Disseminating Cardiopulmonary Resuscitation Training by Distributing 35 000 Personal Manikins Among School Children

Dan L. Isbye, MD; Lars S. Rasmussen, MD, PhD; Charlotte Ringsted, MD, PhD, MHPE; Freddy K. Lippert, MD

Background—Because most cardiac arrests occur at home, widespread training is needed to increase the incidence of cardiopulmonary resuscitation (CPR) by lay persons. The aim of this study was to evaluate the effect of mass distribution of CPR instructional materials among schoolchildren.

Methods and Results—We distributed 35 002 resuscitation manikins to pupils (12 to 14 years of age) at 806 primary schools. Using the enclosed 24-minute instructional DVD, they trained in CPR and subsequently used the kit to train family and friends (second tier). They completed a questionnaire on who had trained in CPR using the kit. Teachers also were asked to evaluate the project. The incidence of bystander CPR in out-of-hospital cardiac arrest in the months following the project was compared with the previous year. In total, 6947 questionnaires (19.8%) were returned. The 6947 kits had been used to train 17 140 from the second tier (mean, 2.5 persons per pupil; 95% confidence interval, 2.4 to 2.5). The teachers had used a mean of 64 minutes (95% confidence interval, 60 to 68) for preparation and a mean of 13 minutes (95% confidence interval, 11 to 15) to tidy up. Incidence of bystander CPR in the months after the project did not increase significantly compared with the previous year (25.0% versus 27.9%; P=0.16).

Conclusions—CPR training can be disseminated in a population by distributing personal resuscitation manikins among children in primary schools. The teachers felt able to easily facilitate CPR training. The incidence of bystander CPR did not increase significantly in the months following the project. (Circulation. 2007;116:1380-1385.)

Key Words: cardiopulmonary resuscitation • health education • heart arrest • resuscitation • survival

The incidence of out-of-hospital cardiac arrest (OHCA) is 190 per 100 000 persons per year, whereas the incidence for emergency medical service (EMS) -treated OHCA approximates to 38 to 55 per 100 000 persons per year. Survival after OHCA depends on the ability of lay responders to identify signs of cardiac arrest, call for help, and begin CPR, including external chest compressions and rescue breaths. Bystander CPR and early arrival of the EMS improve short- and long-term survival after OHCA and quality of life for the survivors. Unfortunately, bystander CPR is begun in only 19% to 45% of witnessed OHCA cases. The reason for this is unknown, but lack of CPR skills and uncertainty could be possible explanations.

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Most cardiac arrests occur at home, and such cardiac arrests are associated with less-favorable outcome. This association is probably related to the observation that people most likely to witness cardiac arrest are less likely to attend conventional CPR courses. These courses are expensive; attendees are usually in their 20s or 30s; and few live with someone at high risk of a cardiac arrest.

A new approach is necessary to increase the incidence of bystander CPR. Video-based self-instruction may effectively disseminate CPR training in the general population. One example is the personal resuscitation manikin CPR Anytime MiniAnne CPR Learning Manikin (Laerdal Medical, Stavanger, Norway), which can teach lay persons and their relatives the fundamentals of CPR in 30 minutes. Training schoolchildren has been recommended because of their ability to retain knowledge and skills. In addition, after schoolchildren bring home the manikins, further training could be obtained if friends and relatives, the so-called second tier, use the CPR Anytime manikin.

The aim of this study was to evaluate the effect of disseminating CPR training by mass distribution of personal resuscitation manikins among seventh-grade schoolchildren. Our research questions were as follows. What is the multiplier effect of the distributed CPR training kits in terms of...
how many people use the kits besides the pupil? What are the teachers’ opinions about the CPR training kits and the perceived help in supporting their role as CPR instructors? Finally, what is the effect of mass distribution of CPR training kits on the incidence of bystander CPR in OHCA?

Methods
The study was conducted in Denmark, a country in northern Europe with ~5.4 million inhabitants, 69,000 pupils in seventh grade, and 3500 OHCA attended by EMS every year. CPR training is not mandatory curriculum in Danish primary schools.

In 2003, the TrygFonden foundation (Lyngby, Denmark) evaluated the attitude toward and need for CPR training in Danish primary schools by contacting the Danish physical education teachers’ organization. The response was very positive and demonstrated a need for new teaching material.

In collaboration with the National Board of Health and the Danish Red Cross, the project to distribute MiniAnne manikins in seventh grade was launched in May 2005. The goal was to teach CPR by donating 1 free personal resuscitation manikin to every pupil in seventh grade in Danish primary schools.

All primary schools in Denmark were invited to participate in the project, and participation was encouraged by a chance to win a trip to Norway for the entire class. This trip was sponsored by Laerdal Medical.

The personal resuscitation manikins were shipped to all participating classes during September 5 through 9. The teachers were encouraged to use a lesson with each class training CPR with the MiniAnne personal resuscitation manikin during the following week, September 12 to 16. Afterward, the children were to take the manikin home and train CPR with friends and relatives. The children were not encouraged to train specific groups for the second tier (eg, parents and grandparents) because the element of playing was considered important.

The kit used in this study is the MiniAnne, which is equivalent to the American Heart Association CPR Anytime MiniAnne training kit developed to reduce the barriers to learning and performing CPR.21

The enclosed DVD contains a 24-minute teaching session (Table 1).

Table 1. Contents of the 24-Minute DVD Developed by Laerdal Medical in Cooperation With TrygFonden, Equivalent to the American Heart Association CPR Anytime MiniAnne Training Kit

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>04:00</td>
<td>How to make MiniAnne ready for use</td>
</tr>
<tr>
<td>06:00</td>
<td>Cardiac compressions—theory and practice</td>
</tr>
<tr>
<td>08:45</td>
<td>Ventilations—theory and practice</td>
</tr>
<tr>
<td>10:45</td>
<td>Combined ventilations and compressions ratio 2:15—practice</td>
</tr>
<tr>
<td>14:45</td>
<td>Check responsiveness, check breathing, and alarming—theory</td>
</tr>
<tr>
<td>17:00</td>
<td>Entire CPR algorithm—practice</td>
</tr>
<tr>
<td>19:45</td>
<td>CPR coach to get compression depth and pace correct—practice</td>
</tr>
<tr>
<td>21:15</td>
<td>Encouragement to use MiniAnne at home to train friends and relatives</td>
</tr>
<tr>
<td>22:30</td>
<td>How to clean MiniAnne after use</td>
</tr>
<tr>
<td>24:00</td>
<td>The end</td>
</tr>
</tbody>
</table>

Study of the Multiplier Effect
An individual questionnaire for the pupils was enclosed with the manikin. The questionnaire included queries about demographic data (name, gender, and age) on those who had used the CPR training kit.

The pupils’ completed questionnaires were to be returned to their teacher ~3 weeks after the training session at school, between October 3 and 7, and subsequently mailed to the research group.

Study of Teachers’ Satisfaction
One week after the CPR training session, a questionnaire was mailed to all the participating teachers on their satisfaction with the CPR training kit and their opinion on the perceived help in supporting their role as CPR instructors. Completed questionnaires were to be returned with those collected from the pupils.

Study of Effect on Bystander CPR
The proportion of bystander CPR in OHCA in Denmark also was assessed. This information was retrieved from the Danish Out-of-Hospital Cardiac Arrest Register in which all OHCA in Denmark are registered by EMS. Data related to survival after OHCA also were obtained from this source. Data from September 12 to December 31, 2005, were compared with data from the same period the year before. Demographic data on bystanders are not collected by the EMS.

Data from questionnaires were entered into Excel 2000. We excluded data from subjects who obviously were pupils in the same class (on the basis of name, gender, and age). The multiplier effect was calculated as the number of subjects completing CPR training with the MiniAnne per manikin.

Statistical Analysis
Age was reported as median with 25% to 75% range (interquartile range [IQR]); other continuous data were reported as means with 95% confidence intervals (CIs). Noncontinuous data were reported as proportions. We compared proportions of bystander CPR in the 2 time periods using a chi² test. Values of P<0.05 were considered statistically significant.

It was estimated that ~800 OHCA would occur in each 3-month period, and we calculated that an increase in the incidence of bystander CPR from 25% to 35% could be detected with a power >90% at the 5% significance level. For statistical analysis, the SAS system 8.2 (SAS Institute Inc, Cary, NC) was used.

The authors had full access to and take responsibility for the integrity of the data. All authors have read and agreed to the manuscript as written.

Results
In total, 35,002 personal resuscitation manikins were distributed to the 1606 participating classes in 806 primary schools from September 5 to 9. At the deadline, October 7, only 6% of the pupils’ questionnaires had been returned. A reminder was sent to the 561 teachers who had given an e-mail address, and the following week, 781 letters were mailed to the responsible teachers. A reminder was printed in the newspaper—distributed weekly among primary schoolteachers; finally, a new letter was sent to the principals of schools not responding.

By December 1, a total of 7225 questionnaires from the pupils had been returned, corresponding to 20.6% of the distributed manikins. We decided not to include questionnaires returned after this date.

In total, 299 schools (37%) returned 6947 questionnaires from seventh-grade pupils (Figure 1). This corresponds to 19.8% of the distributed manikins. These 299 schools received 13,553 of the manikins, corresponding to a response rate of 51%, with only 5 schools (0.6%) having a response rate of 100%.
Multiplier Effect

The 6947 questionnaires were completed by 3484 girls and 3189 boys (gender not known for 274). Their median age was 13 years (IQR, 12 to 13 years). The second tier consisted of 17,140 persons: 9312 females (54%) and 7824 males (46%) (gender not reported in 4). Thus, the multiplier effect was 2.5 per pupil (95% CI, 2.4 to 2.5). The age distribution in the second tier is displayed in Figure 2. The boys had a significantly lower multiplier effect than the girls: 2.1 versus 2.8 (95% CI, 2.1 to 2.2 versus 2.7 to 2.9; \( P < 0.0001 \); Table 2).

When the responding schools are considered individually, the average multiplier effect per manikin was (median) 2.5 (5% to 95% range, 0.6 to 5.2).

Teachers’ Attitude

A total of 366 questionnaires from the teachers were returned from 308 schools. Sixteen questionnaires were excluded because 9 schools had used the manikins in classes other than that intended, 4 had not used the manikins yet, and 3 teachers handed in 2 identical questionnaires. A total of 350 questionnaires from 293 schools were analyzed. The response rate on these questionnaires cannot be established because the total number of teachers involved is unknown. Among those who responded, 53% were women. The median age was 43 years (IQR, 33 to 51 years). In total, 87% of the teachers had...
previously attended a CPR course, and 25% had some experience with teaching CPR.

The teachers used a mean of 64 minutes (95% CI, 60 to 68) for preparation and a mean of 13 minutes (95% CI, 11 to 15 minutes) to tidy up after the lesson. Most teachers (126; 36%) used a physical education lesson, 99 (28%) used a first language lesson, 42 (12%) used a biology lesson, and 83 (24%) used another lesson. In total, 91% of the teachers felt “good” or “very good” about being qualified to teach the lesson after their preparation (Table 3). Among those who had not taught CPR before, this proportion was 89%; for those who had never attended a CPR course themselves, it was 78%.

Bystander CPR

No statistically significant increase in the proportion of bystander CPR or in survival was seen the following months (Table 4).

Discussion

We found that CPR training can be disseminated in a population using personal resuscitation manikins distributed to children in primary schools and that the teachers felt confident in facilitating this initiative. The incidence of bystander CPR did not increase significantly.

The response rate was low, and the results may be biased if the most eager teachers and pupils were most inclined to return the questionnaires. The average multiplier effect varied from 0.2 to 10.3 among the schools, with no clear relationship with the time of returning the questionnaires.

Some manikins were returned to the school after a few weeks with the pupils. Although in contrast to the initial agreement, this was done to ensure that other classes could benefit from the training kits.

One limitation is that the calculation of the multiplier effect was based on information from 13-year-old children; it is questionable if they are a reliable source. They may tend to overstate the number of persons having used the training kit. We sought to counter this effect by excluding members of the second tier who resembled a person from first tier in terms of gender, age, and name. More females were seen in both the first and second tiers, and this corresponds well to the usual distribution on voluntary CPR courses. Choosing children 13 years of age was a compromise between physical ability to

<table>
<thead>
<tr>
<th>Persons Trained Per Manikin, n</th>
<th>Girls, %</th>
<th>Boys, %</th>
</tr>
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<tbody>
<tr>
<td>&gt;7</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1</td>
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<td>6</td>
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<td>14</td>
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<tr>
<td>1</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>0</td>
<td>21</td>
<td>34</td>
</tr>
</tbody>
</table>

1. Have you previously attended a CPR course?
   Yes 87 (306)
   No 13 (44)

2. Have you previously instructed others in CPR?
   Yes 25 (86)
   No 75 (263)

3. Did you study the enclosed instructions before the lesson?
   Yes 93 (321)
   No 7 (24)

4. Did you use MiniAnne to train CPR yourself before the lesson?
   Yes 78 (270)
   No 22 (79)

5. After the lesson, did you encourage the pupils to train family and friends at home?
   Yes 99 (343)
   No 1 (4)

6. How is your evaluation of the project as a whole?
   Very good, % (n) 87 (304)
   Good, % (n) 12 (43)
   Fair, % (n) 1 (3)
   Poor, % (n) 0 (0)
   Do not know, % (n) 0 (0)

7. How did the pupils feel about the training?
   Very good, % (n) 44 (151)
   Good, % (n) 48 (168)
   Fair, % (n) 7 (25)
   Poor, % (n) 1 (2)
   Do not know, % (n) 0 (1)

8. In your opinion, how was the yield for the pupils?
   Very good, % (n) 25 (86)
   Good, % (n) 61 (212)
   Fair, % (n) 14 (47)
   Poor, % (n) 0 (1)
   Do not know, % (n) 0 (1)

9. How was the quality of the training material?
   Very good, % (n) 65 (224)
   Good, % (n) 33 (114)
   Fair, % (n) 3 (9)
   Poor, % (n) 0 (0)
   Do not know, % (n) 0 (0)

10. How qualified did you feel to teach the lesson?
    Very good, % (n) 50 (176)
    Good, % (n) 41 (145)
    Fair, % (n) 4 (15)
    Poor, % (n) 2 (6)
    Do not know, % (n) 2 (8)

11. How did the material fit in 1 lesson (45 min)?
    Appropriate, % (n) 67 (221)
    Too long, % (n) 21 (69)
    Too short, % (n) 12 (41)

12. How do you evaluate this class for training CPR?
    Appropriate, % (n) 88 (294)
    Too Soon, % (n) 9 (30)
    Too Late, % (n) 3 (11)

13. Would you consider teaching CPR next year if you had the same training material?
    Definitely, % (n) 91 (309)
    Maybe, % (n) 8 (28)
    No, % (n) 1 (3)
    Do not know, % (n) 0 (1)
perform CPR, understanding what a cardiac arrest is, and motivation to take home a manikin and train CPR with family and friends. In addition, these children tend to have parents aged 40 to 50 years of age, which was considered an appropriate age group for the second tier. Assessment of skill retention in the parents who had been trained was contemplated, but the tests were conceived as being impossible to carry out without introducing major biases.

The pupils used the manikin primarily to train siblings, friends of the same age, and parents (Figure 2). To a smaller extent, the manikin was used to train persons aged 50 years of age. Approximately 10% from the second tier were aged <10 years of age, and it is unlikely that they have benefited from the training to an extent that has enabled them to perform CPR in a real situation. One can hope that this early familiarization with CPR will make them more susceptible to future training.

It was reassuring that the vast majority of the teachers had previously attended a CPR course. No more than one hour was used for preparation, and tidying up took <15 minutes. Most of the teachers felt qualified to facilitate the training. This training kit has effectively removed some of the barriers for CPR training in schools such as prior CPR training and purchasing and maintenance and cleaning of expensive equipment.

The incidence of bystander CPR tended to be higher in the months after the project, but the difference was only 3%. Approximately 6000 cardiac arrests would be needed to detect a difference between 25.0% and 27.9% with a power of 90% at the 5% significance level. If we presume that 120,000 lay persons have trained CPR in this period, this is still only 2.3% of the population, and it is uncertain how many of these lay persons would take the leap from going through CPR training to performing real CPR. A 10% increase in bystander CPR as a result of this project was probably too optimistic.

It is interesting that a simple resuscitation manikin and a 24-minute DVD can promote training of CPR in 3.5 persons for every manikin within such a short period of time. In addition, the MiniAnne CPR Learning Manikin can later be used to train more persons or to retrain those already trained. Although no data support this, learners from the second tier have the possibility to train a third tier because the CPR Anytime Program is a self-contained training unit. This enables a cascade-like dissemination of CPR in a population. Both the immediate and lasting skill retention of the CPR Anytime Program has been documented to be at least as good as traditional CPR training. Nontraditional CPR training methods have been attempted several times in the form of, for example, mass-distributed training videos, but they had no effect on the incidence of bystander CPR. Public service announcements in television have been shown to increase the incidence of bystander CPR, but it is unknown whether any lasting effect is produced. Two new motivational elements in the CPR Anytime Program are important for a high multiplier effect: the presence of a motivational component in the session that the primary trainee attends and the influence of the primary trainee on the second. In traditional CPR courses, a mean age of ~31 years and a proportion of participants ~50 years of age of 6.6% has been reported. Most adults trained in our study were between 40 and 50 years of age, and the proportion of participants ~50 years of age was slightly higher (9.2%).

Several studies have demonstrated that children in this age group are able to learn and retain CPR skills. Two recent studies have documented that children ~13 years of age are able to perform CPR on a manikin almost as well as adults. How children function as facilitators for CPR training has never been described.

Although the project did not significantly affect the incidence of bystander CPR, we find it very promising that the multiplier effect was as high as 2.5 per pupil and that the CPR Anytime Program seems to be easy to use for the teachers. This project seems to have overcome some of the known barriers to learning CPR, but new barriers seem to have emerged. Many schools chose not to participate in this project although they were offered free materials for teaching CPR. Some teachers chose not to use the manikins for the designated purpose, and some did not let the pupils take the training kits home, thus effectively eliminating the possible cascade effect. Future projects should be aimed at these new barriers. In addition, it would be interesting to know how well adults perform CPR after being facilitated by children.

We hope that the incidence of bystander CPR will increase in the future as a result of the 2005 guidelines, which make CPR for lay persons easier to remember and perform. If at the same time CPR training is made more accessible (eg, with the CPR Anytime Program), an increase is expected.

### Conclusions

CPR training can be disseminated in a population when personal resuscitation manikins are distributed among children in primary schools. The teachers felt able to facilitate this initiative and were generally positive toward the project. The incidence of bystander CPR did not increase significantly in the months following the project compared with the same period the previous year.

### Acknowledgments

We wish to thank Jerry Potts, PhD, for his contributions during the development of the questionnaires for teachers. We also wish to thank TrygFonden (Denmark) for supplying the manikins and especially communications manager Trine Heidemann for her work in developing the questionnaires for teachers.
in coordinating the entire project. Finally, we wish to thank the Danish Out-of-Hospital Cardiac Arrest Register and Statistics Denmark for supplying data for this project.

Sources of Funding
Dr Isbye has received an unrestricted research grant from TrygFonden (Lyngby, Denmark) and the Laerdal Foundation for Acute Medicine (Stavanger, Norway). TrygFonden financed the 35 000 resuscitation manikins and their distribution. The Department of Anesthesia, Center of Head and Orthopedics, Copenhagen University Hospital, Rigshospitalet, supported the remaining practical aspects of this study, including stationery and postage.

Disclosures
Dr Isbye has received an unrestricted research grant from the Laerdal Foundation for Acute Medicine, but neither the Laerdal Foundation nor Laerdal Medical has taken any part in designing the study, analyzing the data, or writing the manuscript. The other authors report no conflicts.

References

CLINICAL PERSPECTIVE
Bystander cardiopulmonary resuscitation (CPR) improves survival after out-of-hospital cardiac arrest. Unfortunately, bystander CPR is initiated in only a minority of witnessed out-of-hospital cardiac arrests. The reason for this is unknown, but lack of CPR skills and uncertainty could be possible explanations. Conventional CPR courses are unable to train a sufficient number of lay persons, and such courses seem to attract people unlikely to witness an out-of-hospital cardiac arrest. The CPR Anytime MiniAnne CPR Learning Manikin might be a solution for disseminating CPR capability in a population in a cascade-like manner. The self-contained system can be used to train and retrain lay persons in CPR without an instructor. We distributed this system to 35 000 children 13 years of age in primary schools who were encouraged to train CPR with their parents and friends. On average, the children used the manikins 2.5 times to train new lay persons in CPR without an instructor. In this way, it may be possible to train a large number of lay persons and even lay persons from an age group more likely to witness an out-of-hospital cardiac arrest, thus potentially increasing bystander CPR rate and survival after witnessed out-of-hospital cardiac arrest.
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_Circulation_. 2007;116:1380-1385; originally published online August 27, 2007; doi: 10.1161/CIRCULATIONAHA.107.710616

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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