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Original Articles

Prognosis of Patient with Cardiopulmonary Arrest Transported to Kyushu University Hospital

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Abstract Three hundreds and sixty six patients with out-of-hospital cardiopulmonary arrest, transported to the Kyushu University Hospital from 2000 to 2006, were examined using the Utstein style in witnessed cardiogenic cardiopulmonary arrest patients. Also, we examined the influence on prognosis due to the difference in the treatment of airway control in out-of-hospital settings. Nineteen patients out of 78 witnessed cardiogenic out-of-hospital cardiopulmonary arrest patients were discharged alive and 11 were with a good prognosis. The number of cases where an initial electrocardiographic complex showed ventricular fibrillation or pulseless ventricular tachycardia was higher than formerly reported in Japan and was equal to the incidence reported in Europe and America. In addition, the survival discharge rate of patients with the ventricular fibrillation or pulseless ventricular tachycardia was higher than that previously reported in Japan and was similar to European and American results. Manual airway maintenance using a bag valve mask was more successful in terms of the survival discharge rate compared to the use of advanced airway devices. By the time course, collapse to cardiopulmonary resuscitation interval, collapse to initial defibrillation interval and collapse to the return of spontaneous circulation interval were shorter in the group discharged with a good prognosis, especially in the witnessed ventricular fibrillation or pulseless ventricular tachycardia patients corresponding to former reports.

Most patients with a good prognosis resuscitated before arrival at the hospital. These results suggest the prehospital treatment is the critical point other than in-hospital treatment.

Introduction

Over thirty years Kyushu University Hospital has contributed to patient with out-of-hospital cardiopulmonary arrest (OHCA). The medical environment for patients with OHCA has changed significantly over the last ten years.

In 2002, basic life support was revised in Japan[1)] based on Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (G2000)[2)] of American Heart Association (AHA) published in 2000. The Major changes in this revision were simplification of the basic cardiopulmonary resuscitation (CPR) (the ratio of chest compression and ventilation is 15 : 2 in 1-rescuer or 2-rescure CPR), an omission of the

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mouth to mouth breathing for the infectious risk (acceptance of the compression-only CPR) and public access defibrillation (defibrillation by the citizen and the defibrillator setting to the public place).

As development of the emergency medical system, a paramedic system was formed in Japan sixteen years ago. About 13,000 paramedics were qualified and working across the country by 2005 (from the homepage of Ministry of Public Management, Home Affairs, Posts and Telecommunications), and 81 paramedics are currently registered in Fukuoka City (from the homepage, Fukuoka Fire Preventing Bureau by March 31, 2006). In addition, the number of paramedics as well as the range of available clinical maneuvers increases year by year. In regard to CPR, in the beginning, paramedics could defibrillate, use advances airway devices, e.g. laryngeal mask airway (LMA), esophageal-tracheal Combitube™ (ETC), or laryngeal tube (LT), and administer intravenous fluid to maintain intravenous routes, only if instructed by a medical doctor. But they could defibrillate under comprehensive instructions from 2003, intubate endotracheal tube from 2004 and administrate drugs (epinephrine) from 2006.

These improvements are all aimed to strengthen the "Chain of Survival" which AHA proposes[1]. In this study, we analyze and review how these improvements contribute to survival discharge with a good prognosis from OHCA in the Fukuoka District and discuss the future of pre-hospital emergency services and treatment after admission to the hospital.

Methods

Regarding OHCA transported to the Kyushu University Hospital emergency department (Emergency and Critical Care Center from August, 2006) from January, 2000 to December, 2006, we analyzed data from the transportation records of emergency medical services (EMS) and our hospital clinical records. The data consisted of the presence of a cardiac arrest witness, the presence of the bystander CPR, an initial electrocardiogram (ECG) confirmed by paramedics, airway control by the personnel of EMS, and a time course. And we examined how these data influenced the patient prognosis, such as the rate of the return of spontaneous circulation (ROSC), the survival-to-discharge rate, and a neurological prognosis at the time of the discharge. Using the Utstein Style template[3], the international standard recording uniform of OHCA, we analyzed only the witnessed OHCA of cardiac etiology.

According to their prognosis, the patients were classified into five groups (good recovery : GR, moderate disability : MD, severe disability : SD, vegetative state : VS and dead) using Glasgow Outcome Scale (GOS)[4].

In the statistical analysis of a time factor, the group means were compared between the two groups by student's t-test. For all results, a p value $< .05$ was considered statistically significant. Data were represented as mean +/− S.E.M.

Results

Patient background

Two hundreds and six of the 366 OHCA cases were diagnosed as having cardiac etiology as they were transported to hospital during this period. Of the 206 patients 78 had a witness to the collapse (37.9% of the cardiogenic OHCA, 21.3% of all OHCA) and bystander CPR was conducted on 34 cases (16.5% of the cardiogenic OHCA, 9.3% of all OHCA) (Fig. 1). Annual changes

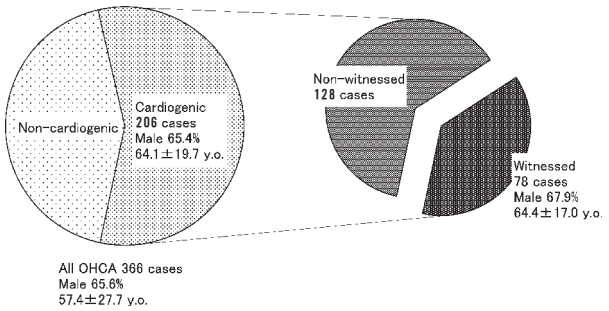

Fig. 1 The number of out-of-hospital cardiopulmonary arrest transported to Kyushu University Hospital from 2000 to 2006
The number of cardiogenic out-of-hospital cardiopulmonary arrest (OHCA) is 56.3% of all OHCA. The witnessed cardiogenic OHCA is 21.6% of all OHCA and 37.9% of cardiac OHCA.

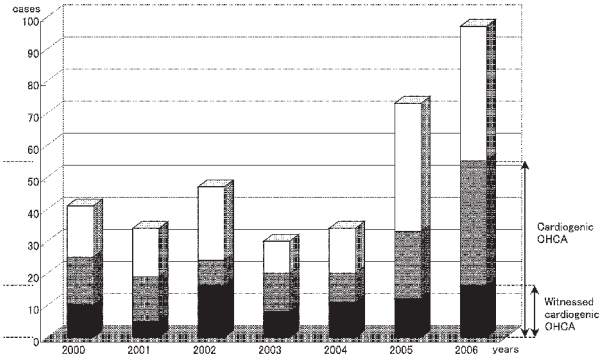

Fig. 2 The annual changes in number of out-of-hospital cardiopulmonary arrest
The black bar: witnessed cardiogenic out-of-hospital cardiopulmonary arrest (OHCA). The gray bar: non-witnessed cardiogenic OHCA. The white bar: non-cardiogenic OHCA. The black bar and the gray bar indicate the number of cardiogenic OHCA. Total bar indicates the number of all of OHCA.

are depicted in Figure 2. We analyzed the 78 cases with a witness to the cardiac arrest as follows.

Regarding the initial ECG confirmed by the personnel of EMS, 29 patients (37.2% of those 78 cases) showed ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), 24 patients (30.8%) showed pulseless electrical activity (PEA), and 25 patients (32.0%) showed asystole (Fig. 3).

In regard to the airway maintenance method used by personnel of EMS, 49 cases (62.8%) were ventilated with bag-valve-mask (BVM) by manual airway maintenance, 24 (30.8%) by the ETC, and 5 (6.4%) by the orotracheal tube (OT) (Fig. 4). (The use of orotracheal intubation by paramedics was introduced after July 2004.) Annual changes are also represented in Figure 5.

Patient background and prognostic relations

Sixteen of 78 witnessed cardiogenic OHCA cases (20.5%) were resuscitated with their own perfusion rhythms on arrival at the hospital and nine cases (11.5%) of them had their own respiration. Twenty-seven cases (34.6%) were admitted to the Intensive Care Units (ICU) with stable vital signs. Nineteen cases of 78 (24.4%) survived and were discharged from our hospital. Thirteen in 29 cases (44.8%) where the initial ECG was VF/VT had their own perfusion rhythms, 16 cases (55.2%) were admitted to the ICU and 14 cases (48.3%) survived and were discharged. Six cases (25.0%) in 24 PEA cases were admitted and four cases (16.7%) survived and were discharged. Five of 25 asystole cases (20.0%) were admitted and one case (2.0%) was discharged (Fig. 3).

The detailed prognosis of 19 cases that survived and were discharged was ten GR, one MD, one SD and seven VS. Of the ten GR cases, six were VF/VT, three were PEA and one was asystole. Nine cases in ten GR were resuscitated with their own perfusion rhythms on arrival at the hospital. In addition, only four out of 110 unwitnessed cardiogenic OHCA patients were discharged from our hospital (3.6%, 2 in GR).

Among 49 cases ventilated with the BVM

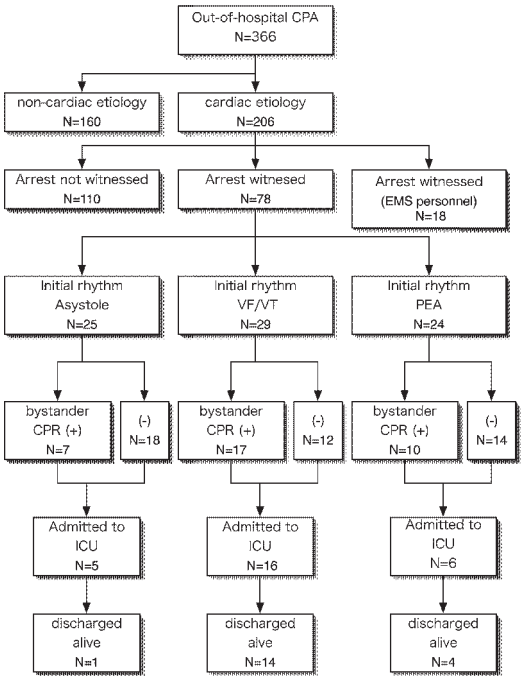

Fig. 3 The Utstein Style Template
CPR ; Cardiopulmonary Resuscitation. VF/VT ; Ventricular Fibrillation/pulseless Ventricular Tachycardia. PEA ; Pulseless Electrical Activity. ICU ; Intensive Care Units.

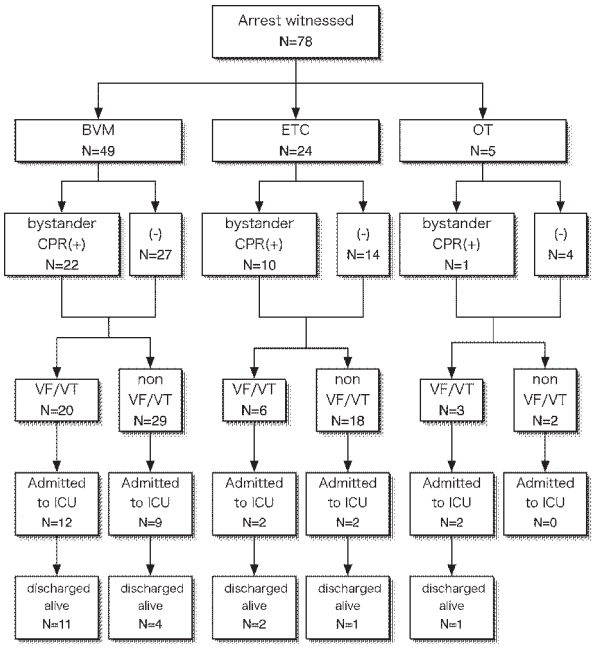

Fig. 4 The airway maintenances and prognosis
BVM ; Bag-Valve-Mask. ETC ; Esophageal-Tracheal Combitube™. OT ; Orotracheal Tube. CPR ; Cardiopulmonary Resuscitation. VF/VT ; Ventricular Fibrillation/pulseless Ventricular Tachycardia. ICU ; Intensive Care Units.

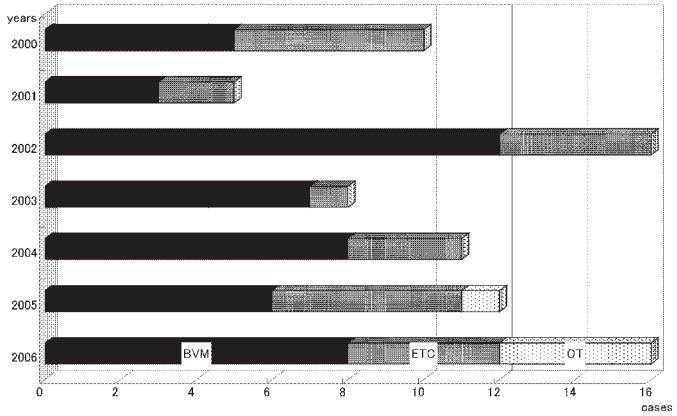

Fig. 5 The annual changes in the airway maintenance by EMS
Over fifty percent of the cases were ventilated with manual BVM method. The use of orotracheal intubation by paramedics was introduced after July 2006.
BVM ; Bag-Valve-Mask. ETC ; Esophageal-Tracheal Combitube™. OT ; Orotracheal Tube.

method, 12 cases (24.5%) were resuscitated on arrival, 21 cases (42.9%) survived and were admitted to the ICU and 15 cases were discharged from hospital (30.6%: 10 GR, 1 MD, 4 VS). Among 24 cases secured by the ETC, five cases (20.8%) were resuscitated on arrival, four cases (16.7%) were admitted and three cases (12.5%: 1 SD, 2 VS) were discharged. Two (40.0%) of five cases secured by OT were resuscitated, two admitted (40.0%) and one discharged (20.0%: 1 VS) (Fig. 4).

A time factor

The critical time for survival and recovery to resume original life is the collapse to cardiopulmonary resuscitation interval, collapse to defibrillation interval and collapse to advanced life support interval[5]. Of the time factors regarding CPR, we analyzed the collapse to activation of EMS interval, collapse to arrival of EMS interval, collapse to CPR interval, collapse to first attempt to defibrillate interval and collapse to ROSC interval. We examined 42 cases where the record of the time course was left, and separated these cases into good prognosis (GR+MD) group, poor prognosis (SD+VS) group, and the Dead group. There were 9 patients in GR+MD, 7 in SD+VS, 26 in the

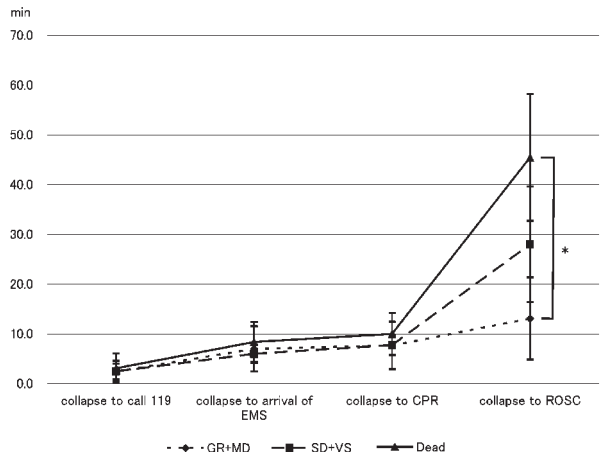

Fig. 6 A time course and prognosis of all witnessed cardiogenic OHCA
A significant difference was observed in collapse to ROSC interval in all witnessed cardiogenic OHCA (GR+MD vs the Dead group; 13.1+−8.3min. vs 45.5+−12.8, $p<0.05$). Points and vertical bars represent mean +/− S.E.M.
EMS; Emergency Medical Services. CPR; Cardiopulmonary Resuscitation. ROSC; Return of Spontaneous Circulation. GR; Good Recovery. MD; Moderate Disability. SD; Severe Disability. VS; Vegetative State

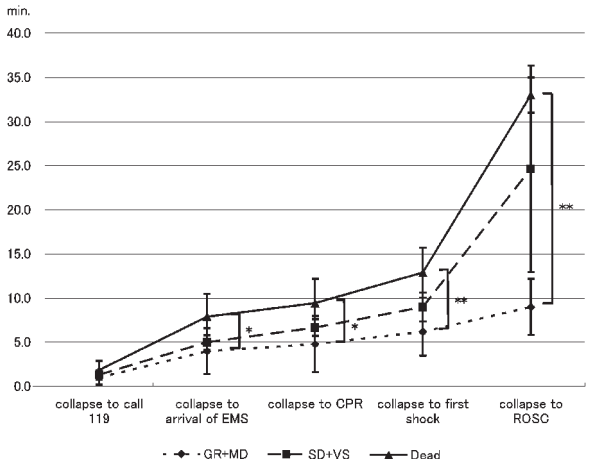

Fig. 7 A time course and prognosis of cases with VF/VT
A significant difference was observed in collapse to arrival of EMS interval (GR+MD vs the Dead group; 4.0+-2.6min. vs 7.9+-2.6, $p<0.05$), collapse to CPR (GR+MD vs the Dead group; 4.8+-3.2 vs 9.4+-2.7, $p<0.05$), collapse to first defibrillation (GR+MD vs the Dead group; 6.2+-2.7min. vs 12.9+-2.8, $p<0.01$), and collapse to ROSC (GR+MD vs the Dead group; 9.0+-3.2min. vs 33.0+-2.0, $p<0.01$). Points and vertical bars represent mean +/- S.E.M.
EMS; Emergency Medical Services. CPR; Cardiopulmonary Resuscitation. ROSC; Return of Spontaneous Circulation. GR; Good Recovery. MD; Moderate Disability. SD; Severe Disability. VS; Vegetative State

Dead group. A significant difference was observed in collapse to ROSC interval in all witnessed cardiogenic OHCA between the GR+MD and the dead group (Fig. 6) and, in the VF/VT cases, collapse to arrival of EMS interval, collapse to CPR, collapse to first defibrillation and collapse to ROSC between the GR+MD and the Dead group. There were no significant differences between the GR+MD and the SD+VS group or between the SD+VS and the Dead group (Fig. 7).

Discussion

Patient background

The number of OHCA transported to the Kyushu University Hospital had not changed significantly before 2004 when an increase in the number of staff in the emergency department was planned. The number did increase drastically in 2005 when the staff increased and in 2006 when the hospital was authorized as an official emergency center. These increases consisted of non-cardiogenic OHCA, especially traumatic OHCA, but not of witnessed cardiogenic OHCA, expected to survive and resume original life.

In this study, we analyzed data with the Utstein Style template[3] which is a standard reporting platform for OHCA cases. In former reports in Japan that differed from those from Western Nations, there were little VF/VT cases in an initial ECG just after the cardiac arrest[6)~12)]. However, there was no difference from former European and American reports[13)~18)] regarding the patient background when we limited a population to witnessed cardiogenic OHCA. It was because of the geographical convenience of Kyushu University Hospital location within an urban region.

In addition, we observed approximately 50% survival discharges in VF/VT cases, and this result exceeded others in Japan[6)~12)], and was equal to European and American reported results[13)~18)].

Out-of-hospital airway maintenance

Out-of-hospital orotracheal intubation during the cardiopulmonary resuscitation did not contribute to survival and the neurological outcome[19]. There is no evidence in Japan to show the supremacy of advanced airway devices to manual BVM. However, in Japan, recently paramedics have been permitted to intubate OT in OHCA as a method of airway maintenance. In this paper, we reviewed the influence of the technique or devices for airway maintenance on patient's prognosis retrospectively. As a result, the patients maintained with manual BVM had a higher rate of ROSC, survival-to-discharge and discharge with good prognosis than the patients treated with any other methods. The paramedics may choose a method for airway maintenance depending on the patient, the place or the staff of EMS. For example, they may choose ETC or OT to transport the patient through a confined aisle or elevator and choose BVM if the collapse location is near a hospital. When the patient shows VF/VT, they precede defibrillation and choose BVM instead of advanced airway devices of which preparation takes some time. When they choose ETC or OT, they stayed at the site of arrest longer than BVM (data not shown). In addition, the paramedics permitted to intubate are not yet distributed widely enough and the patients maintained with OT are still quite few. Although such selection bias prevented us comparing the airway maintenances properly, these results may lead to future study.

A time factor

The key points to survival and resumption of original life are the "Chains of Survival", i.e. early phone, early CPR, early defibrillation, early advanced care. In this paper, we proved this concept applies to our patients, especially in the case of VF/VT.

Conclusion

From the point of prognosis, many of GR showed VF/VT in the initial ECG, maintained with the manual BVM method, and resuscitated with own perfusion rhythm on arrival at the hospital. Only two of the patients who did not resuscitate on arrival at the hospital were discharged with a good prognosis. Both patients showed shock -resistant VF. In other words, for the case except VF/VT, the lives of OHCA may have been destined before arrival at hospital and the cardiopulmonary resuscitation treatment after the arrival at hospital may be meaningless, and we should put weight for the treatment to improve the neurological function of the patient with their own perfusion rhythms. In this report, we reviewed a patient with out-of-hospital cardiopulmonary arrest transported to the Kyushu University Hospital. All medical facilities in the Fukuoka district and Fire Preventing Bureau should corporate together, grasp and analyze the present data to improve prognosis of OHCA cases in the Fukuoka District.

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（和文抄録）

九州大学病院に搬送された病院外心肺停止患者数の傾向と予後

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2000 年から 2006 年までに九州大学病院に搬送された病院外心肺停止患者のうち，心停止を目撃された心原性心肺停止患者について，ウツタイン様式で集計した．また病院前での気道管理の違いによる予後への影響を調べた．初期心電図波形が心室細動または無脈性心室頻拍を示した症例がいままでの日本国内の報告より高く，欧米での発生率に匹敵していた．また心室細動または無脈性心室頻拍を呈していた患者の生存退院率も同様に日本国内より高く，欧米の成績に近かった．器具を用いた気道確保より，バッグバルブマスクを用いた用手的気道確保の方が生存退院率は高かった．時間経過では，今までの報告同様，特に心室細動または無脈性心室頻拍患者においては，予後良好で生存退院した群で，心停止目撃から心肺蘇生開始までの時間，初発除細動までの時間，自己心拍再開までの時間が短いことが示された．予後良好例の多くは病院に到着する前に自己心拍が再開しており，病院前の初期対応の重要性がより明確化した．