

REVIEW ARTICLE

Understanding and improving low bystander CPR rates: a systematic review of the literature

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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.

RÉSUMÉ

Key words: cardiac arrest, systematic review, cardiopulmonary resuscitation

Objectifs : La réanimation cardio-respiratoire (RCR) est un maillon essentiel, quoique faible, de la chaîne de survie lors de la survenue d'un arrêt cardiaque 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

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Received: Apr. 27, 2007; revisions received: Aug. 23, 2007; accepted: Aug. 31, 2007

This article has been peer reviewed.

CJEM 2008;10(1):51-65

RCR devraient être offerts et pourquoi les gens ne sont pas motivés à apprendre la RCR et à l'administrer. Nous avons utilisé des formulaires normalisés pour évaluer les articles selon des critères d'inclusion, de qualité et d'extraction de données. Nous avons regroupé les publications par catégorie et classé les recommandations selon un système de classification normalisé fondé sur le niveau de preuve.

Résultats : Nous avons examiné 2409 articles et évalué le texte intégral de 411 d'entre eux. Notre revue systématique a porté sur 252 de ces 411 articles. En raison de différences dans la conception des études, nous n'avons pu réaliser une méta-analyse. Parmi les 22 recommandations que nous avons classées, voici celles qui ont obtenu la marque la plus élevée : 1) instructions de RCR données par un répartiteur 9-1-1; 2) enseignement de la RCR aux membres de la famille de cardiaques; 3) utilisation de la bande vidéo d'autoformation de Braslow; 4) augmentation du temps de pratique sur des mannequins; 5) enseignement des concepts d'ambiguïté et de diffusion de la responsabilité. Les recommandations non étayées par des preuves portaient sur les activités de formation en masse, la prise du pouls par un non-spécialiste avant de commencer la RCR et l'administration de la RCR avec compressions thoraciques seulement.

Conclusion : Nous avons évalué et classé les diverses interventions proposées pour améliorer le taux de passants pouvant administrer la RCR ainsi que leur impact potentiel. Les résultats de l'étude aideront peut-être les collectivités à concevoir des modèles pour améliorer ce taux.

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 videos^{19,23-25}
- CPR training of high school students.^{24,26-29}

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

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

Quality of the evidence

- I-1 Meta-analysis
- I-2 At least 1 good quality randomized controlled trial
- II-1 Quasi-experiment of good quality
- II-2 Cohort or case-control study
- II-3 Case series, noncontrolled trial, or descriptive studies
- III Expert opinion

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:

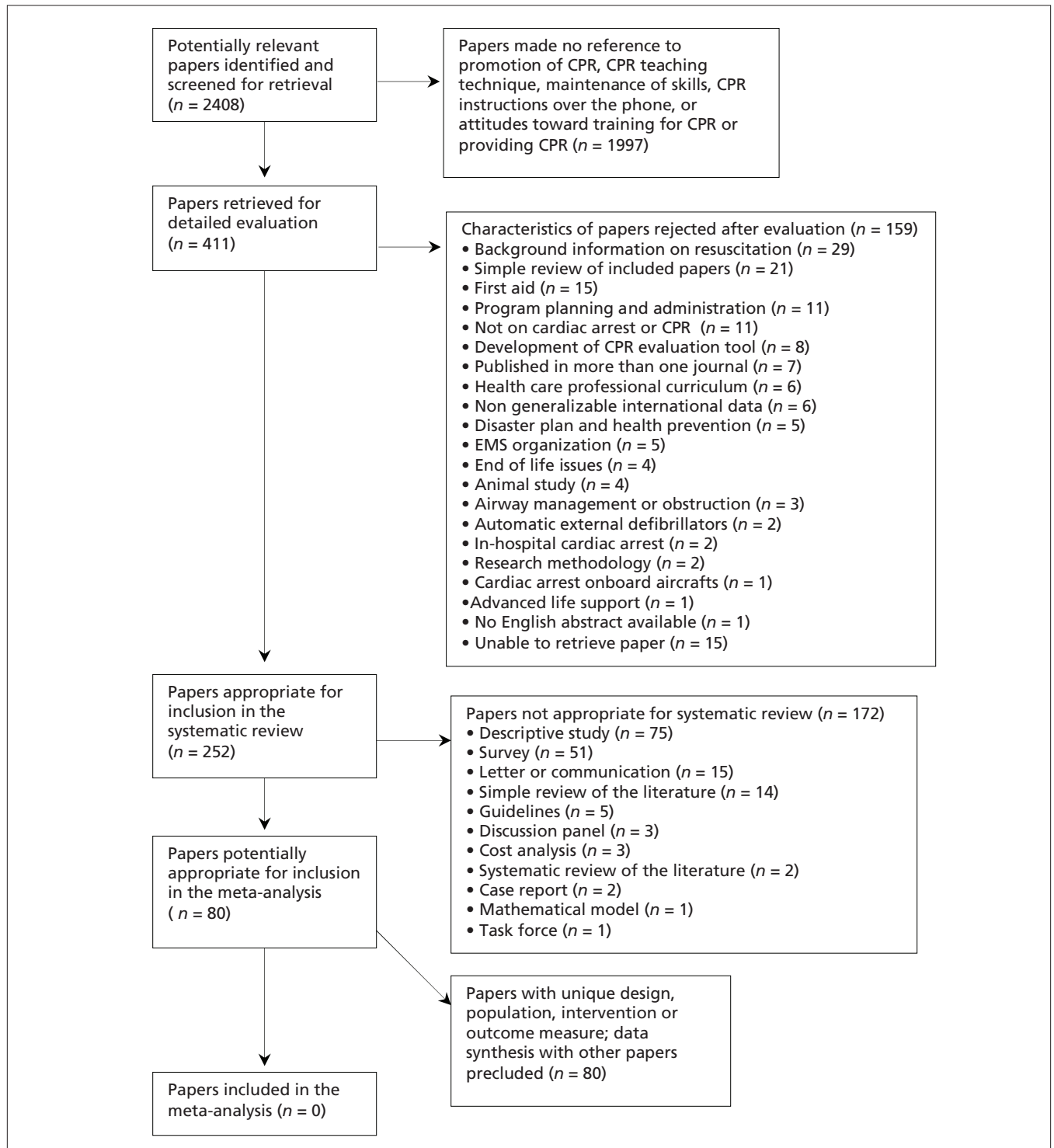


Fig. 1. Systematic review trial flow. CPR = cardiopulmonary resuscitation; EMS = emergency medical services.

one on the effectiveness of life support courses³⁸; the other on infections that were potentially acquired during CPR.³⁹ 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 (1) 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 statement 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 thousands of participants.^{5–10} Although some efforts have been made to target groups at risk,^{40–42} mass training events usually attract young participants unlikely to witness cardiac arrest,^{23,43,44} they are not cost-effective⁴⁵ and the effect of such interventions on survival of cardiac arrest has not been demonstrated in the literature. (Class II-3 evidence; see Box 1)

Table 1. Systematic review characteristics

Systematic review	No. (and %)* of papers, n = 252
Median yr of publication (and range)	1996 (1961–2005)
Publication status	
Full paper	236 (93.7)
Abstract	16 (6.3)
Country of publication	
United States	158 (62.7)
United Kingdom	25 (9.9)
Canada	12 (4.8)
Othert	57 (22.6)
Language of publication	
English	248 (98.4)
German	3 (1.2)
Japanese	1 (0.4)
Research methodology	
Descriptive	75 (29.8)
Survey	51 (20.2)
RCT	42 (16.7)
Quasi-experiment	25 (9.9)
Letter or communication	15 (6.0)
Simple review of the literature	14 (5.6)
Before–after	11 (4.4)
Guidelines	4 (1.6)
Discussion panel	3 (1.2)
Cost-analysis	3 (1.2)
Systematic review	2 (0.8)
Case report	2 (0.8)
Case–control	1 (0.4)
Cohort study	1 (0.4)
Task force	1 (0.4)
Mathematical model	1 (0.4)
Policy statement	1 (0.4)
Topic, ‡ n = 332	
Promotion and provision of CPR courses	97 (29.2)
Understanding and teaching CPR	82 (24.7)
Attitude, motivation and reluctance	72 (21.7)
Maintenance of skills	52 (15.7)
Instructions over the phone	29 (8.7)

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.

Table 2. Summary of findings from our systematic review

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

CPR = cardiopulmonary resuscitation.

Up to 15% of the population suffers from long-term disabilities that may require tailored teaching strategies.^{46,47} Some people may not be able to sustain the effort associated with providing CPR,^{48,49} which is an aerobic exercise that could elicit ischemic symptoms in people with heart disease⁵⁰⁻⁵³ (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.⁵⁴⁻⁵⁶ Many authors suggest we should target family members of those individuals.¹¹⁻²² The estimated rate of CPR training in this target group ranges between 9% and 47%.⁵⁶⁻⁶¹ Although the addition of counselling to deal with the stress associated with being a potential CPR provider may be required,^{62,63} CPR training has been shown to reduce anxiety and increase emotional adjustment and the sense of empowerment in family members of cardiac arrest survivors.⁶⁴⁻⁶⁶ 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.⁶⁷⁻⁶⁹ This is currently being done by 6% to 50% of surveyed physicians^{60,70-74}; another 70% to 90% said they were interested in doing so in the future.^{74,75} 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.^{24,26-29,76-86} Parents of young infants are another group that can learn CPR before leaving the nursery.⁸⁷⁻⁹⁷ Anecdotally, CPR training is mandatory in some countries at the time of obtaining or renewing one's driver's licence.^{24,26} (Class III) Unfortunately, despite a few well-designed trials demonstrating the possibility of teaching CPR to children and parents of young infants, there is little evidence supporting the benefit of these interventions to bystander CPR and survival rates. (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.^{98,99} Assar and colleagues proposed a staged teaching program.¹⁰⁰⁻¹⁰² 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.¹⁰² 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,^{49,103,104} CPR can be taught successfully in 4-, 3- or even 2-hour sessions.^{18,81,105} 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.¹⁰⁶ Because of this, Daiker estimated that 23 million American adults may not be able to comprehend the content of CPR classes.¹⁰⁶ Anecdotes and digression from the CPR curriculum are associated with poorer comprehension.¹⁰⁷ There are various cognitive and behavioural approaches to teaching CPR.^{13,108-112} The content of CPR classes should be reduced and simplified. (Class II-1) This is supported by 3 literature reviews^{24,25,113} and 1 quasi-experimental study.¹⁰⁵

Good quality CPR involves chest rising with each ventilation and a palpable pulse with each chest compression.¹¹⁴ But even health care professionals cannot rapidly and accurately determine if a victim is breathing or if a pulse is present.¹¹⁵⁻¹¹⁸ Laymen have even more difficulty in verifying whether there is a pulse.¹¹⁹ Laymen should not check for the absence of a pulse before initiating CPR.^{46,120} (Class I-2)

Another debate involves teaching chest compression alone or with ventilation.^{121,122} Most of the evidence supporting the chest compression alone approach comes from animal data.¹²³⁻¹²⁶ Contrary to animal anatomy, the human upper airway does not stay open spontaneously thus preventing the free flow of air during chest compressions.^{127,128} Among 885 observed cardiac arrest cases receiving bystander CPR, 16% of people survived with conventional CPR, compared with 10% who received chest compressions alone.¹²⁹ Another study reported survival rates of 6.8% with chest compression alone, compared with 9.7% with traditional CPR ($p < 0.001$).¹³⁰ 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 ($p = 0.005$).¹³¹ While chest compressions alone may be appropriate for instructions over the phone,¹³² 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.^{82,133-135} 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.^{25,113,141-143} (Class I-2)

Modular self-training courses can address the different pace at which various people can learn.^{95,144} Participants in self-training modular courses perform similarly to those taking conventional CPR classes.^{38,77,145-147} 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.^{93,154,155} 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 weeks^{88,105} 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.^{55,172} 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.^{108,174-177} 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.^{18,67,180,181} 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.¹⁸⁶⁻¹⁹⁰ 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.¹³¹ Dispatch-assisted CPR instructions have been shown to increase bystander CPR rate,³⁰ 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.^{6,81,112,152,199,204-206}

While no CPR provider has ever been successfully sued,^{207,208} failure to provide support could have legal con-

sequences.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.¹⁰⁸ Today, HIV and hepatitis B cause the greatest concerns.^{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.^{13,39,214,215} Only 15 cases of *Neisseria meningitidis*, 3 cases of enteric pathogens, 2 cases of labial herpes, 1 case of tuberculosis and 1 potential case of SARS²¹⁶ have ever been linked to providing CPR.³⁹ 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.^{129,217} Willingness to perform CPR is influenced by the relationship with the victim,^{7,15,40,58,218–222} as well as by the presence of vomit, dentures, blood, body odour and alcohol smell.^{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.^{43,226,227} 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.^{17,57,142,228–231} But CPR training is still not an assurance of action.^{187,232–235} People are often unable to make a decision, rather than choosing not to help (the concept of ambiguity).²³⁵ Overall helping behaviour decreases with an increasing number of bystanders (the concept of diffusion of responsibility).^{234,236–239} Simple and complex behavioural methods exist to address those issues.^{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.^{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.³⁸ The Mejicano and Maki review addresses only the issue of disease transmission during CPR.³⁹ We found 2 other large reviews of the literature on CPR.^{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.¹⁹ The 2005

AHA Resuscitation Guidelines,²⁴³ 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.²⁴⁴ 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.³⁷ 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 statements of evidence, along with the quality of the evidence supporting that statement. To receive a high score, an intervention needed to be based on solid research methodology and show an effect on bystander CPR rates or survival for out-of-hospital cardiac arrest.

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.

Competing interests: This project is supported by a grant from the Canadian Association of Emergency Physicians. Dr. Vaillancourt received financial support from the Ontario Ministry of Health's Emergency Health Services Research Fellowship at the time of the project. He is currently supported by the Ottawa Health Research Institute and the Ottawa Hospital Department of Emergency Medicine Academic Practice Plan. Dr. Stiell was a Distinguished Investigator of the Canadian Institutes of Health Research at the time of the review. None of the authors have a conflict of interest to declare.

References

1. Rea TD, Eisenberg MS, Sinibaldi G, et al. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. *Resuscitation* 2004;63:17-24.
2. Vaillancourt C, Stiell IG; Canadian Cardiovascular Outcomes Research Team (CCORT). Cardiac arrest care and emergency medical services in Canada. *Can J Cardiol* 2004;20:1081-90.
3. Stiell IG, Wells GA, Field B, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. *N Engl J Med* 2004; 351:647-56.
4. Herlitz J, Ekstrom L, Wennerblom B, et al. Effect of bystander initiated cardiopulmonary resuscitation on ventricular fibrillation and survival after witnessed cardiac arrest outside hospital. *Br Heart J* 1994;72:408-12.
5. Larkin GL, Marco CA. Who knows CPR?: a national survey. *Acad Emerg Med* 2001;8:434-5.
6. Fong YT, Anantharaman V, Lim SH, et al. Mass cardiopulmonary resuscitation 99-survey results of a multi-organizational effort in public education in cardiopulmonary resuscitation. *Resuscitation* 2001;49:201-5.
7. Pane GA, Salness KA. A survey of participants in a mass CPR training course. *Ann Emerg Med* 1987;16:1112-6.
8. Selby ML, Kautz JA, Moore TJ, et al. Indicators of response to a mass media CPR recruitment campaign. *Am J Public Health* 1982;72:1039-42.
9. Pearn J, Dawson B, Leditschke F, et al. Who accepts first aid training? *Aust Fam Physician* 1980;9:602-5.
10. Eisenberg M, Damon S, Mandel L, et al. CPR instruction by videotape: results of a community project. *Ann Emerg Med* 1995;25:198-202.
11. Alderman C. Emergency bystander life support training. *Emerg Nurse* 1997;5:10-1.
12. Eisenberg MS, Bergner L, Hallstrom A. Cardiac resuscitation in the community. Importance of rapid provision and implications for program planning. *JAMA* 1979;241:1905-7.
13. Standards and guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). National Academy

- of Sciences — National Research Council. *JAMA* 1986;255:2905-89.
14. Arntz HR, Staedcke-Peine C, Brueggemann T, et al. [Sudden cardiac death: Is it really an unforeseeable event?] [Article in German]. *Intensivmed Notfallmed* 1999;36:485-92.
 15. Axelsson A, Thoren A, Holmberg S, et al. Attitudes of trained Swedish lay rescuers toward CPR performance in an emergency. A survey of 1012 recently trained CPR rescuers. *Resuscitation* 2000;44:27-36.
 16. Bachman JW. The Good Neighbor Rescue Program: utilizing volunteers to perform cardiopulmonary resuscitation in a rural community. *J Fam Pract* 1983;16:561-6.
 17. Bahr J. CPR education in the community. *Eur J Emerg Med* 1994;1:190-2.
 18. Baskett PJ. Teaching the public cardiopulmonary resuscitation. *Br J Hosp Med* 1992;48:447, 451.
 19. Chehardy P, Doherty A, Dracup K, et al. Cardiopulmonary resuscitation and emergency cardiovascular care. Education. *Ann Emerg Med* 2001;37(4 Suppl):S49-59.
 20. Jackson RE, Swor RA. Who gets bystander cardiopulmonary resuscitation in a witnessed arrest? *Acad Emerg Med* 1997;4:540-4.
 21. Lie KG, Richardson M. Attitudes of health professionals toward cardiopulmonary resuscitation training for family members of cardiac patients. *Coron Health Care* 1999;3(2):91-8.
 22. Chu KH, May CR, Clark MJ, et al. CPR training in households of patients with chest pain. *Resuscitation* 2003;57:257-68.
 23. Amith G. Revising educational requirements: challenging four hours for both basic life support and automated external defibrillators. *New Horiz* 1997;5:167-72.
 24. Eisenburger P, Safar P. Life supporting first aid training of the public—review and recommendations. *Resuscitation* 1999;41:3-18.
 25. Mancini ME, Kaye W. Resuscitation training: a time for re-assessment. *J Cardiovasc Nurs* 1996;10:71-84.
 26. DeMuth WE Jr, Saunders EF. Public education in emergency medical services. *Pa Med* 1975;78:49-52.
 27. American Academy of Pediatrics Committee on School Health. Basic life support training school. *Pediatrics* 1993;91:158-9.
 28. Lyttle J. Mandatory CPR training for students may improve cardiac-arrest survival rate, MDs say. *CMAJ* 1996;155:1172-4.
 29. Lafferty C, Larsen PD, Galletly D. Resuscitation teaching in New Zealand schools. *N Z Med J* 2003;116:U582.
 30. Eisenberg MS, Hallstrom AP, Carter WB, et al. Emergency CPR instruction via telephone. *Am J Public Health* 1985;75:47-50.
 31. Culley LL, Clark JJ, Eisenberg MS, et al. Dispatcher-assisted telephone CPR: common delays and time standards for delivery. *Ann Emerg Med* 1991;20:362-6.
 32. Sekimoto M, Noguchi Y, Rahman M, et al. Estimating the effect of bystander-initiated cardiopulmonary resuscitation in Japan. *Resuscitation* 2001;50:153-60.
 33. Moher D, Pham B, Jones A, et al. Does quality of reports of randomised trials affect estimates of intervention efficacy reported in meta-analysis? *Lancet* 1998;352:609-13.
 34. Brodsky L. The association between estrogen-progestin replacement therapy and the risk of breast cancer among postmenopausal women: a systematic review and meta-analysis [thesis]. Ottawa (ON):University of Ottawa; 2002.
 35. Dinnes J, Deeks J, Sowden A, et al. A review of quality assessment tools for non-randomized intervention studies. Proceedings of the Annual Meeting of the International Society of Technology Assessment in Health Care. Philadelphia (PA): International Society of Technology Assessment in Health Care; 2001.
 36. Wells GA, Shea B, O'Connell D, et al. The Newcastle–Ottawa Scale (NOS) for assessing the quality of non-randomized studies in meta-analysis. Proceedings of the 3rd Symposium for systematic reviews. Oxford (UK); 2000.
 37. Lowe HJ, Barnett GO. Understanding and using the medical subject headings (MeSH) vocabulary to perform literature searches. *JAMA* 1994;271:1103-8.
 38. Jabbour M, Osmond MH, Klassen TP. Life support courses: are they effective? *Ann Emerg Med* 1996;28:690-8.
 39. Mejicano GC, Maki DG. Infections acquired during cardiopulmonary resuscitation: estimating the risk and defining strategies for prevention. *Ann Intern Med* 1998;129:813-28.
 40. Lester C, Donnelly P, Assar D. Community life support training: does it attract the right people? *Public Health* 1997;111:293-6.
 41. Pane GA, Salness KA. Targeted recruitment of senior citizens and cardiac patients to a mass CPR training course. *Ann Emerg Med* 1989;18:152-4.
 42. Lerner EB, Fairbanks RJ, Shah MN. Identification of out-of-hospital cardiac arrest clusters using a geographic information system. *Acad Emerg Med* 2005;12:81-4.
 43. Axelsson A, Herlitz J, Ekstrom L, et al. Bystander-initiated cardiopulmonary resuscitation out-of-hospital. A first description of the bystanders and their experiences. *Resuscitation* 1996;33:3-11.
 44. Brennan RT, Braslow A. Are we training the right people yet? A survey of participants in public cardiopulmonary resuscitation classes. *Resuscitation* 1998;37:21-5.
 45. Swor R, Compton S. Estimating cost-effectiveness of mass cardiopulmonary resuscitation training strategies to improve survival from cardiac arrest in private locations. *Prehosp Emerg Care* 2004;8:420-3.
 46. Heart and Stroke Foundation of Canada. Instructor resource for basic life support. Ottawa (ON): Desktop Publishing; 2001.
 47. Kelly KJ. Teaching and credentialing the physically challenged: state of the art. A review of change in the clinical and scientific data since 1980. *Circulation* 1986;74:IV66-9.
 48. Memon AM, Salzer JE, Hillman EC Jr, et al. Fatal myocardial infarct following CPR training: the question of risk. *Ann Emerg Med* 1982;11:322-3.
 49. Bachman JW. Cardiac arrest in the community. How to improve survival rates. *Postgrad Med* 1984;76:85-90, 92-5.
 50. Baubin M, Schirmer M, Nogler M, et al. Rescuer's work capacity and duration of cardiopulmonary resuscitation. *Resuscitation* 1996;33:135-9.
 51. Bridgewater FH, Bridgewater KJ, Zeitz CJ. Using the ability to perform CPR as a standard of fitness: a consideration of the influence of aging on the physiological responses of a select group of first aiders performing cardiopulmonary resuscitation. *Resuscitation* 2000;45:97-103.
 52. Lucia A, de las Heras JF, Perez M, et al. The importance of physical fitness in the performance of adequate cardiopulmonary resuscitation. *Chest* 1999;115:158-64.
 53. Van Hoeyweghen RJ, Verbruggen G, Rademakers F, et al. The physiologic response of CPR training. *Ann Emerg Med* 1991;20:279-82.

54. Swor RA, Jackson RE, Walters BL, et al. Impact of lay responder actions on out-of-hospital cardiac arrest outcome. *Prehosp Emerg Care* 2000;4:38-42.
55. Waalewijn RA, Tijssen JG, Koster RW. Bystander initiated actions in out-of-hospital cardiopulmonary resuscitation: results from the Amsterdam Resuscitation Study (ARRESUST). *Resuscitation* 2001;50:273-9.
56. Swor RA, Jackson RE, Compton S, et al. Cardiac arrest in private locations: different strategies are needed to improve outcome. *Resuscitation* 2003;58:171-6.
57. Kivela SL. Resuscitation skills among the population. *Acta Anaesthesiol Scand* 1982;26:626-7.
58. Lyda KK, Perez MA, Chng CL. Cardiorespiratory resuscitation training among individuals aged 60 and above. *Am J Health Behav* 1998;22(1):54-61.
59. Mandel LP, Cobb LA, Weaver WD. CPR training for patients' families: do physicians recommend it? *Am J Public Health* 1987;77:727-8.
60. Swor RA, Jackson RE, Vining F, et al. Elder-perceived self-efficacy and attitudes toward CPR training. *Acad Emerg Med* 2001;8:435.
61. Swor R, Fahoome G, Compton S. Potential impact of a targeted cardiopulmonary resuscitation program for older adults on survival from private-residence cardiac arrest. *Acad Emerg Med* 2005;12:7-12.
62. Dracup K, Guzy PM, Taylor SE, et al. Cardiopulmonary resuscitation (CPR) training. Consequences for family members of high-risk cardiac patients. *Arch Intern Med* 1986;146:1757-61.
63. Dracup K, Moser DK, Taylor SE, et al. The psychological consequences of cardiopulmonary resuscitation training for family members of patients at risk for sudden death. *Am J Public Health* 1997;87:1434-9.
64. McLauchlan CA, Ward A, Murphy NM, et al. Resuscitation training for cardiac patients and their relatives — its effect on anxiety. *Resuscitation* 1992;24:7-11.
65. Moser DK, Dracup K. Impact of cardiopulmonary resuscitation training on perceived control in spouses of recovering cardiac patients. *Res Nurs Health* 2000;23:270-8.
66. Nelson KM. Cardiopulmonary resuscitation training for families of cardiac patients. *Cardiovasc Nurs* 1979;15:28-32.
67. Feero S, Hedges JR, Stevens P. Assessing the need for bystander CPR training. *Acad Emerg Med* 1995;2:74-6.
68. Knapp JF, Pyles LA, American Academy of Pediatrics Committee on Pediatric Emergency Medicine. Role of pediatricians in advocating life support training courses for parents and the public. *Pediatrics* 2004;114:1676.
69. Lam KK, Lau FL, Chan WK, et al. Doctor-based basic cardiopulmonary resuscitation course: an alternative to the conventional approach. *Prehospital Disaster Med* 2002;17:209-12.
70. Bossaert LL, Putzeys T, Monsieurs KG, et al. Knowledge, skills and counselling behaviour of Belgian general practitioners on CPR-related issues. *Resuscitation* 1992;24:49-54.
71. Goldberg RJ, DeCosimo D, St Louis P, et al. Physicians' attitudes and practices toward CPR training in family members of patients with coronary heart disease. *Am J Public Health* 1985;75:281-3.
72. Higgins SS, Hardy CE, Higashino SM. Should parents of children with congenital heart disease and life-threatening dysrhythmias be taught cardiopulmonary resuscitation? *Pediatrics* 1989;84:1102-4.
73. Richardson ME, Lie KG. Cardiopulmonary resuscitation training for family members of patients on cardiac rehabilitation programmes in Scotland. *Resuscitation* 1999;40:11-9.
74. Louis P, Carter WB, Eisenberg MS. Prescribing CPR: a survey of physicians. *Am J Public Health* 1982;72:1158-60.
75. Kohriyama K, Kamochi M, Aibara K, et al. [Occupational physicians' concern and fact-finding methods regarding cardiopulmonary resuscitation education for employees in the workplace] [Article in Japanese]. *J UOEH* 1995;17:105-11.
76. Vanderschmidt H, Burnap TK, Thwaites JK. Evaluation of a cardiopulmonary resuscitation course for secondary schools. *Med Care* 1975;13:763-74.
77. Bircher N, Safar P. Life supporting first aid (LSFA) and Infant CPR (ICPR) self-training in children [abstract]. *Crit Care Med* 1983;11:251.
78. Alvarez HD, Cobb LA. Experiences with CPR training of the general public. In: National Conference on Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care. Dallas (TX): American Heart Association; 1975. p. 33-7.
79. Berkebile P, Benson D, Ersoz C, et al. Public education in heart-lung resuscitation. Evaluation of three self-training methods in teenagers. In: National Conference on Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care. Dallas (TX): American Heart Association; 1975. p. 13-23.
80. Lewis RM, Fulstow R, Smith GB. The teaching of cardiopulmonary resuscitation in schools in Hampshire. *Resuscitation* 1997;35:27-31.
81. Liberman M, Golberg N, Mulder D, et al. Teaching cardiopulmonary resuscitation to CEGEP students in Quebec — a pilot project. *Resuscitation* 2000;47:249-57.
82. Lind B. Teaching mouth-to-mouth resuscitation in primary schools. *Acta Anaesthesiol Scand* 1961;9(Suppl):63-9.
83. Van Kerschaver E, Delooz HH, Moens GF. The effectiveness of repeated cardiopulmonary resuscitation training in a school population. *Resuscitation* 1989;17:211-22.
84. Watson LA. Cardiopulmonary resuscitation competencies of nurses and ninth grade students. *Dissertation Abstracts International* 1980;41:3896.
85. Sherif C, Erdos J, Sohm M, et al. Effectiveness of mouth-to-mouth resuscitation performed by young adolescents on a mannequin. *Am J Emerg Med* 2005;23:51-4.
86. Lester CA, Weston CF, Donnelly PD, et al. The need for wider dissemination of CPR skills: are schools the answer? *Resuscitation* 1994;28:233-7.
87. Bednar RJ. Retention of hospital-taught cardiopulmonary resuscitation skills of caregivers with infants at home on apnea/bradycardia monitors. *Masters Abstracts International* 1996;34:713.
88. Komelasky AL. The effect of home nursing visits on parental anxiety and CPR knowledge retention of parents of apnea-monitored infants. *J Pediatr Nurs* 1990;5:387-92.
89. Conroy R, Bond M, Tao B. Teaching infant resuscitation skills to mothers. *Aust J Adv Nurs* 1990;7:11-5.
90. Donaher-Wagner BM, Braun DH. Infant cardiopulmonary resuscitation for expectant and new parents. *MCN Am J Matern Child Nurs* 1992;17:27-8.

91. McHugh A. Babywatch. Training parents in resuscitation for newborn babies. *Pract Midwife* 2000;3:16-7.
92. Wright S, Norton C, Kesten K. Retention of infant CPR instruction by parents. *Pediatr Nurs* 1989;15:37-41, 44.
93. Messmer P, Meehan R, Gilliam N, et al. Teaching infant CPR to mothers of cocaine-positive infants. *J Contin Educ Nurs* 1993;24:217-20.
94. Kaiserman K, Martin GI, Sindel BC, et al. The effectiveness of a cardiopulmonary resuscitation program for mothers of newborn infants. *J Perinatol* 1989;9:49-51.
95. Longo A. Teaching parents CPR. *Pediatr Nurs* 1983;9:445-7.
96. Drake E. Discharge teaching needs of parents in the NICU. *Neonatal Netw* 1995;14:49-53.
97. Schlessel JS, Rappa HA, Lesser M, et al. CPR knowledge, self-efficacy, and anticipated anxiety as functions of infant/child CPR training. *Ann Emerg Med* 1995;25:618-23.
98. Donnelly P, Assar D, Lester C. A comparison of manikin CPR performance by lay persons trained in three variations of basic life support guidelines. *Resuscitation* 2000;45:195-9.
99. Yakel ME. Retention of cardiopulmonary resuscitation skills among nursing personnel: what makes the difference? *Heart Lung* 1989;18:520-5.
100. Assar D, Chamberlain D, Colquhoun M, et al. A rationale for staged teaching of basic life support. *Resuscitation* 1998;39:137-43.
101. Assar D, Chamberlain D, Colquhoun M, et al. Randomised controlled trials of staged teaching for basic life support. 1. Skill acquisition at bronze stage. *Resuscitation* 2000;45:7-15.
102. Chamberlain D, Smith A, Colquhoun M, et al. Randomised controlled trials of staged teaching for basic life support. 2. Comparison of CPR performance and skill retention using either staged instruction or conventional training. *Resuscitation* 2001;50:27-37.
103. Tweed WA, Wilson E, Isfeld B. Retention of cardiopulmonary resuscitation skills after initial overtraining. *Crit Care Med* 1980;8:651-3.
104. Gombeski WR Jr, Effron DM, Ramirez AG, et al. Impact on retention: comparison of two CPR training programs. *Am J Public Health* 1982;72:849-52.
105. Handley JA, Handley AJ. Four-step CPR—improving skill retention. *Resuscitation* 1998;36:3-8.
106. Daiker BL. Evaluating health and safety lectures: how to measure lucidity. *AAOHN J* 1992;40:438-45.
107. Brennan RT. Student, instructor, and course factors predicting achievement in CPR training classes. *Am J Emerg Med* 1991;9:220-4.
108. Cobb LA, Eliastam M, Kerber RE, et al. Report of the American Heart Association Task Force on the Future of Cardiopulmonary Resuscitation. *Circulation* 1992;85:2346-55.
109. Bosma A. A comparison of three behavioral systems for assessing and training first aid skills. *Dissertation Abstracts International* 1989;50:899-900.
110. Kittleson MJ. Analysis and comparison of cardiopulmonary resuscitation methodology among college students (time on task, spectrum, psychomotor skills). *Dissertation Abstracts International* 1986;47:1199.
111. Rivera-Tovar LA, Jones RT. Effect of elaboration on the acquisition and maintenance of cardiopulmonary resuscitation. *J Pediatr Psychol* 1990;15:123-38.
112. Messmer PR, Jones SG. Saving lives. An innovative approach for teaching CPR. *Nurs Health Care Perspect* 1998;19:108-10.
113. Kaye W, Mancini ME. Teaching adult resuscitation in the United States — time for a rethink. *Resuscitation* 1998;37:177-87.
114. Wik L, Steen PA, Bircher NG. Quality of bystander cardiopulmonary resuscitation influences outcome after prehospital cardiac arrest. *Resuscitation* 1994;28:195-203.
115. Ochoa FJ, Ramalle-Gomara E, Carpintero JM, et al. Competence of health professionals to check the carotid pulse. *Resuscitation* 1998;37:173-5.
116. Ruppert M, Reith MW, Widmann JH, et al. Checking for breathing: evaluation of the diagnostic capability of emergency medical services personnel, physicians, medical students, and medical laypersons. *Ann Emerg Med* 1999;34:720-9.
117. Moule P. Checking the carotid pulse: diagnostic accuracy in students of the healthcare professions. *Resuscitation* 2000;44:195-201.
118. Eberle B, Dick WF, Schneider T, et al. Checking the carotid pulse check: diagnostic accuracy of first responders in patients with and without a pulse. *Resuscitation* 1996;33:107-16.
119. Bahr J, Klingler H, Panzer W, et al. Skills of lay people in checking the carotid pulse. *Resuscitation* 1997;35:23-6.
120. Phillips B, Zideman D, Garcia-Castrillo L, et al. European Resuscitation C. European Resuscitation Council Guidelines 2000 for Basic Paediatric Life Support. A statement from the Paediatric Life Support Working Group and approved by the Executive Committee of the European Resuscitation Council. *Resuscitation* 2001;48:223-9.
121. Swor R, Compton S, Vining F, et al. A randomized controlled trial of chest compression only CPR for older adults — a pilot study. *Resuscitation* 2003;58:177-85.
122. Dick WF, Brambrink AM, Kern T. [“Topless” cardiopulmonary resuscitation? Should heart-lung resuscitation be performed without artificial resuscitation?] [Article in German]. *Anaesthesist* 1999;48:290-300.
123. Kern KB. Cardiopulmonary resuscitation without ventilation. *Crit Care Med* 2000;28(11 Suppl):N186-9.
124. Noc M, Weil MH, Tang W, et al. Mechanical ventilation may not be essential for initial cardiopulmonary resuscitation. *Chest* 1995;108:821-7.
125. Kern KB, Hilwig RW, Berg RA, et al. Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario. *Circulation* 2002;105:645-9.
126. Dorph E, Wik L, Stromme TA, et al. Oxygen delivery and return of spontaneous circulation with ventilation: compression ratio 2:30 versus chest compressions only CPR in pigs. *Resuscitation* 2004;60:309-18.
127. Bircher N, Otto C, Babbs C, et al. Future directions for resuscitation research. II. External cardiopulmonary resuscitation basic life support. *Resuscitation* 1996;32:63-75.
128. Stewart JA. Resuscitating an idea: prone CPR. *Resuscitation* 2002;54:231-6.
129. Van Hoeyweghen RJ, Bossaert LL, Mullie A, et al. Quality and efficiency of bystander CPR. Belgian Cerebral Resuscitation Study Group. *Resuscitation* 1993;26:47-52.
130. Holmberg M, Holmberg S, Herlitz J. Swedish Cardiac Arrest

- R. Factors modifying the effect of bystander cardiopulmonary resuscitation on survival in out-of-hospital cardiac arrest patients in Sweden. *Eur Heart J* 2001;22:511-9.
131. Hallstrom AP. Dispatcher-assisted "phone" cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation. *Crit Care Med* 2000;28(11 Suppl):N190-2.
 132. Roppolo LP, Pepe PE, Cimon N, et al. Modified cardiopulmonary resuscitation (CPR) instruction protocols for emergency medical dispatchers: rationale and recommendations. *Resuscitation* 2005;65:203-10.
 133. Mandel LP, Cobb LA. Reinforcing CPR skills without mannequin practice. *Ann Emerg Med* 1987;16:1117-20.
 134. Sunde K, Wik L, Naess AC, et al. Impact of a child first aid wall calendar on lay people's skills and knowledge of infant CPR. *Resuscitation* 1998;36:59-64.
 135. Winchell S, Safar P. Teaching and testing lay and paramedical personnel in cardiopulmonary resuscitation. *Anesth Analg* 1966; 45:441-9.
 136. Rubens AJ, Merlin M. 'Practical CPR' may ease new-student anxieties. *Occup Health Saf* 1991;60:28-32.
 137. Korttila K, Vertio H, Savolainen K. Importance of using proper techniques to teach cardiopulmonary resuscitation to laymen. *Acta Anaesthesiol Scand* 1979;23:235-41.
 138. Wik L, Thowsen J, Steen PA. An automated voice advisory manikin system for training in basic life support without an instructor. A novel approach to CPR training. *Resuscitation* 2001;50:167-72.
 139. Noordergraaf GJ, Van Gelder JM, Van Kesteren RG, et al. Learning cardiopulmonary resuscitation skills: does the type of mannequin make a difference? *Eur J Emerg Med* 1997;4:204-9.
 140. Boyle AJ, Wilson AM, Connelly K, et al. Improvement in timing and effectiveness of external cardiac compressions with a new non-invasive device: the CPR-Ezy. *Resuscitation* 2002;54:63-7.
 141. Dracup K, Breu C. Teaching and retention of cardiopulmonary resuscitation skills for families of high-risk patients with cardiac disease. *Focus Crit Care* 1987;14:67-72.
 142. Maibach EW, Schieber RA, Carroll MF. Self-efficacy in pediatric resuscitation: implications for education and performance. *Pediatrics* 1996;97:94-9.
 143. Bilger MC, Giesen BC, Wollan PC, et al. Improved retention of the EMS activation component (EMSAC) in adult CPR education. *Resuscitation* 1997;35:219-24.
 144. Friesen L, Stotts NA. Retention of Basic Cardiac Life Support content: the effect of two teaching methods. *J Nurs Educ* 1984;23:184-91.
 145. Coleman S, Dracup K, Moser DK. Comparing methods of cardiopulmonary resuscitation instruction on learning and retention. *J Nurs Staff Dev* 1991;7:82-7.
 146. Nelson M, Brown CG. CPR instruction: modular versus lecture course. *Ann Emerg Med* 1984;13:118-21.
 147. Monsieurs KG, Vogels C, Bossaert LL, et al. Learning effect of a novel interactive basic life support CD: the JUST system. *Resuscitation* 2004;62:159-65.
 148. Batcheller AM, Brennan RT, Braslow A, et al. Cardiopulmonary resuscitation performance of subjects over forty is better following half-hour video self-instruction compared to traditional four-hour classroom training. *Resuscitation* 2000;43:101-10.
 149. Breivik H, Ulvik NM, Blikra G, et al. Life-supporting first aid self-training. *Crit Care Med* 1980;8:654-8.
 150. Edwards MJ, Hannah KJ. An examination of the use of interactive videodisc cardiopulmonary resuscitation instruction for the lay community. *Comput Nurs* 1985;3:250-2.
 151. Long CA. Teaching parents infant CPR—lecture or audiovisual tape? *MCN Am J Matern Child Nurs* 1992;17:30-2.
 152. Moser DK, Dracup K, Doering LV. Effect of cardiopulmonary resuscitation training for parents of high-risk neonates on perceived anxiety, control, and burden. *Heart Lung* 1999;28:326-33.
 153. Starr LM. An effective CPR home learning system. A program evaluation. *AAOHN J* 1998;46:289-95.
 154. Dracup K, Moser DK, Doering LV, et al. Comparison of cardiopulmonary resuscitation training methods for parents of infants at high risk for cardiopulmonary arrest. *Ann Emerg Med* 1998;32:170-7.
 155. Dracup K, Moser DK, Doering LV, et al. A controlled trial of cardiopulmonary resuscitation training for ethnically diverse parents of infants at high risk for cardiopulmonary arrest. *Crit Care Med* 2000;28:3289-95.
 156. Braslow A, Brennan RT, Newman MM, et al. CPR training without an instructor: development and evaluation of a video self-instructional system for effective performance of cardiopulmonary resuscitation. *Resuscitation* 1997;34:207-20.
 157. Todd KH, Braslow A, Brennan RT, et al. Randomized, controlled trial of video self-instruction versus traditional CPR training. *Ann Emerg Med* 1998;31:364-9.
 158. Todd KH, Heron SL, Thompson M, et al. Simple CPR: A randomized, controlled trial of video self-instructional cardiopulmonary resuscitation training in an African American church congregation. *Ann Emerg Med* 1999;34:730-7.
 159. Schnepp SL. Saving lives through community education. *J Emerg Med* 2001;20:325-6.
 160. Wik L, Brennan RT, Braslow A. A peer-training model for instruction of basic cardiac life support. *Resuscitation* 1995;29: 119-28.
 161. Lester C, Donnelly P, Weston C. Is peer tutoring beneficial in the context of school resuscitation training? *Health Educ Res* 1997;12:347-54.
 162. Toms RJM. The effects of peer coaching on psychomotor skill retention in cardiopulmonary resuscitation. *Dissertation Abstracts International: Section B: the Sciences & Engineering* 1998;59(5-B).
 163. Shantzis C. An investigation comparing retention of two methods of cardiopulmonary resuscitation training. *Dissertation Abstracts International* 1983;44:2053.
 164. Berden HJ, Willems FF, Hendrick JM, et al. How frequently should basic cardiopulmonary resuscitation training be repeated to maintain adequate skills? *BMJ* 1993;306:1576-7.
 165. Kaczorowski J, Levitt C, Hammond M, et al. Retention of neonatal resuscitation skills and knowledge: a randomized controlled trial. *Fam Med* 1998;30:705-11.
 166. Su E, Schmidt TA, Mann NC, et al. A randomized controlled trial to assess decay in acquired knowledge among paramedics completing a pediatric resuscitation course. *Acad Emerg Med* 2000;7:779-86.
 167. Ward P, Johnson LA, Mulligan NW, et al. Improving cardiopulmonary resuscitation skills retention: effect of two checklists designed to prompt correct performance. *Resuscitation* 1997;34:221-5.
 168. Greig M, Elliott D, Parboteeah S, et al. Basic life support skill

- acquisition and retention in student nurses undertaking a pre-registration diploma in higher education/nursing course. *Nurse Educ Today* 1996;16:28-31.
169. Curry L, Gass D. Effects of training in cardiopulmonary resuscitation on competence and patient outcome. *CMAJ* 1987;137:491-6.
 170. Chamberlain D, Smith A, Woollard M, et al. Trials of teaching methods in basic life support (3): comparison of simulated CPR performance after first training and at 6 months, with a note on the value of re-training. *Resuscitation* 2002;53:179-87.
 171. Kaye W, Rallis SF, Mancini ME, et al. The problem of poor retention of cardiopulmonary resuscitation skills may lie with the instructor, not the learner or the curriculum. *Resuscitation* 1991;21:67-87.
 172. Lester CA, Donnelly PD, Assar D. Lay CPR trainees: retraining, confidence and willingness to attempt resuscitation 4 years after training. *Resuscitation* 2000;45:77-82.
 173. Bang A, Biber B, Isaksson L, et al. Evaluation of dispatcher-assisted cardiopulmonary resuscitation. *Eur J Emerg Med* 1999;6:175-83.
 174. Troy A. Cardiopulmonary resuscitation on television. [author reply 1607]. *N Engl J Med* 1996;335:1606.
 175. Deloos HH, Corne L, De Block G, et al. A television centered public campaign for the propagation of the general training in basic cardiopulmonary resuscitation. *Acta Anaesthesiol Belg* 1984;35(Suppl):97-101.
 176. Gardner J, Nickolaus MJ, Steckbeck R. Health fair & CPR training: a successful community outreach, partnering & marketing opportunity. *J Cardiovasc Manag* 1999;10:18-27.
 177. Capone PL, Lane JC, Kerr CS, et al. Life supporting first aid (LSFA) teaching to Brazilians by television spots. *Resuscitation* 2000;47:259-65.
 178. Meischke H, Finnegan J, Eisenberg M. What can you teach about cardiopulmonary resuscitation (CPR) in 30 seconds? Evaluation of a television campaign. *Eval Health Prof* 1999;22:44-59.
 179. Becker L, Vath J, Eisenberg M, et al. The impact of television public service announcements on the rate of bystander CPR. *Prehosp Emerg Care* 1999;3:353-6.
 180. Billittier AJ, Lerner EB, Tucker W, et al. The lay public's expectations of prearrival instructions when dialing 9-1-1. *Prehosp Emerg Care* 2000;4:234-7.
 181. Eisenberg MS, Hallstrom AP, Carter WB, et al. Emergency CPR instruction via telephone. *Am J Public Health* 1985;75:47-50.
 182. Garza AG, Gratton MC, Chen JJ, et al. The accuracy of predicting cardiac arrest by emergency medical services dispatchers: the calling party effect. *Acad Emerg Med* 2003;10:955-60.
 183. Bang A, Herlitz J, Martinell S. Interaction between emergency medical dispatcher and caller in suspected out-of-hospital cardiac arrest calls with focus on agonal breathing. A review of 100 tape recordings of true cardiac arrest cases. *Resuscitation* 2003;56:25-34.
 184. Hauff SR, Rea TD, Culley LL, et al. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. *Ann Emerg Med* 2003;42:731-7.
 185. Hallstrom AP, Cobb LA, Johnson E, et al. Dispatcher assisted CPR: implementation and potential benefit. A 12-year study. *Resuscitation* 2003;57:123-9.
 186. Bang A, Herlitz J, Holmberg S. Possibilities of implementing dispatcher-assisted cardiopulmonary resuscitation in the community. An evaluation of 99 consecutive out-of-hospital cardiac arrests. *Resuscitation* 2000;44:19-26.
 187. Clark RD, Word LE. Why don't bystanders help? Because of ambiguity? *J Pers Soc Psychol* 1972;24:392-400.
 188. Atkinson PR, Bingham J, McNicholl BP, et al. Telemedicine and cardiopulmonary resuscitation: the value of video-link and telephone instruction to a mock bystander. *J Telemed Telecare* 1999;5:242-5.
 189. Carter WB, Eisenberg MS, Hallstrom AP, et al. Development and implementation of emergency CPR instruction via telephone. *Ann Emerg Med* 1984;13:695-700.
 190. Flesche C, Grundmann M, Tarnow J. On-line telephone instruction for emergency cardiopulmonary resuscitation (CPR). Proceedings of the European Society of Anaesthesiologists Annual Congress; 1995 Apr. 29–May 3; CNIT Paris (FR). Paris (FR): European Society of Anaesthesiology;1995. p. 130.
 191. Cooke MW, Wilson S. Are 999 callers in a position to give triage information and receive first aid advice? *Pre-hosp Immed Care* 1998;2:193-6.
 192. Meron G, Frantz O, Sterz F, et al. Analysing calls by lay persons reporting cardiac arrest. *Resuscitation* 1996;32:23-6.
 193. Kellermann AL, Hackman BB, Somes G. Dispatcher-assisted cardiopulmonary resuscitation. Validation of efficacy. *Circulation* 1989;80:1231-9.
 194. Heward A, Donohoe RT, Whitbread M. Retrospective study into the delivery of telephone cardiopulmonary resuscitation to "999" callers. *Emerg Med J* 2004;21:233-4.
 195. Dorph E, Wik L, Steen PA. Dispatcher-assisted cardiopulmonary resuscitation. An evaluation of efficacy amongst elderly. *Resuscitation* 2003;56:265-73.
 196. Rea TD, Eisenberg MS, Culley LL, et al. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. *Circulation* 2001;104:2513-6.
 197. Goldberg RJ, Gore JM, Love DG, et al. Layperson CPR — are we training the right people? *Ann Emerg Med* 1984;13:701-4.
 198. Flabouris A. Ethnicity and proficiency in English as factors affecting community cardiopulmonary resuscitation (CPR) class attendance. *Resuscitation* 1996;32:95-103.
 199. Keim S, Anderson K, Siegel E, et al. Factors associated with CPR certification within an elderly community. *Resuscitation* 2001;51:269-74.
 200. Lejeune PO, Deloos HH. Why did persons invited to train in cardiopulmonary resuscitation not do so? *Eur Heart J* 1987;8:224-8.
 201. Demirovic J. Cardiopulmonary resuscitation programs revisited: results of a community study among older African Americans. *Am J Geriatr Cardiol* 2004;13:182-7.
 202. Dracup K, Heaney DM, Taylor SE, et al. Can family members of high-risk cardiac patients learn cardiopulmonary resuscitation? *Arch Intern Med* 1989;149:61-4.
 203. Sigsbee M, Geden EA. Effects of anxiety on family members of patients with cardiac disease learning cardiopulmonary resuscitation. *Heart Lung* 1990;19:662-5.
 204. Dracup K, Moser DK, Guzy PM, et al. Is cardiopulmonary resuscitation training deleterious for family members of cardiac patients? *Am J Public Health* 1994;84:116-8.
 205. Platz E, Scheatzle MD, Pepe PE, et al. Attitudes towards CPR training and performance in family members of patients with heart disease. *Resuscitation* 2000;47:273-80.

206. Ross CA, Winter MK, Mossesso VN Jr. Bystander CPR in two predominantly African American communities. *Top Emerg Med* 2000;22:63-8.
207. Ahrendsen J. Would you help a passenger in need? Trains, boats and planes. *Iowa Med* 1999;89:16-7.
208. Annas GJ. CPR: the beat goes on. *Hastings Cent Rep* 1982; 12:24-5.
209. Miller DF. Emergency care policy. *Health Educ* 1975;6:13-4.
210. Brenner B, Stark B, Kauffman J. The reluctance of house staff to perform mouth-to-mouth resuscitation in the inpatient setting: What are the considerations? *Resuscitation* 1994;28: 185-93.
211. Blumenfield M, Smith PJ, Milazzo J, et al. Survey of attitudes of nurses working with AIDS patients. *Gen Hosp Psychiatry* 1987;9:58-63.
212. Ornato JP, Hallagan LF, McMahan SB, et al. Attitudes of BCLS instructors about mouth-to-mouth resuscitation during the AIDS epidemic. *Ann Emerg Med* 1990;19:151-6.
213. Brenner B. Willingness of male homosexuals to perform mouth-to-mouth resuscitation. *Resuscitation* 1994;27:23-30.
214. Sun D, Bennett RB, Archibald DW. Risk of acquiring AIDS from salivary exchange through cardiopulmonary resuscitation courses and mouth-to-mouth resuscitation. *Semin Dermatol* 1995;14:205-11.
215. Glaser JB, Nadler JP. Hepatitis B virus in a cardiopulmonary resuscitation training course. Risk of transmission from a surface antigen-positive participant. *Arch Intern Med* 1985;145: 1653-5.
216. Christian MD, Loutfy M, McDonald LC, et al. Possible SARS coronavirus transmission during cardiopulmonary resuscitation. *Emerg Infect Dis* 2004;10:287-93.
217. Brenner BE, Van DC, Cheng D, et al. Determinants of reluctance to perform CPR among residents and applicants: the impact of experience on helping behavior. *Resuscitation* 1997;35: 203-11.
218. Kliegel A, Scheinecker W, Sterz F, et al. The attitudes of cardiac arrest survivors and their family members towards CPR courses. *Resuscitation* 2000;47:147-54.
219. Lester C, Donnelly P, Weston C, et al. Teaching schoolchildren cardiopulmonary resuscitation. *Resuscitation* 1996;31:33-8.
220. Rowe BH, Shuster M, Zambon S, et al. Preparation, attitudes and behaviour in nonhospital cardiac emergencies: evaluating a community's readiness to act. *Can J Cardiol* 1998;14:371-7.
221. Shibata K, Taniguchi T, Yoshida M, et al. Obstacles to bystander cardiopulmonary resuscitation in Japan. *Resuscitation* 2000;44:187-93.
222. Locke CJ, Berg RA, Sanders AB, et al. Bystander cardiopulmonary resuscitation. Concerns about mouth-to-mouth contact. *Arch Intern Med* 1995;155:938-43.
223. Brenner BE, Kauffman J. Reluctance of internists and medical nurses to perform mouth-to-mouth resuscitation. *Arch Intern Med* 1993;153:1763-9.
224. McCormack AP, Damon SK, Eisenberg MS. Disagreeable physical characteristics affecting bystander CPR. *Ann Emerg Med* 1989;18:283-5.
225. Piliavin J, Piliavin I. Effect of blood on reactions to a victim. *J Pers Soc Psychol* 1972;23:353-61.
226. Axelsson A, Herlitz J, Karlsson T, et al. Factors surrounding cardiopulmonary resuscitation influencing bystanders' psychological reactions. *Resuscitation* 1998;37:13-20.
227. Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention; a qualitative study. *Resuscitation* 2000;47:71-81.
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.
229. Jelinek GA, Gennat H, Celenza T, et al. Community attitudes towards performing cardiopulmonary resuscitation in Western Australia. *Resuscitation* 2001;51:239-46.
230. Kazdin AE, Bryan JH. Competence and volunteering. *J Exp Soc Psychol* 1971;7:87-97.
231. Pantin HM, Carver CS. Induced competence and the bystander effect. *J Appl Soc Psychol* 1982;12:100-11.
232. Nolan RP, Wilson E, Shuster M, et al. Readiness to perform cardiopulmonary resuscitation: an emerging strategy against sudden cardiac death. *Psychosom Med* 1999;61:546-51.
233. Hawks SR, Peck SL, Vail-Smith K. An educational test of health behavior models in relation to emergency helping. *Health Psychol* 1992;11:396-402.
234. Shotland R, Heinold W. Bystander response to arterial bleeding: helping skills, the decision-making process, and differentiating the helping response. *J Pers Soc Psychol* 1985; (49):347-56.
235. Darley JM, Latane B. Bystander intervention in emergencies: diffusion of responsibility. *J Pers Soc Psychol* 1968;8:377-83.
236. Latane B, Darley JM. Group inhibition of bystander intervention in emergencies. *J Pers Soc Psychol* 1968;10:215-21.
237. Latane B, Darley JM. Bystander 'apathy.' *Am Sci* 1969; 57:244-68.
238. Schwartz SH, Clausen GT. Responsibility, norms and helping in an emergency. *J Pers Soc Psychol* 1970;16:299-310.
239. Piliavin IM, Rodin J. Good samaritanism: an underground phenomenon? *J Pers Soc Psychol* 1969;13:289-99.
240. Hawks SR, Peck SL. Non-traditional teaching methods for emergency care education: student perceptions. *J Health Educ* 1992;23:39-44.
241. Hawks SR, Egan M. The impact of three different first aid curricula on emergency helping among college students. *J Health Educ* 1998;29(5):289-93.
242. Beaman A, Barnes PJ, Klentz B, et al. Increasing helping rates through information dissemination: teaching pays. *Pers Soc Psychol Bull* 1978;4:406-11.
243. American Heart Association in collaboration with the International Liaison Committee on Resuscitation. 2005 International consensus on cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) with treatment recommendations. Part 2: adult basic life support. *Circulation* 2005;112:III-5-III-16.
244. Nagao K; SOS-KANTO study group. Cardiopulmonary resuscitation by bystanders with chest compression only (SOS-KANTO): an observational study. *Lancet* 2007;369:920-6.

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Online appendix 1. Information sources included in the systematic review

Electronic search

- PubMed
- OVID
 - EBM review
 - Biological Abstract
 - CINAHL
 - Current Content/All eds
 - Dissertation Abstracts
 - ERIC
 - HealthSTAR
 - PreMedline and Medline
 - PAIS international
 - PsylInfo
 - SocioFile

Hand search

- *Resuscitation*
- *Canadian Journal of Public Health*

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

- Jackson RE. Basic cardiopulmonary resuscitation. In: Tintinalli JE, ed. Emergency medicine, a comprehensive study guide. New York (NY): McGraw-Hill; 1996. p. 35-37.
- Neumar RW, Ward KR. Cardiopulmonary arrest. In: Rosen P, ed. Emergency medicine concepts and clinical practice. St. Louis (MO): Mosby; 1998. Vol. 1 p. 35-60.

Review articles

- Eisenberg P, Safar P. Life supporting first aid training of the public — review and recommendations. *Resuscitation* 1999;41:3-18.
- Jabbour M, Osmond MH, Klassen TP. Life support courses: Are they effective? *Ann Emerg Med* 1996;28:690-8.

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, PsylInfo, 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\$ techn\$ or teach\$ metho\$ or train\$ activit\$ or train\$ techn\$ 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 residenc\$ characterict\$ or communit\$ or neighborhood\$ 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 neighborhood* 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* techn\$ OR teach* metho* OR train* activit* OR train* techn\$ OR train* 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

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment	Conclusion
Randomized controlled trial						
Assar ¹⁰⁰ (2000) <i>n</i> = 505	Population of South Wales Mean age 42 years	1- Staged CPR teaching (2 hrs) 2- Conventional CPR teaching (2 hrs)	Multiple CPR skill comparisons (with no statistical adjustment)	2	Not used	Staged teaching leads to better skills.
Atkinson ¹⁸⁸ (1999) <i>n</i> = 48	Volunteers trained in CPR or not Age range 23-56 years	1- CPR without instructions 2- CPR instructions on the phone 3- CPR instructions by video-link 4- Instructions given by instructor	No. ventilations, No. chest compressions, hand position, and time to CPR	1	Not used	Video-link instructions were best. Telephone instructions were good. Previous training had no influence on skills.
Batcheller ¹⁴⁸ (2000) <i>n</i> = 202	Recruited from community Mean age 59.4 years	1- Video self-training in CPR (25 min) 2- Conventional CPR teaching (4 hrs)	Effective ventilation, effective compressions, and effective CPR delivery	2	Not used	Self-trained did generally better than conventionally trained.
Baubin ⁵⁰ (1996) <i>n</i> = 12	Professional rescuers Mean age 30.8 +/- 7.9 years	1- Perform regular CPR 2- Perform CPR with ACD device	Duration of CPR, quality of CPR, oxygen consumption, heart rate, and lactate level	1	Not used	Conventional CPR demands less energy than ACD and can be performed longer (29 min v. 16 min).
Berden ¹⁶⁴ (1993) <i>n</i> = 96	Nurses Mean age 28.7 +/- 7.1 years	1- Retested at 3 months + refresher 2- Retested at 6 months + refresher 3- Retested at 1 year	CPR skills	2	Not used	Instructions every 6 months are necessary.
Bilger ¹⁴³ (1997) <i>n</i> = 200	Medical (18%) and laypeople (82%) Mean age 38.4 years	1- Telephone prompt alongside manikin 2- No telephone prompt	Calling 9-1-1 for help	2	Not used	Group trained with prompt telephone remembered to call 9-1-1 more often.
Capone ¹⁷⁷ (2000) <i>n</i> = 202	Auto industry employees 55% between 21-35 years	1- TV spots on CPR (60 sec) 2- Nothing	CPR skills	3	Not used	Both groups had similarly bad CPR skills.
Chamberlain ¹⁰² (2001) <i>n</i> = 495	Population of South Wales Mean age 42 years	1- Staged CPR teaching (2 hrs) 2- Conventional CPR teaching (2 hrs)	Likelihood of returning for further training or retraining	2	Not used	Staged teaching led to higher likelihood of return visits to complete or repeat training.
Coleman ¹⁴⁵ (1991) <i>n</i> = 49	College students Age range 18-70 years	1- Self-taught class (4 hrs) 2- Conventional CPR teaching (4 hrs)	Written exam and skill exam according to Mandel check-list	2	Not used	Both groups were equivalent.
Dorph ¹⁹⁵ (2003) <i>n</i> = 20	Center for elderly Median age 78 years	1- Traditional Dispatch CPR 2- Compression only Dispatch CPR	Time to continuous efforts No. compressions in 9 min.	1	Not used	Poor CPR both groups; more chest compressions in group 2
Donnelly ⁹⁸ (2000) <i>n</i> = 250	Laymen Age unknown	1- European Resuscitation guidelines 2- ILCOR guidelines 3- American Heart guidelines	CPR skills evaluated according to CARE and VIDRAP protocol	2	Not used	European and ILCOR guidelines appeared easier to learn; retention was poor irrespective of method.
Dracup ⁶² (1986) <i>n</i> = 134	Heart disease patients Mean age 59 years Family members Mean age 49 years	1- CPR teaching (90 min) 2- Heart disease education (90 min) 3- Nothing	Multiple adjective affect checklist, psychological adjustment to illness scale and CPR quiz.	1	Not used	Anxiety was worst in CPR group. Adjustment to illness was worst in CPR and education group compared with placebo.
Dracup ²⁰⁴ (1994) <i>n</i> = 337	Family members of heart disease patients Mean age 59 +/- 10.5 years	1- CPR teaching only 2- CPR + education on heart disease 3- CPR + social support 4- Nothing	24-item self administered questionnaire	1	Inadequate	Very positive feeling about CPR training without an increased sense of burden or responsibility compared with placebo.

Online appendix 3. Continued

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment	Conclusion
Dracup ⁶³ (1997) n = 674	Heart disease patients Mean age 62.9 +/- 10.1 years Family members Mean age 59.0 +/- 10.9 years	1- CPR teaching only 2- CPR + education on heart disease 3- CPR + social support 4- Nothing	Multiple adjective affect checklist, psychological adjustment to illness scale and Spanier dyadic adjustment scale	1	Inadequate	Patients coped better if their family members received social support.
Dracup ¹⁵⁴ (1998) n = 480	Parents of sick infants Mean age 29.9 +/- 8.4 years	1- Conventional CPR class 2- Conventional CPR class + social support 3- CPR self-training video	Mandel CPR skill checklist, PAIS, multiple affect checklist and perceived social support scale	2	Not Used	No difference between group 1 and 2; self-training may not be appropriate for that population.
Dracup ¹⁵⁵ (2000) n = 335	Parents of sick infants Mean age 30 +/- 8 years	1- Conventional CPR class 2- Conventional CPR class + social support 3- CPR self-training video	Psychological adjustment to illness, Spielberger state of anxiety inventory, McMaster family assessment device, PAIS	1	Inadequate	CPR training increases adjustment to disease although anxiety is increased at first. Group 2 did best.
Eberle ¹¹⁸ (1996) n = 206	EMT-1; EMT-2; PM-1; PM-2	Pre-op CABG volunteer on/off pump; pulse check	Pulse present or no; Time delay before decision	2	Not used	Diagnostic accuracy increases with training; overall sens. 90% and spec. 55%; delay 24-32 sec.
Eisenberg ¹⁰ (1995) n = 17 318	Washington households Head of household >50 years	1- CPR self-training video 2- Nothing	Bystander CPR rate N = 65 cardiac arrests	2	Not used	Sending a video to households does not increase bystander CPR.
Hallstrom ¹³¹ (2000) n = 520	9-1-1 callers Age unknown	1- Instruction to do chest compression 2- Instruction to do full CPR	Delivery of intervention and survival to hospital discharge	3	Adequate	Group 1 more likely to complete instructions. Survival was similar.
Hawks ²³³ (1992) n = 84	University students Age unknown	1- CPR + bystander education (2 hrs) 2- CPR training alone	Helping behavior and appropriateness of intervention	4	Adequate	Group 1 helped significantly more often; trend toward more appropriate intervention in group 1.
Kaczorowski ¹⁶⁵ (1998) n = 44	Medical student Age unknown	1- Video + unsupervised manikin practice at 3-5 months 2- Booster training + supervised manikin practice at 3-5 months 3- No booster training session	Neonatal knowledge and skill retention at 6-8 months	2	Not used	No difference between groups. All groups performed significantly badly.
Kittleston ¹¹⁰ (1986) N = 96	University students Age unknown	1- Conventional CPR teaching 2- CPR teaching with task behaviour 3- CPR teaching with progressive part practice	19-item skill competency scale	1	Not used	Innovative teaching methods were much more effective than conventional teaching.
Komelasky ⁸⁸ (1990) n = 28	Parents of apneic infants Mean age 29.8 years	1- CPR + home visit/manikin practice 2- CPR + telephone/clinic follow-up	Spielberger state-trait anxiety inventory and CPR skills	2	Not used	No difference in anxiety level or CPR skills between groups.
Liberman ⁸¹ (2000) n = 61	CEGEP students Mean age 24.8 +/- 12.5 years	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	CPR skills	1	Not used	No difference between groups. Self-training video group did just as well.
Mandel ¹³³ (1987) n = 67	City employee Age unknown	1- CPR theory review (3 pages) 2- CPR video review (15 min)	CPR skills	1	Not used	Overall skills were similar; better compression rate in video group.
Messmer ⁹³ (1993) n = 30	Substance abuse mothers Mean age 28.6 +/- 5.3 years	1- Interactive CPR video + manikin 2- Conventional CPR training	CPR knowledge and skills	1	Not used	Conventional CPR training method led to better results.
Monsieurs ¹⁴⁷ (2004) n = 41	1 st year nursing students Mean age 21 +/- 8 years	1- JUST CD-ROM (60-min. training) 2- Nothing	Positive helping attitude BLS skills	2	Not used	Increased helping attitude; CPR skills remain suboptimal
Moser ¹⁵² (1999) n = 335	Parents of sick infants Mean age 30.5 +/- 8.5 years	1- Video on CPR 2- Conventional CPR teaching 3- Conventional CPR + social support 4- Nothing	CPR attitude scale, willingness to attempt CPR, anxiety, sense of burden and feeling of loss of control	1	Not used	Intervention groups performed better on all counts. Groups 2 and 3 performed better than group 1.
Moser ⁶⁵ (2000) n = 196	Family members of heart disease patients Mean age 59 +/- 10.5 years	1- CPR + education on heart disease 2- CPR + social support 3- Nothing	Multiple affect adjective check list and control attitudes scale	1	Not used	Perceived control and emotional adjustment improved in both groups.

Online appendix 3. Continued

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment	Conclusion
Nelson ¹⁴⁶ (1984) n = 104	Medical students, hospital personnel, and laypeople Age unknown	1- Modular CPR class +/- refresher 2- Conventional CPR +/- refresher	Written exam, CPR skills, and harmful behaviour	1	Not used	At 1 year, all groups equal. At 2 years, groups with refresher did better.
Ruppert ¹¹⁶ (1999) n = 261	Health care workers and laymen Age unknown	1- Using a live person 2- Using a manikin	Determination of breathing status (yes or no)	1	Not used	At 4 years, all groups did badly. Only 5% could make the correct diagnosis within the 5 sec recommended by AHA.
Shantzis ¹⁶³ (1983) n = 90	University students Age unknown	1- Modular CPR teaching 2- Conventional CPR teaching	CPR knowledge and skills.	1	Not used	Neither group could perform CPR after 9 weeks.
Shotland ²³⁴ (1985) n = 163	University students Age unknown	2X2X2 table varying: Ambiguity, number of bystander, training status	Helping behaviour	2	Not used	Ambiguous situation and presence of many bystanders decreases helping behaviour. Training only influence nature of help provided.
Su ¹⁶⁶ (2000) n = 43	Paramedics Age unknown	1- Knowledge + manikin refresher 2- Manikin refresher 3- Knowledge refresher 4- No refresher	Pediatric CPR knowledge and skills measured at 12 months	2	Not used	All groups returned to pre-training level at 12 months with or without a refresher at 6 months.
Swor ¹²¹ (2003) n = 80	Hospital mailing list Mean age 71.5 years	1- Traditional CPR training (2h) 2- Chest compression only (2h)	Knowledge/perception; fear of infection; retention at 3 months	2	Not used	Similar perceived ability; fear of infection less in group 2; 49.1% competent at 3 months (same)
Todd ¹⁵⁷ (1998) n = 89	Medical students Mean age 23.1 +/- 2.9 years	1- Video self-training (34 min) 2- Conventional CPR class (4 hrs)	Overall CPR competency and skills	5	Unclear	Video self-training led to superior competency and skills.
Todd ¹⁵⁸ (1999) n = 107	Baptist church laymen Mean age 34.4 +/- 8.6 years	1- Video self-training (34 min) 2- Conventional CPR class (4 hrs)	Written test, overall CPR competency and CPR skills	5	Adequate	Video self-training led to similar competency and skills.
Toms ¹⁶² (1998) n = unknown	Laymen Age unknown	1- Conventional CPR class + peer coaching 2- Conventional CPR class	CPR knowledge and skills	1	Not used	Outcome measure not influenced by peer coaching.
Vanderschmidt ⁷⁶ (1975) n = 400	School children Age 8 th and 11 th grade	1- Didactic teaching + manikin 2- Didactic teaching only	CPR knowledge and skills	1	Not used	Group 1 did better. 11 th grade students did better.
Ward ¹⁶⁷ (1997) n = 169	University students Age unknown	1- Wallet size check list 2- Longer, more detailed check list 3- No check list	CPR skills 2 months later	1	Not used	Longer check list did the best. No difference between wallet size check list and no check list.
Wik ¹³⁸ (2001) n = 24	Paramedics Age unknown	Cross-over trial 1- 3 min CPR, automated feedback 2- 3 min CPR, no feedback	CPR skills	2	Not used	Automated voice advisory manikin rapidly improves CPR skills.
Yakei ⁹⁹ (1989) n = 106	Nurses 3 different ward) Age unknown	1- HeartSaver CPR teaching 2- BCLS teaching	CPR skills	1	Not used	Area of work did not make a difference. Group 2 did better.
Quasi-experiment						
Bang ¹⁷³ (1999) n = 427	9-1-1 callers reporting cardiac arrest Mean age 69 +/- 15 years	1- Phone instruct./no previous training 2- Phone instruct./previous training 3- Phone instruct./CPR aborted 4- No instruct. re previous training 5- Instructions declined by caller 6- No instructions offered	Adequacy of cardiac arrest by dispatcher, survival to hospital discharge.	-	—	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.
Berkebile ⁷⁹ (1975) n = 446	School children Age range 12-13, 15-17 years	1- Conventional CPR teaching 2- Self-training + manikin 3- CPR video only 4- CPR video + manikin 5- Nothing	CPR knowledge and skills. Attempt at doing CPR.	—	—	Self-training compares to conventional CPR teaching. Manikin practice is important. CPR video only was better than no instructions at all.

Online appendix 3. Continued

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment	Conclusion
Boyle ¹⁴⁰ (2002) n = 32	Non-medical personnel Age unknown	1- Chest compressions 2- Chest compressions with CPR-Ezy	Hand position; % effective compressions and rate	—	—	Hand position improved in 31% of group 2; rate and effective compressions improved in group 2
Braslow ¹⁵⁶ (1997) n = 642	Laymen Mean age 32.8 years	1- Self-instruction video 1 (30 min) 2- Self-instruction video 2 (35 min) 3- Conventional CPR class (3-4 hrs)	Chest compression, ventilation, and overall CPR skills	—	—	Video 2 more effective than video 1 (prototype) and conventional teaching. Also if >40 years old.
Breivik ¹⁴⁹ (1980) n = 230	Laymen Mean age 31 years	1- Self-training at home + observer 2- Self-training at home + no observer 3- Self-training at driving school 4- Nothing	CPR knowledge and skills	—	—	All intervention groups shared similar CPR knowledge; CPR skills were best in group 3.
Carter ¹⁸⁹ (1984) n = 143	Laymen Mean age 53.5 +/- 7.4 years	1- Protocol phone instruct./know CPR 2- Protocol phone instruct. 3- Impromptu phone instruct./know CPR 4- Impromptu phone instruct.	CPR cycle, ventilations, compressions, confusion, unrequested returns to phone and time to first compression	—	—	Protocol phone instructions were better than impromptu instructions. Groups without prior CPR knowledge did as well with instruct.
Edwards ¹⁵⁰ (1985) n = 65	Oil company employee Age unknown	1- Interactive video-disc CPR class 2- Conventional CPR class	CPR knowledge, skills and retention	—	—	Knowledge and skills deteriorated at 3 months. Groups were similar.
Flesche ¹⁹⁰ (1995) n = 188	Laymen Age unknown	1- Phone instruct./ no CPR training 2- No phone instruct./ CPR trained	Overall CPR effectiveness, time to ventilation and compression	—	—	Group 1 started CPR components later, but were more effective.
Greig ¹⁶⁸ (1996) n = 72	Nurses Age unknown	1- Teaching classes of 6 2- Teaching classes of 15-20	CPR knowledge and skills	—	—	Small group did better than large. Both groups improved.
Handley ¹⁰⁵ (1998) n = 48	Laymen Mean age 27.3 years	1- Thought 4-step sequence (2 hrs) 2- Thought 8-step sequence (2 hrs)	CPR skills	—	—	No difference between groups.
Hawks ²⁴¹ (1998) n = 98	University students Mean age 22.8 years	1- American Red Cross CPR 2- National Safety Council CPR 3- Emergency helping behaviour class + CPR 4- Nothing	Helping behaviour (yes or no)	—	—	All intervention groups demonstrated improved propensity to help compared with control group. Group 3 did best.
Korttila ¹³⁷ (1979) n = 102	Army conscripts Mean age 20 +/- 2 years	1- 2 hour class/recording manikin 2- 3 hour class/non-recording manikin	CPR skills (recorded), 3 different set of criteria	—	—	Nobody passed the test in 2-3 hour class with non-recording manikin.
Latane ²³⁶ (1968) n = 58	University students Age unknown	1- Alone in smoke-filling room 2- With 2 actors in smoke-filling room 3- 3 subjects in smoke-filling room	Time necessary to notice and report the smoke	—	—	Alone subject noticed and reported smoke much faster.
Lester ¹⁶¹ (1997) n = 243	Middle or Junior High school students Age range 11-12 years	1- CPR class taught by teacher 2- CPR class by teacher + peer	CPR knowledge and skills	—	—	Girls did better than boys in group 2. Overall no difference.
Lind ⁸² (1961) n = 466	School children Age range 12-14 years	1- CPR class + manikin (2 hrs) 2- CPR video only	Quality of ventilations	—	—	Manikin-trained group did much better.
Long ¹⁵¹ (1992) n = 30	Parents of sick infants Mean age 29 years	1- Didactic CPR teaching 2- Audio-video CPR teaching	CPR knowledge and skills	—	—	No difference between groups.
Lucia ⁵² (1999) n = 28	Health care professional Mean age 34 +/- 6 years	1- Sedentary CPR instructors 2- Fit laymen without CPR training	Heart rate, VO ₂ max, and lactate levels for 18-min CPR session	—	—	Physical fitness may have a positive influence on resuscitation.
Noordergraaf ¹³⁹ (1997) n = 161	Medical students Age unknown	1- Actar 911 manikin 1:1 ratio 2- Little Anne manikin 1:1 ratio 3- Recording resusc. Anne 4-5:1 ratio	CPR skills	—	—	No difference between groups. Individual manikin preferred.

Online appendix 3. Continued

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment	Conclusion
Schlesse ⁹⁷ (1995) n = 83	Parents of healthy infant 60% between 25-35 years	1- Infant CPR training (4 hrs) 2- Nothing	CPR knowledge, self-efficacy and anticipated anxiety	—	—	CPR knowledge better, self-efficacy better and less anxiety.
Van Kerschaver ⁸³ (1989) n = 265	School students Age 12, 14, 17 and 20 years	1- Test plus second training 2- Test only	CPR knowledge, CPR skills and fear to apply CPR	—	—	Skills improved with repeated training unlike knowledge and fear.
Winchell ¹³⁵ (1966) n = 2027	Laymen and health care 20 different groups	1- Practiced on manikin (10 groups) 2- No manikin practice (10 groups)	CPR skills on recording manikin	—	—	Group 1 did better.
Beaman ²⁴² (1978) n = 27	University students Age unknown	1- Info on diffusion of responsibility 2- Nothing	Helping behaviour (yes or no)	—	—	Knowing about diffusion of responsibility improved helping.
Pantin ²³¹ (1982) n = 92	University women Age unknown	1- Video on helping in emergencies 2- No video	Helping behaviour in group size of 2 v. 6	—	—	Delay in helping if larger group size, except in group 1.
Friesen ¹⁴⁴ (1984) n = 63	Nurses Age unknown	1- Self-paced teaching method 2- Didactic teaching	CPR knowledge and skills retention at 2 and 8 weeks	—	—	No difference between groups.
Gombeski ¹⁰⁴ (1982) n = unknown	Laymen Age unknown	1- Teaching in 3 sessions (8 hrs) 2- Teaching in 1 session (4 hrs)	CPR knowledge and skills at one year	—	—	Both groups substandard. Group 1 did better.
Before-after						
Alvarez ⁷⁸ (1975) n = 42	High school students Age unknown	1- Medic II program (includes mandatory CPR class in high school)	CPR knowledge and skills at 12 months	—	—	Did well on written exam. Fair results on skill testing.
Becker ¹⁷⁹ (1999) n = unknown	Population based Age unknown	1- Public service announcements teaching CPR on TV	Rate of bystander CPR for 289 cardiac arrests	—	—	Bystander CPR increased from 43% to 55% p <0.05
Bircher ⁷⁷ (1983) n = 87	School children Age range 10-12 years	1- First aid and infant CPR via video, lecture, demonstration, and practice	CPR skills	—	—	Young children can learn to do infant CPR well.
Bosma ¹⁰⁹ (1989) n = unknown	High school students Age unknown	1- System for training and assessing resuscitation skills (STARS) 2- Delayed prompting technique 3- Conventional CPR teaching	Number of errors and time to reach preset criterion for CPR skill	—	—	Delayed prompting technique did best.
Conroy ⁸⁹ (1990) n = 51	Post-partum mothers Age unknown	1- 17 min video, 20 min lecture, and manikin practice. Revision in 2 nd time.	CPR knowledge	—	—	Knowledge increased but not maintained at 6 months.
Culley ³¹ (1991) n = 267	9-1-1 callers Age unknown	1- Phone instructions provided to callers reporting cardiac arrest	Bystander CPR rate and survival to hospital discharge	—	—	Bystander CPR rate increased from 32% to 54% p <0.001. Trend toward improvement in survival.
Curry ¹⁶⁹ (1987) n = 85	Health care professional Age unknown	1- Conventional CPR training	CPR knowledge and skills at 6 and 12 months	—	—	Knowledge and skills back to pre-test level at 6 and 12 months.
Delooz ¹⁷⁵ (1984) n = unknown	Flemish population Age unknown	1- TV flashed with goal to promote CPR classes, followed by survey	Awareness, understanding, and commitment to take CPR class	—	—	Awareness and understanding increased. Commitment to take CPR class mainly in <25 years old.
Sunde ¹³⁴ (1998) n = 421	Laymen Age unknown	1- Mass mailing calendars with CPR 2- Calendar +/- manikin to take home	CPR skills	—	—	Mass mailing of CPR instructions not useful. Practice is necessary.
Pane ⁴¹ (1989) n = 1388	Targeted laymen Age >60 years	1- Targeted recruitment of seniors for mass CPR training, then survey	Demographic data compared with previous mass training event	—	—	The >60 age group doubled. More family members of cardiac patients.
Eisenberg ¹⁸¹ (1985) n N = 446	9-1-1 callers Mean age 53.5 +/- 16.6 years	1- Phone instructions provided to callers reporting cardiac arrest	Bystander CPR rate and survival to hospital discharge	—	—	Bystander CPR rate increased by 11.1% (95%CI 1.8-20.4). Four lives may have been saved.

Online appendix 3. Continued

Study	Participants	Intervention	Outcome measure	Jadad scale	Allocation concealment
Case-control	Cases	Control	Outcome measure	Newcastle-Ottawa Scale	Conclusion
Goldberg ¹⁹⁷ (1984) <i>n</i> = 501	1- Family members of heart disease patients	1- Family members of non-cardiac patients 2- Random neighbourhood control	Previous CPR training status (yes or no)	6/9 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.	
Cohort study	Cohort	Control	Outcome measure	Newcastle-Ottawa Scale	Conclusion
Jackson ²⁰ (1997) <i>n</i> = 927	1- Victims of cardiac arrest at home	1- Victims of cardiac arrest in a public venue	Likelihood of receiving bystander CPR	6/9 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 1.1-2.9)	

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.