演題名：

The Report from The Japanese Registry of CPR for In-hospital Cardiac Arrest (J-RCPR)

抄録本文：

[Backgrounds] In-hospital cardiopulmonary arrest (CPA) is an important matter and National Registry of Cardiopulmonary Resuscitation (NRCPR) from the United States reported that the rate of survival of hospital discharge following CPA was 18%. However, limited data are available in-hospital CPA in Japan.[Methods] Major pre−cardiac arrest and event, therapeutic interventions and time intervals and the data about condition of patients finally confirmed alive before CPA were collected. The patients with in-hospital CPA were registered prospectively from 11 hospitals, during January 2008 to December 2009 in Japan. All patients, visitors, employees, and staff within the facility campus, who experience a cardiopulmonary resuscitation event defined as either a pulselessness or a pulse with
inadequate perfusion requiring chest compressions and/or defibrillation of ventricular fibrillation or pulseless ventricular tachycardia were registered with J-RCPR.[Results] 490 adults (71.0±14.9, M/F 310/180) enrolled. The prevalence of VF/VT as first documented rhythm was 28.3%, asystole was 30.0% and PEA was 41.7%. ROSC (return of spontaneous contraction) was 64.7%, rates of survival on 24 hr after CPA was 50.2%, and rates of good neurological out come at 30 days after CPA was 21.4%. These prognosis of in-hospital CPA were similar as the report from NRCPR. Immediate cause(s) of event were arrhythmia 31.0%, hypotension 15.9%, and acute respiratory insufficiency 26.3%. 67.1% of the patients were confirmed alive within 10 min before CPA, 53.9% of the patients were monitored and 78.
0% of the patients were witnessed at CPA. [Conclusion] This is the first report of in-hospital CPA in Japan. These results were similar as the results reported from NRCPR in the United States.

疫学学会

全国の救急医療機関からの搬送時間と循環器死亡率の関連:地理的要因の検討

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目的:急性心筋梗塞症や脳卒中発症時に高度医療を時間の遅延なく効果的に提供できる救急医療システム構築が必要である。そこで、全国の循環器疾患による死亡状況を把握し、救急医療機関からの距離・時間の情報をあわせて分析し、急性期医療システムのあり方を検討する。
方法:エコロジカル研究。市区町村別死因別死亡率は、厚生労働省人口動態死亡調査のデータを用いた。実際の救急搬送の距離と搬送時間を収集するのは困難であるため、全国の循環器救急二次施設を特定し、施設と市区町村役場との距離を地図上で計測する方法を用いた。性年齢調整死亡率(SMR)、搬送時間、および両者の関連について記述、市区町村別地図に示した。
結果:特定した循環器救急二次施設は、全国で 1998 施設であり、都市部に集中していた。搬送時間の分布は、中央値:13 分、25%点:4 分、75%点:32 分であり、施設の分布と対応し、施設の少ない地域の時間が長かった。73%の市区町村が 30 分以内であった。 心疾患(高血圧以外)の SMR と搬送時間の関係では、東北や北海道、中国、四国、和歌山などの山間部や半島の先端に、SMR が高く搬送時間が長い地域が認められた。また、脳血管障害の SMR と搬送時間の関係は心疾患と類似していた。
考察:心疾患と脳血管障害について、搬送時間と SMR の関係を全国レベルで評価した。その結果、SMR が高く搬送時間が長い地域が明らかになった。施設の分布が都市部に集中していることから、施設までのアクセスに大きな違いがあり、そのアクセスの不便さが SMR の違いつながっている可能性が示唆された。ただし、本研究はエコロジカル研究のためバイアスの影響の可能性があり、個人レベルのデータでの評価が今後必要である。

Ⅶ. 業績集

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Simulation and education

Quality of chest compressions during continuous CPR; comparison between chest compression-only CPR and conventional CPR☆

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ABSTRACT

Objectives: This study aimed to compare the time-dependent deterioration of chest compressions between chest compression-only cardiopulmonary resuscitation (CPR) and conventional CPR.
Methods: This study involved 106 and 107 participants randomly assigned to chest compression-only CPR training and conventional CPR training, respectively. Immediately after training, participants were asked to perform CPR for 2 min and the quality of their CPR skills were evaluated. The number of chest compressions in total and those with appropriate depth were counted every 20-s CPR period from the start of CPR. The primary outcome was the CPR quality index calculated as the proportion of chest compressions with appropriate depth among total chest compressions.
Results: The total number of chest compressions remained stable over time both in the chest compression-only and the conventional CPR groups. The CPR quality index, however, decreased from 86.6 ± 25.0 to 58.2 ± 36.9 in the chest compression-only CPR group from 0–20 s through 61–80 s. The reduction was greater than in the conventional CPR group (85.9 ± 25.5 to 74.3 ± 34.0). The difference in the CPR quality index reached statistical significance ($p = 0.003$) at 61–80 s period.
Conclusions: Chest compressions with appropriate depth decreased more rapidly during chest compression-only CPR than conventional CPR. We recommend that CPR providers change their roles every 1 min to maintain the quality of chest compressions during chest compression-only CPR. (UMIN-CTR C0000000321)

1. Introduction

Bystander-initiated cardiopulmonary resuscitation (CPR) plays a major role in the chain of survival to save cardiac arrest victims.[1] Recently, chest compression-only CPR without ventilations, has been advocated as the alternative to chest compression plus rescue breathing resuscitation (conventional CPR).[2–7] Chest compression-only CPR is attractive because not only can it deliver a greater number of chest compressions without interruption but also it is simpler and easier to learn and perform CPR than conventional CPR.[8] We demonstrated that people who attended chest compression-only CPR training programs performed better chest compressions than those who attended conventional CPR training programs in a randomized controlled trial.[9]

The quality of chest compressions has been recognized as a key determinant of successful CPR and the importance of continuous chest compressions with adequate depth is emphasized.[1] Major concern is that the rescuer's fatigue might deteriorate the quality of CPR during continuous chest compressions.[10,11] Some study showed that the quality of chest compression declines over time during chest compression-only CPR and conventional CPR, but in these studies experimental conditions were insufficient.[10–13] This study aimed to compare the time-dependent deterioration of chest compressions between the two types of CPR as an additional analysis in our abovementioned study.[9]

2. Methods

2.1. Study design and participants

This study was designed as a randomized controlled trial (RCT) and the details are shown in our previous report.[9] Briefly, volunteers aged 18 years or more were recruited from the general

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Table 1
Baseline characteristics of participants.

	Chest compression-only CPR (*n* = 106)	Conventional CPR (*n* = 107)	*p*-value
Men, *n* (%)	55(51.9)	56(52.3)	0.528
Age, year, means ± SD	38.7 ± 20.0	38.1 ± 14.5	0.780
Previous CPR training, *n* (%)	42(39.6)	47(43.9)	0.309
Experience of actual CPR, *n* (%)	4(3.8)	2(1.9)	0.337
Family history of sudden cardiac death, *n* (%)	3(2.8)	7(6.5)	0.170

CPR denotes cardiopulmonary resuscitation.

public (December 2005 through July 2006) and randomly assigned to either the chest compression-only CPR group or the conventional CPR (30:2) group with stratification by sex and age (<40 or ≥40 years) using permuted blocks. Health care professionals or medical/co-medical students were excluded from this study.

A total of 223 participants were enrolled, 112 of whom underwent a 120-min training program consisting of continuous chest compressions and an automated external defibrillator (AED) operation. The remaining 111 were given with a 180-min training program consisting of chest compressions, ventilations, and an AED operation based on the 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care (chest compression/ventilation ratio of 30:2). Mean age of participants was 38 years, and 52% were men.

2.2. Data collection

After the training and a short break, we evaluated participants' resuscitation skills 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." We gave the same scenario for all participants and evaluated their CPR skills. After presentation of the scenario, we evaluated their CPR skills including initial assessment, calling for 119 (emergency call number in Japan), chest compressions, and ventilations (for the conventional CPR group) for 2 min. The data on CPR skills were collected automatically by use of Laerdal Resusci Anne PC Skillreporting Manikin System® (Laerdal Medical, Stavanger, Norway).

2.3. Measure quality of chest compression

We counted the number of chest compressions in total and those with appropriate depth during every 20-s CPR period from the start of CPR (i.e., start of chest compressions in the chest compression-only CPR group and either start of ventilations or chest compressions in the conventional CPR group). The primary outcome of this analysis was CPR quality index calculated as the proportion of chest compressions with appropriate depth among the total chest compressions during every 20-s CPR period. The appropriate depth was defined as 3.5–5.5 cm according to the Japanese CPR guideline.[14] We also evaluated the number of chest compressions, time to CPR, and no-flow time.

2.4. Statistical methods

Analyses were performed on an intention-to-treat basis. The data were compared across groups using chi-square test for categorical variables and Student's *t*-test for continuous variables. Analyses were performed using SPSS Ver.12 (SPSS, Inc., Chicago, IL). A two-tailed value of $p < 0.05$ was considered statistically significant.

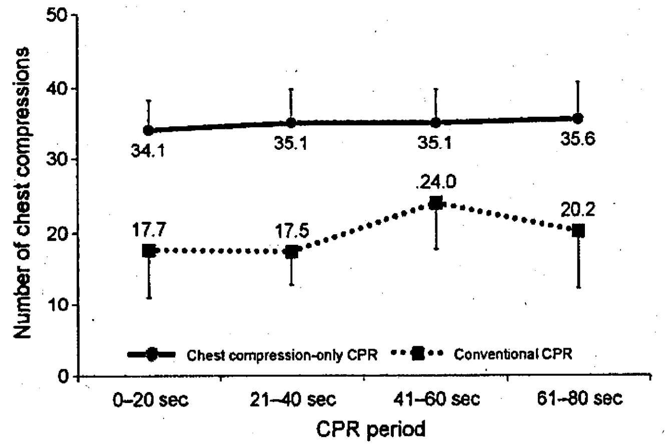

Fig. 1. Number of chest compressions during every 20-s CPR period of chest compression-only CPR and conventional CPR. Error bar indicates standard deviation.

2.5. Ethical considerations

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

3. Results

3.1. Baseline characteristics

In this RCT, 6 participants assigned to the chest compression-only CPR group and 4 to the conventional CPR group were absent from training because of urgent business or poor physical condition. Therefore, the remaining 106 participants in the chest compression-only CPR group and 107 participants in the conventional CPR group were evaluated for their CPR skills. Baseline characteristics of the two groups are shown in Table 1. There were no significant differences in age, sex ratio, previous CPR training, experience of actual CPR, and family history of sudden cardiac arrest between the groups.

3.2. Decline in quality of chest compressions over time

Fig. 1 illustrates the time-course of the number of chest compressions. The numbers were 34.1 ± 4.2, 35.1 ± 4.7, 35.1 ± 4.7 and 35.6 ± 5.1 in the chest compression-only CPR group and 17.7 ± 6.7, 17.5 ± 4.7, 24.0 ± 6.2 and 20.2 ± 7.9 in the conventional CPR group during 0–20, 21–40, 41–60 and 61–80 s, respectively. The numbers of chest compressions remained stable in both groups, but they were greater in the chest compression-only CPR group than in the conventional CPR group at any CPR period.

Fig. 2 shows the chronological change in the quality of CPR. The quality index gradually decreased from 86.6 ± 25.0 (0–20 s) to 58.2 ± 36.9 (61–80 s) in the chest compression-only CPR group and from 85.9 ± 25.5 (0–20 s) to 74.3 ± 34.0 (61–80 s) in the conven-

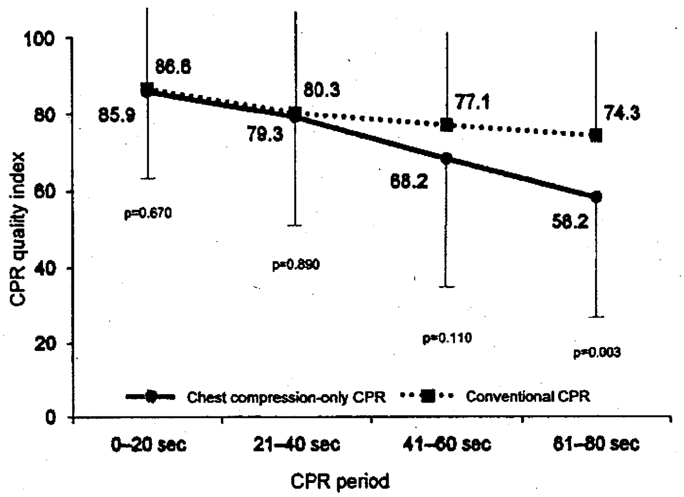

Fig. 2. CPR quality index, the proportion of chest compressions with appropriate depth among the total chest compressions during 20-s CPR period, for chest compression-only CPR and conventional CPR. Error bar indicates standard deviation.

tional CPR group over time. The decay of CPR was greater during the chest compression-only CPR, and the intergroup difference in the CPR quality index increased, reaching statistical significance at 61–80 s period ($p = 0.003$).

3.3. Interruption of chest compressions during 2-min CPR

Time to the first resuscitation (either chest compression or ventilation) was 32.0 ± 8.0 s and 35.0 ± 9.0 s in the chest compression-only CPR group and in the conventional CPR group, respectively ($p = 0.005$). No-flow time was 32.0 ± 9.0 s and 81.0 ± 10.0 s in the chest compression-only CPR group and the conventional CPR group, respectively ($p < 0.001$).

4. Discussion

To our knowledge, this is the first RCT indicating a difference in the time-dependent deterioration of chest compressions between chest compression-only CPR and conventional CPR with compression/ventilation ratio of 30:2. It demonstrated that the quality of chest compressions declined more rapidly in chest compression-only CPR than in conventional CPR and the difference reached statistical significance 1 min after start of CPR. Previous studies evaluating the influence of rescuer fatigue on the quality of chest compressions had some weak points including the non-controlled study design, biased participants such as medical students,[12] and no CPR training before skills evaluation.[13] In the latter study, it is not clear whether their fatigue or lack of CPR knowledge skills hindered their CPR performance, because their CPR were evaluated without prior CPR training. In addition, they compared chest compression-only CPR with the conventional CPR with compression/ventilation ratio of 15:2.[12] Hence, our study provided valid and updated evidence on the time-dependent CPR deterioration.

Although the number of total chest compressions did not change over time, the percentage of correct compressions with sufficient depth was gradually reduced with ongoing resuscitation as previously reported.[12,15,16] Most plausible explanation of this quality deterioration is the cumulative fatigue resulting from continuous chest compressions.[1,10,11,15] One clinical study evaluating actual in-hospital resuscitation also found time-dependent deterioration of chest compression by rescuer's fatigue.[17] This inference was already confirmed by some studies using physiological markers such as heart rate, oxygen saturation by pulse oximetry, blood lactate concentration, and neuromuscular function.[18–21] In these reports, physical fitness may be beneficial to CPR providers to ensure the adequacy of chest compressions during CPR.[10,16,18–21] In the conventional CPR, longer hands-off time caused by ventilations might serve as a rest and result in a recovery from fatigue.

The 2005 American Heart Association guidelines for CPR and emergency cardiovascular care recommend that rescuers change their chest compressions every 2 min during conventional CPR,[1] but it does not refer to a change during chest compression-only CPR due to insufficient evidence. Rescuers generally do not become aware when their fatigue-induced compression impairment begins.[11] Unless the rescuer complains of fatigue, he/she should be replaced with others in order to maintain the quality of chest compressions. According to the findings of this study, we recommend that rescuers should change their roles in CPR every 1 min for chest compression-only CPR.

Even if chest compression-only CPR has the drawback of easy fatigability, much larger numbers of chest compressions during 2-min CPR than the conventional CPR[8,9] would amply compensate for this weakness. It is simpler, easier to learn and perform[8,9] and is expected to increase the number of lay people who could perform bystander-initiated CPR.[9,22] Bearing these features in mind, we should disseminate chest compression-only CPR in order to increase bystander CPR and improve survival after OHCA.

This study has some limitations. First, we did not measure the intermediate factors that lowered the quality of CPR and could not thoroughly infer the biological mechanism of chest compression decay. Second, the resuscitation skills were evaluated by a case-based scenario test and actual resuscitation performances were unknown. Third, although rescuers' characteristics such as gender, height, and weight also would influence the quality of chest compressions,[10] we did not evaluate these factors in this study. We are planning to assess the associations between rescuers' characteristics and CPR quality in the next study. Finally, we cannot rule out the possibility that the difference in duration of CPR training might affect the outcomes."

5. Conclusions

Quality of chest compressions rapidly declined in the chest compression-only CPR compared with the conventional CPR. We recommend that rescuers should change their roles in CPR every 1 min to maintain the quality of chest compressions during chest compression-only CPR.

Conflict of interest statement

There are no conflicts of interest to declare.

Role of funding source

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Efficacy of Out-Patient Cardiac Rehabilitation in Low Prognostic Risk Patients After Acute Myocardial Infarction in Primary Intervention Era

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ORIGINAL ARTICLE
Cardiac Rehabilitation

Efficacy of Out-Patient Cardiac Rehabilitation in Low Prognostic Risk Patients After Acute Myocardial Infarction in Primary Intervention Era

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Background: The efficacy of out-patient cardiac rehabilitation (OPCR) in patients with a low prognostic risk after acute myocardial infarction (AMI) is unclear in the recent primary intervention era.

Methods and Results: A total of 637 AMI patients who participated in in-hospital cardiac rehabilitation were divided into 2 groups; low prognostic risk group (n=219; age <65 years, successful reperfusion, Killip class I, peak serum creatine kinase <6,000 U/L, and left ventricular ejection fraction ≥40%) and non-low prognostic risk group (n=418). The prevalence of coronary risk factors (CRF) was compared between the 2 groups. Then, in the low-risk group, the efficacy of OPCR was compared between active OPCR participants (n=52; ≥20 sessions/3 months) and non-active participants (n=60; <6 sessions/3 months). Compared with the non-low prognostic risk group, the low prognostic risk group had a significantly higher prevalence of current smokers (72% vs. 49%, $P<0.05$) and patients with multiple CRF (3 or more; 49% vs. 39%, $P<0.05$). Among the low- risk group, active OPCR participants showed a significantly greater improvement in exercise capacity (peak $\dot{V}O_2$, $P<0.05$) and maintained a better CRF profile (total cholesterol, triglyceride and blood pressure, all $P<0.05$) than inactive participants at 3 months.

Conclusions: Low prognostic risk AMI patients have a higher prevalence of multiple CRF than non-low risk patients. Even in this low risk group, active participation in OPCR is associated with improved exercise capacity and better CRF profile. (*Circ J* 2011; **75:** 315–321)

Key Words: Acute myocardial infarction; Cardiac rehabilitation; Coronary risk factors; Exercise capacity; Low prognostic risk

Cardiac rehabilitation (CR) is a comprehensive intervention including medically supervised exercise training, risk factor control, patient education, and psychosocial counseling. CR has been reported to be effective in improving numerous intermediate endpoints, including exertional ischemic symptoms, overall feelings of wellness, exercise tolerance, and coronary risk factors (CRF) in patients with coronary artery disease (CAD).[1–6] In addition, recent meta-analyses of randomized studies on the effects of exercise-based CR in patients with CAD have demonstrated a statistically significant reduction in total and cardiac mortality ranging from 20% to 32%[7–9] in patients undergoing CR compared with those receiving standard medical care. The guidelines from the American College of Cardiology/American Heart Association and Japanese Circulation Society recommend the use of CR after acute myocardial infarction (AMI) as Class I.[10–14]

Recently, the widespread use of primary percutaneous coronary interventions (PCI) has enabled early ambulation of patients with AMI by reducing acute phase complications, resulting in minimal physical deconditioning. As a result, many AMI patients leave a hospital early without participating in a recovery phase (phase II) out-patient CR (OPCR) program.[15] However, the necessity and efficacy of OPCR remain unclear in AMI patients who are anticipated to be at low risk in terms of long-term prognosis (ie, non-elderly, successful reperfusion, absence of heart failure, and preserved left ventricular (LV) systolic function).

Accordingly, the purpose of the present study was to clarify the prevalence of CRF and to determine the efficacy of a 3-month OPCR program in such presumably low prognostic risk patients after AMI.

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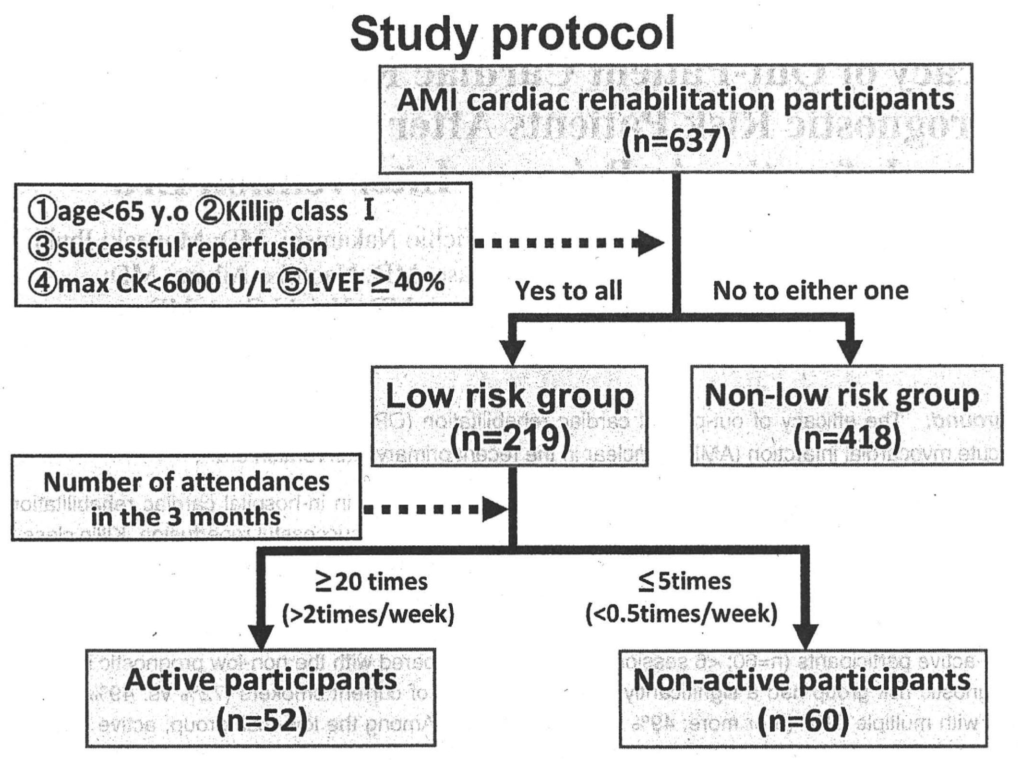

Figure 1. Schematic of study protocol. AMI, acute myocardial infarction; CK, serum concentration of creatine kinase; LVEF, left ventricular ejection fraction.

Methods

Patients

We studied a total of 637 consecutive patients with AMI who participated in a recovery phase CR program and underwent cardiopulmonary exercise testing (CPX) at the beginning and end of a 3-month program in our hospital. The patients were divided into 2 groups: a low prognostic risk group and a non-low prognostic risk group. The low prognostic risk group comprised of 219 patients who fulfilled all of the following criteria indicative of favorable prognosis; age under 65 years, successful reperfusion, Killip class I (an indicator of absence of acute phase heart failure), peak serum creatine kinase (CK) <6,000 U/L, LV ejection fraction (LVEF) ≥40%. The remaining 417 patients who did not fulfill 1 or more of the above 5 criteria were referred to as the non-low prognostic risk group.

As the first step of data analysis, the prevalence each of the CRF (hypertension, hyperlipidemia, diabetes mellitus, obesity and smoking habit) was compared between the low prognostic group and the non-low prognostic group.

As the second step, the efficacy of OPCR in AMI patients at low prognostic risk was examined by comparing the data for exercise capacity and CRF between active participants and non-active participants in the low prognostic risk group. Active participants were defined as patients who attended the OPCR sessions at least 20 times in 3 months (ie, approximately >2times/week), and non-active participants were those who attended OPCR less than 6 times in 3 months (ie, approximately <0.5times/week). There were 52 active participants and 60 non-active participants in the low prognostic group. We did not include the remaining 107 patients with intermediate attendance (patients with 6–19 attendances in 3 months) in the analysis, because the effect of OPCR in this patient group was considered to be modest, if any, and inclusion of this group in the analysis would dilute the measurable efficacy of OPCR. A schematic of the study protocol is provided in **Figure 1**.

CR Program

The CR program began approximately 1 week after AMI and continued after hospital discharge for 3 months. Patients who had angina or evidence of ischemic changes in their electrocardiogram (ECG) at a low level of exercise (walking test), uncontrolled heart failure, and serious arrhythmia were excluded. Program components included supervised exercise sessions (walking, bicycle ergometer and calisthenics) and education, as previously described.[16,17] The exercise intensity was determined individually at 50–60% of heart rate reserve (Karvonen's equation, $k=0.5–0.6$)[18,19] or a heart rate of anaerobic threshold (AT) level obtained in a maximal symptom-limited CPX testing or at level 12–13 ('a little hard') of the 6–20 scale perceived rating of exercise (original Borg's scale).[20] The exercise program was started with supervised sessions for 2 weeks, followed by home exercise combined with once or twice-a-week supervised sessions for the remaining 10 weeks. Home exercise consisted mainly of brisk walking at a prescribed heart rate for 30 to 60 min, 3–5 times a week.

Patients were encouraged to attend the education classes that were held 4 times a week with lectures on CAD, secondary prevention, diet, smoking cessation, medication, and

Table 1. Comparisons of Clinical Characteristics in the Low and Non-Low Prognostic Risk Groups

	Low-risk group (n=219)	Non-low-risk group (n=418)	P value
Age (years)	55±7	65±9	<0.01
Male (%)	88	83	NS
Killip class ≥II (%)	0	13	<0.01
Peak CK (U/L)	2,458±1,444	3,339±2,639	<0.01
CK ≥6,000 U/L (%)	0	17	<0.001
Unsuccessful reperfusion (%)	0	24	<0.001
LVEF (%)	49.1±6.8	44.4±10.4	<0.01
LVEF <40% (%)	0	34	<0.001
BNP (pg/ml)	75.7±70.9	209.8±202.0	<0.001
HT (%)	57	56	NS
DM/IGT (%)	47	42	NS
HLP (%)	59	49	<0.05
Obesity (%)	28	27	NS
Smoking habit (%)	72	49	<0.001
Coronary risk factors ≥3 (%)	49	39	<0.05

CK, serum concentration of creatine kinase; LVEF, left ventricular ejection fraction; BNP, brain natriuretic peptide; HT, hypertention; DM, diabetes mellitus; IGT, impaired glucose tolerance; HLP, hyperlipidemia.
Values are mean ± SD.

Table 2. Baseline Characteristics of Active Participants and Non-Active Participants in the Low-Risk Group

	Active participants (n=52)	Non-active participants (n=60)	P value
Age (years)	57.0±7.3	52.8±7.0	<0.01
Male (%)	83	95	<0.001
Peak CK (U/L)	2,361.1±1,264.2	2,419.5±1,357.1	NS
LVEF (%)	51.4±7.5	47.4±5.7	<0.01
BNP (pg/ml)	83.7±106.0	82.8±74.8	NS
OPCR attendance (times/3 months)	25.5±5.1	1.3±1.7	<0.001
HT (%)	58	52	NS
DM/IGT (%)	44	52	NS
HLP (%)	58	58	NS
Obesity (%)	29	30	NS
Smoking habit (%)	56	75	<0.05
ACE-I/ARB (%)	42	52	NS
β-blocker (%)	19	43	<0.01
Ca channel blocker (%)	40	40	NS
DM medications (%)	8	15	NS
Statin (%)	44	43	NS
Rest HR (/min)	72.6±10.8	71.5±14.9	NS
Rest sBP (mmHg)	123.1±20.2	119.8±21.0	NS
Rest dBP (mmHg)	77.7±11.0	74.7±12.0	NS
Peak WR (W)	132.3±25.2	136.0±31.3	NS
AT ($ml \cdot min^{-1} \cdot kg^{-1}$)	11.1±2.5	11.6±2.6	NS
Peak $\dot{V}O_2$ ($ml \cdot min^{-1} \cdot kg^{-1}$)	23.4±4.2	23.6±5.0	NS
Peak $\dot{V}O_2$ (%predict)	78.5±14.5	73.7±14.3	NS

Values are mean ± SD.
OPCR, outpatient cardiac rehabilitation; ACE-I, angiotensin converting enzyme inhibitor; ARB, angiotensin II receptor blocker; HR, heart rate; sBP, systolic blood pressure; dBP, diastolic blood pressure; WR, work rate; AT, anaerobic threshold; Peak $\dot{V}O_2$, peak oxygen uptake. Other abbreviations see in Table 1.

physical activities given by physicians, nurses, dieticians, pharmacists and exercise instructors. In addition, all patients received individual counseling on exercise prescription, secondary prevention, and daily life activities by a physician and a nurse at the time of hospital discharge and the end of the 3-month CR program. Patients were scheduled to undergo blood tests at the beginning and the end of the 3-month CR program.

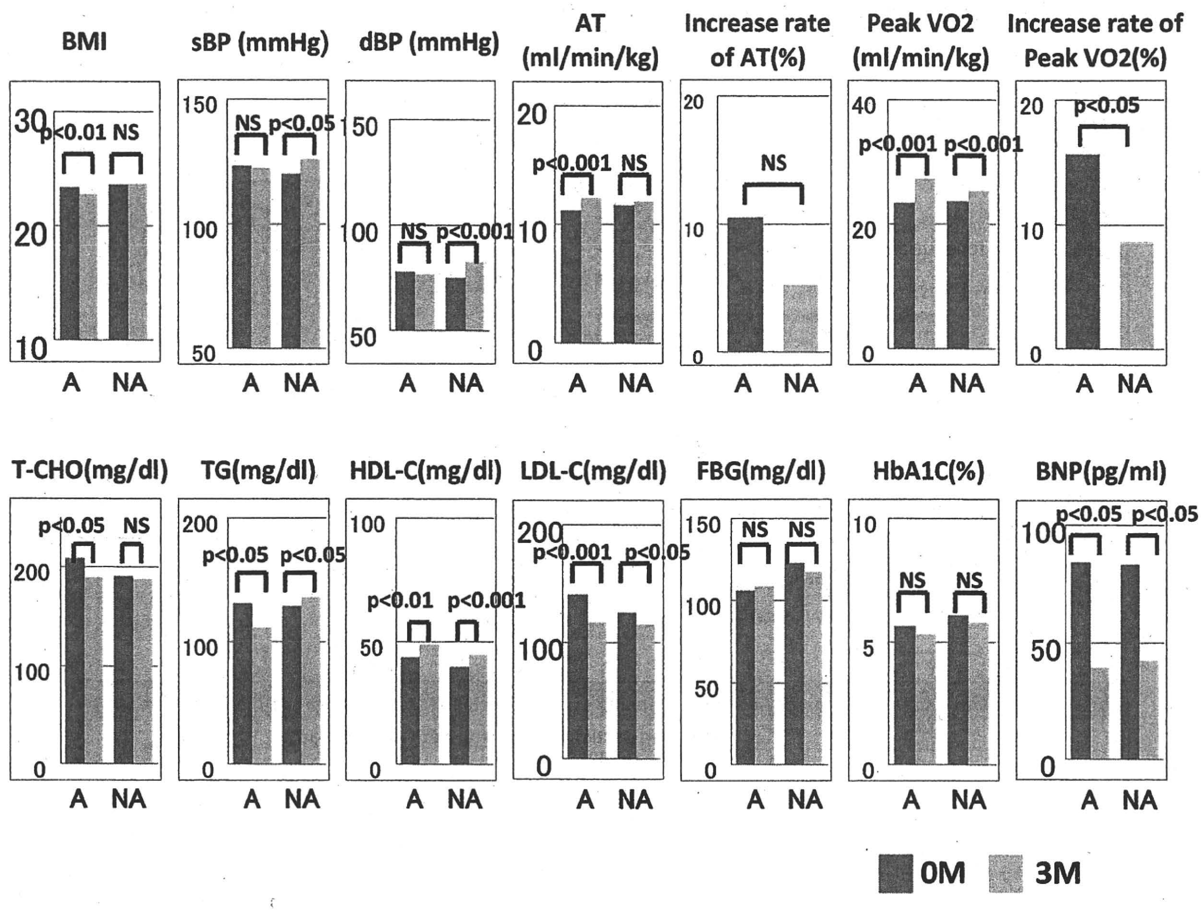

Figure 2. Comparison of the active participants and non-active participants before and after 3 months of outpatient cardiac rehabilitation program. A, active participants; NA, non-active participants; BMI, body mass index; sBP, systolic blood pressure; dBP, diastolic blood pressure; AT, anaerobic threshold; Peak $\dot{V}O_2$, peak oxygen uptake; T-CHO, serum concentration of total cholesterol; TG, serum concentration of triglyceride; HDL-C, serum concentration of high density lipoprotein cholesterol; LDL-C, serum concentration of low density lipoprotein cholesterol; FBG, fasting blood glucose; HbA_{1c}, hemoglobin A_{1c}; BNP, brain natriuretic peptide.

CPX

Patients were scheduled to undergo a symptom-limited CPX at the beginning and the end of the 3-month CR program.[21] After a 2-min rest on the bicycle ergometer in the upright position, the patients started pedaling at an intensity of 0 W for 1 min (warm-up), and then performed an incremental exercise test with a ramp protocol (10 or 15 W/min) until exhaustion. Twelve-lead ECG was continuously monitored and blood pressure (BP) was measured once-a-min with a sphygmomanometer. Expired gas was collected and analyzed continuously with an AE-300S gas analyzer (Minato Co, Osaka, Japan). Peak oxygen uptake (peak $\dot{V}O_2$) was defined as the highest $\dot{V}O_2$ value achieved at peak exercise. Ventilation ($\dot{V}E$) and carbon dioxide output ($\dot{V}CO_2$) were measured and the $\dot{V}O_2$ value at AT or ventilatory threshold was determined as the point at which $\dot{V}CO_2$ increased in a non-linear fashion relative to the rate of $\dot{V}O_2$ (according to the $\dot{V}E/\dot{V}O_2$ time trend, the respiratory exchange ratio flection point, or the V-slope method).[19,22]

Statistical Analysis

Baseline characteristics between the 2 groups were compared using unpaired t-test and chi-square test. Data at baseline and after the 3-month OPCR were compared by paired t-test. A P-value less than 0.05 was considered statistically significant. Data are presented as the mean±standard deviation.

Results

Prevalences of CRF in Low Prognostic Risk Group vs. Non-Low Prognostic Risk Group

Clinical characteristics in the low prognostic risk group and the non-low prognostic risk group are summarized in **Table 1**. Compared with the non-low prognostic risk group, the low prognostic risk group was on average significantly younger, and did not have heart failure on admission or unsuccessful reperfusion, but had lower peak CK and B-type natriuretic peptide (BNP) concentrations and preserved LVEF. Although these findings were anticipated by the definition of the group, they reconfirm that the patients in the low prognostic group were undoubtedly at low prognostic risk. However, when the prevalence of CRF was compared between the 2 groups, the percentage of patients with dyslipidemia, smoking habit and multiple CRF (equal to or more than 3) was significantly higher in the low prognostic risk group than in the non-low prognostic risk group.

Efficacy of OPCR in Low Prognostic Risk Group: Comparison Between Active and Non-Active Participants

Baseline characteristics in active participants and non-active participants in the low prognostic risk group are summarized in **Table 2**. Although active participants were significantly older than the non-active participants, they were both non-elderly (less than 65 years old). Peak CK was low and LVEF was relatively preserved in both groups. These findings reconfirm that both active and non-active participants are apparently at low prognostic risk. Although there were minor differences in the prevalence of male patients, smokers and β-blocker use, there were no significant differences in exercise capacities at baseline between the 2 groups.

During the 3-month OPCR period, only a few patients experienced changes in medication; statins were introduced in 3 patients (5.8%) in the active participants and 2 patients (3.3%) in the non-active participants, and diabetic medications were started in 2 patients (3.3%) in the non-active participants. Thus, the baseline clinical characteristics of active and non-active participants were almost equivalent, except for the frequency of OPCR attendance.

Figure 2 depicts comparisons of parameters before and after the 3-month OPCR between active and non-active participants in the low prognostic risk group. After the 3-month OPCR, only active participants, and not the non-active participants, showed significant improvements in body mass index (BMI; 23.3±2.5 to 22.9±2.5, $P<0.01$), AT (11.1±2.5 to 12.7±2.5 $ml \cdot min^{-1} \cdot kg^{-1}$, $P<0.001$), total cholesterol (208.4±33.7 to 188.8±26.4 mg/dl, $P<0.05$), and triglyceride (130.0±77.4 to 111.0±63.7 mg/dl, $P<0.05$). In addition, while peak $\dot{V}O_2$ increased in both groups (active participants 23.4±4.2 to 27.3±5.0 $ml \cdot min^{-1} \cdot kg^{-1}$, $P<0.001$; non-active participants 23.7±5.0 to 25.3±5.3 $ml \cdot min^{-1} \cdot kg^{-1}$, $P<0.001$), the magnitude of the increase was significantly greater in the active participants (15.6% vs. 8.6%, $P<0.05$). In contrast, only non-active participants showed significant worsening in systolic and diastolic BP (systolic BP: from 119.8±21.0 to 126.1±20.4 mmHg, $P<0.05$, diastolic BP: from 74.7±12.0 to 82.4±11.8 mmHg, $P<0.001$) and triglyceride (128.0±57.1 to 135.3±63.9 mg/dl, $P<0.05$). The following parameters showed significant improvements both in the active and non-active participants; high density lipoprotein cholesterol (HDL-C: 43.6±14.1 to 49.0±12.2 mg/dl, $P<0.01$; 39.7±11.0 to 44.8±11.6 mg/dl, $P<0.001$), low density lipoprotein cholesterol (LDL-C: 140.1±31.9 to 117.6±25.9 mg/dl, $P<0.001$; 124.8±31.2 to 115.3±19.7 mg/dl, $P<0.01$), and BNP (83.7±106.0 to 39.7±44.8 pg/ml, $P<0.05$; 82.9±74.8 to 42.4±51.7 pg/ml, $P<0.05$).

Discussion

The major findings of the present study are that the low prognostic risk AMI patients had a higher prevalence of smoking habit, dyslipidemia and multiple CRF than the non-low prognostic risk patients, and that in the low prognostic risk group, active participation in OPCR was associated with better CRF profile (ie, BP, dyslipidemia, and obesity) and exercise capacity. These findings suggest that, by actively participating in OPCR after AMI, even the low prognostic risk patients might gain clinical benefits such as better CRF modification and physical functioning.

Previous Studies

Various guidelines for management of post-AMI (or established CAD) patients recommend aggressive modifications of CRF for secondary prevention,[10,12,13] and adherence to these recommendations and/or reduction of CRF have been shown to improve long-term prognosis.[23–26] In contrast, Thrombolysis In Myocardial Infarction (TIMI) risk score[27] and Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) risk score[28] have demonstrated that 1-year mortality is very low in AMI patients with age <65 years, successful reperfusion, absence of acute phase heart failure, and preserved LV function, which are compatible with the patient characteristics of the low prognostic risk group in the present study. However, little is known about the prevalence of CRF or clinical significance of accumulation of multiple CRF in such low prognostic risk patients. In relation to this, it is of note that, Lloyd-Jones and colleagues demonstrated that young subjects with accumulated CRF, despite low short-term risk, have a higher 'lifetime risks for CAD' and greater progression of subclinical coronary atherosclerosis compared with those at low lifetime risk.[29,30] These data suggest that apparently low prognostic risk patients stratified by TIMI or CADILLAC risk score are likely to have superb short-term (1 year) prognosis, but not necessarily favorable long-term or lifetime prognosis.

Present Study

The present study has explicitly demonstrated that the low prognostic risk patients actually have higher prevalence of multiple CRF than the non-low prognostic risk patients. Although the finding that younger AMI patients have higher prevalences of smoking and hyperlipidemia than elderly patients is in accordance with previous studies,[31] there has been no report demonstrating higher prevalence of multiple CRF in low prognostic risk AMI patients with successful reperfusion and preserved LVEF. According to TIMI risk score[27] or CADILLAC risk score,[28] this finding might appear confusing or counterintuitive. However, from the viewpoint of lifetime CAD risk,[29,30] this finding might have a significant impact on the long-term prognosis of apparently low prognostic risk AMI patients.

The second major finding in the current study is that active participation in OPCR improved CRF (BP, dyslipidemia, and obesity) and exercise capacity even in the low prognostic risk group. There have been no studies that reported the effect of OPCR in the low prognostic risk AMI patients. Taylor et al[9] reported in a meta-analysis of randomized controlled trials that the effect of OPCR on total mortality did not differ between studies before and after year 1995 (odds ratio 0.84 before 1995 vs. 0.62 after 1995, NS), but they did not assess the effect of OPCR on the low prognostic risk patients after successful reperfusion. Witt et al recently reported that participation in OPCR after AMI was associated with improved survival and reduced recurrent myocardial infarction (MI) at 3 years, but the rate of reperfusion was only 33% in their patients.[32] Squires et al reported that a 3-year coronary disease management program in OPCR for CAD patients was effective in achieving the secondary prevention goals, but their assessment did not target the low prognostic risk patients.[33] Thus, the present study has demonstrated for the first time the favorable effects of OPCR on CRF and exercise capacity in the low prognostic AMI patients.

Clinical Implications

It remains unknown whether the improvements in CRF profiles and exercise capacity achieved by active participation in OPCR can lead to an improved long term prognosis in the low prognostic risk AMI patients. However, Tani et al reported that successful life style modification with exercise, body weight reduction and smoking cessation for 6 months was associated with coronary plaque volume regression in low prognostic risk CAD patients.[34] Belardinelli et al reported in the ETICA (Exercise Training Intervention after Coronary Angioplasty) trial that a 6-month OPCR for the relatively low risk CAD patients after successful PCI (49% having AMI) reduced cardiac events and hospital re-admission during the follow-up period (33±7 months).[35] In addition, because the magnitude of the improvement in endothelial function afforded by OPCR does not correlate with the improvements in CRF,[36] the general consensus at present is that the favorable effect of OPCR on the long-term prognosis is mediated by a direct anti-atherosclerosis effect of exercise training rather than by improvements in CRF.[4] Therefore, further study is necessary to determine the long term effect of OPCR in AMI patients with low prognostic risk.

In the present study, significant differences were found between active and inactive OPCR participants in BMI, total cholesterol, triglyceride and BP, but not in LDL-C or glucose tolerance. One might argue that the prognostic impacts of BMI, total cholesterol, triglyceride and BP might be less powerful compared with those of LDL-C and diabetes. However, Nakatani et al reported that the metabolic syndrome, diagnosed from the combination of BMI, HDL-C, triglyceride, BP, and fasting blood glucose, was an independent predictor of subsequent combined cardiac events of cardiac death and non-fatal MI in Japanese patients after AMI.[37] Therefore, it is plausible that the improvements in BMI, triglyceride and BP observed in the present study might contribute to the improvement in the long-term prognosis in Japanese AMI patients.

Future Direction

In the present study, the rate of active OPCR participation was only 24% (52/219 patients) in the low prognostic risk group. To reduce lifetime CAD risk in these low prognostic risk AMI patients, a substantial increase in participation rate in OPCR is necessary. However, according to a recent nation-wide survey in 526 Japanese Circulation Society authorized cardiology training hospitals,[15] the implementation rate was 92% for emergency PCI, but only 9% for OPCR. In addition, Ades et al reported that, by multivariate analysis, the strength of the physician's recommendation for participation was the most powerful predictor of OPCR participation.[38] Thus, to increase the participation rate in OPCR, it is critically important to greatly increase the number of CR facilities and to enhance physicians' understanding of the benefits of OPCR after AMI.

Study Limitations

First, this study was a retrospective analysis and the number of patients was relatively small. The more active patients would be expected to participate in OPCR and this might have introduced a selection bias.

Second, the low prognostic risk group is anticipated to be at low risk in terms of short-term prognosis[27,28] and hence, whether improvements in CRF profile in such low prognostic risk patients are associated with actual improvements in outcome is uncertain. A longer follow-up in a larger number of patients is necessary to increase the statistical power to demonstrate the beneficial effect of OPCR on the long-term prognosis.

Conclusions

The low prognostic risk AMI patients have a higher prevalence of multiple CRF than the non-low risk patients. Active participation in OPCR program is associated with improved exercise capacity and CRF profile in such low prognostic risk patients. OPCR program can be effective in achieving secondary prevention goals even in the low prognostic risk AMI patients.

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Clinical Paper

Are trained individuals more likely to perform bystander CPR? An observational study☆

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ABSTRACT

Background: This study aimed to evaluate the association of cardiopulmonary resuscitation (CPR) training with bystander resuscitation performance and patient outcomes after out-of-hospital cardiac arrest (OHCA).
Methods: This was a prospective, population-based cohort study of all persons aged 18 years or older with OHCA of presumed intrinsic origin and their rescuers from January through December 2008 in Takatsuki, Osaka prefecture, Japan. Data on resuscitation of OHCA patients were obtained by emergency medical service (EMS) personnel in charge based on the Utstein style. Rescuers' characteristics including experience of CPR training were obtained by EMS personnel interview on the scene. The primary outcome was the attempt of bystander CPR.
Results: Data were collected for 120 cases out of 170 OHCAs of intrinsic origin. Among the available cases, 60 (50.0%) had previous CPR training (trained rescuer group). The proportion of bystander CPR was significantly higher in the trained rescuer group than in the untrained rescuer group (75.0% and 43.3%; $p = 0.001$). Bystanders who had previous experience of CPR training were 3.40 times (95% confidence interval 1.31–8.85) more likely to perform CPR compared with those without previous CPR training. The number of patients with neurologically favorable one-month survival was too small to evaluate statistical difference between the groups (2 [3.3%] in the trained rescuer group versus 1 [1.7%] in the untrained rescuer group; $p = 0.500$).
Conclusions: People who had experienced CPR training had a greater tendency to perform bystander CPR than people without experience of CPR training. Further studies are needed to prove the effectiveness of CPR training on survival.

1. Introduction

Three-quarters of the deaths from coronary heart disease occur suddenly in the out-of-hospital setting,[1,2] and approximately 50,000 sudden cardiac arrests are documented every year in Japan.[3] The high mortality of out-of-hospital cardiac arrest (OHCA) cases is one of the most important clinical issues to be addressed. It is widely accepted that successful resuscitation after OHCA depends on early initiation of cardiopulmonary resuscitation (CPR) and defibrillation,[4,5] and that bystanders CPR could potentially double survival after OHCAs.[3,5] Despite the proven effectiveness of bystander CPR, actual bystander CPR remains infrequent.[3–7] Previous studies indicated that CPR training improved willingness to perform CPR and would increase the proportion of bystander CPR.[8–13]

To increase bystander CPR, substantial societal resources are focused on CPR training, and elaborate CPR training programs are provided for over 1,620,000 persons every year in Japan.[3] However, most studies on the effectiveness of CPR training have evaluated only the improvements in rescuers' CPR skills[14–16] or attitude towards CPR,[8–12] and little is known about the effectiveness of CPR training on the rescuer's performance in real emergency settings or OHCA patient outcomes.

The Utstein Osaka project was launched in 1998, and is an ongoing large, prospective, population-based cohort study of OHCA in Osaka, Japan, covering 8.8 million people.[5,7,17–19] In this study, we collected data on lay rescuer's characteristics including their experience of CPR training by interviewing the lay rescuers on the scene, and linked them to the data on resuscitation simultaneously obtained according to the Utstein style guidelines. The purpose of this study was to evaluate the association of people's CPR train-

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ing with their subsequent resuscitation performances and patient outcomes after OHCA.

2. Methods

2.1. Study design, population and setting

This was a prospective, population-based cohort study of OHCA carried out in Takatsuki, Osaka prefecture, from January 28, 2008 through December 31, 2008. All persons aged 18 years or older who suffered OHCA of intrinsic etiology and were treated by emergency medical service (EMS) personnel, and their rescuers were enrolled in this study. Cardiac arrests from trauma, drowning, drug overdose, asphyxia, exsanguinations or any other external causes were excluded and those without trauma nor any external causes was defined as OHCAs of intrinsic origin. Rescuers who called an ambulance or performed CPR were identified by the EMS personnel at the event scene. If there were two or more rescuers, one of them was selected as the main rescuer by the EMS personnel. The main rescuer was defined as person who played a main role in CPR or called an ambulance when bystander CPR was not performed.

2.2. Emergency medical service system in Takatsuki

Takatsuki has 358,973 residents in an area of 105 km^2. The municipal EMS system is basically the same as the standard of Osaka prefecture which was previously described.[17–19] The EMS system is operated by the Takatsuki Fire Department and activated by dialing 119 on the telephone. The population is covered by a single fire station with an emergency dispatch center. The most highly trained pre-hospital emergency care providers are the Emergency Life Saving Technicians (ELSTs). Each ambulance has 3 providers with at least one ELST. The ELSTs can deliver shocks without online medical direction, and specially trained ELSTs can insert tracheal tubes and use epinephrine. When an OHCA occurs in the city, an additional ambulance with a physician and two staff members follows the regular ambulance. At the scene, 6 EMS personnel in total perform basic and advanced life support.

CPR training programs for the general public were provided about 220 times by the fire department and a total of 6000 citizens attended the program in 2006.[20] Public access defibrillation (PAD) programs were started in July 2004 in Japan.[21] The cumulative number of public-access automated external defibrillators (AEDs) has been increasing year by year and contributes better outcomes after OHCA in Japan.[21,22] Although we could not know the whole number of AEDs because many AEDs were located in private areas, at least 124 AEDs were placed in the city in 2009.[23]

2.3. Data collection

Data on the rescuers' performance were obtained by EMS personnel interview with the main rescuer using a specific data form for this study. Data included bystander's sex, age, relationship to the patient, occupation, experience and the number of previous CPR training (once, twice, ≥three times, unknown), the time of the latest CPR training (within a year, between 1 and 3 years, over 3 years, unknown), knowledge of AEDs, and awareness of the neighborhood AED locations.

Patients' data were collected using a data form that included all core data recommended in the Utstein-style reporting guidelines for OHCA,[24,25] including sex, age, location, activities of daily living before arrest, witness status, initial cardiac rhythm, time-course of resuscitation, type of bystander-initiated CPR, return of spontaneous circulation (ROSC), hospital admission, one-month survival, and neurological outcome one month after the event. All patients who survived the cardiac arrest were followed for up to 1 month after the event by the EMS personnel in charge. One-month neurological outcome was determined by physician responsible for the care of the patient, using the Cerebral Performance Category (CPC) 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.[24,25] Neurologically favorable survival was defined as a CPC score of 1 or 2. The data form was filled out by the EMS personnel in cooperation with the physicians caring for the patient, transferred to the Information Center for Emergency Medical Services of Osaka, and then checked by the investigators. If the data sheet was incomplete, the relevant EMS personnel were contacted and questioned, and the data sheet was completed.

2.4. Statistical analyses

The primary outcome measure was the attempt of bystander CPR. Secondary outcomes included rescuers' performance including bystander CPR with telephone-guidance, knowledge of AEDs, awareness of the neighborhood AED locations, use of an AED, resuscitation time course, ventricular fibrillation (VF) as the initial rhythm, pre-hospital ROSC, one-month survival, and neurologically favorable one-month survival.

The sample size was calculated based on the proportion of bystander CPR in Takatsuki during the last 3 years and previous studies, assumed to be 30% in the untrained rescuer group and 50% in the trained rescuer group. Under the conditions of an alpha error of 5% and a power of 70%, 47 subjects in the trained rescuer group and 154 subjects in the untrained rescuer group were needed. Because approximately 200 people had suffered OHCA in the city in the recent years, we considered one year of data as sufficient to achieve our study aim.

The data were compared between groups using the *chi*-square test or Fisher's exact test for categorical variables, and Student's *t*-test or Mann–Whitney *U* test for numerical variables depending on whether the data were normally distributed or not. Multivariable-adjusted odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated to assess the relationship between the bystanders' previous CPR training and the bystander CPR performance. We adjusted for bystanders' sex and age (<40, 40–64, or ≥65 years), patients' sex and age (<75 or ≥75 years), and factors which was reported to affect CPR performance in previous studies: bystander's occupation[9] (health professionals including physician, nurse, EMS personnel, and care worker or not) and witness status.[13] All analyses were performed using SPSS ver.16.0 (SPSS, Inc., Chicago, IL). A two-tailed value of $p < 0.05$ was considered to be statistically significant.

2.5. Ethical considerations

All procedures were conducted according to the Declaration of Helsinki. This study was approved by the Ethics Committee of Kyoto University Graduate School of Medicine and the Takatsuki Fire Department. Oral informed consent was obtained from all participants (rescuers) by EMS personnel before the interview. The requirement of informed consent for the review of patients' outcomes was waived by the Personal Information Protection Law and the national research ethics guidelines of Japan.

3. Results

3.1. Study flow and baseline characteristics of bystanders and patients

During this study period, 273 adult OHCA patients were documented, and resuscitation was attempted in 258 cases by EMS

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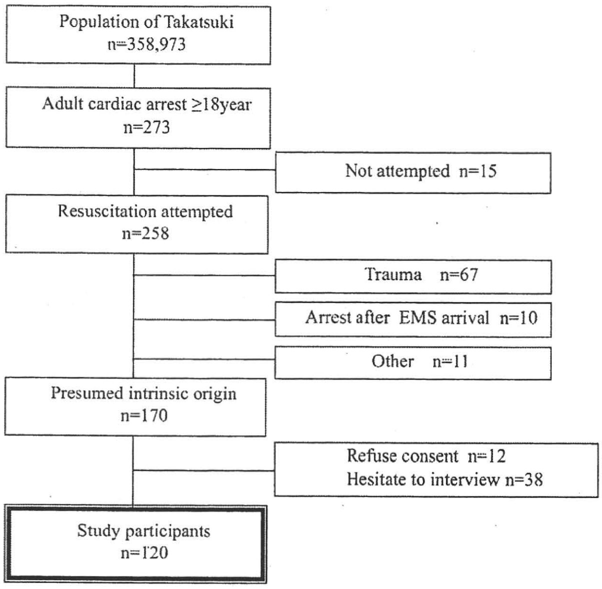

Fig. 1. Participant flow.

personnel. Among them, 170 subjects met the inclusion criteria and interviews were completed for 120 cases (Fig. 1). Rescuer and patient characteristics are shown in Table 1. Just half of the rescuers had experienced CPR training (trained rescuer group) and the remainder did not (untrained rescuer group). In the trained rescuer group, rescuers were younger (52.5 ± 16.1 versus 61.1 ± 15.6 years; $p = 0.018$), less likely to be family members (51.7% versus 83.3%; $p < 0.001$), and more likely to be health professionals (30.0% versus 5.0%; $p < 0.001$) than in the untrained rescuer group. In the trained rescuer group, 60.0% had received CPR training only once, 41.7% had received it more than three years ago, and 50.0% had attended the CPR training courses that included AED operation.

The patients' age was higher (80.3 ± 12.6 versus 75.7 ± 11.4 years; $p = 0.042$) and good activities of daily living before arrest were less frequent (46.7% versus 68.3%; $p = 0.026$) in the trained rescuer group than in the untrained rescuer group. Telephone CPR instruction (i.e., dispatcher assisted CPR via telephone) was frequently and equally provided (62.7% in the trained versus 61.7% in the untrained; $p = 1.000$). The time from call to the first shock was shorter in the trained rescuer group (9.0 min versus 12.0 min; $p = 0.013$).

3.2. *Bystander resuscitation performance*

Resuscitation performances of the rescuers according to their experience of CPR training are shown in Table 2. The proportion of bystander CPR was significantly greater in the trained rescuer group than in the untrained rescuer group (75.0% versus 43.3%; $p = 0.001$). In the trained rescuer group, the proportion of bystander CPR was greater in those with recent CPR training. One-fourth (13/45) in the trained rescuer group performed CPR without telephone instruction, while no one did in the untrained rescuer group ($p = 0.002$). In the telephone CPR instruction cases, 86.5% (32/37) in the trained rescuer group and 70.3% (26/37) in the untrained rescuer group were ultimately provided CPR by bystanders. In the trained rescuer group, rescuers were more likely to perform CPR with other persons than in the untrained rescuer group (37.8% versus 11.5%; $p = 0.027$). The proportion of those who had knowledge of AEDs and the neighborhood AED location were significantly greater in the trained rescuer group than in the untrained rescuer group (88.3% versus 45.0%; $p < 0.001$, 38.6% versus 18.4%; $p = 0.043$, respectively). Among those who had knowledge of AEDs, 6 (11.3%) rescuers in the trained rescuer group actually used an AED, while none in the untrained rescuer group used it. The resuscitation time course was similar in both groups.

Fig. 2 shows multivariable adjusted ORs of the factors possibly associated with bystander CPR performance in attempted bystander CPR. Rescuers who had experienced previous CPR training were 3.4 times (95% CI 1.31–8.85) more likely to perform CPR compared with those without such experience. Middle-aged rescuers (40–64 years compared to under 40 years; adjusted OR, 0.21;

Table 1
Rescuer and patient characteristics according to rescuer's CPR training experience.

	Trained ($n = 60$)	Untrained ($n = 60$)	p-Value
Rescuer characteristics			
Age, year, SD	52.5 ± 16.1	61.1 ± 15.6	0.018
Male, n (%)	22 (36.7)	25 (41.7)	0.354
Family member, n (%)	31 (51.7)	50 (83.3)	<0.001
Health professional, n (%)	18 (30.0)	3 (5.0)	<0.001
Patient characteristics			
Age, year, SD	80.3 ± 12.6	75.7 ± 11.4	0.042
Male, n (%)	32 (53.3)	30 (50.0)	0.428
ADL before arrest, good, n (%)	28 (46.7)	41 (68.3)	0.026
Witnessed, n (%)	18 (30.0)	29 (48.3)	0.030
Location of arrest, n (%)			<0.001
Home	35 (58.3)	52 (86.7)	
Healthcare facility	17 (28.3)	1 (1.7)	
Other	8 (13.3)	7 (11.7)	
Cardiac origin, n (%)	52 (86.7)	50 (83.3)	0.799
Rescue situation			
Telephone CPR instruction, n (%)[a]	37 (62.7)	37 (61.7)	1.000
Resuscitation time course by EMS, min, median (IQR)			
Call to CPR[b]	6.0 (1.0–66.0)	7.0 (1.0–13.0)	0.341
Call to shock[c]	9.0 (4.0–26.0)	12.0 (9.0–27.0)	0.013
Call to hospital arrival[d]	31.0 (18.0–99.0)	32.5 (19.0–91.0)	0.241

CPR denotes cardiopulmonary resuscitation; SD, standard deviation; ADL, activities of daily living; EMS, emergency medical service; IQR, interquartile range.
[a] Data on one participant in trained group were missing ($n = 59$ in trained group, $n = 60$ in untrained group).
[b] Data available for patients with CPR by EMS ($n = 15$ in trained group, $n = 34$ in untrained group).
[c] Data available for patients with EMS shock ($n = 12$ in trained group, $n = 13$ in untrained group).
[d] Data available for patients arriving at hospital ($n = 34$ in trained group, $n = 48$ in untrained group).

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Table 2
Resuscitation performances according to rescuer's CPR training experience.

	Trained (n = 60)	Untrained (n = 60)	p-Value
Bystander CPR, n (%)	45/60 (75.0)	26/60 (43.3)	0.001
Previous CPR training, n (%)			
Within a year	17/21 (81.0)	–	–
Between 1 and 3 years	9/12 (75.0)	–	–
Over 3 years	17/25 (68.0)	–	–
Bystander CPR with telephone CPR instruction, n (%)	32/37 (86.5)	26/37 (70.3)	0.157
Number of rescuers, >2, n (%)	44/60 (73.3)	28/60 (46.7)	<0.001
Number of CPR performers, >2, n (%)	17/45 (37.8)	3/26 (11.5)	0.027
Knowledge of AEDs, n (%)	53/60 (88.3)	27/60 (45.0)	<0.001
Knowledge of the neighborhood AED location, n (%)	22/60 (38.6)	7/60 (18.4)	0.043
Using of AED, n (%)	6/15 (40.0)	0/0 (0.0)	–
Resuscitation time course, min, median (IQR)			
Collapse to call[a]	2.5 (−2.0–17.0)	3.0 (−3.0–30.0)	0.918
Collapse to bystander CPR[b]	2.0 (0.0–17.0)	2.0 (1.0–6.0)	0.765
Call to guided CPR via telephone[c]	0.0 (0.0–2.0)	0.5 (0.0–2.0)	0.959

CPR denotes cardiopulmonary resuscitation; AED, automated external defibrillator; IQR, interquartile range.
[a] Data available for witnessed patients (n = 18 in trained group, n = 29 in untrained group).
[b] Data available for witnessed patients with CPR (n = 12 in trained group, n = 6 in untrained group).
[c] Data available for patients with bystander CPR and who received telephone-guided CPR (n = 23 in trained group, n = 22 in untrained group).

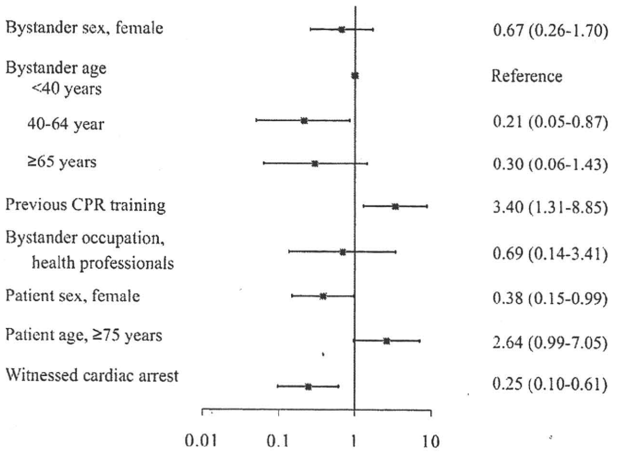

Fig. 2. Multivariable adjusted odds ratios (95% confidence intervals) of the factors possibly associated with bystander CPR performances.

95% CI 0.05–0.87) and female patients (adjusted OR, 0.38; 95% CI 0.15–0.99) were associated with lower proportion of bystander CPR. Surprisingly, patients with witnessed arrest were less likely to receive bystander CPR compared to those without it (adjusted OR, 0.25; 95% CI 0.10–0.61).

3.3. *Patient outcomes*

Patient outcomes according to the rescuers' experience of CPR training are shown in Table 3. One-month survival was 13.3% in the trained rescuer group, while 8.3% in the untrained rescuer group (p = 0.279). Neurologically favorable one-month survival was 3.3% in the trained rescuer group, against 1.7% in the untrained rescuer group (p = 0.500). However the number of survivors was too small to evaluate the difference between the groups.

4. Discussion

This study clearly demonstrated that people who experienced CPR training were more likely to perform CPR at the cardiac arrest scene than those without such experience. Because CPR by bystanders is strongly linked to improved patient survival, increase in CPR attempts should improve patient outcomes. Our study evaluated not only the associations between the rescuers' previous CPR training and their CPR performance, but also that between rescuers' previous CPR training and patient survival after OHCA. In this study, unlike a similar study,[13] which conducted a telephone interview two weeks after the event to obtain data on the rescuers, the EMS personnel interviewed the actual rescuers at the scene which assured the quality of data and minimized recall biases.

There was a trend to improved neurologically favorable survival in the trained rescuer group compared with those in the untrained rescuer group. But unfortunately, the number of survivors was too small to evaluate this intergroup difference. Many reports show bystander CPR increases survival after OHCA.[5,19,26,27] The experience of CPR training could improve rescuers willingness to perform CPR and could result in better patient outcomes after OHCA.

When telephone CPR instruction was provided, CPR was more often provided to OHCA cases treated by the rescuers with previous CPR training. Previous studies reported that CPR instruction by dispatchers could encourage lay rescuers to perform CPR[28,29] and improve the quality of CPR performed by bystanders with previous CPR training.[29] Bystanders with previous CPR training might have a better understanding of the dispatcher's directions for CPR and more likely to perform CPR. In addition, our finding suggested that rescuers with previous CPR training were sometimes confident enough to start CPR without telephone instruction. Both CPR training and telephone CPR instruction could increase bystander CPR.

This study showed that CPR training increased the knowledge of not only an AED itself but also the neighborhood AED locations, which suggested that CPR training engaged their attention to AEDs because there was no uniform location of public access AEDs and no established education about AED location in the training. These improvements in attitudes towards CPR and AEDs would result in increase in willingness to perform CPR or use an AED. However, the actual use of an AED was rare even if the lay rescuers had experienced CPR training. In Japan, nationwide dissemination of public access AEDs produced an increase in public access defibrillation with an AED and survival after out-of-hospital VF.[22] A previous study pointed out difficulties in the actual use of an AED for the general public even if they were trained in CPR and AED use.[30] We need to consider ways to increase the number of people who can use an AED in actual emergency settings.

Our finding is consistent with previous studies showing the importance of CPR training with practice.[14–16,31–33] Some of them suggested the needs of brief re-assessment or refresher course to improve CPR skills and its retention.[14,31] CPR training with practice, therefore, should be widespread. However, the length of conven-

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