Retention of CPR skills and the effect of instructor expertise one year following reciprocal learning

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Abstract: Although Basic Life Support (BLS) and Cardiopulmonary Resuscitation (CPR) education is mandatory in secondary schools in Flanders, many schools do not programme this content because they lack teachers with expertise in this matter. This study aimed at investigating CPR skill performance and skill decay following reciprocal learning with task cards taught by an expert versus a non-expert teacher. Teacher expertise was asserted by European Resuscitation Council (ERC) certification. Skill performance and skill decay of Pedagogy students’ CPR performance was assessed 3 weeks and 12 months following reciprocal learning by an expert teacher versus a non-expert teacher. Students taught by the expert demonstrated significantly higher chest compression rates, although this observation was not clinically relevant. No clinically relevant skill decay was detected. Instructors with no certification and expertise in BLS can achieve equal learning outcomes as certified instructors when applying reciprocal learning with task cards. The model seems resistant for skill decay since no clinical deterioration of skill was found after 12 months.

Key words: Cardiopulmonary Resuscitation (CPR); education; training; retention; peer learning; teaching effectiveness.

Introduction

As early as 1974, the American Heart Association advocated the teaching of BLS and CPR to lay people (1). In 1992, the European Resuscitation Council (ERC) recommended BLS to be taught in schools (2). In Flanders (Belgium), the teaching of BLS and CPR is mandatory in secondary school curricula. However, 47% of schools do not program the teaching of CPR, mainly because they lack experts in this matter (3). In the remaining 53% of schools, CPR is mostly taught during Physical Education (PE) classes, although 30% of PE teachers declare not feeling competent in teaching this content (3). Therefore, many schools invite experts such as Red Cross instructors to teach CPR.

In institutions of higher education, where CPR and first aid courses are offered as part of a health-based curriculum, external experts are also invited to do the job.

Providing teachers with an instructional model and ready-to-use instructional tools might overcome their feeling of incompetence. In order to become a recommended practice in educational settings, this model needs to be successful in terms of learning outcomes, regardless of the teacher’s expertise. In their 1991 paper, KAYE and colleagues state that the problem of poor retention of CPR skills may lie with the instructor, and not the learner or the curriculum (4). In their observation of CPR classes, they report unstandardized teaching, limited practice time, and lack of skill-related feedback. In addition, they incriminate instructor incompetence as negatively affecting skill retention, although research in this matter is almost non-existent (5).

This study investigates the effect of instructor expertise, as asserted by ERC certification, on learning outcomes when teaching BLS through reciprocal learning with task cards. Reciprocal learning is an instructional model in which students work in pairs to maximize each other’s learning. While one student (doer) is performing BLS, the other (helper) is instructing, observing, and providing skill-related feedback, based on the information provided on task cards. Task cards combine a picture of the skill with written instructions about how to perform the skill. Reciprocal learning with task cards has been well studied in PE settings across several motor domains (6), including BLS (7, 8). Previous work recommends reciprocal learning in educational settings for the following reasons: it is time-effective, and the teacher does not necessarily...
need to be an expert in BLS when task cards are available (9).

Goals of study

This study is part of a larger research that aims at developing an instructional model (i.e. reciprocal learning) and instructional tools (i.e. task cards). Through this method, it is hoped to bypass factors negatively affecting skill performance, to render learning outcomes independent from teachers’ expertise, and hence to enhance a widespread teaching of BLS. In this report, skill performance and skill decay in CPR performance 3 weeks and 12 months following a reciprocal learning episode with task cards is analyzed. Subjects are first-year students in Pedagogy. The initial hypothesis was a better performance achievement of students taught by a teacher who is a certified BLS instructor, as well as a slower deterioration of skills as compared to students taught by a non-expert. Quality of CPR was assessed through comparison with the ERC 2005 guidelines (10).

Methods

Initial study

Subjects and test design

Participants were 124 bachelor students in Pedagogy (6 males and 118 females) from a Belgian university. Prior to the start of the study, students completed a questionnaire to assess whether they had received BLS or CPR training in the past three years. Informed consent was received from all students and approval for the study was obtained from the local Institutional Review Board. Students were randomized in two experimental groups. Within each group, students were then further randomized in four equal groups for classroom teaching. All randomizations were conducted using the Graphpad Software (http://www.graphpad.com/quickcalcs/randomize1.cfm). In both groups, students received BLS training by a PE teacher through reciprocal learning with task cards. Teachers of both groups had been teaching PE in secondary schools for more than 10 years. In addition, they were all lecturer in a Physical Education Teacher Education (PETE) program at a Flemish institute for Higher Education. Experimental groups differed in BLS certification of the PE teacher. In the Expert Instructor (EI) group, the teacher (male, age 43) had been an ERC-certified BLS instructor for eight years. In the Instructor (I) group, the teacher (male, age 46) had no certification in BLS, and did not consider BLS as an area of his expertise. Both teachers taught four intervention classes in a standardized format. The class started with a 10 minute standardized PowerPoint presentation, explaining the learning task and the instructional model. Thereafter, students chose a partner and worked in pairs of doers and helpers. They used a Little Anne manikin for 20 minutes, in conjunction with task cards. The function of the helper was defined as ‘instructing the doer how to perform BLS, based on the information provided on the task cards, observing the doer’s performance, comparing and contrasting the performance of the doer with the criteria stated on the task cards, and communicating the results of this analysis by means of skill-related feedback’. The function of the doer was defined as ‘after listening to the instructions of the helper, perform the skill and take account of the given feedback for performing the subsequent trials’. Teachers prompted students every 5 minutes to switch roles. Following these 20 minutes of practice time, students switched roles and engaged 10 minutes in peer evaluation. While one learner was performing BLS (doer), the other (helper) was observing and assessing BLS performance using a scoring sheet. This scoring sheet listed all BLS items, and the assessors (helpers) were asked to mark each item with ‘correct’ or ‘incorrect’. Doers were not allowed to check the task cards during assessment. Learners switched roles after five minutes. Peer evaluation was embedded in the learning episode, since it has been shown to foster BLS skill retention (9). During class time, instructors took care of time management, supervised both doers and helpers, and provided role-related feedback to reinforce appropriate communication. In case the doer performed incorrectly, the teacher had to direct the helper’s attention to the incorrect performance with questions like “Is the doer performing correctly?” or “Is the doer’s performance of this skill similar to what is instructed on the task cards?”. The class ended with a 5 min rehearsal of the BLS sequence by the instructors. Class time in both groups lasted between 49 and 53 minutes.

Reciprocal learning with task cards

Teachers received two separate one-hour training sessions to familiarize with the experimental
Retention of CPR skills

Three previously described quality indicators related to BLS mastery were measured and analyzed (11): compression depth, compression rate, and ventilation volumes. Two supplementary variables were defined: compressions performed with correct hand placement, and duty cycles. These five quality indicators were reported in average group means with SD, 95% Confidence Intervals (CI), and compared to the 2005 ERC guidelines (10). It was hypothesized that the quality of CPR after 12 months would be better in the EI group than in the I group, and that skill decay would be faster in the I group than in the EI group.

Statistical methods

Statistical analysis was performed using SPSS, version 16.0 (SPSS Inc., Chicago, IL, USA). Shapiro-Wilk testing demonstrated normal distribution for all measured CPR variables (P > .05). Therefore, repeated measures analysis of variance (ANOVA) was conducted with groups and time as factors. Dependent variables were the CPR items. Estimates of effect size were reported by means of eta squared (η²). We aimed at detecting a 5 mm difference in chest compression depth. In a previous study assessing 76 subjects, a standard deviation of 5 mm was found for this variable (9). Post hoc sample size calculation determined that a sample size of 17 students in each arm of the study, a power of 0.80 could be reached at a 0.05 alpha level.

Results

One hundred and eighty-two bachelor students in Pedagogy enrolled for a BLS course and signed the informed consent for participation. The course was embedded in their university curriculum. Three women and one man (2%) were excluded from the informed consent for participation. The course was embedded in their university curriculum. Three women and one man (2%) were excluded from data analysis, because they reported previous BLS training. One hundred and seventy-eight students were then randomized into an EI group (n = 60, 58 women and 2 men), an I group (n = 60, 56 women and 4 men), and a Red Cross control group (n = 58, 55 women and 3 men). Mean age in all groups was 19 years (S.D. = 0.7, range 17-21). The large amount of women compared to men reflects the actual student population at the Faculty of Psychology and Pedagogy, and is not the result of exclusion criteria. Three women from the control group did not show up for assessment at three weeks and were excluded.

Outcome measurements

Assessment of CPR quality was performed three weeks and 12 months following the reciprocal learning episode. This occurred individually, using a Laerdal AED ResusciAnne manikin connected to a laptop running the PC Skill Reporting system version 2.21 (Laerdal Medical, Belgium). The assessment was stopped after students performed three compression-ventilation cycles. Three supplementary variables were defined: compressions performed with correct hand placement, and duty cycles. These five quality indicators were reported in average group means with SD, 95% Confidence Intervals (CI), and compared to the 2005 ERC guidelines (10). It was hypothesized that the quality of CPR after 12 months would be better in the EI group than in the I group, and that skill decay would be faster in the I group than in the EI group.
from the experiment. Twelve months after the learning episode, retention testing occurred. Twenty students of the EI group (19 women and 1 man), and 19 students of the I group (18 women and 1 man) were retested. The Red Cross control group was excluded from analysis since only 5 students showed up at 12 months. This large drop out was mainly due to the enrollment of students into other study curricula after this 12 months period. The flow of students in this study is presented in Figure 2.

**Analysis of CPR variables between groups**

Data are presented in Table 1. A significant difference was found between groups for mean chest compression rates \( F(1, 35) = 4.14, P = .04, \eta^2 = .11 \). In the EI group, average rate per minute was 112 compared to 101 in the I group.

No significant differences were found for mean ventilation volume \( F(1, 35) = .52, P = .47, \eta^2 = .02 \), mean percentage of compressions with
RETENTION OF CPR SKILLS

Means (standard deviations), 95% Confidence Intervals (CI), and P-values of Time, Group, and Time by Group interaction effects in the Expert Instructor (EI) and the Instructor (I) group after 3 weeks and 12 months.

<table>
<thead>
<tr>
<th></th>
<th>After 3 weeks</th>
<th>After 12 months</th>
<th>P value</th>
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<tbody>
<tr>
<td></td>
<td>EI (n = 20)</td>
<td>I (n = 19)</td>
<td></td>
</tr>
<tr>
<td>Target</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mean ventilation volume (ml)</td>
<td>499-601</td>
<td>864 (269)</td>
<td></td>
</tr>
<tr>
<td>Mean compressions with correct hand placement %</td>
<td>81 (30)</td>
<td>66-95</td>
<td></td>
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<tr>
<td>Mean compression depth (mm)</td>
<td>39-51</td>
<td>34 (7)</td>
<td></td>
</tr>
<tr>
<td>Mean compression rate (min⁻¹)</td>
<td>100</td>
<td>119 (18)</td>
<td></td>
</tr>
<tr>
<td>Duty cycle (%)</td>
<td>50</td>
<td>47 (7)</td>
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</tbody>
</table>

A significant between-group difference was found only for mean chest compression rates. Although significant, the difference between mean compression rate in the EI group (113 rpm) and the I group (102 rpm) is clinically irrelevant. Since no further group differences were found, instructor expertise has probably little or no effect on student learning in this study. This is in accordance with previous research, where reciprocal learning was suggested for BLS education in schools (9). In that study, and when task cards are used, teachers do not necessarily need to be to support student learning. It nuances existing literature arguing that instructor incompetence negatively affects skill retention (5). Results from this study could convince non-expert teachers to teach BLS and CPR by means of reciprocal learning. The use of task cards dismisses the teacher of instructing content, since these tools comprise all the necessary information to learn BLS.

Skill decay from 3 weeks to 12 months was analyzed through repeated measures. Significant differences in chest compression rates and duty cycles were found. Mean chest compression rates in the EI and I group were 106 and 99/min respectively at 12 months. This difference is clinically irrelevant and both values approach the ERC 2005 guidelines—recommended 100/min rate (10). Therefore, this significant drop in compression rates should not be considered as skill decay. Significant lower mean duty cycles were observed after 12 months (43%), as compared to 3 weeks (47%). The term duty cycle refers to the ratio of compression duration to total cycle time. Standard CPR has a recommended duty cycle of 50% – half compression, half relaxation. However, research suggests that cycles as low as 40% are not clinically different from cycles of 50%, since they do not lead to reduced relative cardiac output (12). The lower mean duty cycles observed at 12 months should therefore not be considered as skill decay.
decay as well. No skill deterioration was found for ventilation volume, compressions with correct hand placement, and compression depth. The absence of skill decay over a 12 month period contrasts with existing literature. Earlier work indicated that BLS performance drops to pre-training levels after 1 or 2 year (13). EINSPRUCH and colleagues observed significant lower percentages of chest compressions with correct hand placement already 2 months after the initial training (14).

Comparison of skill performance in both groups with the ERC guidelines shows that students overinflate and perform shallow compressions. From the perspective of survival, chest compression depth is the most important variable (10, 11). Shallow compressions were prevalent at both 3 weeks and 12 months. Achieving sufficient compression depths should therefore be a focus point in future lifesaving courses. Recent work in this matter has demonstrated that training to deeper compression depths reduced shallow compression rate after 6 months (15). The problem of over-inflation in BLS education has been reported in previous research including peer learning (9), and should continue to be addressed in BLS education. In this study, the ERC 2005 guidelines were used for the reason that CPR training was conducted in September 2010, one month before the new guidelines were released. Furthermore, students in this study received a 40 minutes lesson for learning CPR. Two lessons could perform better at improving mastery of CPR skill. Future research could be designed to confirm this hypothesis.

The outcome of reciprocal learning with task cards seems to be independent from instructor expertise. In addition, the model seems to limit skill decay to a large extent. Researchers have identified variables that negatively affect learning and retention, such as inconsistent teaching, unrelated course content, and complex instructions. Variables that positively affected skill retention were hands-on practice, instruction simplicity, and feedback from instructors (16, 17, 18). In reciprocal learning and the use of task cards limit the provision of unrelated course content and, prevents inconsistent and unstandardized teaching (9). Hands-on practice is also maximized. Indeed, students can start working together after a short 10 min introduction about the instructional model. Total class time for reciprocal learning took about 50 min, which makes it suitable for secondary school teaching where classes usually have that duration. It has been stated that length of CPR classes form a barrier to the more widespread training of CPR (14). Hence, reducing class length, while preserving effective learning, is essential. Research in this matter has shown that lay responders can learn CPR through a 30-min self-instruction program (14). Although skill-related feedback from instructors was absent in this study, research also shows that immediate skill feedback by a peer contributes to learning (19). During reciprocal learning, the helper observes the doer’s performance, compares this performance with the task cards criteria, and gives skill-related feedback. This process enhances learning of both doer and helper (19). The teachers’ prerequisites were leveled, because they were trained to teach by means of a highly formatted model. Teachers served as facilitators, and were only allowed to communicate with the helpers about their partner’s performance. By communicating only with the helper, the instructor places the responsibility for skill acquisition on learners, an essential element for success in CPR training in the reciprocal model (20, 21). When the doer was not performing correctly, the teacher had to communicate this observation to the helper (e.g., “Is the place of chest compressions correct? Take a look at your task cards”). It was therefore only during this significant but limited process of observing, error detection, and communication with the helper that the level of expertise from the teacher could have affected student learning.

This study has some limitations. The large drop out of subjects at the 12 month assessment could have biased the results. One year following intervention, some students already left their initial study program, which made it hard to contact them. It is unclear in which way this could be of influence, but one could argue that only the more motivated students showed up. Also, only the quality of CPR variables was reported in this study, and not the entire BLS algorithm (e.g., checking for consciousness). Analysis of the entire BLS procedure would have provided more information regarding the effectiveness of the reciprocal learning model and skill decay in both groups. Finally, the quality of the peer assessment was not investigated in this study. Future research could assess the quality of this interaction to further improve the learning model.

**Conclusion**

Reciprocal learning with task cards is a feasible instructional model to teach BLS for instructors lacking expertise in this matter. The 50 min duration of the model makes it suitable for teaching
in secondary schools or institutions of higher education. Task cards facilitate the standardized teaching of BLS and outcomes seem independent of teacher expertise when embedded in reciprocal teaching. No clinically relevant skill decay was found after 12 months. Shallow compressions and over-inflation should be addressed in future educational research.

References