

Resuscitation

Does the placement of automated external defibrillators affect first responders' willingness to perform cardiopulmonary resuscitation in high-rise residential buildings?

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Objective: The increasing number of people living in high-rise apartments may result in a delayed response from emergency medical technicians called out for an out-of-hospital cardiac arrest, making the role of apartment managers as the first responders extremely important. This study investigated whether automated external defibrillator (AED) placement influences the willingness of apartment managers to perform cardiopulmonary resuscitation (CPR) and use an AED.

Methods: A cross-sectional target population-based survey was conducted in Daegu, July 2016. Questionnaires were sent to apartment managers working in apartments with more than 500 households. The general characteristics of the respondents, status of CPR education, and knowledge about and willingness to perform CPR and use an AED were investigated.

Results: Of the 1,445 respondents, 758 (52.5%) worked in apartments with AEDs, of which 77.8% and 70.8% were willing to perform CPR and use an AED, respectively, compared with 68.1% and 60.0% of respondents who worked in apartments without AEDs. After adjusting for potential confounders, AED placement was associated with the willingness to perform CPR (odds ratio [OR], 1.33; 95% confidence interval [CI], 1.04-1.71) and use an AED (OR, 1.39; 95% CI, 1.10-1.75). Prior CPR training and accurate knowledge of CPR skills were also associated with the willingness to perform CPR and use an AED.

Conclusion: Placing AEDs in high-rise apartment buildings and providing refresher CPR education for maintaining CPR skills will be necessary to support apartment managers in their role as first responders.

Keywords: Cardiopulmonary resuscitation; Defibrillator; Emergency responders; Survey and questionnaires

INTRODUCTION

In Korea, the incidence rate of non-traumatic sudden out-of-hospital cardiac arrest (OHCA) is 45.1 per 100,000 people. The survival-to-discharge rate is 4.8%, which is lower than that in most developed countries.¹ Immediate bystander cardiopulmonary resuscitation (CPR) and early defibrillation are important in improv-

ing the survival rate of OHCA patients.² Previous studies have shown that the increase in the distribution of automated external defibrillators (AEDs) and the implementation of public access defibrillation (PAD) programs in the community are associated with the increased survival rate of OHCA patients.^{3,4} After the Emergency Medical Service Act of 2008 required the installation of AEDs in apartments with 500 or more households as well as publicly used facilities such as airports, railway stations,

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Capsule Summary

What is already known in the previous study

The increasing number of people living in high-rise apartments may result in a delayed response from emergency medical technicians called out for an out-of-hospital cardiac arrest, making the role of apartment managers as the first responders extremely important.

What is new in the current study

The present study identified the potential of apartment managers to act as first responders. Along with the activation system of the first responder from the dispatch center, automated external defibrillator (AED) dissemination in high-rise residential buildings and refresher cardiopulmonary resuscitation (CPR) education for maintaining accurate knowledge of CPR skills will be necessary to promote the efficient use of AEDs and support the role of apartment managers as first responders.

trains, ships, and public offices, the distribution of AEDs has been consistently increasing in Korea.⁵ According to the 2015 Emergency Medicine Statistical Annual Report from the National Emergency Medical Center of Korea, 24,407 AEDs have been distributed nationwide, which is equivalent to 47 AEDs per 100,000 people. However, contrary to the increasing number of AEDs, the actual public use of AEDs before the arrival of emergency medical services (EMS) is minimal in Korea. Studies conducted in the United States, Canada, the United Kingdom, and Denmark also revealed that the rate of defibrillation use before EMS arrival is below 3%.^{4,6,7}

In Korea, 54.2% of cardiac arrests occur every day, with the house as the major place of occurrence (53.8%).¹ South Korea is a nation with a high rate of living in apartments. According to Korean statistics, 48.1% of the residents in Korea live in apartments. A Canadian study reported that EMS response for patients who experienced cardiac arrest on or above the third floor of buildings was slower than that for patients who live below the third floors. The reported survival rate of those who live on or above the third floor was 2.6%, which is significantly different from the reported survival rate of 4.2% for those who live below the third floor.⁸ Therefore, considering the importance of AEDs, which are important in improving the survival rate

of cardiac arrest patients, a plan of action regarding the placement of AEDs and their active use in high-rise buildings is needed. In addition, to effectively use AEDs that are available in apartment buildings, the role of apartment managers as the first responders, whose main task is to transport AEDs installed in the apartment entrance to the household of the cardiac arrest patient, is crucial.

In 2016, the AED Program Implementation Project was conducted in Daegu Metropolitan City (DMC), which targeted apartments with 500 or more households as part of the plan to enhance the chain of survival in the city. A system was established to inform the apartment managers of the location of the cardiac arrest patients along with the nearby AED locations via a short message service (SMS) sent to the manager's mobile phone after an OHCA from an apartment was called by a 119 dispatcher. This preliminary research aimed to evaluate the baseline status of CPR knowledge and education, along with the apartment managers' willingness to perform CPR and use an AED according to AED placement.

METHODS

1. Study design and participants

We analyzed data from a cross-sectional target population-based survey in Daegu in July 2016. The study population consisted of apartment managers and security guards working in apartments with more than 500 households. The population in DMC was 2,487,829 in 2015. According to the official report, 336 apartment buildings contained more than 500 households in 2016, with an average of 18.9 employees in each apartment building. The survey was performed via mailing a structured questionnaire that evaluated the awareness, experience, and attitude toward CPR and AED. The official cooperation documents of the Public Health Division of Daegu were included to reduce the selection bias and improve the quality of the questionnaire response. The survey response rate was 22.7%. After excluding 72 questionnaires that were insufficiently answered, a total of 1,445 questionnaires were analysed. This study was approved by the Institutional Review Board of Kyungpook National University Hospital (KNUH 2016-06-006), and a signed informed consent was obtained from all participants via mail.

2. Questionnaire and variables

The questionnaire was designed to obtain the following data: (1) demographic data (i.e., sex and age of the manager); (2) data regarding awareness, attitude, and willingness to perform CPR (five questions); (3) data regarding CPR skills (three questions) and awareness of dispatcher-assisted CPR (DA-CPR) and the Good Samaritan Law (two questions); (4) data regarding prior CPR training experience (i.e., training type, last training time, and number of training sessions attended) (five questions); and (5) data regarding awareness and willingness to use an AED (five questions) (Appendix 1).

The outcome variables of interest were willingness to perform CPR and use AEDs. Questions related to the awareness of CPR methods and confidence in performing CPR were assessed using a five-point scale (1, not at all; 5, very likely). Results were divided into two categories for analysis: ≤ 3 points and ≥ 4 points. When a respondent correctly answered three questions about chest compression, then he/she was considered to have correct knowledge of CPR skills.

3. Statistical analyses

Apartment managers and security guards working in apartments with more than 500 households were divided into two groups (AED placement and AED non-placement groups) according to whether an AED was installed in their workplace. Pearson's chi-square and extended Mantel-Haenszel chi-square for linear trend tests were carried out to assess the significance of the differences between the two groups. To examine the association of AED placement and outcomes, logistic regression analysis was used. In general characteristics, the distribution of sex and age is different between the two groups according to AED placement. Confidence in performing CPR, awareness of the Good Samaritan Law and DA-CPR, and knowledge of AED use are factors influenced by CPR training experience. The status of CPR training has been confounded with correct knowledge of CPR skills and prior CPR training, so we have controlled these variables as representative variables related to CPR training experience. We included potential confounding variables such as age, sex, correct knowledge of CPR skills and prior CPR training. The results are expressed as odds ratios (ORs) and 95% confidence intervals (CIs).

All statistical tests were conducted using IBM SPSS Statistics for Windows ver. 22.0 (IBM Corp., Armonk, NY, USA), and P-values of <0.05 were considered statistically significant.

RESULTS

1. Comparison of respondent characteristics and their awareness and willingness to perform CPR and use AEDs in apartment buildings with and without AEDs

Among the respondents who were classified under the AED placement and non-placement groups, 87.5% (663/758) and 81.2% (558/687), respectively, were men. No difference was observed in the distributions of age between the two groups. A higher number of respondents knew how to perform CPR in the AED placement group compared to the AED non-placement group. Among the respondents with AED placement in their workplace, 47.4% (359/758) and 60.7% (460/758) were aware of the Good Samaritan Law and DA-CPR. In the AED non-placement group, 33.3% (229/687) and 44.5% (306/687) were knowledgeable about the Good Samaritan Law and DA-CPR, respectively. The proportion of respondents who felt confident in performing CPR and those who had CPR training was higher in the AED placement group. Significant differences were observed between the two groups in terms of the willingness to perform CPR and use AEDs (Table 1).

2. Comparison of prior CPR training and AED placement

A total of 969 respondents had attended CPR education sessions at least once. Of these, 84% (814/969) indicated that they had also attended practical education sessions. Significant differences were observed between the AED placement and non-placement groups in terms of interval from the last CPR training and AED training. The proportion of respondents who had CPR training within 1 year was higher in the AED placement group. Among the respondents in the AED placement group and non-placement group, 62.1% (352/567) and 50.8% (204/402), respectively, reported that AED training was included in their CPR education (Table 2).

3. Subgroup analyses according to prior CPR training

Fig. 1 shows the results of subgroup analyses according to prior CPR training. Differences were observed in the percentages of persons who were willing to perform CPR and use an AED according to the status of AED placement in the prior CPR training group. The positive response rates of willingness to perform CPR and to use an AED were 83.8% (480/573) and 77.8% (446/573), respectively among those who had CPR training along with AED placement. Moreover, 77.4% (312/403) and 70.2% (283/403) of the respondents living in apartments

without an AED in the prior CPR training group were willing to perform CPR and use an AED, respectively.

4. Factors associated with performing CPR and AED use

AED placement was associated with the willingness to perform CPR (OR, 1.64; 95% CI, 1.30-2.08) and to use an AED (OR, 1.86; 95% CI, 1.32-2.64). After adjustment for potential confounders, AED placement was still associated with the willingness to perform CPR (OR, 1.33; 95% CI, 1.04-1.71) and to use an AED (OR, 1.39;

Table 1. General characteristics and differences according to AED placement

Characteristic	Total (n=1,445)	Group with AED placement (n=758)	Group without AED placement (n=687)	P-value
Sex				
Male	1,221	663 (87.5)	558 (81.2)	0.001
Female	224	95 (12.5)	129 (18.8)	
Age (yr)				
<60	775	394 (52.0)	381 (55.5)	0.185
≥60	670	364 (48.0)	306 (44.5)	
Awareness of how to perform CPR				
Yes	725	403 (53.2)	322 (46.9)	0.017
No	720	355 (46.8)	365 (53.1)	
Awareness of the Good Samaritan Law				
Yes	588	359 (47.4)	229 (33.3)	<0.001
No	857	399 (52.6)	458 (66.7)	
Awareness of DA-CPR				
Yes	766	460 (60.7)	306 (44.5)	<0.001
No	679	298 (39.3)	381 (55.5)	
Confidence in performing CPR				
Yes	264	164 (21.6)	100 (14.6)	0.001
No	1,181	594 (78.4)	587 (85.4)	
Correct knowledge of CPR				
Yes	268	153 (20.2)	115 (16.7)	0.092
No	1,177	605 (79.8)	572 (83.3)	
Knowledge of AED use				
Yes	481	376 (49.6)	105 (15.3)	<0.001
No	964	382 (50.4)	582 (84.7)	
Prior CPR training				
Yes	969	567 (74.8)	402 (58.5)	<0.001
No	476	191 (25.2)	285 (41.5)	
Willingness to perform CPR				
Yes	1,058	590 (77.8)	468 (68.1)	<0.001
No	387	168 (22.2)	219 (31.9)	
Willingness to use an AED				
Yes	949	537 (70.8)	412 (60.0)	<0.001
No	496	221 (29.2)	275 (40.0)	

Values are presented as number (%).

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation.

95% CI, 1.10-1.75) (Table 3). Prior CPR training and accurate knowledge of CPR skills were also associated with the willingness to perform CPR and use an AED.

DISCUSSION

In this study, 73.2% of respondents (1,058/1,445) were willing to perform CPR. Our results indicate that AED placement was associated with apartment managers' willingness to perform CPR and use AEDs. Prior CPR training was also an important factor related to willingness to perform CPR and use AEDs. Previous studies have assessed data from nationwide community surveys, regional community surveys, and surveys on CPR recognition and attitude among students and teachers.⁹⁻¹² However, to the best of our knowledge, no studies or

surveys have included apartment managers. Thus, the present study identified the potential of apartment managers to act as first responders. Furthermore, their willingness to perform CPR and use AEDs according to AED placement was assessed.

Early defibrillation is a key factor in the chain of survival of patients who experience cardiac arrest. In addition, minimizing the time-to-shock interval is a crucial step in improving survival rates.¹³ The public use of AEDs has been permitted in Japan since 2004. Since then, the number of AEDs used has significantly increased to more than 500,000 nationwide in 2013.¹⁴ Furthermore, the time of the administration of the first shock was reduced by the nationwide dissemination of PAD, which in turn improved the OHCA survival rate.³

The deployment of CPR-and-AED-educated volunteers and CPR-only-educated volunteers in public facili-

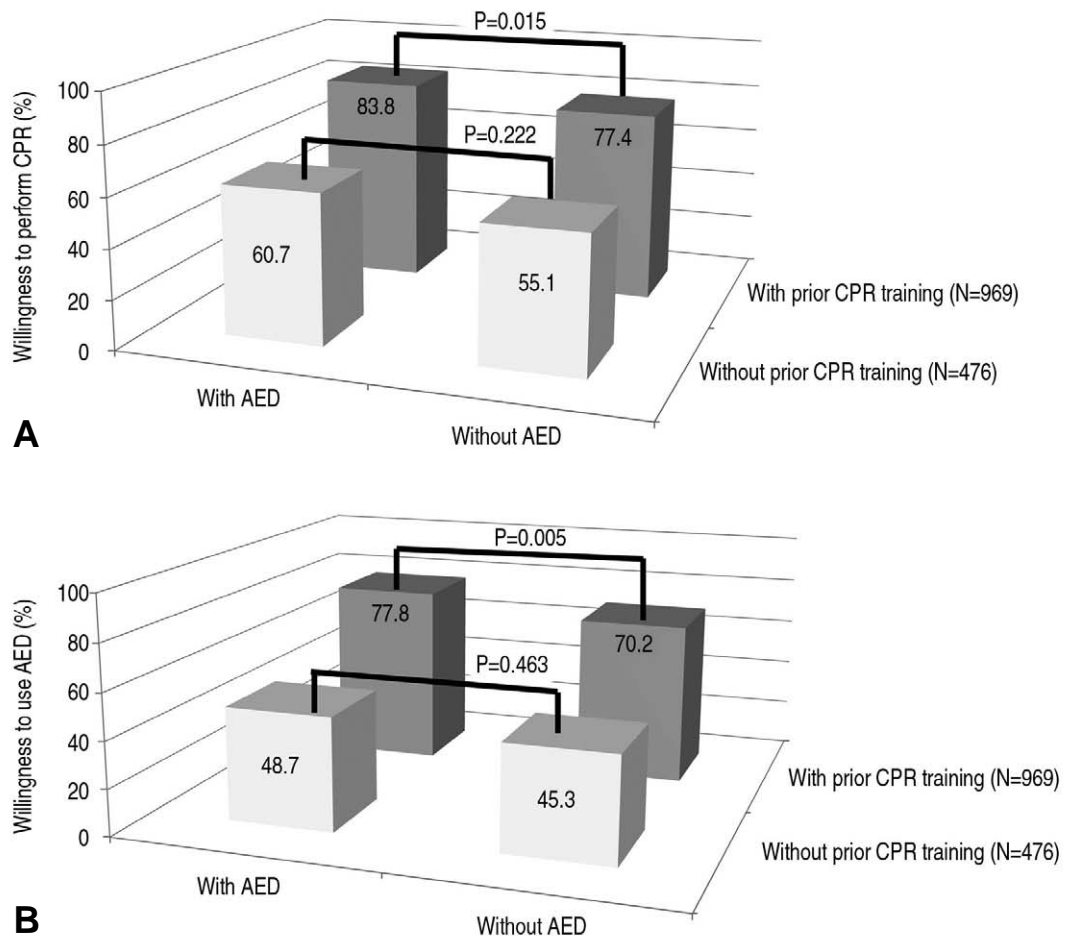


Fig. 1. Association of willingness to perform cardiopulmonary resuscitation (CPR) (A) and use an automated external defibrillator (AED) (B) according to AED placement and prior CPR training. Apartment managers and security guards working in apartments with more than 500 households were divided into two groups (with or without AED) according to whether or not an AED was installed in their workplace.

ties, such as shopping malls, recreational centres, hotels, and apartment complexes, resulted in a significant improvement in the survival-to-hospital-discharge rates.¹⁵ This result showed the importance of AED placement and PAD program implementation, which may improve the survival-to-hospital-discharge rates. Previous studies have suggested the efficacy not only of the widespread placement of AEDs but also their strategic placement along with its linkage to a dispatch center.^{3,16-18} Moreover, the bystander CPR and survival discharge rates of OHCA patients increased due to the

use of an EMS system-linked text message notification system by the volunteers.^{19,20}

Since 2007, efforts have been made to improve the public recognition of CPR and AEDs in Korea. Public CPR education is conducted on a large scale, and those subjected to mandatory education by the Emergency Medical Service Act were required to receive CPR education. In 2008, the Good Samaritan Law was legislated to improve bystander rates and to increase the distribution of AEDs. AED installation was required not only in public facilities but also in apartments with 500 or more

Table 2. Differences in CPR training experience of the study participants

	Total (n=969)	Group with AED placement (n=567)	Group without AED placement (n=402)	P-value
Type of CPR education				
Didactic only	155	88 (15.5)	67 (16.7)	0.632
Didactic along with hands-on practice	814	479 (84.5)	335 (83.3)	
Total No. of CPR education sessions attended				
1	410	234 (41.3)	176 (43.8)	0.401
2	316	192 (33.9)	124 (30.9)	
3	134	69 (12.2)	65 (16.2)	
4 or more	109	72 (12.7)	37 (9.2)	
Interval from the last CPR education session				
≤ 6 mo	298	194 (34.2)	104 (25.9)	0.001
6 mo to 1 yr	289	178 (31.4)	111 (27.6)	
1 to 2 yr	171	82 (14.5)	89 (22.1)	
2 to 5 yr	111	62 (10.9)	49 (12.2)	
≥ 5 yr	100	51 (9.0)	49 (12.2)	
AED training included in CPR education				
Yes	556	352 (62.1)	204 (50.8)	<0.001
No	413	215 (37.9)	198 (49.2)	

Values are presented as number (%).

CPR, cardiopulmonary resuscitation; AED, automated external defibrillator.

Table 3. Factors related to the willingness regarding CPR and AED use

Predictor	Willingness to perform CPR		Willingness to use an AED	
	Crude OR (95% CI)	Adjusted OR ^{a)} (95% CI)	Crude OR (95% CI)	Adjusted OR ^{a)} (95% CI)
AED placement	1.64 (1.30-2.08)	1.33 (1.04-1.71)	1.86 (1.32-2.64)	1.39 (1.10-1.75)
Male sex		1.92 (1.38-2.67)		1.30 (0.94-1.81)
Age (<60 yr)		0.86 (0.66-1.12)		1.78 (1.39-2.27)
Correct knowledge of CPR skills		2.13 (1.47-3.09)		1.60 (1.15-2.22)
Prior CPR training		2.78 (2.16-3.59)		2.90 (2.28-3.69)

CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; OR, odds ratio; CI, confidence interval.

^{a)} Adjusted for AED placement, sex, age, correct knowledge of CPR skills, prior CPR training.

households.⁵ The role of apartment managers is imperative for the (1) efficient use of AEDs placed in apartments through the AED Program Implementation Project and (2) the successful application of the 119 dispatch center-linked SMS notification system, which informs apartment managers of the location of the individual and AEDs in the event of a reported OHCA in an apartment.

In this study, significant differences were observed between the AED placement and non-placement groups in terms of CPR confidence and prior training experience. In a previous study, the confidence of a layperson in performing CPR is influenced by awareness of the neighborhood AED location, having prior CPR training, and having performed CPR.²¹ Similarly, this study shows a higher confidence for performing CPR in the AED placement group. Furthermore, significant differences were observed between the AED placement and non-placement groups regarding awareness of the Good Samaritan Law and DA-CPR. The difference in awareness of the Good Samaritan Law and DA-CPR seemed to be influenced by prior CPR training experience. The proportion of AED training included in CPR education was higher in the AED placement group. It is possible that the AED installation company provided instruction on how to use an AED during its installation.

In the 2012 survey of the general population of Daegu citizens, 57.3% of the respondents were willing to perform CPR, which differs from the 77.8% of the AED placement group found in this study.²² Kuramoto et al.¹² noted that the recognition of AED placement in public places is not directly associated with a willingness to perform CPR but influences the CPR training experience of a layperson. Similar findings were observed in the present study of the specific population group that could act as first responders in cases of OHCA. The AED placement group had the latest CPR training. Furthermore, AED placement was associated with the willingness to perform CPR and use an AED based on the multivariable analysis. A previous study concluded that CPR training affects the willingness to perform CPR.²³ However, in the 2015 survey conducted in a nationwide general population, there was no association between willingness to perform CPR for strangers and prior CPR training experience.²⁴ In the present study, prior CPR training was associated with a willingness to perform CPR and use an AED. Moreover, accurate

knowledge of CPR skills also affected the willingness to perform CPR and use an AED. Differences in the baseline characteristics of the general population and apartment managers and prior CPR training experience may have affected these results. In this study, age under 60 years was associated with a willingness to use an AED. This seems to be the result of younger people learning to use the device more easily and having more confidence in using newer devices than older people.

Surprisingly, among the employees of apartments with AED placement, only 70.9% were aware of the AED locations. Therefore, for apartment managers who will act as the first responders, the importance of AED should be emphasized during CPR training to increase their interest and willingness to use an AED. Previous studies involving laypersons report that it is difficult to maintain CPR skills for more than 1 year.^{25,26} Based on the results of the present study, consistent CPR education of apartment managers should be conducted to maintain adequate CPR knowledge along with their willingness to use an AED. The efficient use of AEDs will require the establishment of a linkage system with the local EMS (i.e., SMS alert system or DA-CPR) and the inclusion of DA-CPR in CPR education programs.

This study has several limitations. First, the retrieval rate was approximately 22.7%. Selection bias may be present owing to the limited number of respondents who were not aware or interested in CPR. In addition, the present study involved a specific population, and it does not represent the whole community population. Therefore, the results of this survey may be difficult to generalize to the community population. Nevertheless, the feasibility of the apartment managers' role as first responders during OHCA must be confirmed. Second, the actual competence and performance of CPR and willingness to use an AED in the event of real cardiac arrest situations may differ from the survey responses. Third, the time since the most recent CPR training, the number of CPR training sessions, and the CPR training methods depended on the respondents' memory and may be subject to recall bias, which may have affected the results. Fourth, the apartment manager did not distinguish whether he or she had undergone firefighting safety education in the questionnaire. Also, the questionnaire did not include the impact of the AED installation on prior CPR training. These differences cannot be reflected in this study.

Although the retrieval rate was only 22.7%, 73.2% of the respondents (1,058/1,445) were willing to perform CPR. Therefore, we identified the potential of apartment managers to act as first responders. AED placement was associated with the willingness to perform CPR and use an AED among the apartment managers in this study. Furthermore, prior CPR training and accurate knowledge of CPR skills were associated with the willingness to perform CPR and use an AED. Therefore, along with the activation system of first responders from the dispatch center, AED dissemination in high-rise residential buildings and refresher CPR education for maintaining accurate knowledge of CPR skills are necessary to promote the efficient use of AEDs and support the role of apartment managers as first responders.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Appendix 1. Questionnaires

Sex:

Age:

1. Do you know what CPR is?
(a) Yes (b) No
2. Do you know how to perform CPR?
(a) Do not know at all
(b) Know little
(c) So-so
(d) Well
(e) Very well
3. Do you have confidence in performing CPR?
(a) Do not have at all
(b) Have little confidence
(c) So-so
(d) Have some confidence
(e) Very confident
4. Where is the correct site of the chest compression?
(a)–(e) (shown in picture)
(f) Have no idea
5. What is the correct chest compression rate per minute during CPR?
(a) 60–70 (b) 70–80 (c) 80–90 (d) 90–100 (e) 100–120 (f) Have no idea.
6. What is the correct chest compression depth during CPR in adult?
(a) About 2 cm
(b) About 3 cm
(c) About 4 cm
(d) About 5 cm
(e) Over 6 cm
(f) Have no idea
7. Do you know the Good Samaritan Law?
(a) Yes (b) No
8. Do you know about “dispatcher-assisted CPR,” in which you can call 119 when a cardiac arrest occurs?
(a) Yes (b) No
9. Will you be able to recognize if a sudden cardiac arrest occurs in the apartment in which you are employed?
(a) Yes (b) No

10. Are you willing to perform CPR for cardiac arrest patients in your workplace?
(a) Yes (b) No
11. Is an AED installed in your working apartment?
(a) Yes (Proceed to question 12)
(b) No (Proceed to question 13)
(c) Have no idea (Proceed to question 13)
12. Do you know where the AEDs are placed?
(a) Yes (b) No
13. How much do you know about AEDs?
(a) Know the name and how to use them
(b) Know only the name but not how to use them
(c) Do not know at all
14. Do you know AED installation is required by law for apartments over 500 households?
(a) Yes (b) No
15. Are you willing to use AEDs for cardiac arrest patients?
(a) Yes (b) No
16. Have you ever been trained in CPR?
(a) Yes (Proceed to question 17)
(b) No (End)
- 17-1. Did your CPR training include hands-on training?
(a) Yes (b) No
- 17-2. How many times have you received CPR training?
(a) Once
(b) Twice
(c) Three times
(d) Four times or more
- 17-3. When was the last time you attended CPR training?
(a) Within 6 months
(b) 6 months-1 year
(c) 1-2 years
(d) 2-5 years
(e) Over 5 years
- 17-4. Did you use AEDs in the CPR training course?
(a) Yes (b) No