR.

Methods

Our study protocol was approved by the Institutional Review Board of Zhongnan Hospital of Wuhan University and written informed consent was waived because of the retrospective and observational nature of our study.

EMS of Wuhan

Wuhan is a large city in central China, located on the yangtz River, with a population of 8,400,000 and a population density of 947 persons per square kilometres. There are 80 provincial or municipal hospitals, 52 of which receive patients transported by the local EMS. EMS of Wuhan is a one-tiered system. When 120 (the phone number of Chinese EMS) is called, the call centre dispatches the nearest available ambulance. After initial treatment, the patient may be transported to one of the 52 hospitals. EMS of Wuhan includes one EMS centre and 17 stations, 15 of which are located in hospitals. Each station has one or two standard ambulances, each serving an area with an eight-kilometre-radius. Each ambulance is equipped with an ECG machine, a monitor/defibrillator, a respiratory machine, a bag-valve ventilator, a laryngoscope and staffed by one doctor, one nurse, one driver and two stretcher bearers. The head of the team is a doctor, who is usually a general practitioner trained in the American Heart Association's Advanced Cardiac Life Support (ACLS)

As far as we know, the Utstein style has not been introduced into China yet. The same dispatch form has been used for all patients and the data is not classified or entered into a computer, making it impossible to track prehospital information.

Zhongnan Hospital and its Emergency Department

Zhongnan Hospital of Wuhan University is a 1200-bed teaching hospital. It is one of the largest public tertiary hospitals in Wuhan. Our emergency department is in charge of emergency skills training for all emergency physicians in

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our province. All cardiac arrest patients are given advanced cardiac life support in our emergency department by full-time emergency doctors according to the contemporary protocols (2000 and 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation). Two of the physicians are certified AHA ACLS instructors. The physician is the head of the team, and at least two nurses are also involved in the resuscitation. One of the nurses is responsible for recording the resuscitative process during the resuscitation as time allows. Consulting doctors are able to arrive at the emergency department within 5 minutes.

Eligible patients

Patients received by our emergency department were included in the study if they had suffered OHCA and failed to obtain return to spontaneous circulation. Patients were excluded if their arrests were related to trauma, electric shock, or intoxication. Patients under age 18 were also excluded.

Study design

The resuscitative process on emergency records was reviewed. The time of the onset of cardiac arrest was always unavailable, but in most cases it was considered to be the time the victim was found unresponsive. Time zero was defined as the moment the patient presented to the emergency department, and the reviving time was the time of restoration of spontaneous circulation (ROSC). ROSC was defined as a spontaneous heart rate greater than 60 bpm and systolic arterial blood pressure above 90mmHg, with or without vasoactive drugs. The following information was obtained: the patient's age, sex, and short-term outcome, endotracheal intubation and shock (defibrillation or electrical conversion), drugs administered, reviving time and cumulative time. Cumulative time (time spent on each patient during the resuscitation multiplied by the number of doctors and nurses, excluding intern doctors and nurses) was used as an indicator of the resuscitative effort as previously described[6]. In the case of patients who accomplished ROSC and were admitted into our hospital, the hospitalization courses were reviewed. Short-term survival was defined as ROSC and admission into our hospital or transportation to another hospital. Long-term survival was defined as being alive at least 12 hours after admission. The following information was obtained from in-patient records: length of hospital stay, time in the critical care unit, time on a respirator, time in coma, complications, final outcome (death or discharge), cause of death and cerebral performance category (CPC) score[7] of those discharged.

Statistical analysis

For the categorical variable, the chi-square test (or Fisher's exact test when appropriate) was used to compare and establish differences between the characteristics of the survivors and those of the dead. For continuous data, normality was tested using the Kolmogorov-Smirnov method. If it was upheld, Student's t-test (unpaired and two-tailed) was used and if not, the Mann-Whitney test was performed. For normally distributed continuous variables, the data was expressed as mean ± standard deviation (SD). For skewed continuous variables, the data was expressed as median [25-75% interquartile range (IQR)]. Kaplan-Meier curves were used to determine resuscitative possibility. All statistics were carried out using the Statistical Program for Social Sciences (SPSS 13.0 for Windows; SPSS Inc., Chicago, Illinois). A two-tailed P-value <0.05 was considered significant.

Results

Characteristics of patients and resuscitative process

Over a period of 6 years, 85 patients were transported to our emergency department where CPR was continued after unsuccessful EMS resuscitation. The mean age was 62±17 years and 61 (72%) patients were male. The median interval between the time when the patient was found unresponsive and the time when the patient was transported to our department was 30 (IQR 20-55) min. Peripheral intravenous lines had been placed into antecubital veins for all the patients before admission to our department while only 2 patients had been orotracheally intubated.

Of the 85 patients, thirteen (15%) patients accomplished ROSC in our emergency department. Resuscitative possibility declined quickly (Fig.1), and it reached zero at around 23 minutes. Less atropine and adrenaline were given to patients with ROSC (Table 1). There were no significant differences in age, sex, interval, shock, or cumulative time spent by doctors and nurses between patients with and without ROSC (Table 1).

Hospital course

Of the 13 patients successfully resuscitated in our emergency department, one patient was transferred to another hospital on her family's insistence without admission

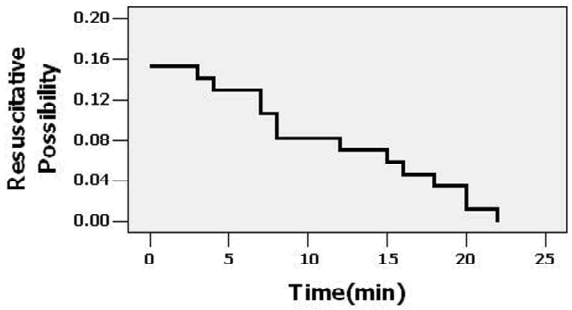

Fig.1 Resuscitative possibility of patients transported to our emergency department. 13 of 85 patients accomplished restoration of spontaneous circulation subsequently.

to our hospital, making her subsequent information untraceable. Of the 12 patients admitted, one patient's hospital record was unavailable. For the remaining 11 patients, the median stay was 2 (IQR 1-6) days and they were in the acute care unit and seven patients died within two days after admission. Of these 11 patients, eight died after withdrawal of treatment as asked by their families, one died due to refractory hypotension and one was discharged with a CPC score of 4. The last patient was diagnosed with myocardial infarction, underwent coronary artery stent placement, was hospitalized for 24 days and discharged with a CPC score of 1. From the whole population of 85 patients only one patient was discharged with a good CPC score (1%, 95% confidence interval 0.03-6%).

Discussion

We reviewed the resuscitative process and hospital course of the patients transported to our emergency department after unsuccessful but continued EMS resuscitation. We have found that the continuation of CPR is not futile and may improve outcomes. For short-term outcomes, 15% of our patients accomplished ROSC in our emergency department. For long-term outcomes, 1% of patients were discharged with favorable neurologic outcomes. We have compared the ROSC rate and the discharge rate of our study with those of other published studies[8] (Table2). Eisenburger et al.[9] reported much better outcomes, but their patients comprised both out-of-hospital and in-hospital cardiac arrest patients, which may skew their outcomes. Compared with the rest of the studies, our results were within the same range. At least two factors may account for our results. First, different criteria are used to help EMS personnel make the decision to transport unsuccessfully resuscitated OHCA patients and it is more of an intuitive decision. [9] Second, the unacceptable unsuccessful EMS resuscitation rate could make the ROSC rate in our emergency department higher. As far as we know, we do not have a national or regional registry of OHCA; it is widely believed that no more than 5% OHCA patients are successfully resuscitated by EMS. On the First Forum of Guangzhou Cardiopulmonary Resuscitation held in August 2006, some

Table 1 Characteristics of patients with and without restoration of spontaneous circulation (ROSC) in the emergency department after unsuccessful but continued EMS cardiopulmonary resuscitation

Variables	Patients with ROSC (n = 72)	Patients without ROSC (n = 13)	P value
Age (yrs)	63 ± 17	61 ± 15	0.82
Men	53 (74%)	8 (62%)	0.50
Interval (min)	30 (20-60)	20 (16-40)	0.87
Shock	40 (56%)	9 (69%)	0.36
Atropine (mg)	2 (1-4)	0 (0-2)	0.004
Adrenaline (mg)	10 (7-15)	5 (2-11)	0.008
Cumulative time spent by (min)			
Doctors	152 (90-240)	142 (107-225)	0.94
Nurses	198 [140-303]	260 (205-330)	0.21

Data are expressed as mean ± SD, median [25%-75% interquartile range (IQR)], or number (percentage).
Interval: the interval between the time when the patient was found unresponsive and the time when the patient was transported to emergency department
Shock: defibrillation or cardioversion.
For all data, more than 80% patients' information was available.

Table 2 Comparison of ROSC and/or hospitalized alive rates and discharge rates in patients transported to emergency department for continuing resuscitation

Nation	Year of publication	No. of transported	No. of ROSC[§] and/or hospitalized alive (%)	No. of discharge (%)
USA	1991 [6]	185	16 (9%, 95%CI: 5-14%)	0
Sweden	1997 [3]	2319	137 (6%, 95%CI: 5-7%)	28(1.2%, 95%CI: 0.8-2%)
Canada	2006 [7]	776[¶]	NA	4(0.5%, 95%CI: 0.1-1%)
Canada	2007 [8]	3841[¶]	NA	3(0.08%, 95%CI: 0.02-0.2%)
Austria	2008 [9]	327	102 (31%, 95%CI: 26-37%)	19(6%, 95%CI: 4-9%)
Our study	NA	85	13 (15%, 95%CI: 8-24%)	1(1%, 95%CI: 0.03-6%)

[§]ROSC: return of spontaneous circulation or restoration of spontaneous circulation; [¶]Actual number should be larger because of a different research objective; CI: confidence interval; NA: data not available.

Chinese experts reported that the rate was less than 1% throughout the mainland, which was much lower than previous reports. As for comparison, one meta-analysis of studies in developed countries reported a 6.4% median survival to hospital discharge for OHCA patients in all rhythm groups.[10] Other western studies had a large disparity in this figure, ranging from 8.2% to 23.4%.[11-14] The fact that only 2% of our patients were orotracheally intubated appears to be a sign of insufficient EMS effort. We cautiously withhold the idea that we did better resuscitation, because almost no prehospital information was available for our study. But we believe that the prehospital resuscitative efforts are far from optimal in our city.

With or without advanced life support procedures implemented, Morrison et al.[7,8] proposed that in patients having an OHCA, efforts should be terminated at the scene if there is no ROSC, no shocks are administered, no bystander CPR and the arrest is not witnessed by emergency medical services personnel. Nevertheless, we think that this proposal should not be carried out in areas where prehospital CPR is sub-optimal. Patients with OHCA should be transported to hospitals before prehospital efforts are seriously evaluated.

The median interval between the time when the patient was found unresponsive and the time when the patient was transported to our department was 20 min (Table I) for short-term survivors. We use unresponsive time instead of collapse time, because the latter is always desirable but not applicable.[15, 16] It is not surprising that more atropine and adrenaline (Table I) were given to the patients who did not survive since physicians use more medications on those patients who fail to respond to resuscitative efforts. It has been reported that an increased dose of adrenaline is indicative of poor neurologic outcome[17] and high short-term and long-term mortality.[18] The fact that more than half of the patients received shock (defibrillation or electrical conversion) was probably partly due to blind defibrillations.

Limitations

Our study has some limitations. First, our study was a retrospective one. Second, no information was available on witness, initial rhythm, bystander CPR, any prehospital ROSC, or time of collapse. The Utstein style template, a useful tool for assisting evaluation and comparison of CPR regionally, nationally, and world-wide,[19] has not yet been introduced into China. Third, Guidelines for CPR were updated in 2005 and may have influenced the outcomes. Last, there was no long-term follow-up of the patients discharged.

Conclusions

This study shows that the continuation of CPR may improve outcomes, particularly when prehospital CPR is not optimal. We are cooperating with the EMS of Wuhan, designing double-print OHCA records according to the Utstein template[16] and hoping to collect copies of these records. We believe the continuation of CPR should be re-evaluated in the future when prehospital information can be combined with in-hospital information.

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References

1. Cobb LA, Werner JA, Trobaugh G B. Sudden cardiac death a decade's experience with out-of-hospital resuscitation. *Mod Concepts Cardiovasc Dis* 1980;49(6):31-6.
2. Norris R M. Fatality outside hospital from acute coronary events in three British health districts, 1994-5. United Kingdom Heart Attack Study Collaborative Group. *BMJ* 1998;316: 1065-70.
3. Herlitz J, Ekstrom L, Axelsson A, et al. Continuation of CPR on admission to emergency department after out-of-hospital cardiac arrest. Occurrence, characteristics and outcome. *Resuscitation* 1997;33:223-31.
4. Herlitz J, Bang A, Gunnarsson J, et al. Factors associated with survival to hospital discharge among patients hospitalised alive after out of hospital cardiac arrest: change in outcome over 20 years in the community of Goteborg, Sweden. *Heart* 2003;89: 25-30.
5. Wik L, Kramer-Johansen J, Myklebust H, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. *JAMA* 2005;293:299-304.
6. Gray W A, Capone R J, Most A S. Unsuccessful emergency medical resuscitation-are continued efforts in the emergency department justified. *N Engl J Med* 1991;325:1393-8.
7. Morrison LJ, Visentin LM, Kiss A, et al. Validation of a rule for termination of resuscitation in out-of-hospital cardiac arrest. *N Engl J Med* 2006;355:478-87.
8. Morrison LJ, Verbeek PR, Vermeulen MJ, et al. Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers. *Resuscitation* 2007; 74:266-75.
9. Eisenburger P, Havel C, Sterz F, et al. Transport with ongoing cardiopulmonary resuscitation may not be futile. *Br J Anaesth* 2008;101: 518-22.
10. Nichol G, Stiell IG, Laupacis A, et al. 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.
11. Rainer TH, Gordon MW, Robertson CE, Cusack S. Evaluation of outcome following cardiac arrest in patients presenting to two Scottish emergency departments. *Resuscitation* 1995;29: 33-9.
12. Stiell IG, Wells GA, DeMaio VJ, et al. Modifiable factors associated with improved cardiac arrest survival in a multicenter basic life support/defibrillation system: OPALS Study Phase I results. Ontario Prehospital Advanced Life Support. *Ann Emerg*

Med 1999;33:44-50.

13. Holmberg M, Holmberg S, Herlitz J. Factors modifying the effect of bystander cardiopulmonary resuscitation on survival in out-of-hospital cardiac arrest patients in Sweden. *Eur Heart J* 2001;22:511-9.
14. Hallstrom AP, Ornato JP, Weisfeldt M, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med* 2004;351:637-46.
15. Kuisma M, Maatta T. Out-of-hospital cardiac arrests in Helsinki: Utstein style reporting. *Heart* 1996;76:18-23.
16. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Councils of Southern Africa). *Circulation* 2004;110:3385-97.
17. Behringer W, Kittler H, Sterz F, et al. Cumulative epinephrine dose during cardiopulmonary resuscitation and neurologic outcome. *Ann Intern Med* 1998;129:450-6.
18. Wang HE, Min A, Hostler D, et al. Differential effects of out-of-hospital interventions on short- and long-term survival after cardiopulmonary arrest. *Resuscitation* 2005;67:69-74.
19. Peberdy MA, Cretikos M, Abella BS, et al. Recommended guidelines for monitoring, reporting, and conducting research on medical emergency team, outreach, and rapid response systems: an Utstein-style scientific statement. A Scientific Statement from the International Liaison Committee on Resuscitation; the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiopulmonary, Perioperative, and Critical Care; and the Interdisciplinary Working Group on Quality of Care and Outcomes Research. *Resuscitation* 2007;75:412-33.