Community first responders for out-of-hospital cardiac arrest in adults and children

Review information

Review type: Intervention

Review number: EC357

Authors

Tomas Barry[1], Maeve C Doheny[1], Siobhán Masterson[2], Niall Conroy[3], Jan Klimas[4,5], Ricardo Segurado[6], Mary Codd[6], Gerard Bury[1]

[1]School of Medicine, University College Dublin, Dublin, Ireland
[2]Discipline of General Practice, School of Medicine, National University of Ireland Galway, Galway, Ireland
[3]Centre for Emergency Medical Science, University College Dublin, Dublin, Ireland
[4]BC Centre on Substance Use, BC Centre for Excellence in HIV/AIDS, Vancouver, Canada
[5]School of Medicine, University College Dublin, Dublin, Ireland
[6]School of Public Health, Physiotherapy and Sport Science, University College Dublin, Dublin, Ireland

Citation example: Barry T, Doheny MC, Masterson S, Conroy N, Klimas J, Segurado R, Codd M, Bury G. Community first responders for out-of-hospital cardiac arrest in adults and children. Cochrane Database of Systematic Reviews 2017 , Issue 8 . Art. No.: CD012764. DOI: 10.1002/14651858.CD012764 .

Contact person

Tomas Barry

General Practitioner/ Lecturer
School of Medicine
University College Dublin
Dublin
Ireland

E-mail: tomas.barry@ucd.ie

Dates

Assessed as Up-to-date:	15 January 2019
Date of Search:	15 January 2019
Next Stage Expected:	20 May 2019
Protocol First Published:	Issue 8 , 2017
Review First Published:	Not specified
Last Citation Issue:	Issue 8 , 2017

What's new

Date	Event	Description

History

Date	Event	Description
3 January 2019	Amended	Editorial team changed to Cochrane Emergency and Critical Care

Abstract

Background

Mobilization of community first responders (CFRs) to the scene of an out-of-hospital cardiac arrest (OHCA) event has been proposed as a means of shortening the interval from occurrence of cardiac arrest to performance of cardiopulmonary resuscitation (CPR) and defibrillation, thereby increasing patient survival.

Objectives

To assess the effect of mobilizing community first responders (CFRs) to out-of-hospital cardiac arrest events in adults and children older than four weeks of age, in terms of survival and neurological function.

Search methods

We searched the following databases for relevant trials in January 2019: CENTRAL, MEDLINE (Ovid SP), Embase (Ovid SP), and Web of Science. We also searched the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) and ClinicalTrials.gov, and we scanned the abstracts of conference proceedings of the American Heart Association and the European Resuscitation Council.

Selection criteria

We included randomized and quasi-randomized trials (RCTs and q-RCTs) that compared routine emergency medical services (EMS) care versus EMS care plus mobilization of CFRs in instances of OHCA.Trials with randomization by cluster were eligible for inclusion, including cluster-design studies with intervention cross-over.

In some communities, the statutory ambulance service/EMS is routinely provided by the local fire service. For the purposes of this review, this group represents the statutory ambulance service/EMS, as distinct from CFRs, and was not included as an eligible intervention.

We did not include studies primarily focused on opportunistic bystanders. Individuals who were present at the scene of an OHCA event and who performed CPR according to telephone instruction provided by EMS call takers were not considered to be CFRs.

Studies primarily assessing the impact of specific additional interventions such as administration of naloxone in narcotic overdose or adrenaline in anaphylaxis were also excluded.

We included adults and children older than four weeks of age who had experienced an OHCA.

Data collection and analysis

Two review authors independently reviewed all titles and abstracts received to assess potential eligibility, using set inclusion criteria. We obtained and examined in detail full-text copies of all papers considered potentially eligible, and we approached authors of trials for additional information when necessary. We summarized the process of study selection in a PRISMA flowchart.

Three review authors independently extracted relevant data using a standard data extraction form and assessed the validity of each included trial using the Cochrane 'Risk of bias' tool. We resolved disagreements by discussion and consensus.

We synthesized findings in narrative fashion due to the heterogeneity of the included studies. We used the principles of the GRADE system to assess the certainty of the body of evidence associated with specific outcomes and to construct a 'Summary of findings' table.

Main results

We found two completed studies involving a total of 1136 participants that ultimately met our inclusion criteria. We also found one ongoing study and one planned study. We noted significant heterogeneity in the characteristics of interventions and outcomes measured or reported across these studies, thus we could not pool study results.

One completed study considered the dispatch of police and fire service CFRs equipped with automatic external defibrillators (AEDs) in an EMS system in Amsterdam and surrounding areas. This study was an RCT with allocation made by cluster according to non-overlapping geographical regions. It was conducted between 5 January 2000 and 5 January 2002. All participants were 18 years of age or older and had experienced or witnessed an OHCA. The study found no difference in survival at hospital discharge (odds ratio (OR) 1.3, 95% confidence interval (CI) 0.8 to 2.2; 1 RCT; 469 participants; low-certainty evidence), despite the observation that all 72 incidences of defibrillation performed before EMS arrival occurred in the intervention group (OR and 95% CI - not applicable; 1 RCT; 469 participants; moderate-certainty evidence). This study reported increased survival to hospital admission in the intervention group (OR 1.5, 95% CI 1.1 to 2.0; 1 RCT; 469 participants; moderate-certainty evidence).

The second completed study considered the dispatch of nearby lay volunteers in Stockholm, Sweden, who were trained to perform cardiopulmonary resuscitation (CPR). This represented a supplementary CFR intervention in an EMS system where police and fire services were already routinely dispatched to OHCA in addition to EMS ambulances. This study, an RCT, included both witnessed and unwitnessed OHCA and was conducted between 1 April 2012 and 1 December 2013. Participants included adults and children eight years of age and older. Researchers found no difference in 30-day survival (OR 1.34, 95% CI 0.79 to 2.29; 1 RCT; 612 participants; low-certainty evidence), despite a significant increase in CPR performed before EMS arrival (OR 1.49, 95% CI 1.09 to 2.03; 1 RCT; 665 participants; moderate-certainty evidence).

Neither of the included completed studies considered neurological function at hospital discharge or at 30 days, measured by cerebral performance category or by any other means. Neither of the included completed studies considered health-related quality of life. The overall certainty of evidence for the outcomes of included studies was low to moderate.

Authors' conclusions

Moderate-certainty evidence shows that context-specific CFR interventions result in increased rates of CPR or defibrillation performed before EMS arrival. It remains uncertain whether this can translate to significantly increased rates of overall patient survival. When possible, further high-quality RCTs that are adequately powered to measure changes in survival should be conducted.

The included studies did not consider survival with good neurological function. This outcome is likely to be important to patients and should be included routinely wherever survival is measured.

We identified one ongoing study and one planned trial whose results once available may change the results of this review. As this review was limited to randomized and quasi-randomized trials, we may have missed some important data from other study types.

Plain language summary

Community first responders for out-of-hospital cardiac arrest in adults and children

Review question

To assess the effect of mobilizing community first responders to out-of-hospital cardiac arrest events in adults and children older than four weeks of age, in terms of survival and neurological function.

Background

Out-of-hospital cardiac arrest is a major cause of death. It occurs when a person's heart suddenly stops pumping blood around the body, and it is often caused by an abnormal heart rhythm. A person who suffers cardiac arrest will die within minutes unless this rhythm can be reversed.

A safe, portable, and affordable device called a 'defibrillator' can be used to terminate ('defibrillate') the abnormal rhythm causing cardiac arrest, allowing the heart to restart. A defibrillator can be used by almost anyone, even without training. To be effective, a defibrillator must be used within minutes of a cardiac arrest.

Cardiopulmonary resuscitation (CPR) is a technique where a bystander can compress and release the chest of a person who has suffered cardiac arrest, thus artificially pumping blood throughout the body. CPR can keep a cardiac arrest victim alive until a defibrillator arrives, but again it is effective only if started very soon after cardiac arrest occurs.

CPR and defibrillation are the most important interventions following cardiac arrest. Even the most advanced emergency medical systems in the world struggle to reach cardiac arrest victims in time to save life by providing CPR and defibrillation.

To shorten the time from cardiac arrest to CPR and defibrillation, healthcare systems have started to mobilize community first responders to provide these treatments. Community first responders are fellow citizens who are present in the community and have received minimum basic training in CPR/defibrillator use. They are generally alerted to cardiac arrest by the emergency medical services.

Study characteristics

This review searched for high-quality research studies that considered whether mobilizing community first responders could improve survival or neurological outcome, or both, following out-of-hospital cardiac arrest in adults and children. We last searched available databases in January 2019.

Key results

We found two eligible research studies with a total of 1136 participants.

One study conducted in Stockholm, Sweden, and funded by the Swedish Heart-Lung Foundation, Laerdal Foundation, and Stockholm County, found that mobilizing community first responders increased the rate of CPR performed before arrival of emergency medical services (data on 665 participants). The other study was conducted in Amsterdam and surrounding areas (the Netherlands) and was funded by the Netherlands Heart Foundation and Medtronic Physio-Control. Study authors reported that when community first responders were mobilized, more patients received defibrillation before emergency medical services arrived and survived to be admitted to hospital (data on 469 participants).

Neither study found that dispatching community first responders resulted in significantly more overall survivors (data on 612 participants in one study and on 469 participants in the other). Neither study reported on the neurological function of survivors or on their health-related quality of life.

Further research is needed to establish whether mobilizing community first responders can yield more survivors of cardiac arrest. Future research should consider both survival and the neurological function of survivors.

Certainty of the evidence

The certainty of available evidence in terms of overall patient survival was considered low. The certainty of available evidence in terms of performance of CPR and defibrillation before arrival of emergency medical services and in terms of survival to hospital admission was considered moderate. This evidence is current to January 2019.

Background

Description of the condition

Sudden cardiac arrest is a condition in which the heart has stopped beating or is not beating efficiently enough to sustain life (Zhan 2017). This health problem is commonly associated with high mortality (Huang 2014). Although cardiac arrest occurs both within and outside of hospital, this review focuses on cardiac arrest that occurs outside the hospital setting, as this problem poses a unique challenge for emergency medical services (EMS) operating in the community. Approximately 275,000 persons in Europe are treated for out-of-hospital cardiac arrest (OHCA), along with 155,000 persons in the USA, and survival is estimated to be in the region of 8% to 10% (Atwood 2005; Daya 2015; Rea 2004). In the USA, both median age (ranging from 66 to 68) and male proportion (63%) of persons experiencing OHCA have remained relatively stable over time (from 2006 to 2010) (Daya 2015).

Survival following cardiac arrest depends on a sequence of necessary time-sensitive interventions conceptualized as "the chain of survival" (Nolan 2006). The chain of survival summarizes the vital links needed for successful resuscitation following OHCA and emphasizes the following: early recognition and call for help; early cardiopulmonary resuscitation (CPR); early defibrillation (within minutes of collapse); and effective post-resuscitation care (Monsieurs 2015). Immediately following OHCA, blood flow to the brain is reduced to virtually zero (Perkins 2015). Cardiopulmonary resuscitation provides some blood flow to the vital organs by compressing and

releasing the chest wall. High-quality CPR remains essential for improving outcomes (Monsieurs 2015), with CPR performed before arrival of the EMS associated with doubling of survival (Hasselqvist-Ax 2015; Riva 2019). Out-of-hospital cardiac arrest is frequently a consequence of coronary artery disease (Zipes 1998), with the mechanism of death commonly due to an abnormal heart rhythm known as 'ventricular fibrillation' (VF) (Myerburg 1982). On initial heart rhythm analysis, approximately 25% of OHCA victims have VF, although this percentage does vary considerably by setting (Dyson 2019). However it is likely that at the time of collapse, an even greater percentage of victims display VF (Nolan 2010). If VF is treated early by means of electrical defibrillation, it may be reversed. Defibrillation within three to five minutes of collapse can produce survival rates as high as 50% to 70% following OHCA (Perkins 2015). However, it is estimated that survival decreases by 10% for every minute's delay to this critical intervention (Valenzuela 1997).

Description of the intervention

The intervention considered in this review is mobilization of community first responders (CFRs) to the scene of an OHCA event to supplement the response provided by statutory ambulance services.

For the purposes of this review, CFRs are defined as individuals who live or work within the community and are organized in a framework that offers OHCA care in that community, to support the standard EMS response. Community first responders are activated in real time to attend OHCA in that community by the EMS dispatch centre or by other means.

Community first responders have received a minimum of basic life support (BLS) training and may be equipped with or have access to an automatic external defibrillator (AED).

Community first responders are distinguished from OHCA bystanders, who provide BLS or AED care opportunistically.

The term 'CFR' includes professionals such as medical, nursing, police, and fire service personnel who perform the task of CFR in addition to their statutory duties, and can relate to lay individuals who organize themselves in voluntary groups and operate within a given community. Community first responders may also include off-duty paramedic staff acting in the role of CFRs.

Community first responders may be present in well-developed and funded EMS systems but also have relevance in resource-poor settings, given the potential for low-cost operation compared with other healthcare interventions.

Mobilization of CFRs to the scene of an OHCA event represents a complex intervention with variation in components depending on the community setting and its system of emergency healthcare delivery. Key features that define CFRs across different settings and systems of care include the following.

- Community first responders are present in the community where cardiac arrest occurs.
- Community first responders do not have statutory responsibility for cardiac arrest response but rather serve to supplement the statutory EMS response.
- Community first responders are mobilized to an OHCA event by an active and predetermined alert mechanism.

How the intervention might work

Mobilization of CFRs to the scene of an OHCA event could result in earlier performance of time-critical interventions known to improve survival, namely, CPR and defibrillation, than would otherwise have been possible. The use of mobile phone technology alert systems has been associated with earlier initiation of CPR following cardiac arrest (Caputo 2017), and analysis of registry data has suggested that community first responders can play a significant role in early defibrillation (Hansen 2015).

Why it is important to do this review

An out-of-hospital cardiac arrest is an important and serious health issue; the most frequent outcome is death. Increasing survival following OHCA is a healthcare service priority. A key uncertainty is whether mobilization of CFRs to OHCA events can result in significantly increased rates of survival. Community first responders have been delegated OHCA response in a variety of diverse geographical regions, including Ireland (Masterson 2013; Maurer 2006), the UK (Healthcare Commission 2007), Japan (Narikawa 2014), Norway (Rortveit 2010), and the USA (Kellermann 1993). In some regions, CFRs have become commonplace. In England in 2006/2007, there were over 10,000 individual CFRs and 1300 CFR schemes, and almost 2% of emergency ambulance calls had a CFR in attendance (Healthcare Commission 2007). The role of CFRs remains poorly understood (Timmons 2013), and although previous research has suggested that CFR involvement in OHCA appears promising (Smith 2007), this remains to be fully established. Mobilization of CFRs to OHCA events is not without cost and complexity and can introduce issues related to medico-legal concerns, professional gate-keeping, and the currency of training and supervision (Smith 2007). We conducted this Review to examine the evidence base for an increasingly prevalent intervention in OHCA and to help ensure that healthcare and community resources are directed towards appropriate evidenced-based interventions in OHCA.

Objectives

To assess the effect of mobilizing community first responders (CFRs) to out-of-hospital cardiac arrest events in adults and children older than four weeks of age, in terms of survival and neurological function.

Methods

Criteria for considering studies for this review

Types of studies

We included randomized and quasi-randomized trials (RCTs and q-RCTs) that compared routine (usual) emergency medical services (EMS) care versus EMS care plus mobilization of community first responders (CFRs) in instances of out-of-hospital cardiac arrest (OHCA). Trials with randomization by cluster were eligible for inclusion, including cluster-design studies with intervention cross-over.

A trial was considered eligible if, on the basis of the best available information, we judged that participants followed in the trial were assigned prospectively to either routine EMS care or routine EMS care with the addition of CFR mobilization, using a random or quasi-random method of allocation (Higgins 2011).

Mobilization of CFRs to OHCA represents a complex community intervention that may rely on organizational structures outside the control of the healthcare system. It is likely that in some instances, it would not be feasible for trial designs to use random allocation with individual participants representing the unit of allocation. For this reason, both randomized and quasi-randomized trials including cluster methods were eligible for inclusion in this Review.

We excluded studies that primarily considered OHCA due to traumatic causes, as the core interventions provided by CFRs, namely, cardiopulmonary resuscitation (CPR) and early defibrillation, are unlikely to be of significant benefit in such circumstances.

Types of participants

We included adults and children older than four weeks of age who had experienced an OHCA.

We excluded studies primarily considering OHCA in infants at birth.

Types of interventions

We included studies that compared routine EMS care (control group) versus EMS care plus mobilization of CFRs (intervention group) in instances of OHCA.

Community first responders were defined as per the Description of the intervention section (above). Community first responders were individuals within a community that was organized by a framework that offered OHCA care within that community to supplement the standard EMS response.

Mobilization of CFRs to the scene of an OHCA event represented a complex intervention with variation in components depending on the community setting and its system of emergency healthcare delivery. Key features that defined CFRs across different settings and systems of care included the following.

- Community first responders were present in the community where cardiac arrest occurred.
- Community first responders did not have statutory responsibility for cardiac arrest response but rather served to supplement the statutory EMS response.
- Community first responders were mobilized to an OHCA event by an active and predetermined alert mechanism.

In some communities, the statutory EMS or ambulance service is routinely provided by the local fire service. For the purposes of this Review, this group represents statutory EMS, as distinct from CFRs, and was not included as an eligible intervention.

We did not include studies primarily focused on opportunistic bystanders. Individuals who were present at the scene of an OHCA event and who performed CPR according to telephone instruction provided by EMS call takers were not considered to be CFRs.

We also excluded studies primarily assessing the impact of specific additional interventions such as administration of naloxone in narcotic overdose or adrenaline in anaphylaxis.

Types of outcome measures

Primary outcomes

- Survival at hospital discharge
- Neurological function at hospital discharge, measured by cerebral performance category (CPC)

Secondary outcomes

- Survival to hospital admission, defined as a person admitted to hospital with spontaneous circulation and measurable blood pressure (Cummins 1991)
- Cardiopulmonary resuscitation performed before EMS arrival
- Defibrillation performed before EMS arrival
- Survival at 30 days
- Neurological function at 30 days, measured by CPC
- Health-related quality of life at 90 days (health-related quality of life can be measured by many different tools; see Measures of treatment effect)

Search methods for identification of studies

Electronic searches

We identified RCTs and q-RCTs through literature searching designed to identify relevant trials, as outlined in Chapter 6.4 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We did not apply restrictions by language

or publication status.

We searched the following databases for relevant trials.

- Cochrane Central Register of Controlled Trials (CENTRAL), in the Cochrane Library, on 16 February 2018.
- MEDLINE (Ovid SP, 1946 onwards), on 16 February 2018.
- Embase (Ovid SP, 1974 onwards), on 19 February 2018.
- Web of Science (1960 to present), on 16 February 2018.

We listed the search strategies used for each database in Appendix 1. We updated the search strategy in January 2019 and re-ran the searches. We screened all new references obtained but detected no additional eligible studies.

We scanned the following trials registries on 20 August 2018 for ongoing and unpublished trials.

- World Health Organization International Clinical Trials Registry Platform (www.who.int/ictrp/en/).
- ClinicalTrials.gov.

Searching other resources

We scanned the reference lists and citations of included trials for further references to additional trials. We also scanned the abstracts of conference proceedings of the American Heart Association and the European Resuscitation Council. When necessary, we contacted trial authors to request additional information.

Data collection and analysis

Selection of studies

Two review authors (TB and MD) independently reviewed all titles and abstracts received to assess potential eligibility, using the inclusion criteria outlined above. We obtained and examined in detail full-text copies of all papers considered potentially eligible, and we approached authors of trials for additional information when necessary. We resolved disagreements by discussion, and when necessary, we involved a third review author (GB or RS). We have summarized the process of study selection in a PRISMA flowchart (Moher 2009).

Data extraction and management

Three review authors (TB, GB, and MD) independently extracted relevant data using our standard data extraction form (Appendix 2), which we adapted from the version used by the Cochrane Effective Practice and Organisation of Care Group (EPOC 2013).

We collected information on study design, study setting, participant characteristics, eligibility criteria, details of intervention(s) given, outcomes assessed, sources of study funding, and any conflicts of interest. We contacted authors of included trials to request additional information when this was necessary. We resolved any disagreements by discussion and consensus.

Assessment of risk of bias in included studies

Three review authors (TB, GB, and MD) independently assessed the validity of each included trial using the Cochrane 'Risk of bias' tool and provided a summary assessment of risks of bias across studies (Higgins 2011).

We assessed each included trial according to the following domains: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other potential sources of bias. Where relevant, the latter included sources related to a cluster-randomized design such as (1) recruitment bias; (2) baseline imbalance; (3) loss of clusters; (4) incorrect analysis; and (5) comparability with individually randomized trials, as outlined in Section 16.3.2 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). For the domain of 'incomplete outcome data', we assessed risk of bias at the outcome level rather than at the study level.

We considered low risk of bias to represent studies with plausible bias unlikely to seriously alter the results; unclear risk of bias to represent studies with plausible bias that raises doubts about the results; and high risk of bias to represent studies with plausible bias that seriously weakens confidence in the results (Higgins 2011). We resolved any disagreements by discussion and consensus.

We constructed a 'Risk of bias' table and generated plots of risk of bias assessments using Review Manager 5 (Review Manager 2014).

Measures of treatment effect

We used odds ratios (ORs) with 95% confidence intervals (CIs) to measure the following dichotomous outcomes.

- Survival at hospital discharge.
- Survival at 30 days.
- Survival to hospital admission.
- Cardiopulmonary resuscitation performed before EMS arrival.

It was not possible to calculate an OR for 'defibrillation performed before ambulance service arrival', as in the only study that reported this outcome, no cases occurred in the control group.

We planned to group neurological outcomes into categories of favourable (CPC score of 1 or 2) and unfavourable (CPC score of 3, 4, or 5), as suggested in a previous systematic review concerning OHCA (Huang 2014); however, data for this outcome were not available.

Health-related quality of life can be measured by many different tools, including the Quality of Life Scale, the Personal Wellbeing Index, Short Form-36, and the Satisfaction With Life Survey (Dronavalli 2015), with potentially varying validity for this target population. We anticipated substantial heterogeneity in measuring this outcome, and for this reason, planned to assess treatment effects of health-related quality of life by narrative description and tabulation in this Review. Unfortunately, outcome data for health-related quality of life were not available.

Unit of analysis issues

We planned that if we included studies with multiple treatment groups, we would follow the recommendations of Higgins 2011 and would combine groups to create a single pair-wise comparison or would select one pair of groups and exclude the other groups. This was not necessary, as we included no such studies.

We included one cluster-randomized trial and evaluated whether clustering was accounted for in the determination of required sample size, whether assessment for design effect was carried out, and whether methods used in analysis are appropriate to the cluster design. Had such a study been inappropriately analysed, as though randomization was performed by individual rather than by cluster, we would have adhered to the advice provided in the *Cochrane Handbook for Systematic Reviews of Interventions,* Section 16.3.4 (Higgins 2011), and we would have adjusted for design effect when possible. This would have necessitated a request to investigators for additional individual-level data to allow assessment of the intraclass correlation coefficient (ICC) in clusters. As we judged the methods used in the analysis to be appropriate, we believed this was not necessary.

Dealing with missing data

When summary statistics were missing, we contacted the first author of the trial to try to retrieve relevant data in the first instance.

When individual studies did not account appropriately for missing data, or did not report how these were handled, we considered whether data were likely to be missing at random or otherwise, and we assessed the resulting risk of bias.

When outcome data were missing and could not be recovered, we adopted the approach suggested in the *Cochrane Handbook for Systematic Reviews of Interventions,* Section 16.2.1 (Higgins 2011), and we used available-case analysis. We included data only for participants whose results were known, and we addressed the potential impact of the missing data by using the 'Risk of bias' tool. Ultimately, we considered the potential impact of including such studies in the overall assessment of intervention effect.

Assessment of heterogeneity

We considered clinical heterogeneity, methodological heterogeneity, and statistical heterogeneity as outlined by Higgins 2011.

We addressed clinical heterogeneity through detailed reporting of the diagnostic and clinical definitions and characteristics of the included studies. We planned to conduct meta-analysis if we considered the included studies to be sufficiently homogeneous for participants, interventions, and outcomes. However, the included studies were too heterogeneous for review authors to proceed.

We assessed methodological heterogeneity using the Cochrane 'Risk of bias' tool.

We planned to assess statistical heterogeneity by considering the consistency of study results, and by examining how this impacted the planned meta-analysis. However as already stated, the included studies were too heterogeneous for review authors to proceed with meta-analysis. Formerly, we had planned to use the Chi^2 test and to consider $P < 0.10$ to represent significant heterogeneity. We also had planned to use the I^2 statistic to describe the percentage of variability in effect estimates that is due to heterogeneity rather than to sampling error (chance), and to assess its potential impact on the planned meta-analysis. We had planned to interpret the I^2 result in keeping with guidance provided in Section 9.5.2 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Assessment of reporting biases

We planned to create a funnel plot to explore publication bias if at least 10 studies were included in the meta-analysis. However, we found too few studies and did not proceed with meta-analysis for the reasons already outlined.

Data synthesis

We planned to perform a meta-analysis; however as already stated, the included studies were too heterogeneous for us to proceed.

We had planned to use a random-effects meta-analysis to provide some robustness against the presence of heterogeneity, with inverse variance weighting provided by the DerSimonian-Laird estimate of between-study variance (tau^2) (DerSimonian 1986), and with all analyses carried out in Review Manager 5 (Review Manager 2014).

As we deemed individual study designs to be too diverse, and thus statistical combination to be inappropriate, we have presented the findings in a narrative fashion.

Subgroup analysis and investigation of heterogeneity

We planned a priori subgroup analysis for our primary outcomes in keeping with the following characteristics and rationale.

- Geographical setting (primarily urban or non-urban): urban CFR mobilization may allow shorter response time.
- Cadre of CFRs (trained laypersons, police service, fire service, and off-duty paramedics): this may influence CFR training, scope of the intervention, and response time.
- Community first responders routinely equipped with a defibrillator: defibrillation is a key time-critical intervention after OHCA.
- Witnessed OHCAs: these are likely to have shorter intervals to initiation of CPR and defibrillation from time of OHCA.
- Age groups (children defined as individuals up to 15 years old vs adults): common causes of OHCA are different in children (Meyer 2012), and this may affect the efficacy of interventions.

However, we did not undertake pooled subgroup analysis because we found insufficient data.

Sensitivity analysis

We planned to perform sensitivity analysis by excluding studies considered to have high risk of bias; however, the heterogeneity of included studies and insufficient data precluded both meta-analysis and sensitivity analysis.

'Summary of findings' table and GRADE

We used the principles of the GRADE system to assess the certainty of the body of evidence associated with specific outcomes in our review, and we constructed a 'Summary of findings' table using GRADE software (GRADEpro GDT; Guyatt 2008). This table includes the following outcomes.

- Survival at hospital discharge.
- Survival at 30 days.
- Neurological function at hospital discharge, measured by cerebral performance category (CPC).
- Neurological function at 30 days, measured by CPC.
- Cardiopulmonary resuscitation performed before EMS arrival.
- Defibrillation performed before EMS arrival.
- Survival to hospital admission.

The GRADE approach appraises the certainty of a body of evidence based on the extent to which one can be confident that an estimate of effect or association reflects the item being assessed. GRADE considers several factors potentially contributing towards bias, including risk of bias associated with study design (methodological quality), directness of the evidence, heterogeneity of the data, precision of effect estimates, and risk of publication bias (Chapter 12, *Cochrane Handbook for Systematic Reviews of Interventions*) (Higgins 2011).

Results

Description of studies

See Characteristics of included studies and Characteristics of excluded studies tables.

Results of the search

A comprehensive literature search current to 15 January 2019 identified 1867 potentially relevant citations: MEDLINE - 447, Embase - 557, CENTRAL - 450, Web of Science - 399, International Clinical Trials Registry Platform (ICTRP) - 5, ClinicalTrials.gov - 5, and conference proceedings - 4 (see Figure 1). After we excluded duplicate citations, 1204 potentially relevant citations remained. Two review authors (TB and MD) independently reviewed each title or abstract, and we excluded a further 1190 records that obviously did not meet the Review inclusion criteria. We (TB and MD) then independently reviewed the full texts of the remaining 14 records; we found five records representing two completed studies that met all inclusion criteria for this review (Ringh 2015; van Alem 2003). In addition, we identified one potentially eligible ongoing study (NCT03633370), and we were made aware of one additional study that is in the protocol development stage (Brooks 2018 [pers comm]).

Included studies

The two included studies had a total of 1136 participants.

van Alem 2003 (469 participants) was undertaken in Amsterdam and its surroundings (the Netherlands) between January 2000 and January 2002; this was a cluster-randomized controlled trial with allocation cross-over. All participants had experienced witnessed OHCA, alerted to the EMS, which ultimately undertook resuscitation. Participants received routine EMS care (226) or routine EMS care supplemented by the dispatch of AED-equipped police or fire service CFRs (243). No significant differences were noted between the two study groups in terms of baseline characteristics of age, gender, and location of the incident. The study was funded by the Netherlands Heart Foundation and by Medtronic Physio-Control.

Ringh 2015 (667 participants) was undertaken in Stockholm, Sweden, between April 2012 and December 2013; this was a randomized controlled trial. Participants had experienced witnessed or unwitnessed OHCA, alerted to the EMS between 6 am and 11 pm, with resuscitation ultimately undertaken by EMS. Participants received either routine EMS care (361) or EMS care supplemented by the dispatch of CPR-trained lay CFRs located within a radius of 500 m of the participant (306). No

significant differences were noted between the two study groups in terms of baseline characteristics of age, gender, and location of the incident. This study was funded by the Swedish Heart-Lung Foundation, Laerdal Foundation, and by Stockholm County.

See the Characteristics of included studies table for further information.

Excluded studies

We excluded six completed studies, one ongoing study, and one withdrawn study (see Characteristics of excluded studies).

We excluded four of the six completed studies because they were not of an RCT or q-RCT design (Berglund 2018; Kellermann 1993; Sayre 2005; Smith 2001).

In addition, Berglund 2018 reports a comparison of CPR only CFR care versus CPR and AED CFR care, and Kellermann 1993 involved a cohort of fire engines that were equipped with AEDs within a single fire-based EMS system; such fire engines were responding to OHCA in advance of this study.

Hallstrom 2004 used an RCT design that involved participants randomized to CFR CPR only care or CFR CPR and AED care. This trial did not include a comparator group randomized to routine EMS care without CFR involvement.

Sweeney 1998 compared EMS response of fire engines providing CPR only versus fire engines providing CPR and AED care within a single fire-based EMS system.

NCT02992873 will compare mobile phone dispatch of CFRs who provide CPR only versus CFRs dispatched to both retrieve an AED and provide CPR. As this study will not include a routine EMS care arm, it would not meet our eligibility criteria for inclusion in this Review.

NCT01746290 had planned to randomize participants experiencing OHCA in Toronto, Canada, to standard care or to standard care with the addition of a CFR or CFRs dispatched via a smart-phone application. Correspondence with the lead researcher suggested that the initial study was withdrawn owing to legal and technical issues; however, a follow-up North American CFR RCT is (at the time of writing) in the protocol planning phase (Brooks 2018 [pers comm]).

Studies awaiting classification

We found no studies awaiting classification.

Ongoing studies

Our search of the trial registries revealed one ongoing study of relevance (clinicaltrials.gov;www.who.int/ictrp/en/); NCT03633370 will involve a stepped wedge cluster RCT that compares routine OHCA care versus a multi-faceted intervention that includes dispatcher training in OHCA recognition, CFR dispatch, and CFR motivational feedback.

Studies in the planning phase

We became aware via personal correspondence with the lead author of a relevant withdrawn study - NCT01746290 - that a further study of potential relevance is in the protocol planning stage (Brooks 2018 [pers comm]).

Risk of bias in included studies

The results of our assessment for risk of bias in included studies can be seen in the Characteristics of included studies table, and we have summarized them in Figure 2 and Figure 3.

Allocation (selection bias)

Random sequence generation

We considered Ringh 2015 to have low risk of selection bias and van Alem 2003 to have unclear risk of selection bias.

Allocation concealment

For Ringh 2015, we considered the risk of bias related to allocation concealment to be low, and for van Alem 2003, we considered risk of bias for this element to be high.

Blinding (performance bias and detection bias)

Performance bias

For both Ringh 2015 and van Alem 2003, we considered the risk of performance bias to be unclear.

Detection bias

For Ringh 2015, we considered the risk of detection bias to be low, and for van Alem 2003, we considered the resultant risk of detection bias to be high.

Incomplete outcome data (attrition bias)

We considered Ringh 2015 to have low risk of bias for the outcome of 'CPR performed before EMS arrival' but high risk of attrition bias for the outcome of 'survival at 30 days'.

We considered van Alem 2003 to have low risk of bias for the outcomes of 'survival at hospital discharge', 'survival to hospital admission', and 'defibrillation performed before EMS arrival'.

Selective reporting (reporting bias)

For Ringh 2015, we considered the overall risk of reporting bias to be low, and for van Alem 2003, we considered the overall risk of reporting bias to be unclear.

Other potential sources of bias

Ringh 2015 reported that during this study, a computerized randomization system was activated via initial activation of a mobile phone positioning system (MPPS) by an EMS dispatcher who suspected OHCA in an eligible participant. Study authors reported that the MPPS was in fact not activated for 237 eligible participants; thus we judged the resultant risk of bias to be high.

For van Alem 2003, we considered several additional potential sources of risk of bias related to cluster-randomization. These included recruitment bias, baseline imbalance, loss of clusters, and incorrect analysis. We considered risk of bias to be low for each of these elements

We found one significant additional source of 'other' bias related to the van Alem 2003 study. In this study, police but not fire CFRs were dispatched during both experimental and control periods. Participants allocated to the control arm but within a 'police area cluster' would not have received police CFR defibrillation but potentially received police CFR CPR. We considered the resultant risk of bias to be high.

Effects of interventions

Community first responders for out-of-hospital cardiac arrest

Owing to significant heterogeneity in the organization of interventions and across outcomes measured or reported, we were unable to pool results data from the two included studies.

van Alem 2003 considered the novel dispatch of police and fire service CFRs equipped with AEDs (automatic external defibrillators) in an EMS (emergency medical services) system at a period in time in which defibrillation before EMS arrival appears to have been otherwise unlikely (Table 1).

Ringh 2015 considered the dispatch of nearby lay volunteers who were trained to perform CPR but were not equipped with an AED as a supplementary CFR intervention in an EMS system where police and fire services were already routinely dispatched to OHCA in addition to EMS ambulances (Table 2).

We have summarized the results in a narrative fashion. We assessed the certainty of evidence for the outcomes survival to hospital discharge; survival at 30 days; neurological function at hospital discharge, measured by cerebral performance category (CPC); neurological function at 30 days, measured by CPC; cardiopulmonary resuscitation performed before EMS arrival; defibrillation performed before EMS arrival; and survival to hospital admission, using the GRADE system. See Summary of findings table 1.

Survival at hospital discharge

Only one study considered survival at hospital discharge: 44/243 (18%) participants in the experimental group and 33/226 (15%) participants in the control group survived to hospital discharge (van Alem 2003). Study authors reported an OR of 1.3 for this outcome with 95% CI of 0.8 to 2.2 (P = 0.33) calculated using the generalized estimating equations model. We judged this to represent low-certainty evidence for this outcome via the GRADE system with downgrading by two levels given that the control group may have been exposed to an intervention effect, namely, CPR before EMS arrival.

Neurological function at hospital discharge, measured by cerebral performance category (CPC)

Neither of the two included studies considered neurological function at hospital discharge.

Survival to hospital admission, defined as a person admitted to hospital with spontaneous circulation and measurable blood pressure

Only one study reported survival to hospital admission: 103/243 (42%) participants in the experimental arm and 74/226 (33%) participants in the control arm (van Alem 2003). Study authors reported an OR for this outcome of 1.5 with CI of 1.1 to 2.0 (P = 0.02) calculated using the generalized estimating equations model. We judged this study to represent moderate-certainty evidence for this outcome according to the GRADE system after downgrading by one level. In this study, the control group may have been exposed to an intervention effect, namely, CPR before EMS arrival; however, this would be expected to reduce the chance of finding a difference between control and intervention for this outcome. In addition, we judged this study to be at risk of both selection and detection bias for this outcome.

CPR performed before EMS arrival

Only one included study reported 'CPR performed before EMS arrival', including both CPR performed according to telephone instructions and what study authors termed 'bystander-initiated' CPR (defined as any form of rescue breaths or chest compression performed by trained volunteers before the arrival of an ambulance or arrival of fire or police services) (Ringh 2015). In all, 196/305 (64.3%) participants in the experimental arm and 197/360 (54.7%) participants in the control arm had CPR performed before EMS arrival. We calculated an OR for this outcome of 1.49 with 95% CI 1.09 to 2.03 (P = 0.01). Of note, Ringh 2015 included dispatched fire or police services as a component of standard EMS in the study design when considering this outcome. We judged this study to represent moderate-certainty evidence for this outcome using the GRADE system. We downgraded by one level, as 26% of eligible participants were excluded from participation.

Defibrillation performed before EMS arrival

Only van Alem 2003 reported 'defibrillation performed before EMS arrival': 72/243 (30%) participants in the experimental

group and none of the 226 participants in the control group. Study authors reported these data but did not include this information as a primary or secondary outcome. We judged this to represent moderate-certainty evidence for this outcome using the GRADE system after downgrading by one level owing to the observation that this outcome was not included as a primary or secondary outcome and owing to risks of both selection and detection bias.

Survival at 30 days

Only Ringh 2015 considered survival at 30 days: 32/286 (11.2%) participants in the experimental group and 28/326 (8.6%) participants in the control group. We calculated an OR for this outcome of 1.34 with 95% CI 0.79 to 2.29 (P = 0.28). We judged this to represent low certainty of evidence for this outcome using the GRADE system, having downgraded it by two levels as data for this outcome were reported as missing for 20/306 (6.5%) participants in the experimental group and 35/361 (9.7%) participants in the control group, and because 26% of eligible participants were excluded from participation. Furthermore, the study design was not adequately powered to detect a difference in this outcome.

Neurological function at 30 days, measured by CPC

Neither of the two included studies considered neurological function at 30 days or at any other time period.

Health-related quality of life at 90 days

Neither of the two included studies considered health-related quality of life at 90 days or at any other time period.

Discussion

Summary of main results

Our extensive search revealed only two eligible trials involving 1136 participants. These two included studies demonstrated significant heterogeneity in terms of overall research design; point in time (2000 to 2002 vs 2012 to 2013); population recruited (witnessed out-of-hospital cardiac arrest (OHCA) vs witnessed and unwitnessed OHCA); organization of experimental intervention ('nearby layperson' cardiopulmonary resuscitation (CPR) only community first responder (CFR) vs police and fire automatic external defibrillator (AED) with CPR CFR), as well as outcomes measured and reported.

The primary outcome of this review - survival at hospital discharge - was reported by only one study (van Alem 2003), and the secondary outcome - survival at 30 days - was reported by the second study (Ringh 2015). Neither study demonstrated a significant difference between experimental and control groups for these outcomes, and ultimately our review authors found low-certainty evidence. Of note, the study by Ringh and colleagues was powered to detect an increase in bystander CPR rather than survival (Ringh 2015), and participants in the control group in van Alem 2003 may have been exposed to an intervention effect. The secondary outcome - survival to hospital admission - was reported by van Alem 2003, which did find a significant increase for this outcome in the intervention group (odds ratio (OR) 1.5, 95% confidence interval (CI) 1.1 to 2.0; 1 randomized controlled trial (RCT); 469 participants; moderate-certainty evidence).

CPR

Ringh 2015 reported CPR performed before EMS service (EMS included police or fire responders) arrival, considering both telephone-directed CPR and CPR performed by a trained responder. Study authors found that mobilizing lay CFRs via text message increased this outcome from 54.7% to 64.3%. This difference was statistically significant (OR 1.49, 95% CI 1.09 to 2.03; 1 RCT; 665 participants; moderate-certainty evidence).

van Alem 2003 did not report the outcome of 'any CPR performed before ambulance service arrival'.

Defibrillation

Of the two included studies, only van Alem 2003 reported defibrillation performed before ambulance service arrival. Study authors found that 30% of participants in the experimental group and no participants in the control group had defibrillation performed before ambulance service arrival (1 RCT; 469 participants; moderate-certainty evidence).

Neither of the two included studies considered neurological function or health-related quality of life at any time period.

Overall completeness and applicability of evidence

Ultimtely, we identified only two completed studies, and the data extracted from these studies were insufficient for us to fully address the objectives of this Review. Further high-quality studies are needed to establish whether mobilization of CFRs improves survival with good neurological function, following OHCA.

Quality of the evidence

Evidence for each reported outcome ranged from low to moderate certainty, assessed via the GRADE approach; see Summary of findings table 1. Both of the included studies were judged to have significant risks of bias, especially in terms of survival outcomes measured and reported.

Potential biases in the review process

Our decision to limit the content of this review to randomized controlled trials (RCTs) and quasi-randomized controlled trials (q-RCTs) means that we may have missed some important data from other study types. Given the paucity of evidence at the level of RCTs/q-RCTs, such data would potentially be significant in addressing the question of our Review in so far as is currently possible.

In addition, this Review does not consider potential negative effects of the intervention. When CFRs with minimal training are

mobilized to high acuity emergency medical situations, it is possible that CFRs could experience physical or psychological ill effects. Furthermore, although considered unlikely, patients could be harmed by the actions of CFRs. This Review has not considered these elements of CFR care, which may be significant.

Agreements and disagreements with other studies or reviews

Smith and colleagues' literature review of lay responder defibrillation programmes found that although early defibrillation by targeted CFRs may improve time to defibrillation, further research is required in terms of other outcomes (Smith 2007). The findings of our Review are in keeping with this finding.

Authors' conclusions

Implications for practice

Moderate-certainty evidence shows that context-specific CFR interventions result in increased rates of CPR or defibrillation performed before EMS arrival. It remains uncertain whether this can translate to significantly increased rates of overall patient survival.

Implications for research

Further research is needed to determine whether mobilizing CFRs to OHCA results in increased rates of survival and in neurological and health-related quality of life outcomes that are acceptable to patients. The International Liaison Committee on Resuscitation core outcome set for cardiac arrest, published in 2018, includes neurological function and health-related quality of life (Haywood 2018). Studies considering the mobilization of CFRs to OHCA should routinely consider and report these outcomes, as well as survival.

Variability in outcome reporting and in definitions limits the degree to which evidence on this topic can be synthesized. Studies considering mobilization of CFRs to OHCA should adopt standardized outcome reporting.

Mobilization of CFRs to OHCA represents a complex intervention with variation in components depending on the community setting and its system of emergency healthcare delivery. Individual health systems and their responses to OHCA are likely in many instances to be constantly evolving rather than fixed. Furthermore, communities may innovate OHCA responses independent of formal health system strategy, for example, by acquiring AEDs that are accessible to the public. We have identified a paucity of evidence on this topic at the level of RCTs and q-RCTs. Early CPR and defibrillation are priority interventions following OHCA; depending on individual health system design, it may be considered unethical to randomize patients to a treatment group that deprives participants of potential early CPR or defibrillation when this might otherwise be made available. Given the limited number of existing, ongoing, or planned RCT or q-RCT studies identified in this review, future updates should consider whether to include non-randomized trials and controlled before-after studies. This approach is advocated by the Cochrane Effective Practice and Organisation of Care Group when RCTs are not available to address questions about the effects of health system interventions (EPOC 2017). In addition, an updated review design with inclusion of studies that compare CPR only CFR versus AED and CPR CFR and studies with only a routine EMS care control comparator should be considered, as such designs might be feasible and ethically and socially acceptable when a no CFR control comparator would not.

Acknowledgements

We would like to thank Jane Cracknell (Managing Editor, Cochrane Anaesthesia, Critical and Emergency Care Group (ACE)) and all other involved editors for their help and advice in preparing the protocol and review, as well as Diarmuid Stokes (University College Dublin (UCD) Health Sciences Library) and Janne Vendt (Cochrane Information Specialist (ACE)) for their help in preparing the search strategy.

The protocol was screened by the following Cochrane Emergency and Critical Care editors: Bronagh Blackwood, Jane Cracknell, Harald Herkner, Nathan Pace, Janne Vendt, and Cathal Walsh.

We would like to thank Anna Lee (Content Editor) and Andrit Lourens, Sandra M Marini, and Kyle Grant (Peer Reviewers) for their help and editorial advice during preparation of the protocol (Barry 2017).

We would like to thank Anna Lee (Content Editor); Judith Finn and Sandra M Marini (Peer Reviewers); Jonathan M Fuchs (Consumer Referee); and Harald Herkner (Co-ordinating Editor) for their help and editorial advice during preparation of this systematic review.

Contributions of authors

Tomás Barry (TB), Maeve Doheny (MD), Niall Conroy (NC), Siobhán Masterson (SM), Jan Klimas (JK), Ricardo Segurado (RS), Mary Codd (MC), Gerard Bury (GB).

Conceiving the review: TB, GB.

Co-ordinating the review: TB.

Undertaking manual searches: TB.

Screening search results: TB, MD.

Organizing retrieval of papers: TB, MD.

Screening retrieved papers against inclusion criteria: TB, MD.

Appraising the quality of papers: TB, MD, GB, MC, RS.

Abstracting data from papers: TB, MD, GB.

Writing to authors of papers for additional information: TB.

Providing additional data about papers: TB.

Obtaining and screening data on unpublished studies: TB.

Managing data for the review: TB, MD, NC, SM, JK, GB, MC, RS.

Entering data into Review Manager: TB.

Analysing RevMan statistical data: TB, RS, MC.

Performing other statistical analysis not using RevMan: TB, RS, MC.

Interpreting data: TB, MD, SM, NC, JK, GB, RS, MC.

Making statistical inferences: TB, RS, MC.

Writing the review: TB, MD, SM, NC, JK, RS, MC, GB.

Securing funding for the review: TB.

Performing previous work that was the foundation of the present study: TB, SM, GB.

Serving as guarantor for the review: TB.

Taking responsibility for reading and checking the review before submission: TB.

Declarations of interest

Tomas Barry is a general practitioner at the Coombe Family Practice, Dublin, and Assistant Professor at the School of Medicine, University College Dublin, who himself provides voluntary emergency response to out-of-hospital cardiac arrest. He declares no conflicts of interest.

Gerard Bury is Professor of General Practice at the School of Medicine, UCD, and a general practitioner in Dublin. Prof Bury declared an interest in a grant pending to the Irish Community Rapid Response (registered charity): "Further development of the GP role as first responder to OHCA". The focus in this project is on the use of alerting technologies. He is a member of a review group for the Health Service Executive, Ireland, developing national KPIs for the statutory ambulance services. He is a member of an expert group for the Medical Advisory Group, Pre-Hospital Emergency Care Council, for the development of Clinical Practice Guidelines for registered prehospital providers.

Prof Bury declares that his academic roles provide a context for involvement in this research programme but do not create a conflict of interest for him in respect of the aim, methods, or outcomes of this work.

Mary Codd is Associate Professor of Epidemiology and Biostatistics at University College Dublin, and Director of UCD CSTAR (Centre for Support and Training in Analysis and Research). She declares no conflicts of interest.

Jan Klimas is a Post-doctoral Fellow at University College Dublin, School of Medicine, and at British Columbia Centre on Substance Use, University of British Columbia. His work on this Review was funded, in part, by a grant from the European Commission (701698). His institution was in receipt of the ELEVATE Grant (2014 to 2017): Irish Research Council International Career Development Fellowship, co-funded by Marie Cure Actions (ELEVATEPD/2014/6).

Niall Conroy is an Assistant Professor at the School of Medicine, University College Dublin. He declares no conflicts of interest.

Siobhan Masterson is the Clinical Lead for Strategy and Evaluation in the Health Service Executive's National Ambulance Service. Dr Masterson is a Research Fellow with the Discipline of General Practice, in National University of Ireland, Galway. She is in receipt of Applied Partnership Award funding from the Health Research Board as a Primary Investigator. She declares no conflicts of interest.

Ricardo Segurado is Assistant Professor of Biostatistics, in University College Dublin, and is a consultant with UCD CSTAR. He is a member of a voluntary first aid organization that could be perceived to have an interest in the outcome of this review.

Maeve Doheny is a general practitioner at the Coombe Family Practice, Dublin, and Assistant Professor at the School of Medicine, University College Dublin. She declares no conflicts of interest.

Differences between protocol and review

We made the following changes to the published protocol (Barry 2017).

- We altered the title to refect the population of concern for this review.
- MD joined as a review author and took responsibility for many of the roles previously provisionally assigned to NC.
- We replaced the term 'ambulance service' with 'EMS' (emergency medical services) throughout the review, as EMS is a more internationally recognized term and was the terminology used in the included studies.
- To increase robustness, three review authors (TB, MD, GB), rather than two, independently extracted data and assessed risk of bias related to included studies.

- For the domain of 'incomplete outcome data', we assessed risk of bias at the outcome level rather than at the study level, as the risk of bias was considered to differ by outcome.
- We had planned to use risk ratios with 95% confidence intervals to measure dichotomous outcomes; however the included cluster-RCT expressed outcomes as odds ratios (ORs) appropriately adjusted for the cluster design effect (van Alem 2003); thus for the purpose of standardization, we expressed dichotomous outcomes as ORs throughout.
- We included all primary outcomes in the 'Summary of findings' table, as per the standard Cochrane protocol. In addition, we included 'cardiopulmonary resuscitation performed before EMS arrival' and 'defibrillation performed before EMS arrival', as these outcomes are of key relevance given the overall review findings. We also included 'survival to hospital admission', as peer review feedback suggested that this would be important to readers.

Published notes

Characteristics of studies

Characteristics of included studies

Ringh 2015

Methods	**Randomized controlled trial** • Single-centre study • 1 dispatch centre handling emergency calls from a population of approximately 2.5 million inhabitants in Stockholm County, Sweden - an area covering 6519 km²
Participants	**Total number of randomized participants** • 667 Individuals* **Inclusion criteria** • 8 years of age and older • Suffering a suspected medical OHCA alerted to EMS dispatch between 6 am and 11 pm; those for whom a CFR mobile phone positioning system (MPPS) was activated by EMS dispatch, and for whom resuscitation was ultimately attempted by EMS upon arrival **Exclusion criteria** • Cases of OHCA witnessed by EMS staff • Traumatic OHCA • Children under 8 years of age • Suicide • Intoxications • Obvious signs of death • Do not resuscitate orders (DNR) • Hazardous environment (*A further 1141 participants were randomized to the experimental or control arm at the point of EMS dispatch, but were later excluded - 794 did not have OHCA, 318 did not have resuscitation attempted by EMS, and 29 had EMS witnessed OHCA) **Baseline characteristics** • Median age was 71 years in the experimental arm (interquartile range 62.5 to 81.3) and 73.5 in the control arm (interquartile range 61.8 to 83.3) • 70.5% of participants in the experimental arm were male and 64.1% in the control arm were male • 69% of OHCAs in the experimental arm and 71.1% in the control arm occurred in the home • 56.9% of OHCAs in the experimental arm and 57.6% in the control arm were bystander witnessed

Interventions	**Experimental arm** • n = 306 • MPPS located all CFRs within 500 metres of the patient. These CFRs were alerted to the OHCA via text message and computer-generated telephone call If no lay volunteers who were trained in CPR were present within 500 metres of the patient, the case was not excluded from the final analysis. One or more lay volunteers who were trained in CPR were located within 500 metres of the patient in 81% of the cases of cardiac arrest (249 of 306 participants). In 199 out-of-hospital cardiac arrests (65%), 1 or more lay volunteers who were trained in CPR tried to reach the patient; in 70 cardiac arrests (23%), the trained volunteer or volunteers reached the patient before arrival of EMS personnel or police/fire service responders. In 40 cases (13%), 1 or more trained volunteers stated that they initiated CPR before anyone else arrived **Control arm** • n = 361 • MPPS located all CFRs within 500 metres of the patient, but no contact was made CFRs in this study were CPR-trained volunteers recruited via advertising campaigns and at CPR training courses. 5989 CFRs were recruited initially, and overall 9828 were recruited during the study. No financial or other compensation was offered. Registration was completed via an on-line platform. EMS dispatchers did not activate the MPPS in 925 OHCAs during the study period; thus this group of patients did not undergo randomization. When OHCA witnessed by EMS was excluded, 736 participants remained; 515 occurred during the hours of the study (6 am to 11 pm). The authors of this study reviewed the dispatch protocol for these 515 OHCAs and found that in 237 cases, the dispatcher suspected OHCA but did not activate the MPPS. This cohort of 237 participants comprised 26% of all eligible participants and was excluded from the study by virtue of the fact that the dispatcher did not activate the MPPS in these cases
Outcomes	**Primary outcome** • Rate of bystander-initiated CPR before arrival of an ambulance or fire or police first responders. 'Bystander CPR' was defined as any form (single or multiple) of rescue breaths or chest compression provided before arrival of an ambulance, or of fire or police services. Dispatcher telephone-assisted CPR (T-CPR) was not accounted for as bystander CPR. If T-CPR provided initially was followed by bystander CPR by a trained rescuer, this was accounted for as 'bystander CPR' **Secondary outcomes** • Rate of bystander-initiated CPR or dispatcher telephone-assisted CPR (both as defined above) before arrival of an ambulance or of fire or police first responders • 30-day survival • Return of spontaneous circulation • Findings of VF or VT at first electrocardiographic assessment

Notes	**Funding/declarations of interest** • This study was funded by the Swedish Heart-Lung Foundation, Laerdal Foundation, and Stockholm County • No potential conflict of interest relevant to this article was reported **Study dates** • 1 April 2012 to 1 December 2013 **Other Information** • In this EMS system, all ambulances carried trained nurses. In suspected out-of hospital cardiac arrests (OHCAs), a 2-tiered system was launched, with 1 first-responding ambulance and 1 additional unit carrying a nurse or doctor trained in anaesthesiology and advanced life support • Police and fire services first responders were simultaneously dispatched to all those over 8 years of age with suspected non-traumatic OHCA **Contact with study authors** We contacted the study author Dr Mattias Ringh via email on 27 August 2018, and again on 13 January 2019, with clarifications regarding study design and conduct. On both occasions, we received an immediate response Dr Ringh reported the reasons why the MPPS was not activated for 237 eligible patients: dispatchers did not recognize the cardiac arrest or failed to activate the system for any other reason or decided not to activate the system (unsafe environment, presumed cause of arrest: intoxication, trauma, etc) Dr Ringh also clarified that Information on survival at 30 days was missing for 20/306 patients in the experimental group and for 35/361 in the control group under circumstances where this information was not known to the Swedish Cardiac Arrest Register

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computerized randomization system within the MPPS involving automatically generated random numbers was used
Allocation concealment (selection bias)	Low risk	A computerized randomization system within the MPPS to which EMS dispatchers were blinded was used
Blinding of participants and personnel (performance bias)	Unclear risk	Blinding was not possible given the nature of the intervention When participants regained consciousness, they may have become aware of CFR involvement in their care; however this is not considered likely to have affected study outcomes EMS staff would have been aware when CFRs were present on their arrival and may have approached patient care differently on this basis However, given that OHCA care is protocolized and reported outcomes are not subjective, the likelihood that the above would have affected outcomes is limited
Blinding of outcome assessment (detection bias)	Low risk	Investigators were unaware as to assignments until the final analysis was complete and the randomization code was revealed
Incomplete outcome data (attrition bias) Survival at hospital discharge	Unclear risk	
Incomplete outcome data (attrition bias) Neurological function at hospital discharge	Unclear risk	

Bias	Authors' judgement	Support for judgement
Incomplete outcome data (attrition bias) Survival to hospital admission	Unclear risk	
Incomplete outcome data (attrition bias) CPR performed prior to EMS arrival	Low risk	Outcome data are missing for 1/306 participants in the experimental group and for 1/361 in the control group. Given the small scale of missing data distributed between experimental and control groups, we believe the risk that this would alter the results is low
Incomplete outcome data (attrition bias) Defibrillation performed prior to EMS arrival	Unclear risk	
Incomplete outcome data (attrition bias) Survival at 30 days	High risk	Outcome data for 20/306 participants in the experimental group and for 35/361 in the control group are missing
Incomplete outcome data (attrition bias) Neurological function at 30 days	Unclear risk	
Incomplete outcome data (attrition bias) Health-related quality of life at 90 days	Unclear risk	
Selective reporting (reporting bias)	Low risk	A study protocol is available, and the study's prespecified (primary and secondary) outcomes that are of interest to this Review have been reported in the prespecified way, with the exception of 'admission to hospital alive', which is not reported. ROSC and 30-day survival are reported
Other bias	High risk	The computerized randomization system was activated via activation of the MPPS by an EMS dispatcher who suspected OHCA in an eligible patient. Study authors reported that the MPPS was not activated in 237 eligible participants accounting for 26% of all eligible participants .
Recruitment bias	Unclear risk	
Baseline imbalance	Unclear risk	
Loss of clusters	Unclear risk	
Incorrect Analysis	Unclear risk	

van Alem 2003

Methods	**Cluster-randomized controlled trial with allocation cross-over** • This study was conducted in a mixed urban and rural area of 885 square kilometres with a population of 1.6 million inhabitants, in Amsterdam and its surroundings (The Netherlands) • Allocation was by cluster • Clusters represented 8 adjacent non-overlapping CFR regions - 2 fire service and 6 police. The experimental area consisted of 1 fire service cluster and 3 police clusters equipped with a total of 50 AEDs. Every 4 months, each CFR cluster crossed over from experimental to control or vice versa, in that AEDs were collected from experimental regions and were distributed to control regions • When the emergency medical system dispatch centre suspected a cardiac arrest, it dispatched 2 ambulances and then immediately alerted the police or fire brigade dispatch centre. After receiving the call from the EMS dispatch centre, the police or the fire dispatch centre directed a police patrol car or fire engine to the scene. Police were dispatched during both experimental and control periods, and the fire brigade was dispatched during experimental periods only
Participants	**Total number of randomized participants** • 469 individuals* **Inclusion criteria** • 18 years of age and older • Witnessed OHCA, alerted to the EMS • Resuscitation by EMS attempted **Exclusion criteria** • Participants with traumatic cardiac arrest • EMS witnessed OHCA *Between 5 January 2000 and 5 January 2002, 905 participants in the study region had an EMS dispatch-suspected cardiac arrest. In 214 participants, cardiac arrest was not present at arrival of help, and in 108 participants, no resuscitation was attempted. Among participants for whom resuscitation was attempted, 114 were not witnessed. A total of 469 participants thus met the criteria for inclusion **Baseline characteristics** • Mean age in years was 67 (SD 14) in the experimental arm and 65 (SD 14) in the control arm • 77% of participants in the experimental arm and 76% in the control arm were male • 71% of OHCAs in the experimental arm and 72% in the control arm occurred in the home
Interventions	**Experimental arm** • n = 243 • EMS dispatch alerted police or fire service dispatch as relevant. Police or fire dispatch directed an AED-equipped police patrol car or fire engine to the OHCA **Control arm** • n = 226 • If the OHCA was in a fire CFR region, no fire engine was dispatched. If the OHCA was in a police CFR region, police were dispatched to the scene but were not equipped with an AED
Outcomes	**Primary outcome** • Survival to hospital discharge **Secondary outcomes** • Return of spontaneous circulation • Admission to hospital

Notes	**Funding/declarations of interest** • This study was funded by a grant from the Netherlands Heart Foundation (Grant 98.179) and an unrestricted grant of Medtronic Physio-Control, Redmond, WA, USA • Competing interests: RWK reported receiving material and financial support from Medtronic Physio-Control in organising the study **Study dates** • 5 January 2000 to 5 January 2002 **Other Information** • All ambulances were manned by a nurse or paramedic and a driver, equipped with a manual defibrillator, and qualified to perform advanced cardiopulmonary life support • Neither the firemen nor the police officers had ever responded to medical emergencies before, but they were trained in cardiopulmonary resuscitation. For this study, 1063 police officers and 586 fire fighters were trained in use of the AED, and their cardiopulmonary resuscitation skills were refreshed • The median time from call to dispatch of the ambulance was 2 minutes in both groups **Contact with study authors** We contacted the study author Dr R.W. Koster via email on 12 January 2019 with clarifications regarding the design and conduct of this study; we received an immediate reply. We specifically queried whether it was possible to report the outcome of 'CPR performed before EMS arrival', as both outcomes of 'CPR performed by first responders before EMS arrival' and '"Basic" CPR performed other than by first responders before EMS service arrival' appear separately in tables in the study's published paper (van Alem 2003). Correspondence with Dr Koster confirmed that the outcome of relevance to this review - 'CPR performed before EMS arrival' was not measured and could not be reported

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The study authors report 'initial random allocation' of AEDs to CFRs in 4 of 8 regions. Method of random sequence generation is not reported. Each region did cross over allocation every 4 months, serving 12 months in both experimental and control designations
Allocation concealment (selection bias)	High risk	Cluster design with allocation of AEDs to CFRs by geographical area did not allow for allocation concealment
Blinding of participants and personnel (performance bias)	Unclear risk	Blinding not possible given the nature of the intervention When participants regained consciousness, they may have become aware of CFR involvement in their care; however this is not considered likely to have affected study outcomes EMS staff would also have been aware when CFRs had been present on their arrival and may have approached patient care differently as a result However, given that OHCA care is protocolized and the outcomes reported are not subjective, the likelihood that the above would have significantly affected outcomes is limited
Blinding of outcome assessment (detection bias)	High risk	Quote: "open clinical trial" design did not allow for blinding

Bias	Authors' judgement	Support for judgement
Incomplete outcome data (attrition bias) Survival at hospital discharge	Low risk	No incomplete outcome data were reported
Incomplete outcome data (attrition bias) Neurological function at hospital discharge	Unclear risk	
Incomplete outcome data (attrition bias) Survival to hospital admission	Low risk	No incomplete outcome data were reported
Incomplete outcome data (attrition bias) CPR performed prior to EMS arrival	Unclear risk	
Incomplete outcome data (attrition bias) Defibrillation performed prior to EMS arrival	Low risk	No incomplete outcome data were reported
Incomplete outcome data (attrition bias) Survival at 30 days	Unclear risk	
Incomplete outcome data (attrition bias) Neurological function at 30 days	Unclear risk	
Incomplete outcome data (attrition bias) Health-related quality of life at 90 days	Unclear risk	
Selective reporting (reporting bias)	Unclear risk	No protocol was available; thus available information is insufficient to permit judgement
Other bias	High risk	Police were dispatched during both experimental and control periods. Participants allocated to the control arm but within a (quote) "police area cluster" would not have received police CFR defibrillation but potentially received police CFR CPR. 30% (74/243) of participants in the experimental group and 27% (61/226) of participants in the control group received first responder CPR before EMS arrival, suggesting that many participants in the control group may have received first responder CPR from dispatched police CFR resources. Before this study, police had not responded to medical emergencies
Recruitment bias	Low risk	Knowledge of whether a cluster was an 'experimental' or 'control' cluster would have been unlikely to influence the types of participants recruited, given that participants had suffered OHCA
Baseline imbalance	Low risk	Experimental and control groups appeared similar at baseline in terms of age, gender, and location of collapse
Loss of clusters	Low risk	No evidence shows loss of clusters
Incorrect Analysis	Low risk	Study authors adjusted for cluster design using a generalized estimating equations model; meta-analysis was not conducted

Footnotes

AED = automatic external defibrillator; am = ante meridiem; CFR = community first responder; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; MPPS = mobile phone positioning system; OHCA = out-of-hospital cardiac arrest; ROSC = return of spontaneous circulation; SD = standard deviation; T-CPR = telephone CPR; VF = ventricular fibrillation; VT = ventricular tachycardia;

Characteristics of excluded studies

Berglund 2018

Reason for exclusion	• Not an RCT or a q-RCT • Study compared CFR CPR care to CFR CPR with AED care (published as conference abstract only)

Hallstrom 2004

Reason for exclusion	Participants were randomized to CFR CPR only care or CFR CPR and AED care. The trial did not include a comparator group randomized to routine EMS care without CFR involvement

Kellermann 1993

Reason for exclusion	• Not an RCT or a q-RCT • A cohort of fire engines were equipped with AEDs within a single EMS fire-based system - these fire engines were already responding to OHCA in advance of this study

NCT01746290

Reason for exclusion	Study withdrawn

NCT02992873

Reason for exclusion	Participants will be randomized to CFR CPR only care or to CFR CPR and AED care. This study will not include a routine EMS care arm

Sayre 2005

Reason for exclusion	Not an RCT or a q-RCT. Police administration selected 1 of 4 districts to implement a law enforcement-based early defibrillation programme

Smith 2001

Reason for exclusion	Not an RCT or a q-RCT. One controlled area (ambulance only dispatch compared to 1 intervention area (ambulance and fire CFR dispatch). Unclear how intervention area was selected

Sweeney 1998

Reason for exclusion	Compared EMS response fire engines providing CPR only vs fire engines providing CPR and AED care within a single fire-based EMS system

Footnotes

AED = automatic external defibrillator; CFR = community first responder; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; OHCA = out-of-hospital cardiac arrest; q-RCT = quasi-randomized controlled trial; RCT = randomized controlled trial.

Characteristics of studies awaiting classification

Footnotes

Characteristics of ongoing studies

NCT03633370

Study name	Multi-faceted intervention for increasing performance of CPR by laypersons in out-of-hospital cardiac arrest (DISPATCH)
Methods	Stepped wedge cluster-randomized controlled trial
Participants	**Inclusion criteria** • All adults with non-traumatic out-of-hospital cardiac arrest diagnosed during the emergency medical service call • Cardiac arrest located in urban area **Exclusion criteria** • Pregnant or breastfeeding women • Participants under the law • Participants deprived of liberty by court ruling or administrative ruling • Traumatic cardiac arrest • CA occurring under the eyes of a professional emergency services patrol on duty • Cardiac arrest for which resuscitation seem unjustified (inevitable death, terminally ill irreversible condition, too long duration of cardiac arrest, non-resuscitation personal directive)
Interventions	**Test group** Multi-faceted intervention • Training using distance learning for medical regulation assistants to recognize cardiac arrest on the phone • Activation of the location software application to send bystanders to cardiac arrest location before arrival of emergency medical services (EMS) • Motivation feedback: volunteers will received feedback regarding CPR initiated before EMS arrival and survival **No intervention: control group** Usual management of patients according to international guidelines. Protocols of call acceptance, phone advice, and sending of emergency services are not modified
Outcomes	**Primary outcomes** • CPR initiated by bystanders before arrival of first professional rescuers (time frame: day 0) • Proportion of participants who received CPR initiated by bystander before EMS arrival **Secondary outcomes** • Survival at 72 hours after out-of-hospital cardiac arrest (time frame: 72 hours): survival at 72 hours • Return of spontaneous circulation (time frame: day 0): proportion of participants who have recovered spontaneous circulation after CPR • Survival to hospital admission (time frame: day 0): vital status at hospital admission • Survival to hospital discharge (time frame: up to 30 days): vital status at hospital discharge • Survival at 30 days (time frame: 30 days): vital status at 30 days • Neurological functional status (time frame: 30 days) as measured by cerebral performance category (CPC) at 30 days • Neurological functional status (time frame: 30 days) as measured by modified Rankin Scale (mRS) at 30 days
Starting date	1 September 2018
Contact information	Guillaume Debaty, MD, PhD gdebaty@chu-grenoble.fr
Notes	

Footnotes

AED = automatic external defibrillator; CA = cardiac arrest; CPC = cerebral performance category; CPR = cardiopulmonary

resuscitation; DNR = do not resuscitate; ECG = electrocardiograph; EMS = emergency medical services; mRS = modified Rankin Scale; MPDS = medical priority dispatch system; OHCA = out-of-hospital cardiac arrest; ROC = resuscitation outcomes consortium; VGR = Region Västra Götaland.

Summary of findings tables

1 Mobilization of community first responders (CFRs) in addition to routine emergency medical services (EMS) care compared to routine EMS care for out-of-hospital cardiac arrest (OHCA)

Mobilization of community first responders (CFRs) in addition to routine emergency medical services (EMS) care compared to routine EMS care for out-of-hospital cardiac arrest (OHCA)

Patient or population: adults and children more than 4 weeks old suffering from OHCA
Setting: all community settings (Sweden and the Netherlands)
Intervention: mobilization of CFRs in addition to routine EMS care
Comparison: routine (usual) EMS care

Outcomes	Impact	№ of participants (studies)	Certainty of the evidence (GRADE)
Survival at hospital discharge	1 study (a cluster-RCT) conducted in Amsterdam and surrounding areas considered mobilization of police and fire service CFRs equipped with AEDs. Study authors found no difference in survival at hospital discharge (OR 1.3, 95% CI 0.8 to 2.2)	469 (1 cluster-RCT)	⊕⊕⊖⊖ Low[a]
Survival at 30 days	1 study (an RCT) undertaken in Stockholm, Sweden, considered mobilization of nearby lay volunteers who were trained to perform CPR. Study authors found no difference in survival at 30 days (OR 1.34, 95% CI 0.79 to 2.29)	612 (1 RCT)	⊕⊕⊖⊖ Low[b]
Neurological function at hospital discharge, measured by cerebral performance category (CPC)	No data were available	This outcome was not measured	-
Neurological function at 30 days, measured by cerebral performance category (CPC)	No data were available	This outcome was not measured	-
Cardiopulmonary resuscitation performed before EMS arrival	1 study (an RCT) undertaken in Stockholm, Sweden, considered mobilization of nearby lay volunteers who were trained to perform CPR. Study authors found an increase in CPR performed before EMS arrival in the intervention group (OR 1.49, 95% CI 1.09 to 2.03)	665 (1 RCT)	⊕⊕⊕⊖ Moderate[c]
Defibrillation performed before EMS arrival	1 study (a cluster-RCT) conducted in Amsterdam and surrounding areas considered mobilization of police and fire service CFRs equipped with AEDs. Study authors found that all 72 incidences of defibrillation performed before EMS arrival occurred in the intervention group	469 (1 cluster-RCT)	⊕⊕⊕⊖ Moderate[d]
Survival to hospital admission	1 study (a cluster-RCT) conducted in Amsterdam and surrounding areas considered mobilization of police and fire service CFRs equipped with AEDs. Study authors found increased survival to hospital admission (OR 1.5, 95% CI 1.1 to 2.0)	469 (1 cluster-RCT)	⊕⊕⊕⊖ Moderate[e]

GRADE Working Group grades of evidence.
High-certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate-certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low-certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low-certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

AED = automatic external defibrillator; CI = confidence interval; CFR = community first responder; CPC = cerebral performance category; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; OHCA = out-of-hospital cardiac arrest; OR = odds ratio; RCT = randomized controlled trial.

Footnotes

[a]Downgraded two levels for very significant risk of bias (control group may have been exposed to an intervention effect; CPR before EMS arrival).

[b]Downgraded two levels for very significant risk of bias (data missing for 55/667 participants for this outcome; 26% of eligible

participants excluded from the trial; study not powered for this outcome).

[c]Downgraded one level for significant risk of bias (26% of eligible participants excluded from the trial).

[d]Downgraded one level for significant risk of bias (risk of both selection and detection bias; this outcome did not represent a primary or secondary outcome in this study).

[e]Downgraded one level for significant risk of bias (control group may have been exposed to an intervention effect - CPR before EMS arrival; however, this would be expected to reduce the chance of finding a difference between control and intervention groups for this outcome; risk of both selection and detection bias for this outcome).

Additional tables

1 van Alem 2003

	Intervention	Control	
Included participants	243	226	
Outcome			OR (95% CI)
Survival at hospital discharge	44/243	33/226	1.3 (0.8 to 2.2)
Neurological function at hospital discharge, measured by cerebral performance category (CPC)	not reported		
Survival to hospital admission	103/243	74/226	1.5 (1.1 to 2.0)
CPR performed before EMS arrival	not reported		
Defibrillation performed before EMS arrival	72/243	0/226	N/A
Survival at 30 days	not reported		
Neurological function at 30 days, measured by CPC	not reported		
Health-related quality of life at 90 days	not reported		

Footnotes

CI = confidence interval; CPC = cerebral performance category; EMS = emergency medical services; N/A =not applicable; OR = odds ratio.

2 Ringh 2015

	Intervention	Control	
Included participants	306	361	
Outcome			OR (95% CI)*
Survival at hospital discharge	not reported		
Neurological function at hospital discharge, measured by cerebral performance category (CPC).	not reported		
Survival to hospital admission	not reported		
CPR performed before EMS arrival	196/305	197/360	1.49 (1.09 to 2.03)
Defibrillation performed before EMS arrival	not reported		
Survival at 30 days	32/286	28/326	1.34 (0.79 to 2.29)
Neurological function at 30 days, measured by CPC	not reported		
Health-related quality of life at 90 days	not reported		

Footnotes

CI = confidence interval; CPC = cerebral performance category; EMS = emergency medical services; OR = odds ratio.

*ORs and 95% CIs for this study were calculated by the review authors.

References to studies

Included studies

Ringh 2015

Published and unpublished data

NCT01789554. The use of mobile phones in out of hospital cardiac arrest to increase bystander CPR (RUMBA). https://clinicaltrials.gov/ct2/show/NCT01789554 (first received 12 February 2013).

Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in out of-hospital cardiac arrest (protocol) [Supplement for: 14-06038 - Mobile Phone Dispatch of Lay Volunteers to Out-of-Hospital Cardiac Arrests]. https://www.nejm.org/doi/suppl/10.1056/NEJMoa1406038/suppl_file/nejmoa1406038_protocol.pdf. [DOI: 10.1056/NEJMoa1406038]

* Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. New England Journal of Medicine 2015;372(24):2316-25. [DOI: 10.1056/NEJMoa1406038; PubMed: 26061836]

Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. Resuscitation 2015;96(S1):2. [DOI: 10.1016/j.resuscitation.2015.09.008]

Supplementary appendix [Supplement to: Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in outof-hospital cardiac arrest. N Engl J Med 2015;372:2316-25. DOI: 10.1056/NEJMoa1406038]. https://www.nejm.org/doi/suppl/10.1056/NEJMoa1406038/suppl_file/nejmoa1406038_appendix.pdf.

van Alem 2003

Published and unpublished data

Finn J, Jacobs I. Survival of people with out-of-hospital cardiac arrest is not improved by equipping first responders with an automated external defibrillator. Evidence-Based Healthcare 2004;8(3):139-41. [DOI: 10.1016/j.ehbc.2004.03.012]

* van Alem AP, Vrenken RH, de Vos R, Tijssen JGP, Koster RW. Use of automated external defibrillator by first responders in out of hospital cardiac arrest: prospective controlled trial. BMJ 2003;327(7427):1312. [DOI: 10.1136/bmj.327.7427.1312; PubMed: 14656837]

Excluded studies

Berglund 2018

Berglund E, Hollenberg J, Claesson A, Jonsson M, Fredman D, et al. The Stockholm automated external defibrillator and mobile bystander activation trial - results from the run-in period. Circulation 2018;134(Suppl 1):A16101. [DOI: 10.1161/circ.134.suppl_1.1610]

Hallstrom 2004

Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. New England Journal of Medicine 2004;351(7):637-46. [DOI: 10.1056/NEJMoa040566; PubMed: 15306665]

Kellermann 1993

Kellermann AL, Hackman BB, Somes G, Kreth TK, Nail L, Dobyns P. Impact of first-responder defibrillation in an urban emergency medical services system. JAMA 1993;270(14):1708-13. [DOI: 10.1016/S0196-0644(94)80412-5; PubMed: 8411501]

NCT01746290

Published and unpublished data

NCT01746290. The PulsePoint randomized controlled trial. https://clinicaltrials.gov/ct2/show/NCT01746290?term=NCT01746290&rank=1 (first received 10 December 2012).

NCT02992873

Published and unpublished data

NCT02992873. The Scandinavian AED and mobile bystander activation trial (SAMBA). https://clinicaltrials.gov/ct2/show/NCT02992873 (first received 14 December 2016).

Sayre 2005

Sayre MR, Evans J, White LJ, Brennan TD. Providing automated external defibrillators to urban police officers in addition to a

fire department rapid defibrillation program is not effective. Resuscitation 2005;66(2):189-96. [DOI: 10.1016/j.resuscitation.2005.02.006; PubMed: 15964123]

Smith 2001

Smith KL, Peeters A, McNeil JJ. Results from the first 12 months of a fire first-responder program in Australia. Resuscitation 2001;49(2):143-50. [DOI: 10.1016/S0300-9572(00)00355-5; PubMed: 11382519]

Sweeney 1998

Sweeney TA, Runge JW, Gibbs MA, Raymond JM, Schafermeyer RW, Norton HJ, et al. EMT defibrillation does not increase survival from sudden cardiac death in a two-tiered urban-suburban EMS system. Annals of Emergency Medicine 1998; 31(2):234-40. [DOI: 10.1016/S0196-0644(98)70313-0; PubMed: 9472187]

Studies awaiting classification

Ongoing studies

NCT03633370

Published and unpublished data [ClinicalTrials.gov: NCT03633370]

NCT03633370. Multifaceted intervention for increasing performance of CPR by laypersons in out-of-hospital cardiac arrest (DISPATCH). https://clinicaltrials.gov/ct2/show/NCT03633370 (first received 16 August 2018).

Other references

Additional references

Atwood 2005

Atwood C, Eisenberg MS, Herlitz J, Rea TD. Incidence of EMS-treated out-of-hospital cardiac arrest in Europe. Resuscitation 2005;67(1):75-80. [DOI: 10.1016/j.resuscitation.2005.03.021; PubMed: 16199289]

Brooks 2018 [pers comm]

Brooks S. Cochrane review [personal communication]. Email to: Steven Brooks 20 August 2018.

Caputo 2017

Caputo ML, Muschietti S, Burkart R, Benvenuti C, Conte G, Regoli F, et al. Lay persons alerted by mobile application system initiate earlier cardio-pulmonary resuscitation: a comparison with SMS-based system notification. Resuscitation 2017; 114:73-8. [DOI: 10.1016/j.resuscitation.2017.03.003; PubMed: 28268186]

Cummins 1991

Cummins RO, Chamberlain DA, Abramson NS, Allen M, Baskett PJ, Becker L, et al. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein Style. A statement for health professionals from a task force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Circulation 1991;84(2):960-75. [DOI: 10.1161/01.CIR.84.2.960; PubMed: 1860248]

Daya 2015

Daya MR, Schmicker RH, Zive DM, Rea TD, Nichol G, Buick JE, et al. Out-of-hospital cardiac arrest survival improving over time: results from the resuscitation outcomes consortium (ROC). Resuscitation 2015;91:108-15. [DOI: 10.1016/j.resuscitation.2015.02.003; PubMed: 25676321]

DerSimonian 1986

DerSimonian R, Laird N. Meta-analysis in clinical trials. Controlled Clinical Trials 1986;7(3):177-88. [PubMed: 3802833]

Dronavalli 2015

Dronavalli M, Thompson SC. A systematic review of measurement tools of health and well-being for evaluating community-based interventions. Journal of Epidemiology and Community Health 2015;69(8):805-15. [DOI: 10.1136/jech-2015-205491; PubMed: 26041904]

Dyson 2019

Dyson K, Brown SP, May S, Smith K, Koster RW, Beesems SG, et al. International variation in survival after out-of-hospital cardiac arrest: a validation study of the Utstein template. Resuscitation 2019;18(138):168-81. [DOI: 10.1016/j.resuscitation.2019.03.018; PubMed: 30898569]

EPOC 2013

Effective Practice and Organisation of Care (EPOC). Data collection form. In: EPOC Resources for Review Authors. Oslo: Norwegian Knowledge Centre for the Health Services, 2013.

EPOC 2017

Cochrane Effective Practice and Organisation of Care (EPOC). What study designs can be considered for inclusion in an EPOC review and what should they be called? EPOC Resources for review authors, 2017 Available at :http://epoc.cochrane.org/resources/epoc-resources-review-authors.

GRADEpro GDT

GRADEpro GDT [Computer program]. Version accessed 6 August 2016. Hamilton (ON): McMaster University (developed by Evidence Prime), 2015.Available at gradepro.org.

Guyatt 2008

Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ (Clinical research ed.) 2008;336(7650):924-6. [DOI: 10.1136/bmj.39489.470347.AD; PubMed: 18436948]

Hansen 2015

Hansen CM, Kragholm K, Granger CB, Pearson DA, Tyson C, Monk L, et al. The role of bystanders, first responders, and emergency medical service providers in timely defibrillation and related outcomes after out-of-hospital cardiac arrest: results from a statewide registry. Resuscitation 2015;96:303-9. [DOI: 10.1016/j.resuscitation.2015.09.002; PubMed: 26386371]

Hasselqvist-Ax 2015

Hasselqvist-Ax I, Riva G, Herlitz J, Rosenqvist M, Hollenberg J, Nordberg P, et al. Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. New England Journal of Medicine 2015;372(24):2307-15. [DOI: 10.1056/NEJMoa1405796; PubMed: 26061835]

Haywood 2018

Haywood K, Whitehead L, Nadkarni VM, Achana F, Beesems S, Böttiger BW, et al. COSCA (Core Outcome Set for Cardiac Arrest) in Adults: An Advisory Statement From the International Liaison Committee on Resuscitation. Resuscitation 2018; 127:147-63. [DOI: 10.1016/j.resuscitation.2018.03.022]

Healthcare Commission 2007

Healthcare Commission. The role and management of community first responders. nacfr.org.uk/wp/wp-content/uploads/docs/CFR%20Healthcare%20Commission%20Report.pdf 2007.

Higgins 2011

Higgins JP, Green S, editor(s). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available at handbook.cochrane.org.

Huang 2014

Huang Y, He Q, Yang LJ, Liu GJ, Jones A. Cardiopulmonary resuscitation (CPR) plus delayed defibrillation versus immediate defibrillation for out-of-hospital cardiac arrest. Cochrane Database of Systematic Reviews 2014, Issue 9. Art. No.: CD009803 DOI: 10.1002/14651858.CD009803.pub2. [PubMed: 25212112]

Masterson 2013

Masterson S, Robinson E, Wright P, Dowling J, Murphy A. Community cardiac first responders in Ireland. Resuscitation 2013;84(Suppl 1):S33. [DOI: 10.1016/j.resuscitation.2013.08.096]

Maurer 2006

Maurer B. Reducing the risk: a strategic approach. Report of the task force on sudden cardiac death. https://health.gov.ie/blog/publications/reducing-the-risk-a-strategic-approach-the-report-of-the-task-force-on-sudden-cardiac-death/ 2006.

Meyer 2012

Meyer L, Stubbs B, Fahrenbruch C, Maeda C, Harmon K, Eisenberg M, et al. Incidence, causes, and survival trends from cardiovascular-related sudden cardiac arrest in children and young adults 0 to 35 years of age: a 30-year review. Circulation 2012;126(11):1363-72. [DOI: 10.1161/CIRCULATIONAHA.111.076810; PubMed: 22887927]

Moher 2009

Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Medicine 2009;6(7):e1000097. [PubMed: 19621072]

Monsieurs 2015

Monsieurs KG, Nolan JP, Bossaert LL, Greif R, Maconochie IK, Nikolaou NI, et al. European Resuscitation Council guidelines for resuscitation 2015. Section 1: executive summary. Resuscitation 2015;95:1-80. [DOI: 10.1016/j.resuscitation.2015.07.038; PubMed: 26477410]

Myerburg 1982

Myerburg RJ, Kessler KM, Zaman L, Conde CA, Castellanos A. Survivors of prehospital cardiac arrest. JAMA 1982; 247(10):1485-90. [DOI: 10.1001/jama.1982.03320350081041; PubMed: 7035698]

Narikawa 2014

Narikawa K, Sakamoto T, Kubota K, Suzukawa M, Yonekawa C, Yamashita K, et al. Predictability of the call triage protocol to detect if dispatchers should activate community first responders. Prehospital Disaster Medicine 2014;29(5):484-8. [DOI:

10.1017/s1049023x14000995; PubMed: 25226347]

Nolan 2006

Nolan J, Soar J, Eikeland H. The chain of survival. Resuscitation 2006;71(3):270-1. [DOI: 10.1016/j.resuscitation.2006.09.001; PubMed: 17070646]

Nolan 2010

Nolan JP, Soar J, Zideman DA, Biarent D, Bossaert LL, Deakin C, et al. European Resuscitation Council guidelines for resuscitation 2010. Section 1: executive summary. Resuscitation 2010;81(10):1219-76. [DOI: 10.1016/j.resuscitation.2010.08.021; PubMed: 20956052]

Perkins 2015

Perkins GD, Handley AJ, Koster RW, Castrén M, Smyth MA, Olasveengen T, et al. European Resuscitation Council guidelines for resuscitation 2015. Section 2: adult basic life support and automated external defibrillation. Resuscitation 2015; 95:81-99. [DOI: 10.1016/j.resuscitation.2015.07.015; PubMed: 26477420]

Rea 2004

Rea TD, Eisenberg MS, Sinibaldi G, White RD. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. Resuscitation 2004;63:17-24. [DOI: 10.1016/j.resuscitation.2004.03.025; PubMed: 15451582]

Review Manager 2014

Review Manager 5 (RevMan 5) [Computer program]. Version 5.3. Copenhagen: Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Riva 2019

Riva G, Ringh M, Jonsson M, Svensson L, Herlitz J, Claesson A, et al. Survival in out-of-hospital cardiac arrest after standard cardiopulmonary resuscitation or chest compressions only before arrival of emergency medical services: nationwide study during three guideline periods. Circulation 2019;139:Epub ahead of print. [DOI: 10.1161/CIRCULATIONAHA.118.038179; PubMed: 30929457]

Rortveit 2010

Rortveit S, Meland E. First responder resuscitation teams in a rural Norwegian community: sustainability and self-reports of meaningfulness, stress and mastering. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2010; 18:25. [DOI: 10.1186/1757-7241-18-25; PubMed: 20441592]

Smith 2007

Smith LM, Davidson PM, Halcomb EJ, Andrew S. Can lay responder defibrillation programmes improve survival to hospital discharge following an out-of-hospital cardiac arrest? Australian Critical Care 2007;20(4):137-45. [DOI: 10.1016/j.aucc.2007.08.003; PubMed: 17931879]

Timmons 2013

Timmons S, Vernon-Evans A. Why do people volunteer for community first responder groups? Emergency Medicine Journal 2013;30(3):e13. [DOI: 10.1136/emermed-2011-200990; PubMed: 22508195]

Valenzuela 1997

Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. Circulation 1997;96(10):3308-13. [DOI: 10.1161/01.CIR.96.10.3308; PubMed: 9396421]

Zhan 2017

Zhan L, Yang LJ, Huang Y, He Q, Liu GJ. Continuous chest compression versus interrupted chest compression for cardiopulmonary resuscitation of non-asphyxial out-of-hospital cardiac arrest. Cochrane Database of Systematic Reviews 2017, Issue 3. Art. No.: CD010134 DOI: 10.1002/14651858.CD010134.pub2. [PubMed: 28349529]

Zipes 1998

Zipes DP, Wellens HJ. Sudden cardiac death. Circulation 1998;98(21):2334-51. [DOI: 10.1161/01.CIR.98.21.2334]

Other published versions of this review

Barry 2017

Barry T, Conroy N, Masterson S, Klimas J, Segurado R, Codd M, et al. Community first responders for out-of-hospital cardiac arrest. Cochrane Database of Systematic Reviews 2017, Issue 8. Art. No.: CD012764 DOI: 10.1002/14651858.CD012764.

Classification pending references

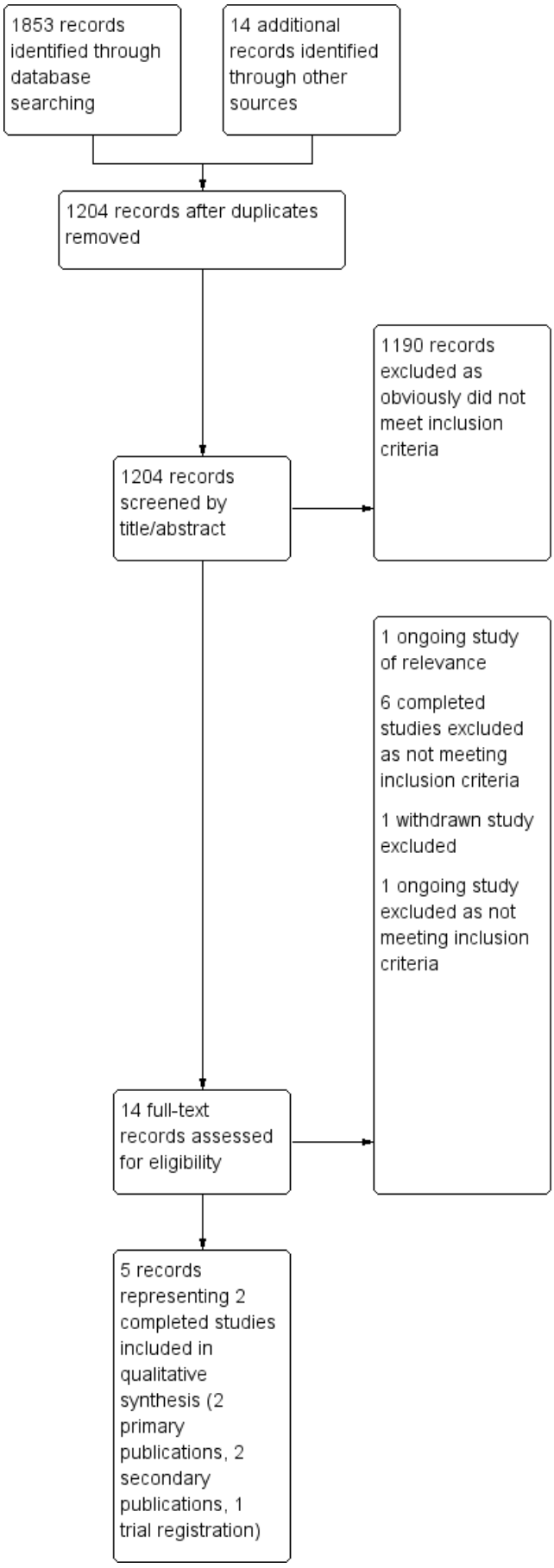
Myerburg 1982b

Myerburg RJ, Kessler KM, Zaman L, Conde CA, Castellanos A. Survivors of prehospital cardiac arrest. JAMA 1982; 247(10):1485-90.

Data and analyses

Figures

Figure 1



Caption

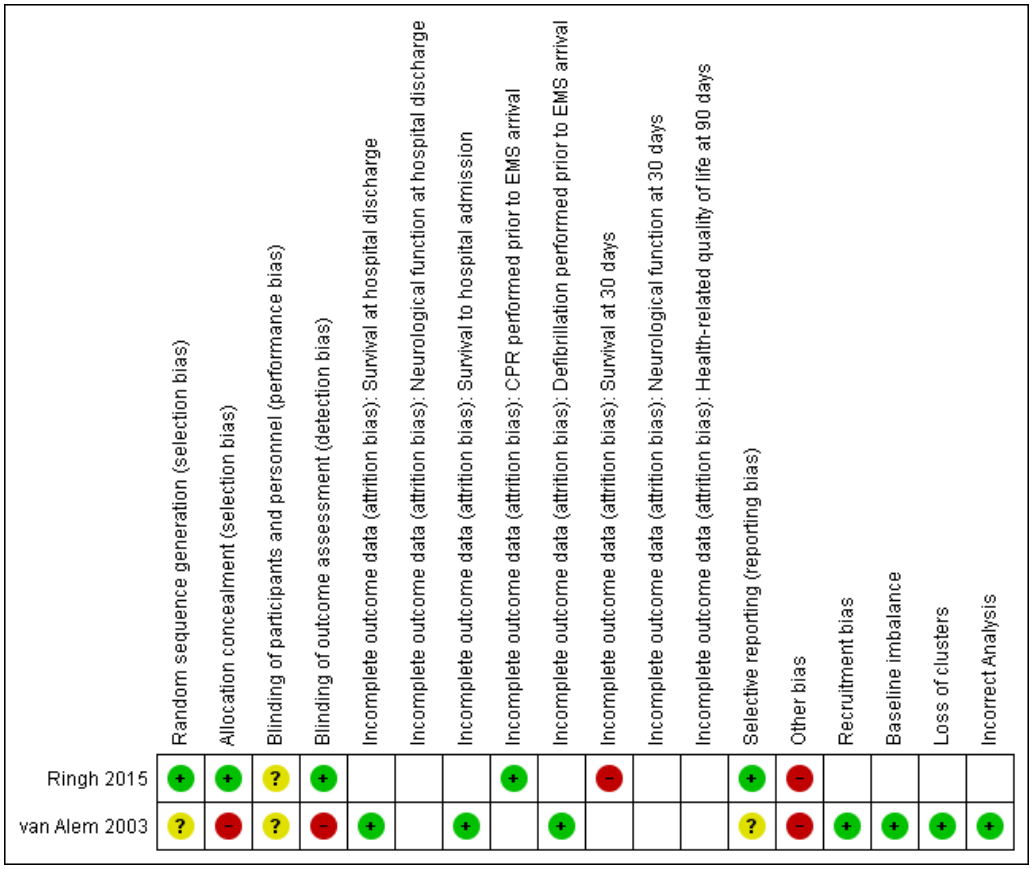
PRISMA study flow diagram.

Figure 2

Caption

Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

Figure 3



Caption

Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

Sources of support

Internal sources

- No sources of support provided

External sources

- European Commission Grant (701698), Ireland
  The work of Jan Klimas on this review was funded, in part, by European Commission Grant (701698)

Feedback

Appendices

1 Search strategies

MEDLINE

1. exp Heart Arrest/ or exp Cardiopulmonary Resuscitation/ or ((cardiac or heart or cardiopulmonary or cardio pulmonary or out of hospital) adj3 (arrest or resuscitation*)) or OHCA or CPR or asystole*

2. exp Emergency Responders/ or exp Volunteers/ or ((emergency or first or lay) adj3 responder*).mp. or volunteer*.mp. or CFR.mp. or layperson*.mp. or lay person*.mp.

3. ((randomized controlled trial or controlled clinical trial).pt. or randomi?ed.ab. or placebo.ab. or drug therapy.fs. or randomly.ab. or trial.ab. or groups.ab.) not (exp animals/ not humans.sh.)

4. 1 and 2 and 3

Embase (Ovid)

1. exp Heart Arrest/ or exp Resuscitation/ or ((cardiac or heart or cardiopulmonary or cardio pulmonary or out of hospital) adj3 (arrest or resuscitat*)).mp. or OHCA.mp. or CPR.mp. or asystole*.mp.

2. exp rescue personnel/ or exp volunteer/ or ((emergency or first or lay) adj3 responder*).mp. or volunteer*.mp. or CFR.mp. or layperson*.mp. or lay person*.mp.

3. ((crossover procedure or double blind procedure or single blind procedure).sh. or (crossover* or cross over*).ti,ab. or placebo*.ti,ab,sh. or (doubl* adj blind*).ti,ab. or (controlled adj3 (study or design or trial)).ti,ab. or allocat*.ti,ab. or trial*.ti,ab. or randomized controlled trial.sh. or random*.ti,ab.) not ((exp animal/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans).ti.))

4. 1 and 2 and 3

CENTRAL

#1 MeSH descriptor: [Heart Arrest] explode all trees
#2 MeSH descriptor: [Cardiopulmonary Resuscitation] explode all trees
#3 ((cardiac or heart or cardiopulmonary or cardio pulmonary or out of hospital) near/3 (arrest or resuscitat*)) or OHCA or CPR or asystole*
#4 #1 or #2 or #3
#5 MeSH descriptor: [Emergency Responders] explode all trees
#6 MeSH descriptor: [Volunteers] explode all trees
#7 ((emergency or first or lay) near/3 responder*) or volunteer* or CFR or layperson* or lay person*
#8 #5 or #6 or #7
#9 #4 and #8
#10 #9 in Trials

Web of Science

1 TS=(((cardiac or heart or cardiopulmonary or "cardio pulmonary" or "out of hospital") NEAR/3 (arrest or resuscitat*)) or OHCA or CPR or asystole*)

2 TS=(((emergency or first or lay) NEAR/3 responder*) or volunteer* or CFR or layperson* or lay person*)

3 #2 AND #1

4 TS= clinical trial* OR TS=research design OR TS=comparative stud* OR TS=evaluation stud* OR TS=controlled trial* OR TS=follow-up stud* OR TS=prospective stud* OR TS=random* OR TS=placebo* OR TS=(single blind*) OR TS=(double blind*)

5 #4 AND #3

2 Data extraction form

Data extraction form***

Review title
ACE 357 Impact of community first responders in out-of-hospital cardiac arrest (OHCA)

Study ID *(surname of first author and year first full report of study was published, e.g. Smith 2001)*

Report IDs of other reports of this study *(e.g. duplicate publications, follow-up studies)*

Notes:

Note – Please ensure

· Consistency in the order and style used to present the information for each included study

· Any missing information is recorded as unclear or not described

General information

1. Date form completed *(dd/mm/yyyy)*	
2. ID of person extracting data	
3. Report title *(title of paper/abstract/report from which data are extracted)*	
4. Report ID *(if there are multiple reports of this study)*	
5. Reference details	
6. Report author contact details	
7. Publication type *(e.g. full report, abstract, letter)*	
8. Study funding source *(including role of funders)*	
Possible conflicts of interest *(for study authors)*	
9. Notes:	

Eligibility

Study characteristics	Review inclusion criteria	Yes/No/Unclear	Location in text *(pg & ¶/fig/table)*
10. Type of study	Randomized trial		
	Quasi-randomized trial		
11. Participants	Adults or children, or both, suffering from OHCA, excluding studies primarily concerned with infants @ birth		
12. Types of intervention	Studies that compare routine statutory EMS vs this care plus mobilization of community first responders in instances of OHCA		
13. Types of outcome measures	At least 1 of … **Primary outcome** 1. Survival to hospital discharge **Secondary outcomes** 2. Neurological outcome at hospital discharge (CPC) 3. Survival to hospital admission, defined as a patient admitted to hospital with spontaneous circulation and measurable blood pressure 4. Cardiopulmonary resuscitation performed before ambulance service arrival 5. Defibrillation performed before ambulance service arrival		
14. Decision:			
15. Reason for exclusion			
16. Notes:			

Population and setting

	Description *Include comparative information for each group (i.e. intervention and controls) if available*	Location in text *(pg & ¶/fig/table)*
17. Population description *(from which study participants are drawn)*		
18. Setting *(including location and social context)*		
19. Inclusion criteria		
20. Exclusion criteria		
21. Method/s of recruitment of participants		
22. Notes:		

Methods

	Descriptions as stated in report/paper	Location in text *(pg & ¶/fig/table)*
Aim of study		
Design		
Unit of allocation *(by individual or cluster)*		
Start date		
End date		
Duration of participation *(from recruitment to last follow-up)*		
Notes:		

Risk of bias assessment

Domain	Risk of bias *Low/High/Unclear*	Support for judgement	Location in text *(pg & ¶/fig/table)*
23. Random sequence generation *(selection bias)*			
24. Allocation concealment *(selection bias)*			
25. Blinding of participants and personnel *(performance bias)*			
26. Blinding of outcome assessment *(detection bias)*			
27. Incomplete outcome data *(attrition bias)*			
28. Selective outcome reporting? *(reporting bias)*			
29. Other bias			
30. Notes:			

Participants

Provide overall data and, if available, comparative data for each intervention or comparison group.

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
31. Total no. randomized		
32. Clusters *(if applicable, no., type, no. people per cluster)*		
33. Baseline imbalances		
34. Withdrawals and exclusions		
35. Age		
36. Sex		
37. Race/Ethnicity		
38. Witnessed OHCA		
39. Initial rhythm		
40. Comorbidities		
41. Other treatment(s) received *(additional to study intervention)*		
42. Other relevant sociodemographics		
43. Subgroups measured		
44. Subgroups reported		
45. Notes:		

Intervention groups

(Provide a table for each intervention and comparison group)

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
46. Group name		
47. No. randomized to group *(specify whether no. people or clusters)*		
48. Description *(include sufficient detail for replication)*		
49. Duration of intervention period		
50. Details of Intervention delivery		
51. Providers *(e.g. no., profession, training)*		
52. Co-interventions if any		
53. Other		
54. Notes:		

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
55. Group name		
56. No. randomized to group *(specify whether no. people or clusters)*		
57. Description *(include sufficient detail for replication)*		
58. Duration of intervention period		
59. Details of Intervention delivery		
60. Providers *(e.g. no., profession, training)*		
61. Co-interventions if any		
62. Other		
63. Notes:		

Outcomes

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
64. Outcome name	**Survival to hospital discharge**	
65. Time points measured		
66. Time points reported		
67. Outcome definition		
68. Person measuring/reporting		
69. Imputation of missing data		
70. Notes:		

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
71. Outcome name	**CPC @ Hospital discharge**	
72. Time points measured		
73. Time points reported		
74. Outcome definition		
75. Person measuring/ reporting		
76. Unit of measurement		
77. Scale		
78. Imputation of missing data		
79. Notes:		

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
64a. Outcome name	**Survival at 30 days**	
65a. Time points measured		
66a. Time points reported		
67a. Outcome definition		
68a. Person measuring/reporting		
69a. Imputation of missing data		
70a. Notes:		

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
71a. Outcome name	**CPC @ 30 days**	
72a. Time points measured		
73a. Time points reported		
74a. Outcome definition		
75a. Person measuring/ reporting		
76a. Unit of measurement		
77a. Scale		
78a. Imputation of missing data		
79a. Notes:		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
80. Outcome name	**Survival to hospital admission**	
81. Time points measured		
82. Time points reported		
83. Outcome definition		
84. Person measuring/reporting		
85. Any imputation of missing data		
86. Notes:		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
87. Outcome name	**CPR before ambulance arrival**	
88. Time points measured		
89. Time points reported		
90. Outcome definition		
91. Person measuring/reporting		
92. Any Imputation of missing data		
93. Notes:		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
94. Outcome name	Defibrillation before ambulance arrival	
95. Time points measured		
96. Time points reported		
97. Outcome definition		
98. Person measuring/reporting		
99. Any Imputation of missing data		
100. Notes		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
x1. Outcome name	HRQOL @ 90 Days	
x2. Time points measured		
x3. Time points reported		
x4. Outcome definition		
x5. Person measuring/reporting		
x6. Scale used + Description		
x7. Any Imputation of missing data		
x8. Notes		

Results

Additional tables will be generated for each outcome and subgroup as required.

	Description as stated in report/paper				Location in text *(pg & ¶/fig/table)*
101. Comparison					
102. Outcome	Survival to hospital discharge				
103. Subgroup					
104. Results *Note whether:* *Adjusted OR* *Unadjusted*	**Intervention**		**Comparison**		
	No. events	No. participants	No. events	No. participants	
105. No. missing participants and reasons					
106. No. participants moved from other group and reasons					
107. Any other results reported					
108. Unit of analysis					
109. Statistical methods used and appropriateness of these methods					
110. Reanalysis required? *(if yes, specify why)*	*Yes/No/Unclear*				
111. Reanalysis possible?	*Yes/No/Unclear*				
112. Reanalysed results					
113. Notes:					

Applicability

114. Have important populations been excluded from the study?	
115. Does the study directly address the review question? *(any issues of partial or indirect applicability)*	
116. Notes:	

Other information

	Description as stated in report/paper	Location in text *(pg & ¶/fig/table)*
117. Key conclusions of study authors		
118. References to other relevant studies		
119. Correspondence required for further study information *(what and from whom)*		
120. Further study information requested *(from whom, what, and when)*		
121. Correspondence received *(from whom, what, and when)*		
122. Notes:		

Adapted from *Effective Practice and Organisation of Care (EPOC).* Data collection form. *EPOC Resources for Review Authors.* Oslo: Norwegian Knowledge Centre for the Health Services; 2013. Available at epoc.cochrane.org/epoc-specific-resources-review-authors

Graphs