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Occupational first aid training: Decay in cardiopulmonary resuscitation (CPR) skills

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One hundred and twenty four occupational first aiders were tested on their ability to carry out cardiopulmonary resuscitation (CPR) at varying times following training (up to three years). Expert assessment of printouts from a Recording Resusci-Anne manikin indicated that only 12 per cent of those tested would be capable of carrying out effective CPR. Measures derived from the same printouts showed that there was a rapid and linear decay in CPR skills over time with fewer than 20 per cent of subjects achieving a score of 75 per cent on performance after only six months had elapsed since training.

Variables such as age, sex, height, weight and practice on a manikin were not found to influence performance.

Despite certain drawbacks in the design of the study it is clear that retraining in CPR skills should be more frequent than the three years recommended by present industrial first aid legislation.

Cardiopulmonary resuscitation (CPR) is one of the most important life saving skills. If carried out efficiently, casualties may be resuscitated or have their respiration and circulation artificially maintained until more advanced treatment is available. CPR, while being a relatively complex procedure, is a teachable skill and there are strong arguments for a large proportion of the population receiving CPR training.

Some research has been undertaken into CPR training and decay in CPR knowledge and skills. At present, around 30 studies in this area have been identified, only one of which was undertaken in the UK.

The aims of this paper are to outline relevant research findings to date; consider the factors likely to influence CPR skill acquisition and retention; and report on a preliminary study designed to investigate CPR skill decay over time.

Research into CPR skill retention and decay

Studies of CPR training have varied widely in quality and methodology. Groups studied range from medical staff and students through to the lay public and school pupils with sample sizes ranging from 18 to nearly 1000 (Alvarez & Cobb, 1975; Vineberg, 1975; McManus & Davin, 1976; Skelton & McSwain, 1977; Frazier & Cannon, 1978; McSwain *et al.*, 1979).

An almost universal finding is that decrements in CPR performance are found for all intervals of time tested. This is true even six weeks after training with severe loss of skill

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occurring after about 12 months, when, typically, 20 per cent or fewer of trainees are able to perform CPR proficiently. Individual differences in CPR skill retention are found but no differences associated with sex or weight of trainee have been reported. It has been shown that decay in CPR skills is greater than for other first aid skills such as traction splinting and bandaging (Latman & Wooley, 1980).

A number of studies have made recommendations for improving the quality of CPR teaching. These recommendations include the following: that

(*a*) practical training is superior to either demonstration only or to passive learning (see, for example, Lind, 1970);
(*b*) feedback is essential, especially via a recording and monitoring manikin (see, for example, Vanderschmidt *et al.*, 1975; Jekic, 1979);
(*c*) practice after initial training measurably improves CPR performance (see, for example, Braun *et al.*, 1965; Weaver *et al.*, 1979);
(*d*) refresher training is important—even a brief review of training material can have a measurable effect (see, for example, Banasik *et al.*, 1976).

Findings from recent reviews of skills decay and retention

Many studies of skills decay and retention are of relevance to CPR. Most psychological studies have concentrated upon perceptual motor skills—usually tested in laboratory settings. Stammers (1981) summarizes the major findings as follows:

(*a*) all skills decay—but at different rates depending on a number of factors;
(*b*) a key variable is the nature of the task; it is an oversimplification to state that continuous motor skills are well retained while procedural motor performance is not; task organization is a more important variable and tasks with high inherent task organization may be retained better where each task follows logically from the one before;
(*c*) some studies show a direct relation between the total amount of training received and the amount of skill retained; over-training will aid retention;
(*d*) the nature and frequency of rehearsal training or retraining are key factors;
(*e*) relearning following a period of non-practice is often very rapid—previous levels of skill often being retained with limited retraining;
(*f*) retraining can be quite effective even if the training situation has low realism.

The lessons to be learned for CPR training and skill retention are that skill loss is inevitable but that it can be recovered relatively easily. Rehearsal or retraining (even on a manikin) is important.

Further information is provided by Hagman & Rose (1983). Both presentation and performance of the task require repetition. Repetition of presentation promotes acquisition of a skill, while repetition of the actual skill leads to long-term retention. Retention is better when practice is spaced rather than massed during training. Introducing equipment variety across the training task repetitions is not detrimental if the equipment similarity is high. Some tasks are retained better than others with the best predictor of forgetting being the number of steps required. Task steps which are not cued by the equipment or by previous steps performed are those most likely to be forgotten. Safety steps are particularly susceptible to forgetting (Shields *et al.*, 1979).

Ability does affect acquisition but rate of forgetting is the same, irrespective of ability. This is particularly relevant to CPR as studies have shown that medical and lay personnel can be trained to the same level (see, for example, Winchell & Safar, 1966; Sampson, 1978; Casey, in press). Higher ability trainees benefit more from self-paced individualized instruction while lower ability trainees benefit more from group-paced classroom instruction (Berkebile *et al.*, 1975).

The general principles outlined above can be applied to CPR teaching. However, there remains the requirement to investigate the specific variables within this type of training which affect retention. There is still a long way to go in the detailed investigation of CPR training. One major problem for the retention of CPR skills is the likelihood that the trainee will never (or at most rarely) be required to carry out the procedure. Consequently, periodic refresher training is essential if the skill is to be retained. The issue of the spacing of such retraining is crucial. Expert respondents in a study by Latman & Wooley (1980) considered that CPR refresher training would be required after skill had decayed by 16 per cent of its optimum value and when knowledge had decayed by 32 per cent.

From this introduction it is clear that existing research has a lot to offer teachers of CPR. It is the authors' experience that the nature and quality of CPR training varies considerably, but that the best training largely conforms to the recommendations set out above. However, research is necessary to determine and demonstrate the most effective training course for CPR skill acquisition and retention. The present study is concerned with the second issue—that of CPR skill decay over time and the spacing of refresher training.

Decay in CPR skills over time

A cross-sectional study of CPR skill decay was set up by a first aid training organization based in the West Midlands of England. The authors were invited to analyse and interpret the data collected. The remainder of this paper will concentrate on this pilot study and show how it has led to a larger-scale longitudinal study of CPR skill decay.

METHOD

One hundred and twenty-four occupational first aiders trained in CPR at varying times were tested on their ability to carry out CPR. The time since training varied from three months to that at which retraining is presently required—three years. Subjects had been trained by various organizations and were tested by different people in a variety of locations. Thus neither the CPR training nor the testing environment were standardized. However, all subjects were required to carry out CPR on a recording Resusci-Anne, a manikin frequently used in CPR training. This training aid has lights to show when correct location for chest compressions is selected and when adequate lung inflation has been achieved (these were not visible by subjects during testing). The manikin also gives a printout showing depth of compression and extent of lung inflation. Time taken for each manoeuvre is also recorded.

Subjects were brought into a room containing the Resusci-Anne and told that they had just witnessed 'this person' collapse and should act appropriately. They were required to continue CPR until asked to stop (after about two minutes).

The following information was collected from each participant:

(*a*) age (mean age = 42 years),
(*b*) sex (103 males and 21 females were tested),
(*c*) height,
(*d*) weight,
(*e*) type of manikin trained on,
(*f*) whether they had read about or seen a film or television feature on CPR, and
(*g*) whether they had practised on a manikin since their training.

These were all factors which might be expected to affect individuals' CPR skill. Subjects were also asked whether they would attempt a rescue now and whether they had attempted CPR on a casualty since their most recent training.

Analysis of performance was based on observations made by the researcher and on the manikin printouts. An overall assessment of ' outcome ' based on this information was made by a highly experienced and qualified CPR teacher.

Reference should be made to current first aid manuals for the presently recommended CPR technique. In brief, subjects were expected to diagnose the absence of breathing and carotid pulse, administer a precordial thump (again testing to see whether the heart had restarted). This should have been followed by four quick ' body building ' breaths. The subject should then proceed to give cycles of 15 chest compressions followed by two lung inflations, checking after approximately one minute to see whether the heart had restarted. The most important aspect of CPR is the 15 : 2 ratio as this builds up sufficient blood pressure and oxygenation to maintain the body's vital organs. Timing is also crucial as blood pressure quickly falls if compressions are too slow or if the delay before restarting compressions (while inflating the lungs) is too long.

Four measures of ability were derived from observation and printouts:

(*a*) *Performance*. This score (out of 8) was for the crucial parts of CPR performance, i.e. the first four ratios of 15 compressions to two breaths. Thirteen to 17 compressions were awarded one mark if they were correctly positioned and of the correct strength. A delay of up to seven seconds between each set of compressions was accepted.

(*b*) *Technique*. (Score out of 5). This covered general skills—giving the precordial thump, good ' body building ' breaths, adequate lung inflations and correct strength and location of the majority of chest compressions.

(*c*) *Diagnosis*. Subjects could score up to four for the diagnosis of: both absent breathing and carotid pulse prior to commencing CPR, carotid pulse following precordial thump and again after one minute of CPR.

(*d*) *Total score*. This score out of 17 was the sum of (*a*) to (*c*) above.

RESULTS

Outcome

Of the 124 subjects, 15 (12·1 per cent) were judged to have been successful in their CPR. Within two years of training the success rate was 32·5 per cent while of those trained three years earlier only 2·4 per cent were judged effective. This difference was statistically significant ($\chi^2 = 20{\cdot}37$, d.f. $= 1$, $P < 0{\cdot}05$).

Total score

The mean total score obtained on the test (out of 17) fell from about 11·5 after two months to less than 4 after three years. As Fig. 1 shows this decline closely approximated to the linear regression line shown in the figure. The decline in score over time was stastistically significant ($F = 139{\cdot}57$, d.f. $= 4{,}119$, $P < 0{\cdot}001$) and the correlation between score and time since training was $-0{\cdot}72$ ($P < 0{\cdot}001$).

Performance

The mean scores obtained on performance (the crucial parts of CPR skill) are also shown in Fig. 1. The maximum attainable score was 8 and the mean score declined from about 4 after two months to less than 1 after three years. The correlation between score and time since training was $-0{\cdot}68$ ($P < 0{\cdot}001$) and the decline in score was statistically significant ($F = 33{\cdot}48$, d.f. $= 4{,}119$, $P < 0{\cdot}001$).

Technique

Figure 2 shows the mean scores obtained on technique and diagnosis at the same four points in time following training. The attainable scores were 5 and 4 respectively. The

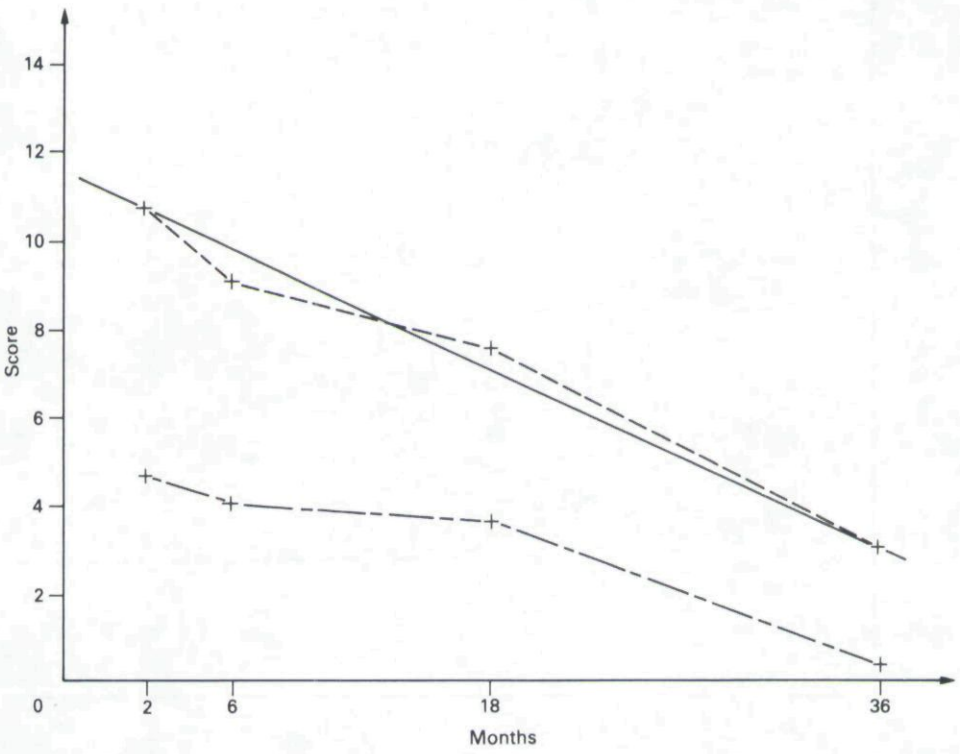

Fig. 1. Mean scores on whole of CPR test and CPR performance. – – –, total score (out of 17); – — – —, performance (out of 8); ——, regression line for total score.

correlation between technique and time since training was $-0{\cdot}58$ ($P<0{\cdot}001$) and the decline in score over time was statistically significant ($F=6{\cdot}54$, d.f. $=4,119$, $P<0{\cdot}001$).

Diagnosis

The correlation between score for diagnosis and time since training was $-0{\cdot}36$ ($P<0{\cdot}001$). For this measure decay seems to reach its maximum after about 18 months—but at a low level—just over 1 out of 4. Despite this, the decline in score over time was statistically significant ($F=5{\cdot}58$, d.f. $=4,119$, $P<0{\cdot}001$).

Possible retraining intervals

Figure 3 shows the estimated proportion of subjects scoring at least 75 per cent on each of the four scaled measures at various times following training. These times represent possible retraining intervals. The figure clearly shows that decay in CPR skills is rapid and that studies of decay should concentrate on the first year following training.

Other variables

When the effect of time since training was partialled out, none of the other variables measured were significantly correlated with scores on any of the dependent variables, suggesting that they did not influence CPR skill decay or performance. However, such variables were not adequately controlled in the present study and further investigations should be undertaken to see how such factors as sex, age, height, weight and practice affect CPR performance.

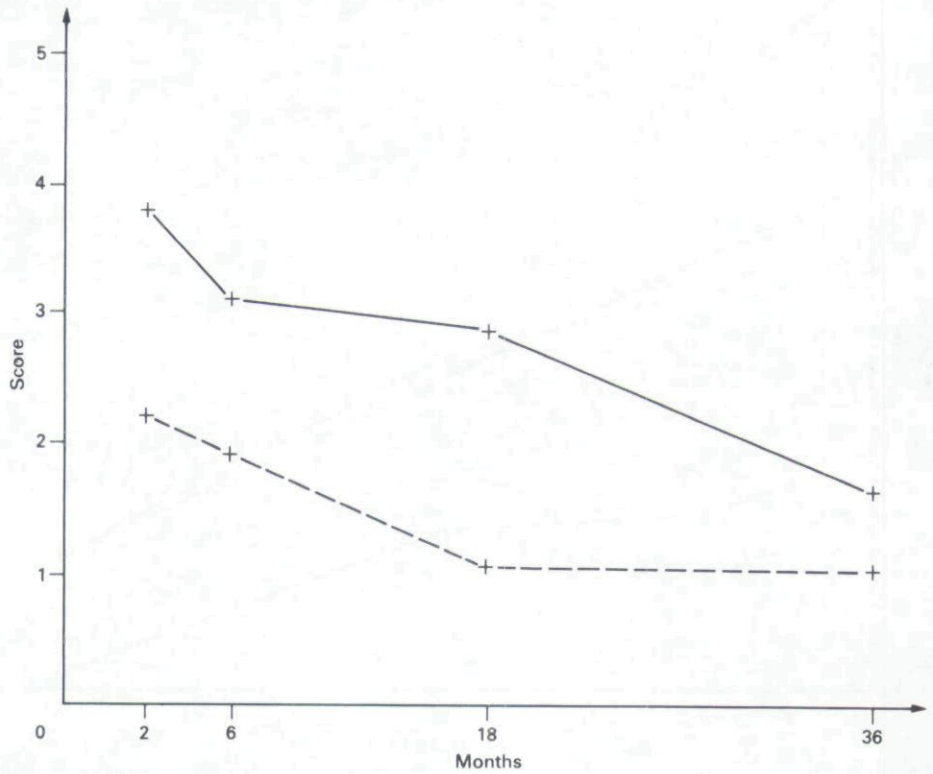

Fig. 2. Mean scores for technique and diagnosis on CPR test. ——, technique (out of 5); – – –, diagnosis (out of 4).

Only nine (7·3 per cent) of the subjects tested said that they would not attempt CPR if faced with a casualty requiring such aid. Of these people, four said they lacked confidence, seven said they would not attempt CPR because of lack of practice and one blamed inadequate training. It is not surprising that so many trainees expressed a willingness to attempt CPR rather than leave a casualty untreated. However, the finding gives no indication either of their perceived confidence in or the competence of their CPR skills.

DISCUSSION

This study clearly shows evidence of decay in CPR skill over time. This loss of skills is rapid and linear with substantial decay occurring in the year following training.

Very few subjects appeared capable of administering effective CPR after three years—the time at which retraining is likely to take place. It is clear that the refresher CPR training should take place much sooner, probably within a year of training.

The results suggest that people of all working ages, of both sexes, and of all weights and heights are equally able to carry out CPR. Unsupervised practice of CPR skills and further passive learning about the technique do not significantly improve CPR skills.

Drawbacks of the study

(1) The initial training given to subjects was not standardized. They had been trained by different organizations with the quality of instruction, time allocated to CPR training and the actual technique taught likely to vary considerably. Forty-eight people (38·7 per

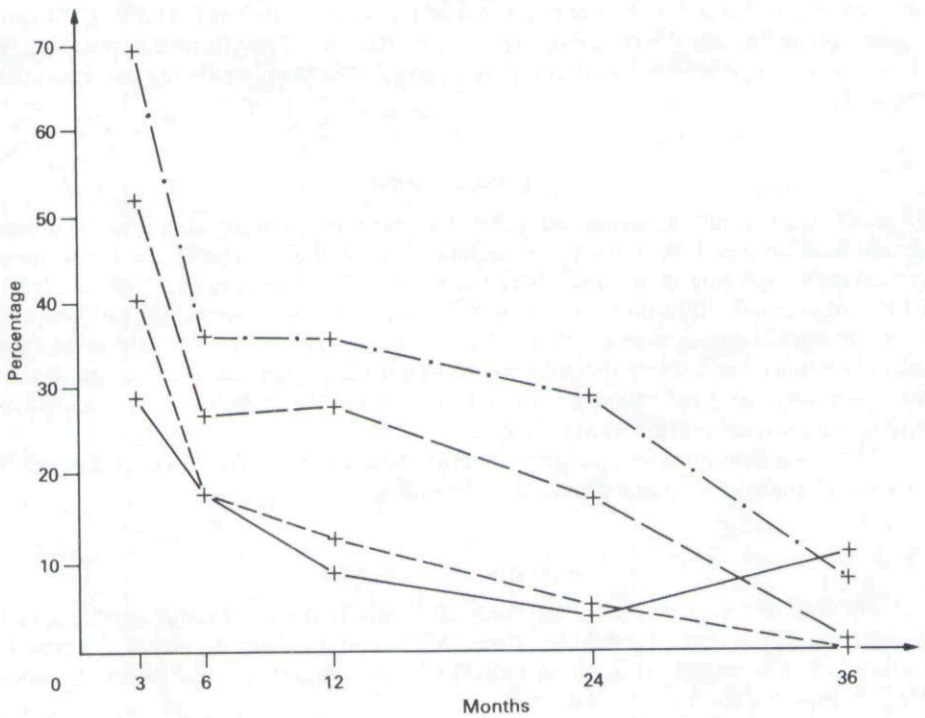

Fig. 3. Percentage of subjects scoring 75 per cent or more on each CPR measure. —·—·—, technique ——, performance; – – – –, total score; ——, diagnosis.

cent) had not received training on a recording manikin, an essential tool for effective CPR training. Finally, the general principles of CPR training may have changed over the three-year period.

(2) There are methodological problems associated with the cross-sectional design of the study. Without being able to assess CPR competence immediately following training it is impossible to prove accurately how much decay in skill has taken place. CPR competence is not a requisite for certification in first aid (though ability to carry out some form of resuscitation must be demonstrated). It is possible that some of the people included in the study had *never* achieved competence in CPR.

(3) Inexperienced researchers were used to collect data. The testing of subjects in this study was undertaken by occupational health nurses interested in the quality of CPR training but not trained in research techniques. They were also known by the people they were testing—reducing levels of anxiety which would normally be engendered by being tested (or indeed by being faced with a real casualty). These factors together with the fact that testing took place in a variety of locations meant that it was unstandardized, introducing experimental error.

These drawbacks, while important, do not negate the highly significant findings from the study. Rather, they imply that a further, more carefully controlled, study should be undertaken to confirm or refute the findings. Such a study is now underway, but results are not yet available. The new study has a longitudinal design with subjects tested immediately following their training and again 3–12 months later. Training and testing have been carefully standardized. Subjects will be assigned randomly to retesting time periods. All subjects will again be employed occupational first aiders and closer attention will be given to individual differences in age, sex, height, weight, etc., to determine whether such

characteristics have any influence upon individual ability to undertake CPR. CPR can be a tiring procedure and there may be physical limitations to its effective application. For this reason measures of physical and psycho-social well-being are being incorporated in the study.

CONCLUSIONS

CPR is a crucial life saving technique. There can be no doubt that it is a skill which should be widespread throughout the community as well as in areas of high risk such as certain manufacturing industries. There has been a lack of research into the teaching of CPR and especially into how well skills are retained following training. This study has gone some way towards showing that CPR skills decay rapidly and that retraining should take place much earlier than the presently recommended three years. There appears to be no reason why any great confidence should be placed in the present quality of CPR cover provided by trained first aiders in industry.

There is a clear need for research into both the decay in CPR skills over time and the nature and quality of training provided in the skill.

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