# Dispatcher-assisted bystander CPR: a KISS for a kiss

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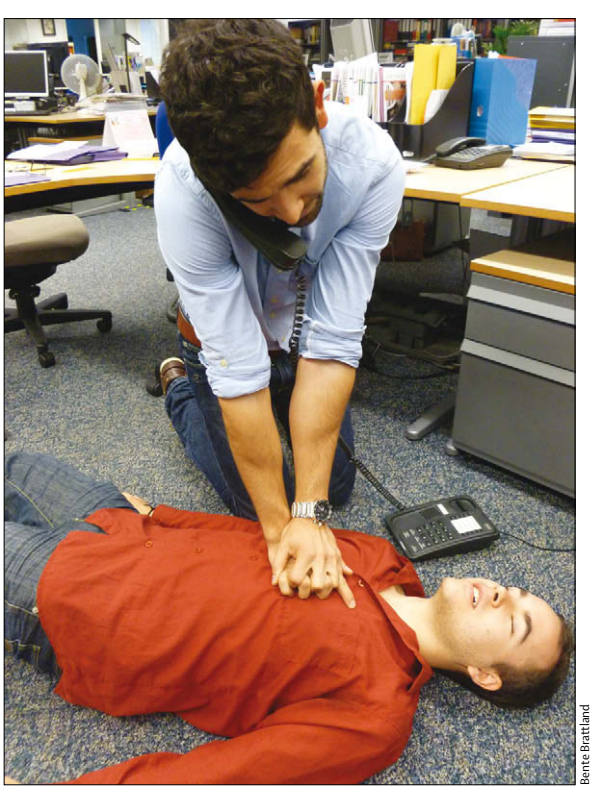
Whether cardiopulmonary resuscitation (CPR) should involve mouth-to-mouth ventilation with chest compressions or just compressions is an interesting question. Many members of the public are uncomfortable with giving rescue breaths (especially if there is vomiting) or have not been trained to give mouth-to-mouth ventilation. Many do not start CPR because they panic, or fear that they will cause harm or do CPR incorrectly. What we do know is that bystander CPR is important. In a meta-analysis, the pooled survival rate to hospital discharge after out-of-hospital cardiac arrest was 7·6% (95% CI 6·7–8·4).[1] Only a third of patients received bystander CPR, an intervention that increases survival by about 2·5 times compared with no bystander CPR. Bystanders with no CPR training can be given telephone instructions by emergency medical dispatchers to provide CPR. This dispatcher-assisted bystander CPR increases survival by about 50% compared with no CPR.[2]

In *The Lancet* today, Michael Hüpfl and colleagues[3] report two meta-analyses of the effect of chest-compression-only bystander CPR versus standard bystander CPR (chest compression plus rescue ventilation) on survival after out-of-hospital cardiac arrest. The primary meta-analysis included the only three randomised trials of dispatcher-assisted chest-compression-only CPR versus dispatcher-assisted standard CPR.[4-6] Each trial increased survival to hospital discharge with compression alone compared with standard CPR, but the associations were not significant. Today's pooled analysis showed a 22% increase in survival to hospital discharge with dispatcher-assisted compression-only bystander CPR (risk ratio 1·22, 95% CI 1·01–1·46); and the number needed to treat was 41. The three dispatcher-CPR studies were of high quality and used similar methods. Patients with cardiac arrest caused by trauma or asphyxia were excluded *a priori* by dispatchers in two studies,[5,6] and before the primary analysis in the third.[4] Only two of the three studies reported survival to hospital discharge as the primary outcome;[4,5] Svensson and colleagues[6] reported 30-day survival as the primary outcome (although survival to hospital discharge was a secondary outcome, these data were missing for more than half of the patients). One weakness of all three dispatcher-assisted CPR studies is that standard CPR was done with a compression:ventilation ratio of 15:2 instead of 30:2, which has been implemented since 2005.[7] The 30:2 ratio increases the number of compressions and might have produced different results.

Why should dispatcher-assisted compression-only CPR produce better survival rates than dispatcher-assisted standard CPR? First, rescue breathing is probably unnecessary in the first few minutes after sudden cardiac arrest—the lungs will contain sufficient oxygen at the time of cardiac arrest, and gasping, which is present initially in a third of cardiac arrests,[8] might provide some ventilation. Second, use of telephone instructions, to try to teach rescue breathing to a distressed bystander, is difficult and time consuming. Rescue-breathing instructions might result in the bystander providing no compressions at all.[5] Resuscitation guidelines from before 2005—when ventilation was attempted before chest compressions—show that the time from answering a call to delivery of the first compression was around 5 min.[9]

Hüpfl and colleagues' secondary meta-analysis included seven observational cohort studies of bystander



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CPR that compared compression-only CPR with standard CPR and excluded the three randomised studies of dispatcher-assisted CPR. This secondary meta-analysis showed no difference in survival to hospital discharge at 1 week or 30 days. Another recent observational cohort study[10] was not included in the secondary meta-analysis: implementation of compression-only CPR in Arizona was associated with an increase in the rate of bystander CPR from 28·2% in 2005 (95% CI 24·6–31·8) to 39·9% in 2009 (36·8–42·9, p<0·001).[10] Overall survival increased from 3·7% (2·2–5·2) to 9·8% (8·0–11·6, p<0·001), but there was no significant difference between compression-only CPR and standard CPR in the individuals with a good neurological outcome (odds ratio 1·50, 95% CI 0·97–2·30). Interpretation of observational studies is problematic because of likely undetected confounders.

Hüpfl and colleagues are correct in separating the randomised studies of dispatcher-assisted CPR from the observational studies of bystander CPR, partly because of the lower quality of the observational studies, but also because of the fundamental difference between dispatcher-assisted compression-only CPR and compression-only CPR done spontaneously by bystanders who might or might not be trained. When the cause of cardiac arrest is asphyxial (including most paediatric cases),[11,12] and when emergency medical response times are longer than 4–6 min, standard CPR might produce better outcomes.

How should the results of these meta-analyses affect practice? If the information from a caller suggests sudden adult cardiac arrest, the dispatcher should provide instructions assertively on compression-only CPR. Thus the "kiss of life" should be replaced by "Keep It Simple, Stupid", which is broadly consistent with the practice of many emergency medical dispatchers in the UK. For adult primary cardiac arrest, dispatchers instruct the bystander to give 600 compressions (about 6 min) followed by two rescue breaths and then a compression:ventilation ratio of 100:2 until emergency medical personnel arrive (Barron T, International Academies of Emergency Dispatch, Bristol, UK, personal communication).[13] The general role of bystander compression-only CPR is less clear. A bystander who starts CPR will not know how long the emergency medical services will take to arrive, and will not understand the difference between asphyxial and primary cardiac arrest. Therefore, ideally, lay people should continue to be trained in standard CPR. But any CPR is better than no CPR. Compression-only CPR has an important role in increasing the rate of bystander CPR by those who are untrained,[10] who have only a minimum time for training, or who are unwilling or unable to provide rescue breathing.

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# Chest-compression-only versus standard cardiopulmonary resuscitation: a meta-analysis

*Michael Hüpfl, Harald F Selig, Peter Nagele*


## Summary

**Background** In out-of-hospital cardiac arrest, dispatcher-assisted chest-compression-only bystander CPR might be superior to standard bystander CPR (chest compression plus rescue ventilation), but trial findings have not shown significantly improved outcomes. We aimed to establish the association of chest-compression-only CPR with survival in patients with out-of-hospital cardiac arrest.

**Methods** Medline and Embase were systematically reviewed for studies published between January, 1985, and August, 2010, in which chest-compression-only bystander CPR was compared with standard bystander CPR for adult patients with out-of-hospital cardiac arrest. In the primary meta-analysis, we included trials in which patients were randomly allocated to receive one of the two CPR techniques, according to dispatcher instructions; and in the secondary meta-analysis, we included observational cohort studies of chest-compression-only CPR. All studies had to supply survival data. The primary outcome was survival to hospital discharge. A fixed-effects model was used for both meta-analyses because of an absence of heterogeneity among the studies ($I^2$=0%).

**Findings** In the primary meta-analysis, pooled data from three randomised trials showed that chest-compression-only CPR was associated with improved chance of survival compared with standard CPR (14% [211/1500] *vs* 12% [178/1531]; risk ratio 1·22, 95% CI 1·01–1·46). The absolute increase in survival was 2·4% (95% CI 0·1–4·9), and the number needed to treat was 41 (95% CI 20–1250). In the secondary meta-analysis of seven observational cohort studies, no difference was recorded between the two CPR techniques (8% [223/2731] *vs* 8% [863/11 152]; risk ratio 0·96, 95% CI 0·83–1·11).

**Interpretation** For adults with out-of-hospital cardiac arrest, instructions to bystanders from emergency medical services dispatch should focus on chest-compression-only CPR.


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## Introduction

The optimal method for out-of-hospital bystander cardiopulmonary resuscitation (CPR) is controversial.[1,2] Recommended standard basic life support combines chest compression and rescue ventilation.[3,4] During the last decade, evidence from studies in animals[5,6] and humans[7–13] has questioned the usefulness of rescue ventilation during adult CPR. In these studies, chest-compression-only CPR was either equivalent or superior to standard CPR with chest compression plus rescue ventilation. However, the evidence was largely inconclusive, mostly because of the observational study design or small sample size.

In a trial published in 2000, 520 patients with out-of-hospital cardiac arrest were randomly assigned to receive either dispatcher-assisted chest-compression-only or standard CPR.[14] Chest-compression-only CPR was associated with a survival benefit, although the difference was not significant (relative difference 40%; absolute difference 4·2%, p=0·18).[14] Two subsequent randomised trials reported a similar benefit with dispatcher-assisted chest-compression-only CPR: Rea and colleagues[15] recorded a 14% increase in survival to hospital discharge (1·5% absolute increase, p=0·31) in 1941 patients with cardiac arrest; and Svensson and co-workers[16] reported a 24% improvement in 30-day survival (1·7% absolute increase, p=0·29) in 1276 patients with cardiac arrest. Despite results favouring chest-compression-only CPR in all three trials, assessment of which dispatcher-assisted CPR method is superior was inconclusive.

Therefore, we aimed to systematically review existing evidence regarding chest-compression-only CPR and compare the findings with standard CPR in a meta-analysis. In the meta-analysis, we followed the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guideline[17] for randomised trials and the MOOSE (Meta-analysis Of Observational Studies in Epidemiology) guideline[18] for observational cohort studies.

## Methods

### Search strategy and selection criteria

We searched Medline and Embase for studies published between January, 1985, and August, 2010, with the search terms "chest compression-only", "compression alone", "hands-only", and "bystander CPR". Additionally, we manually checked the reference list of every article for further suitable studies. We considered articles published in English and German for inclusion in the analysis; despite this restriction, we did not identify studies published in any other languages.

We separated the systematic review and meta-analysis into two parts: primary analysis of randomised trials, and

secondary analysis of observational cohort studies. All studies that were eligible for inclusion compared chest-compression-only bystander CPR with standard bystander CPR by chest compression plus rescue ventilation, were done in adult patients with out-of-hospital cardiac arrest, and supplied survival data. In randomised trials that were eligible for inclusion, patients were randomly assigned to receive one of the two CPR techniques according to instructions from a dispatcher. Observational studies that were eligible for inclusion had a cohort design (no case series), and used an unstratified cohort (eg, arrests of non-cardiac origin only).

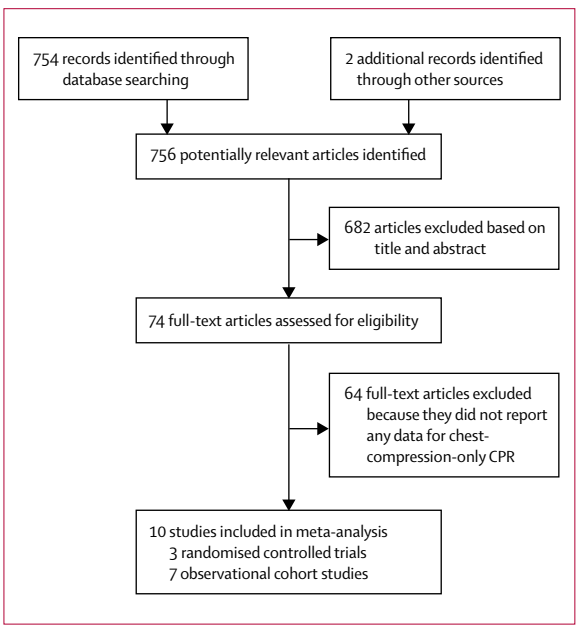


***Figure 1:*** **Selection of studies for the meta-analysis**
CPR=cardiopulmonary resuscitation.

## Data extraction

In addition to information about study design, characteristics, and sample size, we extracted actual numbers of survivors and corresponding cohort sizes and event rates. Survival to hospital discharge was the primary outcome variable, but we also obtained outcome data on return of spontaneous circulation, 30-day survival, and favourable neurological outcome. If data for survival to hospital discharge were not available, we used 30-day survival as the primary outcome.

## Statistical analysis

All analyses were done with Biostat Comprehensive Meta-Analysis software (version 2.2.050). Risk ratios (RR) and 95% CIs were calculated for every study and pooled in both fixed-effects and random-effects models. However,

| | Study design | Patients receiving chest-compression-only CPR | Patients receiving standard CPR | Primary outcome | Secondary outcome | Patients with missing outcome data |
|---|---|---|---|---|---|---|
| **Randomised trials*** | | | | | | |
| Hallstrom et al (2000)[14] | Randomised | 240 | 278 | Survival to hospital discharge | Admission to hospital; neurological status of survivors | 2/520 (<1%) |
| Rea et al (2010)[15] | Randomised | 978 | 956 | Survival to hospital discharge | Favourable neurological outcome at discharge | 7/1941 (<1%) |
| Svensson et al (2010)[16] | Randomised | 282 | 297 | 30-day survival† | 1-day survival; survival to hospital discharge | 0/1276 for 30-day survival; 697/1276 (55%) for survival to hospital discharge |
| **Observational cohort studies‡** | | | | | | |
| Bohm et al (2007)[7] | Retrospective | 1145 | 8209 | Admission to hospital; 30-day survival | .. | 0/11 275 |
| Iwami et al (2007)[8] | Prospective | 544 | 783 | Favourable neurological outcome 1 year after cardiac arrest | Return of spontaneous circulation; admission to hospital; 1-week, 30-day, and 1-year survival | 25/23 436 (<1%) |
| Olasveengen et al (2008)[9] | Retrospective | 145 | 281 | Survival to hospital discharge | Return of spontaneous circulation; admission to hospital | Not reported |
| Ong et al (2008)[10] | Prospective | 154 | 287 | Survival to hospital discharge | 30-day survival | Not reported |
| SOS-KANTO Study Group (2007)[11] | Prospective | 439 | 712 | Favourable neurological outcome 30 days after cardiac arrest | 30-day survival | 0/4068 |
| Van Hoeyweghen et al (1993)[12] | Retrospective | 263 | 443 | Awake 14 days after CPR | .. | Not reported |
| Waalewijn et al (2001)[13] | Prospective | 41 | 437 | Admission to hospital; survival to hospital discharge | .. | Not reported |

Data are number or n/N (%). CPR=cardiopulmonary resuscitation. *In randomised studies, patients and the study investigators were masked to CPR technique, but the bystander, the emergency medical services team, and the dispatcher were not. †For consistency between the three randomised trials, survival to hospital discharge was assessed in the meta-analysis, but for the primary outcome of 30-day survival in Svensson and colleagues' study,[16] 54/620 (9%) patients survived in the group receiving chest-compression-only CPR and 46/656 (7%) survived in the group receiving standard CPR. ‡Data for survival to hospital discharge were used for the meta-analysis except for studies in which this information was unavailable: 30-day survival was used for Bohm and colleagues study,[7] and SOS-KANTO Study Group's studies;[11] 1-week survival was used for Iwami and colleagues study;[8] and awake after 14 days was used for Van Hoeyweghen and colleagues study.[12]

***Table:*** **Study characteristics**

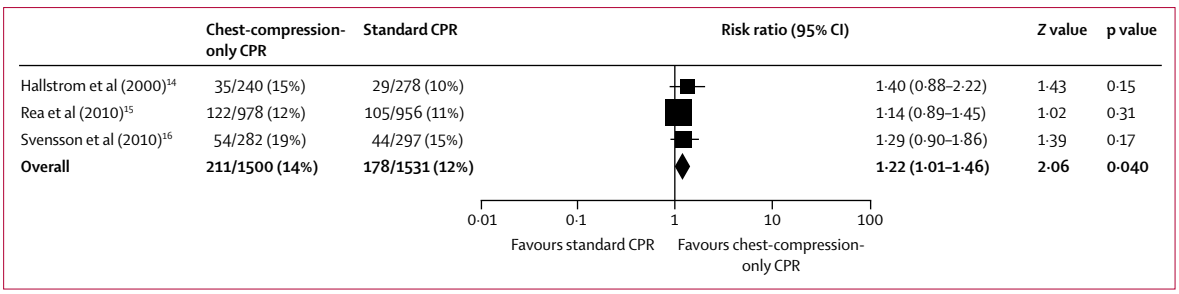


***Figure 2:*** **Primary analysis of survival to hospital discharge in randomised trials**
CPR=cardiopulmonary resuscitation.

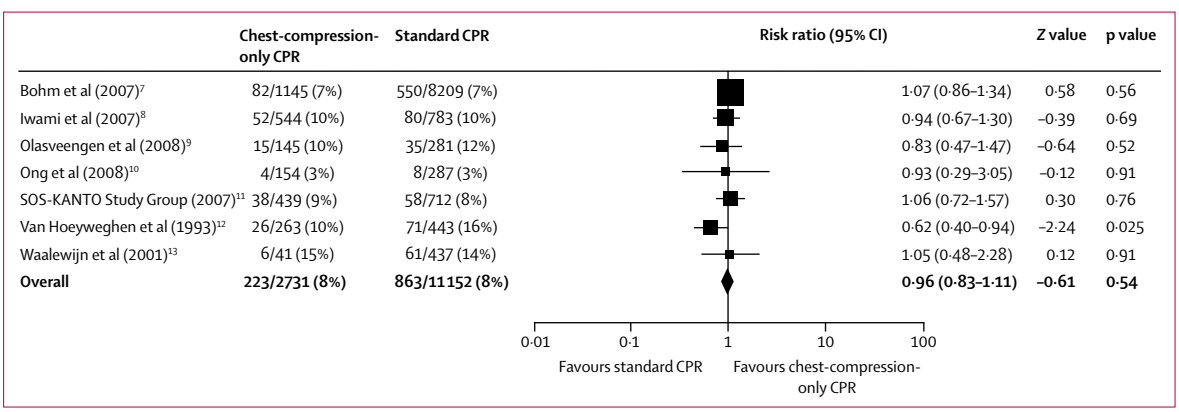


***Figure 3:*** **Secondary analysis of survival outcomes in observational cohort studies**
CPR=cardiopulmonary resuscitation.

the heterogeneity within the primary and secondary meta-analyses was negligible, as indicated by an $I^2$ of 0%, so we report only the results of the fixed-effects model. Comprehensive Meta-Analysis software uses the inverse-variance method for weighting studies; other methods can be selected, such as Mantel-Haenszel, but the results in our meta-analyses did not differ between these methods. Heterogeneity among studies was formally assessed by the $Q$ and $I^2$ statistics. Publication bias was tested with the Egger's regression test.

### Role of the funding source

Both funding organisations had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit for publication. The corresponding author had full access to all the data and had the final decision to submit for publication.

## Results

In the systematic review, we identified three randomised trials that were eligible for inclusion in the primary meta-analysis (figure 1, table).[14–16] The quality of these trials was high; all trials reported outcomes in an intention-to-treat analysis, had few missing data, and had a low rate of intervention crossovers. For the primary outcome of survival to hospital discharge, all three trials individually showed a small benefit in patients who received chest-compression-only CPR, but the differences were not significant (figure 2). Meta-analysis of these studies showed a significantly increased chance of survival with chest-compression-only CPR compared with standard CPR (figure 2), with an absolute increase in survival of 2·4% (95% CI 0·1–4·9). The number needed to treat was 41 (95% CI 20–1250).

Systematic review also identified seven observational cohort studies that were eligible for the secondary meta-analysis (figure 1, table). Notably, of 64 observational cohort studies deemed ineligible because they did not investigate chest-compression-only CPR, none investigated dispatcher-assisted CPR. All seven studies prospectively or retrospectively investigated the association between bystander CPR technique and survival. Apart from one study,[12] none of the observational studies showed a significant survival difference between the two CPR techniques (figure 3). Despite our intention to use survival to hospital discharge as the primary outcome in the meta-analysis, this outcome was not reported in four studies, so instead we used 30-day survival,[7,11] 1-week survival,[8] or awake after 14 days.[12] In the meta-analysis of these studies, chest-compression-only CPR was not associated with a difference in survival compared with standard CPR (figure 3). Furthermore, chest-compression-only CPR did not improve the rate of return of spontaneous circulation (figure 4).

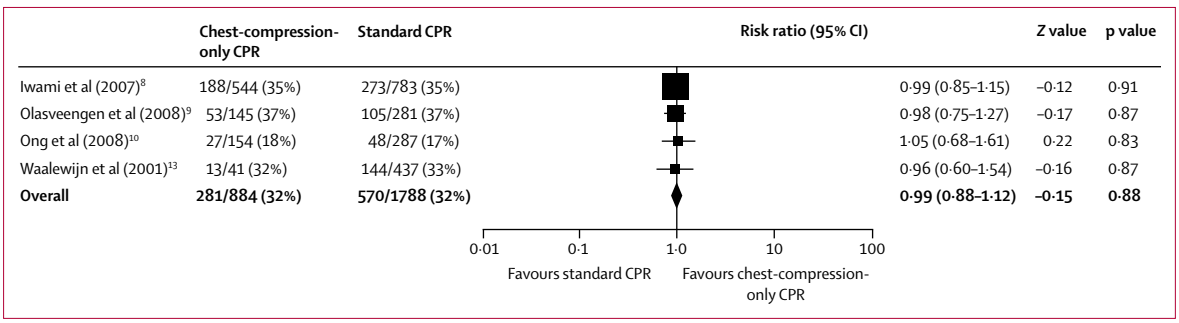


***Figure 4:*** **Analysis of return of spontaneous circulation**
CPR=cardiopulmonary resuscitation.

## Discussion

The results of this meta-analysis show that dispatcher-assisted chest-compression-only bystander CPR is associated with improved survival in adults with out-of-hospital cardiac arrest compared with standard CPR (chest compression plus rescue ventilation; panel).

Since meta-analyses are used to pool existing evidence, we should consider the strength of the evidence favouring chest-compression-only CPR. Despite the small number of trials included in this meta-analysis,[14–16] the evidence favouring dispatcher-assisted chest-compression-only CPR seems to be robust since all randomised trials reported similar positive effects of this CPR technique on survival, although differences were not significant. The pooled effect size of about 22% might seem small, but rates of survival after out-of-hospital cardiac arrest have been about 4–8% for the past few decades, so our result could represent important progress. The incidence of cardiac arrest is about 0·5 cases per 1000 people per year in the USA and Canada.[19] Extrapolation of this number to include the USA, Canada, and the European Union (combined population of about 850 million), with an absolute increase in survival of 2% as recorded in our meta-analysis (eg, from 10% to 12%, which is equivalent to a 20% relative increase), an additional 8000 lives could be saved per year.

None of the randomised trials individually showed a significant improvement with dispatcher-assisted chest-compression-only CPR compared with standard CPR, which was probably because of inadequate statistical power. The fact that only three randomised trials have been done is testament to the difficulties associated with well designed prospective studies in this setting, such as obtaining of informed consent, the little time available to randomise patients, adherence to the study protocol, tracking of patients and outcomes, and masking of investigators, study personnel, and patients from the allocated intervention. Because survival rates after out-of-hospital cardiac arrest are low and large treatment effects are unlikely, very large sample sizes are needed to show a significant survival benefit. No trial of chest-compression-only CPR had more than 125 events of survival in a study group, which is a fairly small number for statistical analyses.

We should also address the plausibility of our findings. Several independent lines of evidence support a survival benefit associated with dispatcher-assisted chest-compression-only CPR compared with standard bystander CPR in out-of-hospital cardiac arrest. The best CPR technique for survival is a controversial issue and has been intensively discussed over the past few years,[20,21] so only the most pertinent explanations will be mentioned. First, uninterrupted, high-quality chest compression is very important for successful CPR.[11,22,23] Minimal hands-off time, both for lay people and health-care professionals, is an important predictor for improved survival after cardiac arrest. By avoidance of rescue ventilation during CPR, which is often fairly time consuming for lay bystanders,[24] a continuous uninterrupted coronary perfusion pressure is maintained, which increases the probability of a successful outcome.[6] These considerations were the main reason to increase the compression-to-ventilation ratio for standard basic life support from 15:2 to 30:2 in the 2005 resuscitation guidelines.[3,4] All three dispatcher-assisted CPR trials used the 15:2 ratio, and whether use of the 30:2 ratio would have changed the results is unclear. Second, provision of oxygenation and ventilation during the first minutes after cardiac arrest, particularly witnessed cardiac arrest, might be less important than is high-quality chest compression. Third, chest-compression-only CPR is easier to teach, learn, and do than is the fairly complex standard CPR algorithm, thus increasing the probability that a bystander will intervene and provide CPR.

Although our secondary meta-analysis of observational cohort studies did not show any benefit of chest-compression-only bystander CPR compared with standard bystander CPR, these studies did not investigate dispatcher-assisted CPR. Chest-compression-only CPR had not been taught to bystanders in any of the studies; rather, the lay bystander made the deliberate decision to avoid mouth-to-mouth rescue ventilation. Although our findings suggest that dispatcher-assisted chest-compression-only CPR increases survival compared with standard CPR in adults with out-of-hospital cardiac arrest,


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### *Panel*: Research in context

#### Systematic review

For this article, a rigorous search strategy was used to identify all clinical trials that prospectively randomised adults with out-of-hospital cardiac arrest to receive dispatcher-assisted chest-compression-only or standard CPR (including rescue ventilation), and all observational studies that distinguished between chest-compression-only and standard CPR in adults with out-of-hospital cardiac arrest.

#### Interpretation

Dispatcher-assisted chest-compression-only bystander CPR is associated with a 22% improved survival rate in adults with out-of-hospital cardiac arrest compared with standard CPR.

CPR=cardiopulmonary resuscitation.

several circumstances exist in which this CPR technique might not be beneficial. Findings from a large-scale prospective cohort study suggest that standard CPR might actually improve survival compared with chest-compression-only CPR in cardiac arrest from non-cardiac causes (eg, drowning, trauma, or asphyxia).[25] Moreover, in children with out-of-hospital cardiac arrest, which is often of non-cardiac origin, standard CPR might confer a similar benefit.[26] Therefore, the benefits of chest-compression-only bystander CPR seem to be largest in adult patients with sudden cardiac death.

Our findings support the idea that emergency medical services dispatch should instruct bystanders to focus on chest-compression-only CPR in adults with out-of-hospital cardiac arrest. However, whether chest-compression-only CPR should be recommended for unassisted lay bystander CPR is unclear.

#### Contributors

MH and PN were responsible for the study concept and design, and provided administrative, technical, or material support. PN was responsible for obtaining of funding, supervision of the study, acquisition of data, and statistical analysis. All authors contributed to analysis and interpretation of data. MH and PN drafted the report, and all authors contributed to revision of the report.

#### Conflicts of interest

PN's institution has received research support from Roche Diagnostics, unrelated to this study; PN has received consultancy fees from Gerson Lehrman Group; and PN and his institution have received grants from the US National Institutes of Health and American Heart Association. MH is receiving a salary and has received payment for development of educational presentations from St John's Ambulance Service, Vienna, Austria; and has received research support, lecture fees, and travel support from Novo Nordisk. HFS declares that he has no conflicts of interest.

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