WILDERNESS INSTRUCTOR

Wilderness First Responder: Are Skills Soon Forgotten?

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Wilderness first responders are trained to provide competent medical care in wilderness settings or until evacuation for more advanced treatment can be obtained. In light of the isolated environments in which they are called upon to respond to illnesses and injuries, their ability to effectively apply their training is crucial. Despite the responsibility assigned to them, there is an absence of research assessing the skill and knowledge retention of wilderness first responders, creating a gap in understanding whether a deficit in their ability to perform exists between certifications. Without such research, it is important to review knowledge and skill retention in related responder groups. The literature over the past 4 decades documents the loss over time of skills and knowledge across an array of trained responders, both professional and laypeople. Although the findings reviewed suggest that WFRs will exhibit a similar pattern of increasing skill loss beginning shortly after certification and a slower, but concurrent, decrease in knowledge, research is needed to document or refute this assumption.

Keywords: knowledge and skill retention, self-efficacy, certification

Introduction

Knowledge and skill retention among first responders and medical professionals is a topic of research interest in numerous studies conducted across 4 decades. These studies include the evaluation of those trained in first aid/cardiopulmonary resuscitation (CPR), wilderness first aid (WFA), and automated external defibrillators (AEDs), as well as emergency medical technicians (EMTs), paramedics, nurses, medical students, residents, and physicians. Missing from this body of research are studies examining the knowledge and skill retention of wilderness first responders (WFRs). As described in a group consensus position paper formulated by experts in the field, the WFR “care(s) for patients in remote locations, in challenging weather, with questionable communication and support, limited equipment and may need to make independent decisions on patient care and transport.”¹

WFR certification is often required by for-profit, nonprofit, and public enterprises when hiring instructors, guides, and staff for outdoor trips and expeditions because of its training in responding to emergencies in

remote settings. Although certifications are valid for a period of 2 to 3 years, it is unclear whether WFRs retain the skills and knowledge to proficiently assess and treat medical emergencies. In light of the isolated settings in which they are called upon to respond to illnesses and injuries, their ability to effectively apply their training is crucial. A lack of research has created a void of critical information regarding WFR skill and knowledge retention. The purpose of this article is to review the research findings on lay and professional medical responders and to focus attention on the need for similar WFR research.

Method

The peer-reviewed and published scientific research used in this article was located using the following search engines: Google, Google Scholar, PubMed, and Medline. Keywords included first aid, wilderness first aid, CPR, AED, basic life support (BLS), advanced cardiac life support (ACLS), resuscitation, medical skill retention, knowledge retention, wilderness first responder (WFR), emergency medical technician (EMT), paramedic, recertification of emergency skills, nursing first aid, intubation, self-efficacy, and skill confidence. Inclusion criteria involved peer reviewed articles on first responder skills and knowledge retention among those trained and certified by recognized training programs, in medical device use, and in life-saving techniques.

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A review of research examining whether first responders' confidence in their life-saving skills matches the performance of those skills is included. This information provides a basis for interpreting findings on first responders.

Results

WILDERNESS FIRST RESPONDER CERTIFICATION

WFR is a widely recognized certification within the outdoor recreation and education field. Often cited as the industry standard, WFR programs are designed to train individuals working in remote settings to respond to medical emergencies. In addition to training on assessment and treatment skills, emphasis is placed on prevention and critical decision making. Certification requires successful completion of a 72- to 80-h course. A standard set of topics has been published for WFR training, although adherence to it by various training programs has not been evaluated.¹ Course time is spent both inside and outside the classroom, learning and completing practical skills, case studies, and scenarios. Participants in WFR programs are evaluated on their written knowledge and applied skills, although final certification criteria are not standardized across training programs.

FORGETTING/LOSS OF SKILLS FOLLOWING TRAINING IN MEDICAL CARE PROVIDERS

In view of the current deficit in research on skills and knowledge retention among WFRs, it is important to evaluate the results of studies examining related responder groups. The following review of research on lay responders and healthcare professionals provides an overview of findings that have relevance to WFR skill and knowledge retention.

Lay individuals trained in CPR/AED

Millions of adults in the United States and other countries have been trained in CPR in an attempt to provide lay individuals with the skills to save lives. Because they are often the first to encounter ill or injured victims in emergency situations, the ability to apply lifesaving CPR techniques is of critical importance. Spanning several decades, research examining the retention of CPR training for lay individuals has produced a consistent body of findings. Skills begin to deteriorate quickly, often within weeks to months of certification, and continue to decline over time.²⁻¹² In studies in which it was assessed, knowledge retention declined more slowly than skills and, in some cases, remained

high.^{4,7,12} When lay individuals received training in both CPR and AED use, the pattern of skill loss in both areas was similar to that found for CPR training only.^{11,12} Practice and more frequent reassessment were recommended for lay individuals trained in CPR.²⁻⁴

Even among groups that are highly motivated or operate in environments isolated from medical care, CPR and AED skills deteriorate. Parents of infants at risk for cardiac arrest receive CPR training in the hospital setting before taking their infants home. In addition to instruction, practice, and demonstration of skills, instructors worked with parents to reach 100% proficiency in CPR performance. When retested in their homes 6 months later, only one third of parents successfully demonstrated CPR skills.³ Relatedly, airline flight crews, often hours away from accessing emergency medical care, receive training in CPR and AED use. Crews were tested on skills and knowledge 12 months later. Using a resuscitation scenario, skill performance was poor on CPR and AED use, but theoretical knowledge remained high. Review of training and reassessment guidelines was recommended.¹²

Healthcare professionals trained in CPR/AED, BLS, and ACLS

Paramedics/EMTs. Paramedics and EMTs are often called upon to respond to emergency situations involving serious illness and injury. As such, they are thought to possess the strongest CPR and resuscitation skills among healthcare professionals.¹³ However, research reveals a pattern of decreasing CPR skill after certification.¹⁴⁻¹⁹ Errors documented in a number of studies assessing paramedic and EMT skill retention revealed inadequate compressions, misplacement of hands, and/or incorrectly performed ventilations in CPR performance.^{13,14,16-19} Knowledge decline was slower than skill decline and, in some cases, knowledge remained adequate.^{14,15}

In addition to CPR skills, EMTs and paramedics are trained to provide a variety of less frequently performed and complex lifesaving skills. These advanced skills are the subject of a number of research investigations. Several studies examining pediatric skill retention and errors among EMTs and paramedics revealed skill and/or knowledge losses in performing infant CPR, pediatric resuscitation, advanced pediatric life support, and endotracheal intubation.²⁰⁻²⁴ Confidence in their abilities to perform skills led paramedics to overrate their actual performance.²⁰⁻²³ Errors evaluated in 45 teams of EMS providers operating in simulated prehospital pediatric emergencies occurred in oxygen delivery, equipment use, glucose assessment, administration of drugs, CPR,

and more.²¹ Only 42% of paramedics could pass pediatric endotracheal intubation skill testing when reassessed.²³ Errors in the insertion of endotracheal tubes by paramedics working in an urban emergency medical service were found in 25% of patients arriving at a Level 1 trauma center.²⁵ The evidence suggests that these complex and infrequently used skills require more practice and refresher courses.^{20–23,25}

Nurses. A number of studies have examined nurses' CPR skills and knowledge retention following certification. Early and continued declines in skills are well documented.^{6,26–34} Beginning as soon as 10 weeks after training, nurses showed a significant decline in CPR skills during reassessments.^{26,29} In one study, there was no difference in CPR skill deterioration between nurses and physicians assessed at 6 months after training. Both groups declined to nearly pretraining levels and reported continuing confidence in their skills despite evidence of marked skill deterioration.³⁴ Across nursing studies reviewed, knowledge retention produced mixed findings. Some studies reported that knowledge deteriorated in a pattern that paralleled skill loss, whereas others reported that it was adequately retained.^{26–29,31–33}

More complex and demanding, ACLS skills and knowledge decline among nurses, particularly if they are not practiced or used.^{35–38} In a study examining BLS and ACLS performance skills and knowledge, nurses retained theoretical knowledge, but their performance skills deteriorated rapidly. ACLS skills decreased faster than BLS skills, with only 14% passing an ACLS reassessment at 12 months.³⁵ Relatedly, nurses and other health professionals trained in newborn life support courses showed decreased skills at 3–5 months and 12–14 months after training. Those involved in more resuscitations or who received additional training performed better.³⁹

Medical students, residents, and physicians. As is the case with other health providers, the public expects medical students, residents, and physicians to maintain a high level of CPR skills and knowledge. Similarly, residents and physicians trained in advanced life support techniques are assumed by most to be fully able to employ these skills in any emergency situation. The bulk of research examining the issue of skill and knowledge retention fails to support these assumptions.

Medical students and other health science students often receive CPR/BLS training during their first year or two of medical school. Studies evaluating the skill and knowledge retention of medical students reported a pattern of skill loss at reassessments over time.^{40–43} Where knowledge retention was also assessed, skill losses were accompanied by a slower rate of know-

ledge loss.^{40,42} Medical students receiving neonatal resuscitation skills training showed knowledge and skill declines at reassessment. Students' confidence in their skills were inflated compared with their skill performance.⁴⁴ First-year medicine and dentistry students taught airway management skills showed skill losses at reassessments. Those who received practice and performance feedback experienced less skill loss than those who received only feedback or no feedback.⁴⁵

Practicing physicians and residents tended to mirror the skill and knowledge retention declines found in medical students, lay individuals, and other healthcare providers. Research on infrequently used skills and knowledge revealed that residents and physicians showed declines in performance when employing these lifesaving techniques. Studies examining the skill and knowledge retention of CPR, ACLS, neonatal resuscitation, and advanced trauma life support revealed that skills deteriorated, usually declining more rapidly than knowledge, where both were assessed.^{6,46–54} Confidence ratings exceeded performance by residents in a number of pediatric resuscitation techniques.⁴⁸ Frequent refresher courses to review critical skills and knowledge were recommended.

WILDERNESS FIRST AID

In a seminal study of WFA responders, researchers examined the retention of skills, knowledge, and self-efficacy/confidence over time. Participants were retested at 4, 8, or 12 months after certification. Confidence in skills and knowledge was assessed using written measures, and applied skills were assessed using a medical scenario. Several important results were reported in this study. Both WFA knowledge and skill performance declined over time. Confidence/Self-efficacy scores and knowledge scores failed to predict scenario skill performance. Participants' rating of their skills was inflated compared with their performance. In addition to discussing simplifying course content and providing memory aids, the authors questioned whether the 2- to 3-year period of certification should be reconsidered.⁵⁵

SELF-EFFICACY/CONFIDENCE

Self-efficacy refers to an individual's self-perceived ability to reach a goal or perform a task.⁵⁶ Relatedly, confidence refers to an individual's assumption of the ability to perform a skill or apply knowledge. They are considered together in this discussion because they measure essentially the same perception in the research reviewed. The study of WFA skill and knowledge retention found that participants overrated their ability to perform skills in an emergency scenario.⁵⁵ A number of studies examining skill and knowledge retention

among first responders and health professionals also reported that participants' confidence led them to overrate their ability to perform those skills.^{20,23,34,44,48} Without practice or frequent use of life-saving skills, first responders and other medical professionals may overestimate their ability to effectively apply their skills.

Conclusion

WFRs are trained to provide competent medical care in wilderness settings or until evacuation for more advanced treatment can be obtained. The responsibility for competence and skills in assessing and treating others rests solely with the responder. The recognition of WFR knowledge and skill training has led many organizations to require WFR training for instructors, guides, outdoor leaders, and educators.⁵⁷ Despite the responsibility assigned to them, there is an absence of research assessing their skills and knowledge during the 2 to 3 years between recertifications.

Based on the research reviewed, there is evidence of skill and knowledge deterioration in medical providers at all levels, from the basic CPR of lay responders to the advanced resuscitation and life support skills of highly trained medical providers. Additionally, there is evidence that responders may overestimate their ability to apply knowledge and perform skills. The WFA study cited in this article provides findings on the group most closely related to WFRs. It, too, revealed a decline in skill and knowledge among that responder group. Although the findings reviewed suggest that WFRs will exhibit a similar pattern of increasing skill loss beginning shortly after certification and a slower, but concurrent, decrease in knowledge, research is needed to document or refute this assumption.

Limitations

Without research verification, it cannot be assumed that the findings from the studies cited in this review apply to WFRs. The research cited in this article is meant to provide a representative review of published findings on the groups examined. Across the literature, a minority of studies have reported interventions that provided some improvement in skill and knowledge retention among the medical responders reviewed. Such studies employed techniques of overtraining, specialized teaching approaches, added practice/shortened retest periods, or the use of automated devices in teaching.^{45,58–65}

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References

1. Johnson DE, Schimelpfenig TD, Hubbell F, Frizzell L, Nicolazzo P, McEvoy D, et al. Minimum guidelines and scope of practice for Wilderness First Responder (WFR). Wilderness Medicine Educators Collaborative website; 2016. Available at: <http://wfr-sop.org/wfr-sop>. Accessed January 24, 2017.
2. Anderson GS, Gaetz M, Masse J. First aid skill retention of first responders within the workplace. *Scand J Trauma Resusc Emerg Med* 2011;19:11–6.
3. Dracup K, Moser DK, Doering LV, Evangelista L. Retention and use of cardiopulmonary resuscitation skills in parents of infants at risk for cardiopulmonary arrest. *Pediatr Nurs*. 1998;24(3):219–24.
4. Kalmthout PM, Speth PA, Rutten JR, Vonk JT. Evaluation of lay skills in cardiopulmonary resuscitation. *Br Heart J* 1985;53(5):562–6.
5. Einspruch E, Lynch B, Audferheide TP, Nichol G, Becker L. Retention of CPR skills learned in a traditional AHA Heartsaver course versus 30-min video self-training: a controlled randomized study. *Resuscitation*. 2007;74(3):476–86.
6. Kaye W, Mancini M. Retention of cardiopulmonary resuscitation skills by physicians, registered nurses, and the general public. *Crit Care Med* 1986;14(7):620–2.
7. Papadimitriou L, Xanthos T, Bassiakou E, Stroumpoulis K, Barouxis D, Iacovidou N. Distribution of pre-course BLS/AED manuals does not influence skill acquisition and retention in lay rescuers: a randomized study. *Resuscitation*. 2010;81(3):348–52.
8. Weaver FJ, Ramirez SB, Dorfman AE. Trainees' retention of cardiopulmonary resuscitation. *How quickly they forget*. *JAMA* 1979;241(9):901–3.
9. Donnelly P, Assar D, Lester C. A comparison of manikin CPR performance by lay persons trained in three variations of basic life support guidelines. *Resuscitation* 2000;45(3):195–9.
10. Wilson E, Brooks B, Tweed WA. CPR skills retention of lay basic rescuers. *Ann Emerg Med* 1983;12(8):482–4.
11. Woollard M, Whitfield R, Smith A, Colquhoun M, Newcombe RG, Vetteer N, et al. Skill acquisition and retention in automated external defibrillator (AED) use and CPR by lay responders: a prospective study. *Resuscitation*. 2004;60(1):17–28.
12. Mahoney PH, Griffiths RF, Larsen P, Powell D. Retention of knowledge and skills in first aid and resuscitation by airline cabin crew. *Resuscitation*. 2008;76(3):413–8.
13. Higdon TA, Heidenreich JW, Kern KB, Sanders AB, Berg RA, Hilwig RW, et al. Single rescuer cardiopulmonary resuscitation: can anyone perform to the guidelines 2000 recommendations. *Resuscitation* 2006;71(1):34–9.
14. Brown TB, Dias JA, Saini D, Shah RC, Cofield SS, Terndrup TE, et al. Relationship between knowledge of

- cardiopulmonary resuscitation guidelines and performance. *Resuscitation*. 2006;69(2):253–61.
15. Latman NS, Wooley K. Knowledge and skill retention of emergency care attendants, EMT-As, and EMT-Ps. *Ann Emerg Med* 1980;9(4):183–9.
 16. Lieberman M, Lavoie A, Mulder D, Sampalis J. Cardiopulmonary resuscitation: errors made by pre-hospital emergency medical personnel. *Resuscitation*. 1999;42(1):47–55.
 17. Stone CK, Thomas SH. Can correct closed-chest compressions be performed during prehospital transport?. *Prehosp Disaster Med* 1995;10(2):121–3.
 18. Bayley R, Weinger M, Meador S, Clovis C. Impact of ambulance crew configuration on simulated cardiac arrest. *Prehosp Emer Care* 2008;12(1):62–8.
 19. Woollard M, Poposki J, McWhinnie B, Rawlins I, Munro G, O'Meara P. Achy breaky makey wakey heart? A randomized crossover trial of musical prompts. *Emerg Med J* 2012;29(4):290–4.
 20. Lammers RL, Byrwa MJ, Fales WD, Hale RA. Simulation-based assessment of paramedic pediatric resuscitation skills. *Prehosp Emer Care* 2009;13(3):345–56.
 21. Lammers RL, Byrwa MJ, Fales WD. Root causes of errors in a simulated prehospital pediatric emergency. *Acad Emerg Med* 2012;19(1):37–47.
 22. Su E, Schmidt TA, Mann NC, Zechin AD. A randomized controlled trial to assess decay in acquired knowledge among paramedics completing a pediatric resuscitation course. *Acad Emerg Med* 2000;7(7):779–86.
 23. Youngquist ST, Henderson DP, Gausche-Hill D, Goodrich SM, Poore PD, Lewis RJ. Paramedic self-efficacy and skill retention in pediatric airway management. *Acad Emerg Med* 2008;15(12):1295–303.
 24. Garza AG, Algren DA, Gratton MC, Ma OJ. Populations at risk for intubation nonattempts and failure in the prehospital setting. *Prehosp Emerg Care* 2005;9(2):163–6.
 25. Katz SH, Falk JL. Misplaced endotracheal tubes by paramedics in an urban emergency services system. *Ann Emerg Med* 2001;37(1):32–7.
 26. Bloomfield R. A quasi-experimental research to investigate the retention of basic cardiopulmonary resuscitation skills and knowledge by qualified nurses following a course in professional development. *J Adv Nurs* 1996;23(5):1016–23.
 27. Lewis FH, Kee CC, Minick MP. Revisiting CPR knowledge and skills among registered nurses. *J Cont Educ Nurs* 1993;24(4):174–9.
 28. Nori JM, Saghafina M, Motamedi M, Hosseini S. CPR training for nurses: how often is it necessary? *Iran Red Crescent Med J*. 2012;14(2):104–7.
 29. Madden C. Undergraduate nursing students' acquisition and retention of CPR knowledge and skills. *Nurse Educ Today* 2006;26(3):218–27.
 30. Oermann MH, Kardong-Edgren SE, Odom-Maryon T. Effects of monthly practice on nursing students' CPR psychomotor skill performance. *Resuscitation*. 2011;82(4):447–53.
 31. Everett-Thomas R, Turnbull-Horton V, Valdes B, Baldes GR, Rosen LF, Birnbach DJ. The influence of high fidelity simulation on first responders retention of CPR knowledge. *Appl Nurs Res* 2016;30:94–7.
 32. Sankar J, Vijayakanthi N, Sankay MJ, Dubey N. Knowledge and skill retention of in-service versus preservice nursing professionals following an informal training program in pediatric cardiopulmonary resuscitation: a repeated-measures quasiexperimental study. *Biomed Res Int* 2013;2013:403–15.
 33. West H. Basic infant life support: retention of knowledge and skill. *Paediatr Nurs*. 2000;12(1):34–7.
 34. Curry L, Gass D. Effects of training in cardiopulmonary resuscitation on competence and patient outcome. *Can Med Assoc J* 1987;137(6):491–6.
 35. Smith KK, Gilcreast D, Pierce K. Evaluation of staff's retention of ACLS and BLS skills. *Resuscitation*. 2008;78(1):59–55.
 36. Hammond F, Saba M, Simes T, Cross R. Advanced life support: retention of registered nurses' knowledge 18 months after initial training. *Aust Crit Care* 2000;13(3):99–104.
 37. O'Steen DS. The retention of advanced cardiac life support knowledge among registered nurses. *J Nurs Staff Dev* 1996;12(2):66–72.
 38. Young R, King L. An evaluation of knowledge and skill retention following an in-house advanced life support course. *Nurs Crit Care* 2000;5(1):7–14.
 39. Mosely CM, Shaw BN. A longitudinal cohort study to investigate the retention of knowledge and skills following attendance on the newborn life support course. *Arch Dis Child* 2013;98(8):582–6.
 40. Fossel M, Kiskaddon RT, Sternbach GL. Retention of cardiopulmonary resuscitation skills by medical students. *J Med Educ* 1983;58(7):568–75.
 41. Martin WJ, Loomis JD, Lloyd CW. CPR skills: achievement and retention under stringent and relaxed criteria. *Am J Public Health* 1983;73(11):1310–2.
 42. Pande S, Pande S, Parate V, Pande S, Sukhsohale N. Evaluation of retention of knowledge and skills imparted to first-year medical students through basic life support training. *Adv Physio Ed* 2014;38(1):42–5.
 43. de Ruijter PA, Biersteker HA, Biert J, van Goor H, Tan EC. Retention of first and basic life support skills in undergraduate medical students. *Med Educ Online* 2014;19:24841.
 44. Curran VR, Aziz K, O'Young S, Bessell C. Evaluation of the effect of a computerized training simulator (ANAKIN) on the retention of neonatal resuscitation skills. *Teach Learn Med* 2004;16(2):157–64.
 45. Kovacs G, Bullock G, Stolarz S, Cain E, Petrie D. A randomized controlled trial on the effect of educational interventions in promoting airway management skill maintenance. *Ann Emerg Med* 2000;36(4):301–9.
 46. McNaughton G, Hall DJ, Stark C. Resuscitation skills and doctors working in psychiatry. *Psychiatr Bul* 1994;18:403–4.
 47. Grant EC, Marczynski CA, Menon K. Using pediatric advanced life support in pediatric residency training: does

- the curriculum need resuscitation? *Pediatr Crit Car Med* 2007;8(5):433–9.
48. Kaczorowski J, Levitt C, Hammond M, Outerbridge E, Grad R, Rothman A, et al. Retention of neonatal resuscitation skills and knowledge: a randomized controlled trial. *Fam Med* 1998;30(10):705–11.
 49. Nadel FM, Lavelle JM, Fein JA, Giardino AP, Decker JM, Durbin DR. Assessing pediatric senior residents' training in resuscitation: fund of knowledge, technical skills, and perception of confidence. *Pediatr Emerg Med* 2000;16(2):73–6.
 50. Patel J, Posencheg M, Ades A. Proficiency and retention of neonatal resuscitation skills by pediatric residents. *Pediatrics* 2012;130(3):515–21.
 51. Schwid HA, O'Donnell D. Anesthesiologists' management of simulated critical incidents. *Anesthesiology* 1992;76(4):495–501.
 52. White JM, Shugerman R, Brownlee C, Quinn L. Performance of advanced resuscitation skills by pediatric house-staff. *Arch Pediatr Adolesc Med* 1998;152(12):1232–5.
 53. Ali J, Cohen R, Adam R, Gana TJ, Pierre I, Ali E, et al. Attrition of cognitive and trauma management skills after the advanced trauma life support (ATLS) course. *J Trauma* 1996;40(6):860–6.
 54. Blumenfeld A, Abraham RB, Stein M, Shapira SC, Reiner A, Reiser B, et al. Cognitive knowledge decline after advanced trauma life support courses. *J Trauma* 1998;44(3):513–6.
 55. Schumann SA, Schimelpfenig T, Sibthorp J, Collins RH. An examination of wilderness first aid knowledge, self-efficacy, and skill retention. *Wilderness Environ Med* 2012;23(3):281–7.
 56. Bandura A. Self-efficacy mechanism in human agency. *Am Psychol* 1982;37(2):122–47.
 57. Ewert AW, Hollenhorst SJ. Adventure recreation and its implications for wilderness. *Int J Wilderness* 1997;3(2):21–6.
 58. Wik L, Myklebust H, Auestad BH, Steen PA. Retention of basic life support skills 6 months after training with an automated voice advisory system without instructor involvement. *Resuscitation* 2002;52(3):273–9.
 59. Wayne DB, Siddall VJ, Butter J, Fudala MJ, Wade LD, Feinglass J, et al. A longitudinal study of internal medicine residents' retention of advanced cardiac life support skills. *Acad Med* 2006;81(10 Suppl):S9–12.
 60. Moazed F, Cohen ER, Furiase N, Singer B, Corbridge TC, McGaghie WC, et al. Retention of critical care skills after simulation-based mastery learning. *J Grad Med Educ* 2013;5(3):458–63.
 61. Yakel ME. Retention of cardiopulmonary resuscitation skills among nursing personnel: what makes the difference?. *Heart Lung* 1989;18(5):520–5.
 62. Ali J, Howard M, Williams J. Is attrition of advanced trauma life support acquired skills affected by trauma patient volume? *Am J Surg* 2002;183(2):142–5.
 63. Wik L, Myklebust H, Auestad BH, Steen PA. Twelve-month retention of CPR skills with automatic correcting verbal feedback. *Resuscitation* 2005;66(1):27–30.
 64. Cummins RO, Schubach JA, Litwin PE, Hearne TR. Training lay persons to use automatic external defibrillators: Success of initial training and one-year retention of skills. *Am J Emerg Med* 1989;7(2):143–9.
 65. Riegel B, Nafziger SD, McBurnie MA, Powell J, Ledingham R, Sehra R, et al. How well are cardiopulmonary resuscitation and automated external defibrillator skills retained over time? Results from the Public Access Defibrillation (PAD) Trial. *Acad Emerg Med* 2006;13(3):254–63.