国士舘大学審査学位論文

# 「Effects of Life saver Resuscitation for Drowning OHCA victims on Good neurological outcome」

# 「溺水心停止に対するライフセーバーの実施した心肺蘇生の脳神経学的予後への効果」

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# 博士論文

Effects of Life saver Resuscitation for Drowning OHCA victims on Good neurological outcome

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Fiscal 2015 Doctoral Thesis

# Effects of Life saver Resuscitation for Drowning OHCA victims on Good neurological outcome.

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CONTENTS

# Chapter 1. BACKGROUND

## Chapter 1. Background

Japan faces with approximately 35,000 km of ocean coastline. More than 20 million people visit beaches nationwide to enjoy swimming on 1,250 beaches in the summer season. Lifesaving at the beach has developed along with the increase of swimming accidents.

On the other hand, out-of-hospital cardiopulmonary arrest (as OHCA) in Japan, there is the drowning of the coast and beaches. Of all the accidents, drowning is as high as 17%, following the death rate of 20% due to traffic accidents, account for 50% of drowning in the sea[1)].

The origin of lifesaving in Japan is considered to be when qualified persons from the Japanese Red Cross (JRC) were allocated to the Katase-Nishihama Beach in Kanagawa Prefecture in 1963, to implement water safety techniques created by the JRC in 1944[2)]. Currently, 30,000 persons are certificated as lifesavers by the Japan Lifesaving association (JLA) across the nation, and 600 new persons are trained to be qualified every year. All surf lifesavers have mastered techniques of CPR&AED and first aid at a much higher level than that of the layperson, regarding not only basic knowledge of the sea and lifesaving but also management for injury and sudden illness at the beach.

In fact, 136 local lifesaving clubs of the regions and JLA-qualified lifesaver are engaged in supervisory/rescue activities from 9 a.m. until 5 p.m. in general on nearly 200 bathing beaches[3)]. On individual beaches, these lifesavers compose a club team to be engaged in beach guarding consigned by regional administration (Fig 1).

The basic surf lifesaver qualifications issued by JLA are provided to individuals aged 18 years or older who have clear swimming ability (being capable of swimming 400 m within 9 min, 50 m within 40 sec, diving 20 m or deeper, and treading water for 5 min or longer) and basic knowledge of the sea and lifesaving. In addition, the individuals have learned management for injury and sudden illness at the beach, CPR for drowning victims and how to use AED. They complete a 35-h course on rescue methods at the beach and must pass the practical/proficiency tests[4)]. Though their qualification is basic, their proficiency in CPR and first aid is at a much higher level than that of laypersons. In particular, lifesavers undergo training routinely for high-quality CPR because they (even though they are volunteers) routinely have many opportunities to encounter cardiac arrest resulting from drowning. Nevertheless, medical effects of high-quality CPR for OHCA administered by the lifesaver in charge of waterfront rescue have not been clarified[5].

# Chapter 2. OBJECTIVE

## Chapter 2. Objective

This study aimed to clarify the lifesaving effect of seaside basic life support performed by trained lifesavers, by analysing the effect of the support given by lifesavers, the survival rate and good neurological function in the drowning victim (CPC1-2) one month later, using a Utstein-style format and focusing on cases of drowning-induced OHCA near the beach.

# Chapter 3. METHODS

## Chapter 3. Methods

### Section 1: JLA accident report data

Since 2006, JLA has distributed and corrected beach activity data such as the 'Patrol Log', 'Lifesaving Report' and 'Rescue Report' to the more than 200 regional lifesaving clubs before and after the summer season. Based on them, the clubs record their daily activity by bathing beach, in the 'Patrol Log' and the 'Lifesaving Report' (annual activity report), summarising the logs to JLA after the end of the season. JLA has summarised detailed reports from clubs across the nation and published the summary as an activity report since 2009. The 'Rescue Report' is a detailed report on accident management activities in the rescue and transport of drowning victims with or without consciousness.

This study retrospectively analysed those lifesaving reports and emergency care by the JLA- qualified lifesavers, between 2009 and 2014 to examine the efficacy of basic life support by the lifesavers according to the Utstein style.

Recently, JLA revised the description of rescue report to adopt the Utstein-style data, which can be compared by international analysis. The 'Rescue Report' is submitted to JLA on all such occasions to undergo follow-up review by the Drowning Accident Inspection Committee and Emergency Resuscitation Committee in JLA, regarding the management of accidents for feedback to the club as required. We therefore extracted Utstein-matched data from the rescue reports.

### Section 2: Patients selection

In total, 89 cases of drowning-induced OHCA record between 2009 and 2014 from individual JLA beaches were retrospectively analysed. The inclusion criteria of this study were as follows: 1) drowning occurred in the sea; 2) drowning occurred after entering sea within 30 min before witness or found of body; 3) CPR was started for conditions, such as respiratory arrest or agonal breathing, unconsciousness and no pulse, as detected by a lifesaver; 4) exist all of the following data (records of witnessing cardiac arrest, time of cardiac arrest, time of reporting, bystander CPR, start time of CPR, shockable rhythm, use of AED, the presence or absence of ROSC or CPC1-2 among the parameters of the Utstein style). Patient's not resuscitated or unknown hand-over time to EMS or treatment and outcome in the hospital were excluded. Consequently, 43 patients were eligible. Our definition of a witnessed of drowning a drowning accident that was witnessed by family, friend or lifesavers, whereas in a non-witnessed drowning, a body was found after drowning without any witness. Time of zero ware used witness time or found body time to calculate start of CPR. The definition of ROSC in this study is ROSC occurring before the start of ambulance transportation. Figure 2 indicates inclusion, patient's selection and exclusion criteria of this study.

Section 3: Study group and endpoint

First, the 43 subjects were divided into two groups. Further, 22 patients had not witnessed drowning accidents, whereas the other 21 drownings were witnessed, and we compared the two groups. Return of spontaneous circulation (as ROSC), survival rate and CPC1-2 one month after drowning were analysed by using multivariable logistic analysis between the witnessed and non-witnessed groups.

Secondly, Patients whose time between zero time and start CPR was divided at the 50th percentile[6] (shorter than 4 minute; whereas the early CPR group and 5 min or longer were defined as and late CPR group), respectively, and were subjected to logistic regression analysis of the presence or absence of ROSC and CPC1-2 one month after drowning.

Thirdly, 21 cases of witnessed drowning-induced OHCA were retrospectively compared with 168 cases using propensity-score method with consistent non-cardiac cause OHCA patient characteristics (age, sex, bystander CPR and PAD) extracted from the nationwide Utstein-style Japanese database in the same month (July to Aug), year (2008–2013) and period (9 a.m. to 5 p.m.).

Section 4: Statistical analysis

Data were expressed as mean±1S.D. For group comparison of continuous variance, we used the unpaired t-test, whereas for comparison of category variance, we used Fisher's exact test. The difference was considered significant when the P-value was less than 0.05.

In addition, logistic analyses were done using JMP11 software for ROSC and CPC1-2, one month after drowning as the primary endpoints and their odds ratios.

For comparison of rescue reports and the nationwide Utstein-style data, optimised propensity matching analysis was done using R statistic software.

Section 5: Submission ethics review board and consent

Before conducting this study, a research proposal was submitted to the institutional IRB (Approval No. 15-MD003), and personal information was provided on the condition that it would be used in an anonymised manner, for permission to use the JLA data.

# Chapter 4. RESULTS

**Chapter 4. Results**

Section 1: Frequency of drowning accident at beaches

Table 1 shows activity performance of individual lifesaving clubs from 2009 until 2014, provided to JLA. According to these records of activities during the opening time (9 a.m. until 5 p.m.) of beaches, among the total 63,495,377 (10,600,000 / year) individuals who entered the beaches, 11,122 (1900 per individuals) individuals underwent preventable action to avoid a hazard, such as drowning, in advance, and 99,091 individuals underwent first aid (Table 1). Among them, 89 cases of emergency care in which a lifesaver performed CPR, were reported, meaning that OHCA developed at the rate of 89/63,495,377 (1 per 713,000 individuals)[7]. Among these 89 victims of serious drowning, 43 victims excluding those applicable to the exclusion criteria were subject to analysis.

Section 2: Patient background and characteristics

Table 2 shows the background and characteristics of the 43 patients. The cause of OHCA was drowning in the sea in all cases. The 43 patients (39 males and 4 females) were aged 36.1±20.4 years on average (Fig 3). Further, 22 drownings were not witnessed (51%); 21 (49%) were witnessed (Table 2).

All of the 43 subjects with drowning-induced OHCA (unconsciousness, non-spontaneous regular respiration or no pulse) judged by a lifesaver underwent CPR by the lifesaver (lifesaver CPR), which applied conventional CPR combining chest compression (100%) and ventilation (100%) (Fig 4). In addition, an AED pad was applied to 40 patients (93.0%), and it was confirmed whether or not defibrillation was necessary. As a result of ECG analysis, 3 patients showed shockable rhythm by AED at the time of contact, whereas 40 patients showed non-shockable rhythm (Fig 5).

Section 3: Comparison of witness and no witness in 43patients

The time between drowning and start of CPR in the witnessed cases was 4.3±2.5 min on average, which was revealed to be significantly shorter than 8.9±5.3 min in the non-witnessed cases ($P<.001$) (Fig 6). The ROSC rate among the 43 patients was

34.9%, whereas the ROSC rate of the witnessed group was 71.4%. In addition, their survival rate and CPC1-2 a month later were 61.9% and 61.9%, respectively, significantly higher than that of the non-witnessed group (P<.001) (Fig 7).

Section 4: Subgroup analysis regarding witnessed drowning

Influences of early initiation of CPR by a lifesaver on ROSC and CPC1-2 were examined using multiple logistic regression analysis. Patients whose time between perception and start of CPR was at the 50th percentile (shorter than 4 minute) and those at more than 5 min or longer were defined as the 'early CPR' group (n=18) and 'late CPR' group (n=25), respectively, and were subjected to logistic regression analysis of the presence or absence of ROSC and CPC1-2 a month later. As a result, the unadjusted odds ratio of ROSC of the early CPR group using the late CPR group as a reference was 8.25 (2.12-38.46), whereas the odds ratio adjusted by age/gender, the presence or absence of PAD and the presence or absence of witnessing was 11.0 (2.32-67.33). On the contrary, the odd ratios of CPC1-2 were 5.25 (1.35-23.85), 6.01 (1.27-35.10), respectively (Table 3).

Section 5: Comparison of lifesaver CPR and layperson CPR on good neurological outcome

Matched case-control analysis using the nationwide Utstein-style Japanese database performed to compare the odds ratio in logistic regression analysis is not sufficient to obtain statistical power because of the small number of the patients in this study.

Among the studied patients, 21 cases of witnessed OHCA were retrospectively compared with 168 cases by propensity score method with consistent non-cardiac cause cardiac arrest patient characteristics extracted from the nationwide Utstein-style Japanese database. After calculation of propensity score, age, sex, chest compressions, artificial ventilation and use of a PAD were used as a covariate factors for extraction. The Phi[8], an index for proper case-to-control ratio, was 0.22, the maximum, when the ratio was 1:8. As a result of optimised matching using propensity score at 1:8 of case to control, 168 victims with approximate background were extracted from 4,635 matched cases (as layperson CPR group).

No significant difference was detected in the patient characteristics between the two groups (Table 4). In the outcomes, the ROSC rate was 71.4% and 41.7% in the lifesaver CPR and layperson CPR groups (risk rate [RR], 3.48; 95%CI, 1.20-11.50; P=0.01) respectively, higher in the lifesaver CPR group (61.9%), whereas the survival rate one month later was 20% higher in the lifesaver CPR group than in the layperson CPR group (36.3%) (RR, 2.33; 95%CI, 0.85-6.64, P=0.09. Also, CPC1-2 was 61.9% and 26.2% in the lifesaver CPR and layperson CPR groups (RR, 3.73; 95%CI, 1.34-10.77, P<0.01), respectively.

# Chapter 5. DISCUSSION

## Chapter 5. Discussion

This study analysed the influence of lifesaver presence, as first responders on beaches, on the prognosis of brain function. In the witnessed cases, lifesaver-performed CPR induces significantly higher ROSC rate (71.4%) and favourable neurological outcome a month later (61.9%) than that of layperson-initiated CPR. Thus, it was clarified that CPR by lifesaver is also effective in patient outcomes in this study.

Drowning is a special condition and environment leading to cardiac arrest. Further, water temperature and age of drowning OHCA victim are not associated with the neurological outcomes; however, the salt content of water is correlated with a favourable result in brain function prognosis. According to previous research, good brain function outcome in drowning patients is closely correlated with having a witness and submersion time of drowning[9], which are describe in the JRC resuscitation guidelines 2015[10].

Our result showed that a lifesaver could start CPR immediately (average 4.3 minutes), and therefore, the ROSC rate was 71.4%, and CPC1-2 was 61.9% in cases of witnessed drowning OHCA. In drowning OHCA, recording the witness time of submersion is important.

To start CPR immediately after drowning, the implementation of the early artificial respiration in the water has been identified as an important element to successful resuscitation and good neurological outcome. The lifesaver may implement ventilation even during water transport. In addition, Winkler et al. mentioned that a group of 21 lifesavers was superior to 21 layperson in all parameters, including time required for rescue, diving capacity, aspiration capacity and technical evaluation, in their study comparing the two groups and the presence and absence of rescue breaths while moving in water in a 50-m outdoor pool, and that rescue breaths by a trained lifesaver in the water were useful but rescue breaths in the water by untrained general citizens were not efficient and should not be recommended[11].

As mentioned in the results, artificial ventilation by lifeguards has been performed in all of 43 patients with drowning-induced OHCA. Among these, the 18 cases in which the lifeguard performed CPR within 4 minutes in the witnessed group show a high ROSC rate and good brain function outcome. In drowning accidents in which OHCA was induced by hypoxia, it is effective to carry out conventional CPR, including adequate continuous chest compressions and appropriate ventilation without interruption.

It has been reported in various articles that lifesaver CPR is of high quality, as has been clarified in this study. Adelborg et al. reported that in their examination comparing mouth-to-mouth ventilation, using a pocket mask, and a bag-valve mask by 60 lifesavers, mouth-to-mouth ventilation had the shortest chest compression pause and an adequate ventilator volume[12], indicating that mouth-to-mouth ventilation improves quality of CPR by lifesavers.

In addition, 168 patients (1:8 match study) were extracted from the nationwide data of the Utstein database with consistent patient characteristics with 21 OHCA patients with the witnessed drowning. As a result, it was revealed that the lifesaver CPR group underwent early recognition of drowning and exact bystander CPR was started at 4.2 min after the witnessing, significantly earlier than the 168 patients in the layperson CPR group. Thus, the high ROSC rate and CPC1-2 of the lifesaver CPR group were 71.4% and 61.9%, respectively, showing highly frequent ROSC and improvement of CPC1-2. In other words, we could prove that early recognition of cardiac arrest and high-quality CPR given by a lifesaver allows earlier ROSC and improvement of CPC1-2 before the arrival of ambulance service.

Bystander CPR is a recognised as second key in the 'chain of survival', and its importance has been emphasised in lifesaving guidelines since 2000. The effect of the bystander CPR before the arrival of the EMT 1) prevents keeping the VF on initial ECG, 2) increases the success rate of defibrillation, 3) contributes to the maintenance of cardiac function and brain function and 4) can improve survival rate. The survival rate improved from 3.9% to 16.1% because of any bystander CPR in Japan[13]. However, the quality of bystander CPR by laypersons is not clear, whereas the effect of bystander CPR by trained lifesavers has not yet been verified. If, immediately after near-drowning, OHCA patients are rescued and high-quality CPR is done, it is easy to imagine a very high brain function prognosis. In other words, in the absence of lifeguards on beach, the high brain function prognosis rate if the laypersons did CPR could not be obtained.

Defibrillation was performed in only three cases in the present study. Of the 130,000 cardiac arrest cases occurring in Japan, little less than 60% were cardiogenic cardiac arrest[14]. However, when near-drowning or suffocation leads to cardiac arrest with hypoxia, many cases show that the PEA or asystole on initial ECG of the adaptation of the defibrillation is only 5-15%[15-17]. Berg reported that chest-compressions-only CPR showed better neurological results compared with doing nothing in animal experiments. The best results have been shown in drowning or choking cardiac arrest when both chest compressions and ventilation was initiated[18, 19]. As shown by this study, for cardiac arrest resulting from hypoxia, such as drowning or FABO causes, artificial ventilation and chest compressions are effective in ROSC and favourable in improving brain function prognosis.

On the contrary, several new improvement factors for OHCA are considerable during transport by EMTs and during hospital post-resuscitation treatment, such as the implementation of the targeted temperature management, which has not been analysed to study. However, as a result of the four rings of resuscitation from the early ROSC of in-hospital ICU post-resuscitation treatment linked to a short period followed in brain function outcome.

Currently, AEDs are installed in all of the beaches by regulation in Japan. Securing of such beach safety management systems by JLA is the main reason why AED pads were applied in 40 of the 43 cases. Further, 2/3 cases of victims who drowned by vomiting gastric juices received artificial respiration, 19 of which are known to occur in 86% of those who received CPR[20]. Therefore, in drowning cases at the beach, in addition to AED, it is necessary to provide a suction device to maintain the airway.

Moreover, it is important to improve the monitoring and rescue skills such as surf rescue, first aid and training of CPR of lifesavers routinely and often. The accuracy and speed of palpation of the carotid artery by lifeguards are better than that given by laypersons, and equal to that of EMTs[5]. Lifesavers are non-medical personnel, but they have a higher resuscitation ability and are continually working to improve. In this study, we have shown the medical effects of lifesaver CPR for drowning-induced cardiac arrest at the beach.

Our common cognition of drowning has been that it is an extraordinary category. However, drowning in the bathtub occurs ordinarily, and drowning because of natural disaster (e.g., tsunami or river flooding) has become an ordinary accident in all seasons. Hence, prevention of drowning can be said to be an urgent task because the first ring of the lifesaving chain is prevention of emergency illness (as also shown in the JRC guidelines 2015)[10].

JLA requires high-level capacity of performing CPR for issuance of basic lifesaver qualification. Results of this study could prove that lifesavers are educated at a high level, as seen in the level of quality in lifesavers' CPR as compared to that administered by laypersons. Currently, qualified lifesavers now total more than 40,000 nationwide in Japan and Preventive Actions are practiced for more than 2,000 individuals annually. The role of the lifesaver is not only resuscitation but also practice of Preventive Actions including prevention of swimming accidents and drowning. To achieve zero accidents of waterside, cooperative measures were securely taken between a lifesaving group and a public rescue institution such as the Fire and Disaster Management Agency and Marine Safety Agency.

# Chapter 6. CONCLUSIONS

## Chapter 6. Conclusions

In conclusion, we found that the lifesaving effect of qualified lifesaver-administered CPR for drowning OHCA improved prognosis of brain function. Thus, it was clarified that high-quality bystander CPR by lifesaver is also effective in patient outcomes, and lifesavers not only prevent development of CA but also play an important role in enabling resuscitation procedures on site earlier before ambulance service arrives on scene, through supervision at the sea and pools.

However, there are several limitations. This study was a retrospective study. Further, non-cardiac-cause cardiac arrest is considered the same pathophysiology as drowning cardiac arrest in the Utstein statistics, which became the subject of case studies matched with the present study. Finally, the study did not evaluate the quality of CPR given by laypersons and lifesavers.

Acknowledgments

In conclusion of this article, we express our respect for all lifesavers maintaining seaside safety across Japan. We also appreciate the Specified Non-Profit Corporation Japan Lifesaving Association for provision of their valuable data.

**References**


1) Ministry of Health, Labor and Welfare: Current population Statistics in Japan(2013Ed)chttp://www.mhlw.go.jp/toukei/saikin/hw/jinkou/kakutei14/dl/10_h6.pdf (final date :2016, Jan,16)

2) Chihara E, Komine T, Miyama M: Life Saving History and Education, GAKUBUNSHA: Tokyo, 2002

3) Ishikawa T, Nakagawa N, Kazama T, et al: Drowning and First Aid Regarding the Beach Accidents of Japan. World Conference of Drowning Prevention, 2015: 223

4) Non-Profit Corporation Japan Lifesaving Association site. http://jla.gr.jp/

5) Nakagawa Y, Inokuchi S, Morita S, et al: Accuracy of Pulse Checks in Terms of Basic Life Support by Lifesavers, as Lay Persons. Circulation Journal, 2010; 74: 1895-1899

6) Drinker, P: the reports of WHO. 1966

7) Non Profit organization, Japan Life saving association :JLA annual reports. 2011-2013

8) Hennessy S, Bilker WB, Berlin JA, Strom BL: Influencing the optimal control to case ratio in matched case control studies. American Journal of Epidemiology, 1999; 149: 195-197

9) Suomien P, Baillie C, Korpela R, et al: Impact of age, submersion time and water temperature on outcome in near-drowning. Resuscitation, 2002; 52: 247-54

10) Japanese Resuscitation Council: JRC resuscitation guideline. Chaper2. ALS JRC resuscitation guideline 2015 online version http://jrc.umin.ac.jp/pdf/20151016/2_ALS.pdf (final date :2016, Jan,16)

11) Winkler BE, Eff AM, Ehrmann U, et al: Effectiveness and safety of in-water resuscitation performed by lifeguards and laypersons: A crossover manikin study. Prehosp Emerg Care, 2013; 17: 409-15

12) Adelborg K, Dalgas C, Grove EL, et al: Mouth-to-mouth ventilation is superior to mouth-to-pocket mask and bag-valve-mask ventilation during lifeguard CPR: A randomized study. Resuscitation, 2011; 82: 618-22

13) Sasson C, Rogers MA, Dahl J, et al: Predictors of survival from out-of-hospital cardiac arrest: A systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes, 2010; 3: 63-81

14) Fire and Disaster agency: Annual report 2015: Status of EMS andresuc ue.http://www.fdma.go.jp/neuter/topics/fieldList9_3.html (Final date of 2016.Jan.16)

15) Appleton GO, Cummins RO, Larson MP, Graves JR: CPR and the single rescuer: at what age should you "call first" rather than "call fast"?. Ann Emerg Med, 1995; 25: 492–494

16) Hickey RW, Cohen DM, Strausbaugh S, Dietrich AM: Pediatric patients requiring CPR in the prehospital setting. Ann Emerg Med, 1995; 25: 495–501

17) Mogayzel C, Quan L, Graves JR, Tiedeman D, Fahrenbruch C, Herndon P: Out-of-hospital ventricular fibrillation in children and adolescents: causes and outcomes. Ann Emerg Med, 1995; 25: 484–491

18) Berg RA, Hilwig RW, Kern KB, Babar I, Ewy GA: Simulated mouth-to-mouth ventilation and chest compressions (bystander cardiopulmonary resuscitation) improves outcome in a swine model of prehospital pediatric asphyxial cardiac arrest. Crit Care Med, 1999; 27: 1893–1899

19) Berg RA, Hilwig RW, Kern KB, Ewy GA: "Bystander" chest compressions and assisted ventilation independently improve outcome from piglet asphyxial pulseless "cardiac arrest". Circulation, 2000; 101: 1743–1748

20) The European Resuscitation Council Guidelines for Resuscitation 2005. https://www.erc.edu/index.php/guidelines_download_2005/en/ (final date :2016, Jan,16)

**Figure and Table**

## Figure and Table

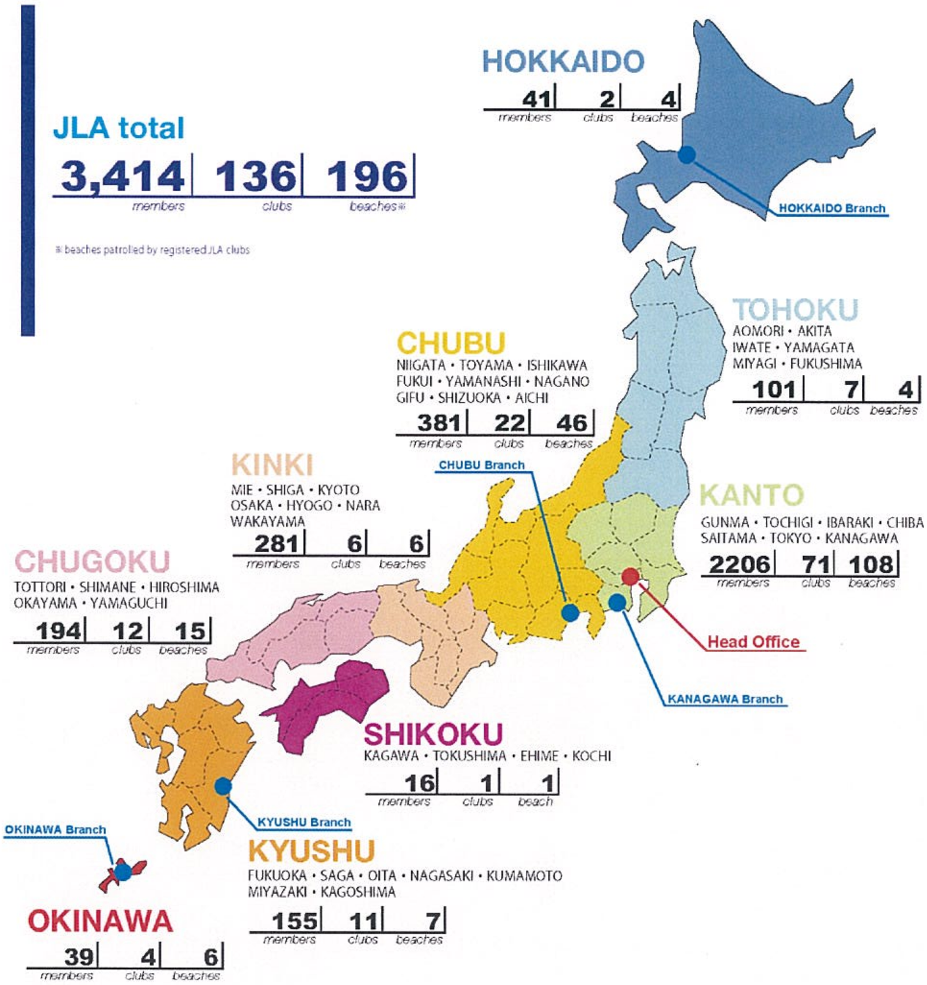



**Fig 1. Japan Life Saving Association lifeguards located beach[3)]**

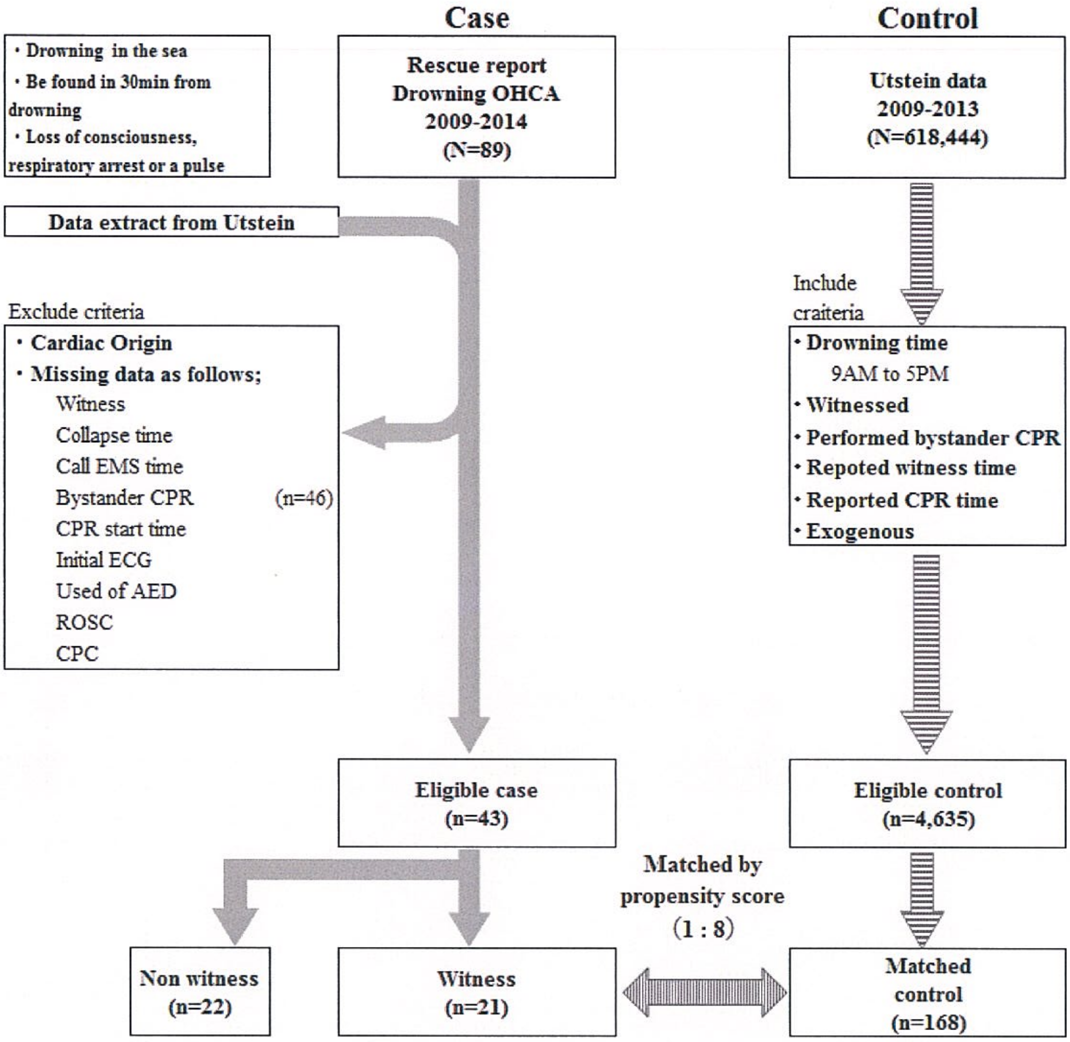



Fig 2. Inclusion criteria, patient's selection, and exclusion criteria of this study

*Note.* n.s.: not significant

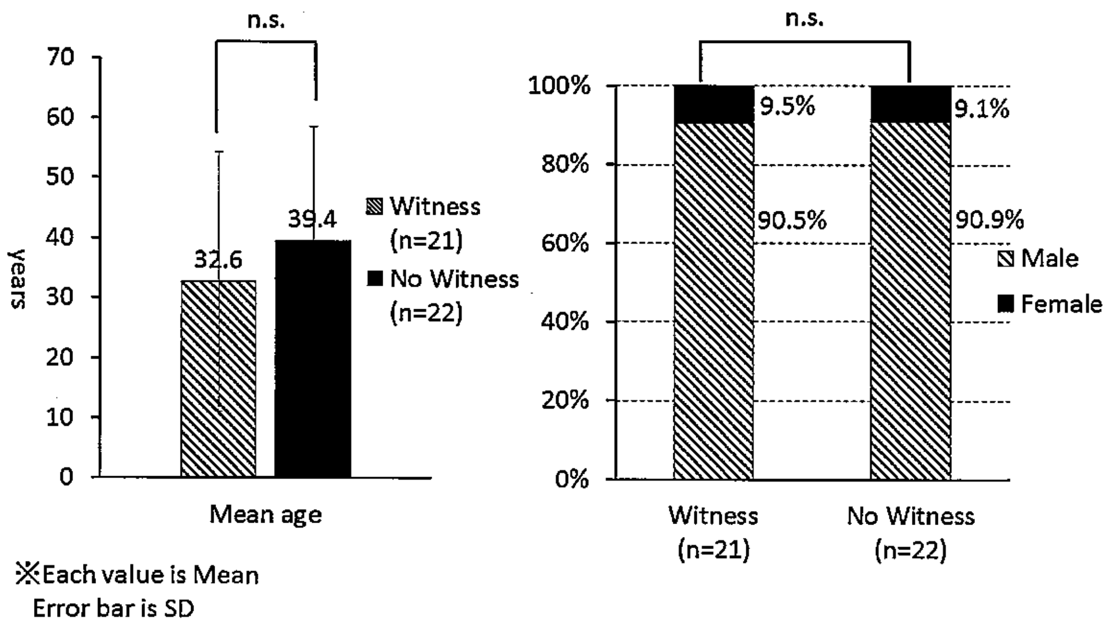



**Fig 3. Rate of age and male to female by the presence or absence of witness**

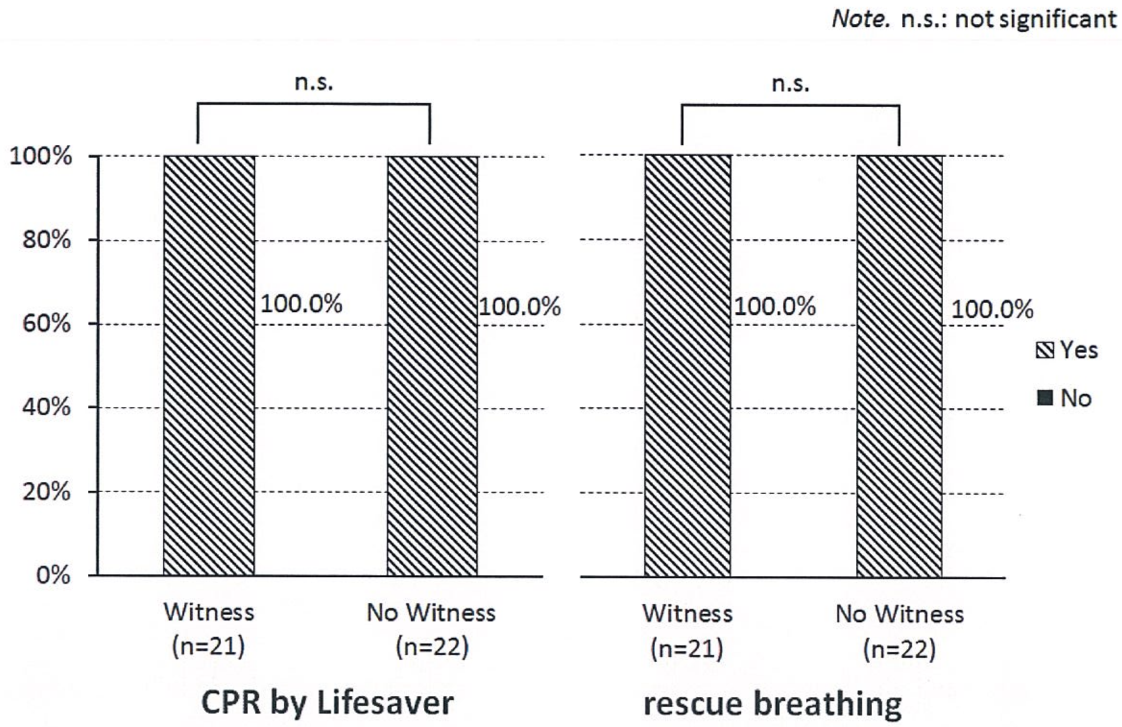



**Fig 4. Rate of CPR by Lifesaver and rescue breathing by the presence or absence of witness**

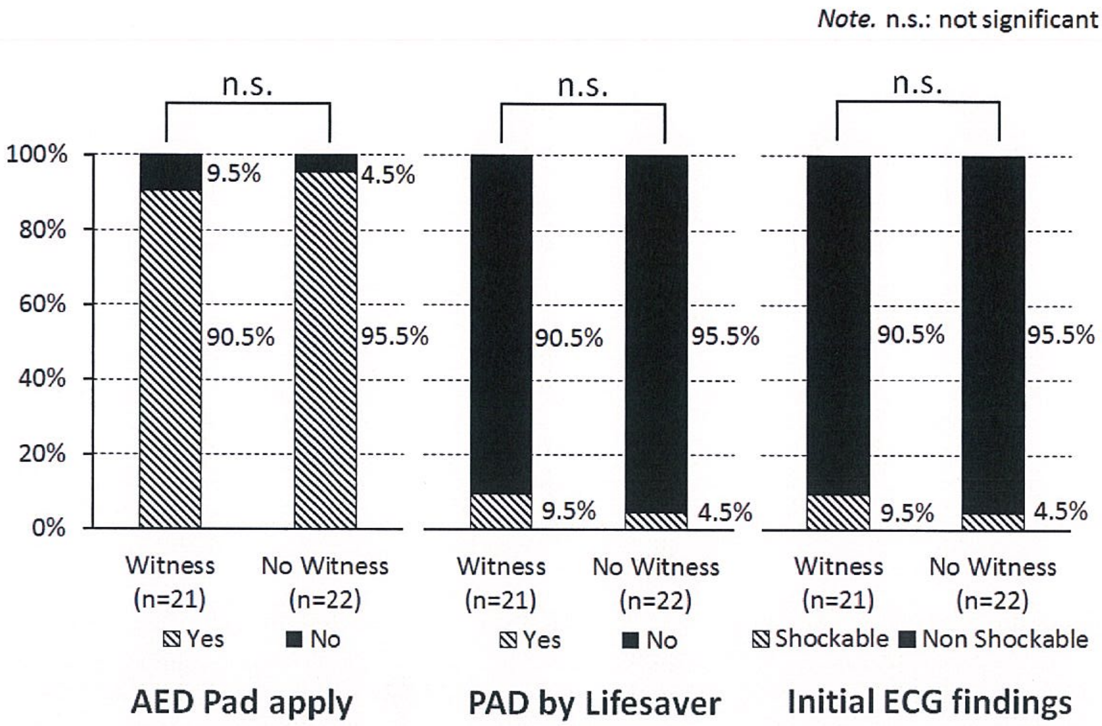
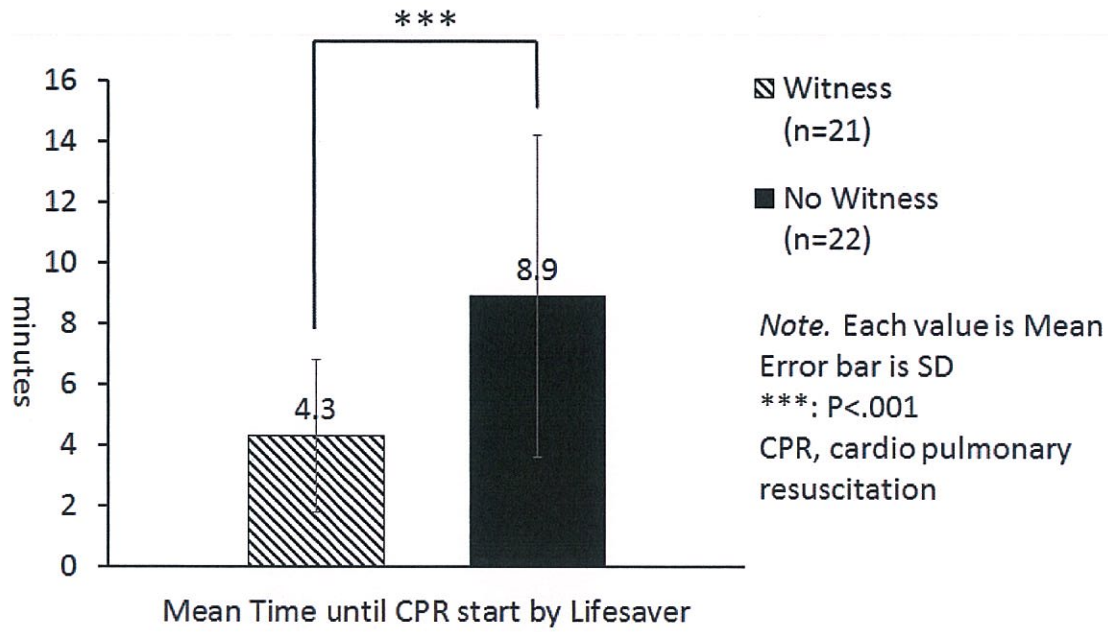



**Fig 5. Rate of AED Pad apply, PAD by lifesaver, and Initial ECG findings by the presence or absence of witness**




## Time related characteristics

**Fig 6. Time related characteristics by the presence or absence of witness**

Note. ***: P<.001

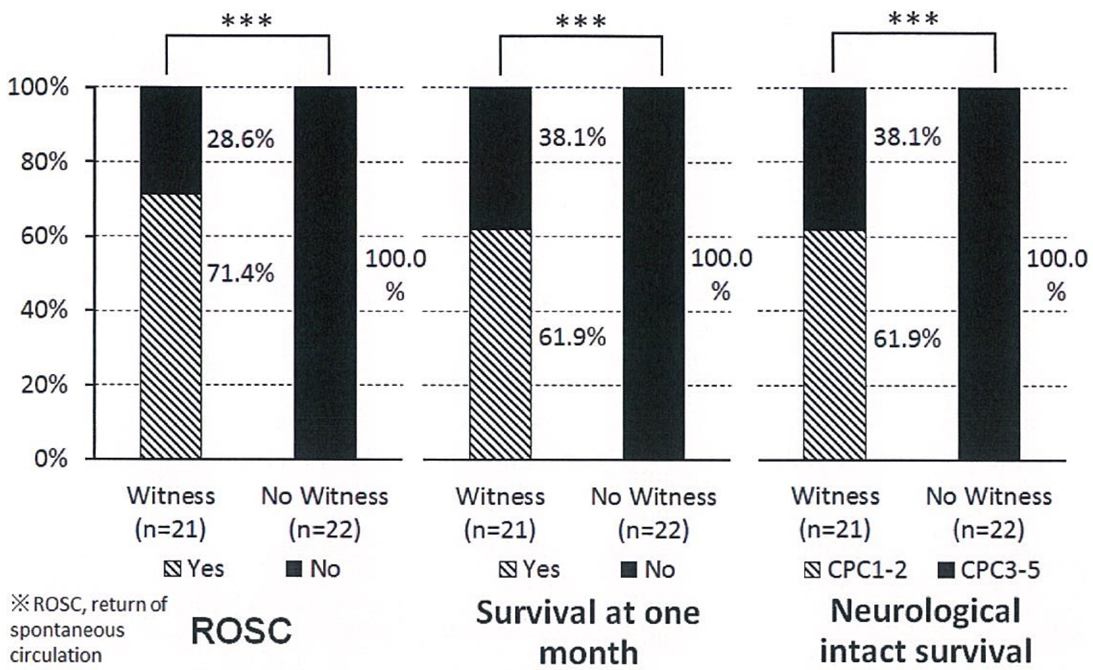



**Fig 7. Rate of ROSC, survival at one month, and neurological intact survival by the presence or absence of witness**

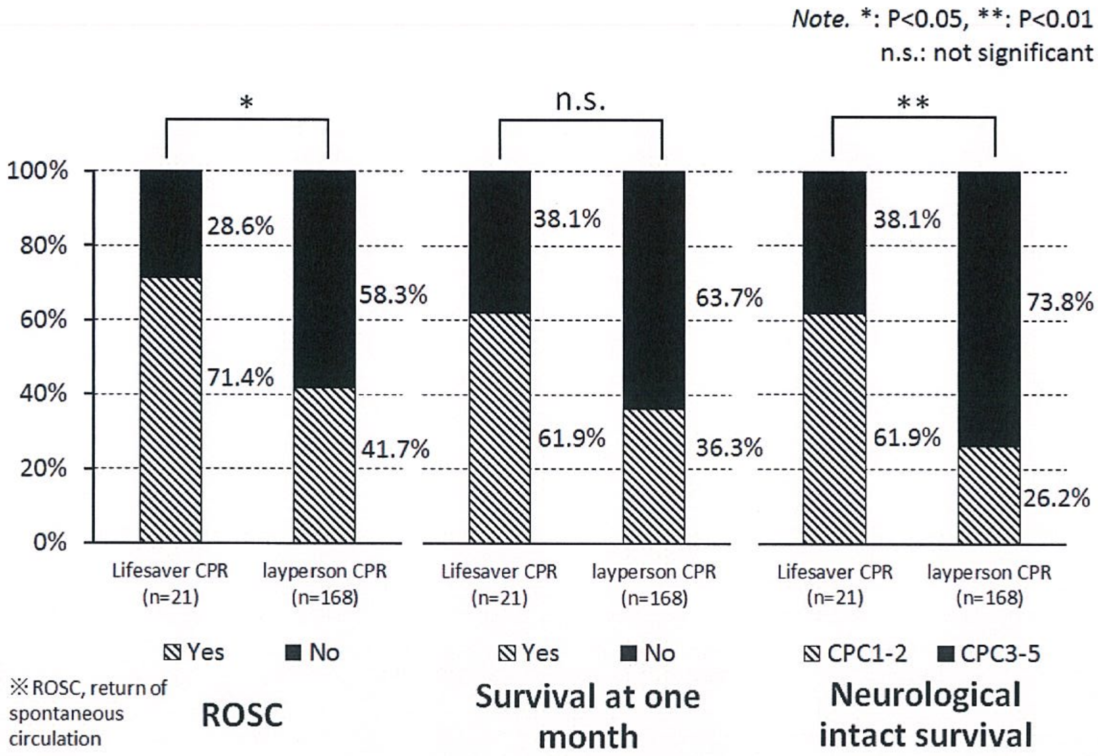



**Fig 8. Comparisons of ROSC, survival at one month, and neurological intact survival by Lifesaver CPR and layperson CPR**

**Table 1. The number of Beaches, guests, EC, PA, and FA in JLA is involved[7)]**

| year | JLA involved | Report completed | Number of guests | Emergency Care | Preventive Action | First Aids |
|---|---|---|---|---|---|---|
| 2009 | 212 | 138 | 8,638,959 | 14 | 2,018 | 14,054 |
| 2010 | 214 | 134 | 11,030,630 | 12 | 1,040 | 14,903 |
| 2011 | 196 | 125 | 8,687,646 | 8 | 1,060 | 9,717 |
| 2012 | 202 | 124 | 7,737,376 | 12 | 1,973 | 12,406 |
| 2013 | 177 | 177 | 16,073,085 | 23 | 2,253 | 27,013 |
| 2014 | 186 | 186 | 11,327,681 | 20 | 2,778 | 20,998 |
| Total | 1187 | 884 | 63,495,377 | 89 | 11,122 | 99,091 |
| Average | 198 | 147 | 10,582,563 | 15 | 1,854 | 16,515 |

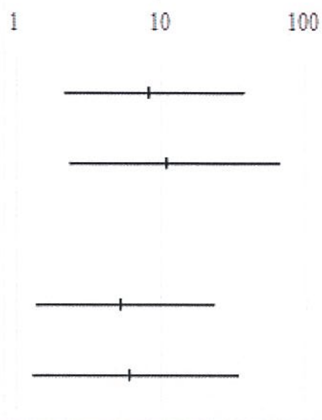
JLA, Japan Life saving Association

**Table 2. The sub-group classification in the presence and absence of the witness and patient background**

| Characteristeics | Total number of Drowning CPA patients (n=43) | | Witness (n=21) | | No Witness (n=22) | | P value |
|---|---|---|---|---|---|---|---|
| Patient's characteristics | | | | | | | |
| Mean age, (SD), y | 36.1 | (20.4) | 32.6 | (21.6) | 39.4 | (19.1) | 0.28 |
| Male, n(%) | 39.0 | (90.7) | 19.0 | (90.5) | 20.0 | (90.9) | 1.00 |
| CPR by Lifesaver, n, (%) | 43 | (100.0) | 21 | (100.0) | 22 | (100.0) | 1.00 |
| rescue breathing, n, (%) | 43.0 | (100.0) | 21 | (100.0) | 22 | (100.0) | 1.00 |
| AED Pad apply, n, (%) | 40.0 | (93.0) | 19 | (90.5) | 21 | (95.5) | 0.61 |
| PAD by Lifesaver, n, (%) | 3.0 | (7.0) | 2 | (9.5) | 1 | (4.5) | 0.61 |
| Initial ECG findings | | | | | | | |
| Shockable, n, (%) | 3 | (7.0) | 2 | (9.5) | 1 | (4.5) | 0.61 |
| Non Shockable, n, (%) | 40 | (93.0) | 19 | (90.5) | 21 | (95.5) | 0.61 |
| Outcome | | | | | | | |
| ROSC, n, (%) | 15 | (34.9) | 15 | (71.4) | 0.0 | (0.0) | <.001 |
| One month survival, n, (%) | 13 | (30.2) | 13 | (61.9) | 0.0 | (0.0) | <.001 |
| Neurological intact survival (CPC1-2), n, (%) | 13 | (30.2) | 13 | (61.9) | 0.0 | (0.0) | <.001 |
| Time related characteristics | | | | | | | |
| Mean Time until CPR start by Lifesaver, min, (SD) | 6.7 | (4.7) | 4.3 | (2.5) | 8.9 | (5.3) | <.001 |
| Time until ROSC in the field,min (SD) | 8.1 | (4.0) | 8.1 | (4.0) | - | (-) | - |

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; PAD, public access defibrillation;
ROSC, return of spontaneous circulation; SD, standard deviation;

## Table 3. Odds Ratio of Early CPR vs Late(ref) by Lifesaver




| | OR (95%CI) |
|---|---|
| ROSC | |
| Unadjusted | 8.25 (2.12-38.46) |
| Adjusted by age, sex, PAD | 11.0 (2.32-67.33) |
| CPC1-2 | |
| Unadjusted | 5.25 (1.35-23.85) |
| Adjusted by age, sex, PAD | 6.01 (1.27-35.10) |

CPR, cardiopulmonary resuscitation;
PAD, public access defibrillation; ROSC, return of spontaneous circulation;

**Table 4. Clinical Characteristics of Lifesaver treated and Extracted case much OHCA Patients**

| | Lifesaver CPR (n=21) | | layperson CPR (n=168) | | P value |
|---|---|---|---|---|---|
| Patient's characterstics | | | | | |
| Age, mean(SD), y | 32.6 | (21.6) | 28.0 | (23.3) | 0.40 |
| Male, n(%) | 19 | (90.5) | 123 | (73.2) | 0.11 |
| The presence or absence of | | | | | |
| CPR, n(%) | 21 | (100.0) | 168 | (100.0) | 1.00 |
| rescue breathing, n(%) | 21 | (100.0) | 148 | (88.1) | 0.14 |
| PAD by Lifesaver or layperson, n(%) | 2 | (9.5) | 19 | (11.3) | 1.00 |
| Outcome | | | | | |
| ROSC, n(%) | 15 | (71.4) | 70 | (41.7) | 0.01 |
| Survival at one month, n(%) | 13 | (61.9) | 61 | (36.3) | 0.09 |
| Neurological intact survival(CPC1-2), n(%) | 13 | (61.9) | 44 | (26.2) | 0.01 |

CPR, cardiopulmonary resuscitation; PAD, public access defibrillation;
ROSC, return of spontaneous circulation; SD, standard deviation;