Dispatcher-Assisted Cardiopulmonary Resuscitation
Validation of Efficacy

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Dispatcher-delivered telephone instruction in cardiopulmonary resuscitation (CPR) has been proposed to increase rates of bystander CPR in cases of out-of-hospital cardiac arrest. We tested the efficacy of a previously developed CPR message using a recording manikin in a high stress, simulated cardiac arrest scenario. Community volunteers were unaware they would perform CPR until immediately before each trial. Performance of volunteers without prior CPR training (group A, \( n=65 \)) who received telephone instruction was compared with that of previously trained volunteers (group B, \( n=43 \)) who received the same message. Performances of both groups were also compared with a third group (group C, \( n=43 \)) composed of previously trained volunteers who did not receive the message. Quality of CPR was graded by three CPR instructors using explicit criteria. Printout strips from the recording manikins were also analyzed. Evaluators were unaware of the training status of volunteers. The three groups were of comparable sex, race, and educational level, but group C was significantly younger than groups A and B (31.7 vs. 37.7 years, \( p<0.001 \)). Because of the time required for telephone instruction, groups A and B started chest compressions a mean of 4.0 minutes after collapse compared with 1.2 minutes for group C (\( p<0.0001 \)). We found that the previously untrained volunteers of group A performed CPR of an overall quality comparable to that performed by previously trained members of group C. Group A performed chest compressions significantly better than group C (\( p<0.02 \)) but had greater problems performing effective ventilations. The global performance of group B, the group with prior CPR training and telephone instruction, was superior to that achieved by groups A and C (\( p<0.005 \)). We conclude that telephone CPR can offer a safe and cost-effective means to increase the rate of bystander CPR in communities where few citizens are trained to perform CPR. Telephone instruction also improves the quality of CPR performed by persons with prior CPR training. (Circulation 1989;80:1231–1239)

Prompt initiation of cardiopulmonary resuscitation (CPR) substantially improves a victim’s chances of surviving out-of-hospital cardiac arrest.\(^1\)\(^-\)\(^5\) In cases of witnessed cardiac arrest due to ventricular fibrillation, provision of CPR by a bystander doubles a victim’s chances of survival to hospital discharge.\(^6\) To boost community rates of bystander CPR, large scale community training programs have been actively promoted by both the American Heart Association and the American Red Cross for many years.\(^1\)\(^,\)\(^7\)

Despite determined efforts, the national impact of citizen CPR training has been limited by a variety of factors. Time constraints, apathy, and unjustifiable fears of communicable diseases keep many from seeking CPR training. Because three fourths of cardiac arrests involve men and because most arrests occur at home, middle-aged and older women are the group most likely to witness a cardiac arrest. Unfortunately, women in these age groups are least likely to participate in community CPR training programs.\(^8\)\(^-\)\(^10\) Although risk factors for sudden cardiac death are well characterized, physicians infrequently recommend CPR to family members of high-risk patients.\(^11\)\(^-\)\(^13\) As a result, victims collaps-
ing at home are less likely to receive bystander CPR than are victims collapsing in public places.\textsuperscript{14}

The idea that CPR instruction could be provided to callers reporting a cardiac arrest was first explored in 1972, when the Phoenix Fire Department began assigning paramedics to dispatch centers in a pilot telephone instruction program. Although not evaluated formally, encouraging anecdotal reports led researchers at the University of Washington to develop a carefully worded set of telephone CPR instructions.\textsuperscript{15} After extensive testing in simulated cardiac arrest episodes, Carter and associates\textsuperscript{16} reported in 1984 that untrained community volunteers receiving these telephone CPR instructions performed manikin CPR of comparable quality to that achieved by previously trained volunteers receiving the same message. Subsequent implementation of telephone CPR instruction in suburban King County, Washington, boosted county rates of bystander CPR from an already remarkable 45% to 56%.\textsuperscript{17}

Unfortunately, the original work by Carter et al has not been replicated, and telephone CPR has not been actively promoted by the American Heart Association or the American Red Cross. In the 1986 edition of the AMA's Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care, scant attention is given to telephone CPR.\textsuperscript{1} Also, no mention of telephone CPR instruction is made in the AMA's 1987 Textbook of Advanced Cardiac Life Support.\textsuperscript{18} In the absence of independent validation or official support, implementation of telephone CPR programs has been slow.

In Memphis, Tennessee, fewer than 10% of victims of out-of-hospital cardiac arrest receive bystander CPR (unpublished data, June–December, 1987, Emergency Medical Services Bureau, Memphis Fire Department). Before considering implementation of a telephone CPR program for Memphis, we sought to validate its effectiveness in a controlled manner with local volunteers.

**Methods**

**Volunteers**

This study was approved by the Institutional Review Board of the University of Tennessee, Memphis, for research involving human subjects. During a period of 3 months, community volunteers were recruited by targeted notices to civic organizations, church groups, and nonmedical city government and hospital employees. Persons with prior CPR training were recruited by mailings to Memphis area graduates of American Red Cross and American Heart Association CPR training programs. Practicing health care workers were excluded from participation in the trial. To minimize advance study or review of CPR techniques, volunteers were told only that they were invited to attend a workshop to “develop new teaching methods for first aid” and that they would receive a special T-shirt for participating. They were not told that they would be asked to perform CPR until immediately before each trial.

**Protocol**

On arriving for a scheduled “workshop,” volunteers were informed of the true nature of the trial and were asked to provide written consent. After informed consent was obtained, each subject was escorted into a room containing five to eight project members, video equipment, a recording CPR manikin (Chris Clean, Armstrong Industries, Northbrook, Illinois), and a telephone. Each volunteer was then handed a short, written scenario (which described an apparent cardiac arrest involving a family member), and a stopwatch was started.

Subjects were expected to read the scenario, telephone for an ambulance, receive the telephone CPR message, and begin CPR. After 5 minutes of CPR, subjects were told that “help has arrived.” Each was then escorted into an adjoining room, where they completed a postexercise questionnaire. Through this questionnaire, volunteers noted any prior training in CPR, time since most recent review of CPR material, and their reaction(s) to emergency CPR instruction by telephone. A short debriefing session was then held.

Telephone CPR instruction was provided by alternating six professional ambulance dispatchers trained to deliver a slightly modified version of the original telephone message developed by Carter et al.\textsuperscript{16} All had successfully completed a 6-hour training curriculum (Emergency Medical Telephone Instructions, Emergency Training, Akron, Ohio) before the exercise, and all were required to read a modified set of CPR instructions verbatim from a printed text. After each session, videotape recordings were reviewed, and dispatchers were given directed feedback to ensure consistent delivery of the telephone message. During each exercise, dispatchers were housed in a room remote from the exercise area and could only communicate with volunteers by telephone. All dispatchers were unaware of the training status of volunteers.

Volunteers waiting their turn for the exercise were monitored to discourage impromptu “coaching” or last minute review. Once each exercise was begun, no feedback or guidance was given to any volunteer until completion of his trial. All subjects knew they could terminate CPR at any time.

In an initial series of 14 sessions during a 4-month period, we tested a randomly ordered series of 108 volunteers (some with and some without prior CPR training) using the telephone CPR message. After completion of this initial series of trials, an additional 43 volunteers (all with prior CPR training) were recruited during a 6-week follow-up period and tested without the telephone message. Testing and scoring were otherwise conducted in an analogous manner throughout the study.
Quality of CPR was determined by two methods. First, three observers scored each cycle of ventilations and compressions for proper completion of seven critical actions (pinch nose, head tilt, form seal, blow hard, hand placement, proper depth of compressions, and proper compression rate). These observers also watched the volunteers for any signs of confusion, unrequested return(s) to the telephone, one or more cycles of potentially harmful CPR, or termination of efforts before being told to stop. Observers were drawn from a rotating group of nine certified CPR instructors. All were unaware of the training status of volunteers.

Second, through use of the recording manikin, we directly measured the number and volume of ventilations and the number, relative depth, and rate of chest compressions in each cycle of CPR. To prevent observer bias or cueing of volunteers, the manikin’s recorder box was screened from view during each exercise. CPR performance strips were later analyzed by two staff members who did not attend any of the trials. Both strip reviewers were unaware of observer scores and of the training status of volunteers.

Statistical Analysis

Statistical tests included analysis of variance, analysis of covariance, χ² tests, and logistic regression. All intergroup differences were analyzed with Scheffe’s multiple comparison procedure whenever the primary analysis was significant (p<0.05). Significance of differences identified by Scheffe’s procedure was set at the p<0.05 level.

Results

Approximately one of every four volunteers who mailed back a card or promised to participate did not arrive on the day they were scheduled for testing. One volunteer was disqualified on arrival when it was learned that she was a practicing critical care nurse. No volunteer withdrew after being informed of the true nature of the exercise. In all, 151 volunteers participated in the trial.

CPR performance was analyzed in three groups. Group A consisted of 65 persons with no prior CPR training who received telephone instruction. Group B consisted of 43 persons with prior CPR training who also received telephone CPR instruction. Group C consisted of 43 persons with prior CPR training who did not receive telephone instruction. Members of these three groups were of comparable sex, race, weight, and educational level. However, members of group A were somewhat older than members of groups B and C. Of those subjects who reported time since last CPR, 74% of members of group C noted they had received training within the past year compared with only 26% of group B (Table 1).

The time required to provide the telephone CPR message significantly delayed initiation of CPR (analysis of variance followed by Scheffe’s multiple comparison procedure). Members of groups A and B (all of whom received the telephone CPR message) started ventilations an average of 1.5 minutes later than members of group C (the group that did not receive the message). Because volunteers receiving telephone assistance were required to return to the phone to receive instructions on how to perform chest compressions, time to beginning compressions was delayed even longer (4 minutes for groups A and B vs. 1.25 minutes for group C). However, all three groups completed an average of 10 or more cycles of ventilations and compressions during the 5-minute study period (Table 2).

### Table 1. Group Comparison

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=65)</th>
<th>Group B (n=43)</th>
<th>Group C (n=43)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior CPR training</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Telephone CPR</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Age (yr) (mean±SD)</td>
<td>39±11</td>
<td>36±13</td>
<td>32±9</td>
<td>0.007*</td>
</tr>
<tr>
<td>Sex (% female)</td>
<td>62</td>
<td>65</td>
<td>70</td>
<td>0.68†</td>
</tr>
<tr>
<td>Race (% white)</td>
<td>74</td>
<td>67</td>
<td>71</td>
<td>0.53†</td>
</tr>
<tr>
<td>Weight (average rank)</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>0.99*</td>
</tr>
<tr>
<td>Education (average rank)</td>
<td>3.3</td>
<td>3.5</td>
<td>3.3</td>
<td>0.50*</td>
</tr>
<tr>
<td>CPR training within past year (%)</td>
<td>NA</td>
<td>26</td>
<td>74</td>
<td>0.001†</td>
</tr>
</tbody>
</table>

CPR, cardiopulmonary resuscitation.

*p associated with ANOVA; †p associated with χ²; significant intergroup differences are indicated by brackets. The p values shown are those associated with three-way comparisons.

### Table 2. Time From Collapse to Initiation of Cardiopulmonary Resuscitation

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to ventilations (min)</td>
<td>2.38±0.25</td>
<td>2.29±0.24</td>
<td>1.03±0.26</td>
<td>0.0001</td>
</tr>
<tr>
<td>Time to compressions (min)</td>
<td>4.07±0.37</td>
<td>3.53±0.29</td>
<td>1.15±0.26</td>
<td>0.0001</td>
</tr>
<tr>
<td>Cycles in 5 minutes (n)</td>
<td>10.2±4.4</td>
<td>12.2±3.3</td>
<td>12.1±4.1</td>
<td>0.015</td>
</tr>
</tbody>
</table>

Data are mean±SD.

*Significant intergroup differences are indicated by brackets. The p values shown are those associated with three-way ANOVAs.
For any given cycle of CPR, a critical action was considered to have been performed adequately when at least two of the three observers graded its accomplishment as "satisfactory" for that cycle. Using this definition, untrained members of group A generally performed ventilations as effectively as the previously trained members of group B and as effectively or better than members of group C. However, the previously trained members of groups B and C were somewhat more adept at properly tilting the mannikins' head than were members of group A (Figure 1). Complete neck extension is essential for successful mannikin ventilation.

Observers rated chest compressions performed by members of group A comparable with those achieved by members of group B (χ² tests followed by the Scheffe's procedure for categorical data). Members of both groups (A and B) performed chest compressions significantly better than did members of group C, the group that did not receive telephone CPR instruction. Hand placement was judged "satisfactory" in over 60% of cycles performed by members of groups A and B compared with only slightly more than 40% of cycles performed by members of group C (Figure 1). Proper hand position is essential for safe and effective chest compressions.

Ventilation volumes were measured from mannikin recorder strips and were totaled for each cycle. Members of groups B and C delivered similar average ventilation volumes, approximately 1 l/cycle. In contrast, the untrained members of group A delivered somewhat less, about 700 ml/cycle. We then generated a global ventilation score by considering a cycle of ventilations to have been "adequate" if it contained at least one breath of 500 ml or more. By this standard, only one third of the cycles performed by members of group A were scored "adequate," significantly less than the +50% of cycles performed by members of groups B and C (Table 3).

The number, rate of delivery, and depth of chest compressions were also measured for each cycle. In contrast to problems that members of group A had with mannikin ventilation, members of this group performed chest compressions as effectively as members of group B and significantly better than members of group C. Mean number and mean depth of compressions for each cycle were significantly higher in groups A and B, whereas group C delivered compressions at a significantly faster rate. We considered a cycle of compressions to have been "adequate" if it contained 10 or more compressions/
cycle, at a rate of 50 to 100 compressions/min, and compressions resulted in a recorder needle deflection of at least 15 ml (the minimum level specified as "acceptable" by the manufacturer of the training mannikin). This amount of needle deflection roughly correlates with the American Heart Association’s recommended compression depth of 1.5 in.\(^1\) Using these criteria, 27% of group A compression cycles and 34% of group B compression cycles were scored "adequate" compared with less than 13% of cycles performed by members of group C (Table 3).

Finally, each volunteer’s performance was considered globally to determine whether or not his resuscitation attempt included 5 or more cycles with "adequate" ventilations and 5 or more cycles of "adequate" compressions. Based on these explicit criteria, only 14% of attempts by members of group A (telephone CPR, no prior training) and 9% of those by group C (prior training, no telephone CPR) were scored globally "adequate." Group B, with both prior CPR training and telephone instruction, performed significantly better than the other two groups, meeting criteria 33% of the time. The difference between group A and group C’s global performance was not statistically significant (Table 4). Adjustment for age and other potential demographic confounders using logistic regression for categorical variables and analysis of covariance for continuous data did not substantially affect these results.

Group A volunteers tended to show signs of confusion or make unrequested returns to the telephone more often than members of groups B and C (group A, 68% vs. groups B and C, 48%, \(\chi^2 p=0.056\)). Six members of group C (14%) and seven members of group A (11%) terminated CPR before being told to stop compared with only one member of group B (2%). One or more cycles of potentially harmful CPR were performed by almost two thirds of the members of group C (most often due to repeated abdominal, xyphoid, or parasternal compressions). In contrast, less than 35% of members of group A and 28% of group B members performed one or more cycles of potentially harmful CPR (\(\chi^2 p<0.001\)).

Analysis of postexercise questionnaires revealed that only one of the 86 volunteers with prior CPR training studied or reviewed CPR material within the month preceding his trial. Ninety-eight percent of volunteers in groups A and B reported that they found telephone CPR to be helpful. Of note, more than 90% of the members of group B (the group with prior CPR training) indicated that they would be more likely to attempt CPR in real life if telephone CPR instruction was available. Only three volunteers (two from group A and one from group B) believed that telephone CPR instruction was confusing. These three objected to the

### Table 3. Strip Performance Data

<table>
<thead>
<tr>
<th></th>
<th>Group A (mean±SD)</th>
<th>Group B (mean±SD)</th>
<th>Group C (mean±SD)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ventilations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume (l)</td>
<td>0.70±0.92</td>
<td>1.00±1.02</td>
<td>0.98±0.85</td>
<td>0.14(\dagger)</td>
</tr>
<tr>
<td>Percentage of cycles adequate*</td>
<td>36.0</td>
<td>52.7</td>
<td>58.3</td>
<td>0.02(\dagger)</td>
</tr>
<tr>
<td><strong>Compressions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycles (n)</td>
<td>14.8±2.0</td>
<td>14.9±2.5</td>
<td>12.7±4.6</td>
<td>0.001(\dagger)</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>18.1±8.8</td>
<td>18.4±9.0</td>
<td>12.4±9.1</td>
<td>0.002(\dagger)</td>
</tr>
<tr>
<td>Rate (n/min)</td>
<td>58±26</td>
<td>62±17</td>
<td>77±21</td>
<td>0.0002(\dagger)</td>
</tr>
<tr>
<td>Percentage of cycles adequate†</td>
<td>26.9</td>
<td>34.4</td>
<td>12.6</td>
<td>0.005(\dagger)</td>
</tr>
</tbody>
</table>

*Percentage of cycles with at least 1 ventilation ≥0.5 l.
†Percentage of cycles with ≥10 compressions per cycle, at a mean depth ≥20 mm, at a rate between 50 and 100 per minute.
\(\dagger\)\(\dagger\) associated with ANOVA; \(\dagger\)\(\dagger\) associated with \(\chi^2\). Significant intergroup differences are indicated by brackets. The \(p\) values shown are those associated with three-way comparisons.

### Table 4. Strip Performance Data: Global Assessment

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ventilations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate (%)</td>
<td>34.4</td>
<td>53.5</td>
<td>58.1</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Compressions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate (%)</td>
<td>48.0</td>
<td>47.5</td>
<td>24.8</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>Attempts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate (%)</td>
<td>14.3</td>
<td>32.6</td>
<td>9.5</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Attempts containing ≥5 cycles with at least 1 ventilation ≥0.5 l.
†Attempts containing ≥5 cycles with ≥10 compressions per cycle, at a mean depth ≥20 mm, at a rate between 50 and 100/min.
‡Attempts containing ≥5 cycles with adequate ventilations and ≥5 cycles with adequate compressions.
\(\dagger\)Significant intergroup differences are indicated by brackets. The \(p\) values shown are those associated with three-way \(\chi^2\) tests.
length of time required for the message or the need to return to the phone for compression instructions before beginning full CPR.

Discussion
In their original study, Carter et al.\textsuperscript{16} used community volunteers to compare the effectiveness of a formal CPR message with impromptu CPR instruction by paramedics. Four groups were tested: one with prior CPR training and one group without received impromptu CPR instruction from a paramedic in a manner similar to that first used in Phoenix. Two additional groups (one with and one without prior training) received telephone CPR instruction from a study staff member using the team’s new CPR message. Using this method, the University of Washington team demonstrated that their scripted telephone message was superior to impromptu paramedic instruction. In addition, the quality of CPR performed by untrained volunteers receiving formal telephone CPR instruction was reported to be roughly comparable to that performed by previously trained volunteers receiving the same message. However, a comparison group with prior training but no telephone instruction was not included in the evaluation. Thus, two key questions remained unanswered. First, how does CPR performed by untrained subjects receiving telephone instruction compare with that performed by previously trained but unassisted persons? Second, does telephone CPR instruction confuse people with prior CPR training or does it remind them of what to do?

To answer these questions and build on the original research of Carter et al.,\textsuperscript{16} we recruited a comparable number of volunteers and incorporated many elements of the University of Washington team’s original methodology in our study design. We also addressed a number of additional concerns:

1) Study or review before the trial was minimized by recruiting volunteers with a vaguely worded announcement. Responses to our postexercise questionnaire confirmed that this strategy was successful. Only one person with prior CPR training reported that he had reviewed CPR instructional material within the month before his trial. None of the volunteers reported reviewing CPR techniques within a week of participation in the trial.

2) We attempted to approximate the delay between a witnessed collapse and initiation of CPR as closely as possible. Time required for recognition of cardiac arrest and the decision to call for help was simulated by having each volunteer read a single paragraph describing an apparent collapse. Study dispatchers also put each caller on “hold” long enough to contact and send an ambulance before returning to the phone to offer telephone CPR instruction. With these allowances, we found that telephone instruction required an average 2.75±0.6 (mean±SD) minutes, a figure comparable to the 2.4±1.6 minutes reported by King County dispatchers when telephone CPR instruction was actually implemented in their emergency medical service system.\textsuperscript{17} Because trained volunteers without dispatcher assistance did not begin CPR until a mean of 1.25 minutes after collapse, the additional time required for telephone instruction delayed initiation of chest compressions until a mean of 4 minutes after collapse. This time interval is almost twice as long as that originally reported by Carter et al.\textsuperscript{16}

3) Instead of relying on study staff members, we used professional ambulance dispatchers to deliver the telephone CPR message for our trial. This may explain (along with regional differences in cadence and speech) why our dispatchers required a significantly longer period of time to deliver the protocol than the research staff of Carter et al.

4) To test subject comprehension, message retention, and CPR performance in as rigorous a manner as possible, we subjected our volunteers to a highly stressful study environment. The use of video equipment, flood lights, and multiple observers was calculated to engender a high degree of performance anxiety. Almost every volunteer was noticeably excited during his trial.

5) We sought to identify lack of resolve and rapid extinction of training by asking all subjects to perform CPR for 5 full minutes after initiation of chest compressions. This allowed us to study an average of 10 or more cycles of CPR per volunteer, twice the number studied by the University of Washington team. This combination of emotional and physical stress was substantial. Although none of the subjects in the study by Carter et al terminated CPR before being told to stop, 14 of our volunteers chose to do so.

Unlike the originators of the telephone CPR message, we found that the performance of untrained volunteers receiving telephone CPR instruction was not entirely comparable to that of previously trained volunteers receiving the same message. This difference was probably due to our more rigorous study design and the use of explicit performance criteria. Members of group B, the group with prior training and telephone assistance, gave the best overall performance by a large margin. Although group A members approached group B in terms of observer scores and measured chest compression ratings, they were far less successful than group B in actually ventilating the manikin. Members of group A did, however, perform CPR of a quality comparable to members of group C, which was our “community standard” control group. This finding suggests that telephone CPR instruction can teach previously untrained bystanders to perform CPR of a quality roughly comparable to that currently achieved by mass community training programs. Furthermore, telephone CPR significantly enhances prior CPR training by reinforcing previously acquired skills.

Although most of the members of group A tilted the manikin’s head to some degree, relatively few extended the neck fully, a maneuver essential for
successful mannikin ventilation. Although we stressed neck extension to a greater degree than the original protocol by Carter et al (and perhaps more than is advisable with actual victims), this emphasis had little additive effect on previously untrained volunteers. Prior experience with mannikin ventilation may have given members of groups B and C (the groups with prior CPR training) an advantage when delivering ventilations. It is doubtful that the same degree of neck extension required for mannikin ventilation is necessary for successful ventilation of actual victims. Several participants noted during debriefing that it might have been helpful if the dispatcher had asked them if their ventilation efforts caused the mannikin’s chest to rise and fall. Assessment of the adequacy of ventilations at the time callers return to the telephone for chest compression instructions is included in current telephone CPR protocols for infants and children but is not part of the most widely used adult protocol (Emergency Medical Telephone Instructions, Emergency Training, Akron, Ohio).

In contrast to group A’s problems with ventilations, most volunteers in group C failed to perform adequate chest compressions. In addition to receiving poorer compression scores by both observer ratings and strip review, most group C members (60%) performed potentially harmful chest compressions. Several observers noted that group C volunteers used the proper technique for locating the xyphoid notch but that most failed to place the heel of their hand two fingers breadth above it. The result was repeated abdominal and xyphoid compressions. This observation suggests that incomplete retention of currently taught techniques may result in potentially dangerous CPR.

Deterioration of CPR skills over time has been shown in physicians, nurses, medical students, emergency medical technicians, police officers, and the public at large. In general, these studies have found that both ventilation and compression skills are poorly retained from 6 months to 1 year after initial training. Stross has reported that periodic mailings of educational material to physicians reinforce cognitive aspects of cardiac resuscitation but have little or no effect on motor skills. Mandel and Cobb have shown that spot reinforcement by video instruction or written review can generate substantial improvement in CPR performance scores without mannikin practice, but the duration of this effect is unknown. Although we noted substantial deterioration of CPR skills over time in our “community standard” control group (group C), much of this effect was reversed by telephone CPR instruction (group B). This observation is even more remarkable in light of the fact that almost three fourths of group C members were trained within the past year compared with only 26% of group B.

Several limitations to our study warrant comment. First, although our three comparison groups were larger than those originally studied by Carter et al, study of even greater numbers might have revealed additional intergroup differences beyond those noted by our trial. Second, despite attempts to create a highly stressful testing environment, it is unlikely that we generated the level of stress that results from the need to perform CPR on an actual victim. Therefore, quality of dispatcher-assisted CPR may vary in real emergencies. Third, although study observers and strip reviewers were unaware of the training status of group A and B volunteers, blinded study of group C was not possible, because this group did not receive the telephone message. Use of explicit criteria and our requirement for interrater agreement was designed to minimize observer bias, but the potential for this effect cannot be completely excluded. Fourth, because middle-aged to elderly women are most likely to need telephone CPR instruction, it might have been preferable to focus testing on this group. However, all three groups did include a number of older women, and the relative quality of CPR performed by each group was not affected by minor intergroup differences in age or sex. Fifth, although all three groups included blacks and persons of varying ages and educational backgrounds, group composition did not precisely mirror that of the city population overall. Finally, all of our study participants were highly motivated volunteers; their talents and capabilities could, therefore, exceed those of the Memphis community at large.

Only a minority of the members of our three study groups met explicit criteria for an “adequate” resuscitation effort. Traditionally, American Heart Association and Red Cross training programs have demanded nearly perfect performance of CPR before certification, though it is widely recognized that skills degrade rapidly over time. It appears likely, however, that even “poor” CPR improves a victim’s chances of survival. For example, although Mandel and Cobb found that fewer than 20% of a group of King County employees performed “adequate” CPR 12 months after training, initiation of bystander CPR in King County is associated with a twofold increase in the rate of survival after witnessed out-of-hospital cardiac arrest. Curry and Gass studied the effect of CPR retraining on patient outcomes after in-hospital cardiac arrest and reported that despite poor staff performance of CPR by mannikin skills testing, substantial rates of survival were achieved if CPR was begun within 4 minutes of collapse. These data suggest that the quality of CPR necessary to keep a victim alive may be substantially less than is currently taught.

By focusing training on a small group of emergency medical service dispatchers rather than the entire population, emergency CPR instruction over the telephone could offer a highly cost-effective approach to getting CPR instruction to the people who need it most—persons without CPR training who have just witnessed an apparent cardiac arrest.
Although our data suggest that telephone instruction can teach many people to perform adequate CPR, it should be considered an adjunct rather than a substitute for community-based CPR training. Currently approved courses in basic life support provide important information about cardiac risk factors, symptom recognition, and the need for rapid access to the emergency medical service system. These cannot be taught through a telephone CPR program. Even more importantly, persons who acquire CPR training and have confidence in their skills can initiate CPR much sooner than those who need dispatcher assistance. Shorter times from collapse to initiation of CPR are associated with better patient outcomes.\(^2\) Although faster speaking may shorten the time required for message delivery without sacrificing caller comprehension, the 4-minute average time from collapse to dispatcher-assisted CPR noted in our study is probably unavoidable. However, for untrained persons (and for CPR-trained persons who have forgotten their training or who lack confidence in their skills), telephone instruction may prove to be the only way to provide the teaching or spot reinforcement needed to start and sustain bystander CPR.

Communities interested in a telephone CPR program should consider several factors:

1) If a city's first-responding emergency medical service units consistently reach victims in less than 4 minutes after collapse, such help will often arrive before telephone CPR instruction is complete. However, benefit may still be derived in instances where response times are prolonged. Early initiation of ventilations and proper positioning of the patient on the floor before emergency medical service arrival may also be beneficial even if chest compressions are not begun.

2) Advanced cardiac life support (especially defibrillation) must be provided within 10–12 minutes of collapse if victims are to have any real chance of survival, regardless of the timeliness of bystander CPR.\(^2\) Communities unable to provide prehospital advanced cardiac life support within this time frame will probably realize little benefit from a telephone CPR program.

3) Dispatch center staffing in relation to call volumes must be carefully assessed. Telephone CPR instruction requires a minimum of 3.5–5 minutes of uninterrupted time for each call. Furthermore, telephone CPR protocols are generally adopted as part of a set of instructions for a variety of emergency conditions. In busy alarm offices manned by a single dispatcher, contingency plans for handling multiple calls or additional staff might be needed to support an effective program.

4) Quality of prehospital care, including telephone CPR, is highly dependent on the quality of medical control. Emergency medical service medical directors must be willing to expand their training and supervisory functions to meet the expanded needs of their dispatchers.

As substantial as these commitments seem, they are modest in comparison to the potential benefits of telephone CPR. Provision of telephone CPR instruction in communities already offering timely prehospital advanced cardiac life support could significantly boost rates of bystander CPR and therefore improve survival from out-of-hospital cardiac arrest. The combination of telephone CPR instruction and emergency medical technician (EMT)-defibrillation using automatic external defibrillators could even offer smaller towns that cannot afford paramedics a cost effective way to provide prehospital advanced cardiac life support.\(^3\) Telephone CPR instruction can and should play a major role in a community-based approach to emergency cardiac care.

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