Does the number of rescuers affect the survival rate from out-of-hospital cardiac arrests? Two or more rescuers are not always better than one

Does the number of rescuers affect the survival rate from out-of-hospital cardiac arrests? Two or more rescuers are not always better than one.

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Abstract

Review: An increased number of rescuers may improve the survival rate from out-of-hospital cardiac arrests (OHCAs). The majority of OHCAs occur at home and are handled by family members.

Materials and Methods: Data from 5,078 OHCAs that were witnessed by citizens and unwitnessed by citizens or emergency medical technicians from January 2004 to March 2010 were prospectively collected. The number of rescuers was identified in 4,338 OHCAs and was classified into two (single rescuer (N=2,468) and multiple rescuers (N=1870)) or three (single rescuer, two rescuers (N=887) and three or more rescuers (N=983)) groups. The backgrounds, characteristics and outcomes of OHCAs were compared between the two groups and among the three groups.

Results: When all OHCAs were collectively analysed, an increased number of rescuers was associated with better outcomes (one-year survival and one-year survival with favourable neurological outcomes were 3.1% and 1.9% for single rescuers, 4.1% and 2.0% for two rescuers, and 6.0% and 4.6% for three or more rescuers, respectively, ($p=0.0006$ and $p<0.0001$)). A multiple logistic regression analysis showed that the presence of multiple rescuers is an independent factor that is associated with one-year survival (odds ratio (95% confidence interval): 1.539 (1.088-2.183)). When only OHCAs that occurred at home were analysed (N=2902), the OHCAs that were handled by multiple rescuers were associated with higher incidences of bystander CPR but were not associated with better outcomes.

Conclusions: In summary, an increased number of rescuers improves the outcomes of OHCAs. However, this beneficial effect is absent in OHCAs that occur at home.

Word count 250

Key words: Out-of-hospital cardiac arrest; home; location; Telephone-CPR; Prospective cohort study

1. Introduction

According to the ERC Basic Life Support (BLS) guidelines 2010, a bystander should shout for help after he or she finds a victim who is unresponsive [1, 2]. This recommendation may be based on the assumption that an increased number of rescuers may facilitate the BLS actions. The majority of out-of-hospital cardiac arrests (OHCAs) occur at home, where the response to OHCAs and the characteristics of OHCA patients and their rescuers may differ from those in other locations [3, 4, 5, 6]. The aging population accompanied with an increase in number of households with elderly residents [7-9] may influence not only the number of rescuers but also the performance of BLS [10,11,12].

Nevertheless, it has not been investigated whether an increased number of rescuers may improve the survival rate from OHCAs. The aim of this study was to elucidate the effect of the number of rescuers on the outcomes of OHCAs with an emphasis on the different characteristics of the OHCAs that occurred at home.

2. Materials and Methods

The data were collected in accordance with the national guidelines of ethics for epidemiological surveys. This study was approved by the review board of the Ishikawa Medical Control Council.

Populations and setting

The Ishikawa prefecture encompasses a snowfall area of 4,186 km^2, and has a resident population of 1,170,000. There are 11 fire departments. The prefecture is divided into four administrative regions: one central/urban region with five fire departments and three semi-rural/rural, regions with six departments. Sixty-two percent of the residents are located in the central region, which has an area of 1,432 km^2. The population age is older in semi-rural/rural regions (28.5% vs. 20.3% over the age of 65, respectively).

Since the beginning of 2004, telephone-assisted instruction of CPR (telephone-CPR) has been conducted by all fire departments. All fire departments have a one-tiered ambulance dispatch system. Nine fire departments have a centralised dispatch system. EMTs resuscitate patients experiencing OHCA according to the protocol developed by the Ishikawa Medical Control Council. This protocol is based on the guidelines of the American Heart Association and the Japan Resuscitation Council. The paramedics are authorised to perform the following procedures during the resuscitation: (1) the use of supra-pharyngeal airways, (2) infusion of Ringer's lactate and (3) the use of semi-automated external defibrillators. Since July 2004, specially

trained paramedics have been permitted to insert tracheal tubes under a limited indication criteria [14], and since April 2006, they have been permitted to administer intravenous adrenaline. In all fire departments, each ambulance is usually boarded with three or more EMTs including at least one paramedic. The EMTs are not permitted to terminate resuscitation in the field.

Patient data and identification of the number of rescuers

Data from 5,078 OHCAs that were witnessed by citizens and were not witnessed by citizens or EMTs from January 2004 to March 2010 were prospectively collected by fire departments in the Ishikawa prefecture. The EMTs made an every effort to identify the number of rescuers defined as lay people who were close to the scene at arrest recognition or witness, responded to the first rescuer's cry for help and participated in any part of basic life support (BLS) and other related supports provided to the victim. The counting did not include either spectators at the scene, curious citizens who arrived at the scene after a time lapse or "responders" who arrived at the scene shortly before EMT arrival. The number of rescuers was identified in 85.4% (4,338) of 5,078 OHCAs and was classified into two (single rescuer (N=2,468) and multiple rescuers (N=1870)) or three (single rescuer, two rescuers (N=887) and three or more rescuers (N=983)) groups.

The collected data were based on the Utstein template [15, 16] and included the region, place, patient's age, patient's sex, arrest witness, causes of arrest (presumed cardiac or not), bystander CPR, initial cardiac rhythm, estimated time of collapse, times of the initiation of CPR by bystanders and EMTs, interval between the emergency call and arrival at the patient, sustained return of spontaneous circulation (SROSC), one-month (1-M) survival, one-year (1-Y) survival and 1-Y survival with a favourable neurological outcome, determined based on the Pittsburgh cerebral performance category (CPC) [17, 18]. The times of collapse and the initiation of CPR by bystanders were estimated by an interview, as reported previously [4]. The SROSC is defined as the continuous presence of palpable pulses for more than 20 min [15, 16]. The survival rate at 1-Y was defined as the patient being alive in a hospital at 1-Y or as the patient being alive and discharged from the hospital to home or to a care or rehabilitation facility within 1-Y. One-year survival with favourable neurological outcome was defined as a CPC of one (good recovery) or two (moderate disability) in patients without any neurological disturbance before the arrest event and when the best CPC was equal to the pre-arrest category in patients with neurological disturbance. The primary end point was 1-Y survival.

The quality of bystander CPR was rarely evaluated at EMT arrival and excluded from analysis. There were no data on how many cases having continuous CPR with a

high quality.

The backgrounds, characteristics and outcomes of OHCAs were compared between the two groups and among the three groups with reference to arrest location (home and others). The comparisons included BLS performance.

Statistical analysis

We analysed the data using JMP ver.7 for Windows (SAS institute, Cary, NC). The chi-squared test, with and without Pearson's correction, was applied for univariate analyses. The Kruskal-Wallis test was used for non-parametric comparisons. We used a multiple logistic regression analysis to identify the factors associated with 1-Y survival. In all analyses, $p < 0.05$ was considered significant. Odds ratio (OR) and 95% confidence interval (95% C.I.) were shown when they were defined. Validity of model was evaluated using a value of the logit R^2

3. Results

Characteristic of 740 OHCAs without an identified number of rescuers (Supplemental Tables 5 & 6)

The incidences of non-central region (20.5% vs 51.8%), female patients (54.6% vs. 60.8%), location of arrest (other than home, 37.4% vs. 33.1%) and unwitnessed OHCAs (91.9% vs. 61.0%) were higher in the OHCAs without an identified number of rescuers (N = 740) than in other OHCAs grouped and analysed by an identified number of rescuers (N = 4338). Furthermore, the patient's age (median (95% C.I.), 79(67-86) vs. 76 (63-84)) and the interval between arrest recognition/witness and emergency call (3(1-6) vs. 2(1-6)) were significantly prolonged in the OHCAs without an identified number. The survival rates in these OHCAs were significantly lower at 1-M (2.7% vs. 5.2%) and 1-Y (1.8% vs. 3.9%). However, the incidences of bystander CPR and CPR on bystander's own initiative did not significantly differ between the OHCAs with and without a identified number

Comparisons of backgrounds and characteristics of OHCAs between the groups categorised by the number of rescuers (Table 1)

Patients' age and sex did not significantly differ among the groups. Multiple rescuers were more frequently present when OHCAs were witnessed ($p=0.0032$) and when a tracheal intubation was performed ($p=0.0074$). Multiple rescuers were less frequently present when OHCAs occurred in central regions ($p<0.0001$), at home ($p<0.0001$) and when the OHCAs had cardiac aetiology ($p=0.0032$). When multiple rescuers were present, the interval between the call and arrival at the patient was significantly prolonged ($p=0.0196$), but the interval between the call to the initiation of

CPR (CPR was initiated by citizens or EMTs) was significantly shortened ($p<0.0001$).

Effects of the number of rescuers on BLS performance in all OHCAs (Table 2

When all OHCAs were analysed collectively, the presence of multiple rescuers exerted beneficial effects on BLS performance before EMT arrival at the patient. The presence of multiple rescuers was associated with higher incidences of CPR before EMT arrival ($p<0.0001$), CPR due to the rescuer's own initiative ($p<0.0001$), healthcare provider as the CPR performer ($p<0.0001$) and early initiation of CPR, as indicated by a decreased interval between the call and bystander CPR ($p<0.0001$).

Public access defibrillation (PAD) was very rarely applied. However, the PAD was more frequently applied and defibrillation was more frequently attempted by bystanders when multiple rescuers were present ($p<0.0001$).

Effects of the number of rescuers on incidences of shockable initial rhythm and EMT-performed defibrillation, as well as the outcomes of OHCAs

As illustrated in Fig. 1A, the number of rescuers was significantly associated with incidences of shockable initial rhythm ($p=0.0003$), EMT-performed defibrillation ($p=0.0174$), SROSC ($p=0.0146$), 1-M survival ($p=0.0148$), 1-Y survival ($P=0.0006$) and 1-Y survival with favourable neurological outcome ($p<0.0001$). These incidences were lowest in OHCAs with a single rescuer and were highest in OHCAs with three or more rescuers.

The effects of the number of rescuers on some of the outcomes remained significant when the analysis was made based on bystander-witnessed OHCAs of presumed cardiac aetiology (Fig. 2A). The increased number of rescuers was associated with higher incidences of shockable rhythm ($p=0.0002$), EMT-performed defibrillation ($p=0.0001$), 1-Y survival ($p=0.0049$) and 1-Y survival with favourable neurological outcome ($p=0.0049$).

Factors associated with 1-Y survival in all OHCAs (Table 3)

A univariate analysis revealed that the presence of multiple rescuers (OR: 95% C.I = 1.685: 1.238-2.292), central region (1.766: 1.281-2.434), patient's age ($p<0.0001$), male patients (1.473: 1.059-2.048), arrest location ($p<0.0001$), presumed cardiac aetiology (1.947: 1.412-2.684), witnessed arrest (4.424: 3.115-6.284), CPR before EMT arrival (1.417: 1.040-1.931), interval between call and EMT arrival at patient ($p<0.0001$), interval between call and first CPR ($p=0.0004$) and interval between arrest witness/recognition and call ($p<0.0001$) were factors that were associated with 1-Y survival. A multiple logistic regression analysis ($R^2 = 0.1665$) confirmed that the presence of multiple rescuers is an independent factor that is associated with 1-Y survival (OR: 95% C.I.) =1.539 : 1.088-2.183). Presumed cardiac aetiology and

witnessed arrest were also independent factors that were associated with 1-Y survival. An increase in the patient's age, care facilities as arrest location, increased interval between call and arrival at patient and increased duration between arrest witness/recognition and call were other independent factors related to a low 1-Y survival.

Effects of the number of rescuers on OHCAs that occurred at home

When the backgrounds and characteristics of OHCAs were compared among the groups (Table 4), there were significant differences in the region and aetiology of arrest among the groups. The interval between the call and arrival at the patient significantly differed between single rescuer and multiple rescuer groups. The interval between the call and first CPR was significantly shortened when multiple rescuers were present. These differences were almost similar to those observed in all OHCAs.

As shown in Table 2, the presence of multiple rescuers significantly increased the incidence of bystander CPR ($p<0.0001$) but did not significantly reduce the interval between the call and bystander CPR($p=0.0862$). Healthcare providers performed bystander CPR more frequently when multiple rescuers were present ($p<0.0001$), as observed in all OHCAs, but healthcare providers very rarely performed CPR at home (4.8% at home and 47.1% at other locations, $p<0.0001$). It should also be noted that most (84%) bystander CPR was initiated following telephone-CPR. Bystanders applied the PAD in one case.

Despite these beneficial effects on CPR performance before EMT arrival at the patients, we failed to detect any significant effects on the incidences of shockable initial rhythm, EMT-performed defibrillation and patient outcomes in all OHCAs that occurred at home (Fig. 1B). When analysed based on bystander-witnessed OHCAs of presumed cardiac aetiology that occurred at home (Fig. 2B), the presence of multiple rescuers had no significant influences on patient outcomes but was associated with higher incidences of shockable initial rhythm ($p=0.0119$) and EMT-performed defibrillation ($p=0.0187$).

Univariate analysis followed by multiple logistic regression analysis (for 1-Y survival ($R^2 = 0.1451$) confirmed that the number of rescuers is not an independent factor associated with 1-Y survival (OR: 95% C.I.) = 1.282: 0.820-1.985),). The analysis demonstrated that the patient's age, witnessed cardiac arrest, interval between the call and arrival at patient and interval between arrest witness/recognition and the call are other independent factors associated with 1-Y survival.

4. Discussion

To the best of our knowledge, this study is the first to investigate the effect of the number of rescuers on BLS performance and outcomes of OHCA patients. When all OHCAs were analysed collectively, an increased number of rescuers, as expected by ERC BLS Guidelines, was associated with higher incidences of CPR before EMT arrival, healthcare provider as a CPR performer, shockable initial rhythm and better outcomes. Furthermore, the PAD was more frequently applied and defibrillation was more frequently attempted by bystanders when multiple rescuers were present. However, these beneficial effects of an increased number of rescuers on patient outcomes were absent in OHCAs that occurred at home. Of note, the presence of multiple rescuers significantly increased the incidences of shockable initial rhythm and EMT-performed defibrillation in bystander-witnessed OHCAs of presumed cardiac aetiology that occurred at home. The presence of multiple rescuers in OHCAs that occurred at home significantly increased the incidence of CPR before EMT arrival at the patient but did not reduce the interval between the call and CPR prior to EMT arrival. Furthermore, in most (67%) OHCA cases that occurred at home, bystander-CPR was initiated following telephone-CPR, and more than half (55%) of the cases were managed by a single rescuer. The presence of multiple rescuers in public places may be one reason why survival is less for the in-home OHCAs than the public OHCAs.

Japan has a rapidly ageing population [7, 8], which has led to an increase in the number of households with elderly residents (42% in 2010) [9]. Furthermore, the number of household members was 2.5 members/household in 2010. Approximately 20% of all households are “elderly households” (defined as households consisting of individuals aged 65 years or over, with or without unmarried dependents below the age of 18), and nearly half of them are composed of elderly couples [9]. These characteristics of Japanese households may contribute to our observations.

In Japan, fire departments [19], the Japanese Red Cross Society [20] and qualified drivers license schools [21, 22] provide the BLS training program for citizens. Annual participants in these qualified programs are reported to be approximately 2,600,000 in total. Assuming that participants in the BLS course maintain fundamental BLS skills and sufficient willingness to perform BLS for two years [10, 23, 24], approximately 4.4% (2*2.6/127*100) of the population in Japan is estimated to have an ability to perform BLS with the fundamental skills. The sum of healthcare providers represents 1.4% of the population in Japan [25,26]. Thus, the incidence of a well-trained rescuer performing BLS for victims is 5.8% when estimated approximately in an ideal situation. This incidence increases in proportion to the number of rescuers for OHCAs that occur in most public locations because these high-potential bystanders are consistently

distributed. In this study, we showed that multiple rescuers were less frequently present and healthcare providers less frequently performed CPR in OHCAs that occurred at home. The willingness to attend a BLS course [11] and to perform BLS [10, 12] has been reported to be low in elderly citizens. The home environment is a relatively confined location where high-potential bystanders are rarely present. Presumably, the low quality of bystander CPR due to the rescuers' educational backgrounds and unwillingness to performing BLS (including AED use) on bystander's own initiative may also explain the lack of beneficial effects of multiple rescuers on outcomes.

Finally, the diffusion of responsibility among family members [27] and bureaucracy and/or patriarchal system in Japanese families [28] may be a reason for the lack of beneficial effects of multiple rescuers. Male has a shorter life than female. A male patriarch (or a husband) is frequently the first victim of OHCA that is witnessed or detected by a family member (occasionally by a housewife). This situation may cause a chaos at home. These behavioural properties of Japanese families may cause the delay in the initiation of bystander CPR and the delay in emergency calls [4].

The results of the present study suggest that different strategies will be needed to improve BLS performance for OHCAs that occur at home. Because the incidence of a single rescuer is higher in OHCAs that occur at home than those that occur at other locations, BLS instruction for families should be arranged in case help from other rescuers is unavailable. BLS instruction should be targeted to the "elderly household." The implementation of a community first responder system [29] or recruitment of well-trained citizens to perform BLS on OHCA victims at home [30] may be necessary.

Limitations

There are some limitations in our study. Apparently ineffective bystander CPR, including ventilation-only CPR, was characterised as "no CPR," but the quality of bystander CPR was not evaluated or quantified. Furthermore, backgrounds for BLS training were not obtained. Rescuers defined in this study may include some laypersons that just help without doing any CPR. This may be the reason why multiple rescuers did not show any benefit on survival of in-home OHCAs. Exclusion of OHCA patients without an identified number of rescuers might modify the results although the number was identified in 85.4% of OHCAs during the study period.

However, this study contains a considerably large prospective cohort. The results of the present study are interpreted with reference to the current BLS guidelines and BLS education that was designed for a small household where multiple rescuers are present.

5. Conclusions

As a whole, an increased number of rescuers improved the outcomes of OHCAs that were not witnessed by EMTs. However, this beneficial effect was absent in OHCAs that occurred at home. Different strategies, including BLS instruction focused on a single rescuer in a small family or household and the recruitment of well-trained citizens to perform BLS on OHCA victims at home, may be necessary to improve the outcome of OHCAs that occur at home.

6. CONFLICT OF INTEREST STATEMENT

We have no conflicts of interest to disclose.

7. ACKNOWLEDGEMENTS

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Figure legends

Fig. 1 Effects of the number of rescuers on incidences of shockable initial rhythm and EMT-performed defibrillation, as well as the outcomes of all categories of OHCAs

Fig. 2 Effects of the number of rescuers on incidences of shockable initial rhythm and EMT-performed defibrillation, as well as the outcomes of bystander-witnessed OHCAs of presumed cardiac aetiology

Table 1. Differences in patient backgrounds and time factors between/among the groups

Characteristics and backgrounds	Group (Number of rescuers), N			Statistics	
	single N=2468	multiple N=1870		*p* value by univariate analysis between 2 groups[a] / among 3 groups	Odds ratio (95% C.I.) for multiple rescuers (single rescuer as reference)
		two N=887	three or more N=983		
Region – central, % (N)	55.2%(1361)	48.7%(910)		**<0.0001** **<0.0001**	**0.771** **(0.683-0.869)**
		49.9%(443)	47.5%(467)		
Patient's age, median (25%-75%)	77(64-84)	76(62.75-85)		0.7845 0.6557	-
		77(64-84)	75(61-85)		
Patient's sex – male, % (N)	60.4%(1490)	60.8%(1136)		0.8019 0.8721	1.016 (0.898-1.149)
		60.2%(534)	61.2%(602)		
Location - home, % (N)	79.1%(1952)	50.8%(950)		**<0.0001** **<0.0001**	**0.273** **(0.239-0.312)**
		69.7%(618)	33.8%(332)		
Aetiology - presumed cardiac, % (N)	51.9%(1282)	47.4%(887)		**0.0032** **0.0083**	**0.834** **(0.740-0.941)**
		48.6%(431)	46.4%(456)		
Arrest - witnessed, % (N)	39.7%(979)	44.1%(825)		**0.0032** **0.0012**	1.201 (1.063-1.356)
		41.5%(368)	46.5%(457)		
Call to arrival at patient, median (25%-75%)	7(6-10)	8(6-10)		**0.0196** **0.0389**	-
		7(6-10)	8(6-10)		
Call to first CPR[b], median (25%-75%)	5(1-8)	3(0-8)		**<0.0001** **<0.0001**	-
		3(0-7)	3(0-8)		
Arrest recognition/witness to call, median (25%-75%)	2(1-5)	2(1-5)		0.1381 0.3054	-
		2(1-5)	2(1-5)		

a) 2 groups: single or multiple

b) first CPR: Whoever performed CPR first, between citizens and EMTs

Table 2. Effect of the number of rescuers on BLS performance

Characteristics and backgrounds	All OHCAs				In-home OHCAs			
	Group (Number of rescuers), N		Statistics		Group (Number of rescuers), N		Statistics	
	single N=2468	multiple N=1870	*p* value by univariate analysis between 2 groups*	Odds ratio (95% C.I.) for multiple rescuers (single rescuer as reference)	single N=1952	multiple N=950	*p* value by univariate analysis between 2 groupsa)	Odds ratio (95% C.I.) for multiple rescuers (single rescuer as reference)
CPR before EMT arrival to patient, % (N)	44.2% (1092/2468)	56.6% (1059/1870)	**<0.0001**	**1.645 (1.458-1.857)**	42.7% (833/1952)	55.6% (528/950)	**<0.0001**	**1.681 (1.438-1.965)**
CPR performer – HCP, % (N)	12.9% (141/1092)	28.0% (296/1059)	**<0.0001**	**2.617 (2.096-3.267)**	3.8% (32/833)	6.3% (33/528)	**0.0450**	**1.669 (1.013-2.749)**
CPR following Telephone CPR, % (N)	34.0% (839/2468)	34.1% (637/1870)	0.9621	1.003 (0.884-1.139)	37.0% (723/1952)	44.9% (427/950)	**<0.0001**	**1.388 (1.186-1.624)**
CPR on bystander's initiative, % (N)	10.3% (253/2468)	22.6% (422/1870)	**<0.0001**	**2.552 (2.154-3.022)**	5.6% (110/1952)	10.6% (101/950)	**<0.0001**	**1.992 (1.502-2.641)**
Public Access Defibrillation applied, %(N)	0.6% (13/2468)	2.6% (48/1870)	**<0.0001**	**4.975 (2.687-9.210)**	0% (0/1952)	0.1% (1/950)	0.1350	**undefined[b)]**
– defibrillation attempted – attachment only	7.7%(1/13) 92.3%(12/13)	18.8%(9/48) 81.3%(39/48)	0.3054	2.769 (0.318-24.131)	0%(0/1) 100%(1/1)	0%(0/2) 100%(2/2)	undefined[b)]	**undefined[b)]**
Call to bystander CPR, median (25%-75%)	1(0-2)	0(-1-2)	**<0.0001**	-	1(0-2)	1(0-2)	0.0862	-

a) 2 groups: single or multiple.

b) undefined because defibrillation was not attempted in any case.

Table 3. Independent factors associated with survival at 1-year

Factors analysed		1-year survival % (number) or values	Statistics	
			Odds ratio (95% C.I.) or *p* value by univariate analysis	Adjusted Odds ratio (95% C.I.) by multiple logistic regression analysis[b] for survival
Number of rescuers, % (N)	single	3.1% (76/2468)	Reference	Reference
	2 or more	5.1% (95/1870)	**1.685(1.238-2.292)**	**1.539(1.088-2.183)**
Region, % (N)	central	4.9%(112/2271)	**1.766(1.281-2.434)**	1.265(0.806-1.988)
	non-central	2.9% (59/2067)	Reference	Reference
Patient's age, median (25%-75%)	survivor	63(52-76)	**<0.0001**	**0.974(0.966-0.982)**
	non-survivor	77(64-84)		
Patient's gender, % (N)	male	4.5%(118/2626)	**1.473(1.059-2.048)**	1.064(0.744-1.540)
	female	3.1% (53/1712)	Reference	Reference
Location, % (N)	home	3.5%(100/2902)		0.735(0.506-1.075)
	care facilities	1.5%(8/548)	**<0.0001**	**0.238(0.093-0.549)**
	others	7.1% (63/888)		Reference
Aetiology, % (N)	presumed cardiac	5.2%(112/2169)	**1.947(1.412-2.684)**	**2.170(1.532-3.110)**
	non-cardiac	2.7%(59/2169)	Reference	Reference
Arrest - witnessed, % (N)	witnessed	7.1%(128/1804)	**4.424(3.115-6.284)**	**4.169(2.885-6.146)**
	unwitnessed	1.7% (43/2534)	Reference	Reference
CPR before EMT arrival to patient, % (N)	CPR	4.6%(99/2151)	**1.417(1.040-1.931)**	1.188(0.739-1.947)
	no CPR	3.3%(72/2187)	Reference	Reference
CPR performer, % (N)	HCP	3.1%(14/448)	0.725(0.415-1.265)	1.167(0.560-2.302)
	no CPR/others	4.3%(149/3498)	Reference	Reference
Tracheal intubation, % (N)	perform	3.1%(14/455)	0.753(0.432-1.313)	0.997(0.527-1.755)
	not performed	4.0%(157/3883)	Reference	Reference
Adrenaline, % (N)	perform	2.1%(3/145)	0.506(0.160-1.604)	0.385(0.065-1.318)
	not performed	4.0%(168/4192)	Reference	Reference
Type of hospital, % (N)	high level	5.1%(102/2000)	**0.0013**	1.057(0.678-1.660)
	others	3.0%(69/2338)		Reference
Call to arrival at patient, median (25%-75%)	survivor	6.0(5.0-8.0)	**<0.0001**	**0.906(0.865-0.945)**
	non-survivor	8.0(6.0-10.0)		
Call to first CPR[a], median (25%-75%)	survivor	2.5(0-6.0)	**0.0004**	0.959(0.915-1.007)
	non-survivor	4.0(0-8.0)		
Arrest witness/recognition - call, median (25%-75%)	survivor	2.0(1.0-3.0)	**<0.0001**	**0.945(0.912-0.977)**
	non-survivor	2.0(1.0-5.0)		

a) first CPR: Whoever performed CPR first, between citizens and EMTs.

b) $R^2 = 0.1665$.

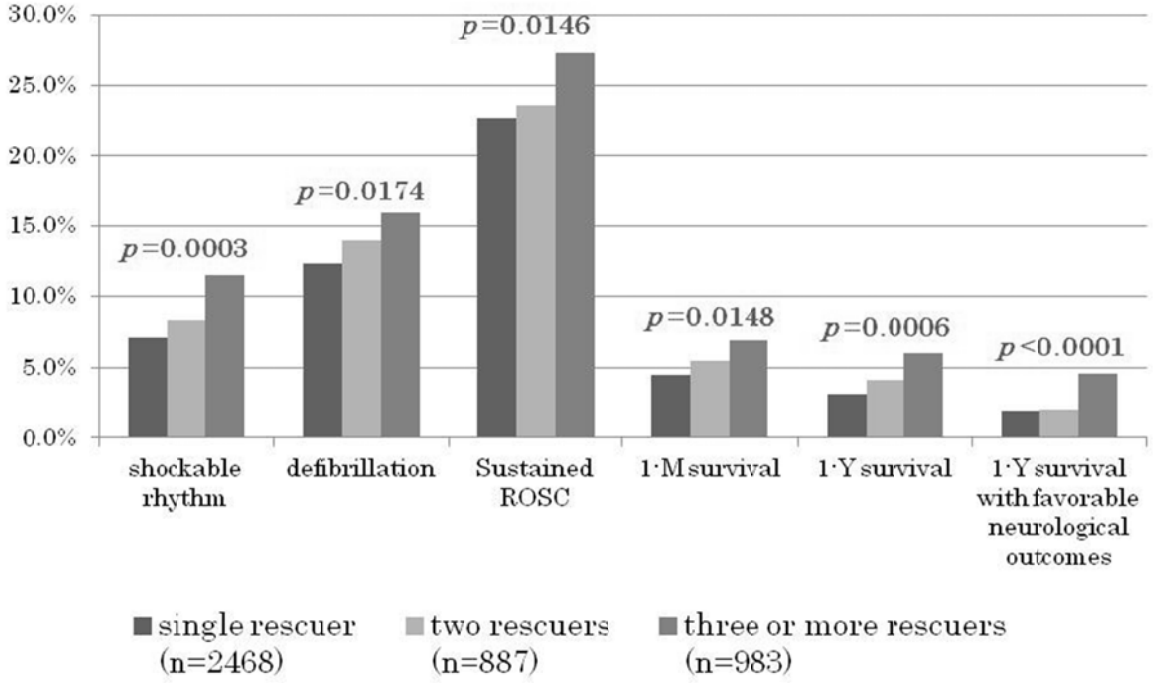
Table 4. Differences in patient backgrounds and time factors among the groups in in-home OHCAs (univariate analysis)

Characteristics and backgrounds	Group (Number of rescuers), N			Statistics	
	single N=1952	multiple N=950		*p* value by univariate analysis between 2 groups[a] / among 3 groups	Odds ratio (95% C.I.) for multiple rescuers (single rescuer as reference)
		two N=618	three or more N=332		
Region – central, % (N)	54.2%(1057)	47.0%(446)		**0.0003** **<0.0001**	**0.749** **(0.641-0.875)**
		52.3%(323)	37.1%(123)		
Patient's age, median (25%-75%)	76(64.3-83)	77(66-84)		0.3049 0.0972	-
		76(64-84)	78(68-85)		
Patient's sex - male, % (N)	60.7%(1184)	61.0%(579)		0.8800 0.6690	1.012 (0.864-1.187)
		62.0%(383)	59.0%(196)		
Aetiology - presumed cardiac, % (N)	52.8%(1031)	48.3%(459)		**0.0228** **0.0224**	**0.835** **(0.715-0.975)**
		50.2%(310)	44.9%(149)		
Arrest - witnessed, % (N)	38.6%(753)	39.8%(378)		0.5296 0.6511	1.052 (0.898-1.233)
		39.0%(241)	41.3%(137)		
Call to arrival at patient, median (25%-75%)	7(6-9)	7(6-10)		0.0768 **0.0301**	-
		7(6-10)	8(6-10)		
Call to first CPR[b], median (25%-75%)	5(1-8)	3(0-8)		**<0.0001** **<0.0001**	-
		3(0-7)	4(1-8)		
Arrest recognition/witness to call, median (25%-75%)	2(1-6)	2(1-5)		0.4189 0.5904	-
		2(1-5)	2(1-5)		

a) 2 groups: single or multiple

b) first CPR: Whoever performed CPR first, between citizens and EMTs

A. all OHCAs



B. OHCAs that occurred at home

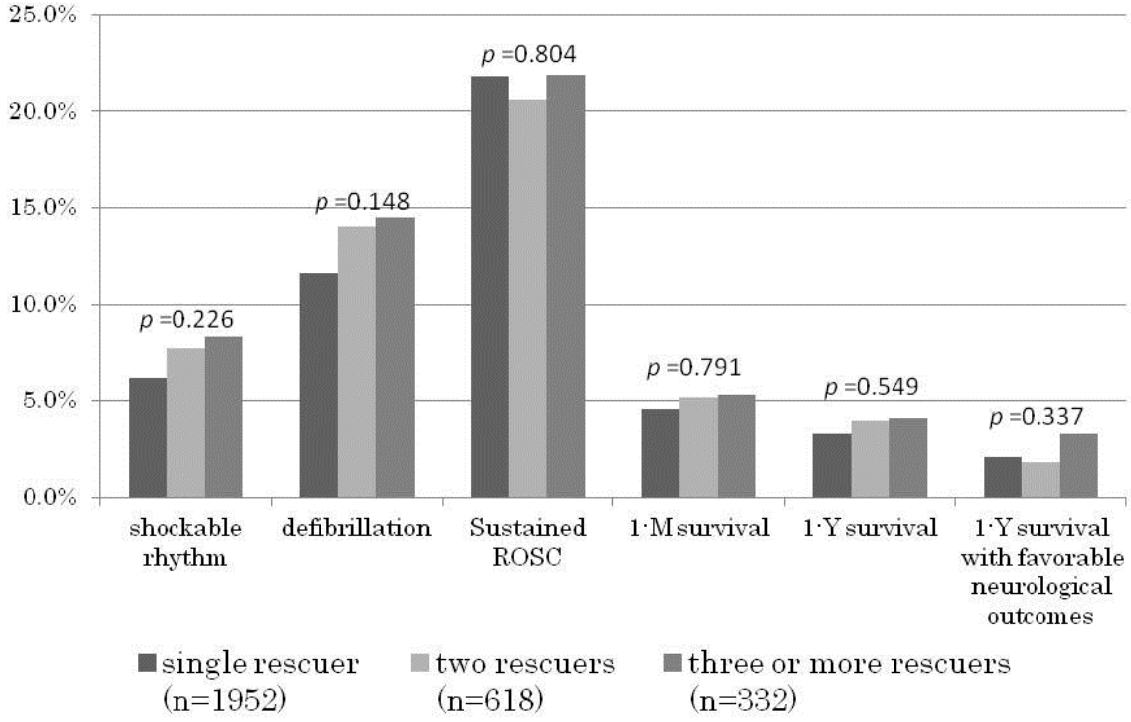
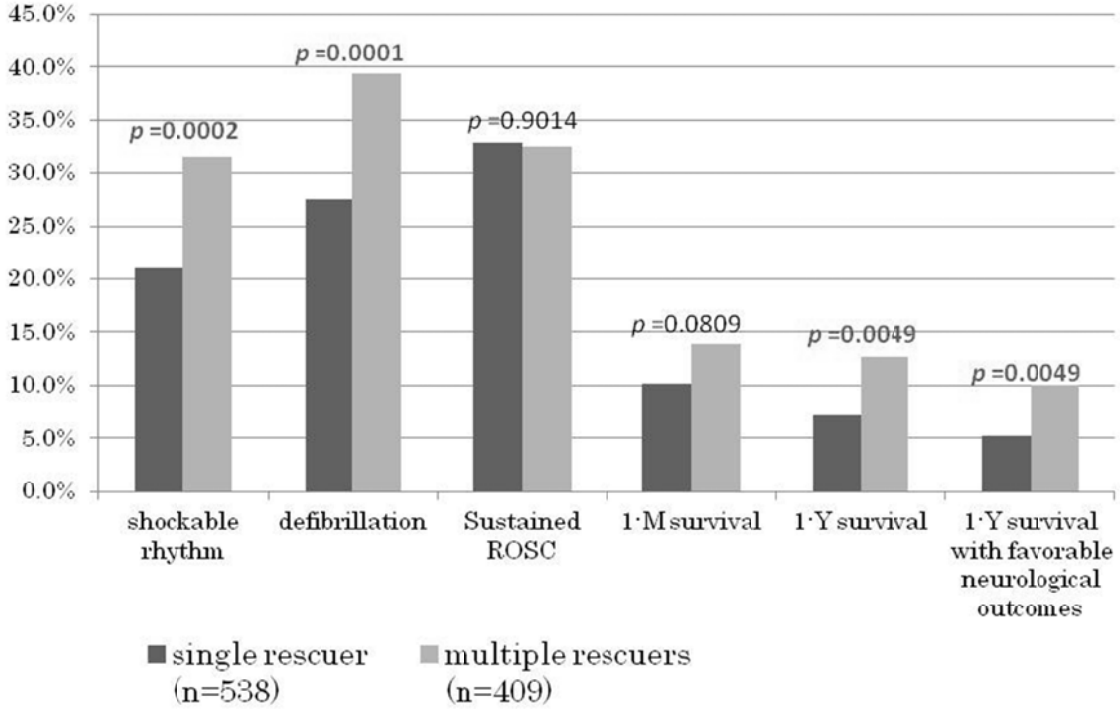


Fig. 1

A. All bystander-witnessed OHCAs of presumed cardiac aetiology



B. Bystander-witnessed OHCAs of presumed cardiac aetiology at home

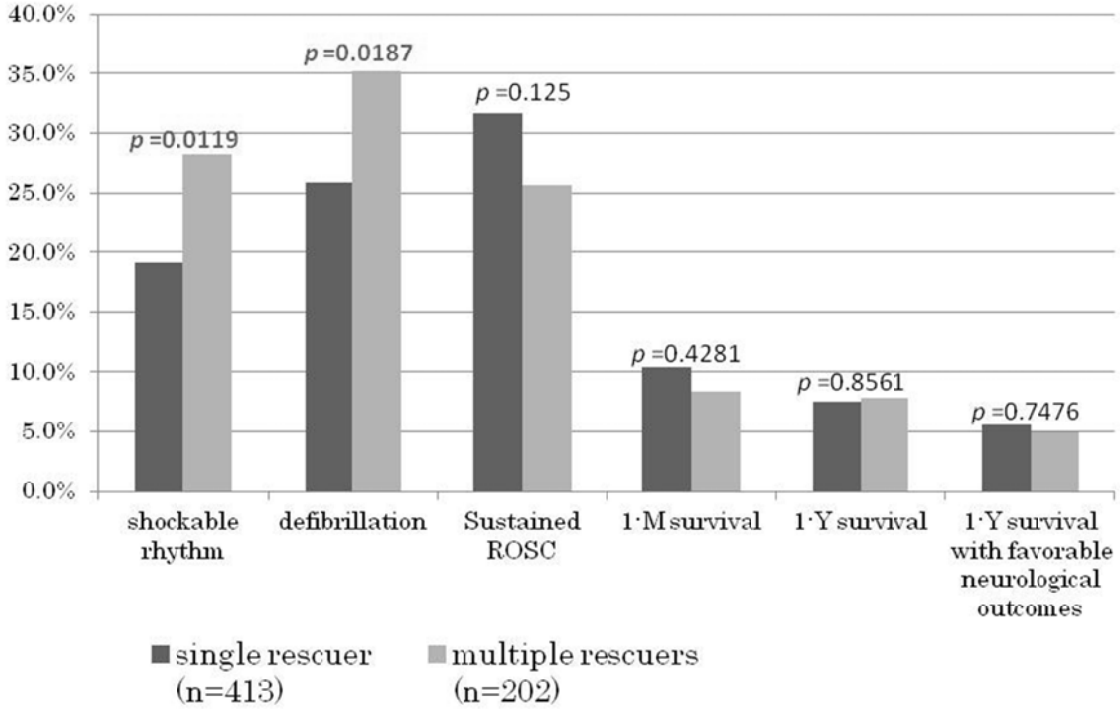


Fig. 2

Table 5 (Supplementary). Comparisons of backgrounds and time factors between OHCAs with and without an identified number of rescuers.

Characteristics and backgrounds	Group (Number of rescuers), n		Statistics	
	Number of rescuers		*p* value by univariate analysis between 2 groups[a] / among 3 groups	Odds ratio (95% C.I.) for number-identified OHCAs (unidentified OHCAs as reference)
	unidentified	identified		
	N=740	N=2468		
Region – central, % (N)	26.6%(197)	55.2%(1361)	**<0.0001**	**3.028 (2.546-3.602)**
Patient's age, median (25%-75%)	79(67-86)	76(63-84)	**<0.0001**	-
Patient's sex – male, % (N)	56.2%(416)	60.5%(2626)	**0.0273**	**1.195 (1.021-1.398)**
Location - home, % (N)	62.6%(463)	66.9%(2902)	**0.0222**	**1.209 (1.028-1.421)**
Aetiology - presumed cardiac, % (N)	46.4%(343)	50.0%(2169)	0.0664	1.157 (0.990-1.353)
Arrest - witnessed, % (N)	11.4%(84)	41.6%(1804)	**<0.0001**	**5.560 (4.395-7.033)**
CPR before EMT arrival to patient, % (N)	47.6%(352)	49.6%(2151)	0.3102	1.084 (0.927-1.267)
CPR performer – HCP, % (N)	16.2% (57/352)	20.2% (434/2151)	0.0751	1.308 (0.967-1.770)
CPR on bystander's initiative, % (N)	35.8% (126/352)	31.4% (675/2151)	0.1025	0.820 (0.648-1.039)
Call to bystander CPR, median (25%-75%)	0(-1-2)	0(-1-2)	0.3848	-
Call to arrival at patient, median (25%-75%)	7(5-11)	7(6-10)	0.8846	-
Call to first CPR[b], median (25%-75%)	4(0-8)	4(0-8)	0.7790	-
Arrest recognition/witness to call, median (25%-75%)	3(1-6)	2(1-6)	**0.0275**	-

a) 2 groups: single or multiple

b) first CPR: Whoever performed CPR first, between citizens and EMTs

Table 6 (Supplementary). Comparisons of outcomes between OHCAs with and without an identified number of rescuers

Outcomes	OHCAs at all locations			In-home OHCAs		
	Number of rescuers			Number of rescuers		
	unidentified	identified	*p* value by univariate analysis	unidentified	identified	*p* value by univariate analysis
	N=740	N=4338		N=463	N=2902	
Sustained ROSC	14.1% (104/740)	23.8% (1033/4338)	**<0.0001**	13.2% (61/463)	21.5% (625/2902)	**<0.0001**
1-M survival	2.7% (20/740)	5.2% (227/4338)	**0.0015**	2.6% (12/463)	4.8% (138/2902)	**0.0250**
1-Y survival	1.8% (13/740)	3.9% (171/4338)	**0.0013**	1.7% (8/463)	3.5% (100/2902)	**0.0354**
1-Y survival with favorable neurological outcomes	1.2% (9/740)	2.5% (110/4883)	**0.0174**	1.3% (6/463)	2.1% (62/2902)	**0.2061**