Table 1. Characteristics of the Study Population

	Suita study	MI subjects	*p* value
Number	974	322	—
YAP(+) (*n* (%))	291 (31.0)[a]	97 (30.1)	n.s.
YAP(+) (*n* (%))	278 (30.5)[b]	97 (30.1)	n.s.
SRY+465(T) (*n* (%))	277 (29.7)[c]	—	—
M175(+) (*n* (%))	437 (46.8)[d]	—	—
Age (year)	65.95±10.47	57.40±9.69	<0.0001
BMI (kg/m^2)	23.39±2.93	23.82±2.85	0.019
HTN (*n* (%))	400 (41.1)	158 (49.1)	0.041
TG (mg/dL)	120.6±79.6	—	—
TC (mg/dL)	199.2±31.9	—	—
Current smokers (*n* (%))	270 (27.7)	213 (66.1)	<0.0001
MI (*n* (%))	26 (2.7)	322 (100)	—

Data are presented as mean±SD. [a]n=938, [b]n=912 without coronary artery disease, [c]n=932, [d]n=934. n.s., not significant; YAP, Y chromosome *Alu* insertion polymorphism; BMI, body mass index; HTN, prevalence of hypertension as defined by SBP≥140 mmHg, DBP≥90 mmHg and/or current use of antihypertensive medication; TG, triglyceride; TC, total cholesterol; MI, myocardial infarction.

Table 2. Sequences of Primers and Probes Used for Genotyping of Y Chromosome Polymorphisms

Polymorphism	Probe		Primer	
	VIC	FAM	Forward	Reverse
YAP			caggggaagataaagaaata	aagccactattagacaacct
SRY+465	tgcacttcgctgcaga	tgcacttcactgcagag	agatgctgccgaagaattgc	tagctggtgctccattcttgagt
M175	acttctcttctcaagaat	tcacttctcaagaatgaa	ctcaactccagtcatttaaactctctg	catgtactttgtccaatgctgaaa

analysis of variance (ANOVA) was used to test whether there was a difference in continuous variables between the groups. Group differences in categorical variables were assessed by the χ^2 test. Multiple logistic regression analyses were performed to obtain predictors for MI. The level of significance was adjusted for multiple testing by a Bonferroni correction: *p* values were multiplied by 57 (19 phenotypes and 3 genotypes). Statistical analyses were performed with the JMP statistical package (SAS Institute Inc., Cary, USA) and Sample Power 2 (SAS Institute Inc.).

Results

Characteristics of the Study Populations

Clinical characteristics of male subjects in the Suita study (n=974) and MI case group (n=322) are presented in Table 1. Subjects in the MI group were significantly younger and had higher BMI than those in the Suita study. MI cases were also characterized as having a higher prevalence of smokers and hypertension compared with those in the Suita study. We analyzed three Y chromosome polymorphisms (YAP, SRY+465, and M175) in our Japanese sample. Sequences of primers and probes used for genotyping are shown in Table 2. The frequency of the YAP(+) in MI subjects (30.1%) was not different from that in the Suita study (31.0%) (Table 1). The difference remained non-significant when comparisons of the YAP(+) frequency were made between the Suita study without MI subjects (n=912) and the MI group (n=322). The prevalence of SRY+465(T) and M175(+) in the Suita study was 29.7% and 46.8%, respectively.

Y Chromosome Polymorphism and Cardiovascular Risk Factors

Table 3 shows the association analysis between YAP polymorphism and cardiovascular risk factors. Levels of HDL cholesterol were significantly higher in YAP(+) than YAP(−) men (57.0±14.6 mg/dL *vs.* 54.2±14.2 mg/dL, nominal p=0.011). The association of the YAP(+) genotype with higher HDL cholesterol remained significant even after controlling for age, BMI, and daily ethanol and cigarette consumption. Men in the YAP(−) group were taller than those in the YAP(+) group (165.6±6.0 cm *vs.* 164.7±5.9 cm, nominal p=0.026, age-adjusted p=0.032). Hypertension tended to be more prevalent in the YAP(+) group than in the YAP(−) group (47.2% *vs.* 40.7%, nominal p=0.066). When the analysis was restricted to those aged 65 years or older, the prevalence of hypertension was significantly higher in the YAP(+) group than in the YAP(−) group (59.7% *vs.* 48.6%, nominal p=0.014). However, we did not find any significant association between the YAP genotypes and BP levels among the

Table 4. Association between SRY+465 Polymorphism and Cardiovascular Risk Factors

	SRY+465(C) (n=655)	SRY+465(T) (n=277)	Nominal p	Corrected p
Age (year)	65.9±10.5	66.2±10.4	n.s.	n.s.
BMI (kg/m^2)	23.4±3.0	23.3±2.7	n.s.	n.s.
W/H ratio	0.93±0.05	0.93±0.05	n.s.	n.s.
HTN (%)	43.5	40.6	n.s.	n.s.
Antihypertensive drugs (%)	29.8	29.8	n.s.	n.s.
Height (cm)	165.1±5.9	165.7±6.0	n.s.	n.s.
Res, Height[a]	−0.15±5.39	0.43±5.3	n.s.	n.s.
TC (mg/dL)*	199.6±32.5	199.2±30.6	n.s.	n.s.
TG (mg/dL)*	120.5±80.7	117.4±81.6	n.s.	n.s.
HDL cholesterol (mg/dL)*	55.3±14.3	54.7±14.5	n.s.	n.s.
Res, HDL cholesterol*[,b]	0.11±13.0	−0.24±13.3	n.s.	n.s.
SBP (mmHg)**	123.2±16.7	122.1±17.6	n.s.	n.s.
Res, SBP**[,c]	0.3±16.1	−0.6±16.6	n.s.	n.s.
DBP (mmHg)**	77.4±10.0	76.5±10.1	n.s.	n.s.
Res, DBP**[,d]	0.3±9.6	−0.5±9.6	n.s.	n.s.
Glucose (mg/dL)***	100.1±18.3	102.9±28.1	0.078	n.s.
Res, Glucose***[,c]	17.7±0.7	27.9±1.8	0.050	n.s.
HbA1c (%)***	5.49±0.68	5.59±0.91	0.063	n.s.
Res, HbA1c***[,c]	0.68±0.03	0.90±0.06	0.052	n.s.

Data are presented as mean±SD. *Subjects without medication for dyslipidemia were included: 577 men for SRY+465(C) and 245 men for SRY+465(T). **Subjects without the use of antihypertensive drugs were included: 457 and 199 men for SRY+465(C) and SRY+465(T), respectively. ***Subjects who were not receiving treatment for diabetes were included: 610 men with SRY+465(C) and 255 men with SRY+465(T). Covariates used to calculate residual values were [a]age, [b]ethanol consumption (g/d) and number of cigarettes per day, [c]age and BMI, [d]age-squared and BMI. See Table 3 for abbreviations.

Table 5. Association between M175 Polymorphism and Cardiovascular Risk Factors

	M175(−) (n=498)	M175(+) (n=436)	Nominal p	Corrected p
Age (year)	65.9±10.5	66.1±10.5	n.s.	n.s.
BMI (kg/m^2)	23.4±2.8	23.4±3.0	n.s.	n.s.
W/H ratio	0.93±0.05	0.93±0.05	n.s.	n.s.
HTN (%)	40.4	45.4	n.s.	n.s.
Antihypertensive drugs (%)	30.2	28.3	n.s.	n.s.
Height (cm)	165.5±5.9	165.1±6.0	n.s.	n.s.
Res, Height[a]	0.20±5.16	−0.20±5.56	n.s.	n.s.
TC (mg/dL)*	199.0±31.1	199.8±33.0	n.s.	n.s.
TG (mg/dL)*	125.2±89.7	113.1±69.0	0.032	n.s.
HDL cholesterol (mg/dL)*	54.5±14.1	55.8±14.6	n.s.	n.s.
Res, HDL cholesterol*[,b]	−0.57±13.1	0.65±13.1	n.s.	n.s.
SBP (mmHg)**	121.7±16.4	124.0±17.6	0.09	n.s.
Res, SBP**[,c]	−1.0±15.7	1.1±17.0	0.094	n.s.
DBP (mmHg)**	76.8±9.9	77.4±10.3	n.s.	n.s.
Res, DBP**[,d]	−0.2±9.3	0.2±10.0	n.s.	n.s.
Glucose (mg/dL)***	101.1±23.8	100.6±18.9	n.s.	n.s.
HbA1c (%)***	5.53±0.81	5.49±0.68	n.s.	n.s.

Data are presented as mean±SD. *Subjects without medication for dyslipidemia were included: 441 men for M175(−) and 382 men for M175(+). **Subjects without the use of antihypertensive drugs were included: 350 M175(−) and 306 M175(+) men. ***Subjects who were not receiving treatment for diabetes were included: 468 M175(−) and 399 M175(+) men. Covariates used to calculate residual values were [a]age, [b]ethanol consumption (g/d) and number of cigarettes per day, [c]age and BMI, [d]age-squared and BMI. See Table 3 for abbreviations.

found to be associated not only with younger age at peak height velocity but also with higher SBP and DBP levels before and after pubertal growth, suggesting the possible role of earlier exposure to androgen among the *Hin*dIII negative males in the development of hypertension (*18*). Previous studies in animal models may support this notion. In male SHR, the increase in blood pressure has been shown to be suppressed by treatment with androgen receptor antagonist or castration (*32*, *33*). Further research is required to clarify the role of the Y chromosome in androgen-mediated hypertension.

In conclusion, the Y chromosome polymorphisms genotyped in 974 Japanese men (YAP, SRY+465, and M175) showed nominal associations with height, lipid levels, and the prevalence of hypertension, none of which remained significant after adjustment for multiple testing. The contribution of the YAP polymorphism to height, HDL cholesterol, and the prevalence of hypertension appears to be small, if even present, and it could not be reliably detected in our current sample size. Much larger sample sizes and/or additional independent samples will be required to make definitive conclusions.

Acknowledgements

We thank all those who participated in the study. In addition, we gratefully acknowledge all the members of Suita City Health Center and the Suita Medical Association.

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Resuscitation (2008) 79, 90–96

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TRAINING AND EDUCATIONAL PAPER

Effectiveness of simplified chest compression-only CPR training for the general public: A randomized controlled trial☆

Chika Nishiyama[a], Taku Iwami[a], Takashi Kawamura[a,*], Masahiko Ando[a], Naohiro Yonemoto[b], Atsushi Hiraide[c], Hiroshi Nonogi[d]

[a] *Department of Preventative Services, Kyoto University School of Public Health, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan*
[b] *Department of Biostatistics, Kyoto University School of Public Health, Yoshida Konoe-cho, Sakyo-ku, Kyoto 606-8501, Japan*
[c] *Center for Medical Education, Kyoto University Graduate School of Medicine, Yoshida Konoe-cho, Sakyo-ku, Kyoto 606-8501, Japan*
[d] *Division of Cardiology, National Cardiovascular Center, 5-7-1 Fujishiro-dai, Suita, Osaka 565-8565, Japan*

Received 17 January 2008; received in revised form 8 May 2008; accepted 14 May 2008

KEYWORDS
Basic Life Support (BLS);
Bystander CPR;
Cardiac arrest;
Cardiopulmonary resuscitation (CPR);
Chest compression;
Education;
Manikin;
Randomized controlled trial

Summary
Objectives: To compare the quality of resuscitation between those with a simplified chest compression-only cardiopulmonary resuscitation (CPR) program and those with a conventional CPR program.
Methods: The participants were randomly assigned to either the 120-min training program of chest compressions (chest compression-only CPR) or the 180-min training program of chest compressions and ventilations (conventional CPR). Main outcome measures were the net number of appropriate chest compressions during the 2-min test period and the proportion of appropriate chest compressions over the theoretically attainable number one month after the training.
Results: 223 participants were enrolled and 104 in each group completed this study. The 2-min number of appropriate chest compressions was 86.1 ± 57.2 in the chest compression-only CPR group, which was significantly greater than 57.1 ± 30.2 in the conventional CPR group ($p < 0.001$). The proportion of appropriate chest compressions was higher in the chest compression-only CPR group than in the conventional CPR group ($47.1 \pm 31.1\%$ versus $38.1 \pm 20.1\%$, $p = 0.022$). Time without chest compressions during conventional CPR reached 85.5 ± 17.0 s out of 120 s, which was significantly longer than that during chest compression-only CPR (33.9 ± 10.0 s, $p < 0.001$). The total number of ventilations and the number of appropriate ventilations during 2 min was 2.5 ± 3.0 and 0.9 ± 1.6, respectively.

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at doi:10.1016/j.resuscitation.2008.05.009.

* Corresponding author at: Kyoto University Health Service, Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501, Japan. Tel.: +81 75 753 2411; fax: +81 75 753 2424.
E-mail address: kawax@kuhp.kyoto-u.ac.jp (T. Kawamura).

0300-9572/$ – see front matter
doi:10.1016/j.resuscitation.2008.05.009

Conclusions: A simplified chest compression-only CPR program makes it possible for the general public to perform a greater number of appropriate chest compressions than the conventional CPR program (UMIN-CTR C0000000321).

Introduction

Sudden cardiac arrest is one of leading causes of adult death, and 20,000–30,000 events are estimated to occur every year in Japan.[1] The survival rate from out-of-hospital cardiac arrest (OHCA) has been increasing as the "chain of survival" improves, but it is still low.[1–3] Bystander-initiated cardiopulmonary resuscitation (CPR) plays a major role in the "chain of survival" to save the OHCA.[4] Survival of those with witnessed ventricular fibrillation (VF) decreased by 7–10% minute by minute without CPR.[5] When bystander CPR is provided, this decline each minute is reduced to 3–4%,[5,6] and double or triple survival could be expected.[7,8]

However, bystander CPR is currently provided to only about 20–30% of victims of out of hospital cardiac arrest.[9–11] Fear of causing harm or aversion to mouth-to-mouth rescue breathing was pointed out as reasons of this low rate of bystander CPR.[12] Difficulties in learning and performing this complex psychomotor task might also disturb bystanders performing CPR.[13–15] These findings prompt us to simplify our CPR training procedure.

Recently, the importance of continuous chest compressions has been emphasized. Animal and clinical investigations suggest that continuous chest compressions without ventilation (chest compression-only CPR) is no less effective than chest compression plus rescue breathing resuscitation (conventional CPR) for cardiac arrest cases.[16–19] Our population-based observation also indicates that chest compression-only CPR is equally effective compared with conventional CPR for OHCAs except for very long-duration cardiac arrests.[20] Chest compression-only CPR has another advantage: simplicity so as to allow the general public to learn and perform. This study aimed to compare the quality of chest compressions between those who underwent a simplified chest compression-only CPR training program and those who underwent a conventional CPR training program.

Methods

Study design

The design of this study was a prospective individual randomized controlled trial. The study started in December 2005 and ended in July 2006.

Participants and randomization

The participants were people aged 18 years or more who were recruited from Kyoto, Osaka and vicinity in Japan via billboard advertisements and the Kyoto University website as well as by word of mouth from the participants themselves. Health care professionals, medical/co-medical students and those who were considered unsuitable for the resuscitation training by the program director were excluded.

Participants were randomly assigned to either the chest compression-only CPR group or the conventional CPR group using computer-aided randomization stratified by sex and age (under 40 years or not). The results of allocation were concealed from all instructors and participants until the day of training.

Interventions

The chest compression-only CPR group members were given a 120-min training program consisting of continuous chest compressions and an automated external defibrillator (AED) operation. The conventional CPR group members were provided with a 180-min training program consisting of chest compressions, mouth-to-mouth ventilations, and an AED operation based on the 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (chest compressions/ventilation ratio of 30:2).[4] The training program was carried out using widely used digital video disk instruction material which was produced by the non-profit organization to educate citizens CPR in Osaka (http://osakalifesupport.jp/osakalsa/), Leardal Resusci Anne CPR manikins®, and AED trainer (Leardal Medical, Stavanger, Norway). Twenty registered physicians, nurses and emergency medical technicians, all of them being certified instructors of Immediate Cardiac Life Support (ICLS) course by the Japanese Association for Acute Medicine (JAAM)[21] and specially trained for this study, instructed the participants with an instructor/participants ratio of 1:4. Instructors were assigned to each of the two groups an almost equal number of times.

Data collection and outcomes

Resuscitation skills of each participant were evaluated immediately after the training and one month later using a case-based scenario. In this test, a participant was called into the testing room and said: "Imagine, you are at a department store. Suddenly a man collapses in front of you. You are the only person around. Do whatever you can do to help this man." After presentation of the scenario, we evaluated their CPR skills (including initial assessment, calling for 119, chest compressions, and ventilations) for 2 min using the Leardal Resusci Anne PC skillreporting manikin system®. After the 2-min CPR evaluation, AED was brought to the manikin by the instructor and they were asked to use it (Figure 1).

The primary outcome measures were the net number of appropriate chest compressions performed during 2-min test period one month after the training and its proportion

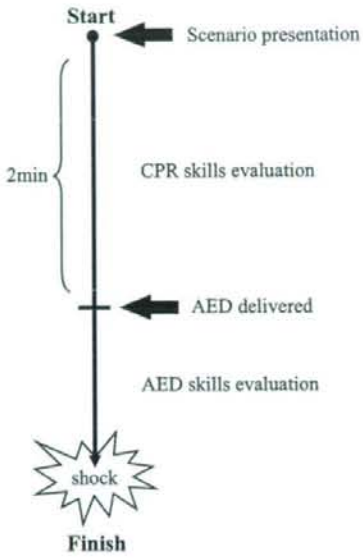

Figure 1 CPR skills evaluation flow.

calculated as the actual number of appropriate chest compressions over the theoretically attainable number based on the 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care[4]: 183 in the chest compression-only CPR and 150 in the conventional CPR. The appropriate chest compression was defined as compression with the depth of 3.5–5.5 cm, the correct hand position, and complete recoil according to the Japanese CPR guideline.[22]

The secondary outcome measures included call for help, call for an AED, total number of chest compressions, number of chest compressions with appropriate depth, number of chest compressions with correct hand position, number of chest compressions with appropriate recoil, number of total ventilations, number of appropriate ventilations, correct positioning of defibrillator pads, clearing of self and area, time to first resuscitation (earlier one between the first chest compression and the first ventilation), time to chest compression, time without chest compressions, and time to the first defibrillation.

Statistical methods

The sample size was calculated based on the number of appropriate chest compressions performed for 1 min by a medical student,[13] assuming the number among the general public to be 40 times in the chest compression-only CPR group and 20 times in the conventional CPR group. Under the condition of an alpha error of 5% and a power of 80%, 81 subjects per group were needed. Projecting a 10% dropout, the sample size was estimated to be 200 subjects in total.

Analyses were performed on an intention-to-treat basis, but participants who were absent from any evaluation were not included in the skill analyses. The data were compared across groups using chi-square test or Fisher's exact test for categorical variables and Student's two-tailed *t*-test for continuous variables. An analysis of covariance was conducted to adjust for sex and age. Resuscitation skills immediately after the training program and one month later were com-

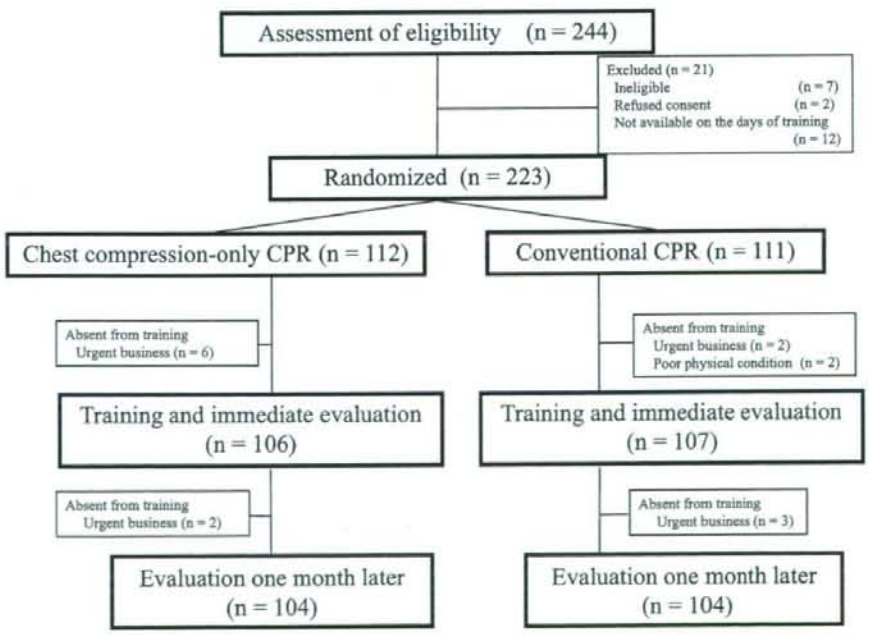

Figure 2 Participant flow.

Table 1 Baseline characteristics of participants

	Chest compression-only CPR ($n=112$)	Conventional CPR ($n=111$)	p value
Men, n (%)	58 (51.8)	58 (52.3)	0.94
Age, year, mean ± S.D.	38.8 ± 16.8	38.3 ± 14.6	0.81
Education, n (%)			0.69
Junior high school	7 (6.3)	5 (4.5)	
High school	44 (39.3)	40 (36.0)	
Junior college	19 (17.0)	16 (14.4)	
University	42 (37.5)	50 (45.0)	
Previous CPR training, n (%)	43 (38.4)	49 (44.1)	0.38
Experience of actual CPR, n (%)	4 (3.6)	2 (1.8)	0.41
Family history of sudden cardiac death, n (%)	3 (2.7)	7 (6.3)	0.19

CPR denotes cardiopulmonary resuscitation.

pared using paired t-test. Analyses were performed using SPSS Ver.12 (SPSS, Inc., Chicago, IL). A value of $p < 0.05$ was considered statistically significant.

Ethical consideration

All procedures were conducted according to the Declaration of Helsinki. Participants submitted their written informed consent prior to participation. This study was approved by the Ethics Committee of Kyoto University Graduate School of Medicine.

Additional ventilation training was offered to the participants of chest compression-only CPR group after the final evaluation of their skills to assure that both groups received equal training.

Results

Flow and baseline characteristics of participants

A total of 244 participants applied for this trial between December 2005 and May 2006. Of them, seven were ineligible, two did not submit informed consent in writing, 12 did not attend for various reasons, and the remaining 223 were randomly assigned to the chest compression-only CPR group (112) or the conventional CPR group (111). The 106 in the chest compression-only CPR group and 107 in the conventional CPR group attended the CPR training, and 104 in each group (92.9% and 93.7%, respectively) completed the study protocol (Figure 2).

Baseline characteristics of the participants are shown in Table 1. The mean age was 38 years in both groups, and there were no significant differences in sex ratio, educational backgrounds, previous CPR training, experience of actual CPR, and family history of sudden cardiac death between groups. Ten participants who did not receive the training and five who did not attend the second evaluation of resuscitation skills were not significantly different in demographic features from those who completed the training.

Resuscitation skills one month after training

Table 2 shows participants' performance of resuscitation including an AED operation one month after the training. The number of total chest compressions performed during 2-min test period was 140.4 ± 28.9 in the chest compression-only CPR group and 78.8 ± 19.8 in the conventional CPR group ($p < 0.001$). Among them, appropriate chest compressions were delivered 86.1 ± 57.2 times during 2-min test period in the chest compression-only group, which was significantly greater than in the conventional CPR group (57.1 ± 30.2, $p < 0.001$). The proportion of appropriate chest compression was significantly greater in the chest compression-only CPR group than in the conventional CPR group (47.1 ± 31.1% versus 38.1 ± 20.1%, $p = 0.022$). The number of chest compressions with appropriate depth, those with correct hand position, and those with appropriate recoil during 2-min test period was significantly greater in the chest compression-only CPR group than in the conventional CPR group (117.3 ± 43.2 versus 65.5 ± 28.2, $p < 0.001$, 100.9 ± 59.7 versus 68.0 ± 27.6, $p < 0.001$, and 140.4 ± 28.9 versus 78.7 ± 19.9, $p < 0.001$, respectively).

The total number of ventilations in the conventional CPR group was 2.45 ± 2.99, and 0.92 ± 1.57 of them were performed appropriately during 2-min test period. The number of ventilation attempts without air flow was unknown.

The AED operation, including pad-positioning and area-clearing were not significantly different between groups, although some mistakes were made in both. Seven participants in the chest compression-only CPR group and three in the conventional CPR group mistakenly positioned the pads, and one in the chest compression-only CPR group put them over the clothes.

Time to the first resuscitation (either chest compression or ventilation) was 33.8 ± 10.4 s in the chest compression-only group and 37.0 ± 12.0 s in the conventional CPR group ($p = 0.042$). Time to the first chest compression was much longer in the conventional CPR group (47.0 ± 12.7 s). Time without chest compressions in the conventional CPR group reached 85.5 ± 17.0 s out of 120 s, which was significantly longer than that in the chest compression-only CPR group (33.9 ± 10.0 s, $p < 0.001$). Time to defibrillation

Table 2 Resuscitation skills one month after the training

	Chest compression-only CPR ($n=104$)	Conventional CPR ($n=104$)	p value
Activation of EMS			
Call for help (119), n (%)	102 (98.1)	102 (98.1)	1.000
Call for AED, n (%)	104(100)	102 (98.1)	0.498
Chest compressions during 2-min test period			
Total chest compressions, n	140.4 ± 28.9	78.8 ± 19.8	<0.001
Appropriate chest compressions, n	86.1 ± 57.2	57.1 ± 30.2	<0.001
Chest compressions with appropriate depth, n	117.3 ± 43.2	65.5 ± 28.2	<0.001
Chest compressions with correct hand position, n	100.9 ± 59.7	68.0 ± 27.6	<0.001
Chest compressions with appropriate recoil, n	140.4 ± 28.9	78.7 ± 19.9	<0.001
Proportion of appropriate chest compressions[a], %	47.1 ± 31.1	38.1 ± 20.1	0.022
Ventilations during 2-min test period			
Total ventilations, n	–	2.45 ± 2.99	
Appropriate ventilations, n	–	0.92 ± 1.57	
AED operations			
Correct positioning of defibrillator pad, n (%)	95 (91.3)	101 (97.2)	0.134
Clear self and area, n (%)	100 (96.2)	102 (98.1)	0.683
Resuscitation time course			
Time to first resuscitation[b], s	33.8 ± 10.4	37.0 ± 12.0	0.042
Time to chest compression, s	33.8 ± 10.4	47.0 ± 12.7	< 0.001
Time without chest compression, s	33.9 ± 10.0	85.5 ± 17.0	< 0.001
Time to first defibrillation[c], s	70.3 ± 13.0	73.0 ± 13.3	0.138

Data are means ± S.D. and p-values were derived by analysis of covariance adjusting for sex and age for continuous variables.
CPR denotes cardiopulmonary resuscitation and AED, automated external defibrillator.
[a] Proportion of appropriate chest compressions over theoretically attainable number.
[b] Time to either first chest compression or first ventilation.
[c] Time from arrival of an AED on the scene to first defibrillation.

with an AED was not significantly different between groups (Table 2).

CPR skill deterioration during one month

We also observed the deterioration of CPR skills during one month subsequent to the training. The number of appropriate chest compressions during 2-min test period decreased from 113.0 ± 55.0 to 86.1 ± 57.2 ($p<0.001$) in the chest compression-only CPR group and from 62.5 ± 29.0 to 57.1 ± 30.2 ($p=0.014$) in the conventional CPR group. The proportion of appropriate chest compressions also showed a downward trend from 61.8 ± 30.1 to 47.1 ± 31.1 ($p<0.001$) in the chest compression-only CPR group and from 44.2 ± 19.7 to 38.1 ± 20.1 ($p=0.014$) in the conventional CPR group. In the conventional CPR group, both the number of total ventilations (from 2.54 ± 3.00 to 2.45 ± 2.99, $p=0.398$) and the number of appropriate ventilations during 2-min test period (from 1.01 ± 1.87 to 0.92 ± 1.57, $p=0.414$) were little changed during one month. Time to first defibrillation was prolonged from 66.9 ± 10.3 to 70.3 ± 13.0 s ($p<0.001$) and from 66.5 ± 11.0 to 73.0 ± 13.3 s ($p<0.001$) in the chest compression-only CPR group and conventional CPR group, respectively. The proportion of those who correctly positioned the defibrillator pads decreased from 99.0% to 91.3% ($p=0.002$) in the chest compression-only CPR group while it did not change (from 97.1% to 97.2%, $p=1.000$) in the conventional CPR group. These deterioration patterns were similar in both groups.

Discussion

This study afforded strong evidence that simplified CPR training program without ventilations could make the general public perform a greater number of appropriate chest compressions than conventional CPR. Our findings consist with previous studies[13,23–27] but there were some important differences in study design and outcome measures. First, participants of our study were randomly assigned to one of the two training regimens and their resuscitation skills were evaluated at the same time, while many of other studies were non-randomized trials.[13] Second, we took the time needed for ventilations into consideration and evaluated appropriate chest compressions referring to the theoretical number derived from the guideline. Previous studies simply compared the number of chest compressions between the different types of CPR. Our study clearly showed that the number of chest compressions was greater in the chest compression-only CPR group even adjusting for ventilation time in the conventional CPR group. Third, some studies limited the participants to medical staff,[13,28] whereas we targeted the general public. Hence, our study lends support

to the superiority of the simplified chest compression-only CPR training program in terms of its high validity and generalizability.

The current study clearly demonstrated that people who took chest compression-only CPR training could perform a greater number of chest compressions with fewer interruptions of chest compressions compared with those receiving conventional CPR training. An initial static period of over 30 s prior to beginning resuscitation suggests that people struggled to assess the victims regardless of type of CPR and that they struggled longer when they intended to perform ventilations. To our surprise, chest compressions were not delivered during two-thirds of the 2-min CPR period in the conventional CPR group: time to the first ventilation of 37 s, 10 (47.0 minus 37.0) s for initial two breathings, and about 40 (85.5 minus 47.0) s for subsequent ventilations. These data suggests that the attempt for ventilations itself might interfere with chest compressions as indicated in previous studies.[24,29]

In this study, the participants in the conventional CPR group could perform only 2.5 ventilations and 1.0 appropriate ventilation during 2-min testing, far less than the theoretically attainable number of 10 ventilations. This fact indicated the difficulties of adequate ventilation for the general public, which is consistent with a recent report.[30] Considering the importance of continuous chest compressions for OHCA[16,31] and poor quality of chest compressions in real settings,[32,33] it would be reasonable to simplify CPR procedure and concentrate lay rescuers' energy on chest compressions.[34]

Our study showed that resuscitation skills were slightly diminished at one month after the training. However, it is still unclear how long the acquired resuscitation skills were retained. A previous study showed that CPR skills were not maintained for a long time.[30] Another suggested that the resuscitation performance deteriorated less over time with chest compression-only CPR training than conventional CPR training.[13,27] Further investigations are needed to evaluate the long-term effectiveness of simplified resuscitation training and to propose the best time to reinforce the resuscitation skills.

A shorter chest compression-only CPR training program has another advantage. Since a long standard CPR training program would hinder the spread of bystander CPR among the general public,[35] this simplified and shorter CPR training program might encourage the general public to attend a CPR course. And it would be more cost effective than standard CPR training program which usually takes over 3 or 4 h.

This study has some inherent limitations. The resuscitation skills were evaluated by a case-based scenario test, and resuscitation performance was unknown in the real setting where lay persons might easily panic. Moreover, appropriate resuscitation skills on a manikin might not necessarily lead to better clinical outcomes. Thus, we are planning to develop this simplified resuscitation program in communities and evaluate their effectiveness in the real world, measuring the proportion of bystander CPR and survival from OHCA.

Conclusion

The simplified CPR program without mouth-to-mouth ventilation makes it possible for the general public to perform a greater number of appropriate chest compressions than the conventional CPR program. Besides, the quality of ventilation was quite poor even if delivered according to the conventional CPR description. These findings suggested that simplified chest compression-only CPR training would encourage the general public to perform effective chest compressions for OHCA cases.

Conflict of interest

None.

Acknowledgments

We gratefully acknowledge the generous cooperation of Masaaki Matsumoto, Katsuharu Hirai, Shohei Nakai, Keiji Akatsuka, Tatsuo Azuma, Katsuo Ogura, Eiji Ohtani, Nobuyuki Iwai, Masato Ando, Kazushi Nakajima, Hiroyuki Shinkai, Katsuya Ito, Rei Suzuki, and other members of Osaka Life Support Association in the CPR training program. We also thank all members of the Japanese Population-based Utstein-style Study with Basic and Advanced Life Support Education (J-PULSE), and the faculty of Kyoto University School of Public Health for helpful comments on the design and data analyses, which were critical to the successful study.

Funding: This study was supported by a Grant-in-Aid for Health and Labour Sciences Research Grants (H16-Shinkin-02) from the Ministry of Health, Labour and Welfare.

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Continuous Improvements in "Chain of Survival" Increased Survival After Out-of-Hospital Cardiac Arrests

A Large-Scale Population-Based Study

Taku Iwami, MD, PhD; Graham Nichol, MD, MPH; Atsushi Hiraide, MD, PhD; Yasuyuki Hayashi, MD, PhD; Tatsuya Nishiuchi, MD; Kentaro Kajino, MD, PhD; Hiroshi Morita, MD, PhD; Hidekazu Yukioka, MD, PhD; Hisashi Ikeuchi, MD, PhD; Hisashi Sugimoto, MD, PhD; Hiroshi Nonogi, MD, PhD; Takashi Kawamura, MD, PhD

Background—The impact of ongoing efforts to improve the "chain of survival" for out-of-hospital cardiac arrest (OHCA) is unclear. The objective of this study was to evaluate the incremental effect of changes in prehospital emergency care on survival after OHCA.

Methods and Results—This prospective, population-based observational study involved consecutive patients with OHCA from May 1998 through December 2006. The primary outcome measure was 1-month survival with favorable neurological outcome. Multiple logistic regression analysis was used to assess factors that were potentially associated with better neurological outcome. Among 42 873 resuscitation-attempted adult OHCAs, 8782 bystander-witnessed arrests of presumed cardiac origin were analyzed. The median time interval from collapse to call for medical help, first cardiopulmonary resuscitation, and first shock shortened from 4 (interquartile range [IQR] 2 to 11) to 2 (IQR 1 to 5) minutes, from 9 (IQR 5 to 13) to 7 (IQR 3 to 11) minutes, and from 19 (IQR 13 to 22) to 9 (IQR 7 to 12) minutes, respectively. Neurologically intact 1-month survival after witnessed ventricular fibrillation increased from 6% (6/96) to 16% (49/297; $P<0.001$). Among all witnessed OHCAs, earlier cardiopulmonary resuscitation (odds ratio per minute 0.89, 95% confidence interval 0.85 to 0.93) and earlier intubation (odds ratio per minute 0.96, 95% confidence interval 0.94 to 0.99) were associated with better neurological outcome. For ventricular fibrillation, only earlier shock was associated with better outcome (odds ratio 0.84, 95% confidence interval 0.80 to 0.88).

Conclusions—Data from a large, population-based cohort demonstrate a continuous increase in OHCA survival with improvement in the chain of survival. The incremental benefit of early advanced care on OHCA survival is also suggested. **(*Circulation*. 2009;119:728-734.)**

Key Words: cardiopulmonary resuscitation ■ heart arrest ■ death, sudden ■ epidemiology ■ ventricular fibrillation

Sudden cardiac arrest is a leading cause of adult death and has been an important public health problem in the industrialized world.[1] Approximately three fourths of deaths due to coronary heart disease occur in the out-of-hospital setting.[2,3] Extrapolation of the mortality rate observed in a recent large, prospective, multicenter observational study to the total population of the United States suggests that ≈300 000 people die annually in out-of-hospital settings in the United States.[4] During the last 3 decades, despite efforts to the contrary, survival after out-of-hospital cardiac arrests (OHCAs) has not improved,[5,6] in contrast to the decline in morbidity and mortality observed for most cardiovascular diseases.[7–9]

Clinical Perspective p 734

The importance of using a "chain of survival" with early activation of emergency medical services (EMS), early cardiopulmonary resuscitation (CPR), early defibrillation, and early advanced life support (ALS) measures to decrease death and disability from OHCA has been accepted widely.[1,10] The benefit of early CPR and early defibrillation on survival has been shown in multiple settings[5,11–14]; however, overall sur-

Received June 24, 2008; accepted November 28, 2008.

From Kyoto University Health Service (T.I.,T.K.), Kyoto, Japan; University of Washington–Harborview Center for Prehospital Emergency Care (G.N.), Seattle, Wash; Center for Medical Education (A.H.), Kyoto University Graduate School of Medicine, Kyoto, Japan; Senri Critical Care Medical Center (Y.H.), Osaka Saiseikai Senri Hospital, Suita, Japan; Osaka Prefectural Senshu Critical Care Medical Center (T.N.), Izumisano, Japan; Emergency and Critical Care Medical Center (K.K.), Osaka Police Hospital, Osaka, Japan; Department of Emergency Medicine (H.M.), Osaka Medical College, Takatsuki, Japan; Yukioka Hospital (H.Y.), Osaka, Japan; Osaka General Medical Center (H.I.), Osaka, Japan; Department of Traumatology and Acute Critical Medicine (H.S.), Osaka University Graduate School of Medicine, Suita, Japan; and Division of Cardiology (H.N.), National Cardiovascular Center, Suita, Japan.

Correspondence to Taku Iwami, MD, PhD, Kyoto University Health Service, Yoshida Honmachi, Sakyo-Ku, Kyoto 606-8501, Japan. E-mail iwamit2000@yahoo.co.jp

Circulation is available at http://circ.ahajournals.org

DOI: 10.1161/CIRCULATIONAHA.108.802058

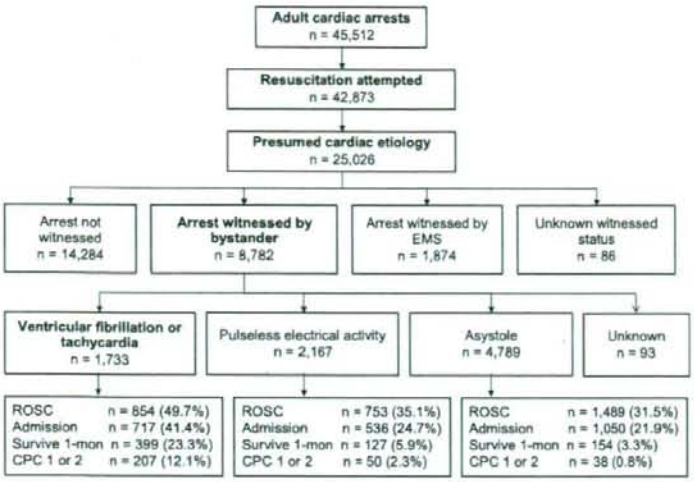

Figure 1. Overview of EMS-treated cardiac arrests with an abridged Utstein template (May 1, 1998, to December 31, 2006). ROSC indicates return of spontaneous circulation; CPC, cerebral performance category; and mon, month.

vival after OHCA does not exceed 5% in most communities and is <3% in large urban populations.[15–17] The incremental benefit of ALS for OHCA remains to be determined.[18–21]

The Utstein Osaka Project, begun in 1998, is an ongoing large, prospective, population-based cohort study of OHCA in Osaka, Japan, that covers 8.8 million people.[22–24] More than 45 000 adult OHCAs occurred from May 1998 through December 2006 in Osaka. During this period, some changes were made in the EMS system in this area to improve the chain of survival, such as training citizens in CPR and enabling EMS personnel to deliver shocks without online medical direction by physicians and to intubate in the field. The objectives of the present study were to determine whether improvement in the chain of survival increased survival after OHCA in a large population and to assess the incremental benefit of implementation of prehospital ALS programs on survival.

Methods

Study Design, Population, and Setting

The investigation was a prospective, population-based cohort study of all persons 18 years or older with OHCA of presumed cardiac origin that was witnessed by bystanders and treated by EMS in Osaka Prefecture, Japan, from May 1, 1998, through December 31, 2006. The research protocol was approved by the institutional review board of Osaka University, with the assent of the EMS authorities and local governments in Osaka Prefecture.

Cardiac arrest was defined as the cessation of cardiac mechanical activities, as confirmed by the absence of signs of circulation.[25] The arrest was presumed to be of cardiac origin unless it was caused by trauma, drowning, drug overdose, asphyxia, exsanguination, or any other noncardiac causes determined by a physician in charge, in collaboration with the EMS rescuers.

EMS System in Osaka

Osaka Prefecture has approximately 8.8 million residents in an area of 1892 km^2, which includes both urban and rural communities. The population is served by 35 fire stations, with a corresponding number of emergency dispatch centers. The EMS system is operated by the local fire stations, and life support is provided 24 hours per day via a single-tiered system in 33 stations and a 2-tiered system in 2 stations. The latter uses medics followed by physicians responding by vehicle. The most highly trained prehospital emergency care providers are the Emergency Life-Saving Technicians (ELSTs). Each ambulance has 3 providers, and most have at least 1 ELST. The ELST system was started in 1991, but before 2003, they were allowed only to insert an intravenous line and an adjunct airway and to use a semiautomated external defibrillator for OHCA patients under the online medical direction of a physician. ELSTs have been allowed to deliver shocks without online medical direction since April 2003, and trained ELSTs have been allowed to insert tracheal tubes since July 2004 (tracheal intubation phase) and to use epinephrine since April 2006. Public access defibrillation programs were started in July 2004. CPR training for lay rescuers has been offered by local fire departments, the Japan Red Cross, Inc, and the Osaka Life Support Association throughout the study period. Approximately 120 000 citizens per year participate in conventional CPR training. No programs were in place to train individuals in compression-only CPR during this study period. Dispatcher instruction in CPR was introduced in July 1999.

Data Collection

Data were collected prospectively with a data form that included all core data recommended in the Utstein-style reporting guidelines for cardiac arrests,[25] such as sex, age, initial cardiac rhythm, time course of resuscitation, type of bystander-initiated CPR, return of spontaneous circulation, hospital admission, 1-month survival, and neurological status 1 month after the event. Special emphasis was placed on determining the time course of resuscitation. The time of EMS call receipt and time of vehicle arrival at the scene were recorded automatically at the dispatch center. The times of collapse and initiation of bystander CPR were obtained by EMS interview with the bystander before leaving the scene. The time of defibrillation was recorded by the semiautomated defibrillator. Watches of EMS personnel were synchronized with the clock at their dispatch center. During this study period, no change was made in this reporting system. Time interval from collapse to CPR was defined as the shorter of the time from collapse to CPR by bystanders and that by EMS personnel. The time interval from collapse to shock was defined as the shorter of the time from collapse to shock by bystanders and that by EMS personnel. The time interval from collapse to intubation was replaced with time to hospital arrival unless EMS personnel inserted an endotracheal tube in the field.

All survivors were followed up for up to 1 month after the event by EMS personnel. Neurological outcome was determined by a telephone interview 1 month after successful resuscitation that used the Cerebral Performance Category scale: category 1, good cerebral performance; category 2, moderate cerebral disability; category 3,

severe cerebral disability; category 4, coma or vegetative state; and category 5, death.[25]

The methods of data collection and verification have been described previously.[24] Although a computer-based registration system was introduced in January 2005, the essentials of data collection were unaltered. Before the present study, a 6-month run-in period was used to ensure the completeness of episode identification and data capture. The steering committee of the present study verified uniform data collection, consistent definition of technical terms, and time synchronization to minimize these potential information biases. Because termination of resuscitation efforts and declaration of death are the exclusive domain of medical doctors in Japan, the only arrests that may have been missed from these data would be those associated with illegal activities that were not reported.

Statistical Analysis

Analyses were conducted for both all EMS-treated, bystander-witnessed cardiac arrests of presumed cardiac origin and witnessed ventricular fibrillation (VF) cardiac arrests. The primary outcome measure was neurologically intact 1-month survival, defined as Cerebral Performance Category categories 1 or 2.[25] Secondary outcome measures included return of spontaneous circulation, admission to hospital, and 1-month survival.

Patient characteristics were evaluated with ANOVA for numerical variables and χ^2 test for categorical variables. Time trends in categorical values and numerical values were tested with univariable regression models and linear tests for trend, respectively. Multiple logistic regression analysis assessed the factors associated with better neurological outcome; odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated. Potential confounding factors that were biologically essential or significantly associated with survival at $P<0.1$ in the univariable analyses were considered in the multivariable analyses. Both bystander-initiated, compression-only CPR and conventional CPR with rescue breathing were considered as bystander CPR, whereas bystander-initiated rescue breathing without compressions was classified as no bystander CPR. Interactions between bystander CPR and time to CPR and between tracheal intubation phase and time to tracheal intubation were also incorporated in multivariable analyses. Statistical analyses were performed with SPSS statistical package version 12.0J (SPSS, Inc, Chicago, Ill). A 2-sided P value of 0.05 or less was regarded as statistically significant.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

A total of 45 512 adult OHCAs were documented during the 8 years and 8 months of the study period. Resuscitation was attempted in 42 873, and 25 026 OHCAs were presumed to be of cardiac origin. Of these OHCAs with presumed cardiac origin, 8782 were witnessed. Among them, 1733 (20%) had VF (including pulseless ventricular tachycardia), 2167 (25%) had pulseless electrical activity, and 4789 (55%) had asystole as the initial rhythm. We could not obtain data on the initial rhythm for 93 cases. Figure 1 provides an overview of the arrests, with the important outcomes by initial rhythms. The proportion of neurologically intact 1-month survival among those with witnessed VF, pulseless electrical activity, and asystole was 12%, 2%, and 1%, respectively.

Demographic and resuscitation characteristics of patients with witnessed cardiac arrest of presumed cardiac origin and witnessed VF arrests are noted in Table 1. Factors associated with 1-month survival with favorable neurological outcome included sex, age, location of arrest, activities of daily living status before arrest, VF as initial rhythm, bystander-initiated CPR, and time interval from collapse to the initiation of CPR by bystanders or EMS personnel. Time interval from collapse to intubation was included in the final model because it confounded the effect estimate for location of arrest.

Table 1. Patient Characteristics Throughout Study Period

	Witnessed Cardiac Arrests of Presumed Cardiac Origin (n=8782)	Witnessed VF Cardiac Arrests (n=1733)
Age, y, mean (SD)	70.5 (15.2)	63.0 (14.2)
Male, n (%)	5546 (63.3)	1349 (78.0)
Location of arrests, n (%)		
Home	6014 (68.5)	900 (51.9)
Public space	1273 (14.5)	485 (28.0)
Work place	321 (3.7)	142 (8.2)
Healthcare facility*	695 (7.9)	62 (3.6)
Other	452 (5.1)	136 (7.8)
Activity of daily living before arrests, n (%)		
Good	6220 (70.8)	1481 (85.5)
Disability	2087 (23.8)	143 (8.3)
VF as initial rhythm, n (%)	1733 (19.9)	...
Bystander-initiated CPR, n (%)		
Compression-only CPR	1145 (13.1)	278 (16.1)
Conventional CPR	1565 (17.9)	348 (20.1)
Collapse to call, min		
Mean (SD)	4.9 (6.9)	3.0 (3.9)
Median (IQR)	3 (1–6)	2 (1–4)
Collapse to first CPR, min		
Mean (SD)	8.5 (7.0)	6.4 (5.2)
Median (IQR)	7 (3–12)	6 (2–9)
Collapse to first shock, min		
Mean (SD)	...	12.9 (6.2)
Median (IQR)	...	12 (9–16)
Collapse to intubation†, min		
Mean (SD)	26.9 (9.6)	26.2 (8.9)
Median (IQR)	26 (20–33)	26 (20–32)

*Includes chronic care facilities and medical clinics.
†Time to tracheal intubation by EMS personnel in the field or hospital arrival.

Table 2 shows temporal trends in patient and EMS characteristics for bystander-witnessed cardiac arrests of presumed cardiac origin. The mean age of patients gradually increased from 68 to 72 years during the period (P for trend <0.001). The male/female ratio approximated 5:3 and showed no significant temporal trend (P for trend $=0.53$). The proportion of those with VF as the initial rhythm increased from 16% to 25% (P for trend <0.001). The proportion of those who received bystander-initiated CPR also increased,

Table 2. Patient and EMS Characteristics for Witnessed Cardiac Arrests of Presumed Cardiac Origin According to Time Period

	1998 (n=598)	1999 (n=964)	2000 (n=987)	2001 (n=1035)	2002 (n=939)	2003 (n=1003)	2004 (n=975)	2005 (n=1083)	2006 (n=1198)
Age, y, mean (SD)	68.2 (16.0)	68.3 (15.4)	69.4 (15.7)	70.7 (14.8)	70.3 (14.5)	70.4 (15.5)	72.0 (14.8)	71.6 (15.2)	72.2 (14.5)
Male, n (%)	387 (65.0)	607 (63.4)	624 (63.4)	669 (65.0)	580 (61.9)	634 (63.3)	589 (60.4)	685 (63.3)	771 (64.4)
VF, n (%)	98 (16.4)	168 (17.4)	147 (15.1)	171 (16.8)	179 (19.3)	206 (20.7)	226 (23.3)	241 (22.3)	297 (24.8)
Bystander-initiated CPR, n (%)									
Compression-only CPR	44 (7.4)	112 (11.7)	96 (9.8)	133 (13.0)	117 (12.6)	136 (13.6)	152 (15.8)	156 (14.4)	199 (16.6)
Conventional CPR	68 (11.4)	127 (13.2)	148 (15.1)	182 (17.7)	181 (19.5)	196 (19.7)	203 (21.1)	227 (21.0)	233 (19.4)
Resuscitation time course, min, median (IQR)									
Collapse to call	4 (2–11)	4 (1–11)	4 (1–10)	3 (1–6)	3 (1–5)	3 (1–5)	3 (1–5)	3 (1–6)	2 (1–5)
Collapse to first CPR	9 (5–13)	8 (3–12)	8 (4–12)	8 (3–11)	7 (3–11)	7 (2–11)	7 (2–11)	7 (3–11)	7 (3–11)
Collapse to first shock*	19 (13–22)	17 (13–20)	14 (11–18)	14 (11–18)	14 (11–18)	11 (8–15)	11 (8–14)	10 (7–12)	9 (7–12)
Collapse to intubation†	25 (20–33)	25 (20–32)	26 (20–33)	26 (20–33)	26 (20–31)	27 (22–33)	28 (22–33)	26 (20–33)	25 (19–32)

*Calculated for cases with VF as initial rhythm.

†Time to tracheal intubation by EMS personnel in the field or hospital arrival.

from 19% to 36% (P for trend <0.001). Compression-only CPR accounted for >40% of bystander-initiated CPR.

The median time interval from collapse to call for medical help shortened from 4 (interquartile range [IQR] 2 to 11) to 2 (IQR 1 to 5) minutes (P for trend=0.02). The median time interval from collapse to initiation of CPR decreased from 9 (IQR 5 to 13) to 7 (IQR 3 to 11) minutes (P for trend <0.001) as the proportion of bystander-initiated CPR increased, whereas the time to CPR by EMS personnel remained ≈7 minutes (data not shown). The median time interval from collapse to first shock decreased significantly from 19 (IQR 13 to 22) to 9 (IQR 7 to 12) minutes (P for trend <0.001) owing to the improvement in EMS response. Only 24 patients received shocks by bystanders during the study period. The median time to intubation remained around 25 minutes, but it took only 15 minutes (n=353; IQR 12 to 20 minutes) when the specially trained ELST performed intubation in the field during the tracheal intubation phase. Thirteen percent (356/2745) of OHCA patients received intubation by specially trained ELSTs during the tracheal intubation phase.

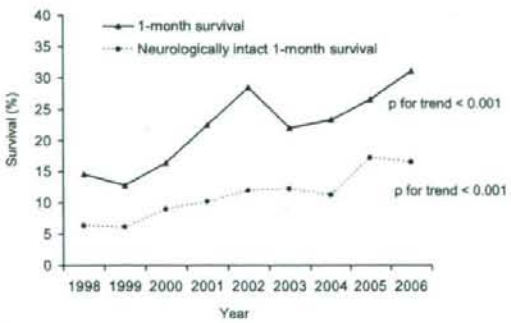

Figure 2. Temporal trend in survival after witnessed VF cardiac arrests.

One-month survival after all rhythms of witnessed cardiac arrests of presumed cardiac origin increased from 5% (31/591) to 12% (146/1197; P for trend <0.001), and neurologically intact survival increased from 2% (12/591) to 6% (71/1197; P for trend <0.001). One-month survival after witnessed VF cardiac arrests significantly increased from 15% (14/96) to 31% (92/297; P for trend <0.001), and the proportion of neurologically intact 1-month survival also increased, from 6% (6/96) to 16% (49/297) during the period (P for trend <0.001; Figure 2).

Table 3 shows the adjusted ORs and their 95% CIs for neurologically intact survival. Among all witnessed cardiac arrests of presumed cardiac origin, VF as the initial rhythm (OR 6.46, 95% CI 4.86 to 8.59), shorter time to CPR (OR for a 1-minute increase 0.89, 95% CI 0.85 to 0.93), and shorter time to intubation (OR for a 1-minute increase 0.96, 95% CI 0.94 to 0.99) were associated with better neurological outcome. With regard to witnessed VF cardiac arrests, only earlier shock was associated with a better outcome (OR for a 1-minute increase 0.84, 95% CI 0.80 to 0.88), whereas other resuscitation procedures were not.

Discussion

This study showed that improvements in the chain of survival for OHCA were associated with increased survival in a large population. The time from collapse to CPR shortened from a median of 9 to 7 minutes because of the increase in bystander-initiated CPR, time to shock shortened from 19 to 9 minutes because of the refinement of the EMS system, and neurologically intact 1-month survival after witnessed VF cardiac arrests increased from 6% to 17% during the 8-year study period. To improve outcomes from OHCA, measures are

Table 3. Adjusted OR (95% CI) of Patient and EMS Characteristics for Neurologically Intact Survival After Witnessed Cardiac Arrests of Presumed Cardiac Origin and Witnessed VF Cardiac Arrests

	Witnessed Cardiac Arrests of Presumed Cardiac Origin (n=8782)	Witnessed VF Cardiac Arrests (n=1733)
Female	1.51 (1.13–2.02)	1.52 (1.01–2.28)
Age ≥75 y	0.43 (0.30–0.61)	0.65 (0.40–1.05)
Location of arrests		
Home	Reference	Reference
Public space	1.33 (0.97–1.83)	1.13 (0.76–1.67)
Work place	1.75 (1.11–2.76)	1.90 (1.09–3.30)
Healthcare facility*	1.76 (1.00–3.08)	2.47 (1.09–5.60)
Other	0.91 (0.52–1.61)	0.91 (0.45–1.83)
Disability in activity of daily living before arrests	0.37 (0.21–0.62)	0.47 (0.20–1.08)
VF as initial rhythm	6.46 (4.86–8.59)	...
Bystander-initiated CPR	0.61 (0.39–0.94)	1.51 (0.88–2.61)
Collapse to first CPR†	0.89 (0.85–0.93)	1.00 (0.95–1.06)
Bystander CPR interaction	1.09 (1.01–1.17)	1.06 (0.95–1.17)
Collapse to shock by EMS†	...	0.84 (0.80–0.88)
Tracheal intubation phase	0.80 (0.37–1.72)	0.46 (0.17–1.26)
Collapse to tracheal intubation (ALS)†	0.96 (0.94–0.99)	0.97 (0.94–1.00)
Tracheal intubation interaction	1.03 (1.00–1.06)	1.03 (0.99–1.07)
Epinephrine by EMS	0.71 (0.25–2.05)	0.23 (0.03–1.78)

*Includes chronic care facilities and medical clinics.
†OR for 1-minute increase in time.

needed to strengthen the chain of survival. Although uniform reporting of OHCA has been strongly recommended,[1,25] there have been only a few reports that continuously evaluated local EMS and resuscitation outcomes.[5,6,13,21] The present data, based on a large-scale, population-based cohort, provide further evidence of the effect of strengthening the chain of survival to save OHCA victims.

During the study period, some new measures were introduced. In April 2003, EMS personnel began to be allowed to deliver shocks without online medical direction, and the time interval from collapse to shock decreased by 3 minutes; however, survival did not improve similarly. Although dispatcher instruction in CPR was introduced in July 1999, no stepwise changes occurred in bystanders' behaviors and patient outcomes. The most plausible explanation for the observed improvement in survival is the accumulation of citizens trained in CPR in the population and continuous efforts of the EMS system.

The present study suggests the incremental benefit of some ALS procedures on survival after OHCA. Despite the broad use of advanced treatments for OHCA victims, evidence for the effectiveness of ALS treatment for OHCA is scarce.[18] Several small, nonexperimental studies showed the effectiveness of ALS treatment,[26–28] whereas 2 meta-analyses showed no benefit of ALS for OHCA.[19,20] The Ontario Prehospital Advanced Life Support (OPALS) study, a large "before-and-after" controlled study of the effects of prehospital care, could not demonstrate a benefit of ALS treatments for OHCA.[21] However, the OPALS study adjusted for ALS phase (ie, before and after ALS program introduction) but not for the timing of field interventions, whereas we considered the time to intubation and showed the benefit of earlier advanced treatment. Both the type and timing of field ALS treatments might be important to increase survival after OHCA.

Although both the Utstein Osaka project and the OPALS study were large-scale, population-based cohort studies of OHCA, some differences were identified in clinical conditions. The proportion of patients who received bystander-initiated CPR increased to 36% at the end of the study period in Osaka, whereas the increase in the OPALS study was only 15%. The ALS program was added to the existing program of rapid defibrillation in the OPALS study, in which >90% victims received shocks within 8 minutes after call receipt, whereas only 36% in the present study received shocks within 8 minutes of call receipt. These differences may explain the discrepancy in the results, because early CPR initiated by bystanders and early defibrillation are critical factors for survival.[1,10,29] Furthermore, only specially trained ELSTs in Osaka are allowed to use ALS treatments, which resulted in only 13% of OHCA patients receiving intubation by them even during the tracheal intubation phase. The training and experience of EMS providers who perform ALS might also be different between the 2 study areas and affect the outcomes of OHCA.[30]

The increased survival in Osaka over time is due mainly to improvements in the first 3 links in the chain of survival. Although the present study suggests the benefit of early-initiated advanced cardiac care, we need to recognize that our data confirm the greater importance of early CPR and early shock for increasing survival after OHCA. ORs of time to CPR and time to shock for a 1-minute increase were less than that of time to intubation (ALS). These data are consistent with many previous studies that showed the importance of early CPR and shocks.[21,29,31] Emphasis should be placed on increasing bystander-initiated CPR and integrating such changes with improvements in ALS to save more lives.

The present study demonstrated continuous improvement in the chain of survival and OHCA survival, but absolute survival is still less than optimal. Although the proportion of those with bystander-initiated CPR increased in Osaka, approximately two thirds of OHCA victims still do not receive bystander-initiated CPR, and lay use of defibrillators has not been implemented widely. Bystander CPR is typically provided to fewer than 25% of cardiac arrest victims,[6,21,32] and it is known that delivering shocks can be difficult for lay rescuers.[33] Considering the difficulties of performing CPR and delivering shocks and the evidence that supports the effectiveness of bystander-initiated, compression-only CPR,[24,34,35] further efforts to strengthen the first 3 links in the chain of survival by use of compression-only CPR might be more feasible, as recommended recently by the American Heart Association.[36]

Study Limitations

An important limitation of the present study was the potential for bias on the basis of its observational design. As with all multisite epidemiological studies, data integrity, validity, and ascertainment bias are also potential limitations. We believe that the use of uniform data collection and consistent definitions based on Utstein-style guidelines for reporting cardiac arrest, the time synchronization process, the large sample size, and a population-based design that included all known adults with OHCA in Osaka Prefecture minimize these potential sources of bias.

In the present study, we had no data at the hospital level, such as the prevalence of postresuscitation care, including therapeutic hypothermia. The incremental benefit of advanced hospital care should be investigated further.

Conclusions

Data from a large-scale population-based cohort in Osaka demonstrate a continuous increase in survival after witnessed OHCA of presumed cardiac origin with improvements in the chain of survival. An incremental benefit of some ALS procedures on survival after OHCA is also suggested.

Acknowledgments

We greatly appreciate Toshifumi Uejima, Kikushi Katsurada, Masafumi Kishimoto, Chizuka Shiokawa, Masahiko Nitta, Toshimasa Hayashi, Akihiko Hirakawa, Tokihiko Yamamoto, Hiroshi Rinka, and the other members of the Utstein Osaka Project for their contribution in the organization, coordination, and oversight of this study as its steering committee. Chika Nishiyama, Kayo Tanigawa, Tetsuhisa Kitamura, and Tomohiko Sakai provided support for the data analyses. We also thank Akiko Kada, Naohiro Yonemoto, Hiroyuki Yokoyama, Hiroyuki Kakuchi, Kazuhiro Sase, and the other members of the Japanese Population-based Utstein-style study with basic and advanced Life Support Education (J-PULSE) group and Masahiko Ando, Masashi Goto, and the other members of the Preventive Services and Master of Clinical Research Course of Kyoto University for supporting the analyses of the data. Hiroko Kurahashi assisted in data entry and patient follow-up. We are also deeply indebted to all of the EMS personnel and concerned physicians in Osaka Prefecture and to the Osaka Medical Association for their indispensable cooperation and support.

Sources of Funding

This study was supported by a grant-in-aid for university and society collaboration from the Ministry of Education, Science, Sports, and Culture, Japan (No. 11794023) and by Health and Labour Sciences research grants (H19-Shinkin-003) from the Ministry of Health, Labour, and Welfare.

Disclosures

None.

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CLINICAL PERSPECTIVE

This large, population-based study covering 8.8 million residents and ranging from 1998 to 2006 demonstrates a continuous increase in out-of-hospital cardiac arrest survival with improvements in the "chain of survival." Among 42 873 resuscitation-attempted adult out-of-hospital cardiac arrests, 8782 bystander-witnessed arrests of presumed cardiac origin were analyzed. During the study period, the proportion of those who received bystander-initiated cardiopulmonary resuscitation increased from 19% to 36%, and the median time interval from collapse to initiation of cardiopulmonary resuscitation decreased from 9 to 7 minutes. The median interval from collapse to first shock decreased from 19 to 9 minutes because of improvements in the emergency medical service response. Neurologically intact 1-month survival after all rhythms and after ventricular fibrillation of witnessed cardiac arrests increased from 2% to 6% and from 6% to 17%, respectively. The concept that survival improves as response times decrease and bystander efforts increase is widely accepted, but few reports have shown the potential impact of ongoing efforts to improve the chain of survival. In multivariable analyses, earlier cardiopulmonary resuscitation (odds ratio per minute 0.89) and earlier intubation (odds ratio per minute 0.96) were associated with better neurological outcome. For ventricular fibrillation, only earlier shock was associated with better outcome (odds ratio 0.84). The incremental benefit of early advanced care on out-of-hospital cardiac arrest survival is also suggested. Emphasis should be placed on increasing bystander-initiated cardiopulmonary resuscitation and integrating such changes with improvements in advanced life support to save more lives.

原著

心肺蘇生講習会による受講者の救命意識の変化

西山 知佳　石見 拓　川村 孝
米本 直裕[1]　平出 敦[2]　野々木 宏[3]

【要旨】 背景：心停止患者の救命率向上のためには一般市民の救命意識・AEDに対する認知を高め，蘇生処置への積極的な参加を促す必要があるが，市民の救命意識に関する検討はなされていない。目的：心肺蘇生講習会の受講による救命意識の変化を検討する。対象：心肺蘇生講習会に参加した大学生。方法：3時間の心肺蘇生講習会を実施し，講習会の前後に，心肺蘇生法，AED使用など救命意識に関する質問紙調査を行った。結果：今回の講習会には大学生307名が参加し，203名から有効回答が得られた。203名のうち，見知らぬ人が倒れていたら自ら心肺蘇生を試みようと思う受講者は講習会前後で4%から52%に増加した。蘇生現場でAEDがあれば使用してみようと思う受講者は8%から80%にまで増加した。一方で受講後も倫理的な問題で蘇生処置を躊躇する受講者が少数いた。結論：講習会を受講することで，受講者の救命意識の向上が見られたが，倫理面での不安が蘇生処置参加への障害となっていた。

索引用語：CPR（心肺蘇生），講習会，AED（自動体外式除細動器），市民，救命の連鎖

はじめに

日本国内における心疾患による死亡者数は年々増加傾向にあり，成人の死因の第2位（全死因の15.7%）を占めている[1]。これら心疾患による死亡は突然死の形をとることが多く，心臓突然死は年間3～5万件発生しているともいわれる[2]。特に，急性心筋梗塞症においては死亡の半数から3分の2が病院に到着する前の死亡であるとされており[3,4]，心疾患による死亡を減らすための方策の1つとして，病院外心停止に対する迅速・適切な処置は重要である。

病院外心停止患者を救命するためには，①迅速な通報，②迅速な心肺蘇生，③迅速な除細動，④二次救命処置，の4つの要素からなる「救命の連鎖」を忠実に履行させる必要があり，市民の蘇生処置への積極的な参加が不可欠である[5,6]。中でも，居合わせた市民による迅速な心肺蘇生（bystander-initiated cardiopulmonary resuscitation，以下bystander CPR）は，救命の鍵であり，心停止後直ちに行われると心停止患者の救命率（生存退院）を2～3倍にすることができるといわれている[5-7]。また，心室細動（Ventricular Fibrillation：以下VF）症例においては，

Changes in Attitudes toward CPR by a CPR Training Program for Lay Responders

Chika NISHIYAMA, Taku IWAMI, Takashi KAWAMURA, Naohiro YONEMOTO[1], Atushi HIRAIDE[2] and Hiroshi NONOGI[3]

Department of Preventive Services, Kyoto University School of Public Health, [1]Department of Biostatistics, Kyoto University School of Public Health, [2]Center for Medical Education, Kyoto University Graduate School of Medicine, [3]Division of Cardiology, National Cardiovascular Center

京都大学大学院医学研究科社会健康医学系専攻予防医療学分野，[1]京都大学大学院医学研究科社会健康医学系専攻医療統計学分野，[2]京都大学医学研究科　医学教育推進センター，[3]国立循環器病センター心臓血管内科

〔原稿受付日 2007年6月6日　原稿受理日 2008年5月7日〕

表1　講習会前後に行った質問内容

質問1. 心肺蘇生講習会受講の有無
　①あり　②なし
質問2. もし見知らぬ人が目の前で倒れたら自ら心肺蘇生法を試みようと思いますか？
　思わない　　思う
　1　2　3　4　5
質問3. 上記1～4を選択された方に伺います。心肺蘇生法をためらう理由は何ですか？
　①何をしたらいいかわからない　②人工呼吸はしたくない　③救急隊を待ったほうがいいと思う
　④うまくいかなかった時に責任がもてない　⑤恥ずかしい　⑥その他
質問4. AEDという言葉を今まで聞いたことがありますか？
　①はい　②いいえ
質問5. 実際のAEDをどこかで見たことがありますか？
　①ある　②ない
質問6. 実際の心停止の現場でAEDがあれば使用してみようと思いますか？
　思わない　　思う
　1　2　3　4　5
質問7. 上記1～4を選択された方に伺います。AEDの使用をためらう理由は何ですか？
　①AEDを正しく使えるかどうか不安　②誤った除細動をして倒れている人を傷つけるのが心配
　③（感電等）救助者の身の安全が確保できるかどうか不安　④AEDが救急隊員にやってもらったほうがいい　⑤その他

＊質問2.3.6.7については講習会後にも質問を行った。

除細動が1分遅れるごとにその救命率は10%低下するが，迅速なbystander CPRにより1分ごとの救命率の低下は3～4%程度に抑えられるといわれる[5,6,8]。

近年，欧米を中心に自動体外式除細動器（Automated External Defibrillator：以下AED）を用いた公共の場における除細動（Public Access Defibrillation：以下PAD）プログラムが地域に導入され[9,10]，ますます市民の担う役割が大きくなってきている。わが国においても2004年7月より非医療従事者によるAEDの使用が認められ，公共スペースをはじめとしたさまざまな所にAEDの配備が進んできた。しかし，AEDをただ配備しただけでは「救命の連鎖」が機能せず救命率向上に結びつかないのは明らかである。

院外心停止症例の救命率を高めるためには，適切にAEDを配備すると同時に，市民の救命意識を高めbystander CPRの実施率を高めさせ，配備されたAEDが有効に利用されることが重要である。これまで，AEDの使用法に関する教育によってAED使用に対する市民の姿勢が向上すると報告されている[11]。しかし，心肺蘇生講習会の実施による一般市民の救命意識の変化に関する検討はほとんど行われていない。そこで，心肺蘇生講習会前後における受講者の心肺蘇生術施行やAED使用に対する意識の変化を調査・検討したので報告する。

方　法

1. 対象者

2005年8月3日～5日に大学コンソーシアム京都において，単位互換授業として京都大学医学研究科により開催された心肺蘇生講習会に参加した大学生を対象とした。

2. 心肺蘇生講習会内容

講習会初日は，心肺蘇生法の意義・必要性およびその方法について2時間にわたり講義形式で解説を行った。2日目は，蘇生トレーニング用人形およびAEDトレーナーを用いて3時間の心肺蘇生実習（厚生労働省が推奨する『自動体外式除細動器（AED）を使用する非医療従事者（一般市民）に対する講習』の枠組みに準じ，心肺蘇生と救急心血管治療のためのガイドライン2000[3]の内容を指導）を行った。学生4～5名を1グループとし，救急救命士，医師，および看護師からなる日本救急医学会認定ICLS（Immediate Cardiac Life Support）インストラクター

(26名) を各グループに1～2名ずつ配置した。

3. 質問紙調査方法

心肺蘇生実施やAED使用に対する意識に関する質問紙 (表1) を作成した。心肺蘇生を行うかどうか，AEDを使用するかという意向を尋ねる質問については5段階選択式とし，その他の質問項目は択一式とした。講習会の前後に，参加者全員にこの質問紙を配布し無記名で調査を行った。講習会前後で個人の意識変化を検討するために，無記名であるが，両親の誕生日を記載させ，匿名性を維持しながら連結を試みた。解析対象は，講習会前後の質問紙が連結できたもののみとした。

なお，質問紙配布時に本研究の説明を口頭および文書で行い，質問紙の提出をもって同意が得られたものとした。

結　果

本講習会に参加した大学生は307名(男性183名，女性124名) であった。質問紙回収率は，講習会前が296名 (96.4%)，講習会後が275名 (94.1%) であった。講習会前後で質問紙が連結できたものは203名 (68.0%) であった。

1. 対象者の属性

男性121名 (59.6%)，女性82名 (40.4%)，平均年齢は21±3歳であり，そのうち医学系の大学生 (医学部，薬学部) は8名 (3.9%) であった。過去の心肺蘇生講習会の受講歴有が126名 (62.1%)，無が77名 (37.9%) であった。これら受講歴有の者のうち，113名 (89.7%) が運転免許取得時に受講していた。それ以外では，日本赤十字社の救命講習，消防署主催の普通救命講習，中学や高校の授業で受講していた。

2. 心肺蘇生処置参加

『見知らぬ人が倒れたら自ら心肺蘇生を試みようと思うか』という質問2に対しては，講習会前に5の「思う」を選択したものはわずか8名 (3.9%)，4を選択したものは34名 (16.7%) であった。講習会後にはそれぞれ106名 (52.2%) と72名 (35.4%) にまで増加していた (図1)。

前質問で5の「思う」以外を選択したものに対して尋ねた質問3の『心肺蘇生をためらう理由』については，講習会前は194名 (95.6%) のうち『何をしたらいいのかわからない』および『うまくいかなかったときに責任がもてない』がそれぞれ77名 (39.7%) を占めていた (図2)。その他には『(蘇生処置に) かかわりたくない』，『うろ覚えで中途半端に行うなら，やらないほうがいい』，『うまくいかなかった時，罪に問われなくても，自分の心の中に生涯残ってしまう』，『医学知識がないのに勝手に判断して心肺蘇生を行ってもいいのかわからない』という回答があった。

講習会後に，依然心肺蘇生処置参加への抵抗感を示したもの (5の「思う」を選択しなかったもの) は95名 (46.8%) であった。このうち54名 (56.8%) が『うまくいかなかったとき責任がもてない』を選んだのに対し，『何をしたらいいのかわからない』と答えたものは1名と大幅に減少した (図2)。

3. AEDの使用

講習会前に，『AEDという言葉を今まで聞いたことがあるか』との問に，「はい」と答えたものは52名 (25.6%) であった。また『実際のAEDをどこかで見たことがあるか』との問に，「ある」と答えたものはわずか17名 (8.4%) であった。

『実際の心停止の現場でAEDがあれば使用してみようと思うか』という質問6に対して，講習会前に5の「思う」を選択したものはわずか17名(8.3%)，4を選択したものは21名 (10.3%) であった。講習会後にはそれぞれ162名 (79.8%) と27名 (13.3%) にまで増加していた (図3)。

前質問で5の「思う」以外を選択したものに対して尋ねた質問7の『AEDの使用をためらう理由は何か』については，講習会前は『正しく使えるか不安』と答えていたものが最も多く (180名中97名，53.9%)，『患者を傷つけないか不安』(27名，15%) が続いていた。講習会後は，『患者を傷つけないか不安』(39名中15名，38.5%)，『正しく使えるか不安』(11名，28.2%) であった。その他の回答として，『他に使える人がいれば任せる』があった (図4)。