

Survival Is Similar After Standard Treatment and Chest Compression Only in Out-of-Hospital Bystander Cardiopulmonary Resuscitation

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Background—We sought to compare the 1-month survival rates among patients after out-of-hospital cardiac arrest who had been given bystander cardiopulmonary resuscitation (CPR) in relation to whether they had received standard CPR with chest compression plus mouth-to-mouth ventilation or chest compression only.

Methods and Results—All patients with out-of-hospital cardiac arrest who received bystander CPR and who were reported to the Swedish Cardiac Arrest Register between 1990 and 2005 were included. Crew-witnessed cases were excluded. Among 11 275 patients, 73% (n=8209) received standard CPR, and 10% (n=1145) received chest compression only. There was no significant difference in 1-month survival between patients who received standard CPR (1-month survival=7.2%) and those who received chest compression only (1-month survival=6.7%).

Conclusions—Among patients with out-of-hospital cardiac arrest who received bystander CPR, there was no significant difference in 1-month survival between a standard CPR program with chest compression plus mouth-to-mouth ventilation and a simplified version of CPR with chest compression only. (*Circulation*. 2007;116:2908-2912.)

Key Words: cardiopulmonary resuscitation ■ heart arrest ■ survival

Survival after out-of-hospital cardiac arrest (OHCA) remains poor.¹ Improvement is required, all the way from a deeper understanding of the prodromal symptoms before cardiac arrest to the handling of early alarm and defibrillation as well as postresuscitation care.^{2,3} This chain of care is often described as the “chain of survival”.⁴

The aim of this retrospective investigation was therefore to compare the 1-month survival rates among OHCA patients who received bystander CPR in the form of standard CPR with those given the more simplified treatment with compression-only CPR.

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It is well established that bystander cardiopulmonary resuscitation (CPR) improves survival rates in patients with prehospital ventricular fibrillation (VF).^{5,6} The mechanistic explanation of this improved survival rate may work in the form of a “bridge to successful defibrillation” on the assumption that early CPR prolongs the patient’s phase of VF.^{7,8}

Bystander CPR can be performed according to a “standard mode” with chest compression plus mouth-to-mouth ventilation (standard CPR) or as a “single mode” with chest compression only (compression-only CPR). Standard CPR is widespread and widely accepted. However, during the last decade, investigators have addressed the method of compression-only CPR as an alternative to standard CPR.^{9,10} The importance of chest compression is now also given a more predominant role in the recently published international CPR guidelines.¹¹

Methods

Register

This study is based on patient material collected by the Swedish Cardiac Arrest Register, which is a joint venture between the Federation of Leaders in Swedish Ambulance and Emergency Services and the Swedish Council for Cardiopulmonary Resuscitation. Since 1993, the register has been funded by the Swedish National Board of Health and Welfare. This voluntary register was started in 1990 and covers ≈70% of the population in Sweden (total population, 8.9 million). Larger cities (including all major cities) as well as sparsely populated areas are represented in the register, which also has a geographic distribution covering most of Sweden. The ambulance organizations not reporting to the register are not different in terms of education or guidelines.

Patients

We included patients who suffered from OHCA and received any form of bystander CPR and who were reported to the Swedish Cardiac Arrest Register between 1990 and 2005. Crew-witnessed (ambulance staff, police, healthcare provider) cases of OHCA were excluded.

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Table 1. Characteristics of Patients Receiving Standard Bystander CPR Compared With Chest Compression Only

	Standard CPR Only (n=8209)	Chest Compression Only (n=1145)	P
Age, mean±SD, y	63±18	66±16	<0.0001
Female sex, %	25	23	0.045
Bystander witnessed, %	74	73	NS
Location at home, %	49	52	0.076
Cardiac cause, %	70	71	NS
Initial rhythm VF, %	40	36	0.012
Delay from call for to arrival of ambulance, min			
Median	8	6	<0.0001
Quartile 1 to quartile 3	5–13	4–10	
Type of bystander in relation to CPR method, %			
Layperson	51	67	
Ambulance staff	3	1	
Police	2	2	
Healthcare provider	32	20	
Other	16	11	

There was missing information concerning bystander witnessed, cause, initial rhythm, and type of bystander in up to 10% of patients. For the other variables, there was missing information in up to 5% of patients.

Study Design

For each OHCA, the ambulance crew completed a form with demographic information and information regarding whether the collapse was witnessed (ie, seen or heard). The form also included questions regarding the resuscitation procedure and interventions, as well as information regarding the bystander (layman, ambulance crew, or others). The first recorded rhythm was defined as VF, pulseless electric activity, or asystole. Rhythm detection by the rescue team was obtained with the use of a manual defibrillator. When automated external defibrillators came into use, the rhythm was defined as shockable or nonshockable. For the purposes of this survey, VF includes also pulseless ventricular tachycardia. The form was completed during and immediately after the acute event. Each form was sent to the medical director, and a copy was sent to the central register in Göteborg, Sweden. Another copy was subsequently sent with additional information about whether the patient was dead or alive after 1 month. Any uncertainty about survival was controlled by checking with the National Register of Deaths.

This study was approved by the local ethics committee.

Statistical Methods

Distribution of variables is given as medians (quartile 1 to quartile 3) and percentage. For comparison between groups regarding ordered and continuous variables, the Fisher nonparametric permutation test was used. For comparison of dichotomous variables between groups, the Fisher exact test was used. Logistic regression was used to adjust for variables that were significantly different in the 2 groups. Odds ratio was calculated with 95% confidence interval. A probability value of <0.05 was regarded as significant.

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

Results

After exclusion of crew-witnessed cases, 12 740 patients who had suffered from OHCA in 1990–2005 and who had received bystander CPR before arrival of the rescue team

were included in the survey. Information regarding the type of CPR that had been given was missing in 1465 patients (11%).

Among the remaining 11 275 patients, 8209 (73%) received standard CPR, whereas 1145 patients (10%) received compression-only CPR. For unknown reasons, 1921 patients (17%) had received only mouth-to-mouth CPR. The purpose of this study was to compare standard CPR and compression-only CPR, but a short comment on mouth-to-mouth CPR will be found in the end of Results.

Standard CPR Versus Compression-Only CPR

Patients who were given compression-only CPR were older and less likely to have VF, and the interval between the call for and the arrival of the ambulance was shorter (Table 1). There was, however, no significant difference between patients who received compression-only CPR and standard CPR in terms of being hospitalized alive or being alive after 1 month. When we adjusted for differences at baseline (age [continuous variable], sex [men versus women], time [continuous variable], type of bystander [healthcare provider versus non-healthcare provider]), the adjusted odds ratio for survival to 1 month (standard CPR versus compression-only CPR) was 1.18 (95% confidence interval, 0.89 to 1.56), as shown in Table 2.

Type of Bystander

Patients who received standard CPR had significantly more often been given CPR by healthcare providers than patients who received compression-only CPR.

Table 2. Survival of Patients Receiving Standard Bystander CPR Compared With Chest Compression Only

	Standard CPR	Compression-Only CPR	Odds Ratio
Hospitalized alive, %	19.6	20	
Adjusted			1.03 (0.86–1.23)
Unadjusted			0.97 (0.85–1.13)
Alive at 1 month, %	7.2	6.7	
Adjusted			1.18 (0.89–1.56)*
Unadjusted			1.10 (0.86–1.40)*
Survival in relation to ambulance response time and mode of bystander CPR, % (n)			
0 to 8 min	11.5 (3937)	9.5 (697)	NS
>8 min	2.7 (3743)	1.8 (369)	NS

*95% confidence interval, adjusted for age, sex, ambulance response time, and type of bystander.

Time Delay

When survival was related to ambulance response time, there was no significant difference between standard CPR and compression-only CPR in survival to 1 month either when delay was short (≤ 8 minutes; 11.5% versus 9.5%; $P=NS$) or when delay was long (>8 minutes; 2.7% versus 1.8%; $P=NS$). The relationship between ambulance response time and survival in the 2 groups is illustrated in detail in the Figure.

Standard CPR Versus Mouth-to-Mouth Ventilation Only

Patients who received mouth-to-mouth ventilation only were somewhat younger, were more often women, considerably more frequently suffered from OHCA at home, were less likely to have a cardiac cause, and were less frequently found in VF. They had a shorter delay time between call for and arrival of the ambulance than patients who received standard CPR.

Furthermore, fewer patients who received mouth-to-mouth ventilation were hospitalized alive, and a lower proportion of patients were alive after 1 month compared with patients who received standard CPR (4.5%; $P<0.0001$ versus standard CPR).

Discussion

Overall Results

We found that in patients who received bystander CPR after OHCA, 73% received standard CPR, whereas 10% were

given compression-only CPR only. (An additional 17% of patients received mouth-to-mouth CPR only and were excluded from the primary analysis.)

There was no significant difference in 1-month survival between patients who received compression-only CPR compared with those who received standard CPR. This is similar to the findings of Hallstrom et al,¹² who reported equal survival between these 2 groups in a dispatcher-assisted CPR study. In a recent report on bystander participation in OHCA, other workers have described a subset of patients with apnea, shockable rhythm, and resuscitation start within 4 minutes in whom there was a better outcome when bystanders performed compression-only CPR compared with standard CPR.¹³

Factors Influencing Results

Our 2 groups differed in some aspects at baseline. These differences were adjusted for in the multivariate analysis with the exception of initial rhythm because initial rhythm can be regarded as an effect variable. Some of these aspects need further comment.

Sex and Age

Women and younger persons are reported to have a better prognosis in OHCA.^{14,15} However, none of these 2 factors affected survival rate in our study population.

Initial Rhythm

VF was more frequently encountered in the standard CPR group than in the compression-only CPR group. One possible reason for the similar survival results in the standard CPR and compression-only CPR groups could be that these 2 methods are probably similarly effective in maintaining pump function during VF.

Ambulance Response Time

One of the major contributors to a better survival rate after OHCA is the time interval between call and arrival of the rescue team.¹⁶ The ambulance response time in the compression-only CPR group was significantly shorter (6 minutes) than in the standard CPR group (8 minutes), which may have influenced the outcome in a favorable direction in the compression-only CPR group. However, when we adjusted for this difference, the overall result did not change. Furthermore, the association between the ambulance response

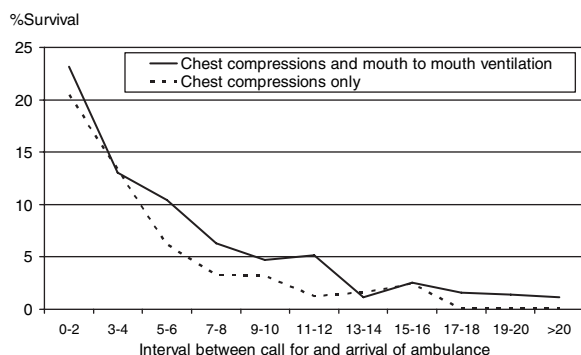


Figure. Percent survival for standard CPR and compression-only CPR in relation to ambulance response time.

time and survival appeared very similar in the 2 treatment groups (Figure).

Quality of CPR

A factor that might affect our results in the univariate analysis may be that CPR was more often performed by healthcare providers in the standard CPR group, as also shown by others.¹⁷

Role of Ventilation

The relatively high survival rate in the compression-only CPR group requires further comment. These patients received no ventilation before arrival of the rescue team. One possible explanation for this favorable finding in the compression-only CPR group is most probably the predominant importance of rapidly starting and continuously performing chest compression without interruption,^{18–20} which, furthermore, is in agreement with the new CPR guidelines.¹³

Reason Not to Start CPR

We do not know why some patients received standard CPR, whereas others were given compression-only CPR. Our study covers a time when only standard CPR had been taught. In a small, unpublished survey from Stockholm in which 76 emergency calls for OHCA were evaluated, it was observed that patients who did not receive standard CPR more often were lying or sitting in a difficult position, which prevented the caller from performing standard CPR.

Investigators have also shown that even if people have been trained to perform CPR, only a minority start such treatment.²¹ One reason may be that a considerable number of bystanders have doubts about performing CPR including ventilations for reasons that include fear of infections.^{22–24}

Improvement of CPR by Dispatching

A way to stimulate more bystanders to start early and effective CPR, even among those who have had no previous CPR training, is for the dispatcher, when responding to the alarm call, to give CPR instructions to the caller. Similar survival rates have been obtained with dispatcher-assisted CPR compared with basic CPR.²⁵ Indeed, dispatcher-assisted CPR with a compression-only mode seems to result in survival rates as good as those for dispatcher-assisted standard CPR.¹²

Limitations

The major problem with observational studies is how to deal with confounding factors. Although we adjusted for several confounding factors in the multivariate analysis, we cannot exclude the possibility of the existence of other such factors. One is most likely comorbidity, for which there are no data in the cardiac arrest register. Data from this survey are applicable for unexpected sudden collapse outside the hospital, a condition that is almost always due to cardiac arrest. In contrast, in patients with respiratory arrest, ventilations are probably more important, and standard CPR including chest compression and ventilation is superior to either technique alone.²⁶

Implications

This study lends further support for the use of chest compression only as a simpler version of CPR in people suffering from OHCA while waiting for medical assistance. This may be especially important in dispatcher-assisted CPR and also in cases involving elderly bystanders, in which the simplest algorithm is probably also the best.

However, a randomized trial must be performed to give us further information concerning this central question. Two large independent, prospective, randomized trials are ongoing in the United States (Seattle, Wash) and in Finland and Sweden. The dispatchers randomize patients to either standard CPR or compression-only CPR. The primary end point is death, and the studies will include 6000 patients. We therefore suggest waiting for the results of these randomized trials before starting any new discussion to change guidelines.

Conclusions

In this retrospective registry study of CPR in patients suffering from OHCA, there was no significant difference in the 1-month survival rate in patients who received standard CPR compared with those given compression-only CPR.

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Disclosures

None.

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CLINICAL PERSPECTIVE

Out-of-hospital sudden cardiac arrest is a leading cause of death in the western world, being responsible for $\approx 50\%$ of adult deaths from coronary heart disease. The vast majority of out-of-hospital cardiac arrest victims die, with only $\approx 5\%$ resuscitated. Early initiation of cardiopulmonary resuscitation (CPR) is a critical link in this “chain of survival” that improves outcomes. Although many lay people have some awareness of how to perform CPR, only a minority start such treatment promptly when they observe out-of-hospital cardiac arrest. The perception that CPR requires mouth-to-mouth resuscitation is a factor that likely reduces bystander CPR. Data are emerging that support use of chest compressions without mouth-to-mouth ventilation, and international CPR guidelines from 2005 give chest compression a more predominant role. Using the Swedish Cardiac Arrest Register, we examined outcomes from out-of-hospital cardiac arrest when any form of bystander CPR was administered according to whether the bystander included mouth-to-mouth ventilation or only chest compressions. Interestingly, 10% of the 11 275 arrests received chest compressions only. The 1-month survival was not significantly lower for victims who received only chest compressions compared with those who received standard CPR. Better public awareness of these findings may increase bystander participation in CPR.

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