

*Original Article*

## Out-of-hospital Cardiac Arrest in Okayama City (Japan): Outcome Report according to the "Utstein Style"

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The purpose of this study was to evaluate the outcomes for out-of-hospital cardiac arrest (OHCA) and cardiopulmonary resuscitation (CPR) in the city of Okayama, Japan, during a 1-year period after the reorganization of defibrillation by Emergency Life-Saving Technicians (ELSTs) with standing orders of CPR. The data were collected prospectively according to an Utstein style between June 1, 2003 and May 31, 2004; OHCA was confirmed in 363 patients. Cardiac arrest of presumed cardiac etiology (179) was witnessed by a bystander in 62 (34.6%) cases. Of this group, ventricular fibrillation (VF) was documented in 20 cases (32.3%), and 1 patient (5%) was discharged alive without severe neurological disability. This outcome is average in Japan, but it is quite low level compared with Western countries because there is less VF in Japan. The Utstein style revealed that we must try to detect VF before the rhythm changes and to provide defibrillation as soon as possible in order to improve outcomes. Further research will be required to accurately evaluate OHCA in Okayama city.

**Key words:** outcomes, utstein style, out-of-hospital cardiac arrest (OHCA), ventricular fibrillation (VF), early defibrillation

With regard to the outcomes of out-of-hospital cardiac arrest (OHCA), there have been many reports thus far. However, disagreements regarding terms, methods and definitions have created large variations in the results, so it was difficult to compare them [1]. In 1990, the Utstein conference (involving the European Resuscitation Council (ERC), American Heart Association (AHA), Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council) established uniform terms and recommendations for the evaluation and reporting of data from OHCA [2-4]. These guidelines have been of great importance, since they

created a uniform nomenclature and mode of reporting, making comparative analysis between different emergency medical service (EMS) systems possible. Now, the outcomes according to the "Utstein style" have been reported from every country in the world and have been established as a worldwide standard [5-23]. In the Utstein style, data are categorized as follows: the etiology (cardiac or noncardiac), witnessed or nonwitnessed, the initial cardiac rhythm (VF, Asystole or pulseless electrical activity; PEA). We cannot guess the interval from arrest in nonwitnessed cases, so it is difficult to compare outcomes. In cases of noncardiac etiology, there were many causes of arrests in the present study (*e.g.* trauma, suffocation, cerebral vascular attack, *etc.*), so comparisons were made difficult. With these categories of the Utstein style, however, we can evaluate the data

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without mixing imprecise and precise data. The most important and precise category is “witnessed VF in cardiac etiology”, making it the most suitable for comparison.

This study is the first analysis from the city of Okayama to use the “Utstein Template” in reporting outcomes of such arrests. We also evaluated the outcomes of OHCA and CPR in Okayama city, Japan, after the recent reorganization of defibrillation by Emergency Life-Saving Technicians (ELSTs) under a standing order.

## Materials and Methods

Data for all the patients who were considered for cardiopulmonary resuscitation (CPR) by the emergency medical service (EMS) of Okayama City, Japan, were recorded prospectively using the Utstein style during the 12-month period between June 1, 2003 and May 31, 2004.

The target area for this study was Okayama City, in Japan. Okayama City has a residential population of 647,879 inhabitants.

The total number of out-of-hospital “cardiopulmonary arrest” patients who were transported to the hospital was 373, out of which 8 were “respiratory arrests” and CPR was not attempted on 2 patients. Therefore, the number of out-of-hospital “cardiac arrests” (OHCA) was 363, and these made up the target cases for the Utstein style, with an incidence of 56.9 per 100,000 people-year. Two hundred and twenty-six patients were male and 137 female. The average age was 67.1 years, ranging from 0–96 years. The main location of the collapse was home (72%).

The EMS consists of a single-tiered system with a 3-person unit providing life support 24 h a day. Ambulance squads are staffed with EMS personnel, some of whom are called Emergency Life-Saving Technicians (ELSTs). The latter have passed a state examination and are allowed to insert an intravenous line and to use airway adjuncts. From spring 2003 the Japanese government allows them to defibrillate with a standing order. During this period there were 55 ELSTs in Okayama City.

**Statistical methods.** Patients and resuscitation details were analyzed in relation to discharge from hospital without severe neurological disability. Categorical variables were analyzed using a  $\chi^2$ -test (with Yates correction, if appropriate) or an Exact Fisher Test, while for group differences the *t*-test (if the data were normally

distributed) and Mann-Whitney test (if the normality test failed) were used.

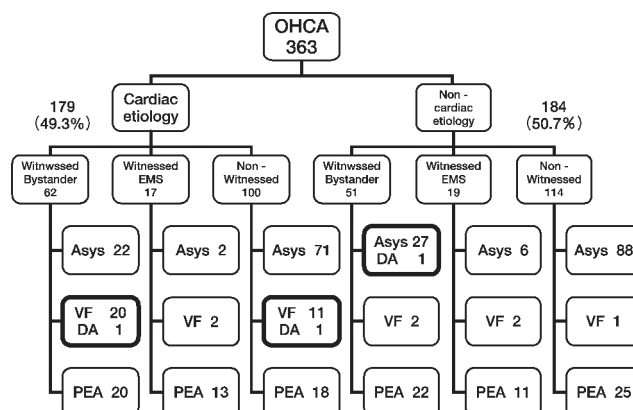
## Results

CPR was attempted to 363 OHCA in Okayama city by EMS from July 2003 to May 2004. The rate of all cardiac arrests was 56.9 per 100,000 people-years, with 179 (49.3%) presumed to be of cardiac etiology. Of these, 62 (34.6%) were witnessed by bystanders. There were 3 cases discharged alive in a nonvegetative state in the 363 OHCA. Two were VF in cardiac etiology and one was a witnessed Asystole in noncardiac etiology (Fig. 1).

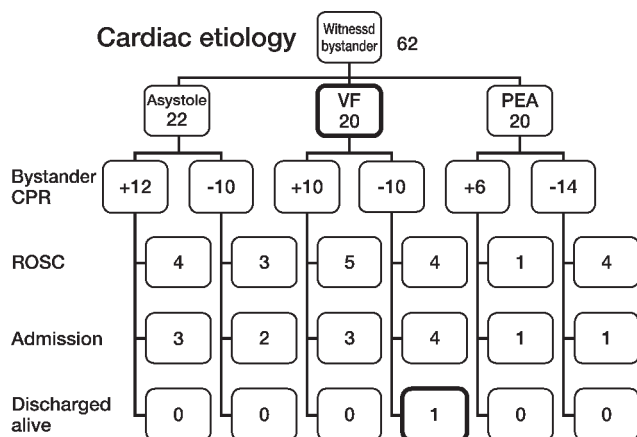
Fig. 2 displays the main results of the 62 witnessed OHCA divided by the initial cardiac rhythm. Of the 62 bystander-witnessed cardiac arrests, VF was the initial cardiac rhythm recorded by the EMS in 20 (32.3%) of the cases. The crude rate of bystander-witnessed cardiac arrests with a VF initial rhythm was 3.1 per 100,000 people-years.

Fig. 3 shows the overall outcomes. The rate of live discharge without severe neurological disability was only 0.8%.

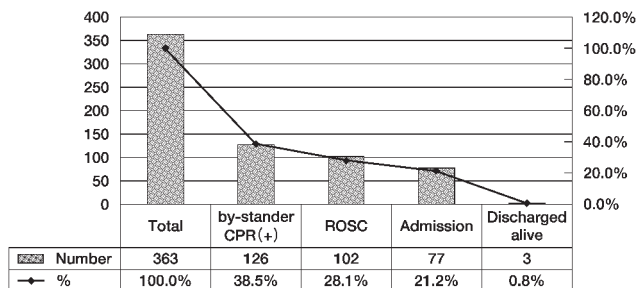
Fig. 4 shows the relationship between the initial cardiac rhythm and outcomes. The rate of live discharge



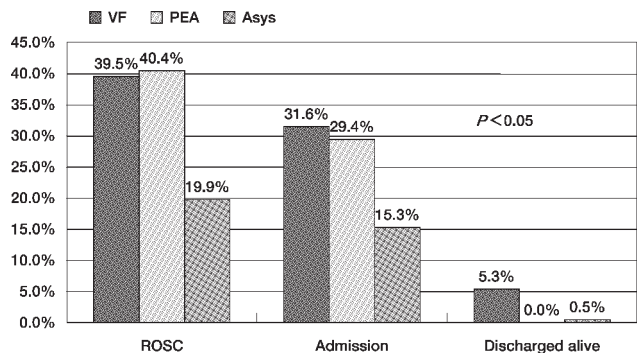
**Fig. 1** Overall data for the 363 OHCA patients. CPR was used to treat 363 cases of out-of-hospital cardiac arrest (OHCA) by emergency medical service from July 2003 to May 2004. Of these, 179 (49.3%) were presumed to be of cardiac etiology. Of these, 62 (34.6%) were witnessed by bystanders. There were 3 cases discharged alive in a nonvegetative state. Two were VF in cardiac etiology, and one was a witnessed Asystole of non cardiac etiology. CPR, cardio-pulmonary resuscitation; DA, Discharged alive; non-vegetative state; PEA, pulseless electrical activity; VF, ventricular fibrillation.



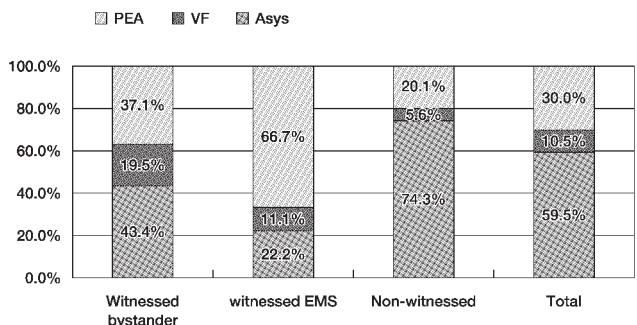
**Fig. 2** The outcome of the cardiac etiology, witnessed OHCA. In the group of bystander-witnessed cardiac etiology arrest, ventricular fibrillation (VF) was documented in 20 cases (32.3%), and one (5%) was discharged alive without severe neurological disabilities ROSC, return of spontaneous circulation.



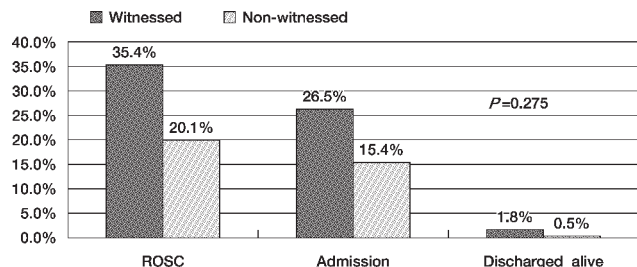
**Fig. 3** The overall outcomes. Bystander CPR was performed in 126 of all OHCA (38.5%). The number of live discharge without severe neurological disabilities was only 3 (0.8%).



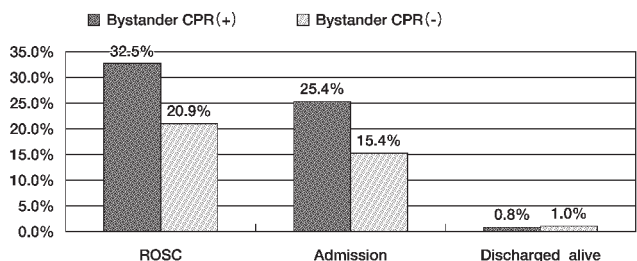
**Fig. 4** The relationship between the initial cardiac rhythm and outcome. The rate of live discharge in VF (2/38) was higher than that in Asystole (1/216) (5.3% vs. 0.5%; *P* < 0.05). No one in PEA was discharged alive.



**Fig. 5** The relationship between the witness and the initial cardiac rhythm. Compared with nonwitnessed OHCA, witnessed OHCA tended to show VF as an initial cardiac rhythm (19.5% vs. 5.6%).



**Fig. 6** The relationship between witness and outcome. The outcome of witnessed OHCA was better than that of nonwitnessed OHCA.



**Fig. 7** The relationship between bystander CPR and outcome. Bystander CPR was performed in 38.5% of all OHCA, but the rate of live discharge with bystander CPR was no better than that without bystander CPR.

in VF was higher than that in Asystole (5.3% *vs.* 0.5%;  $P < 0.05$ ). No one in PEA was discharged alive.

Compared with nonwitnessed OHCA, witnessed OHCA tended to show VF as an initial cardiac rhythm (19.5% *vs.* 5.6%) (Fig. 5), hence a higher rate of live discharge (1.8% *vs.* 0.5%;  $P = 0.275$ ) (Fig. 6).

Bystander CPR was performed in 38.5% of all OHCA, but the rate of live discharge with bystander CPR was no better than that without bystander CPR (Fig. 7).

Of the 38 out-of-hospital VF (OHVF), 2 were discharged alive without severe neurological disability (5.3%). Defibrillation was not performed in 3 cases. The mean time interval from call to defibrillation was 11 min 26 sec in all cases.

## Discussion

In Okayama city, the rate of live discharge in VF was higher than that in the non-VF (5.3% (2/38) *vs.* 0.3% (1/325),  $P < 0.05$ ; Fig. 4). The bystander witnessed rate of VF was obviously higher than the nonwitnessed rate (19.5% (22/113) *vs.* 5.6% (12/214); Fig. 5) and in witnessed cardiac etiology OHCA, the rate increased further to 32.3% (20/62). In all cardiac etiology OHCA, the rate of bystander-witnessed VF was 11.2% (20/179) and the live discharge rate was 5.0% (1/20), which is relatively high for Japan (Table 1). However, compared with Western countries, the rate was quite low (Table 2) [5, 20]. This difference is related to the low incidence of VF and the delay in defibrillation by ELSTs in Japan.

The incidence of VF in the West is 2–5 times higher than that in Japan. Since it is clear that the prognosis of VF is good, total results for OHCA should also improve if there is more VF. Why does such a difference arise

between the West and Japan? In the West, the incidence of ischemic heart disease is 6–8 times higher than that in Japan [13, 28]. Probably less ischemic heart disease produces less VF in Japan. This point should be taken into consideration when comparing results with those obtained in the West.

To improve the results of OHCA in Okayama city, we have to capture more VF and perform earlier defibrillation.

VF can change to PEA or Asystole, against which defibrillation is not effective in a short time. Bystander CPR can prolong VF and consequently increases the chances of success for defibrillation [22], and as has been reported in other areas, bystander CPR is associated with an increased survival in OHCA [5]. In this research, bystander CPR was performed in 38.5% of all OHCA. These results are above average compared with national and international rates [5, 20]. The rates of ROSC and admission in bystander CPR cases are better than those for nonbystander CPR cases (32.5% *vs.* 20.9%, 25.4% *vs.* 15.4%), but the existence of bystander CPR is not related to the rates of VF and of live discharge (11.9% *vs.* 9.5%, 0.8% *vs.* 1.0%). These results suggest that the quality of CPR is not good; hence, we must improve not only the frequency of CPR but the quality (Fig. 7). As a result, we are planning a new CPR course, including the use of the AED, for the general public.

In 1996, of the 824 cases of nontrauma out-of-hospital VF (OHVF) reported in Japan, 210 patients were not provided defibrillation by Emergency Life-Saving Technicians (ELSTs) [27]. In 1998, of the 30 cases of OHVF reported in Osaka, Japan, only 12 patients received defibrillation on the scene (40%) [13]. Since spring 2003, the Japanese government has allowed ELSTs to

**Table 1** Domestic comparison: bystander-witnessed VF in cardiac etiology CA [5, 20]

	The Rate (%)	Discharged alive (%)
Okayama city	11.2	5
Akita city	13.6	8.2
Funabashi city	11.6	2.1
Northern Osaka	7.5	0.3
Nagoya city	4.9	0.2
Northern Tama	7.3	0.7

In all cardiac etiology OHCA, the rate of bystander-witnessed VF was 11.2% and the live discharge rate was 5.0%, which is relatively high within Japan. CA, cardiac arrest.

**Table 2** International comparison: bystander-witnessed VF in cardiac etiology CA [5, 20]

	The Rate (%)	Discharged alive (%)
Okayama city	11.2	5
Helsinki	49.8	32.5
Saint-Etienne	27.4	6.5
Auckland	50.9	16
Glamorgan	21.8	13
Bonn	25.6	34.4

There were big differences observed in the incidence and outcome of bystander-witnessed VF in cardiac etiology between Okayama city and Western countries.

defibrillate with a standing order. In this study, there were 38 cases of OHVF in Okayama city, and 35 patients were provided defibrillation (92%). The standing order has produced the fixed effect of providing on-the-scene defibrillation.

This is generally consistent with previous research, where it has been concluded that survival after VF arrests decreases by approximately 7–10% for every minute that defibrillation is delayed [26]. In this study, the mean time interval from the call to defibrillation in all OHVF was 11 min 26 sec. This duration is absolutely too long. There were 38 OHVF cases, and 2 of them were discharged alive without severe neurological disabilities (5.3%). In these cases, defibrillation was performed at the scene, and the time intervals were 6 min and 7 min, respectively. The mean time of the remaining 32 cases was 11 min 45 sec (Defibrillation was not performed in 3 cases, and the time of one case was unknown). In the 15 cases that it took over 11 min to defibrillate, 11 of these defibrillations were performed in an ambulance. In Okayama city, electrocardiogram transmission was required in order to get permission for defibrillation by ELSTs up until 2002. Since the transmitter was too heavy to bring to the scene, the monitor was attached to the patient after carrying him or her into the ambulance. It seems that for some ELSTs, the custom remains. Hence the time taken to monitor is too long, allowing time for the rhythm to change. ELSTs must be educated to bring a defibrillator and use it at the scene in order to reduce the time to defibrillation. Since July 1, 2004, the Japanese government has permitted the general public to use the Automated External Defibrillator (AED) and has recommended early defibrillation. This change also provides a good opportunity to reduce the arrest-to-defibrillation interval.

Although there have been a few studies in Japan using the Utstein Style, this is the first to use it in Okayama. The Utstein Style template provides an easy-to-use method to collect reports and to compare out-of-hospital cardiopulmonary resuscitation procedures as well as outcome data. In this study, there were only 3 cases discharged alive without severe neurological disabilities. There were only 20 cases of witnessed ventricular fibrillation in cardiac etiology, so an increase of just one could change the outcome by 5%. Thus, further studies will be needed to accurately evaluate OHCA in Okayama city. In Japan, prehospital care is currently undergoing dramatic change and can be further improved by regular studies and

reports according to the Utstein Style.

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