Europace (2013) **15**, 1259–1266
doi:10.1093/europace/eut053

Public access defibrillation improved the outcome after out-of-hospital cardiac arrest in school-age children: a nationwide, population-based, Utstein registry study in Japan

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Received 14 November 2012; accepted after revision 12 February 2013; online publish-ahead-of-print 19 April 2013

Aims The purpose of this study was to determine whether implementation of public access defibrillation (PAD) improves the outcome after out-of-hospital cardiac arrest (OHCA) in school-age children at national level.

Methods and results We conducted a prospective, nationwide, population-based Japanese Utstein registry study of consecutive OHCA cases in elementary and middle school children (7–15 years of age) who had a bystander-witnessed arrest of presumed cardiac origin during 2005–09 and received pre-hospital resuscitation by emergency responders. The primary endpoint was a favourable neurological outcome 1 month after an arrest. Among 230 eligible patients enrolled, 128 had ventricular fibrillation (VF) as an initial rhythm. Among these 128 patients, 29 (23%) children received a first shock by a bystander. Among these 29 patients, the proportion of the favourable neurological outcome after OHCA was 55%. During the study period, the proportion of patients initially shocked by a bystander among eligible patients increased from 2 to 21% ($P = 0.002$ for trend). The proportion of patients with a favourable neurological outcome after OHCA increased from 12 to 36% overall ($P = 0.006$). The collapse to defibrillation time was shorter in bystander-initiated defibrillation when compared with defibrillation by emergency responders (3.3 ± 3.7 vs. 12.9 ± 5.8 min, $P < 0.001$), and was independently associated with a favourable neurological outcome after OHCA [$P = 0.03$, odds ratio (OR) per 1 min increase, 0.90 (95% confidence interval 0.82–0.99)]. A non-family member's witness was independently associated with VF as the initial rhythm [$P < 0.001$, OR 4.03 (2.08–7.80)].

Conclusion Implementation of PAD improved the outcome after OHCA in school-age children at national level in Japan.

Keywords Cardiopulmonary resuscitation • Sudden unexplained death • School health • Public access defibrillation • School-age children

Introduction

Sudden cardiac death in elementary and middle school children is a rare but tragic event, which has tremendous impact on the family, school, communities, and health-care providers, and which may be relevant to cardiopulmonary resuscitation (CPR)/automated external defibrillator (AED) programmes in the public environment surrounding these children.[1,2] Recently, implementation of public

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What's new?

- This is the first population-based study, which specifically addressed the impact of public access defibrillation on the outcome of out-of-hospital cardiac arrests (OHCAs) in elementary and middle school children.
- Among 230 eligible patients, 128 (56%) had ventricular fibrillation (VF) as an initial rhythm. Among these 128 patients, 29 (23%) children received a first shock by a bystander. Among these 29 patients, the proportion of the favourable neurological outcome after OHCA was 55%.
- During the study period 2005–09, the proportion of patients initially shocked by a bystander among eligible patients increased from 2 to 21%. The proportion of patients with a favourable neurological outcome after OHCA increased from 12 to 36% overall.
- A non-family member's witness was independently associated with VF as the initial rhythm. The collapse to defibrillation time was independently associated with a favourable neurological outcome, the survival at 1 month, and the prehospital return of spontaneous circulation after OHCA.

access defibrillation (PAD) improved outcomes among adults after out-of-hospital cardiac arrest (OHCA) in public locations, by reducing the time interval from the patient's collapse to defibrillation.[3–6] However, the impact of PAD on the outcome after OHCA in such school-age children was unclear. This question is challenging two-fold. First, paediatric patients of different ages have diverse aetiologies of OHCA; relatively poor survival has been reported in this heterogeneous group of patients.[7,8] The reported incidence of ventricular fibrillation (VF) as an initial rhythm in paediatric OHCA is lower than that reported in adults, and the effectiveness of early defibrillation programmes even for paediatric patients in VF arrest has been questioned.[7,8] Secondly, although school-age children are reported to spend a large part of their active daytime in public locations,[9] it is uncertain whether PAD programme, if any, would be effective for ordinary children in the children's public environment, including schools.[2,9–11] Recently, VF was found to be present in a higher percentage of high school-age athletes with sudden arrest, and recent small series have noted improved survival when early defibrillation with CPR was provided for such patients in high schools.[11–13] However, the limited deployment of AED devices in elementary and middle schools, and other public locations, a small sample size of OHCA in this age population in local studies, and the lack of an appropriate reporting system of OHCA, may have hampered any investigations involving the epidemiological basis of the benefit of PAD for OHCA in such school-age children.[11,12,14,15]

In Japan in July 2004, the Ministry of Health, Labour and Welfare approved AED use by citizens. By 2009, the number of AED devices in public places increased to 203 924 (106.6/100 000 population).[16,17] Of note, up to 28.9% of public access AED devices in Japan were placed in schools; by 2009, AEDs were placed in 72% of elementary schools and 89.8% of middle schools.[18,19] In January 2005, the Fire and Disaster Management Agency of Japan launched a prospective, nationwide, population-based, Utstein-style registry involving consecutive OHCA victims in all the age groups.[20] A recent study, using the Utstein registry database, demonstrated that there was a temporal increase in public access AED application and improved outcomes after OHCA in adults at the national level.[20] However, the impact of the national PAD programme on outcomes of OHCA in elementary and middle school children has not been reported. We therefore investigated whether PAD may have an impact on the outcome after OHCA in such school-age children at the national level, by using the Japanese Utstein registry database.[20,21]

Methods

Study design

The All-Japan registry of the Fire and Disaster Management Agency of Japan is a prospective, nationwide, population-based registry of OHCA, which is based on the standardized Utstein style, as reported in detail previously.[20,21] Briefly, this cohort enrolled all consecutive patients who suffered OHCA all over Japan, and were treated by emergency medical service (EMS) personnel and transported to hospitals. Specific enrolment process was described in Supplementary material online, Supplementary methods.[20,21] Among these patients, who had OHCA during January 2005–December 2009, we identified eligible patients who were 7–15 years of age, because we would include school-age students in compulsory education, which corresponds to the elementary and middle schools in Japan: high school students were thereby excluded. We identified those school-age victims with bystander-witnessed OHCA of presumed cardiac origin occurring during the entire day. Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation.[22–24] The arrest was presumed to be of cardiac origin unless it was caused by non-cardiac (respiratory disease, malignant tumours, and central nervous system disorders), external (trauma, hanging, drowning, drug overdose, and asphyxia) , or any other non-cardiac factors.[22–24] The data form was filled out by the EMS personnel in cooperation with the physicians in charge of the patients, and the data were integrated into the registry system on the database server. The working group for All-Japan Utstein registry designed the study protocol; collected and managed the data; and the authors analysed the data and wrote the manuscript. The protocol for analyses was approved by the Ethics Committee of Mie University Graduate School of Medicine.

Study setting

Emergency medical service and training system in Japan was previously reported in detail.[20,21] Briefly, Japan has an area of ~378 000 km^2, and its population was 127 million, including 3 666 839 male and 3 496 405 female 7–12-year-old children (elementary school students), and 1 871 134 male and 1 780 230 female 13–15-year-old children (middle school students) in 2005.[25] Placement of AEDs in public locations was driven by either public or private initiatives.[17] The cumulative number of public access AEDs, excluding those in medical facilities and EMS institutions, as estimated from sales of AEDs, increased from 9906 to 203 924 during the 5-year study period (see Supplementary material online, *Table*).[16] A total of 96.5% of public access AEDs are located in public locations (28.9% in schools, 20.6% in workplaces, 8.8% in nursing homes, 5.7% in sports facilities, 4.8% in cultural facilities, 2.6% in public transportation facilities, and 25.1% in other public locations), 1.4% in residential areas, and 2.1% in others.[18] From 2007 to 2009, the

percentage of elementary or middle schools equipped with at least one AED device increased from 18.1 to 72.9% in elementary schools and from 38.3 to 89.8% in middle schools (see Supplementary material online, *Table*).[19] School teachers and other staff were trained in CPR programmes by EMS providers or other instructors, under the guidance of local school boards, in which paediatric and adult PADs were generally recommended for children at 7 years of age and older, respectively, in accordance with the Japanese CPR guidelines.[26] In Japan, ~1.4–1.5 million citizens per year participated in the CPR/AED training programmes, generally provided by local fire departments.[27]

Data collection

Procedure of data collection was described previously.[20,21] Briefly, registry data were prospectively collected in accordance with the Utstein-style reporting guidelines for OHCA, which is a standardized form (uniform definitions, terminology, and recommended data sets) for clinical investigators to report human resuscitation studies.[20,21,23,24] Specific data sets and data collecting process were described in Supplementary material online, Supplementary methods.[20,21,23,24] In the present Japanese Utstein reporting system, a patient initially shocked by a bystander was defined as one in which a public access AED was used and the shock was delivered; if the public access AED was applied but the shock was not delivered, the patient was not included in this category.[20,21] In this analysis, an OHCA witnessed by non-family members was presumed to be an event in a public location, because of a lack of data with respect to specific locations in the registry; when a bystander delivered shocks with an AED, the initial rhythm of the patient was regarded as VF, including pulseless ventricular tachycardia.

Endpoints

The primary endpoint was survival at 1 month with minimal neurological impairment, which was defined as a Glasgow–Pittsburg cerebral performance category of 1 (good performance) or 2 (moderate disability).[23,24] Secondary endpoints were survival at 1 month and return of spontaneous circulation (ROSC) before arrival at the hospital.

Statistical analysis

The age-stratified annual incidence of OHCA was calculated with the use of 2005 census data.[25] Continuous variables between two groups were assessed by the unpaired *t*-test. Trends in categorical and continuous variables were analysed with the use of univariate regression models and linear tests, respectively, in overall and subgroups of eligible patients, determined by the relation of bystanders to the victims (family or non-family member). The planned subgroup analysis was intended to determine the impact of PAD on trends in outcome parameters of arrest in presumed public locations (non-family member-witnessed arrests) in comparison with the non-public location arrest (family member-witnessed arrests). Univariate and multivariable logistic regression analyses were performed to assess the factors associated with VF as the initial rhythm, and outcome parameters. Adjusted and unadjusted odds ratios with their 95% confidence intervals and *P* values were reported. Potential confounding factors adjusted for VF as the initial rhythm included the calendar year, the age, gender, the relation of the bystander to the patient (family or non-family member), the type of CPR initiated by a bystander (compression-only or conventional CPR), and the time from the witnessed collapse to the EMS arrival, in accordance with previous reports.[20,21,28] Potential confounding factors for outcome parameters included VF as an initial rhythm, bystander's AED use at the first shock, and the time from the witnessed collapse to the first shock, in addition to the potential confounders for VF, in accordance with previous reports.[20,21,28] All statistical analyses were performed with the use of the SPSS statistical package, version 16.0J (SPSS). Data were reported as mean ± standard deviation. All tests were two-tailed, and *P* values of <0.05 were considered to indicate statistical significance.

Results

Among 2072 OHCA children, 522 were of presumed cardiac origin; 230 of 522 arrests were witnessed by bystanders (*Figure 1*). Among a total of 230 eligible patients, 128 (56%) children had VF as the initial rhythm. Among these 128 patients, 29 (23%) children received a first shock by bystanders using a public access AED before the arrival of EMS personnel and 96 (75%) children received a first shock by EMS personnel (32 with a monophasic and 64 with a biphasic defibrillator). In addition, among 102 patients without VF as the initial rhythm, none received bystander's defibrillation, but 13 (13%) received a shock by EMS personnel following CPR. Among 128 children with VF as the initial rhythm, 53 (41%) survived with a favourable neurological outcome, 67 (52%) survived 1 month after the arrest, and 55 (43%) had pre-hospital ROSC. Among the subset of 29 school-age children with OHCA who received initial AED shock by bystanders, 16 (55%) survived with favourable neurologic outcome, 19 (66%) survived 1 month after the arrest and 19 (66%) had prehospital ROSC. Among 102 patients without VF as the initial rhythm, 8 (8%) survived with favourable neurological outcome, 15 (15%) survived 1 month after the arrest and 11 (11%) had pre-hospital ROSC. The time interval from collapse to the initiation of CPR was shorter in bystander-initiated CPR than EMS-initiated CPR (3.2 ± 4.9 vs. 8.9 ± 6.8 min, $P < 0.001$). The interval from collapse to the initiation of AED use was shorter in bystander-initiated AED use than EMS-initiated one (3.3 ± 3.7 vs. 12.9 ± 5.8 min, $P < 0.001$). Clinical and outcome parameters in the overall, family and non-family member witnessed arrests were reported in *Table 1*. The population-based age-stratified incidence of bystander-witnessed OHCA of presumed cardiac origin in children was constant during the study period (see Supplementary material online, *Table*).

Trends in clinical and outcome parameters

During the study period (*Table 2*), the proportion of patients initially shocked by a bystander's AED among total patients increased from 2% in 2005 to 21% in 2009 ($P = 0.002$). Such a temporal increase was observed in non-family member-witnessed arrests, from 4% in 2005 to 37% in 2009 ($P = 0.001$), but not in family member-witnessed arrests. The collapse to AED time tended to become shorter only in non-family member-witnessed arrests, from 11.1 min in 2005 to 8.3 min in 2009 ($P = 0.07$). The proportion of any other categorical and continuous variables investigated in either subgroup of patients did not change significantly (see Supplementary material online, *Appendix 1*). As the outcome parameters (*Figure 2*), the proportion of patients with a favourable neurological outcome among total patients increased from 12% in 2005 to 36% in 2009 ($P = 0.006$). Such a temporal improvement

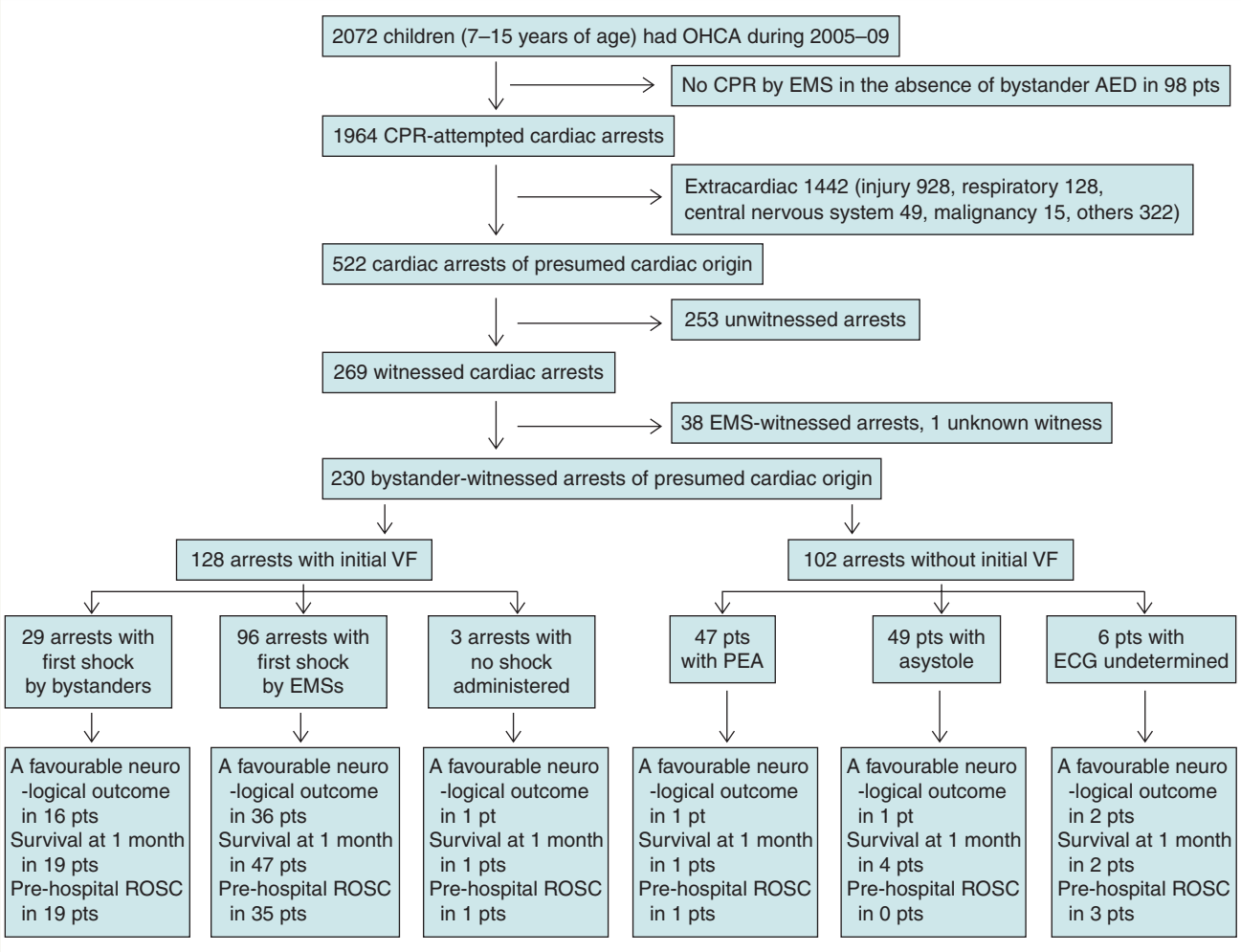

Figure 1 Study profile. OHCA, out-of-hospital cardiac arrest; CPR, cardiopulmonary resuscitation; EMS, emergency medical service; AED, automated external defibrillator; VF, ventricular fibrillation; PEA, pulseless electrical activity; ECG, electrocardiography; ROSC, return of spontaneous circulation; pts, patients.

was observed only in non-family member-witnessed arrests, from 9% in 2005 to 53% in 2009 ($P = 0.001$). The proportion of survival at 1 month after OHCA ($P = 0.008$) and ROSC before arrival at the hospital ($P = 0.046$) increased only in non-family member-witnessed arrests, from 17 and 17% in 2005 to 53 and 42% in 2009, respectively. Trends in specific values in all the clinical and outcome parameters investigated in overall and subgroups of patients were reported (see Supplementary material online, *Appendix 1*).

Multivariable analysis

In multivariable analysis (*Table 3*), a non-family member's witness [$P < 0.001$, adjusted odds ratio (OR) 4.03 (2.08–7.80)] was independently associated with the presence of VF as the initial rhythm. The collapse to AED time, either by a bystander or an emergency responder [$P = 0.03$, OR per 1 min increase, 0.90 (0.82–0.99)], and female gender [$P = 0.008$, 3.20 (1.35–7.56)] were independently associated with a favourable neurological outcome. The collapse to AED time was the only variable independently associated with the survival at 1 month [$P = 0.045$, 0.92 (0.85–0.99)] and pre-hospital ROSC [$P = 0.001$, 0.82 (0.73–0.92)]. Results of univariate analysis were reported in the see Supplementary material online, *Appendix 2*.

Discussion

Although the epidemiological data related to the impact of disseminating PAD programmes on OHCA in elementary and middle school children were limited,[7,8] the present Utstein registry study would supply evidence supporting that implementation of PAD programmes increases the likelihood of early defibrillation by bystanders, and improves the outcome after OHCA in such school-age children. These findings may underscore the benefit of PAD in the prevention of sudden cardiac death in school-age children.

Table 1 Clinical and outcome parameters

Parameters	Total (n = 230)	Family witnessed (101)	Non-family witnessed (129)
Age, years of age	12.2 ± 2.5	11.3 ± 2.7	12.8 ± 2.1
Male gender, *n* (%)	145 (63)	63 (62)	82 (64)
Ventricular fibrillation, *n* (%)	128 (56)	37 (37)	91 (71)
CPR initiated by bystanders, *n* (%)	161 (70)	55 (55)	106 (82)
Conventional CPR, *n* (%)	102 (64)	30 (55)	72 (69)
Collapse to CPR time (min)	4.9 ± 6.1	5.3 ± 6.3	4.6 ± 6.0
Shock initiated, *n* (%)			
by bystanders	29 (13)	2 (2)	27 (21)
by EMS	109 (47)	38 (38)	71 (55)
Collapse to AED time (min)	10.9 ± 6.7	13.1 ± 7.0	10.0 ± 6.4
Collapse to EMS arrival (min)	34.6 ± 17.2	35.0 ± 16.5	34.3 ± 17.7
Favourable neurological outcome, *n* (%)	63 (27)	15 (15)	48 (37)
Survival at 1month, *n* (%)	84 (37)	22 (22)	62 (48)
Prehospital ROSC, *n* (%)	66 (29)	20 (20)	46 (36)

Favourable neurological outcome denotes cerebral performance category 1 or 2 at 1 month.
Conventional CPR indicated chest compression with rescue breathing, as a type of bystander-initiated CPR. Percentages were calculated on the basis of the available data in overall or each subgroup of arrests (family or nonfamily witnessed). Plus–minus values are means ± SD.
CPR, cardiopulmonary resuscitation; EMS, emergency medical service; AED, automated external defibrillator; ROSC, return of spontaneous circulation.

Table 2 Trends in clinical parameters

Variables	2005	2006	2007	2008	2009	*P* value for trend
Type of bystanders, (*n*)						
Total	41	46	51	48	44	
Family member	18	18	21	19	25	0.27
Non-family member	23	28	30	29	19	
CPR initiated by bystanders, *n* (%)						
Total	26 (63)	33 (72)	36 (72)	37 (77)	29 (66)	0.65
Family member	8 (44)	9 (50)	12 (60)	12 (63)	14 (56)	0.35
Non-family member	18 (78)	24 (86)	24 (80)	25 (86)	15 (79)	0.90
Shock initiated by bystanders, *n* (%)						
Total	1 (2)	1 (2)	10 (20)	8 (17)	9 (21)	0.002
Family member	0 (0)	0 (0)	0 (0)	0 (0)	2 (8)	0.99
Non-family member	1 (4)	1 (4)	10 (33)	8 (28)	7 (37)	0.001
Shock initiated by EMS, *n* (%)						
Total	18 (44)	24 (52)	26 (51)	19 (40)	22 (50)	0.94
Family member	6 (33)	3 (17)	10 (48)	7 (37)	12 (48)	0.14
Non-family member	12 (52)	21 (75)	16 (53)	12 (41)	10 (53)	0.22
Collapse to AED time (min)						
Total	11.8 ± 4.8	12.5 ± 5.4	10.4 ± 7.2	10.2 ± 6.2	10.3 ± 8.4	0.22
Family member	13.5 ± 7.2	14.3 ± 4.6	13.3 ± 4.4	12.7 ± 3.0	12.6 ± 10.3	0.71
Non-family member	11.1 ± 3.2	12.2 ± 5.5	9.2 ± 7.8	9.4 ± 6.8	8.3 ± 5.9	0.07

Percentages were calculated on the basis of the available data in overall or each subgroup of arrests (family or non-family witnessed) in the respective year. Plus-minus values are means ± SD.
CPR, cardiopulmonary resuscitation; EMS, emergency medical service; AED, automated external defibrillator.

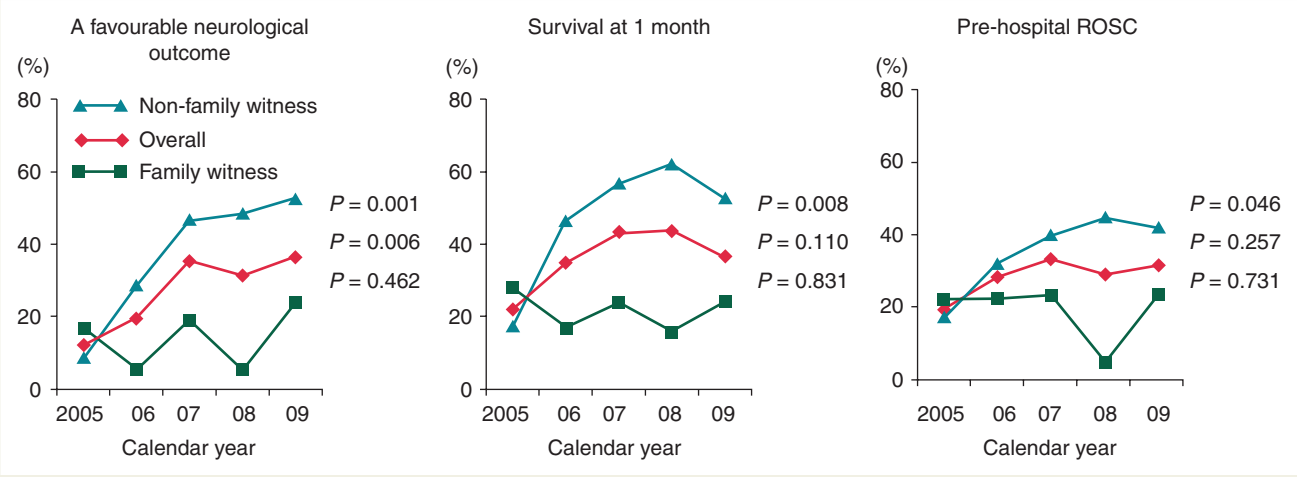

Figure 2 Trends in outcome parameters in arrests, by the relationship of a bystander to the victim. P values are for trend; ROSC, return of spontaneous circulation.

Table 3 Multivariable analyses of factors associated with ventricular fibrillation as the initial rhythm and outcome parameters

Variable	Ventricular fibrillation	Favourable neurological outcome	Survival at 1 month	Pre-hospital ROSC
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Year (per 1-year increase)	1.09 (0.87–1.37)	1.19 (0.87–1.63)	0.97 (0.73–1.30)	0.80 (0.58–1.10)
P value	0.46	0.29	0.86	0.17
Age≥13 years	1.83 (0.96–3.48)	1.79 (0.76–4.20)	1.60 (0.72–3.54)	1.60 (0.67–3.80)
P value	0.07	0.18	0.25	0.29
Female gender	0.76 (0.39–1.47)	3.20 (1.35–7.56)	1.80 (0.79–4.10)	2.17 (0.91–5.19)
P value	0.41	0.008	0.16	0.08
Non-family witnessed	4.03 (2.08–7.80)	1.53 (0.58–4.03)	1.68 (0.70–4.02)	0.86 (0.32–2.29)
P value	<0.001	0.39	0.27	0.76
CPR				
Not bystander-initiated	reference	reference	reference	reference
Bystander-initiated				
Conventional	0.76 (0.35–1.65)	1.01 (0.34–3.00)	1.24 (0.45–3.43)	0.90 (0.29–2.78)
P value	0.49	0.98	0.68	0.86
Compression only	0.79 (0.34–1.83)	1.55 (0.51–4.71)	1.08 (0.38–3.06)	1.77 (0.58–5.46)
P value	0.58	0.44	0.88	0.32
Collapse–EMS time (per 1 min increase)	0.99 (0.97–1.37)	1.00 (0.98–1.03)	1.00 (0.98–1.03)	1.01 (0.99–1.04)
P value	0.30	0.74	0.89	0.33
Ventricular fibrillation as the initial rhythm		2.03 (0.43–9.46)	1.30 (0.34–4.91)	0.76 (0.18–3.20)
P value		0.37	0.70	0.71
Bystander's AED		0.49 (0.12–2.02)	0.59 (0.15–2.23)	0.61 (0.14–2.76)
P value		0.32	0.43	0.53
Collapse–AED time (per 1-min increase)		0.90 (0.82–0.99)	0.92 (0.85–0.99)	0.82 (0.73–0.92)
P value		0.03	0.045	0.001

Favourable neurological outcome denotes cerebral performance category 1 or 2 at 1 month.
OR, odds ratio; ROSC, return of spontaneous circulation; EMS, emergency medical service; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator.

Impact of public access defibrillation on out-of-hospital cardiac arrest in school-age children

Between 2005 and 2009 in Japan, there was a remarkable increase in the availability of AED in public spaces surrounding school children, including schools.[16–19] During this period, there was an increase in the proportion of OHCA in which the victim was initially shocked by a bystander, and this was temporally associated with an improvement in the neurological outcome in children with OHCA. In subgroup analyses, (i) temporal trends in these parameters were evident in non-family member-witnessed arrests, but not in family member-witnessed arrests, (ii) similar trends in secondary outcome parameters were observed in non-family member-witnessed arrests, and (iii) trends in other clinical parameters were not affected in either subgroup of patients during the same period. Therefore, trends in relevant variables, together with multivariable analysis data, consistently support that introduction of PAD programmes would increase the likelihood of early defibrillation by bystanders, and improve the outcomes of school-age children after public location arrest. Such an impact of PAD on OHCA in school-age children is consistent with that reported in adults.[20] In an adult study ($\geq$18 years of age) by using the same Japanese Utstein registry data during 2005–07, 32% of patients with bystander-witnessed OHCA of presumed cardiac origin with initial rhythm of VF who received bystander AED shock delivery had a favourable neurological outcome.[20] In the present study during the corresponding years 2005–07 (data not shown), 58% (7/12) of children who received bystander-initiated shock had a favourable neurological outcome. In other adult studies, the survival rate of OHCA patients initially shocked by a bystander was ~60%.[3,4,6,13] Thus, the survival to 1 month with good neurological outcome of school-age children who experience witnessed OHCA with bystander CPR and AED shock delivery appears to equal or surpass that reported in adults. The more favourable outcome in this paediatric population may result from the higher rate of bystander CPR, and the shorter collapse to CPR and collapse to AED shock delivery intervals than those observed in adults with OHCA during the same period in Japan. This may be explained in part by factors in the school environment, such as constant visual observation of the children and focused training of teachers and staff.

Frequency of ventricular fibrillation as the initial rhythm in out-of-hospital cardiac arrest in school-age children

The frequency of VF in OHCA in children has been debated for a decade, and has been negatively influenced by the young age ($<$1 year of age), and traumatic and respiratory aetiologies.[7,8,14,15] In the present study, as high as 56% of bystander-witnessed arrests of presumed cardiac origin in school-age children were associated with VF. This is consistent with the results in local studies (in King county of USA, and in a province of the Netherlands), in which the frequency of VF has been positively associated with the advanced age ($\geq$8 years of age), witnessed arrest, and cardiac aetiology, and a half of arrest patients had an initial rhythm of VF among adolescents aged 13–18 years with witnessed arrest.[11,29] In our study, we could further demonstrate that the non-family member-witnessed arrest was independently associated with VF as the initial rhythm, which is consistent with the results in an adult study.[28] The relatively low proportion of initial VF in adolescent OHCA in ROC study may be related to the difference of witness status, aetiology, and the reporting system.[14] The present study suggests that the relatively high proportion of initial VF in bystander-witnessed OHCAs of presumed cardiac origin in public locations in school-age children may confer an epidemiological basis for early defibrillation in this age population.

Limitations

Several limitations could be acknowledged in this study, in addition to those, as described previously.[20,21] First, the proportion of OHCA patients in schools among total eligible samples is unknown, because of the lack of data with respect to school as a specific location in the registry. Secondly, there might be unmeasured confounding factors (i.e. quality of bystander's CPR) that might influence the association between bystander's defibrillation and outcomes. Thirdly, information on in-hospital treatment (ie, hypothermia) is unavailable, which might affect survival after OHCA. Fourthly, it is unknown whether the present information can be generalized to other communities with different emergency response programmes at schools and other public locations surrounding children,[18,19] or different EMS systems.[20] Fifthly, the present investigation is not a cost-effectiveness analysis, although a previous study of cardiac arrests in high schools indicated that PAD may be cost-effective in schools.[12] Sixthly, specific data on the scope of the budgetary barriers and logistic issues (i.e. the locations of AED placement, training schedule for teachers) in implementing and refining AED/CPR programmes at the national level in Japan is unavailable.[17]

Conclusions

Although the impact of PAD has been largely elusive in overall children of different ages after etiologically diverse OHCAs in their public environmnent,[7,8] the present study would supply evidence which could dissect an epidemiological basis of the benefit of PAD in school-age children after bystander-witnessed OHCA of presumed cardiac origin. We believe that these findings are relevant to medical emergency response and CPR/AED programmes in the public environment surrounding school-age children.[1,2]

Supplementary material

Supplementary material is available at *Europace* online.

Acknowledgement

We thank the emergency medical personnel and participating physicians in Japan, and the Fire and Disaster Management Agency and Institute for Fire Safety and Disaster Preparedness of Japan, for generously gifting their Utstein database.

Conflict of interest: none declared.

Funding

This study was supported by grants from the Ministry of Education, Culture, Sports, Science, and Technology (21590558 to K.O., 24791056 to H.O.), the Ministry of Health, Labour, and Welfare (H-18-myocardium-01 to K.O., 2010-145 to N.K.), and Miyata Pediatric Heart Disease Research Fund (to Y.M.).

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