ABSTRACT

Objectives: Cardiopulmonary resuscitation (CPR) is a crucial yet weak link in the chain of survival for out-of-hospital cardiac arrest. We sought to understand the determinants of bystander CPR and the factors associated with successful training.

Methods: For this systematic review, we searched 11 electronic databases, 1 trial registry and 9 scientific websites. We performed hand searches and contacted 6 content experts. We reviewed without restriction all communications pertaining to who should learn CPR, what should be taught, when to repeat training, where to give CPR instructions and why people lack the motivation to learn and perform CPR. We used standardized forms to review papers for inclusion, quality and data extraction. We grouped publications by category and classified recommendations using a standardized classification system that was based on level of evidence.

Results: We reviewed 2409 articles and selected 411 for complete evaluation. We included 252 of the 411 papers in this systematic review. Differences in their study design precluded a meta-analysis. We classified 22 recommendations; those with the highest scores were 1) 9-1-1 dispatch-assisted CPR instructions, 2) teaching CPR to family members of cardiac patients, 3) Braslow’s self-training video, 4) maximizing time spent using manikins and 5) teaching the concepts of ambiguity and diffusion of responsibility. Recommendations not supported by evidence include mass training events, pulse taking prior to CPR by laymen and CPR using chest compressions alone.

Conclusion: We evaluated and classified the potential impact of interventions that have been proposed to improve bystander CPR rates. Our results may help communities design interventions to improve their bystander CPR rates.

Key words: cardiac arrest, systematic review, cardiopulmonary resuscitation

RÉSUMÉ

Objectifs : La réanimation cardio-respiratoire (RCR) est un maillon essentiel, quoique faible, de la chaîne de survie lors de la survenue d’un arrêt cardiaco-hors de l’hôpital. Nous avons cherché à comprendre les déterminants du taux de passants pouvant administrer la RCR et les facteurs liés à une formation efficace.

Méthodes : Dans le cadre de cette revue systématique, nous avons analysé 11 bases de données électroniques, un registre d’essais cliniques et neuf sites Web scientifiques. Nous avons réalisé des recherches manuelles et communiqué avec six experts du contenu. Nous avons examiné sans restriction toutes les communications portant sur les questions suivantes : qui devrait apprendre la RCR, ce qu’on devrait enseigner, QUAND la formation devrait être renouvelée, où les cours de...
Introduction

Cardiac arrest is the leading cause of mortality in North America. The annual incidence of out-of-hospital cardiac arrest in the United States and Canada is estimated to be 55 per 100,000, resulting each year in more than 173,000 cardiac arrests.1,2 Overall survival rate for out-of-hospital cardiac arrest rarely exceeds 5%.1,2 Bystander cardiopulmonary resuscitation (CPR) is associated with increased survival: a victim is almost 4 times more likely to survive a cardiac arrest event when receiving CPR from a bystander.3 Unfortunately, bystander CPR rates have remained low over the past decade, rarely exceeding 20%.2,4 Various attempts have been made in the past to improve bystander CPR rates, including

- the organization of mass CPR training events5-10
- CPR training of family members of patients suffering from heart disease11-22
- promotional CPR videos19,23-25
- CPR training of high school students24,26-29

None of these initiatives have succeeded in significantly improving bystander CPR or survival rates for out-of-hospital cardiac arrest. CPR instructions through 9-1-1 dispatch assistance have been shown to increase bystander CPR rates,30 but their benefit on cardiac arrest survival remains unknown. While some communities have been able to reach bystander CPR rates as high as 54%,31,32 factors affecting these rates in the population are still unknown.

The objectives of this study were to systematically review the determinants of bystander CPR rates in the community, more specifically:

1. Who should be targeted to receive CPR training?
2. What CPR teaching program should be implemented to maximize understanding and retention?
3. When should maintenance of skills sessions occur?
4. Where should CPR instructions be given?
5. Why do people lack motivation to learn or perform CPR?

Methods

Study design, subjects and interventions

We systematically reviewed experimental and nonexperimental studies published on bystander CPR, including randomized controlled trials (RCTs), quasi-experiments, observational studies, literature reviews, editorials and letters. We included human participants of any age, sex, ethnic background, social status or geographical area. We excluded studies pertaining exclusively to the curriculum of health care professionals such as physicians, medical students, nurses and EMS personnel. We reviewed all educational tools applied at the individual, group or community level. These included computer software, media campaign, CPR instructions given over the phone and various CPR training curricula.

Outcome measures and search strategy

We evaluated various CPR promoting methods for their ability to:

1. Increase the proportion of CPR-trained individuals in the population.
2. Increase the bystander CPR rate for cardiac arrest victims.
3. Increase survival from cardiac arrest as a result of an intervention promoting CPR training.

Our information sources are available at www.cjem-online.ca/v10/n1/p51. Our electronic search strategy had no restriction for year, language or status of publication, and it was reviewed by an information specialist (www.cjem-online.ca/v10/n1/p51). We searched 11 electronic databases using the OVID interface and included subject headings, truncation terms and text words in order to access databases that do not support the use of subject headings. We used an adapted electronic search strategy for the PubMed interface. We reviewed the Cochrane Controlled Trial Registry, hand searched the Canadian Journal of Public Health and the journal Resuscitation, reviewed the bibliography of emergency medicine textbooks (see www.cjem-online.ca/v10/n1/p51) and review articles, visited the websites of numerous scientific associations and contacted content experts in the field. Content specialists were selected based on their contribution to cardiac arrest research or for the recognized success of their respective communities in promoting bystander CPR, or both.

**Selection and abstraction process**

We imported the references into a bibliographical database library using Endnote version 7.0.0 (Thomson Scientific, Carlsbad, California). Duplicates were removed manually. We used titles and abstracts to make a first selection of references that met the study inclusion criteria. A reference was also selected if a decision could not easily be made from the title or abstract alone. Hard copies of the selected articles were obtained for further examination. One investigator (CV) reviewed the selected printed articles using standardized criteria to determine final eligibility in the systematic review. Studies were considered for meta-analysis if measures of spread were available or obtainable and if clinical homogeneity was present. A single reviewer (CV) performed data abstraction on all the selected articles using a standardized form. Data extraction included information on publication status, year, country and language of publication. Description of the study design, participant, intervention and outcomes was then extracted. The source of the data (i.e., text, table or graph) was also mentioned.

**Methodologic quality of reports, data synthesis and assessment of retrieval bias**

We evaluated the quality of RCTs using allocation concealment and the validated Jadad scoring system.33 This system allocates points (out of a maximum of 5) for quality and description of randomization, blinding and dropouts. Case–control and cohort studies were evaluated using the validated Newcastle–Ottawa scales.34–36 These scales allocate stars (out of a maximum of 9) for quality of selection, comparability, exposure and outcome of study participants. We grouped studies by topic and issued a “statement of evidence” for each topic. This statement of evidence is based on the scientific quality of the studies reviewed (Box 1) and the documented effect of the intervention on bystander CPR or cardiac arrest survival rates. We have calculated the recall and precision of our electronic search strategy. Recall is defined as the number of papers included in the systematic review found by the electronic search strategy divided by those found by the full search strategy; precision is defined as the number of papers included in the systematic review found by the electronic search strategy divided by all papers found by the electronic search strategy. Expected values for recall and precision are up to 90% and 20%, respectively.37

**Results**

We completed the search strategy in September 2005, and we identified 2408 potentially relevant papers. Using predetermined selection criteria, we rejected 1997 publications based on manuscript title and abstract. We used the same criteria to review full-text copies of the remaining 411 papers. Characteristics of the 159 publications rejected at this stage are presented in Figure 1. We were unable to locate 15 of the 159 rejected publications despite exhaustive research and librarian support.

Our systematic review includes 252 publications. Meta-analysis was not possible because of the lack of homogeneity.

Our electronic search strategy was successful in retrieving 77.8% of all papers included in the systematic review. This high recall rate was achieved at the cost of having to review a large number of publications not relevant to our topic (with a precision of 8.6%). With 22.2% of all publications included in the systematic review coming from a

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**Box 1. Classification of the statements of evidence made from the systematic review**

<table>
<thead>
<tr>
<th>Quality of the evidence</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-1 Meta-analysis</td>
<td></td>
</tr>
<tr>
<td>I-2 At least 1 good quality randomized controlled trial</td>
<td></td>
</tr>
<tr>
<td>II-1 Quasi-experiment of good quality</td>
<td></td>
</tr>
<tr>
<td>II-2 Cohort or case–control study</td>
<td></td>
</tr>
<tr>
<td>II-3 Case series, noncontrolled trial, or descriptive studies</td>
<td></td>
</tr>
<tr>
<td>III Expert opinion</td>
<td></td>
</tr>
</tbody>
</table>
source other than the electronic search, we are confident that a significant effort was made to find most of the information pertaining to our topic of interest.

Characteristics of the 252 papers that were included in our systematic review are presented in Table 1. Over 62% of the literature on CPR originates from the United States and is predominantly published in English. Most publications are hypothesis generating rather than hypothesis testing. Nearly 50% of the information comes from surveys or descriptive analysis. We came across 2 systematic reviews:

![Systematic review trial flow diagram](image)

**Fig. 1.** Systematic review trial flow. CPR = cardiopulmonary resuscitation; EMS = emergency medical services.
one on the effectiveness of life support courses," which the other
on infections that were potentially acquired during CPR. Hypothesis-testing studies are described in more detail at
www.cjem-online.ca/v10/n1/p51, including RCTs (42),
quasi-experimental (25), before–after (11), case–control
and cohort studies (1).

Findings from the systematic review

The large number of studies included in our systematic
review precludes their individual detailed description. Instead,
we grouped the studies by topic and summarized
their findings. At the end of each topic we included a state-
ment along with a measure of the quality of the evidence
supporting it (Box 1). A summary of all the statements of
evidence appears in Table 2.

Who should be targeted to receive CPR training?

One approach to improving bystander CPR rates has been to
train as many CPR providers as possible in mass training
events. Such events can reach groups of a few hundred to thou-
sands of participants. Although some efforts have been
made to target groups at risk, mass training events usually
attract young participants unlikely to witness cardiac
arrest, they are not cost-effective and the effect of such
interventions on survival of cardiac arrest has not been demon-
strated in the literature. (Class II-3 evidence; see Box 1)

Table 1. Number of studies included in our systematic
review

<table>
<thead>
<tr>
<th>Topic, † n = 332</th>
<th>No. (and %)† of papers, n = 252</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion and provision of CPR courses</td>
<td>97 (29.2)</td>
</tr>
<tr>
<td>Understanding and teaching CPR</td>
<td>82 (24.7)</td>
</tr>
<tr>
<td>Attitude, motivation and reluctance</td>
<td>72 (21.7)</td>
</tr>
<tr>
<td>Maintenance of skills</td>
<td>52 (15.7)</td>
</tr>
<tr>
<td>Instructions over the phone</td>
<td>29 (8.7)</td>
</tr>
</tbody>
</table>

†There were 16 other countries, each with less than 10 papers published.
‡A paper may cover more than 1 topic.

Table 2. Summary of findings from our systematic review

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Class of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train family members of individuals with heart disease</td>
<td>I-2</td>
</tr>
<tr>
<td>Use the Braslows self-training video</td>
<td>I-2</td>
</tr>
<tr>
<td>Maximize time spent practising skills on a manikin</td>
<td>I-2</td>
</tr>
<tr>
<td>Provide dispatch-assisted CPR instructions</td>
<td>I-2</td>
</tr>
<tr>
<td>Teach concepts of ambiguity and diffusion of responsibility</td>
<td>I-2</td>
</tr>
<tr>
<td>Reduce duration of CPR classes</td>
<td>I-2</td>
</tr>
<tr>
<td>Teach CPR using self-training modular courses</td>
<td>I-2</td>
</tr>
<tr>
<td>Take a CPR class every year</td>
<td>I-2</td>
</tr>
<tr>
<td>Children can be taught CPR</td>
<td>I-2</td>
</tr>
<tr>
<td>Parents of newborn can be taught CPR</td>
<td>I-2</td>
</tr>
<tr>
<td>Individuals with heart disease should not perform CPR</td>
<td>I-2</td>
</tr>
<tr>
<td>Staged strategy leads to low completion rate for CPR training</td>
<td>I-2</td>
</tr>
<tr>
<td>Laymen should not check for pulse before initiating CPR</td>
<td>I-2</td>
</tr>
<tr>
<td>Airway and mouth-to-mouth should still be taught during CPR classes</td>
<td>I-2</td>
</tr>
<tr>
<td>The content of CPR classes should be simplified</td>
<td>II-1</td>
</tr>
<tr>
<td>Reassure trainees about low risk of disease transmission</td>
<td>II-3</td>
</tr>
<tr>
<td>Television can be used to promote and teach CPR</td>
<td>II-3</td>
</tr>
<tr>
<td>Organize mass training events</td>
<td>II-3</td>
</tr>
<tr>
<td>Physicians should prescribe CPR classes</td>
<td>II-3</td>
</tr>
<tr>
<td>Teach CPR using peer coaching</td>
<td>II-3</td>
</tr>
<tr>
<td>Inform trainees about what to expect during resuscitation</td>
<td>II-3</td>
</tr>
<tr>
<td>Mandatory CPR training at time of renewing driver’s licence</td>
<td>III</td>
</tr>
</tbody>
</table>

RCT = randomized controlled trial; CPR = cardiopulmonary resuscitation.
*Unless otherwise specified.
†There were 16 other countries, each with less than 10 papers published.
‡A paper may cover more than 1 topic.

Understanding and improving low bystander CPR rates

(1) and cohort studies (1).
Up to 15% of the population suffers from long-term disabilities that may require tailored teaching strategies. Some people may not be able to sustain the effort associated with providing CPR, which is an aerobic exercise that could elicit ischemic symptoms in people with heart disease. (Class I-2) Until further information is available, patients with known cardiac disease should seek the approval of their treating physician before attempting to perform CPR.

Spouses of individuals with cardiac disease are the most likely to witness cardiac arrest. Many authors suggest we should target family members of those individuals. The estimated rate of CPR training in this target group ranges between 9% and 47%. Although the addition of counselling to deal with the stress associated with being a potential CPR provider may be required, CPR training has been shown to reduce anxiety and increase emotional adjustment and the sense of empowerment in family members of cardiac arrest survivors. Family members of individuals with cardiac disease should be trained in CPR. (Class I-2)

Some authors suggest that physicians should “prescribe” CPR training to family members of individuals with cardiac disease. This is currently being done by 6% to 50% of surveyed physicians; another 70% to 90% said they were interested in doing so in the future. The real benefit of physician-prescribed CPR training for family members of patients with cardiac disease remains unknown. (Class II-3)

Other groups have been targeted for CPR training. Students and children as young as 10 years of age, although unlikely to encounter cardiac arrest, can be taught CPR. Parents of young infants are another group that can learn CPR before leaving the nursery. Anecdotal training is mandatory in some countries at the time of obtaining or renewing one’s driver’s licence. CPR curriculum. (Class I-2)

What CPR training program should be implemented to maximize understanding and retention?

CPR teaching guidelines are slightly different among national resuscitation councils. All programs share similar content delivery methods, and no clear support can be given to one over the other. Assar and colleagues proposed a staged teaching program. In the bronze stage, students are taught to recognize a cardiac arrest, call for help, open the airway and perform chest compressions; in the silver stage, they are taught how to provide ventilation and pediatric first aid; and in the gold stage they learn pediatric CPR and neonatal first aid. Although students finishing all 3 stages have better skills than conventionally trained students, only 38% completed the program. Staged training is not recommended because of its low rate of completion. (Class I-2)

Course length also varies. While 8-hour training sessions are associated with better retention of skills at 1 year, CPR can be taught successfully in 4-, 3- or even 2-hour sessions. There is good evidence demonstrating CPR skill acquisition during short CPR classes. (Class I-2)

A study using validated readability formulas (Smog and Flesch-Kincaid) determined that transcripts of CPR classes corresponded to a 10th grade level. Because of this, Daiker estimated that 23 million American adults may not be able to comprehend the content of CPR classes. Anecdotes and digression from the CPR curriculum are associated with poorer comprehension. There are various cognitive and behavioural approaches to teaching CPR. The content of CPR classes should be reduced and simplified. (Class II-1) This is supported by 3 literature reviews and 1 quasi-experimental study.

Good quality CPR involves chest rising with each ventilation and a palpable pulse with each chest compression. But even health care professionals cannot rapidly and accurately determine if a victim is breathing or if a pulse is present. Laymen have even more difficulty in verifying whether there is a pulse. Laymen should not check for the absence of a pulse before initiating CPR. Another debate involves teaching chest compression alone or with ventilation. Most of the evidence supporting the chest compression alone approach comes from animal data. Contrary to animal anatomy, the human upper airway does not stay open spontaneously thus preventing the free flow of air during chest compressions. Among 885 observed cardiac arrest cases receiving bystander CPR, 16% of people survived with conventional CPR, compared with 10% who received chest compressions alone. Another study reported survival rates of 6.8% with chest compression alone, compared with 9.7% with traditional CPR (p < 0.001). In a study on dispatch instructions, 62% of 9-1-1 callers were able to perform CPR according to directives, and 81% of those were able to at least perform chest compressions correctly (p = 0.005). While chest compressions alone may be appropriate for instructions over the phone, airway and breathing management should continue to be taught as part of the CPR curriculum. (Class I-2)
Students’ CPR skills improve significantly with more time spent practising on a manikin.62,133–135 Although sophisticated interactive manikins have been designed,136–138 cheaper basic models may do just fine.139 Other small portable prompt devices are arriving on the market.140 Efforts should be made to maximize the time spent practising the skills during CPR training.25,133–143 (Class I-2)

Modular self-training courses can address the different pace at which various people can learn.35,141 Participants in self-training modular courses perform similarly to those taking conventional CPR classes.36,77,145–147 There are a small number of well-designed trials supporting the use and benefit of modular self-training courses. (Class I-2)

Another popular self-training method uses videos.19,23–25 They can give results similar to conventional CPR training.79,81,94,148–153 Fewer studies found conventional CPR teaching superior to video self-teaching.30,154,155 Very good results have been obtained using a video developed by Braslow and colleagues.156 The video was validated on a group of medical students,157 and its effectiveness confirmed in a Baptist Church volunteer group.158 There is good evidence supporting the use of the Braslow self-training video. (Class I-2)

Another self-training method involves peer teaching (where a family member or friend becomes the instructor after having received basic CPR training).159–162 A peer teaching program successfully trained 1303 laymen over a few weeks in Norway.160 However, there is insufficient data to support the use of peer teaching at the moment. (Class II-3)

When should maintenance of skills sessions occur?
Irrespective of the teaching method, retention of CPR knowledge and skills is poor,24,27,38,163–169 and can significantly decrease as early as 6 weeks68,102 after a CPR class. Retraining may be protective against decline in CPR skills.170 Retention of CPR knowledge and skills may be poor because students never learned them well in the first place. In 1 study, investigators independently examined students at the completion of their CPR class; although all students received their CPR certification, none of them passed according to strict American Heart Association (AHA) criteria.171 This being said, there is no data suggesting outcomes are superior if a bystander were to perform CPR skills perfectly.35,172 Prior CPR training, even if completed a long time ago, appeared to result in better survival compared with the victims who received no CPR (11% v. 3%).173 While there is good evidence that retraining should take place on a regular basis in order to meet the AHA certification standards (Class I-2), there is little evidence that regular retraining is necessary for bystander CPR to be effective.

Where should CPR instructions be given?
Television has an influence on awareness and understanding of CPR.106,174–177 It is considered a privileged window into the population segment that is aged 50 years and older.178 In Seattle, Washington, repeated CPR instructions on television have led to a significant rise in bystander CPR rates.179 Although promising, there are currently limited data supporting the use of television to promote or teach CPR. (Class II-3)

CPR instructions over the phone could improve the low bystander CPR rates observed in residential dwellings.180,181,184–186 The ability of dispatchers to recognize cardiac arrest over the phone ranges between 68% and 90%.173,182 Agonal breathing, present as frequently as 30% in cardiac arrest victims, can limit their ability to recognize cardiac arrest.183,184 In Seattle, dispatchers overcalled cardiac arrest 14% of the time, leading to 4.3% inappropriate CPR administrations, though no adverse events were incurred.185 CPR instructions may only be possible in 30% to 37% of cases.186–189 While callers are emotionally capable of following instructions,173,191,192 they are not always in close range with the victim,31,191,192 or they struggle with the mouth-to-mouth instructions.193–195 In a randomized controlled trial of instructions to provide full CPR versus chest compressions alone, complete delivery of the instructions was achieved in 62% and 81%, respectively.196 Dispatch-assisted CPR instructions have been shown to increase bystander CPR rate,60 and possibly survival for cardiac arrest victims.173,196 There is strong evidence that 9-1-1 dispatchers should provide CPR instructions to callers. (Class I-2)

Why do people lack motivation to learn or perform CPR?
Although interest in CPR training decreases with advancing age,197–201 all but 1 study107 show a high success rate in an older age group (> .55 yr).148,202,203 Common reasons for not learning CPR include
• lack of time or interest
• inconvenience of having to leave the house
• cost
• inability to find a course
• bad health or physical limitations
• fear of contracting HIV
• fear of being sued.181,112,152,199,204–206

While no CPR provider has ever been successfully sued,207 failure to provide support could have legal con-
sequences.\textsuperscript{209} We have descriptive evidence that modifiable factors exist and influence the knowledge translation of CPR skills in the community (Class II-3), but little is known about how to modify behaviour.

People are afraid they may contract an infectious disease when learning CPR on a manikin or when providing CPR to a victim. Historically, tuberculosis and polio were major concerns on the minds of potential rescuers.\textsuperscript{108} Today, HIV and hepatitis B cause the greatest concerns.\textsuperscript{108,210–213} But no case of HIV, hepatitis B, hepatitis C, or Creutzfeld–Jakob disease has ever been reported as a result of providing CPR to a victim or a manikin.\textsuperscript{13,39,214,215} Only 15 cases of \textit{Neisseria meningitidis}, 3 cases of enteric pathogens, 2 cases of labial herpes, 1 case of tuberculosis and 1 potential case of SARS\textsuperscript{216} have ever been linked to providing CPR.\textsuperscript{26} It is extremely safe to practise CPR. Fears about disease transmission should be addressed in CPR classes. (Class II-3)

Mouth-to-mouth ventilation is an intimate act that may dissuade rescuers from performing CPR.\textsuperscript{129,217} Willingness to perform CPR is influenced by the relationship with the victim.\textsuperscript{7,15,40,58,218–222} as well as by the presence of vomit, dentures, blood, body odour and alcohol smell.\textsuperscript{161,223–225} Information on what to expect when required to perform CPR should be provided. (Class II-3)

Most CPR providers describe their experience as being positive.\textsuperscript{41,226,227} CPR certification is associated with greater confidence in one’s ability to provide care, which in turn is associated with an increase in helping behaviour.\textsuperscript{7,57,142,226–231} But CPR training is still not an assurance of action.\textsuperscript{187,222–223} People are often unable to make a decision, rather than choosing not to help (the concept of ambiguity).	extsuperscript{235} Overall helping behaviour decreases with an increasing number of bystanders (the concept of diffusion of responsibility).\textsuperscript{234,267,268} Simple and complex behavioural methods exist to address those issues.\textsuperscript{240–242} CPR teaching should include information on the concepts of ambiguity and diffusion of responsibility. (Class I-2)

**Discussion**

The findings of our systematic review of the literature on bystander CPR can be summarized in the following way:

**Who**

There seems to be clear evidence that family members of potential victims of cardiac arrest should be targeted for CPR training. Those include spouses of individuals with known coronary disease and all senior citizens, perhaps with the exception of individuals who may not be able to sustain the physical effort required to perform CPR, such as patients who themselves suffer from coronary disease.

**What**

The content of most CPR classes need to be simplified and shortened. Time spent training on a manikin should be maximized, ventilations should continue to be taught and checking for a pulse should be omitted for laymen. CPR classes should include information about the very low–risk of disease transmission and about the concepts of ambiguity and diffusion of responsibility. The use of visual aids such as the Braslow video and self-training methods should be encouraged.

**When**

Although the ability to pass a CPR competency test starts to fade within months of the initial training, there is acceptable evidence that prior training in CPR may help save lives regardless of how long it has been since the training last occurred.

**Where**

Perhaps the most attractive intervention to increase bystander CPR rates is providing CPR instructions over the phone to callers reporting a victim of cardiac arrest. There is clear evidence that such an intervention is associated with higher bystander CPR rates.

**Why**

The lack of motivation to leave the house and register for a CPR class seems to be a major determinant of low bystander CPR rates, perhaps more so than the fear of disease transmission or litigation. We need to consider measures that will actively recruit individuals for CPR training.

Our search strategy identified 2 other systematic reviews of the literature pertaining to CPR.\textsuperscript{38,39} Jabbour and colleagues reviewed the effectiveness of basic and advanced life support courses on the basis of mortality and morbidity, retention of knowledge and change in practice behaviour. With regard to basic life support, they conclude that knowledge retention is poor, that modular courses are effective and that more studies on provider behaviours are warranted.\textsuperscript{38} The Mejicano and Maki review addresses only the issue of disease transmission during CPR.\textsuperscript{39} We found 2 other large reviews of the literature on CPR.\textsuperscript{19,24} Neither review describes the methodology by which publications were identified and selected. Chehardy used a recommendation classification system similar to our statement of evidence.\textsuperscript{19} The 2005
AHA Resuscitation Guidelines, published 2 months after we completed our search strategy, concentrated on the science of CPR rather than on determinants of its practice among bystanders.

Limitations

Our review had several potential limitations. First, because there was a significant amount of information to be reviewed and synthesized, a non-negligible amount of time elapsed between the completion of our search strategy and the publication of our results. A number of pertinent papers that could have affected our findings and recommendations may have been published during that period of time. For example, a recent study by Nagao may have influenced our recommendations against removing the ventilation component of CPR. Second, manuscript selection and data extraction were completed by a single reviewer; the potential selection bias resulting from this practice was limited by the use of standardized criteria for study selection and data extraction. Third, while we could not evaluate selection and extraction bias with formal statistical testing such as Funnel plots or file drawer numbers, our search strategy recall was in agreement with current methodologic standards for systematic reviews. In other words, we found an adequate number of studies in sources other than electronic searching. Fourth, we could have restricted our search strategy to experimental or well-designed observational studies, but felt that important information could be missed if we neglected to review other types of publications such as editorials, letters and expert communications. Finally, while the diversity of patient populations, interventions and outcome measures precluded a formal meta-analysis, we were able to group studies by topics and suggest standards for systematic reviews. In other words, we found an adequate number of studies in sources other than electronic searching.

Conclusion

This systematic review of the literature examines the determinants of bystander CPR. Lack of interest and motivation play a major role in the lack of CPR training in the community. Targeted efforts are required to recruit learners most likely to witness cardiac arrest. CPR class format and content need to be shortened and simplified; learners need to spend more time practising on manikins; reassurance with regard to infectious diseases should be maintained; and more attention should be paid to behavioural aids that promote helping attitudes. Improved strategies to provide dispatcher-assisted CPR instructions should also be developed.

Acknowledgements: We would like to acknowledge the contribution of Mrs. Margaret Sampson, Research Information Specialist with the Thomas C. Chalmers Centre for Systematic Reviews, Children’s Hospital of Eastern Ontario, for her review of our electronic search strategy.

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Understanding and improving low bystander CPR rates


228. Crider DA. A study of the attitudes and behaviors of potential rescuers and their willingness to respond in an emergency situation (First Aid, CPR). Dissertation Abstracts International 1508;57:1508.


Correspondence to: Dr. Christian Vaillancourt, The Ottawa Hospital, Civic Campus, Clinical Epidemiology Unit, Rm. F658, 1053 Carling Ave, Ottawa ON K1Y 4E9; cvaillancourt@ohri.ca
## Online appendix 1. Information sources included in the systematic review

<table>
<thead>
<tr>
<th>Electronic search</th>
<th>Hand search</th>
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</thead>
<tbody>
<tr>
<td>• PubMed</td>
<td>• Resuscitation</td>
</tr>
<tr>
<td>• OVID</td>
<td>• Canadian Journal of Public Health</td>
</tr>
<tr>
<td>• EBM</td>
<td></td>
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<tr>
<td>• Biological Abstract</td>
<td></td>
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<tr>
<td>• CINAHL</td>
<td></td>
</tr>
<tr>
<td>• Current Content/All eds</td>
<td></td>
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<tr>
<td>• Dissertation Abstracts</td>
<td></td>
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<tr>
<td>• ERIC</td>
<td></td>
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<tr>
<td>• HealthSTAR</td>
<td></td>
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<tr>
<td>• PreMedline and Medline</td>
<td></td>
</tr>
<tr>
<td>• PAIS international</td>
<td></td>
</tr>
<tr>
<td>• PsycInfo</td>
<td></td>
</tr>
<tr>
<td>• SocioFile</td>
<td></td>
</tr>
</tbody>
</table>

### Experts in the field
- Dr. Andy Anton, Calgary, Alberta
- Dr. Wes Clark, Ottawa, Ontario
- Dr. Ian Stiell, Ottawa, Ontario
- Dr. Valerie De Maio, Chapel Hill, North Carolina
- Dr. Mickey Eisenberg, Seattle, Washington
- Dr. Lars Wik, Oslo, Norway

### Trial registry
- Cochrane Controlled Trial Registry

### Scientific association websites
- Heart and Stroke Foundation of Canada
- American Heart Association
- Resuscitation Council (UK)
- Canadian Association of Emergency Physicians
- Association des Médecins d’Urgence du Québec
- American College of Emergency Physicians
- Society for Academic Emergency Medicine
- Canadian Coordinating Office for Health Technology Assessment
- National Institute for Clinical Excellence

### Review of bibliography

#### Textbooks

#### Review articles
Online appendix 2. Electronic search strategies for the systematic review

OVID search
PreMEDLINE/MEDLINE, EBM Cochrane-ACP JC-DARE, EBM Cochrane Controlled Trials Register, Biological Abstract, CINAHL, Current Content, Dissertation Abstract, ERIC, HealthSTAR, PAIS International, PsycINFO, SocioFile

Teaching
1. exp teaching/ or exp education/ or exp computer user training/ or exp educational technology/ or exp models, educational/ or exp audiovisual aids/ or exp textbooks/
2. (teach$ or educat$ or academi$ train$ or educat$ personnel or educat$ techni$ or teach$ metho$ or train$ activi$ or train$ techni$ or [train$ adj3 train$] or [comput$ adj3 train$] or educat$ technolog$ or educat$ mode$ or instruct$ mode$ or audiovisua$ or textboo$).tw.

Cardiopulmonary resuscitation
3. exp cardiopulmonary resuscitation/ or exp resuscitation/ or exp first aid/ or exp heart massage/ or exp respiration, artificial/
4. (cardio?pulmonary resuscitation or resuscitatio$ or mouth?to?mouth or basic life support or cpr or code blue or first aid? or first respond$ or heart massage or cardiac massage or artificial respiration).tw.

To the population
5. bystander/ or exp sociology/ or exp population characteristics/ or exp residence characteristics/ or exp group processes/ or exp group structure/ or exp behavior/ or exp psychology, social/ or exp social medicine/ or exp social planning/
6. (population or bystander? or social phenomen$ or sociolog$ or population characterist$ or residence characterist$ or communit$ or neighborhoo$ or domicile or group proces$ or group structu$ or behavi$ or social medicine or social pla$).tw.
7. exp population/

Merging medical subject headings with text word search
8. or/1-2
9. or/3-4
10. or/5-7

Combining concepts
11. and/8-10

PUBMED
#4 Search #1 AND #2 AND #3
#3 Search population OR bystander OR social phenomen$ OR sociolog$ OR population characterist$ OR residenc$ characterist$ OR communit$ OR neighborhoo$ OR domicile OR group proces$ OR group structu$ OR behavi$ OR social medicine OR social pla$
#2 Search cardiopulmonary resuscitation OR resuscitatio$ OR mouth to mouth OR basic life support OR cpr OR code blue OR first aid OR first respond OR heart massage OR cardiac massage OR artificial respiration
#1 Search teach$ OR educat$ OR academi$ train$ OR educat$ personnel OR educat$ techni$ OR teach$ metho$ OR train$ activi$ OR train$ techni$ OR train$ OR comput$ train$ OR educat$ technolog$ OR educat$ mode$ OR instruct$ mode$ OR audiovisua$ OR textboo$
### Online appendix 3. Hypothesis testing studies: characteristics by methodology

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcome measure</th>
<th>Jadad scale</th>
<th>Allocation concealment</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assar et al. (2000)</td>
<td>Population of South Wales</td>
<td>1: Staged CPR teaching (2 hrs)</td>
<td>Multiple CPR skill comparisons (with no statistical adjustment)</td>
<td>2</td>
<td>Not used</td>
<td>Staged teaching leads to better skills.</td>
</tr>
<tr>
<td>Adkinson et al. (1999)</td>
<td>Volunteers trained in CPR or not</td>
<td>2: Conventional CPR teaching (2 hrs)</td>
<td>No. ventilations, No. chest compressions, hand position, and time to CPR</td>
<td>1</td>
<td>Not used</td>
<td>Video-link instructions were best. Telephone instructions were good. Previous training had no influence on skills.</td>
</tr>
<tr>
<td>Batcheller et al. (2000)</td>
<td>Recruited from community</td>
<td>1: Video self-training in CPR (25 min)</td>
<td>Effective ventilation, effective compressions, and effective CPR delivery</td>
<td>2</td>
<td>Not used</td>
<td>Self-trained did generally better than conventionally trained.</td>
</tr>
<tr>
<td>Baillin et al. (1996)</td>
<td>Professional rescuers</td>
<td>2: Conventional CPR teaching (4 hrs)</td>
<td>Duration of CPR, quality of CPR, oxygen consumption, heart rate, and lactate level</td>
<td>1</td>
<td>Not used</td>
<td>Conventional CPR demands less energy than ACD and can be performed longer (29 min v. 16 min).</td>
</tr>
<tr>
<td>Berden et al. (1993)</td>
<td>Nurses</td>
<td>3: Retested at 1 year</td>
<td>CPR skills</td>
<td>2</td>
<td>Not used</td>
<td>Instructions every 6 months are necessary.</td>
</tr>
<tr>
<td>Bilger et al. (1997)</td>
<td>Medical (18%) and laypeople (82%)</td>
<td>1: Retested at 6 months + refresher</td>
<td>Call 9-1-1 for help</td>
<td>2</td>
<td>Not used</td>
<td>Group trained with prompt telephone remembered to call 9-1-1 more often.</td>
</tr>
<tr>
<td>Capon et al. (2000)</td>
<td>Auto industry employees</td>
<td>1: TV spots on CPR (60 sec)</td>
<td>CPR skills</td>
<td>3</td>
<td>Not used</td>
<td>Both groups had similarly bad CPR skills.</td>
</tr>
<tr>
<td>Chamberlain &amp; others (2001)</td>
<td>Population of South Wales</td>
<td>2: Conventional CPR teaching (2 hrs)</td>
<td>Likelihood of returning for further training or retraining</td>
<td>2</td>
<td>Not used</td>
<td>Staged teaching led to higher likelihood of return visits to complete or repeat training.</td>
</tr>
<tr>
<td>Coleman et al. (1999)</td>
<td>College students</td>
<td>1: Staged CPR teaching (2 hrs)</td>
<td>Written exam and skill exam according to Mandel check-list</td>
<td>1</td>
<td>Not used</td>
<td>Both groups were equivalent.</td>
</tr>
<tr>
<td>Dorf et al. (2000)</td>
<td>Center for elderly</td>
<td>2: Conventional CPR teaching (4 hrs)</td>
<td>Time to continuous efforts</td>
<td>2</td>
<td>Not used</td>
<td>Poor CPR both groups; more chest compressions in group 2.</td>
</tr>
<tr>
<td>Donnelly et al. (2000)</td>
<td>Laymen</td>
<td>1: Traditional Dispatch CPR</td>
<td>CPR skills evaluated according to CARE and VIDRAP protocol</td>
<td>2</td>
<td>Not used</td>
<td>European and ILCOR guidelines appeared easier to learn; retention was poor irrespective of method.</td>
</tr>
<tr>
<td>Draugute et al. (1996)</td>
<td>Heart disease patients</td>
<td>1: CPR teaching (90 min)</td>
<td>Multiple adjective affect checklist, psychological adjustment to illness scale and CPR quiz.</td>
<td>1</td>
<td>Not used</td>
<td>Anxiety was worse in CPR group. Adjustment to illness was worse in CPR and education group compared with placebo.</td>
</tr>
<tr>
<td>Draugute et al. (1994)</td>
<td>Family members of heart disease patients</td>
<td>2: Heart disease education (90 min)</td>
<td>24-item self administered questionnaire</td>
<td>1</td>
<td>Inadequate</td>
<td>Very positive feeling about CPR training without an increased sense of burden or responsibility compared with placebo.</td>
</tr>
</tbody>
</table>

Note: Mean age and age range are provided for each study. Additional details include study methodology, intervention, and outcomes measured.
<table>
<thead>
<tr>
<th>Study</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Moser et al. (1993)</td>
<td>n = 674</td>
<td>Heart disease patients Mean age 62.9 +/- 10.1 years Family members Mean age 59.0 +/- 10.9 years</td>
<td>1- CPR teaching 2- CPR + education on heart disease 3- CPR + social support 4- Nothing</td>
<td>Multiple affective affect check list, psychological adjustment to illness scale and Spanier dyadic adjustment scale</td>
<td>1</td>
<td>Inadequate</td>
</tr>
<tr>
<td>Dracup et al. (1998)</td>
<td>n = 400</td>
<td>Parents of sick infants Mean age 29.9 +/- 8.4 years</td>
<td>1- Conventional CPR class 2- Conventional CPR class + social support 3- CPR self-training video</td>
<td>Mandel CPR skill checklist, PAIS, multiple affect checklist and perceived social support scale</td>
<td>2</td>
<td>Not Used</td>
</tr>
<tr>
<td>Dracup et al. (2000)</td>
<td>n = 315</td>
<td>Parents of sick infants Mean age 30 +/- 8 years</td>
<td>1- Conventional CPR class 2- Conventional CPR class + social support 3- CPR self-training video Pre-op CABG volunteer on/off pump pulse check</td>
<td>Psychological adjustment to illness, Spielberger state of anxiety inventory, McMaster family assessment device, PAIS</td>
<td>1</td>
<td>Inadequate</td>
</tr>
<tr>
<td>Eiberle et al. (1996)</td>
<td>n = 206</td>
<td>EMT-1; EMT-2; PM-1; PM-2</td>
<td>Pulse present or no; Time delay before decision</td>
<td></td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Eisenberg et al. (1995)</td>
<td>n = 17316</td>
<td>Washington households Head of household &gt;50 years</td>
<td>1- CPR self-training video 2- Nothing</td>
<td>Bystander CPR rate N = 65 cardiac arrests</td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Hansström et al. (2000)</td>
<td>n = 520</td>
<td>9-1-1 callers Age unknown</td>
<td>1- Instruction to do chest compression 2- Instruction to do full CPR</td>
<td>Delivery of intervention and survival to hospital discharge</td>
<td>3</td>
<td>Adequate</td>
</tr>
<tr>
<td>Hawke et al. (1992)</td>
<td>n = 84</td>
<td>University students Age unknown</td>
<td>1- CPR + bystander education (2 hrs) 2- CPR training alone</td>
<td>Helping behavior and appropriateness of intervention</td>
<td>4</td>
<td>Adequate</td>
</tr>
<tr>
<td>Kazciorowski et al. (1998)</td>
<td>n = 44</td>
<td>Medical student Age unknown</td>
<td>1- Video + unsupervised manikin practice at 3-5 months 2- Booster training + supervised manikin practice at 3-5 months 3- No booster training session</td>
<td>Neonatal knowledge and skill retention at 6-8 months</td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Kittison et al. (1986)</td>
<td>N = 96</td>
<td>University students Age unknown</td>
<td>1- Conventional CPR teaching 2- CPR teaching with task behaviour 3- CPR teaching with progressive part practice</td>
<td>19-item skill competency scale</td>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>Komasky et al. (1990)</td>
<td>n = 28</td>
<td>Parents of apnic infants Mean age 29.8 years OEGP students Mean age 24.8 +/- 12.5 years</td>
<td>1- CPR + home visit/manikin practice 2- CPR + telephone/clinic follow-up 1- 4 hrs, manikin/student 1:4 2- 4 hrs, manikin/student 1:1 3- 2 hrs, manikin/student 1:1 4- 11 min. self-training video + manikin</td>
<td>Spielberger state-trait anxiety inventory and CPR skills</td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Liberman et al. (2000)</td>
<td>n = 61</td>
<td></td>
<td>1- CPR theory review (3 pages) 2- CPR video review (15 min)</td>
<td>CPR skills</td>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>Mandel et al. (1987)</td>
<td>n = 67, City employee Age unknown</td>
<td></td>
<td>1- CPR teaching only 2- Instruction to do full CPR</td>
<td>CPR knowledge and skills</td>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>Messmer et al. (1993)</td>
<td>n = 30</td>
<td>Substance abuse mothers Mean age 28.6 +/- 5.3 years 1st year nursing students Mean age 21 +/- 8 years</td>
<td>1- JUST CD-ROM (60-min. training) 2- Nothing</td>
<td>Positive helping attitude</td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Monsieurs et al. (2004)</td>
<td>n = 41</td>
<td>Medical student Age unknown</td>
<td></td>
<td></td>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>Moser et al. (1999)</td>
<td>n = 305</td>
<td>Parents of sick infants Mean age 30.5 +/- 8.5 years</td>
<td>1- Video on CPR 2- Conventional CPR teaching 3- Conventional CPR + social support 4- Nothing</td>
<td>CPR attitude scale, willingness to attempt CPR, anxiety, sense of burden and feeling of loss of control</td>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>Moser et al. (2000)</td>
<td>n = 196</td>
<td>Family members of heart disease patients Mean age 59 +/- 10.5 years</td>
<td>1- CPR + education on heart disease 2- CPR + social support 3- Nothing</td>
<td>Multiple affective affect check list and control attitudes scale</td>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
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<tr>
<td>Nelson (1984)</td>
<td>Medical students, hospital personnel, and laypeople</td>
<td>Group 1: Conventional CPR +/- refresher; Group 2: Modular CPR class +/- refresher</td>
<td>Written exam, CPR skills, and harmful behaviour</td>
<td>1</td>
<td>Not used</td>
<td>At 1 year, all groups equal. At 2 years, groups with refresher did better.</td>
</tr>
<tr>
<td>Ruppert (1999)</td>
<td>Health care workers and laymen</td>
<td>Group 1: Using a live person; Group 2: Using a manikin</td>
<td>Determination of breathing status (yes or no)</td>
<td>1</td>
<td>Not used</td>
<td>Only 5% could make the correct diagnosis within the 5 sec recommended by AHA.</td>
</tr>
<tr>
<td>Shantais (1983)</td>
<td>University students</td>
<td>Group 1: Modular CPR teaching; Group 2: Conventional CPR teaching</td>
<td>CPR knowledge and skills</td>
<td>1</td>
<td>Not used</td>
<td>Neither group could perform CPR after 9 weeks.</td>
</tr>
<tr>
<td>Shantais (1985)</td>
<td>University students</td>
<td>Group 1: 2X3X2 table varying: Ambiguity, number of bystander, training status</td>
<td>Helping behaviour</td>
<td>2</td>
<td>Not used</td>
<td>Ambiguous situation and presence of many bystanders decreases helping behaviour. Training only influence nature of help provided.</td>
</tr>
<tr>
<td>Su (2000)</td>
<td>Paramedics</td>
<td>Group 1: Knowledge + manikin refresher; Group 2: Manikin refresher</td>
<td>Pediatric CPR knowledge and skills measured at 12 months</td>
<td>2</td>
<td>Not used</td>
<td>All groups returned to pre-training level at 12 months with or without a refresher at 6 months.</td>
</tr>
<tr>
<td>Swor (2003)</td>
<td>Hospital mailing list</td>
<td>Group 1: Traditional CPR training (2h); Group 2: Chest compression only (2h)</td>
<td>Knowledge/permission; fear of infection; retention at 3 months</td>
<td>2</td>
<td>Not used</td>
<td>Similar perceived ability; fear of infection less in group 2; 39% more competent at 3 months (same)</td>
</tr>
<tr>
<td>Todd (1998)</td>
<td>Medical students</td>
<td>Group 1: Video self-training (34 min); Group 2: Conventional CPR class (4 hrs)</td>
<td>Overall CPR competency and skills</td>
<td>5</td>
<td>Unclear</td>
<td>Video self-training led to superior competency and skills.</td>
</tr>
<tr>
<td>Todd (1999)</td>
<td>Baptist church laymen</td>
<td>Group 1: Video self-training (34 min); Group 2: Conventional CPR class (4 hrs)</td>
<td>Written test, overall CPR competency and CPR skills</td>
<td>5</td>
<td>Adequate</td>
<td>Video self-training led to similar competency and skills.</td>
</tr>
<tr>
<td>Toms (1998)</td>
<td>Laymen</td>
<td>Group 1: Conventional CPR class + peer coaching; Group 2: Conventional CPR class</td>
<td>CPR knowledge and skills</td>
<td>1</td>
<td>Not used</td>
<td>Outcome measure not influenced by peer coaching.</td>
</tr>
<tr>
<td>Vanderschmidt (1975)</td>
<td>School children Age 8th and 11th grade</td>
<td>Group 1: Didactic teaching + manikin; Group 2: Didactic teaching only</td>
<td>CPR knowledge and skills</td>
<td>1</td>
<td>Not used</td>
<td>Group 1 did better. 11th grade students did better.</td>
</tr>
<tr>
<td>Ward (1997)</td>
<td>University students</td>
<td>Group 1: Wallet size check list; Group 2: Longer, more detailed check list</td>
<td>CPR skills</td>
<td>2</td>
<td>Not used</td>
<td>Longer check list did the best. No difference between wallet size check list and no check list.</td>
</tr>
<tr>
<td>Wa (2001)</td>
<td>Paramedics</td>
<td>Group 1: Cross-over trial; Group 2: 3 min CPR, automated feedback; Group 3: 2 min CPR, no feedback</td>
<td>CPR skills</td>
<td>2</td>
<td>Not used</td>
<td>Automated voice advisory manikin rapidly improves CPR skills.</td>
</tr>
<tr>
<td>Yakul (1989)</td>
<td>Nurses 3 different wards</td>
<td>Group 1: Conventional CPR class + peer coaching; Group 2: Conventional CPR class</td>
<td>CPR knowledge and skills</td>
<td>1</td>
<td>Not used</td>
<td>Area of work did not make a difference. Group 2 did better.</td>
</tr>
<tr>
<td>Quasi-experiment</td>
<td>9-1-1 callers reporting cardiac arrest</td>
<td>Group 1: Phone instruct. no previous training; Group 2: Phone instruct. previous training</td>
<td>Adequacy of cardiac arrest by dispatcher, survival to hospital discharge</td>
<td>-</td>
<td>—</td>
<td>High accuracy of dispatchers for diagnosis of cardiac arrest. Bystanders with previous CPR training did better, more so with phone instructions. Phone instructions increase survival.</td>
</tr>
<tr>
<td>Berkle (1975)</td>
<td>School children Age range 12-13, 15-17 years</td>
<td>Group 1: Conventional CPR teaching; Group 2: Self-training + manikin</td>
<td>CPR knowledge and skills. Attempt at doing CPR.</td>
<td>—</td>
<td>—</td>
<td>Self-training compares to conventional CPR teaching. Manikin practice is important. CPR video only was better than no instructions at all.</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
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</tr>
<tr>
<td>Boye (2000)</td>
<td>Non-medical personnel</td>
<td>1: Chest compressions</td>
<td>Hand position, % effective compressions and rate</td>
<td>—</td>
<td>—</td>
<td>Hand position improved in 31% of group 2; rate and effective compressions improved in group 2 Video 2 more effective than video 1 (prototype) and conventional teaching. Also if &gt;40 years old.</td>
</tr>
<tr>
<td>Braslow (1997)</td>
<td>Laymen</td>
<td>1: Self-instruction video 1 (30 min)</td>
<td>Chest compression, ventilation, and overall CPR skills</td>
<td>—</td>
<td>—</td>
<td>All intervention groups shared similar CPR knowledge; CPR skills were best in group 3.</td>
</tr>
<tr>
<td>Braslow (1980)</td>
<td>Laymen</td>
<td>1: Self training at home + observer</td>
<td>CPR knowledge and skills</td>
<td>—</td>
<td>—</td>
<td>Protocol phone instructions were better than impromptu instructions. Groups without prior CPR knowledge did as well with instruct.</td>
</tr>
<tr>
<td>Carter (1984)</td>
<td>Laymen</td>
<td>1: Protocol phone instruct.</td>
<td>CPR cycle, ventilations, compressions, confusion, unrequested returns to phone and time to first compression</td>
<td>—</td>
<td>—</td>
<td>Knowledge and skills deteriorated at 3 months. Groups were similar.</td>
</tr>
<tr>
<td>Edwards (1985)</td>
<td>Oil company employee</td>
<td>1: Interactive video-disc CPR class</td>
<td>CPR knowledge, skills and retention</td>
<td>—</td>
<td>—</td>
<td>Group 1 started CPR components later, but were more effective.</td>
</tr>
<tr>
<td>Flosch (1995)</td>
<td>Laymen</td>
<td>1: Phone instruct./no CPR training</td>
<td>Overall CPR effectiveness, time to ventilation and compression</td>
<td>—</td>
<td>—</td>
<td>Small group did better than large. Both groups improved.</td>
</tr>
<tr>
<td>Geijer (1996)</td>
<td>Nurses</td>
<td>1: Teaching classes of 15-20</td>
<td>CPR knowledge and skills</td>
<td>—</td>
<td>—</td>
<td>No difference between groups.</td>
</tr>
<tr>
<td>Handley (1998)</td>
<td>Laymen</td>
<td>1: Thought 4-step sequence (2 hrs)</td>
<td>CPR skills</td>
<td>—</td>
<td>—</td>
<td>All intervention groups demonstrated improved propensity to help compared with control group. Group 3 did best.</td>
</tr>
<tr>
<td>Hawke (1998)</td>
<td>University students</td>
<td>1: American Red Cross CPR</td>
<td>Helping behaviour (yes or no)</td>
<td>—</td>
<td>—</td>
<td>None passed the test in 2-3 hour class with non-recording manikin; manikin-trained group did much better.</td>
</tr>
<tr>
<td>Korttila (1979)</td>
<td>Army conscripts</td>
<td>1: 2 hour class/record manikin</td>
<td>CPR skills (recorded), 3 different set of criteria Time necessary to notice and report the smoke</td>
<td>—</td>
<td>—</td>
<td>Manikin-trained group did much better.</td>
</tr>
<tr>
<td>Lutatia (1966)</td>
<td>Medical students</td>
<td>1: Alone in smoke-filling room</td>
<td>Quality of ventilations</td>
<td>—</td>
<td>—</td>
<td>No difference between groups.</td>
</tr>
<tr>
<td>Laster (1997)</td>
<td>Middle or Junior High school students</td>
<td>1: CPR class taught by teacher</td>
<td>CPR knowledge and skills</td>
<td>—</td>
<td>—</td>
<td>Girls did better than boys in group 2. Overall no difference.</td>
</tr>
<tr>
<td>Long (1990)</td>
<td>Parents of sick infants</td>
<td>1: Didactic CPR teaching</td>
<td>CPR knowledge and skills</td>
<td>—</td>
<td>—</td>
<td>No difference between groups.</td>
</tr>
<tr>
<td>Luci (1999)</td>
<td>Health care professional</td>
<td>1: Sedentary CPR instructors</td>
<td>Heart rate, VO2 max, and lactate levels for 18-min CPR session</td>
<td>—</td>
<td>—</td>
<td>Physical fitness may have a positive influence on resuscitation.</td>
</tr>
<tr>
<td>Noordergraaf (1997)</td>
<td>Medical students</td>
<td>1: Actar 911 manikin 1:1 ratio</td>
<td>CPR skills</td>
<td>—</td>
<td>—</td>
<td>No difference between groups. Individual manikin preferred.</td>
</tr>
</tbody>
</table>
## Online appendix 3. Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcome measure</th>
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<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schlesseg</td>
<td>Parents of healthy infant</td>
<td>1: Infant CPR training (4 hrs)</td>
<td>CPR knowledge, self-efficacy and anticipated anxiety</td>
<td>—</td>
<td>—</td>
<td>CPR knowledge better, self-efficacy better and less anxiety.</td>
</tr>
<tr>
<td></td>
<td>Age 12, 14, 17 and 20 years</td>
<td>2: Nothing</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Skills improved with repeated training unlike knowledge and fear.</td>
</tr>
<tr>
<td>Van Kerschaverf</td>
<td>School students</td>
<td>1: Test plus second training</td>
<td>CPR knowledge, CPR skills and fear to apply CPR</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Test only</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Winchelli</td>
<td>Laymen and health care</td>
<td>1: Practiced on manikin (10 groups)</td>
<td>CPR skills on recording manikin</td>
<td>—</td>
<td>—</td>
<td>Group 1 did better.</td>
</tr>
<tr>
<td></td>
<td>20 different groups</td>
<td>2: No manikin practice (10 groups)</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Beamantg</td>
<td>University students</td>
<td>1: Info on diffusion of responsibility</td>
<td>Helping behaviour (yes or no)</td>
<td>—</td>
<td>—</td>
<td>Knowing about diffusion of responsibility improved helping.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Nothing</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Delay in helping if larger group size, except in group 1.</td>
</tr>
<tr>
<td>Parini</td>
<td>University women</td>
<td>1: Video on helping in emergencies</td>
<td>Helping behaviour in group size of 2 v. 6</td>
<td>—</td>
<td>—</td>
<td>No difference between groups.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: No video</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Friesen</td>
<td>Nurses</td>
<td>1: Self-paced teaching method</td>
<td>CPR knowledge and skills retention at 2 and 8 weeks</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Didactic teaching</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Gombaski</td>
<td>Laymen</td>
<td>1: Teaching in 3 sessions (8 hrs)</td>
<td>CPR knowledge and skills at one year</td>
<td>—</td>
<td>—</td>
<td>Both groups substandard.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Teaching in 1 session (4 hrs)</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Group 1 did better.</td>
</tr>
</tbody>
</table>

### Before–after

<table>
<thead>
<tr>
<th>Study</th>
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<th>Conclusion</th>
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<tbody>
<tr>
<td>Alvarezj</td>
<td>High school students</td>
<td>1: Medic II program (includes mandatory CPR class in high school)</td>
<td>CPR knowledge and skills at 12 months</td>
<td>—</td>
<td>—</td>
<td>Did well on written exam.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Fair results on skill testing.</td>
</tr>
<tr>
<td>Becklj</td>
<td>Population based</td>
<td>1: Public service announcements teaching CPR on TV</td>
<td>Rate of bystander CPR for 289 cardiac arrests</td>
<td>—</td>
<td>—</td>
<td>Bystander CPR increased from 43% to 55% p &lt;0.05</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Calendar +/- manikin to take home</td>
<td>CPR skills</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Bircher</td>
<td>School children</td>
<td>1: First aid and infant CPR via video, lecture, demonstration, and practice</td>
<td>CPR skills</td>
<td>—</td>
<td>—</td>
<td>Young children can learn to do infant CPR well.</td>
</tr>
<tr>
<td></td>
<td>Age range 10-12 years</td>
<td>2: TV flashed with goal to promote CPR teaching</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Bosmajl</td>
<td>High school students</td>
<td>1: System for training and assessing resuscitation skills (STARS)</td>
<td>Number of errors and time to reach preset criterion for CPR skill</td>
<td>—</td>
<td>—</td>
<td>Delayed prompting technique did best.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Conroym</td>
<td>Post-partum mothers</td>
<td>1: 17 min video, 20 min lecture, and manikin practice. Revision in 2nd time.</td>
<td>CPR knowledge</td>
<td>—</td>
<td>—</td>
<td>Knowledge increased but not maintained at 6 months.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Fair results on skill testing.</td>
</tr>
<tr>
<td>Culleyn</td>
<td>9-1-1 callers</td>
<td>1: Phone instructions provided to callers reporting cardiac arrest</td>
<td>CPR knowledge</td>
<td>—</td>
<td>—</td>
<td>Bystander CPR rate and survival to hospital discharge</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td>Bystander CPR rate increased from 32% to 54% p &lt;0.001. Trend toward improvement in survival.</td>
</tr>
<tr>
<td>Cury</td>
<td>Health care professional</td>
<td>1: Conventional CPR training</td>
<td>CPR knowledge and skills at 6 and 12 months</td>
<td>—</td>
<td>—</td>
<td>Knowledge and skills back to pre-test level at 6 and 12 months.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: TV flashed with goal to promote CPR classes, followed by survey</td>
<td>Awareness, understanding, and commitment to take CPR class</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Doherty</td>
<td>Flemish population</td>
<td>1: TV flashed with goal to promote CPR classes, followed by survey</td>
<td>Awareness, understanding, and commitment to take CPR class</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Sundol</td>
<td>Laymen</td>
<td>1: Mass mailing calendars with CPR</td>
<td>CPR knowledge</td>
<td>—</td>
<td>—</td>
<td>Knowledge increased and skills back to pre-test level at 6 and 12 months.</td>
</tr>
<tr>
<td></td>
<td>Age unknown</td>
<td>2: Calendar +/- manikin to take home</td>
<td>CPR skills</td>
<td>—</td>
<td>—</td>
<td>Mass mailing of CPR instructions not useful. Practice is necessary.</td>
</tr>
<tr>
<td>Pane</td>
<td>Targeted laymen</td>
<td>1: Targeted recruitment of seniors for mass CPR training, then survey</td>
<td>Demographic data compared with previous mass training event</td>
<td>—</td>
<td>—</td>
<td>The &gt;60 age group doubled. More family members of cardiac patients.</td>
</tr>
<tr>
<td></td>
<td>Age 60&lt; years</td>
<td>2: Delayed prompting technique</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Eisenbergl</td>
<td>9-1-1 callers</td>
<td>1: Phone instructions provided to callers reporting cardiac arrest</td>
<td>CPR knowledge</td>
<td>—</td>
<td>—</td>
<td>Bystander CPR rate increased by 11.1% (95%CI 1.8-20.4). Four lives may have been saved.</td>
</tr>
</tbody>
</table>
### Online appendix 3. Continued

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<tr>
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<tbody>
<tr>
<td><strong>Case-control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goldberg [1984]</td>
<td>Cases</td>
<td>1: Family members of heart disease patients</td>
<td>Control</td>
<td>1: Family members of non-cardiac patients 2: Random neighbourhood control</td>
<td>Newcastle-Ottawa Scale</td>
<td>Conclusion</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Previous CPR training status (yes or no)</td>
<td></td>
<td>6/9</td>
<td>Family members of cardiac patients were less likely to be trained in CPR; if they were, they had taken the class much further in the past compared with control.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cohort study</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jackson [1997]</td>
<td>Cohort</td>
<td>1: Victims of cardiac arrest at home</td>
<td>Control</td>
<td>1: Victims of cardiac arrest in a public venue</td>
<td>Newcastle-Ottawa Scale</td>
<td>Conclusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Likelihood of receiving bystander CPR</td>
<td></td>
<td>6/9</td>
<td>More likely to receive bystander CPR in public venue: crude OR 3.8 (99%CI 2.5-5.9), adjusted OR 1.8 (95%CI 1.1-2.3)</td>
<td></td>
</tr>
</tbody>
</table>

CPR = cardiopulmonary resuscitation; ACD = active compression-decompression; ILCOR = International Liaison Committee on Resuscitation; CARE = Cardiff Assessment of Response and Evaluation; VIDRAP = video and recording Anne printout; PAIS = psychosocial adjustment to illness scale; CABG = coronary arterial bypass graft; CEGEP = collège d’enseignement général et professionnel; BLS = basic life support; BCLS = basic cardiac life support; CPR-Ezy = manufacturer trademark.