American Red Cross

American Red Cross
Advisory Council on
First Aid, Aquatics,
Safety and Preparedness

ACFASP Scientific Review

CPR Skill Retention

Questions to be addressed:

Primary Question:

Following training (or retraining) in CPR, how long is the ability to perform effective CPR retained?
Supplemental Questions:

1. Is there a difference in retention between lay and professional rescuers?
2. Is there a difference in retention between adult, child, and infant CPR?
3. How long should the Red Cross retraining be?
4. Are there novel strategies that can enhance retention of CPR?

Introduction/Overview:

Increasing evidence reaffirms the lifesaving value of CPR in improving outcomes in sudden cardiac arrest. Recent studies among hospital and prehospital healthcare professionals have reported poor quality of CPR during actual resuscitations. Currently, the American Red Cross requires annual refresher training on an annual basis. The American Heart Association and other organizations require refresher training on a biannual basis. Several studies have concluded that CPR skills rapidly deteriorate following training. The impact on retraining intervals and the quality of CPR is unclear. Information from a scientific review may influence policy decisions on refresher intervals and potentially identify novel strategies to enhance critical skill retention.

Review Process and Literature Search Performed

1. Databases Searched:
    a. MEDLINE (First Search)
    b. Cochrane
    c. Secondary search of references from a and b above.
2. Search Criteria (MeSH)
    a. “Cardiopulmonary resuscitation”
    b. “Retention”
3. Number of Articles for Initial Review
    a. MEDLINE: 96
    b. Cochrane: 24

Total Articles in Final Review: 47

Adult Only: 46

Adult CPR: 45

Scientific Foundation:

This Scientific Review identified 16 papers that focused on healthcare providers, including physicians, nurses, medical students, nursing students, pharmacy students, and other healthcare students. Four of these papers were excluded as they did not include an objective means of assessing skill performance. One of the excluded papers involved a follow-up questionnaire completed by nurses after an actual attempted resuscitation but did not include a means to accurately measure skill performance. The 12 remaining papers all utilized a type of commercial manikin capable of capturing quantitative data regarding CPR performance. There were no studies identified that addressed actual patient outcome and CPR skill retention or retraining intervals.

Of the 12 healthcare focused papers, 3 reported outcomes that would be consistent with satisfactory CPR skill retention. These papers included 190 subjects and the retraining interval varied from 3 to 9 months. There were 8 papers that reported unsatisfactory skill retention in a total of 341 subjects. The retraining interval varied from 6 weeks to 24 months. There was one paper in which the level of satisfactory performance was unclear.

There were a total of 30 papers reviewed that focused on non-healthcare providers, including flight attendants, police officers, and school students. Two papers were excluded as they failed to have an objective means to assess CPR skill performance. The 28 remaining papers included a total of 3923 subjects.

Satisfactory skill retention was reported in 12 studies that included 2,012 subjects. The retraining interval for these studies varied from 3 to 18 months. There were 13 studies which reported unsatisfactory retention of CPR skills among a total of 1,594 subjects. The retraining intervals varied from 2 to 48 months. In 3 studies the level of satisfactory performance was unclear.

In summary, the data indicate substantial CPR skill degradation occurs within the first year after CPR training for both health professionals and the lay public. The majority of skill deterioration seems to occur within the first year. There is no published evidence indicating adequate retention of CPR skills at 2 years. Two studies report adequate retention of skills at 17 and 18 months after training. Several studies report improved retention when a brief refresher is conducted every 6 to 12 months.

There were numerous limitations associated with this Scientific Review. First and most notable was the lack of any study with actual patient outcomes. All studies used a CPR manikin as a surrogate for human patients. The ability to translate performance on a patient simulator to an actual patient has yet to be established. Another important limitation was the lack of a common standard to evaluate satisfactory or unsatisfactory skill performance. Satisfactory performance in one study might be considered unsatisfactory in another. In many studies, the quality of performance was mixed. For example, the ability to provide ventilations is frequently

unsatisfactory while the quality of chest compressions might be considered satisfactory. For the purpose of this Scientific Review, when such conflicts occurred, satisfactory performance was based on the quality of chest compressions.

Response to Initial Questions:

Primary Question: Following training (or retraining) in CPR, how long is the ability to perform effective CPR retained?

Answer: The ability to retain CPR skills is likely multi-factorial. The majority of studies indicate substantial skill degradation within the first year of training. Several studies suggest improved retention associated with brief (<30 minute) refresher training.

Supplemental Questions:

1. Is there a difference in retention between lay and professional rescuers?
   Answer: Both groups appear to have challenges with long term retention of skills. The more recent simplification of CPR skills for lay rescuers may improve retention. However, studies supporting this are lacking.

2. Is there a difference in retention between adult, child, and infant CPR?
   Answer: There was only one identified study addressing infant CPR skill retention and no studies on child retention. Therefore, this question remains unanswered.

3. How long should the Red Cross retraining be?
   Answer: Most studies support retraining at least annually.

4. Are there novel strategies that can enhance retention of CPR?
   Answer: Several studies support enhanced long-term retention with more frequent (e.g., semi-annual) brief (<30 minute) refresher training. Novel strategies including the use of modern electronic media (e.g., internet-based media) have not been reported.

Summary:

Recommendations and Strength (using table below):

Standards: None

Guidelines: CPR skills show declining retention after 6-12 months, unless there is refresher training (III). For best skill retention, there should be refresher training every 6-12 months (II).

Options: None

The strength of all recommendations and conclusions is related to the scientific evidence upon which they are based. All recommendations therefore derive from critical review of the available medical literature including formal clinical trials and studies and the strength of their design, standard reference material, textbooks, and expert opinion. All recommendations are weighted based upon the source and strength of the scientific evidence and are classified into one of three groups - Standards, Guidelines, or Options.

Treatment Standards represent the strongest recommendations and have a high degree of clinical certainty. These recommendations result from strong evidence obtained from well designed, prospective, randomized controlled studies.

Treatment Guidelines provide a moderate degree of clinical certainty and are based on less robust evidence such as non-randomized cohort studies, case-control studies, or retrospective observational studies.

Treatment Options result from all other evidence, publications, expert opinion, etc. and are the least compelling in terms of scientific evidence.

Class	Description	Implication	Level of Evidence
I	Convincingly justifiable on scientific evidence alone.	Usually supports Standard	One or more Level 1 studies are present (with rare exceptions). Study results consistently positive and compelling
II	Reasonably justifiable by scientific evidence and strongly supported by expert opinion.	Usually supports Guideline but if volume of evidence is great enough and support from expert opinions is clear may support standard	Most evidence is supportive of guideline. Level 1 studies are absent, or inconsistent, or lack power. Generally higher levels of evidence. Results are consistently supportive of guideline.
III	Adequate scientific evidence is lacking but widely supported by available data and expert opinion. Based on	Usually supports Option.	Generally lower or intermediate levels of evidence. Generally, but not consistently results are supportive of opinion.
IV	No convincing scientific evidence available but supported by rational conjecture, expert opinion and/or non peer-reviewed publications	Usually does not support standard, guideline, or option. Statement may still me made which presents what data and opinion exists. In some cases and in conjunction with rational conjecture may support option.	Minimal evidence is available. Studies may be in progress. Results inconsistent, or contradictory.

Overall Recommendation:

ARC should investigate strategies to enhance retention of CPR skills, including skills in performing infant and child CPR and within both the lay rescuer and professional rescuer populations.

Summary of Key Articles/Literature Found and Level of Evidence/Bibliography:

Author(s)	Full Citation	Summary of Article (provide a brief summary of what the article adds to this review)	LOE
Isbye DL ; Høiby P ; Rasmussen MB ; Sommer J ; Lippert FK ; Ringsted C ; Rasmussen LS	*Resuscitation* (*Resuscitation*) 2008 Oct; 79(1): 73-81	Compared 2 approaches to CPR Training in 43 2nd year med students. No difference between Voice Advisory Manikin and traditional instructor facilitated training after 3 months, except better BVM with traditional training.	2a
Mahony PH ; Griffiths RF ; Larsen P ; Powell D	*Resuscitation* (*Resuscitation*) 2008 Mar; 76(3): 413-8	Evaluated CPR and AED skills of 35 flight attendance 1 year after refresher training. AED skills were retained but poor CPR retention.	3b
Andresen D ; Arntz HR ; Gräfling W ; Hoffmann S ; Hofmann D ; Kraemer R ; Krause-Dietering B ; Osche S ; Wegscheider K	*Resuscitation* (*Resuscitation*) 2008 Mar; 76(3): 419-24	Compared CPR and AED retention in 849 lay people randomly assigned to 2-hour, 4-hour and 7-hour training at 6 and/or 12 months after training. Skill retention decreased significantly in the three groups and was lowest after 12 months if no 6-month retests were done. In trainees who did undergo retesting at 6 months, skills did not deteriorate at 12 months. There were no significant differences between the three groups (overall correct responses: 2 h: 72%, 4 h: 73%, 7 h: 74%) (ns). A 2-h class is sufficient to acquire and retain CPR and AED skills for an extended time period provided that a brief re-evaluation is performed after 6 months.	2a
Einspruch EL, Lynch	*Resuscitation*	Retention of CPR skills was compared 2 months	2a

B, Aufderheide TP, Nichol G, Becker L	(*Resuscitation*) 2007 Sep; 74(3):476-86	post-training for 285 lay adults between 40 and 70 years old who had taken either a traditional Heartsaver CPR course or a 22-min video self-directed training course. Although performance declines occurred in the 2-month interval, self-trained subjects generally demonstrated CPR skill retention equivalent to that of Heartsaver-trained subjects, although for both groups skill decline on some measures reached the level of untrained controls.	
Spooner BB, Fallaha JF, Kocierz L, Smith CM, Smith SC, Perkins GD	*Resuscitation* (*Resuscitation*) 2007 Jun; 73(3):417-24	Marginal retention in 98 healthcare students after 6 weeks with better retention in group that was randomized to training using manikin that provides continuous performance feedback compared to group that used identical manikin without feedback. CPR performance declined substantially in both groups.	2a
Riegel B ; Nafziger SD ; McBurnie MA ; Powell J ; Ledingham R ; Sehra R ; Mango L ; Henry MC	*Academic emergency medicine : official journal of the Society for Academic Emergency Medicine* (*Acad Emerg Med*) 2006 Mar; 13(3): 254-63	Among 6,182 PAD Trial volunteer laypersons participating in a simulated resuscitation, the proportions of volunteers judged by instructors to have adequate CPR and AED skills demonstrated small declines associated with longer intervals between initial training and subsequent testing. However, based on instructors' judgment, large majorities of volunteers still retained both CPR and AED core skills through 17 months (range 3 to 17) after initial training.	2a
Riegel B ; Birnbaum A ; Aufderheide TP ; Thode HC Jr ; Henry MC ; Van Ottingham L ; Swor R	*American heart journal* (*Am Heart J*) 2005 Nov; 150(5): 927-32	PAD Trial with 7261 lay people initially trained in CPR with or without AED and retested 3 to 18 months later. Certain student characteristics (eg, older age, no college education, minority status, native language	3a

		other than English) can be used to identify volunteers who may need particular attention (eg, more time during training, specific skills targeted, or more frequent refresher training). Repetition promotes skill retention. Volunteers who had prior training in CPR or other first aid, supplementary training, or previous experience assisting in an emergency event all performed relatively better during testing	
Wik L ; Myklebust H ; Auestad BH ; Steen PA	*Resuscitation 66 (2005) 27–30*	28 lay people had initial training using only a computer-based training manikin with 20 or 50 minutes of training and then retested 6 months later and again at 12 months. Did okay 12 months after initial training (6 months after 6 month retest/refresher training which used the automatic correcting verbal feedback).	3b
Woollard M ; Whitfeild R ; Smith A ; Colquhoun M ; Newcombe RG ; Vetteer N ; Chamberlain D	*Resuscitation* (*Resuscitation*) 2004 Jan; 60(1): 17-28	76 lay people evaluated immediately and 6 months after CPR/AED training. Time to 1st shock okay after 6 mos. CPR skills poor after initial training and at 6 months.	3b
Smith A ; Colquhoun M ; Woollard M ; Handley AJ ; Kern KB ; Chamberlain D	*Resuscitation* (*Resuscitation*) 2004 Apr; 61(1): 41-7	260 lay people randomized to staged training (3) or conventional training. Tested @ 6 & 12 mos. Staged Group did better. Both ok with compressions, poor ventilations at 12 months. Both groups had 6 month retest.	2a
Swor R ; Compton S ; Vining F ; Ososky	*Resuscitation* (*Resuscitation*)	Older lay people (age >55), compared cc CPR to nl CPR. No major difference between groups.	2a

Farr L ; Kokko S ; Pascual R ; Jackson RE	2003 Aug; 58(2): 177-85	Overall competence 44-52% @ 3 mos.	
Wik L ; Dorph E ; Auestad B ; Andreas Steen P	*Resuscitation* (*Resuscitation*) 2003 Feb; 56(2): 167-72	62 flight attendants were evaluated in pairs in a mock code 10±3 months after a 4-hour CPR/AED course. AED and CPR performance were generally acceptable. The study does support the need for annual training and recertification in order to maintain speed and CPR quality.	3b
Wik, Lars, Myklebust, Helge, Auestad, Bjorn H, et al.	*Resuscitation* (*Resuscitation*) 2002 Mar; 52(3): 273-9	33 lay people previously trained in CPR took a refresher course using VAM training w/o an instructor and with and w/o overtraining. Both groups showed adequate retention at 6 mos.	2a
Chamberlain, Douglas, Smith, Anna, Woollard, Malcolm, et al.	*Resuscitation* (*Resuscitation*) 2002 May; 53(2): 179-87	127 lay people received traditional CPR training with 6-9 month follow-up. Some had 1 or 2 refresher sessions and performed better. Over half of each group appeared to perform okay.	2a
Donnelly, P, Assar, D, Lester, C	*Resuscitation* (*Resuscitation*) 2000 Aug; 45(3): 195-9	121 laypeople randomized to 3 different methods of training. Only 14% judged effective at 6-9 month recheck.	2a
Handley JA, Handley AJ	*Resuscitation, Volume 36, Issue 1, January 1998, Pages 3-8*	48 laypeople had comparable, acceptable retention after 6 weeks from completing a simplified 4-step CPR training program compared to a more traditional 8-step approach.	2a
Dracup K ; Doering LV ; Moser DK ;	*Pediatric nursing*	Parents of NICU grads trained in CPR and retested 6 months later. One third able to	3b

Evangelista L	(*Pediatr Nurs*) 1998 May-Jun; 24(3): 219-25; quiz 226-7	perform satisfactorily.	
Morgan CL, Donnelly PD, Lester CA, Assar DH.	*Br Med J 1996;313:912–6.*	280 laypeople who completed a mass CPR training program had unannounced home skill assessments performed 6 months after training. Only 12% were able to demonstrate effective CPR.	3b
Broomfield R	*Journal of advanced nursing* (*J Adv Nurs*) 1996 May; 23(5): 1016-23	19 nurses evaluated 2.5 months after training. Retention of skills and knowledge quickly deteriorates if not used or updated regularly	3b
Berden HJ, Bierens JJ, Willems FF, Hendrick JM, Pijls NH, Knape	*Ann Emerg Med May 1994;23:1003-1008*	151 laypeople previously trained in CPR underwent testing 12 months after completing a refresher course and approximately half demonstrated effective CPR.	3b
Fabius DB ; Grissom EL ; Fuentes A	*Journal of nursing staff development : JNSD* (*J Nurs Staff Dev*) 1994 Sep-Oct; 10(5): 262-8	70 nurses trained in traditional vs. computer-based instruction. Better results with traditional CPR at 6 months.	2a
Lewis FH ; Kee CC ; Minick MP	*Journal of continuing education in*	73 nurses tested in CPR. Cognitive knowledge was adequately retained but skills were not.	3b

	nursing (*J Contin Educ Nurs*) 1993 Jul-Aug; 24(4): 174-9		
Moser DK ; Dracup K ; Guzy PM ; Taylor SE ; Breu C	*The American journal of emergency medicine* (*Am J Emerg Med*) 1990 Nov; 8(6): 498-503	Retention of CPR Skills was poor 12 months after training for 31 lay people.	3b
Coleman S ; Dracup K ; Moser DK	*Journal of nursing staff development : JNSD* (*J Nurs Staff Dev*) 1991 Mar-Apr; 7(2): 82-7	49 nurses had 3-month retention assessed comparing conventional and modular instruction. Both groups were equal at 3 months	2a
Van Kerschaver, E, Delooz, H H, Moens, G F	*Resuscitation* (*Resuscitation*) 1989 Jun; 17(3): 211-22	School students trained in CPR with 10 month f/u. Performance better after 2 refreshers vs. 1.	2a
Curry L ; Gass D	*CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne*	85 healthcare professionals had reduction in skills to pre-training level after 6 months in both docs and nurses.	3b

	(*CMAJ*) 1987 Sep 15; 137(6): 491-6		
Nelson M ; Brown CG	*Annals of emergency medicine* (*Ann Emerg Med*) 1984 Feb; 13(2): 118-21	Poor retention at 2 years unless a 1-year refresher completed. At 48 mos only 3 of 104 could pass but high standards of testing. Mixed group of lay people and health professionals.	2a
Martin WJ ; Loomis JH Jr ; Lloyd CW	*American journal of public health* (*Am J Public Health*) 1983 Nov; 73(11): 1310-2	Poor retention in rate (>60/min) and depth at 3 months for pharmacy students. A shorter recertification period should help curb CPR skill deterioration, but may further strain limited manpower resources.	3b
Wilson E ; Brooks B ; Tweed WA	*Annals of emergency medicine* (*Ann Emerg Med*) 1983 Aug; 12(8): 482-4	40 laypeople had significant reduction in skills at 6 months.	3b
Gombeski WR Jr ; Effron DM ; Ramirez AG ; Moore TJ	*American journal of public health* (*Am J Public Health*) 1982 Aug; 72(8): 849-52	114 laypeople had 8hr vs 4 hr training. No one could meet certification standard, < 25% able to give >60 compressions per minute.	2a

Level of Evidence	Definitions **(See manuscript for full details)**
Level 1a	Population based studies, randomized prospective studies or meta-analyses of multiple studies with substantial effects
Level 1b	Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	Prospective, controlled, non-randomized, cohort or case-control studies
Level 2b	Historic, non-randomized, cohort or case-control studies
Level 2c	Case series: convenience sample epidemiological studies
Level 3a	Large observational studies
Level 3b	Smaller observational studies
Level 4	Animal studies or mechanical model studies
Level 5	Peer-reviewed, state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements
Level 6	Non-peer reviewed published opinions, such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	Rational conjecture (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	Extrapolations from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.