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Clinical paper

Actual resuscitation actions after the training of chest compression-only CPR and AED use among new university students



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Abstract

Background: Although cardiopulmonary resuscitation (CPR) training is recommended in schools, there are few attempts to train all students at universities and no reports showing actual resuscitation actions at emergency settings after the training. We surveyed how many students encountered a collapsed person, whether they performed any resuscitation actions, and any reasons why they could not do any resuscitation actions.

Methods: We have provided chest compression-only CPR and automated external defibrillator (AED) use training for 3000 new university students every April since 2015 and followed up on their subsequent emergency actions to collapsed persons in the real world. We carried out a questionnaire survey for 2nd through 4th-year students during the annual student health checkup period in 2018.

Results: A total of 7595 students underwent the annual health checkup and 5549 of them (73.1%) responded to the survey. The rates of encountering collapsed persons and out-of-hospital cardiac arrest (OHCA) patients were 2.5 and 1.1 per 100 person-years, respectively. Of the 264 students who encountered a collapsed person, 82 (53.6%) who encountered non-OHCA collapsed persons and 54 (48.6%) who encountered OHCA persons performed at least one resuscitation action including either chest compression, AED use, or any other various resuscitation actions.

Conclusions: The incidence rate of encountering OHCA patients was 1.1 per 100 person-years and half of them who encountered a collapsed person performed at least one resuscitation action. Hands-on mass training would encourage university students to perform any resuscitation actions on the emergency scene.

Keywords: Cardiac arrest, Cardiopulmonary resuscitation (CPR), Mass training, Chest compression-only CPR, Education

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Introduction

Cardiopulmonary resuscitation (CPR) training plays a key role in increasing the occurrence of bystander CPR.^{1–4} As bystander CPR has been proven to increase survival after out-of-hospital cardiac arrests (OHCAs),^{5,6} municipal fire departments in Japan have provided a 3-h CPR training to about 1.4 million persons every year.⁷ However, still less than 50% of victims of OHCA receive CPR and only 5% of witness-cardiac arrest patients received shocks with automated external defibrillator (AED) by bystanders before the arrival of the emergency medical service (EMS) personnel.⁷

In order to increase bystander CPR and AED use, we need a strategic approach to train a large number of people in CPR and AED use with limited time and expenditure. To train more people in CPR and AED use, the Japanese resuscitation guidelines recommend chest compression-only CPR, which is easier to teach and learn in a shorter community-targeted training course.³ Teaching CPR in schools is a promising approach to covering the entire population.^{3,8,9} Many countries have started to provide CPR training to schoolchildren from junior high school to high school because schoolchildren are expected to be potential bystander CPR providers even after growing up.^{10–13} However, there are few attempts to spread CPR and AED use training in universities.

Importantly, the World Health Organization (WHO) regards universities, as well as junior high and high schools, as an appropriate infrastructure for health promotion to improve people's health and wellbeing.¹⁴ We expect that university students can be one of the most effective targets for acquiring CPR skills and can play a key role in spreading CPR and AED use in communities. Hence, at Kyoto University, we have conducted a 40-minute mass CPR training program called "PUSH training,"¹⁵ which includes chest compression-only CPR and AED use, for the entire cohort of approximately 3000 new undergraduate students, every year at the new students' orientation course since 2015.¹⁶

The effectiveness of CPR training has been evaluated by measuring willingness to perform CPR and CPR skills in the simulation settings.^{17–22} However, the actual actions and their performances in the real world have not been sufficiently evaluated because of the difficulty in collecting data.^{1,3} Thus, we surveyed how many students encountered a collapsed person, how many of the encounters took any resuscitation actions, and why onlookers could not take any resuscitation actions, in an actual emergency situation even though they had received the mass CPR training.

Methods

PUSH training for new students

Based on our previous study,¹⁵ we have carried out a 40-minute chest compression-only CPR and AED use mass training called "PUSH training" in the new students' orientation course at Kyoto University every April since 2015.¹⁶ This training was animated video-based and consisted of a lecture and practice covering the following contents: (1) emergency call and recognition of cardiac arrest, (2) chest compressions, and (3) AED use. Students practiced chest compressions and AED use using one CPR training kit named "Mr. PUSH" for every two students. Details of the PUSH training were previously

described.¹⁵ For the training, we divided approximately 3000 students into three groups according to their majors and further divided each group into four subgroups. One main instructor and some supporting instructors (one for every 20 students) were assigned to each subgroup.

Study design, setting and population

We conducted a questionnaire survey among the 2nd- through 4th-year 8852 undergraduate students of Kyoto University during the annual student health checkup period from April 9 through April 17 in 2018. Annual health checkups are mandatory for university students and the coverage is almost 90% every year at Kyoto University.

Questionnaire and data collection

The questionnaire was composed of two multiple-choice and seven single-choice questions about: (1) experiencing hands-on CPR training before entering university, (2) experiencing hands-on CPR training after entering university, (3) experiencing encountering a collapsed person after entering university, (4) relationship with a collapsed person, (5) presence of other persons in an emergency setting, (6) performance of chest compressions in an emergency setting, (7) use of an AED including powering on the AED, applying AED pads, and pushing the shock button in an emergency setting, (8) performance of any resuscitation action other than chest compression and AED use in an emergency setting, (9) reasons for not performing chest compression or not using AED in an emergency setting (multiple-choice), as well as the students' characteristics including age, gender, grade, and major. Collapse included sudden cardiac arrest and other situations requiring an ambulance call irrespective of pathologies. Other resuscitation actions were defined as checking the collapsed person, calling for emergency services, finding and/or delivering AED to the scene, and guiding the EMS personnel to the scene.

The questionnaire was distributed to all candidate students and then collected at the annual health checkup venue. We carefully explained the survey to attain the maximum response rate.

Statistical analysis

Data were summarized as numbers and percentages for categorical variables and means \pm standard deviations (SDs) for numerical variables. To describe the probability that students encounter a collapsed person within their university life, incidence rate was indicated as number of the events per 100 person-years. All analyses were performed using SPSS ver. 24.0J (IBM Corp. Armonk, NY).

Ethical considerations

All procedures were conducted according to the Declaration of Helsinki and the Ethical Guidelines for Medical and Health Research Involving Human Subjects of Japan. Based on the Ethical Guidelines, we individually obtained oral consent using an informed consent form. We also provided information about this study on the website of our research groups. Voluntary participation in the study and free withdrawal from the study was assured. This study was approved by the Ethics Committees of Kyoto University Graduate School of Medicine (Registration number R0706).

Results

Characteristics of students

A total of 8852 undergraduate students were eligible. Among them, 7595 underwent the annual health checkup and 5549 of them (73.1%) responded to the questionnaire survey. The characteristics of responding students are shown in Table 1. Among the respondents, 3842 (69.2%) had experienced hands-on CPR training before admission to the university; 432 (7.8%) at elementary schools, 1481 (26.7%) at junior high schools, 2628 (47.4%) at high schools, and 252 (4.6%) at all three of them.

Frequency of encountering collapsed persons after the training

A total of 264 (2215 s year, 1773 third year, 1561 fourth year) students (4.8%) encountered collapsed persons during the one-, two-, or three-year follow-up period (10,444 person-years). The rate was 2.5 per 100 person-years.

Excluding 165 students who met collapsed persons with no apparent cardiac arrest signs, the remaining 111 students encountered OHCA patients, the rate being 1.1 per 100 person-years.

Table 1 – Characteristics of the respondents to the questionnaire survey.

	n = 5549	
	n	%
Grade		
Second year	2215	39.9
Third year	1773	32.0
Fourth year	1561	28.1
Sex, male	4068	73.3
Age, year, mean (SD)	20.5 (1.5)	
Major		
Integrated human studies	240	4.3
Letters	455	8.2
Education	136	2.5
Law	682	12.3
Economics	389	7.0
Science	629	11.3
Medicine	248	4.5
Human health science	251	4.5
Pharmaceutical sciences	193	3.5
Engineering	1700	30.6
Agriculture	614	11.1
Experience in hands-on CPR training before admission to university ^a	3842	69.2
Elementary school	432	7.8
Junior high school	1,481	26.7
High school	2628	47.4
Out of class	396	7.1
Driving school	783	14.1
Other	72	1.3
Elementary school + junior high school + high school	255	4.6
Experience in hands-on CPR training after admission to university	3203	57.7

SD denotes standard deviation; CPR, cardiopulmonary resuscitation.

^a Multi-choice was allowed.

Experience of encounter with a collapsed person and performance of any resuscitation actions in an emergency setting

Table 2 shows the emergency situation and the students' resuscitation actions towards collapsed persons [either for a person not in cardiac arrest (non-OHCA persons) or in cardiac arrest (OHCA persons)], and reasons for not performing actions. Of the 264 students who encountered collapsed persons, 153 encountered non-OHCA persons and 111 encountered OHCA persons. Persons not in cardiac arrest were strangers 123 (80.4%) followed by friends or acquaintances 21 (13.7%) and family member 5 (3.3%) for the students. Persons in cardiac arrest were strangers 80 (72.1%) followed by friends or acquaintances 13 (11.7%) and family members 11 (9.9%) for the students.

Of the 264 students, 82 (53.6%) who encountered non-OHCA persons and 54 (48.6%) who encountered OHCA persons performed at least one resuscitation action including either chest compression, AED use, or any of other various resuscitation actions (e.g., checking response, 119 call, or AED delivery to the scene).

Of the 111 students who encountered OHCA persons, 17 (15.3%) performed chest compression and 15 (13.5%) used AED at the scene. As to performing other resuscitation actions (checking the collapsed person, calling for emergency services, finding and/or delivering AED to the scene, and guiding the EMS personnel to the scene) either instead of, or in addition to, chest compression and AED use, 82 (53.6%) of students those who encountered non-OHCA persons and 50 (45.0%) of those who encountered OHCA persons had done.

We also asked the students who did not perform chest compression about the reasons for not performing chest compression (n = 94). The most common cause cited by students was that another person had already performed chest compressions (51.0%). The remainder included panic (13.8%); difficulties in judging cardiac arrest (11.7%); lack of confidence (9.6%); fear of performing chest compression (9.6%); burden of taking responsibility for chest compression (6.4%); performing resuscitation actions other than chest compression (6.4%), and sex difference to the patient (3.2%).

The most frequent reason for not using an AED was AED use by others (35.4%) followed by difficulties in finding an AED (10.4%), performing resuscitation actions other than AED use (9.4%), and difficulties in judging AED applicability (8.3%). No one answered sex difference to the patient.

The most frequent reason for not performing other resuscitation actions either instead of, or in addition to, chest compression and AED was another person's preceding actions for both non-OHCA persons (84.5%) and OHCA persons (72.1%). For non-OHCA persons, no idea of what to do (7.0%), sex difference to the patient (4.2%), panic (2.8%) followed, but no one answered lack of confidence. For OHCA persons, by contrast, fear of attempting resuscitation actions (8.2%), burden of taking responsibility for attempting resuscitation actions (6.6%), panic (4.9%), and lack of confidence (3.3%) followed.

Discussion

We have provided chest compression-only CPR and AED use training for all 3000 new university students and surveyed their subsequent emergency actions toward collapsed persons in the real world. Using the opportunity provided by mandated health checkups, we achieved a high response rate (76.1%). We found that (1) the rate of encountering collapsed persons was 2.5 per 100 person-years; (2) that of encountering

Table 2 – Students' resuscitation actions towards collapsed persons in the emergency setting.

	Non-OHCA persons		OHCA persons	
	n = 153		n = 111	
	n	%	n	%
Students-collapsed person relationship				
Stranger	123	80.4	80	72.1
Friend or acquaintance	21	13.7	13	11.7
Family member	5	3.3	11	9.9
Others	1	0.7	2	1.8
No data	3	2.0	5	4.5
Presence of other persons in the emergency setting	138	90.2	100	90.1
Performed chest compression	–		17	15.3
Reasons for not performing chest compression ^a	–			
Another person had already performed chest compressions	–		48	51.0
Panic	–		13	13.8
Difficulties in judging cardiac arrest	–		11	11.7
Lack of confidence	–		9	9.6
Fear of chest compressions	–		9	9.6
Burden of responsibility for chest compression	–		6	6.4
Performed resuscitation actions other than chest compression	–		6	6.4
Sex differences between students and patient	–		3	3.2
No data	–		16	17.0
Used an AED	–		15	13.5
Reasons for not using an AED ^b	–			
Another person had already used AED	–		34	35.4
Difficulties in finding AED	–		10	10.4
Performed other resuscitation actions other than AED use	–		9	9.4
Difficulties in judging applicability of AED	–		8	8.3
Lack of confidence in AED use	–		7	7.3
Panic	–		6	6.3
Fear of AED use	–		5	5.2
Burden of responsibility for AED use	–		3	3.1
Sex differences between bystander and patient	–		0	0
No data	–		24	25.0
Performed other resuscitation actions either instead of, or in addition to, chest compression and AED use	82	53.6	50	45.0
Reasons for not performing other resuscitation actions ^c				
Another person had already started actions	60	84.5	44	72.1
No idea what to do	5	7.0	1	1.6
Sex differences between bystander and patient	3	4.2	1	1.6
Panic	2	2.8	3	4.9
Fear of attempting resuscitation actions	1	1.4	5	8.2
Burden of responsibility for resuscitation actions	1	1.4	4	6.6
Lack of confidence	0	0	2	3.3
No data	6	8.4	3	4.9

OHCA denotes out-of-hospital cardiac arrest; AED, automated external defibrillator.

^a Using data for those who encountered a OHCA person but did not perform chest compressions (n = 94). Multi-choice was allowed.

^b Using data for those who encountered a OHCA person but did not use AED (n = 96). Multi-choice was allowed.

^c Using data for those who encountered a collapsed person but did not perform other resuscitation actions (n = 71 in those who encountered a non-OHCA person; n = 61 in those who encountered a OHCA person in cardiac arrest). Multi-choice was allowed.

OHCA patients was 1.1 per 100 person-years; (3) 51.2% of the collapse encounters attempted at least one of the resuscitation actions including chest compressions, AED use, calling 119 and searching for an AED; (4) 15.3% of OHCA encounters performed chest compression and 13.5% used AED at the scene, among the university students.

The rate of encountering at least one OHCA patients of 1.1 per 100 person-years indicates that among 12,000 Kyoto University undergraduate students, more than a hundred students would meet one or more OHCA patient each year, in other words, one out of

25 students entering Kyoto University would encounter one or more OHCA patient during their 4-year undergraduate student life. Expanding on this, every student could be expected to meet an OHCA patient during his/her post-undergraduate life. In addition, since few data exist on the incidence of witnessing a cardiac arrest among the general public, the incidence rate of witnessing of OHCA would be useful to improve their awareness toward OHCA and CPR training even though this study was carried out for university students. Because general public are hardly able to imagine when they

encounter OHCA patient in their life, incident rate may provide them an opportunity to consider how likely they are to witness cardiac arrest. Encountering a collapsed person does not seem to be rare events, more detailed studies are required for evaluating the incidence rate of witnessing a cardiac arrest among the general public in other age groups or other areas/countries.

Our program would enable the students to overcome their barriers to initiating resuscitation actions. In this follow-up survey, less than 10% of students showed a diffident attitude to performing chest compression and using AED. Previous studies show that trainees without the experience of hands-on training rarely have the confidence to provide CPR in a time of emergency.²² Since hands-on training increases bystanders' self-efficacy and intention to perform CPR,^{23,24} students who attended the PUSH training could overcome this barrier and initiate a resuscitation action.

Our findings indicate a necessity to improve our training program. Among 111 students encountering OHCA patients, 94 did not perform chest compression and half of them made an excuse that another person had started a resuscitation action. These students did not fully understand the importance of cooperation in performing chest compressions. Since it is very difficult for a lay rescuer to continue high-quality chest compressions that are strongly associated with a higher chance of survival,^{25,26} he/she should be replaced by another before feeling fatigued.^{27,28} Thus, our study would reinforce the importance of participation in the resuscitation activities even if another bystander had already performed chest compressions. In addition, there are many operations at OHCA scenes. When witnessing someone collapse, he/she have to perform many processes such as checking patient's consciousness, calling 119, checking breathing, chest compression, AED bringing and operation, leading the paramedics to the scene, and so on. However, doing all resuscitation actions by oneself is impossible. Given these situations, our training program would reinforce the importance of participation in the resuscitation activities even if another bystander had already performed chest compressions. We therefore also emphasize that one should ask someone else to join CPR when doing chest compressions.

There are several limitations. First, we analyzed data on students' performances using a self-administered questionnaire, and no clinical data were involved. As we did not obtain data on patients' outcomes, the contribution of the students' resuscitation actions to the patients' outcomes is unknown. Future research is needed to determine whether our training program has beneficial effects on increasing bystander CPR or survival after OHCA. Second, since students are more likely to respond to the survey because performing CPR is socially desirable response (social desirability bias).^{29,30} This social desirability bias might let us overestimate their CPR actions. Third, the students' recall of emergency experiences would be potentially inaccurate. There is a need for an objective data collection method to measure students' performances in the future. Fourth, the true access to AED is a confounder and the AED location should be different by local settings. However, our study did not include detailed information regarding AED settings. Finally, since the intervention and analyses were derived from one highly academic university, our findings cannot be generalized.

Conclusion

Based on the survey for whole trained CPR university students, the incidence rate of encountering OHCA patients was 1.1 per

100 person-years and half of those who encountered a collapsed person performed at least one resuscitation action in the emergency setting. Hands-on mass training would encourage university students to perform any resuscitation actions on the emergency scene.

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Conflicts of interest

Taku Iwami is one of the developers of Mr.PUSH[®] and is an executive director of the non-profit organization Osaka Life Support Association, but has no financial conflict of interest to be declared. The other authors have no potential conflicts of interest to be disclosed.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.resuscitation.2019.05.040>.

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