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CPR and First Aid Skill Retention

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CPR and First Aid Skill Retention

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Executive Summary

When first aid and CPR certificates are issued, an expiry date for the certificate is issued. These expiry dates vary between training agencies, provinces and regulatory bodies with no defendable position as to why the discrepancy. There have been no scientific studies to date in Canada showing how long trained rescuers can remember the course information to justify these discrepancies.

Insufficient skills of basic life saving are caused by a lack of training and appropriate instruction, limited practice, lack of self-efficacy, and poor skill retention. Some recent literature states that many necessary skills of CPR and first aid are forgotten shortly after certification in laypersons. The purpose of this study was to determine the skill and knowledge decay in first aid and CPR in those who are paid to respond to emergency situations within a workplace. This information is critical if we want to maintain a safe environment for employees within the province of British Columbia, as there is an expectation of emergency life-saving first aid and CPR from those paid to provide such services in their work environment.

Sample

- 258 participants had first aid training, and complete data for analysis. Of these, 154 were male, and 104 were female, with an average age of 34.0 years.
- 244 participants had CPR training, and complete data for analysis. Of these, 140 were male, and 104 were female, with an average age of 34.3 years.

First Aid

- First aid knowledge was hirer in those who were trained at a higher level, and did not significantly decline over time.
- Those who had renewed their certificate one or more times generally performed better than those who had learned the information only once, although the difference between the groups was not statistically different ($p=0.0587$).

Choking

- Some skills were performed poorly, regardless of days since last training, such as hand placement and abdominal thrusts
- Compressions following the victim becoming unconscious also showed classic signs of skill deterioration after 30 days
- Skill-based components may deteriorate in a more predictable fashion following training
- Reduction in knowledge is most likely contaminated by the repetition of training in those that had recertified their first aid one or more times.
- The knowledge-based items did not show any typical pattern of decay, although some items (ensure no danger) were performed seldomly

CPR

- the number of times certified appears to be a much better predictor of performance on subsequent tests of CPR skill and knowledge. Due to the small to moderate correlation between these variables, cautious predictions of test score based on the number of prior certifications can be made

- there was a trend for fewer individuals to correctly landmark for chest compressions and control the airway for ventilations as the time since training increased.
- skill-based components may deteriorate in a more predictable fashion following training
- reduction in knowledge is most likely contaminated by the repetition of training in those that had recertified their first aid one or more times.
- many of the knowledge-based items did not show any typical pattern of decay, although “ensuring no danger” and “activating the EMS” both showed a decline over time since last training.
- A significant negative correlation was observed between days since training and a pre-CPR safety check variable (e.g. skills such as remembering to “tap or gently shake the patient” or “ear over mouth, observe chest: look, listen, and feel for breathing”)
- A significant negative correlation was observed between days since training and periodic checks for breathing, head positioning, and patient placement
- Deviations in the number of chest compressions from a trained target increased with time since CPR training for CPR cycles one to four. Cycles 5-8 were performed poorly regardless of time since training
- some CPR training is poorly retained independent of time since training. For example, CPR cycles five to eight were performed poorly regarding the number of compressions from the trained target and the number of ventilations attempted independent of time since training.

Discussion

- to improve skill retention, and hence, survival rates following bystander initiated CPR, strategies are required to reduce skill deterioration that are simple and effective, independent of time and place, and that cause minimal disruption of one's working day.
- our present data suggests that repetition may be more important to skill retention than days since last trained
- repetition of training appears to be a significant variable in skill retention, and hence, strategies for increasing the repetition of the skills and knowledge should be explored
- as many skills deteriorate rapidly over the course of the first 90 days, changing frequency of certification is not necessarily the most obvious choice to increase retention of skill and knowledge. Alternatively, methods of regularly “refreshing” a skill should be explored as could be delivered at a high frequency – such as every 90 days
- efforts should be made to investigate skill deterioration, and determine if simple and cost effective updating strategies (email, web-based scenarios that will include video and/or text, posters) can reduce the rate of decay

Chapter 1

Introduction

Although clear guidelines for cardiopulmonary resuscitation (CPR) training were introduced over 30 years ago and organized first aid training has been taught for more than 130 years, the delivery, acquisition, and retention of these fields remain in question. Little research has been done to investigate the efficacy of the current methods for the teaching, learning, and retention of first aid. Much of the data that currently exists has found flaws in CPR and first aid training (Pearn 1994; Cullen 1992). Training has been shown to be sub-par, with the development of new and improved methods of instruction falling behind the information that has emerged, and the information that is being taught is often done so in manners that are not conducive to learning and retention of information.

The value of CPR is well documented and it is known that immediate resuscitation is necessary in order to achieve conscious survival for persons that have lost their airway or pulse. Complete upper airway obstruction must be managed in a prompt, effective manner because it can lead to cardiac arrest in as little as 5 minutes (Krisoffersen MB, Rattenborg CC, Holaday DA. 1967); permanent brain damage can occur after just 4 minutes (Cole S, Corday E. 1956); and permanent damage to the heart occurs after 20 minutes (Reich H, Angelos M, Safar P, Sterz F, Leonov Y 1990). CPR has been shown to maintain neurologic function (Sanders AB, Kern KB, Bragg S, Ewy GA. 1987) and preserve brain viability after as much as 10 minutes without circulation (Angelos M, Safar P, Reich H. 1991) and increase survival rates in cases of ventricular fibrillation from 20 to 40 percent (Pearn J. 2000).

Injuries are the leading cause of death for Canadians between the ages of one and 44, and with 13,000 Canadians dying every year as a result of injuries, it accounts for more deaths than cancer, heart disease, and stroke combined. For those who complete first aid training, research

shows increased awareness of potential injury and a reduction of personal injury by up to 40% (Canadian Red Cross, 2007). Basic first aid training prepares bystanders to react and provide immediate, efficient treatment for a wide variety of incidents, including alerting the EMS, maintaining the airway, breathing and circulation emergencies, and respiratory and cardiac arrest. More comprehensive first aid training also covers bone, muscle and joint injuries; wound care; head and spine injuries; sudden medical emergencies; environmental emergencies; and automated external defibrillation (AED) certification as well as CPR training.

With many benefits being known for the training of CPR and first aid and more than 17.5 million people receiving first aid certifications each year in the United States, it is disappointing that less than 30% of all out-of-hospital resuscitation attempts are initiated by lay bystanders and bystander initiated CPR occurs in less than 30% of all cases when warranted (Eisenburger & Safar, 1999). Even with many initiatives in Canada and the United States to train many people, from healthcare workers to laypersons, the number of lives saved through the initiation of life supporting first aid is less than desired. Fear of liability, lack of confidence, fear of making things worse, anxiety about performing in front of an audience, and apprehensions about contracting disease or infection are among the reasons why many bystanders, both trained or untrained do not respond in emergency situations (Das and Elzubeir 2001; Larsson, Martensson and Alexanderson 2003).

The large number of training services for CPR and first aid has caused for different standards in the design and delivery of training (Cullen 1992). Millions of people are being trained each year, but the efficacy of this training, and the subsequent performance of the skills learned, has come into question. The response time in emergency situations is critical, but the CPR and first aid provided must be performed properly in order to prevent further complications

and potentially save lives (Engeland et al. 2002). With the need for effective initiation of intervention being known, healthcare professionals and laypersons often face criticism for inadequate basic life saving skills (Das and Elzubeir 2001; McCormack, Camon and Eisenberg 1989; Engeland, Roysamb, Smedslund and Sogaard 2002). Insufficient skills of basic life saving are caused by a lack of training and appropriate instruction, limited practice, lack of self-efficacy, and poor skill retention (Das and Elzubeir 2001). Current literature states that many necessary skills of CPR and first aid are forgotten shortly after certification. Why is it that levels of knowledge, confidence, and motivation decrease? Are there any ways to improve skill retention and self-efficacy in CPR and first aid providers? This paper investigates the answers to these questions and many other issues with the current state of CPR and first aid training.

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Chapter 2

Methods

In order to recruit participants for the study researchers contacted large industrial employers in the Lower Mainland of British Columbia, Canada that regularly contract out first aid training. All employees that are paid to provide first aid within the workplace were eligible to participate. Researchers also located corporations that employ large numbers of people and approached the person/people in charge of safety and/or first aid to recruit more participants.

Researchers went to volunteer worksites to evaluate the knowledge and skill retention of first aid and CPR. Employers were instructed to schedule their employees to participate in the study individually throughout their day and give them no details except that it was a first aid and CPR study. Participants would enter the study room individually, where they met the researchers and gained their first knowledge of the details of the study. After their demographic information was recorded on data collection papers, participants were introduced to the first of two scenarios that they were asked to aid with – a first aid choking incident.

The choking incident involved a mannequin in a wheelchair that was choking at a restaurant. The participant was told "you are in a restaurant, you see a person in a wheelchair grabbing their throat and attempting to cough. The person is wheelchair bound. The person is unable to cough. No one knows what happened. Everything is as found unless we tell you otherwise." A timestamp program using an EXCEL spreadsheet was used to record and assess the correct order and proper execution of each of the steps for the first aid scenario. The Laardal recording mannequin was connected to sensors and a computer that recorded the rate, depth, and frequency of breathing, and the rate, depth, and location of chest compressions. The participants were observed for proper scene safety and management of the airway, which included abdominal thrusts to clear the airway. The victim was said to have lost consciousness after one minute

elapsed and they were lowered to the floor. Alerting EMS, managing the airway, providing ventilations, performing compressions to clear the airway, and monitoring of ABC's were evaluated after moving the victim to the floor.

After completing the choking scenario, participants were moved to a different room to allow for the second scene to be prepared. A researcher plugged a frayed electrical cord into an outlet and placed the end of it across the chest of the mannequin lying on the ground as the Master First Aid Instructor introduced the CPR scenario to the participant. The participant was told "(y)ou are called to a scene by a fellow worker. The worker said that the patient fell to the ground and was shaking. No one knows what happened. Everything is as found unless we tell you otherwise." The participant and first aid instructor returned to the study room when the scene set up was complete and the second scenario took place. Researchers watched for scene safety, monitoring the victim's level of consciousness, alerting EMS, effective management of ABC's, and cycles of compressions and ventilations, followed with reassessment of ABC's, and finally they were expected to place the victim in the recovery position. The same mannequin was used in both scenarios and the data recorded by the sensors was analyzed after the data collection was completed.

Standard answers were given for common questions that were asked by participants. When asked to phone 911, the researchers replied with "I can do that", and then they told them "EMS will be here in about 10 minutes." When asked any specific question that could bias the outcome of the scenario the reply was to "do what you would do in real life." The participants were told that the mannequin was wheelchair bound and could not be moved from the wheelchair until it lost consciousness (after the first minute of the choking scenario) because of the difficulty

in repeatedly standing the mannequin in a self-supportive manner and in order to discern whether participants knew the proper protocol for clearing the airway of a person in a wheelchair.

After completing both scenarios, participants completed a written multiple choice first aid exam that used questions from the Worker's Compensation Board of British Columbia's first aid exam. Participants that had level one certification answered the first 10 questions of the exam, level two participants completed questions 1-15, and participants with level three certifications completed all 20 questions in the exam booklet.

Data Assembly

Data was assembled in a series of Microsoft EXCEL spreadsheets. Descriptive statistics were calculated using EXCEL functions, and Tables and graph of data were developed within EXCEL and imported into a Word document. Descriptive and graphical data is reported throughout the report based upon the groupings of "days since last training". In each case data was assembled using the following categories: category 1 = 1-30 days (<1 month); 2 = 31-90 days (1 – 2.9 months); 3 = 91 – 182 days (3 – 5.9 months); 4 = 183 – 364 days (6 – 11.9 months); 5 = 365 – 546 days (12 – 17.9 months); 6 = 547 – 729 days (18 – 23.9 months); 7 = 730 – 1094 days (24 – 35.9 months); and 8 = >1094 days (3 or more years).

Data Analysis

Both descriptive and statistical analyses were performed. Regressions and multivariate ANOVA's were performed to explore the impact of the number of days since the person was last trained, and to investigate the relationship between previous training and recertification on performance measures.

Chapter 3

First Aid Skill Retention Literature Review

To date, little research has been done to investigate the efficacy of current methods for the teaching, learning, and retention of first aid. Of the data available, most findings point to flaws in the learning and maintenance of first aid skills, in particular, the methods used in skills training. Studies that document the performance of various incidents of basic life saving care have been sub-optimal indicating a slow progression in the adaptation of new education and training methods.

First aid training has been taught for over 130 years, and millions of people are trained and certified in first aid courses every year. However, retention of the material being taught is low. With unintentional injury being the fifth leading cause of death in the United States in 2004, the need for new methods of instructing first aid is very apparent. Response time is crucial in times of emergency, and the most effective way to reduce the time for interventions is to train lay people in the first aid skills necessary to save lives. New methods that improve retention and self-efficacy with skill have been studied and new training possibilities exist.

Methods:

The literature review conducted for this paper was completed using four Internet databases: Google Scholar, ScienceDirect, Academic Search Premier, and Medline (through PubMed) and there were no limiting factors set for any of the searches performed. The results of these searches are documented in Table 3.1.

The lists of articles found with the Internet search were checked for relevance, with the most relevant 29 articles being used for the making of this review. The date range for the articles used in this paper was 1984-2006, with 14% from 1980-1989, 31% published between 1990 and 1999, and 55% published between 2000 and 2006.

Table 3.1. Search Results

	Google Scholar	ScienceDirect	Academic Search Premier	PubMed
"first aid" AND retention	5060	29	23	16
"first aid" AND knowledge	21900	210	110	269
"first aid" AND choking	1060	2	63	16
knowledge AND "trauma care"	3210	133	12	1697
"life saving first aid"	70	10	0	61
"first aid" AND skill	18100	54	27	146

Literature Review

The technical practice and skill of first aid has been evolving over the last 130 years. Originally established in the 1870's in the battlefield, first aid, using a standard set of skills for bandaging, splinting and wound recovery, was used for military training purposes. Colonol Francis Duncan initially advocated the concept of teaching first aid skills to civilians (Pearn, 1994; Cullen 1992) while surgeon, and younger colleague of Duncan, Major Peter Shepard discovered that the complementary medical skills needed to provide the technical training were invaluable to the evolving army medical department and other military training. Before long, comprehensive first aid skills, lecture series and medical emergency responses were developed into now known enterprises such as St. John Ambulance, St. Andrew Ambulance Association and the American Red Cross Society (ARC) (Pearn, 1994; Cullen 1992).

By 1887, St. John Ambulance first aid classes were being taught to the public worldwide, progressing to where millions of people of all ages were being trained in the rudiments of first aid. However, the multitude of training services has produced differing standards in the practice and delivery of first aid (Cullen 1992). Until the Employment Medical Advisory proposed a first

aid legislation, known as the Health and Safety First Aid Regulations (1982), there was no direction given on what skills civilians should be taught (Cullen 1992).

With the rapid development of first aid, training seems self evident. However, health care professionals and lay persons are often criticized for not having adequate basic life saving (BLS) skills (Das and Elzubeir 2001; McCormack, Camon and Eisenberg 1989; Engeland, Roysamb, Smedslund and Sogaard 2002). Reasoning for such critique includes lack of training and appropriate instruction, limited practice, lack of self efficacy and poor skill retention (Das and Elzubeir 2001). Many bystanders, trained or untrained, do not respond in emergency situations due to fear of liability and lack of confidence in skills. Bystanders may hesitate to offer first aid due to various reasons, such as fear of making things worse, thinking an ambulance will arrive shortly, apprehensions about contracting disease or infection, or fear of performing in front of an audience (Larsonn, Martensson and Alexanderson 2002). Bystander BLS attempts have led to low survival rates with less than 10% in Europe and urban areas in the USA (Eisenburger & Safar 1999) and only slightly higher survival rate of 20-30% (Larsson et al. 2002) is seen from those with more extensive training from basic life saving initiation at the scene of the accident.

In the United States unintentional injury is the fifth leading cause of death (2004), exceeded only by chronic diseases such as heart attacks, cancer, stroke and chronic obstructive lung disorder. These unintentional injuries result in approximately 2.6 million hospitalizations, 34.9 million emergency room visits and 87.6 million medical office visits per year for all workers (Resuscitation 2000). In 2003, St. John Ambulance of England issued first aid training certificates to more then 500,000 people while the ARC trained more then 11 million people and the American Heart Association (AHA) more than 5.5 million certifications (Handschu, Reitmayer, Raschick, Erbguth, Neundorfer and Babjar 2006).

With millions of people trained in first aid, the efficacy of properly performed basic life saving skills becomes questionable. As more medical professionals and lay persons acquire these skills, retention of skill and motivation become factors open for debate. Overall response time in emergency situations is critical, whereby using applied knowledge and first aid skills at the scene of the accident can prevent further complications and potentially save lives (Engeland et al. 2002). Evidently, is it seen that these skills are forgotten shortly after the original certification. Reasons as to why knowledge and self efficacy (motivation, confidence) decline and what methods help to improve retention and self efficacy with skill will be addressed in this review. The importance of further development in training recommendations within the educational and occupational settings will also be outlined.

Review of Guidelines

Initially published in 1974, the Guidelines on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC) have developed to more evidence based recommendations (Resuscitation 2000). The development of specified guidelines varied from resuscitation of infants, children and neonates in the delivery room, to the expanded scope of injury prevention, asphyxia, shock and respiratory failure. In a review of current guidelines- ECC, European Heart Association (EHA) and AHA, common injury responses requiring trained first aid attendants consist of: infection control, bleeding/hemorrhage, wounds, burns (chemical and electrical), spinal cord injury, musculoskeletal trauma and poisoning (Resuscitation 2000, European Guidelines).

As early as the 1960's and as recently as 1999, "life supporting first aid" (LSFA) consisted of a few simple measures that remain critical in extending patient's survival while

waiting emergency response (Resuscitation 2000, Eisenburger 1999). In October of 1999, a task force on first aid was appointed to develop more evidence based guidelines for first aid, with the overall goal of reducing morbidity and mortality due to emergency events (Resuscitation 2000). The task force addressed emergencies in adults including worksites and through extensive review of texts and published studies developed a set of recommendations with evidence based support for the assessment and management of first aid. It was seen that general recommendations follow basic checklists of: a) ensuring personal safety, b) not moving a casualty from an accident unless in immediate danger, c) acknowledging and introducing yourself to the victim and d) alerting the local EMS or emergency response (Van de Velde et al., 2006, Resuscitation 2000). All guidelines follow routine step-by-step procedure to evaluate the situation and responding accordingly, dependant on situation and injury. However, with the introduction of new courses being offered through the AHA, St. John Ambulance and other executive providers, there is a common concern for consistency among practices and retention of these skills.

Skill Retention with Basic First Aid Skills

BLS skills have to be taught, learned and remembered, and most evidence demonstrates that skill decay is rapid, even among professionals in an occupational and health care setting (Handley 1997, Eisenbuger 1999, Cullen 1992, Safar et al. 1981, Larsson et al. 2005). Extensive literature indicates that overall skills and CPR retention decay with time, while research with a specific focus on first aid skills is limited. In most course certifications both CPR and basic first aid are taught collectively, therefore, outside of the context of CPR, it is safe to assume that basic first aid skills would follow a similar pattern of deterioration if certifications/skills are not frequently updated. Survey results demonstrated that first-aiders appear to retain a limited amount

of learned first aid knowledge, with retention of knowledge base deteriorating rapidly after initial training (Cullens 1992, Kano, Siegal and Bourque 2005; Starr and Burford 1994, Handley 1997). Studies have shown that trained individuals are more competent than untrained individuals, but that practical competency may not correspond with theoretical or perceived competency, and that skill retention is poor (Kano, Siegal and Bourque 2005). Overall, there is limited understanding of the actual impact of skills and knowledge on bystander behavior during emergency response (Shotland and Heinold 1985).

Exploration in to the retention of first aid skill, proposed by the Branch D, Health Policy Division, Health and Safety Executive, tested knowledge at six month periods and up to three years after initial training. Results indicated that 4-14% were unable to answer questions. A very poor achievement was seen overall with only 37% of responders within one year of training able to score adequately on the questionnaire with a slight increase of 40.4% in a 1-2 year post training group and 32.3% in the 2-3 year post training groups. Collectively, these results confirm the deterioration of knowledge and skills after original training (Cullens 1992). If those certified are not compliant with keeping their skills current it can be expected that correct performance of skills and confidence levels will decline.

First Aid in the Workplace and Health Care Setting

First aid is mandated in the occupational setting. The Occupational Safety and Health Administration require that ‘at least one person’, preferably two or more, are trained in first aid and available at the worksite (Chameides et al. 2000). Injuries and accidents are known contributors to mortality and morbidity rates worldwide. Within a workplace setting common injuries include burns (electrical and chemical), bleeding, poisoning, altered mental stress, head

trauma and cervical/spinal injuries (Chameides et al. 2000). In any of these given situations, first aid training and competency is critical and ultimately life saving.

Inquiries into CPR skill retention and decay indicate that in an occupational setting only 12% of those tested were actually capable of performing and carrying out effective and correct CPR (McKenna and Glendon 1985). McKenna et al. also showed that there is a linear decay in skills over time with fewer than 20% of subjects performing moderately (75%) only after an elapsed six months from original training (McKenna et al. 1985). McKenna and Glendon clearly provide evidence for the decay in skill over time, where there is substantial loss of skills occurring in the year following training.

A common workplace injury that requires immediate first aid treatment for a favorable outcome is burns. More than 1.25 million people sustain burns each year within the United States with 250,000 in the UK and over 170,000 in Australia (Rea et al., 2005). When investigating whether patients (n=227) from a small burn clinic received appropriate first aid treatment, Rea, Kuthubutheen, Fowler and Wood (2005) found that 61% of patients received inadequate or deemed inappropriate treatment, with 21.6% of those patients receiving no first aid and 15% received a combination of other treatments. Of those who received inadequate first aid, 50% were treated by a primary health care worker, physician or emergency nurse. By presenting case scenarios to both health care workers and the general population, current knowledge of first aid procedures in health care providers was fair, if not poor, with only 18.5% correctly identifying proper treatment for all 4 of the presented cases (Rea et al., 2005). Uptake of first aid courses was found to be high among health care workers with an overall 75% retained knowledge. In non health care workers it was found to be significantly lower with only 28% of knowledge being retained. In both cases, 42% of health care workers and only 14% of non-health care workers

reported taking these certifications within the last 5 years. Rea et al. conclude that keeping knowledge current with frequent updates of first aid procedures demonstrates a significant difference in overall knowledge and appropriate application of procedures in the context of burn treatment.

Subsequent to a severe injury, death occurs in a three-peak pattern, with the first peak being immediately following the trauma. This peak is due to non-survivable injuries and uncontrollable bleeding or due to a lack of life saving measures from bystanders before professional emergency first aid can be provided (Thierbach, Pelinka, Reuter, Mauritz, 2004).

Guidelines for teaching external hemorrhage control to the lay public were in place by the end of the 1950's (American Red Cross 1999). In 1978/79, a study of 376 high school students aged 15-16 showed that acquisition of this skill was possible without manikin practice (Safar et al. 1999), and Capone et al. (2000) found that external hemorrhage control can be learned by watching television clips without any other teaching supplement needed. Viewing television clips led to performance scores that increased from 3% at the pre-test date to 81% one week after viewing, finally ending at 64% 13 months after viewing.

This ability to learn by watching television clips is relevant with the most recent methods for controlling bleeding which were announced by the ARC in it's 2005 Guidelines for Emergency Care and Education. In this update it was stated that in addition to direct pressure being the most suitable treatment for external hemorrhage, direct pressure alone is as effective as combining direct pressure with elevation and the use of pressure points (CPR Updates 2006). The relatively simple approach to hemorrhage treatment makes the use of TV clips effective as there is little hands on training necessary.

Pelinka, Thierbach, Reuter and Mauritz (2004) found that control of hemorrhage was done correctly more often by people with higher levels of training. Pelinka et al. also found that there was no difference in the frequency and quality of hemorrhage control carried out between groups of bystanders that either knew or did not know the patient.

Pelinka et al. (2004) and Shotland & Heinold (1985) found that bystanders were more likely to respond to emergency incidents if there are no other bystanders present but there was a decrease in performance quality of the interventions when there were no other bystanders.

Teaching for Learning

Knowing that skills decay, it is important to convey first aid knowledge and skill performance through effective means. Teaching must stress that only resuscitation initiated within seconds of collapse can provide the necessary oxygen to delivery to maintain viability of the organism until emergency response arrival. Teaching must also stress the importance of basic life saving skills with first aid treatments and procedures. With the existing literature examining CPR and BLS there is no valid attempt to evaluate the effectiveness of individual components of the response to the victim, with little being known about the impact of learned skills on the intervention rate of bystanders (Shotland and Heinold 1985). The trained bystander response is critical in time of emergency. Therefore, teaching must also stress that BLS can help to prevent further injury and avoid complication, possibly death, while waiting for emergency medical services (EMS) to arrive. Restructured guidelines of training need to be established to not only train the individual with BLS skills but also evaluating skill acquisition and the impact it has on saving a life. Upon initial first aid certification, additional updates provided through various

modalities should be mandated (aside from annual re-certification) with the intended outcome of improving knowledge and retention of skill.

Traditional Instructional Methods

Starr and Burford (1994) examined the safety training and management of first aid and CPR skills, concluding that review sessions should be offered one month after original training followed by a recommendation of semiannual, preferably quarterly, review sessions. Collectively a majority of the literature concludes that effective training and retention is not simply watching a movie or working with a manikin, but a more hands-on approach where more critical aspects of emergency care and learning are more appropriate and accurate in retaining skills. Starr and Burford propose a possible strategy for effective training which involves five key components in an instructional setting: distributed emergency care training, role playing, psychological preparation and follow-up, appropriate emergency equipment and documentation and testing. The incorporation of such a strategy could result in the successful management of critical events and a potential increase in the confidence of the responders in a medical situation, ultimately affecting the number of saved lives.

As a campaign to increase first aid knowledge and skills, Engeland et al. (2002) introduced a multi-dimensional training program into junior high schools in Norway during the 1997/98 school year, with the long term goal of increasing student's ability to perform first aid successfully. Several variables were measured and scored based on a questionnaire distributed to 82 schools. Variable indices included knowledge of first aid, self efficacy, attitudes towards giving and learning first aid, intended behavior (situation based analysis) and emotions. Results concluded that first aid knowledge was of less importance than self efficacy and intended behavior in a situation requiring the use of first aid skills. It was also seen that the increase in

knowledge of first aid in the intervention group had a positive change, possibly being attributed to the training program. No significant differences were seen in attitude towards learning first aid.

Peer training models

Wik, Brennan and Braslow (1995) demonstrated that the peer training approach instead of the traditional instructor led CPR course can be an effective training method for large groups. It was found that CPR performed by peer trainees is probably better than, and certainly no worse than, CPR performed by trainees from traditional CPR classes. Peer training methods appear to reduce overall costs and training time from traditional instructor-led courses. This proves to be effective not only in the workplace, with training of very large numbers, but potentially reaching new populations, thus increasing survival following out-of-hospital cardiac arrest by forging a stronger link in the chain of survival (Wik et al., 1995).

In the context of school resuscitation training, evidence suggests that children as young as 11-12 years of age can retain life supporting techniques (Lester, Donnelly and Weston 1997). Using a teacher only and a peer tutoring approach (teacher assisted by an older pupil) demonstrated effectiveness in the content delivery of first aid skills.

Video/Television Based Methods

With traditional training still being used, other methods of delivery are continually being assessed for cost effectiveness, reduction in training time and expanding to new and larger populations. Several approaches have been taken in program development and delivery, with video/television and the use of the Internet becoming some of the most popular methods used. Subjects who were shown films that detailed various first-aid procedures were found to respond

more quickly in comparison to those who did not view the films (Pantin and Carver 1982 (from Shotland and Heinold 1985)).

In the article, *Life supporting first aid (LSFA) teaching to Brazilians by television spots*, Capone, Lane, Kerr, and Safar (2000) investigate the feasibility of teaching several LSFA steps to industry workers through exposure to television spots demonstrating eight skills. The trainee's performance was seen for specific skills improved and overall results indicated that 1-31% of the control group performed skills correctly compared to 9-96% of the television group. Conclusively, Capone et al. provide convincing evidence of knowledge retention following 13 months with television viewing increasing basic LSFA and correct air control performance from 5-25% of trainees, concluding that factory works can acquire basic LSFA skills through television viewing alone. Recommendations for enhancing acquisition of skills included television spots with longer demonstration films, promoting self-practice and learning laboratories in schools and work.

Web-based Training

Over the past decade, the use of the Internet has increased rapidly - more individuals are accessing the World Wide Web (WWW) as a means of researching information for health and education purposes, business services and improved communication methods. More recently, it is noted that the number one reason people use the Internet is for health related information (Roine, Ohinma and Hailey 2001, HealthNet B.C. 2002, Blach and Tichenor 1997, Grisby and Sanders 1998), commonly referred to as "telehealth" or "e-health". The growing public interest in health and wellness information stems from many sources, including social changes related to consumer's rights to health movements, and to economic changes brought about by the managed

health care revolution. With such advancements in technology, one would assume that first aid updates would be provided online. Yet, limited research exists investigating the use of the Internet to provide online education or updates for BLS skills, both CPR and first aid included.

Teague and Riley (2006) investigated the use of an online 'crash course' to assess the knowledge and first aid skill acquisition and compared to those with no first aid training. BLS skills were assessed using patients and manikins with knowledge being evaluated through a written assessment. Results indicated significant differences in the written assessment (p *value* 0.035). Scores were higher in the group who had accessed the Internet course than the group who did not, but no significant differences were seen with respect to the performance of BLS skills between the two groups. Teague and Riley conclude that online course instruction provides evidence for improvements in course participant's knowledge of BLS but not in their ability to perform these skills. Bearing in mind that many issues surrounding trained bystanders failure to act in an emergency situation include 'readiness', fear of infection, legal liability and lack of confidence, the Internet appears as a reasonable approach for training students.

Peterson (2006) provides support for Internet training as an efficient and convenient training tool to maintain and improve CPR skills. Staff feedback suggested the benefit of online CPR training makes it easier to review parts of CPR training multiple times and refresh themselves on correct procedures and to have as a readily available reference (Peterson). Over three years, compliancy increased from 79% in 2001 to nearly 99.8% in 2004, attributing this improvement to the overall layout, modules and provided links to additional online training. Though limited, these studies grant support that online web training is an effective resource tool that is not only cost effective but also efficient for CPR and first aid training. Web based training

of basic knowledge and skills, in addition to delivery of first aid and CPR updates and information to those trained in between certifications seems ideal (Teague & Riley).

Multiple Modalities Approach

Earlier research investigating life saving first aid (LSFA) (airway control, external bleeding, rescue pull, recovery position and shock) for the lay public using high school students as subjects demonstrated using a multitude of training approaches (manuals, audiotapes, flip charts and recordings) to significantly improve test results for knowledge and skill of first aid. It was seen that all three methods were effective in significantly increasing overall knowledge and retention (Safar et al. 1981).

Das and Elzubeir (2001) also investigate the use of a multi-modality approach through a training program provided to medical students during 3 academic years. Incorporating teaching methods such as lectures with videos, demonstrations and hands on practical experience with models, peers and simulated patients. Participants (n=180) took both written and clinical skills assessments at the end of the course. Feedback from participants indicated that overall approaches were accepted and deemed relatively effective (56.2% for teaching sessions, 70% for practical component and 28.5-32.7% for the usefulness of the video and lecture component). Statistically significant differences were seen among students of the three academic years with confidence in performing certain clinical skills (Das and Elzubier 2001). These differences include recording respiratory rate, bites and stings, small foreign bodies ($p < .03$), shock and the provision of first aid in cases of sprains and fractures ($p < .01$) and regulation of temperature and shock ($p < .001$). Although there were significant correlations seen between opportunities to practice and confidence in numerous skills, it appears that confidence depends not solely on the number of times students practiced but on the overall experience students perceived during the course (Das

and Elzubier 2001). These results support that students who are provided sound knowledge and practice in first aid and BLS contribute to improving knowledge, skill retention and overall confidence in performance of skills.

There is a limited body of work on how to effectively teach life saving skills. However, it is seen that computer mediated method of instruction is the most effective when used in conjunction with other training techniques, such as traditional, group or private study (Mackenzie and Greenes 1997). A multi-modal approach fits with the experiential learning model and is deemed an effective way of conveying skill-based information about BLS.

Recommendations/Conclusions

To improve emergency response and outcome of the casualty, first aid must be taught correctly to the lay person. The acquisition of knowledge and the effectiveness in the retention of skill remains questionable, justifying the need for effective and appropriate training of first aid procedures to reduce the number of harmful and inadequate treatments. Innovative training methods more effective than courses taught solely by instructors have been shown to improve both knowledge and skill retention (Cullens 1992, Teague and Riley 2005, Peterson 2006, Starr and Burford 1994). Multifaceted novel programs for maximizing skill retention are necessary in order to not only justify cost effectiveness but to also minimize morbidity and mortality due to accidental injury. Simple, straightforward guidelines with repetition of multifaceted training initiatives will be complementary as they use different approaches and may reach different target groups.

Basic CPR skills and first aid skills are crucial life saving techniques. They are fundamental skills that should be widespread within the community, workplace and educational

settings. First aid training organizations, employers and those concerned for their safety at work should address the need for educational improvements. Recognizing that skills decay rapidly after original training, employers should be encouraging their first-aiders to refresh their knowledge between recertification and refresher courses, as well as offering BLS courses and skills training to all employees as an added safety precaution. With the lack of existing research focusing on first aid skills, further research investigating the efficacy of various training techniques and innovative delivery methods is necessary to see significant results in knowledge transfer, retention and performance of BLS. With the development of feasible and safe training protocols as well as the integration of innovative teaching techniques it is quite possible to improve retention and motivation of the lay person within the community. It is suggested that further research involving web based training and skill retention be conducted in order to improve overall retention, increase safety and awareness and reduce overall injuries and deaths.

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Chapter 4

First Aid Skill Retention Results

A total of 258 participants had first aid training, and complete data. Of these, 154 were male, and 104 were female, with an average age of 34.0 years. These participants were divided into categories based on the number of days since their last first aid training (category 1 = 1-30 (<1 month); 2 = 31-90 (1 – 2.9 months); 3 = 91 – 182 (3 – 5.9 months); 4 = 183 – 364 (6 – 11.9 months); 5 = 365 – 546 (12 – 17.9 months); 6 = 547 – 729 (18 – 23.9 months); 7 = 730 – 1094 (24 – 35.9 months); 8 = >1094 (3 or more years)). The distribution of participants across the 8 categories of "days since training" are provided in Table 4.1. Table 4.2 reports the occupation distribution across each category of "days since training" while the full data is presented in Table 4.3.

Table 4.1. Distribution of participants across categories of "days since training".

Category	Days Since Training	Number (n)	Male (n)	Female (n)	Average Age (yr)
1	1 – 30	21	11	10	30.5
2	31 – 90	34	26	8	36.2
3	91 – 182	41	23	18	33.2
4	183 – 364	48	29	19	33.5
5	365 – 546	43	24	19	35.1
6	547 – 729	25	14	11	33.5
7	730 – 1094	18	12	6	32.3
8	> 1094	27	15	12	35.3
Totals		257	154	103	34.0

The participants in the present study were distributed across 14 different WCB occupation codes, with the largest number in accommodation, food, and leisure services, followed by manufacturing other products, other services, transportation and related services, general construction, utilities and warehousing. The majority of participants in each “days since last training” category had not been recertified, and held Level 1 certification. In all categories, at least one participant was previously certified at a higher level which they no longer held.

Table 4.2. Occupations, by WCB Code, of participants across categories of "days since training".

	Occupation (WCB Code)													
Days Since Training	7150	7210	7310	7320	7410	7530	7610	7620	7630	7640	7650	7660	7670	8110
Category 1	2		5	1			8			1	1	3		
Category 2	16	2				1	4	1		7	1		2	
Category 3	3	3			1	4	10	4		7	1		8	
Category 4	8	5	1	4	1	3	7	5		8	1	3	2	
Category 5	4	6	3	1	1	2	7	6	2	6	1	1	3	
Category 6	1	1	3	2	1		4	4	1	3	2	1	2	
Category 7	1	1		3	1		10						1	1
Category 8		3		7	2			4	1		3	1	2	
Total Number	**36**	**21**	**12**	**18**	**7**	**10**	**55**	**24**	**4**	**32**	**10**	**9**	**20**	**1**

Table 4.3: Demographical data of participants expressed as percent of

		Day Since Training (n)							
		1-30 (21)	31-90 (34)	91-182 (41)	183-365 (48)	366-547 (43)	548-730 (25)	731-1095 (18)	1096+ (27)
AVERAGE AGE:	years	30.55	36.21	33.22	33.47	35.14	33.50	32.29	35.33
GENDER:	male	48	76	56	60	56	56	67	56
	female	52	24	44	40	44	44	33	44
OCCUPATION:	manufacturing other products	10	47	7	17	9	4	6	0
	general construction	0	6	7	10	14	4	6	11
	heavy construction	0	0	0	0	0	0	0	0
	warehousing	24	0	0	2	7	12	0	0
	transportation and related services	5	0	0	8	2	8	17	26
	retail	0	0	2	2	2	4	6	7
	public administration	0	3	10	6	5	16	0	0
	accommodation, food, and leisure services	38	12	24	15	16	16	56	19
	business services	0	3	10	10	14	16	0	15
	professional, scientific, technical services	0	0	0	0	5	4	0	4
	other services	5	21	17	17	14	12	0	0
	education	5	3	2	2	2	8	0	11
	health care and social assistance	14	0	0	6	2	0	0	0
	utilities	0	6	20	4	7	0	6	7
	federal government	0	0	0	0	0	0	6	0
NUMBER OF	0	43	29	29	35	37	52	39	56
RECERTIFICATIONS:	1	19	18	10	17	14	4	22	19
	2	19	12	2	8	7	8	11	7
	3	10	18	20	15	14	12	11	7
	4	10	6	10	8	9	0	11	11
	5+	0	18	29	15	19	16	6	0
CERTIFICATION	1	57	68	56	77	56	64	94	96
LEVEL:	2	33	12	27	8	19	16	6	4
	3	5	0	2	4	8	12	0	0
	other	5	21	15	10	16	8	0	0
HIGHEST LEVEL	1	57	59	41	67	49	60	83	93
ACHIEVED:	2	29	12	29	13	14	12	6	7
	3	10	9	15	8	19	20	6	0
	other	5	21	12	13	19	8	6	0

First Aid Exam:

First aid knowledge, as calculated on the first 10 questions of the multiple choice exam which all persons' trained in first aid performed, was hirer in those who were trained at a higher level (Figure 4.1), but did not significantly decline over time. Of those who held a Level 1 first aid certificate, those who had renewed their certificate one or more times generally performed better than those who had learned the information only once (Figure 2), although the difference between the groups was not statistically different (p=0.0587). The difference between the groups was most evident in the groups who had no recent training experience.

Figure 4.1. Average scores on the first aid multiple choice exam (first 10 questions) for those with Level 1 training, and those with greater than Level 1 training.

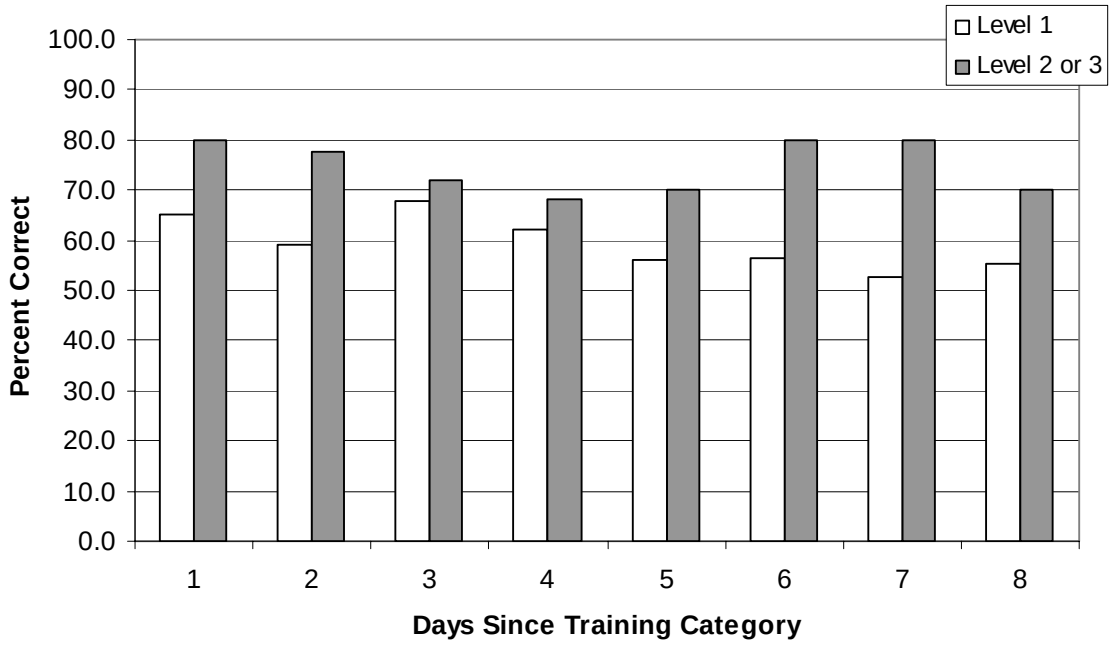
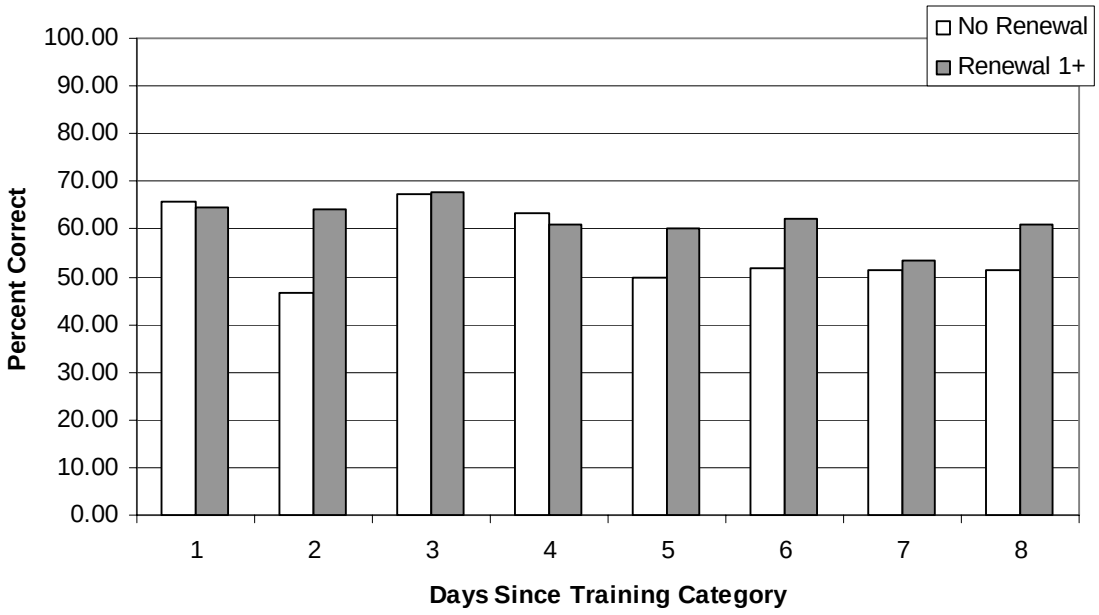


Figure 4.2. A comparison of multiple choice exam scores between those who were trained only once, and those who had renewed their first aid at least once.



Choking Scenario:

The victim for the choking scenario was in a wheel chair, and many individuals were confused on how they would proceed because of this. Once deciding to engage, fewer than 5% of the participants ensured they were in no danger before proceeding with first aid treatment for choking, and only 27% specifically asked the person if they were choking. During the treatment of the victim, 41% of the participants used gloves, and 65% used the pocket mask provided.

The physical skills required to dislodge a foreign body and reinstate unassisted breathing were also not performed well. Only 33% of the participants could correctly perform abdominal thrusts with correct hand placement, and once the victim went unconscious, only 52% activated the EMS. Once unconscious, 45% of the participants correctly placed their hands in order to

perform compressions; 74% of the participants performed compressions, although only 31% performed the compressions to the trained standard.

The Figures 6 through 11 demonstrate the trends in both knowledge and skill performance. For example, ensuring you are in no danger is not a physical skill, nor is remembering to activate the EMS while correct hand placement for abdominal thrusts and chest compressions are physical skills. For example, there is no distinct pattern across days since training for those items which are knowledge oriented (Figure 4.6, 4.7 and 4.8). In fact, Figure 4.6 demonstrates that participants remembered to identify if the victim to speak or cough before performing abdominal thrusts fairly consistently for the first 2 years before there was drop off. Figure 4.7 demonstrates that few individuals ensured their own safety before proceeding to help the victim, while similarly, few participants activated the EMS after their victim became unconscious, although in neither of these cases were there any trend for reduced performance with increased days since training.

The skill-based components appeared to diminish with time. An abrupt decrease in opening the airway was evident (Figure 4.10) after only 30 days. Correct hand placement and abdominal thrust were not performed well by those with 1-90 days of training, but showed deterioration from 90 days onwards. Compressions following the victim becoming unconscious also showed classic signs of skill deterioration after 30 days (Figure 4.11). It appears that the skill-based components may deteriorate in a more predictable fashion following training, while the reduction in knowledge would be contaminated by the repetition of training in those that had recertified their first aid one or more times. The knowledge-based items did not show any typical pattern of decay, although some items (ensure no danger) were performed seldomly.

Table 4.4: Choking scenario: Percentage of person's completing each step based on days since training

Days Since Training	1-30	31-90	91-182	183-365	366-547	548-730	731-1095	1096+
Scene Safety								
Ensure No Danger	5	0	15	6	2	4	0	4
Gloves	52	41	46	44	42	40	27	38
Pocket Mask	57	68	71	73	65	56	53	50
AIRWAY								
Ask "Are you choking"	38	21	34	29	21	32	20	29
Determine if patient can speak or cough	71	79	78	63	58	72	7	38
Clear the Airway								
Abdominal thrust - correct placement	14	38	80	31	26	16	20	8
Repeat thrusts (airway cleared/unconscious)	19	21	76	21	21	20	7	0
EMS								
Activate EMS	33	62	71	50	49	40	33	52
AIRWAY								
Open the airway (appropriate technique)	62	53	59	58	72	36	33	29
Look in mouth for foreign body	57	53	59	60	56	40	53	29
Breathing								
Seal pocket mask properly	62	50	71	67	65	28	47	25
Attempt to ventilate	71	53	71	77	70	52	53	58
Reposition the head	67	15	34	38	40	20	7	17
Re-attempt to ventilate	48	47	56	48	53	40	33	29
Clear the Airway								
Landmark - correct hand placement	81	50	41	56	35	44	33	21
Compressions	100	76	83	83	65	56	60	63
Correct number of compressions	57	32	39	25	30	20	14	12
Airway								
Open the airway with a head-tilt / chin-lift	71	35	34	31	35	28	27	21
Look in the mouth	52	47	51	48	49	44	33	25
Remove object when seen	95	74	83	92	81	72	67	67
ABC's								
Check patient's pulse	52	59	56	44	35	44	13	29
Check patient's breathing	76	59	63	63	77	32	40	46
Ventilate	86	79	78	79	65	60	53	50
Perform assisted ventilations								
Ventilate 1	67	59	68	71	56	48	47	46
Ventilate 2	62	50	68	58	51	52	33	38
Ventilate 3	48	38	59	52	42	40	20	25

Table 4.5. Mean order of events for persons' performing each task in response to the choking victim.

	"Days Since Last Training" Category															
	1		2		3		4		5		6		7		8	
	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**	Mean	**Rank**
Ask "Are you choking"	1.4	**3**	1.7	**2**	1.9	**2**	1.3	**1**	1.2	**1**	1.8	**3**	1.3	**2**	1.4	**2**
Determine if patient can speak/cough	1.3	**2**	1.6	**1**	1.8	**1**	1.4	**2**	1.5	**2**	1.4	**2**	1.0	**1**	1.7	**3**
Ensure No Danger	1.0	**1**	--	**--**	2.0	**3**	2.3	**3**	2.0	**3**	1.0	**1**	--	**--**	1.0	**1**
Gloves	2.7	**5**	3.4	**5**	3.8	**6**	3.4	**6**	2.9	**6**	3.6	**8**	3.8	**9**	2.1	**5**
Abdominal thrust -correct placement	3.0	**6**	2.4	**4**	2.6	**4**	2.5	**4**	2.7	**5**	2.3	**4**	1.7	**3**	2.0	**4**
Abdominal thrust -incorrect placement	2.2	**4**	2.4	**3**	3.1	**5**	2.6	**5**	2.4	**4**	2.6	**6**	1.7	**4**	2.3	**6**
Repeat thrusts until unconscious	3.5	**7**	3.9	**6**	4.5	**7**	3.6	**7**	3.8	**8**	3.4	**7**	2.0	**5**	--	**--**
Have someone activate EMS	4.6	**9**	5.3	**9**	5.3	**8**	3.8	**8**	3.0	**7**	2.5	**5**	3.0	**7**	4.2	**10**
Open airway using appropirate technique	4.4	**8**	4.6	**7**	5.3	**9**	4.8	**9**	4.3	**9**	4.4	**9**	2.4	**6**	4.0	**8**
Look in mouth for foreign body	5.4	**11**	4.7	**8**	5.4	**10**	5.2	**10**	5.0	**10**	5.3	**10**	3.6	**8**	3.3	**7**
Pocket Mask	5.1	**10**	5.4	**10**	6.0	**11**	5.7	**11**	5.2	**11**	6.3	**11**	4.5	**10**	4.0	**9**
Seal pocket mask properly	6.4	**12**	7.6	**12**	7.5	**13**	6.6	**12**	6.6	**12**	8.1	**16**	4.9	**11**	5.5	**12**
Attempt to ventilate	6.7	**13**	7.2	**11**	7.4	**12**	6.7	**13**	6.6	**13**	6.5	**12**	5.0	**12**	5.1	**11**
Reposition the head	8.7	**16**	8.6	**16**	9.5	**14**	8.4	**14**	7.5	**14**	9.8	**17**	5.0	**13**	5.8	**14**
Re-attempt to ventilate	9.3	**17**	8.4	**13**	9.7	**16**	9.1	**17**	8.5	**15**	7.7	**15**	6.0	**15**	7.0	**16**
Landmark - correct hand placement	8.5	**14**	8.5	**14**	10.0	**17**	8.4	**15**	9.4	**16**	6.8	**13**	5.8	**14**	5.6	**13**
Compressions	8.5	**15**	8.5	**15**	9.5	**15**	8.8	**16**	8.9	**17**	7.2	**14**	7.0		6.3	**15**
Open airway with a head-tilt / chin-lift	13.2	**20**	11.3	**19**	13.5	**20**	12.0	**20**	11.7	**19**	11.7	**20**	7.8	**16**	7.4	**17**
Look in the mouth	12.5	**19**	11.0	**18**	12.2	**19**	11.0	**18**	11.8	**20**	10.9	**19**	8.4	**17**	7.5	**18**
Remove object when seen	11.5	**18**	10.8	**17**	11.9	**18**	11.1	**19**	11.2	**18**	10.7	**18**	9.0	**18**	7.8	**19**
Check patient's pulse	15.4	**24**	14.3	**23**	16.0	**24**	16.1	**24**	15.2	**24**	15.2	**24**	12.5	**22**	11.1	**23**
Check patient's breathing	13.7	**21**	13.4	**21**	13.6	**21**	13.3	**22**	13.1	**21**	14.3	**23**	10.5	**19**	8.7	**20**
Ventilate (a)	13.8	**22**	12.8	**20**	14.3	**22**	12.9	**21**	13.7	**22**	12.5	**21**	10.8	**20**	9.1	**21**
Ventilate (b)	14.7	**23**	13.9	**22**	15.3	**23**	14.2	**23**	14.9	**23**	12.5	**22**	11.8	**21**	9.7	**22**

Figure 4.6. Percentage of participants in each "days since last training" category who determined if the victim was able to speak or cough.

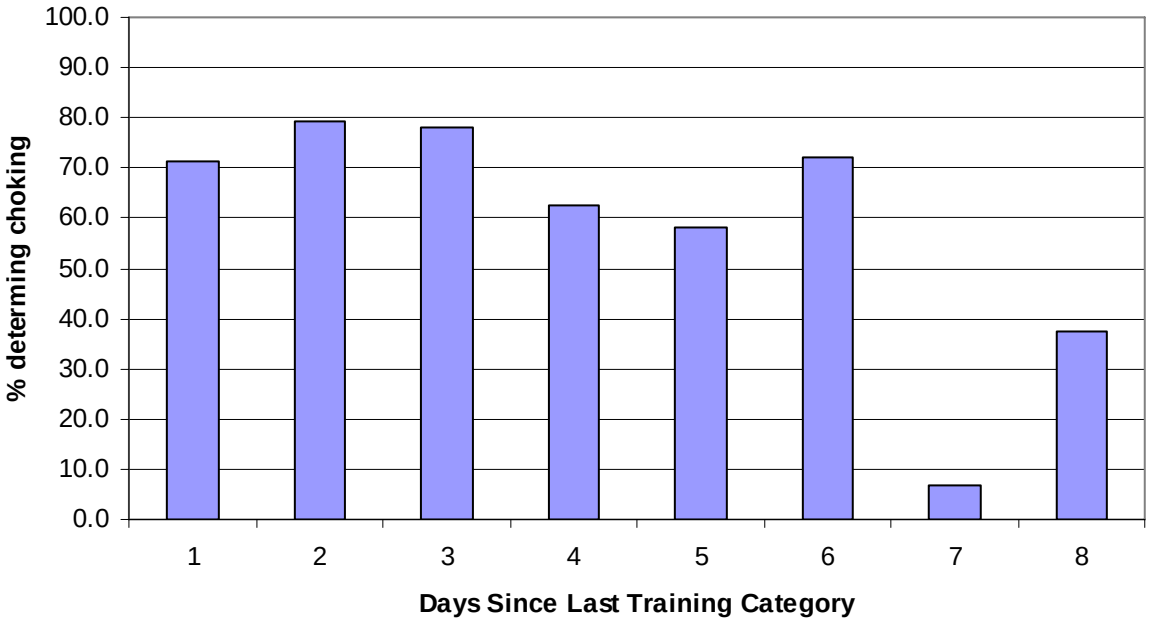


Figure 4.7. Percentage of participants in each "days since last training" category who insured they were in no danger.

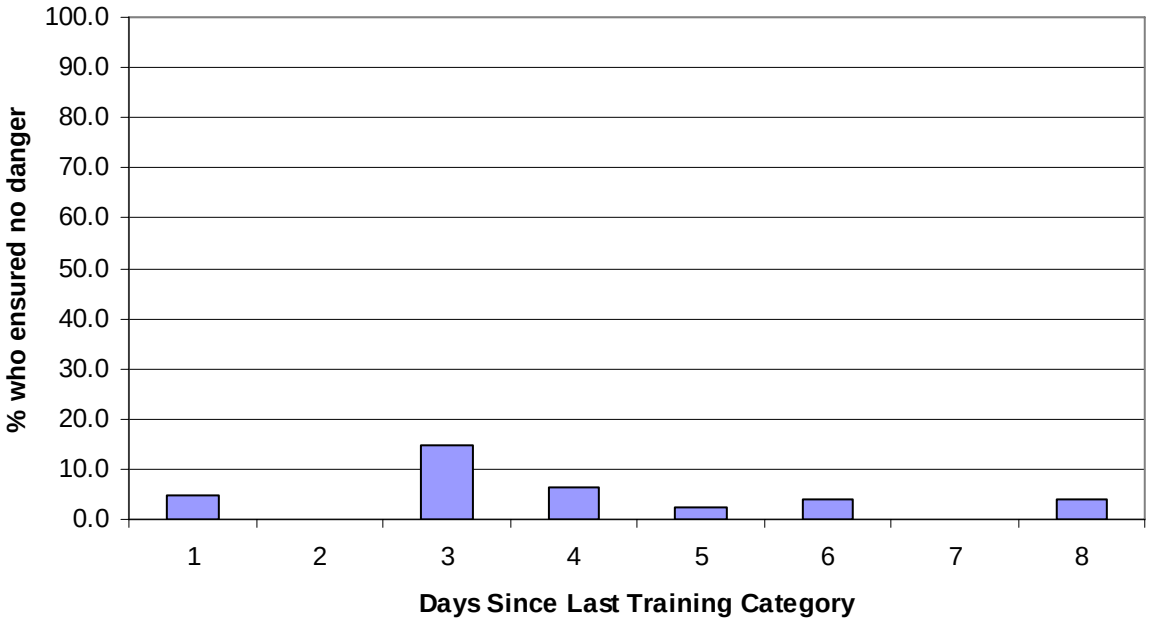


Figure 4.8. Percentage of participants in each "days since last training" category who had someone activate the EMS after their victim went unconscious.

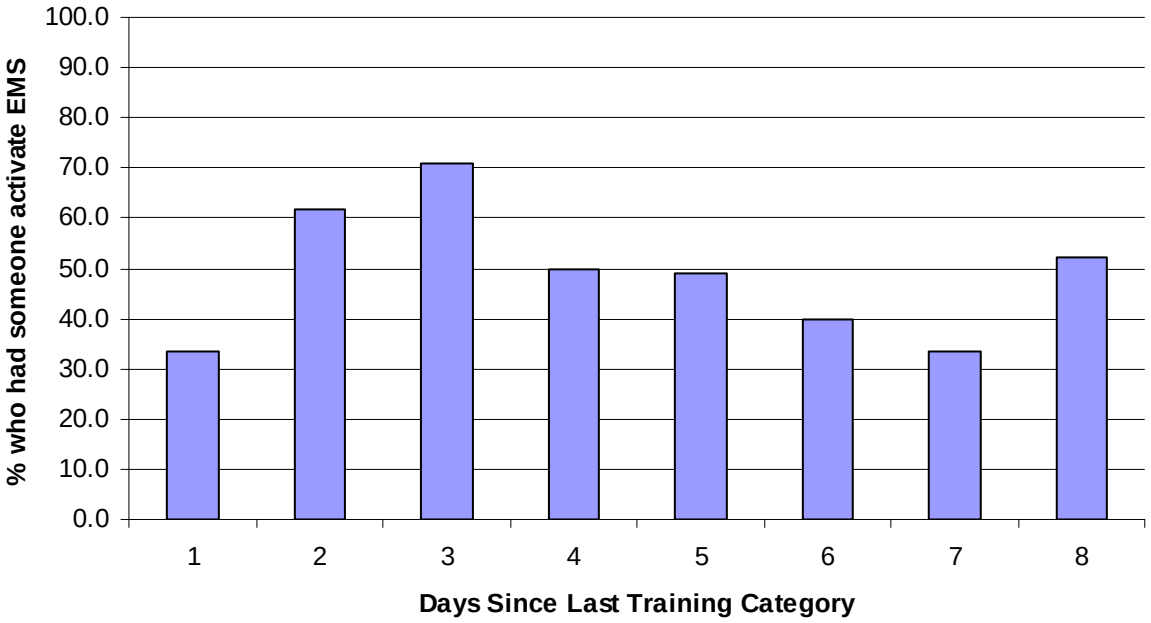


Figure 4.9. Percentage of participants in each "days since last training" category who correctly landmarked for, and performed abdominal thrusts.

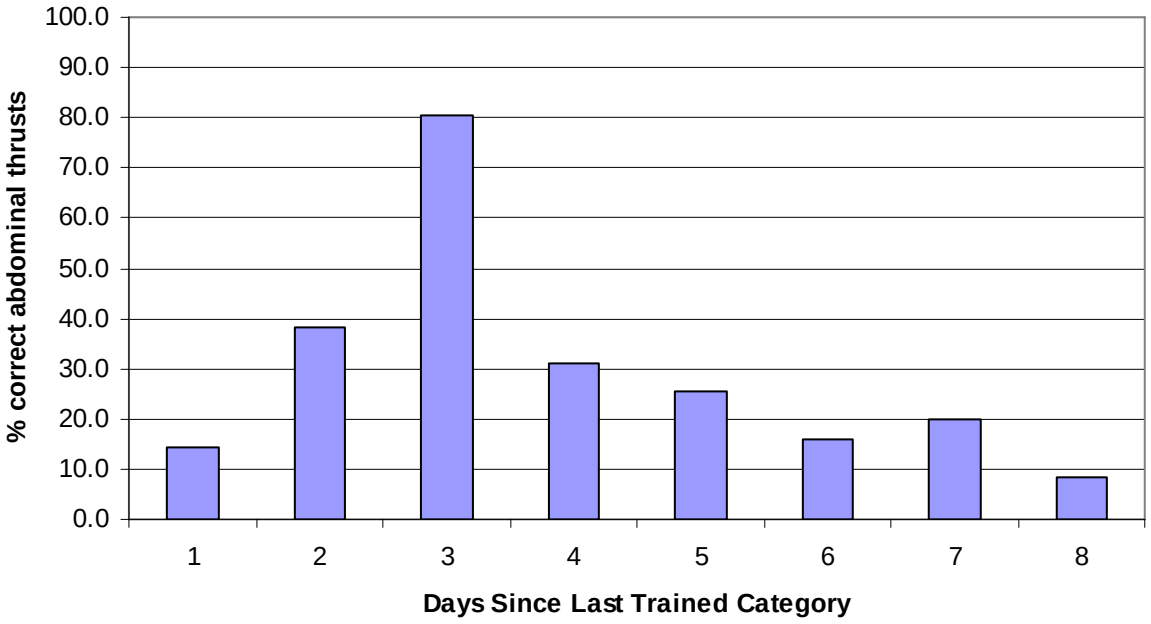


Figure 4.10. Percentage of participants in each "days since last training" category who correctly opened the airway.

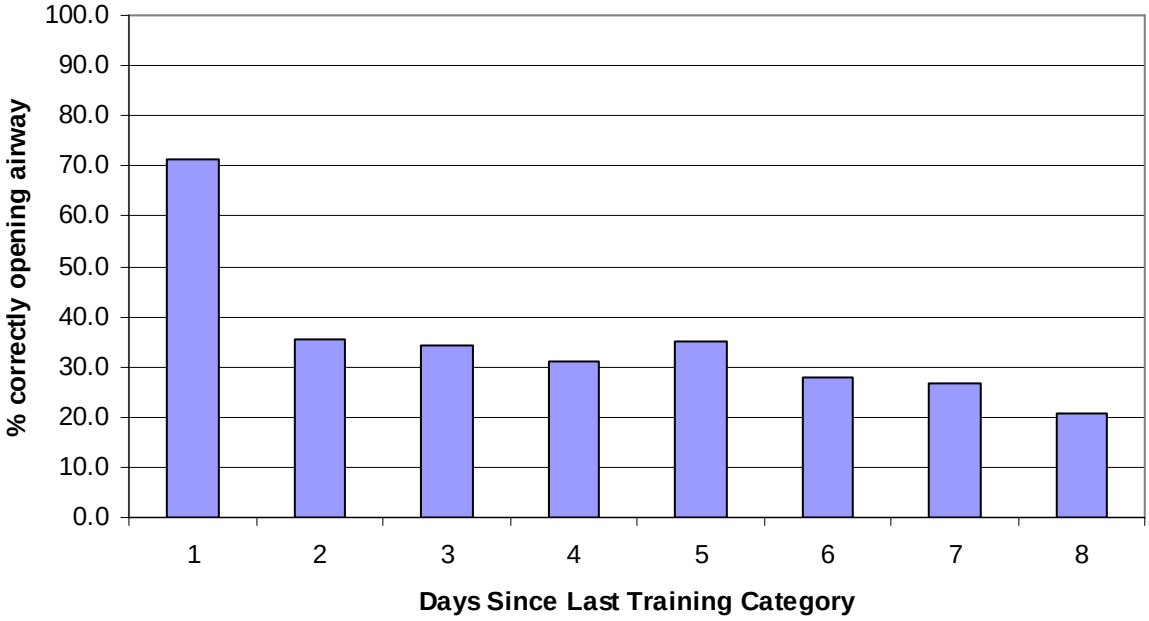
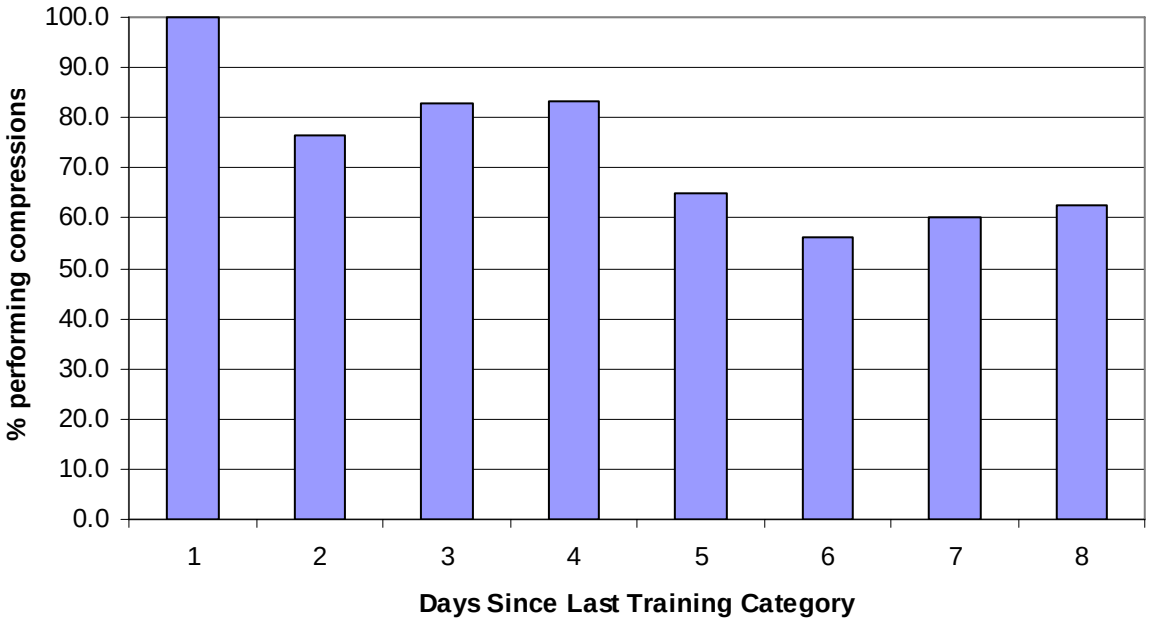


Figure 4.11. Percentage of participants in each "days since last training" category who correctly performed compressions after their victim was unconscious.



Statistical Results

Regression Analysis: Once missing data were removed there were 253 cases. The output for a linear regression of the number of renewals on test score is presented below (Table 4.6). The results suggest that approximately 40% of the variance in first aid multiple choice exam score can be accounted for by the numbers of times certified R Squared = 0.401). The correlation among these two variables is approximately 0.64 and is significant (F [1, 252] = 171.89, $p <$ 0.000).

Table 4.5. Summary output for the linear regression analysis between first aid multiple choice exam score and number of first aid renewals.

Regression Statistics	
Multiple R	0.636796
R Square	0.40551
Adjusted R Square	0.401541
Standard Error	4.990954
Observations	253

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4281.776	4281.776	171.8925	2.9E-30
Residual	252	6277.224	24.90962		
Total	253	10559			

The results for the linear regression of days post certification on score are presented in Table 4.6. Results demonstrate that days post certification is a moderate predictor of first aid multiple choice exam score, but not as good as the number of times certified. The results suggest that only 26% of the variance in score can be accounted for by the days since certification (R Squared = 0.256). The correlation among these two variables is approximately 0.51 and highly significant (F [1, 252] = 86.98, $p <$ 0.000) but less so than the number of times certified and score.

Table 4.6. Summary output for the linear regression analysis between first aid multiple choice exam score and days since first aid training.

Regression Statistics	
Multiple R	0.50656
R Square	0.256603
Adjusted R Square	0.252635
Standard Error	5.581122
Observations	253

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2709.473	2709.473	86.98449	5.94E-18
Residual	252	7849.527	31.14892		
Total	253	10559			

General Summary

In summary, the number of times certified appears to be a much better predictor of performance on subsequent tests of first aid knowledge. Due to the moderate to large correlation between these variables, reasonable predictions of test score based on the number of prior certifications can be made.

Chapter 5

CPR Skill Retention Literature Review

CPR Skill Development and Retention: A Review

Objective: Despite wide-spread training initiatives spanning 30 years, the number of lives saved through the initiation of basic life supporting first aid remains suboptimal. This review consolidates information pertaining to cardiopulmonary resuscitation (CPR) skill retention and training practices. **Methods:** This article provides a systematic review of articles found in searches using Medline (through PubMed), ScienceDirect, and Academic Search Premier. **Results:** In reality, all skills decay. Retention of CPR skill and knowledge will depend on a multitude of factors, including task complexity, time spent on rehearsal, previous training, and type and length of instruction. **Conclusions:** In order to increase ultimate survival rates of person's suffering cardiac arrest, changes may be required in CPR training methods, skill refresher frequencies, and the CPR message itself.

Key Words: Cardiopulmonary resuscitation, education, training, knowledge, practice

Introduction

Survival from cardiac arrest remains low, despite the introduction and dissemination of clear guidelines for cardiopulmonary resuscitation over 30 years ago. Despite wide-spread initiatives in Canada and the US to train health care providers and laypersons alike, the number of lives saved through the initiation of basic life supporting first aid remains suboptimal, due in part to the low rates of life saving attempts by bystanders (Axelsson, 2001: Eisenburger and Safar, 1999; Moser and Coleman, 1992). In both Europe (Lund and Skulberg, 1976; VanHoeyweghen et al., 1993) and the United States (Becker et al., 1991; Gallagher, Lombardi and Genis, 1995; Jackson and Swor, 1997) bystander initiated CPR is reported to occur in less than 30% of all cases when warranted; however, a bystander or workplace first aid provider able to deliver CPR followed quickly by advanced cardiac life support improves both survival rate and recovery (Bossaert and VanHoeyweghen, 1989; Gallagher, Lombardi and Genis, 1995; Gilmore et al., 2006; Herlitz et al., 2005; VanHoeyweghen et al., 1993).

Bystander initiated CPR increases a victim's chances of survival in cases of ventricular fibrillation from 20 to 40 percent (Pearn, 2000). Increasing survival rates through rapidly employed CPR is just one of the reasons why CPR is taught, and millions continue to be trained and respond. Over 17.5 million people are trained in CPR techniques annually in the United Sates (Eisenburger and Safar, 1999), but how effective is that training, especially in the long term? Further, what is the rate of skill deterioration in those who are trained to provide these services?

For individuals who possess advanced training in anatomy, physiology, and pathophysiology and who are working within the health care system, there is strong evidence of CPR skill deterioration after 6-12 months post-training. However, these results can not be generalized to non-health related workplace settings or to civilian bystanders. Knowledge of

skill deterioration of those employed to provide first responder care to person's in commercial, service, and industrial settings will be critical to policy development and review concerning training and re-training schedules for those hired in a workplace setting to provide critical first aid and CPR. For this reason, this review will address the training and retention of CPR skills and knowledge.

Methods

The literature reviewed in this paper was identified using three primary database searches: Medline through PubMed, ScienceDirect, and Academic Search Premier. Dates were not limited with the exception of ScienceDirect; dates were limited to 1960-2006. The results of this search are listed in Table 5.1.

Research articles published in English were selected between 1985 and 2007, and reference lists were scrutinized to find relevant, historical documents. In the end, the most relevant 100 articles were included in the review, spanning 1956 to 2007 – 41% of which were published between 2000 and 2007, 33% published between 1990 and 1999, and 15% published between 1980 and 1989.

Table 5.1. Library search results.

	PubMed	ScienceDirect*	Academic Search Premier
CPR	4653	2251	2315
CPR + Training	827	292	289
CPR + Retention	100	58	34

* limited to 1960 – 2006.

CPR Background

In order to achieve conscious survival for those who lose their airway or pulse, immediate resuscitation is required. This immediate response is typically performed by a bystander and/or workplace first aid provider who serves as the first link in the 'chain of survival'.

Complete upper airway obstruction often occurs in unconscious individuals due to soft tissue obstruction (Safar, 1958). Airway obstruction must be managed in a fast and efficient manner for the following reasons: 1) Complete airway obstruction can lead to cardiac arrest within 5-10 minutes (Kristoffersen, Rattenborg and Holaday, 1967); 2) Permanent brain damage may occur after four minutes of cardiac arrest without circulation (Cole and Corday, 1956); and 3) Permanent damage to the heart will occur after 20 minutes (Reich et al., 1990). Optimal CPR has been reported to preserve neurologic function (Sanders et al., 1987) and brain viability after even after 10 minutes with no circulation (Angelos, Safar, and Reich, 1991). Gilmore et al. (2006) found that the odds ratio of survival improved when a person in cardiac arrest received bystander initiated CPR, and that the importance of this intervention was more pronounced when the time interval between collapse and defibrillation increased.

In order to provide immediate, basic life-support measures to members of the public, basic life supporting first aid training was introduced in the 1960's. Community education programs have been educating citizens in cardiopulmonary resuscitation techniques since the 1970's with the hope that more bystanders would take the lead in providing CPR while reducing premature deaths. These measures initially included control of airway and breathing (A,B,C's) in 1961 (Lind, 1961; Morikawa, Safar and DeCarlo, 1961; Safar, 1958). Nonetheless, it was not until the efficacy of external chest compressions were documented (Jude, Kouwenhoven and Knickbocker, 1961; Winchell and Safar, 1966) that the A,B,C's became mainstream and were endorsed by the American Heart Association in 1966

(Eisenburger and Safar, 1999). However, it is important to recognize that due to the minimal blood flow that is created through the use of external chest compressions, they remain the most serious limitation in properly performed CPR due to the low perfusion pressures created (Bircher et al., 1996).

CPR Skill and Knowledge Assessment

CPR skill and knowledge assessment have been reported utilizing a number of different methods (Berden et al., 1992; Brennan and Braslow, 1995; Brennan et al., 1996; Kaye et al., 1991). Measures of CPR skill typically include checklists and manikins that record rate and depth of both ventilation and chest compressions. Items making reference to CPR knowledge include multiple choice exams, and the demonstration of proper sequence for the steps involved in proper CPR performance. Brennan et al. (1996) report that assessment methods are rarely described in the detail required for study replication, and few studies report the validity and/or reliability of their assessment methods (Berden et al., 1992; Brennan et al., 1996).

Reliability and validity of CPR evaluation methods have recently been questioned bringing to light the issue of standardization between different studies (Berden et al., 1992; Brennan et al., 1996). While the evaluation of training has typically relied on American Heart Association or American Red Cross performance checklists, inter-rater reliability is reported to be low (Brennan and Braslow, 1995), and visual assessment of compression and ventilation has been questioned (Mancini and Kaye, 1985). Brennan et al. (1996) identified four challenges posed when utilizing skill sheet evaluation: the interpretation of minimum adequate performance; assessment of compression rate and depth; assessment of ventilation proficiency; and, dividing the attention of the rater between a large multi-page checklist and the subject. They demonstrated that the use of the Laerdal Recording Resusci-Anne manikin allowed for precise recording compressions and ventilations that, when combined with simplified

qualitative checklists for assessment (14 items), produced a reliability coefficient of 0.87 across a sample of 171 CPR trainees.

Criteria for retention of CPR skills have traditionally integrated the American Heart Association or American Red Cross criteria with the use of a recording manikin. Winchell and Safar (1996) used the ability to feel pulse, ventilations of greater than 5 l/min, and more than 30 compressions in the second minute as their criteria in one of the earliest studies on skill retention. Berkebile et al. (1975: as cited in Eisenburger and Safar, 1999) proposed both a "relaxed" and a "stringent" criteria. Their relaxed criteria included correct sequence, no injurious performance, and 12 ventilations of over 0.8 liters and 60 or more compressions in the first two minutes. Their stringent criteria, in addition to the above included feeling a pulse within 10 seconds, six 0.8 litre ventilations in each minute, a minimum of 20 compressions in the first minute, and 40 compressions in the second minute, with compressions initiated within the first 30 seconds of patient contact.

Criteria for retention of CPR skills have typically included both sequence and skill information. Berden et al. (1992) developed criteria based on American Heart Association Guidelines, assessing correct hand placement on the chest, compression rate, compression/relaxation ratio, compression depth, ventilation volume and breathing interval. The six criteria were independently evaluated against a standard, and penalty points were assessed for incorrect performance, based on the deviation from the standard guidelines. The scoring system was easily applied in practice, had small inter- and intra-observer variability, and produced reproducible results while sensitive enough to pick up changes in skill after training. Brenan et al. (1996) adopted a revised, simplified checklist that rated each of 14 essential skills on a five point subjective rating scale as either outstanding, very good, competent, questionably competent, or not competent. The checklists provided coefficients of similarity between two raters of 0.76 and 0.98 across the 14 items, and when used in

combination with a recording manikin, provide a reliable and valid measure of CPR skill performance. The use of a combination of checklists for procedural elements and manikins with recording capabilities for performance elements was strongly recommended for evaluation (Jansen et al., 1997).

CPR Skill Retention

The performance of CPR requires approximately 50 separate psychomotor skills applied in a specific sequence (Flint et al., 1993). With such a complex task (regardless of teaching methods) one should expect CPR skills and knowledge to decay. In fact, this is not unique to CPR, as all psychomotor skills decay without rehearsal (McKenna and Glendon, 1985).

Studies of CPR knowledge and skill retention suggest a rapid deterioration of psychomotor skills post-training, with a slower, but progressive loss of CPR knowledge. Retention of CPR skills have been most widely studied in clinical settings, in both practitioner and trainee populations, and suggest that CPR performance of nurses and other health care practitioners is often unsatisfactory within a short time post-training. It is suggested that, even in health professionals, CPR skills deteriorate to pre-training levels within 6-12 months (Eisenburger and Safar, 1999).

In a study of pre-clinical medical students attending Denver General Hospital, Fossel et al. (1983) had assessed ventilation and compression depth and rate in those who had received CPR certification 2-3 weeks prior, one year prior, or 2 years prior. In this group, significant ($p < 0.05$) differences were found in both practical skill and knowledge between the 1 and 2 year groups as compared to group trained 2-3 weeks prior. Rate of chest compressions and compression to ventilation ratio by single rescuers were most problematic.

When examining the CPR skills of registered nurses and physicians who had been trained in CPR techniques within the previous 4 – 12 months, Kaye and Mancini (1986) found that none of the participants were able to perform each step of CPR in proper sequence as outlined by the American Heart Association (AHA). No significant difference was found between MDs and RNs, although when compared to the general public, physicians and nurses were statistically better. Similar results were found in laypersons who had received a 4 hour Basic Life Support course (Weaver et.al., 1979), with CPR skills and knowledge decreasing significantly shortly after training. Kaye and Mancini (1986), while not testing the cognitive aspect of the CPR training, found that the psychomotor skills presented the greatest difficulty, with inadequate compression rates and depths, and no call for backup or emergency medical assistance. Similarly, Martin, Loomis and Lloyd (1983) found a significant decline in both the psychomotor skills and knowledge (sequence) required to perform adequate CPR three months post-training in health professional students.

The skill and knowledge components have been separated out in several studies of CPR retention. CPR skills include correct rate and depth of ventilations, and rate, depth and hand placement during compressions; CPR knowledge is typically represented by the demonstration of the proper sequence of events, regardless of their effectiveness. One assumption that is often made is that increased knowledge will be related to increased performance, although Brown et al. (2006) found this to be only true for performance of chest compression rate and compression to ventilation ratio. In their review of the literature, Moser and Coleman (1992) suggest that CPR skills appear to decline at a faster rate than knowledge, with significant decline in CPR skills occurring as early as two weeks post-training. Leith (1997) documented CPR knowledge retention for 6-12 months post-training in intensive care nurses, but an inability to meet the standard passing criteria in CPR skill performance. On the contrary,

Broomfield (1996) observed significant decline in both CPR knowledge and skill in nurses after only 10 weeks post-training.

Data examining CPR skill and knowledge retention in lay persons is less abundant. In one study, Gombreski et al. (1982) demonstrated significant decline in skill retention in groups of trainees who had either a four or eight hour course after one year. Weaver et al. (1979) demonstrated significant decline in both knowledge and skill after six months CPR training in a group of laypersons, with not one person performing without error at the six month retesting. Glendon et al. (1988) demonstrated a significant time effect demonstrating CPR skill decline when laypersons were re-tested at three month intervals, with the rate of decline dependent on their initial skill mastery. In their literature review, Kiskaddon and Sternbach (1985) found no support for the notion that CPR skills are retained for a two year period, with skill retention loss occurring as early as two weeks post-training.

Only one study could be found that documented CPR skill retention in occupational first aid providers (McKenna and Glendon 1985). These authors measured the CPR skills of 124 occupational first aid attendants at 2, 6, 18 and 36 months post-training. Their results showed a rapid, linear decay in CPR skills from 2 to 36 months, with a 50% decline in performance over 2 months. Only 2.4% of those trained were deemed to be effective after three years. As with other authors, these authors concluded that CPR retraining must occur more frequently if industrial first aid legislation was to provide protection to employees who were under the assumption they would be provided adequate care should it be required.

Similarly, Moser & Coleman (1992) found that although learning the skills can be accomplished through various training methodologies, the deterioration of the skill retention and inadequate performance began after two weeks post-training – one year post-training the knowledge and skill level had reached pre-training levels. Other retention studies with healthcare professionals suggest neither advanced education, nor background, improve CPR

retention. Furthermore, Gass and Curry (1983) found that even though the physicians had a greater knowledge base of physiology and diagnoses of patients, when compared to nurses both demonstrated equally poor skill retentions. Methods suggested by Moser and Coleman (1992) to improve retention included a retesting at approximately four months and six months after initial testing. This resulted in increased retention when retested again several months later, compared to control group subjects who were not retested. Manikin review in short review courses have been demonstrated to improve skills retention (Nelson and Brown, 1984). Even minimal practice improved significantly CPR retention. Moser and Coleman (1992) conclude that manikin practice in the first six months post initial training, at the six month mark, and one year post initial training improves CPR skill knowledge and performance within the conditions of feedback directly after performance–test period and actual hands-on practice.

Many studies have suggested strategies for improving skill retention. Moser and Coleman (1992) identified factors having a positive impact on CPR skills retention as being: demonstrations with commentary on purpose of technique; use of manikins for more realistic skills movements; provision of quantitative immediate and frequent feedback; practice (longer classes six to eight hours) to allow for mastery of each skill of CPR; practice during and after training is needed, with an initial review within two to four weeks post-training, followed by periodic retraining three to six months. Lewis et al. (1993) concluded that for optimal skill maintenance constant reinforcement is required. Variables related to knowledge and skill retention were increased frequency of training or time spent performing the actual skills involved in CPR. This is supported by the results of Reigel et al. (2005) who demonstrated a clear relationship between prior training and experience and skill retention. Lewis et al. (1993) conclude that under current AHA guidelines the knowledge and skills are not retained adequately when tested one-year post-training. Davies and Gould (2000) suggest that CPR

teaching methods and retraining schedules may require refinement in order to effectively increase resuscitation skills.

CPR Teaching Methods

Since the development of CPR standards in 1974, the ABC's of CPR have been taught widely throughout the developed world. Eisenburger and Safar (1999) report 17.5 million people were trained in CPR techniques in the US in 1999, suggesting that 6.5% of the population receives CPR training annually. However, the ability to perform these skills deteriorates rapidly, and many have questioned the ability of the traditional course-based training to adequately develop the necessary skills required (Eisenburger and Safar, 1999). Despite the wide-spread training, these authors suggest that the bystander is the weakest link in the life support chain. Davies and Gould (1999) suggest that CPR teaching methods and retraining schedules may require refinement in order to effectively increase resuscitation skills.

Brennan (1991) investigated the quality of cardiopulmonary resuscitation (CPR) instruction by the American Heart Association instructors and other course factors in prediction of student achievement of bystander-initiated CPR. Student factors such as age, reading ability and prior CPR training were significant predictors of success. Videotape and workbooks were also found to produce an increase in student achievement. One of the significant main effects studied was the addition of material given to the class by the instructor, or instructor-led lectures, which were found to decrease student performance due to reduction of class time that could have been otherwise allotted to more valuable class activities such as practice of motor activities.

Despite widely disseminated and clearly articulated guidelines related to CPR training (Handley et al., 1998; Robertson et al., 1998), there appears to be wide variability in the training of either basic or advanced life support (Garcia-Barbero and Caturla-Such, 1999; Nurmi and Castren, 2004). These disparities have been recognized for some time, prompting Kaye et al. (1991) to bring forth a different perspective, relating poor CPR skills to instructors that did not deliver the standardized course despite clearly outlined curriculums. Limitations on practice times, uncorrected errors in performance, and consistently rating student's performance as acceptable when they were in fact not, led Kaye et al. to conclude that a checklist is an inaccurate evaluation tool for CPR assessment, and that poor retention of skills may lie with instructor or curriculum rather than the learner. To address poor learner results, many studies have examined alternative or adjunctive types of training.

Instructor-Lead: Traditional course-based CPR training has been the topic of investigation since introduced in the 1960's and 1970's. While the ability to make an immediate impact on CPR skill performance is not questioned in the literature, the ability of this type training to have lasting effects on CPR skill retention have been widely debated (Eisenburger and Safar, 1999).

In traditional lecture-based courses, the instructor is to provide feedback on performance to insure that trainees develop the proper sequence and methods of skill execution. The instructor is to supervise trainee practice to develop competencies in CPR delivery. However, the instructor's ability to develop task mastery in these class-based situations has recently been brought into question (Brennan and Braslow, 1998; Kaye et al., 1991). For example, Brennan and Braslow (1995) found that trainees did not practice the skills until mastery, and that they were provided ineffective feedback concerning errors or omissions in CPR performance. At the end of instruction, these authors found that only 1 in 10 of the

trainees could perform both compressions and ventilations correctly, with fewer than 12% of all compressions and 25% of all ventilations meeting published criteria. These authors concluded that such courses fail to adequately prepare trainees for meeting published CPR criteria, and that the lack of perfected skill during training could greatly impact measures of retention of skills.

Similar conclusions were made by Kaye et al. (1991) who found instructors to deviate significantly from the set CPR curriculum, resulting in non-standardized instruction with large variances in acceptable performance. While instructors consistently rated trainee performance as acceptable, the authors consistently rated them as unacceptable. The lack of adequate skill development was suggested to be in part due to poor instruction in skills, lack of practice time, and poor error detection and correction during skill practice. These authors clearly identify the instructor as a weak link in developing adequate CPR skills and skill retention and suggest that more practice time with immediate feedback on skill performance is required to improve trainee skill development. This is consistent with skill acquisition literature. Hagman and Rose (1983) found repetition in presentation of information can lead to improved performance, but physical repetition of the skill is required for long-term skill retention. The nature and frequency of training are essential elements in skill development and retention.

Simplified deliver of instruction has also been investigated in traditional classroom settings. A three staged approach to teaching CPR was proposed by Assar et al. (1998) as a potential strategy to increase skill retention, and reduce the difficulties trainee's have in learning a complex skill in a short period of time. Using this approach, Chamberlain et al. (2001) concluded that there may be several advantages to the staged-approach, although conclusive evidence was not provided due to poor re-test participation and low final numbers of participants. Assar et al. (1998) suggest that following instruction in the simplest stage of this approach (bronze stage), trainees more frequently shouted for help, opened the airway, and

mentioned to phone an ambulance. In a follow-up study, Smith et al. (2004) did however find better retention of CPR skills 6 to 12 months post-training following a staged approach to teaching. These observations fit well with contemporary skill acquisition and retention literature that suggests dispersed practice to lead to better skill development and retention as compared to massed practice (Hagman and Rose, 1983).

Task complexity and inherent task organization are important factors in skill retention (McKenna and Glendon, 1985). If this holds true, simplification of the CPR process and sequence should improve skill retention, and has been suggested by others (Flint et al., 1993). To examine the impact of task complexity, Handley and Handley (1998) examined the retention of performance 1 and 6 weeks post-training using both an 8-step and 4-step training program. These authors found the simplified program of instruction significantly increased the number of participants who could remember the sequence of skills, while there was no significant difference in the quality of performance. Hallstrom et al. (2000) examined the outcomes following operator assisted CPR, having operators use either traditional (chest compressions and ventilations) or simplified (chest compressions only) instructions. The simplified instructions reduced the time for instructions by 1.4 minutes (from 2.4 to 1.0 minutes), while rates of survival to hospital discharge did not differ between the two instructions. Uninterrupted chest compressions have been put forward as a simple, easy to remember alternative to traditional CPR (Heidenreich et al., 2004; Dias et al., 2007). In comparing traditional CPR to chest compressions alone, Heidenreich et al. (2004) reported better skill retention for chest compressions alone, with a greater number of chest compressions being delivered. Similarly, Dias et al. (2007) found the number of chest compressions to the correct depth, and the proportion of compressions performed without error were both significantly better when performing chest compressions when following operator-assisted CPR instruction. With continuous chest compressions Higdon et al. (2005) reported 88

compressions per minute, as compared to 44 chest compressions using the standard CPR recommendations. These results are similar to Odegaard et al. (2006) who found 73 compressions per minute with continuous compressions and 40 and 43 with compression:ventilation ratios of 15:2 and 30:2 respectively. However, while providing more chest compressions, the depth of compressions were significantly less in the continuous chest compression group, and their depth decreased with time of performance. Yet, despite declining performance, those who performed continuous chest compressions had significantly less time with no blood flow (1%) as compared to either compression:ventilation ratios of 15:2 (49% of time with no flow) and 30:2 (38% of time with no flow).

Simplifying the CPR message to include continuous chest compressions has been advocated by many. The notion of providing only chest compressions without ventilations has accumulated support from both human and animal studies. In swine, following three minutes of untreated ventricular fibrillation, swine that received chest compression only CPR almost twice the left ventricular blood flow as compared to those that receive a 15:2 compression-to-ventilation ratio (Berg et al., 2001). Attempts to defibrillate and regain spontaneous rhythm in these animals following the 15 minutes was found to be far superior (12 of 15 versus 2 of 15) in those receiving continuous chest compressions (Kern, et al., 2002). While arterial oxygen saturation was higher in those receiving traditional CPR using a ratio of 15:2, oxygen delivery is not jeopardized due to increased perfusion (Berg et al., 2001). To help maintain arterial oxygen saturation, Sanders et al. (2002) suggested using continuous chest compressions for the first four minutes, followed by a compression to ventilation ratio of 15:2, finding 24 hour survival and neurological outcomes to be best in this condition.

In human studies, Abella et al. (2005) found chest compression rates during CPR performed in-hospital to be well below the published guidelines. In their study, return of spontaneous rhythm was associated with increased chest compressions frequencies, with mean

compression rates of 90±17 in survivors as compared to 79±18 in non-survivors. In order to increase the number of chest compressions, Heidenreich et al. (2004) suggest using uninterrupted chest compressions, as the two breath sequence delays chest compressions for 13 seconds. In an animal model, Yu et al. (2002) demonstrated that delays in compression that exceeded 15 seconds compromised survival and post-resuscitation myocardial dysfunction. Using computer simulations Turner, Turner and Armstrong (2002) suggest that continuous chest compressions in humans can generate significantly higher blood flows (1.39 l/min) as compared to those receiving a 15:2 compression:ventilation ratio (0.86 l/min). Also using computer simulations, Babbs and Kern (2002) found the current guidelines to significantly overestimate the need for ventilations, suggesting a compression ratio of 60 compressions to 2 ventilations may be better for lay rescuers.

There is growing evidence suggesting that a simplified CPR protocol, which may be as simple as continuous chest compressions, may provide better outcomes for those suffering out of hospital ventricular fibrillation. Any technique that minimizes the time of interruption of chest compressions may be useful in maintaining forward flow pressures and the probability of spontaneous return of circulation following defibrillation (Berg et al., 2001; Eftestol, Sunde and Steen, 2002; Kern et al., 2002; Kern et al., 2005; Sanders, et al., 2002; Turner, Turner and Armstrong, 2002). Simplified versions of CPR that reinforce chest compression rate and depth may be of great benefit to victim survival (Kern et al., 2002), and may lead to better skill retention (with fewer variables to remember) (Heidenreich et al., 2004). It is also postulated that removing mouth-to-mouth ventilations may increase the rate of bystander CPR administration, with mouth-to-mouth contact being a primary concern of bystanders. In Arizona, Locke et al. (1995) reported only 15% of the population surveyed would definitely perform CPR that included mouth-to-mouth resuscitation on a stranger, while in the same

population, found 68% to report they would definitely perform CPR that included chest compressions alone.

Self-Training: Self-training involves the use of learning aids such as flip charts, audio and video tapes to deliver the basic skill instruction, couple with skill practice during which automated feedback is provided immediately. Early studies were promising using self-training in children attending public schools. In one such study, Berkebile (1985) found film viewing with self practice to provide better retention of CPR skills one year post-training in grade seven and 11 students as compared to those of students receiving the standard instructor lead course. Kaye et al. (1983) found passing rates for CPR performance to be higher in trainees who performed computerized video-disk self-training as compared to traditional course-based trainees. Using a computer based automatic correcting, verbal feedback system built into a manikin, Wik, Thowsen and Steen (2001) demonstrated immediate improvement in skills performance. Using the same system, Wik et al. (2005) later found 10 three minute self-training sessions spaced throughout the year to eliminate skill deterioration over that time. Davies and Gould (1999) found self-instruction retraining in CPR with manikin practice increased competence in subjects when compared to subjects who were not given the opportunity to retrain.

More recently, Braslow et al. (1996) developed and evaluated a video self-instruction system that utilized a 34 minute video tape and a take-home manikin. Trainees were provided no written material, or physiological explanations, only performing mimicry by mirroring what they viewed on the video. This self training technique with manikin practice resulted in 80% of the trainees meeting published criteria for adequate performance, as compared to 45% in the traditional course-based control group. Following up 1 month post training, self-trained

trainees still out-performed their traditionally-trained counterparts. These authors (Batcheller et al., 2000) then targeted training of family members of at risk individuals using the same video training technique. Immediately post-training, those individuals who were exposed to video-self training performed better than those that were provided a four hour traditional training workshop. Using a similar 30 minute video self-instruction method, Lynch et al. (2005) also found trainees who were trained using video self-instruction to perform better than untrained peers on both procedural and performance items, while performing generally better than those receiving traditional training over 4 hours. Todd et al. (1999) also compared video self-instruction to a traditional 4-hour CPR course in a population of African Americans, and also found the video self-instruction trainees to perform as well as those trained in the traditional way on both performance and knowledge-based criteria. Results of self-training techniques to date suggest that self-training methods might be a useful technique to deliver CPR instruction in a self-paced, time and place dependent environment that may be appealing to many trainees. However, not all literature is supportive. Friesen and Stotts (1984) compared CPR retention of nursing students who received either lecture demonstrations or self-paced instruction, finding knowledge to be retained with either instructional scenario, while the skills deteriorated significantly after 8 weeks regardless of the format of instruction.

Television and Video: While audio-tape or video-tape directed self-practice on manikins has been reported to lead to similar or better CPR skill development and retention, this is often related to time spent on manikin practice. However, without manikin practice, Berkebile (1985) found increased skill and performance with repetitive film viewing alone, without skill rehearsal. Lane and Nagase (1980) found that video tape viewing alone resulted in 41% of students and 21% of soldiers recruited for the study to meet acceptable standards in CPR immediately following. Capone et al. (2000) used television viewing to expose an adult

Brazilian population to CPR methods. Their results suggested a significant improvement in CPR performance in those who had viewed the television, although performance was poor in both groups, especially in ventilation and compressions.

In 2004 a group of students were exposed to the European Union funded "JUST-in-time health emergency interventions – training for non-professionals by virtual reality and advanced IT tools" (Monsieurs et al., 2004). The interactive CD provided step-by-step instructions in basic lifesaving skills, with a video of real life application and a self-testing area. Students exposed to the CD viewed it for a mean time of 42 minutes, after which they demonstrated better assessment and procedural skills, but not motor skill acquisition with poor airway control, ventilation and compressions.

In the town of Everett, Washington, Eisenberg et al. (1995) sent out 8,659 10-minute videos which outlined proper CPR techniques. These authors then followed up each witnessed cardiac arrest to determine if the person who initiated the CPR had received, and importantly viewed, the video. During their surveillance 65 cardiac arrests occurred, of which 47% of those bystanders who initiated CPR had received the video. With 53% of the bystanders who initiated CPR had not received or viewed the tape, the general conclusion was that mass mailing of videos was not an effective intervention to increase bystander initiated CPR rates. In fact, at nine cardiac arrests there was a bystander who had received the tape that did not initiate CPR. While the results of such studies are not promising, the use of television in retraining or providing refresher type exposures to those who had previously mastered the skill have not been investigated. Short exposures to CPR throughout the year have been reported to effectively reduce skill deterioration (Wik et al., 2005).

The use of videos as an adjunct to classroom lectures are now being promoted, with the introduction of "practice-as-you-watch" and "watch then practice" approaches (Cummins and Hazinski, 2000).

Internet: According to Pew Internet & American Life Project in 2006 73% of Americans regularly used the internet, with 42% having broadband connections (www.pewinternet.org). There has been a rapid proliferation of internet use in North America, with only 66% of Americans having internet, and 29% having broadband in 2005. With this proliferation in internet, and particularly broadband access, the internet has become a venue for distribution of training and skill refresher types of material. While much CPR material exists on the internet, including much information on basic life support, with broadband access, CPR instruction via the internet can take many forms including text, illustrations, audio clips or short videos. Petersen (2006) suggests that the internet offers convenient, flexible, and potentially less intimidating experience. Petersen suggests that internet viewing prior to recertification may be beneficial, as webpage content can concise, interactive, and trainees can review material in increments on their own time. The use of the internet in recertification preparation in a clinical environment increased CPR compliance from 79 to 99.8% over the first three years of its implementation. However, while data is limited, contrary points of view are available. For example, while Castren et al. (2004) found the internet to be as effective as course-based instruction in teaching lay persons defibrillation using automated external defibrillators, Makinen et al. (2006) recently concluded that internet training could not substitute for traditional small-group training. This is in line with the findings of Teague and Riley (2006) who found the internet a useful tool for developing knowledge, but not in the development of the motor skills required to perform CPR. Conclusive evidence to support or refute the use of the internet for training and retraining of CPR skills is still to be presented.

Conclusions

In reality, all skills decay. Retention of CPR skill and knowledge will depend on a multitude of factors, including task complexity, time spent on rehearsal, previous training, and type and length of instruction. When training laypersons and school aged children, simplifying the information has met with some success, and the use of continuous chest compressions has gain much support in the literature. In all populations, immediate feedback on manikin-based practice consistently yield superior results, although need not be in a traditional classroom-based instructional setting. Previous training does not appear to impact skill deterioration rates, although retraining may be quicker in those who had better skills to begin with, and these individuals may respond to self-training better.

Traditional, class-based instruction has been heavily criticized and has been linked to poor skill retention. Traditional training is thought to have poor outcomes for several reasons, including: limited manikin practice for skill development, with delays between demonstrations and practice (*cf.* Brennan and Braslow, 1995), lack of meaningful, specific, and timely instructor feedback for the purpose of error correction (*cf.* Kaye et al., 1991), course content that is related to background knowledge and not specific to skill development (*cf.* Flint et al., 1993; Kaye and Mancini, 1998), and logistical factors such as time, place, cost, learning environment and student anxieties (*cf.* Braslow et al., 1997; Liberman et al., 2000; Wik, Brennan and Braslow, 1995). For this reason, the use of alternative teaching methods is an area to be investigated. Many of these alternative methods may be useful not only as teaching venues, but methods for allowing repeated exposure to the basic life support messages that may help in reducing the rate of skill deterioration.

Much more research is required to evaluate the use of a blend of methods in CPR skill development and retention, looking at innovative ways to deliver repeated exposure to the basic CPR messages throughout the year. Even with annual renewals, skill deterioration will be significant. Repeated exposure to simplified messages throughout the year may be a simple,

cost effective and efficient way to preserve CPR skills in those who are required to respond to emergencies in an occupational setting.

In order to increase bystander CPR and ultimate survival rates of person's suffering cardiac arrest, changes may be required in training methods, skill refresher frequencies, and the CPR message itself. A simpler message that emphasizes skill development rather than broad-based knowledge, delivered more frequently through multiple media with repeated exposures may well be the future direction of CPR training.

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Chapter 6

CPR Skill Retention Results

A total of 244 participants had CPR training, and complete data for analysis. Of these, 140 were male, and 104 were female, with an average age of 34.3 years. These participants were divided into categories based on the number of days since their last first aid training (category 1 = 1-30 (<1 month); 2 = 31-90 (1 – 2.9 months); 3 = 91 – 182 (3 – 5.9 months); 4 = 183 – 364 (6 – 11.9 months); 5 = 365 – 546 (12 – 17.9 months); 6 = 547 – 729 (18 – 23.9 months); 7 = 730 – 1094 (24 – 35.9 months); 8 = >1094 (3 or more years)). The distribution of participants across the 8 categories of "days since training" are provided in Table 6.1. Of the participants with complete data, 62.7% were trained in CPR at a Level A, and 36.9% at a Level C, and on average, had renewed their certificate 2.5 times.

Table 6.1. Distribution of participants across categories of "days since training".

Category	Age		Male	Female	Certification Level			Renewals
	(yrs)	Number	(%)	(%)	A (%)	B (%)	C (%)	(number)
1	29.4	24	41.7	58.3	70.8	0.0	29.2	1.9
2	37.1	40	62.5	37.5	52.5	2.5	45.0	2.9
3	33.8	38	55.3	44.7	63.2	0.0	36.8	3.8
4	31.5	47	57.4	42.6	53.2	0.0	46.8	2.5
5	36.3	37	62.2	37.8	73.0	0.0	27.0	3.1
6	31.7	19	57.9	42.1	73.7	0.0	26.3	1.5
7	34.7	16	62.5	37.5	68.8	0.0	31.3	1.5
8	37.0	23	56.5	43.5	60.9	0.0	39.1	0.8
Overall	34.3	244	57.4	42.6	62.7	0.4	36.9	2.5

The percentage of person's completing each step in the provision of CPR to an unconscious victim, based on days since training categories, are provided in Table 6.2. The scenario was set up so that an apparently live, frayed electrical wire was lying on the manikin, and the first step in providing a safe response was to unplug the extension cord. However, as few as 50% of the participants recognized and removed this danger before engaging the manikin. Many of the knowledge-related assessment skills appeared to deteriorate with time, such as those involved in determining scene safety, and activation of the EMS. These are typical of decay in knowledge, rather than decay in physical skill. A decline in physical skill can be seen in airway control and landmarking for chest compressions.

Criteria for retention of CPR skills have typically included both sequence and skill information. In 1996 Brenan et al. adopted a revised, simplified checklist that rated each of 14 essential skills on a five point subjective rating scale as either outstanding, very good, competent, questionably competent, or not competent. Using their list of 14 skills on a dichotomous scale as performed or not performed, participants in the present study we provided a potential overall rating out of 14. Figure 6.1 demonstrates average scores out of 14 for each of the categories of "days since training". Scores deteriorated over time since last training, demonstrating a general decay in CPR provision. The highest scores in category 3 may be partially inflated because this group had the greatest number of renewals of any of the groups. There appears to be a positive effect on skill retention with the number of renewals – someone who had renewed their CPR certificate 7 or more times had the highest scores related to CPR skill (see Figure 6.2).

The skill-based components appeared to diminish with time. There was a trend for fewer individuals to correctly landmark for chest compressions (Figure 6.3) and control the airway for ventilations (Table 6.2) as the time since training increased. It appears that the skill-based components may deteriorate in a more predictable fashion following training, while the

reduction in knowledge would be contaminated by the repetition of training in those that had recertified their first aid one or more times. Many of the knowledge-based items did not show any typical pattern of decay, although “ensuring no danger” (Figure 6.5) and “activating the EMS” (Figure 6.6) both showed a decline over time since last training.

Figure 6.1. Calculated relaxed Brennan scores (out of 14) for each category of "days since training".

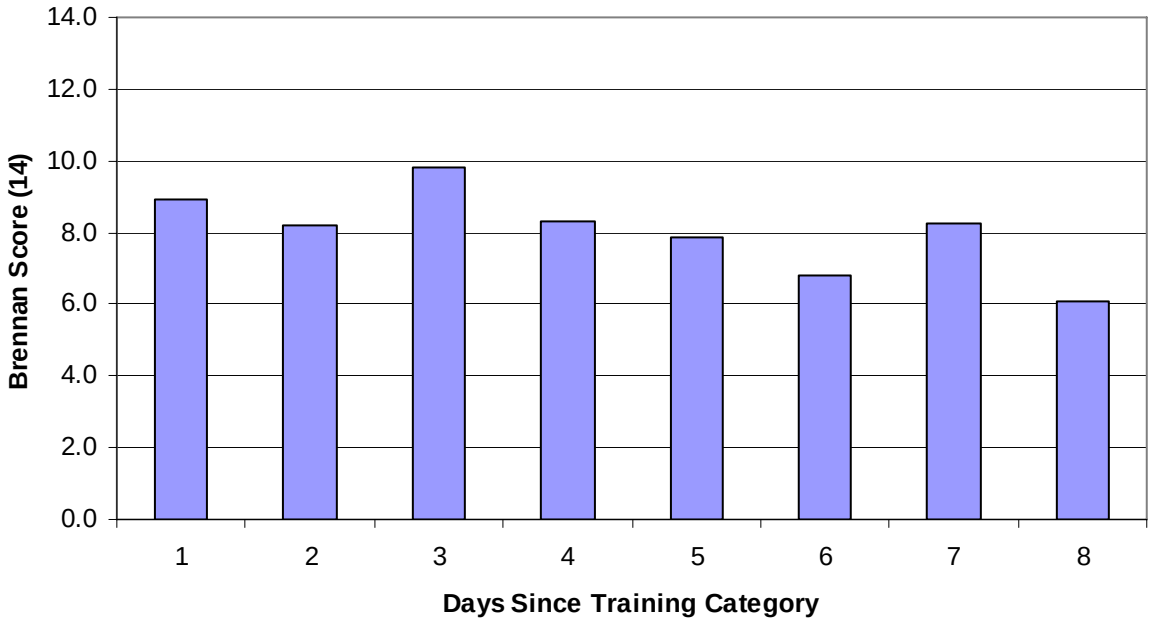


Figure 6.2. Calculated relaxed Brennan scores (out of 14) as related to the number of times participants had renewed their certificate.

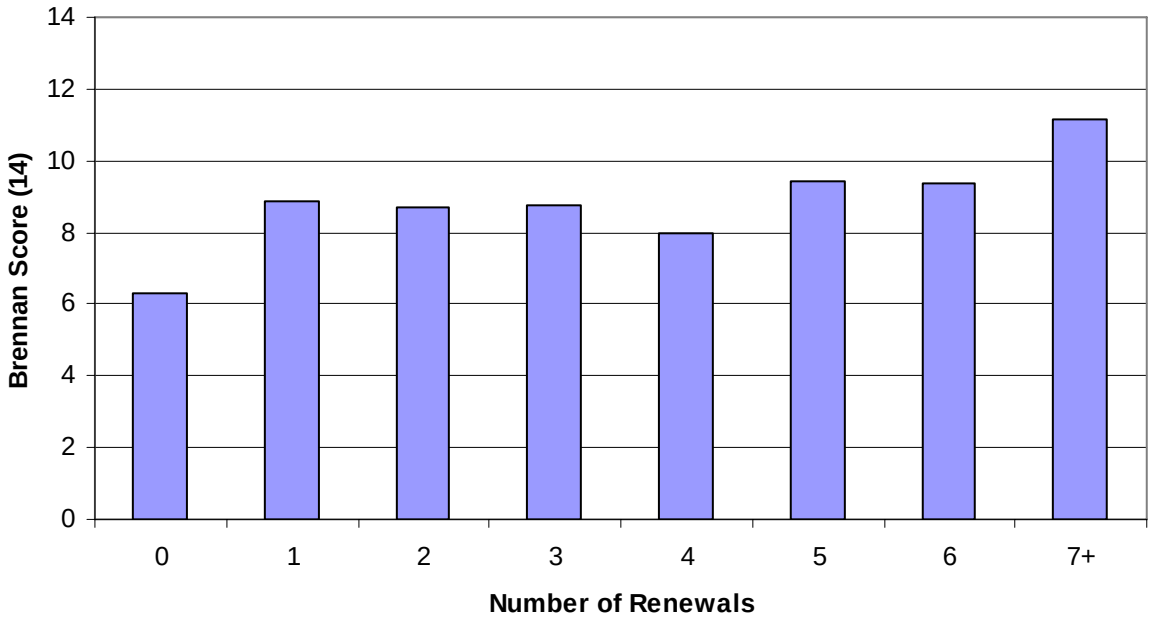


Table 6.2: Unconscious CPR scenario: Percentage of person's completing each step based on days since training

	Days Since Training							
	1-30	**31-90**	**91-180**	**181-365**	**366-547**	**548-730**	**730-1095**	**1096+**
Scene Safety								
Ensure No Danger	63	43	68	60	62	53	50	32
Gloves	25	23	42	51	35	32	31	16
Pocket Mask	67	35	61	62	59	63	50	36
Shake and Shout								
Tap or gently shake shoulder	29	35	34	34	24	32	13	16
Speak to Patient	54	65	61	60	49	58	31	52
EMS								
Activate EMS	71	83	79	72	78	63	63	56
Airway								
Open the airway using appropriate technique	33	28	50	40	30	16	31	20
Maintain open airway	33	33	53	40	35	16	25	20
Look, listen, feel	92	73	84	77	76	63	69	60
Seal pocket mask properly	58	45	71	55	59	26	44	24
Ventilate	79	65	79	70	62	53	69	60
Assess								
Assess for signs of circulation	88	68	87	77	73	74	69	72
Landmark - correct hand placement	67	55	66	55	38	53	44	32
Cycle 1								
Compressions	92	88	97	91	84	95	100	84
Correct Number of compressions	67	56	68	41	59	16	51	24
Ventilate	88	85	92	79	78	79	100	64

Cycle 2								
Compressions	83	88	92	85	84	95	81	80
Correct Number of compressions	79	53	68	47	54	21	50	24
Ventilate	88	78	84	79	76	79	88	64
Cycle 3								
Compressions	92	85	92	89	81	95	94	72
Correct Number of compressions	54	50	76	34	51	21	38	24
Ventilate	92	83	87	77	76	79	94	68
Cycle 4								
Compressions	88	83	92	83	81	95	94	68
Correct Number of compressions	75	53	58	36	54	16	50	24
Ventilate	75	70	79	79	70	74	75	64
Assess ABCs								
Re-assessed pulse	27	21	29	28	26	21	16	16
Re-assessed breathing	27	23	25	27	24	13	25	14
Recovery Position								
Place patient in recovery position	17	38	32	43	22	21	25	24

Figure 6.3. Percentage of participants in each "days since last training" category who correctly landmarked for chest compressions.

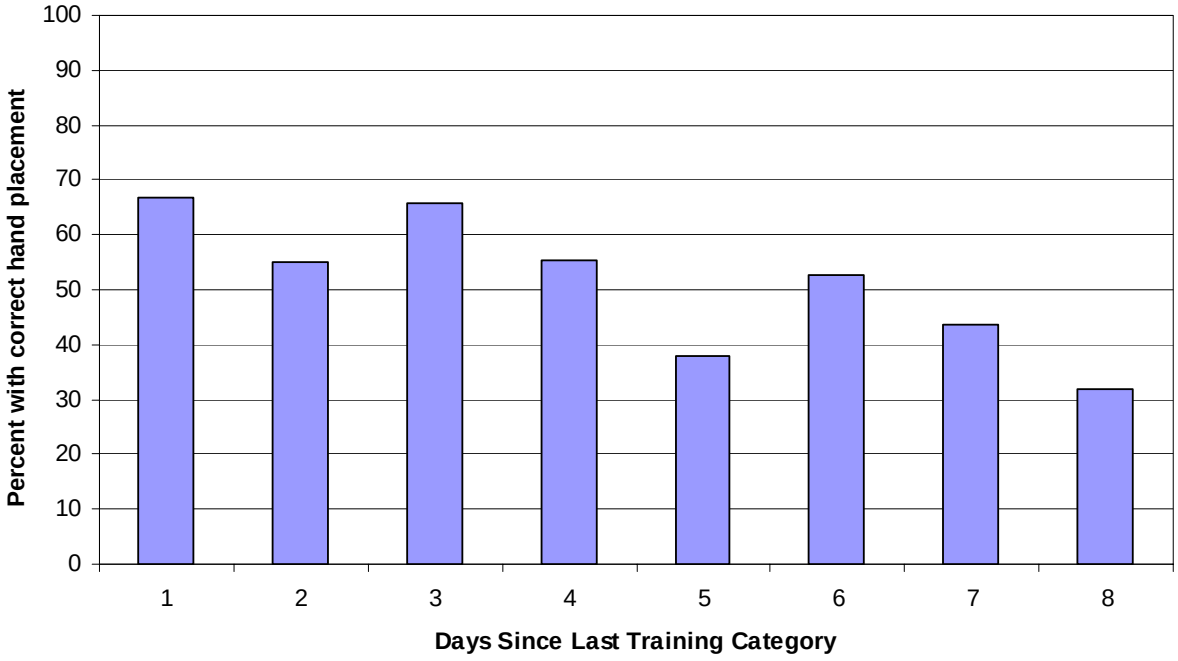


Figure 6.4. Percentage of participants in each "days since last training" category who performed the correct (+/- 4) number of chest compressions.

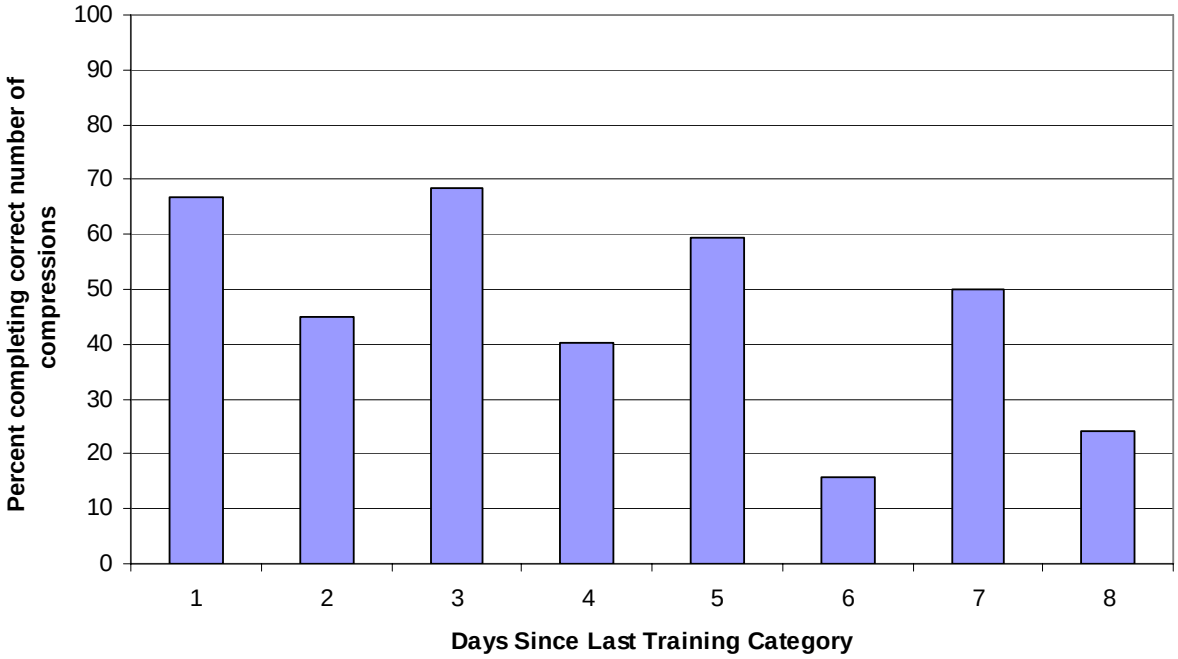


Figure 6.5. Percentage of participants in each "days since last training" category who ensured there was no danger to themselves.

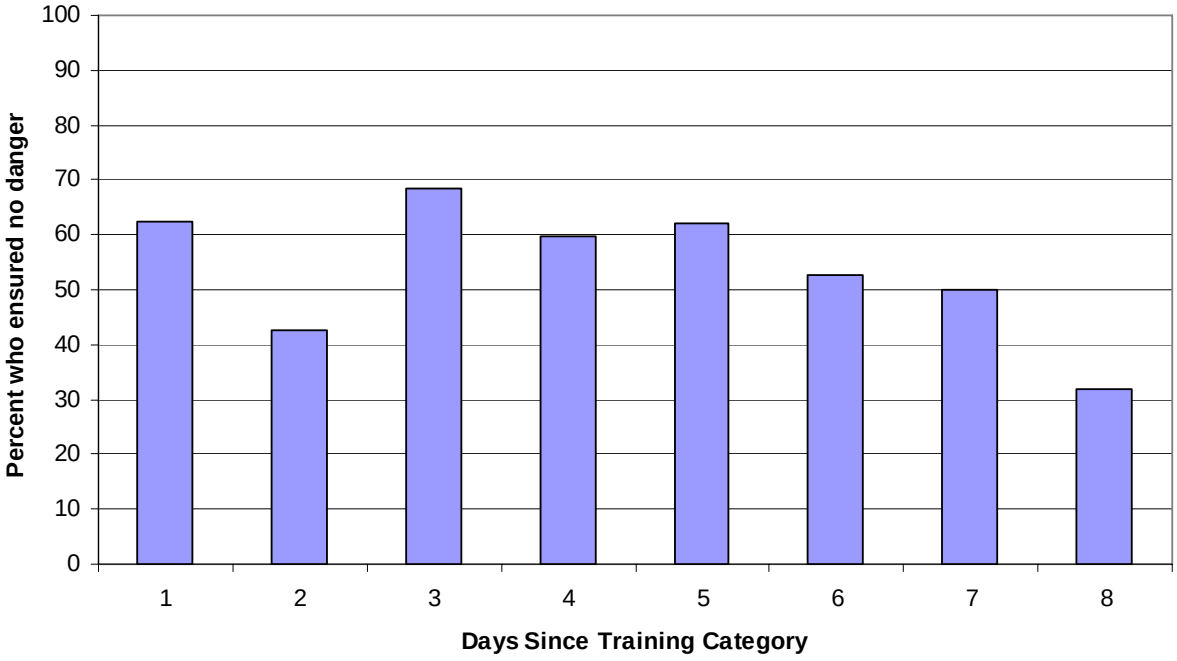


Figure 6.6. Percentage of participants in each "days since last training" category who activated the EMS.

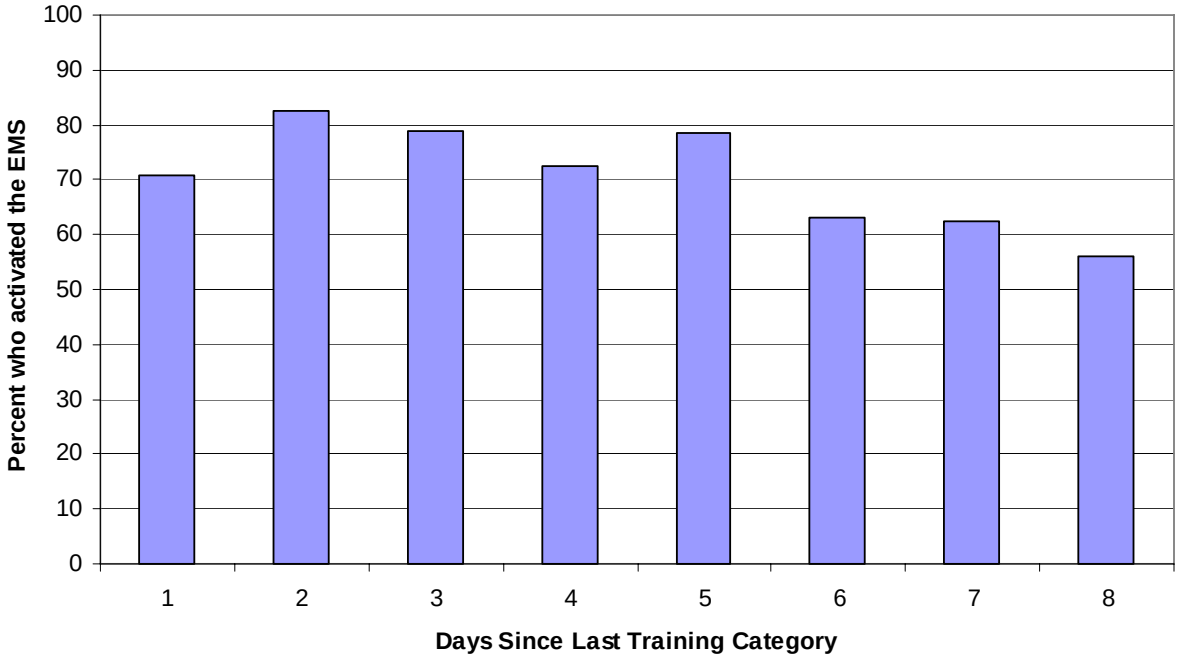


Figure 6.7. Percentage of participants in each "days since last training" category who opened the airway correctly.

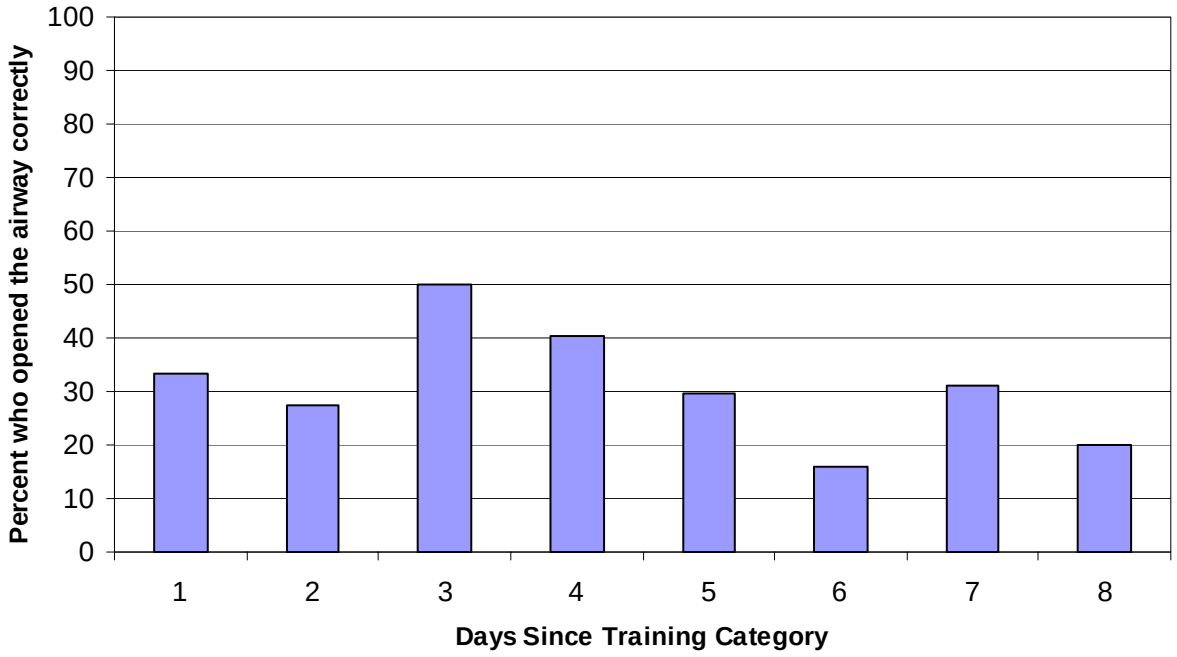
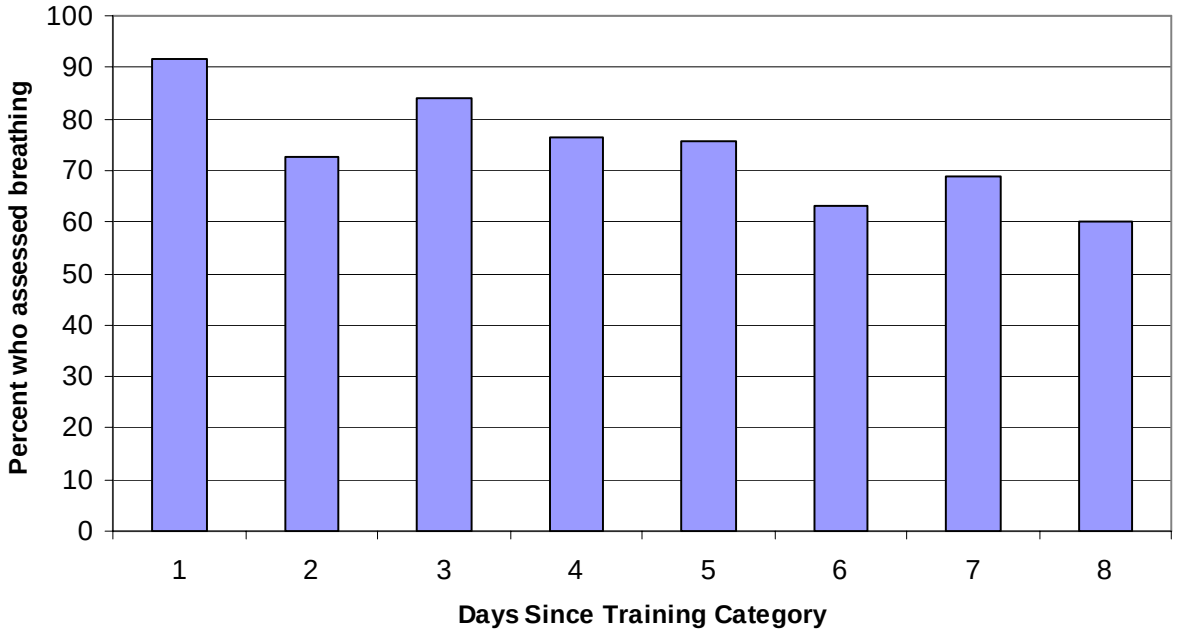


Figure 6.8. Percentage of participants in each "days since last training" category who assessed breathing correctly.



Statistical Results

Regression Analysis: Once missing data were removed there were 243 cases that were used for regression analysis. Below is the output for a linear regression of the number of renewals on test score (Table 6.3). The results below suggest that approximately 15% of the variance in score can be accounted for by the numbers of times certified (R Squared = 0.147). The correlation among these two variables is approximately 0.38 and is significant (F [1, 241] = 41.58, $p <$ 0.000).

Table 6.3. Results of regression analysis using Brennan Scores and Number of Certifications.

SUMMARY OUTPUT **Renewals on Score**

Regression Statistics	
Multiple R	0.383596
R Square	0.147146
Adjusted R Square	0.143607
Standard Error	2.869483
Observations	243

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	342.3711	342.3711	41.5805	6.13E-10
Residual	241	1984.378	8.233933		
Total	242	2326.749			

The results for the linear regression of days post certification on score are presented below (Table 6.4). It is clear that days post certification is a worse predictor of CPR score than the number of re-certifications. The results below suggest that only 4% of the variance in score can be accounted for by the days since certification (R Squared = 0.04). The correlation among these two variables is approximately 0.19 and is far less significant than the relation between the number of times certified and score (F [1, 241] = 9.94, $p < 0.002$).

Table 6.5. Results of regression analysis using Brennan Scores and Days Post Training

SUMMARY OUTPUT **Days post training on score**

Regression Statistics	
Multiple R	0.198989
R Square	0.039597
Adjusted R Square	0.035611
Standard Error	722.3888
Observations	243

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5185161	5185161	9.936198	0.001826
Residual	241	1.26E+08	521845.6		
Total	242	1.31E+08			

In summary, the number of times certified appears to be a much better predictor of performance on subsequent tests of CPR skill and knowledge. Due to the small to moderate correlation between these variables, cautious predictions of test score based on the number of prior certifications can be made.

Days since training affects pre-CPR safety check: An aggregate score was created from the variables:

- Ensure no danger
- Gloves
- Pocket Mask
- Tap or gently shake shoulder
- Speak to Patient
- If another person is available, have them activate EMS
- Open the airway using appropriate technique
- Maintain open airway

- Ear over mouth, observe chest: look, listen, and feel for breathing
- Seal pocket mask properly
- Ventilate 1
- Ventilate 2
- Assess for visible signs of circulation and carotid pulse
- Landmark - correct hand placement

The highest score on this aggregate variable was 14 with one point assigned for each of the variables performed prior to beginning CPR cycle 1. A Pearson correlation was used to determine whether a linear relation existed between the variables days since training and the aggregate variable described above (Pre-CPR). The variables were negatively correlated (n=244,*r*=-.224, *p*=.000). As days since last training increased, performance was worse. The number of days since CPR training was completed was significantly correlated with decreased performance of the pre-CPR safety assessment and preparation for CPR.

8x8 General Linear Model Repeated Measures ANOVA with Ventilations as the within factor and Time Since Training (8 time periods) as the between factor. An aggregate variable for ventilations within each cycle was created based on whether the participant ventilated the patients twice as required (score=2), once (score=1), or did not ventilate at all. For this variable the maximum score per cycle was 2 and the minimum score was 0. Days since training ranged from 7 to 4422. Eight days since training ranges were created: 1-30; 31-90; 91-182; 183-365; 366-547; 548-730; 731-1095; and 1096 and above. Pearson correlations were performed with the actual number of days since training versus the number of ventilation attempts performed at each cycle. There were no significant correlations linking days since training with ventilatory attempts. ANOVA results for ventilations and days since training

indicate that the Observed Power for each test performed were 1, indicating that statistical power was sufficient for each test. Box's Test of Equality of Covariance Matrices were significant (Box M = 661.23, F = 2.278, p = .000) and the null hypothesis that the observed covariance matrices of the dependent variables were equal across groups was rejected. As a result, Dunnett's T3 was utilized for all post-hoc paired contrasts. Wilk's Lambda (0.563) indicated a significant multivariate effect $F($7, 244 = 25.472, p=.000, Partial Eta^2 = .259) for ventilations but not for ventilations by time of training. Mauchley's Test of Sphericity was significant and a Greenhouse-Geisser correction for degrees of freedom was utilized to test within subject effects. There was a significant within subjects effect F(2.585, 244 = 82.399, p = .000) indicating a significant change in the number of ventilation attempts over the eight cycles. There was a significant linear effect F(7, 236 = 152.899, p. 000, Partial Eta^2 = .393) indicating a linear trend in the data for ventilations performed at each cycle. The number of ventilations at each cycle is shown in the figure 6.9 below. There is a distinct decrease in the ventilatory attempts following cycle four regardless of time since training.

The between subjects effect was non-significant F(7, 236 = 1.333, p = .235, Partial Eta^2 = .038) indicating that the number of ventilations performed did not change with the number of days since training. There were no significant between group contrasts using Dunnett's T3. Figure 6.10 demonstrates considerable variability in the number of ventilations attempted but this does not appear to be related to time since training in a consistent manner. This result indicates that there is no significant decrement in skill retention associated with ventilations attempted.

Figure 6.9. The number of ventilations per CPR cycle decreases with each successive cycle.

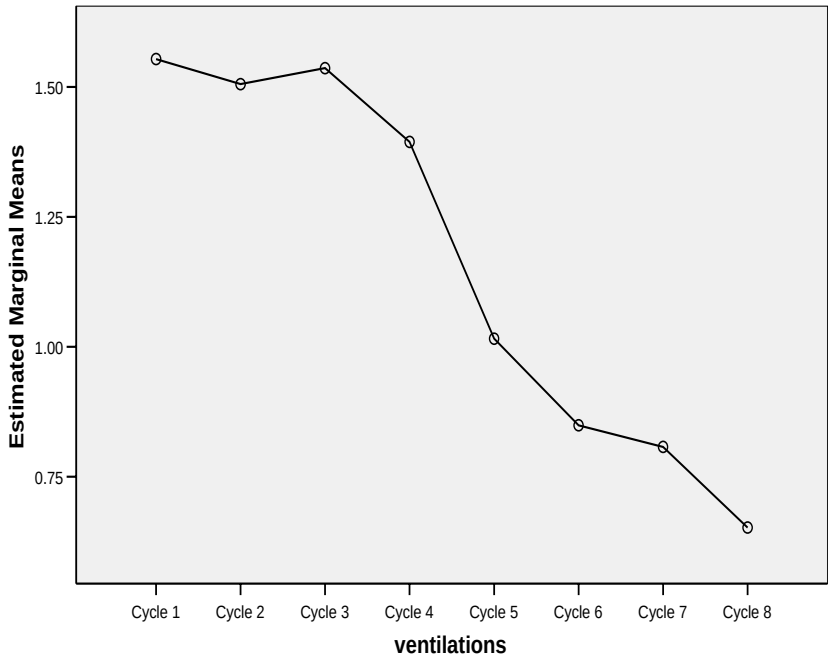
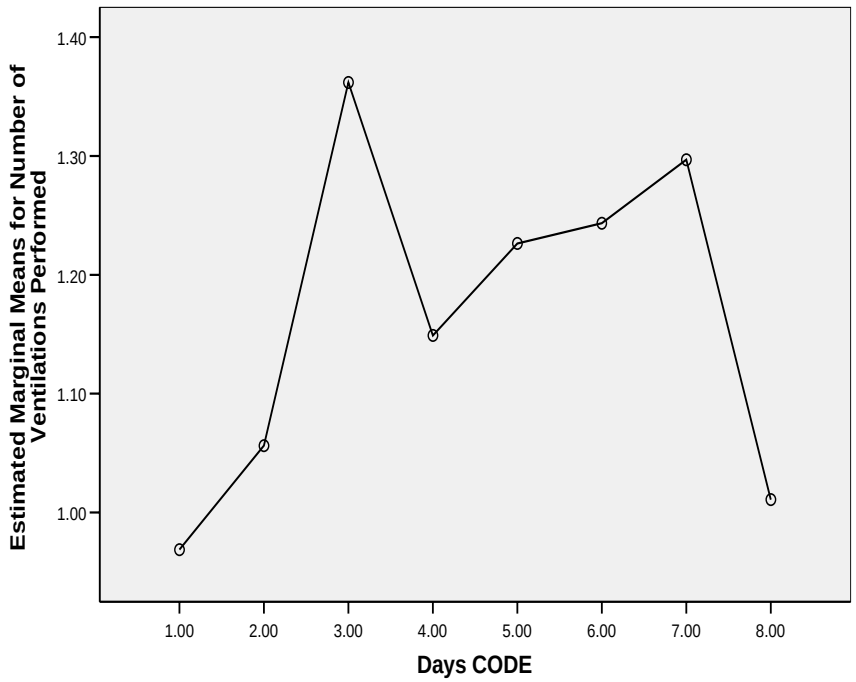


Figure 6.10. The mean number of ventilations attempted within each of the eight days since training groups. There were no significant differences between these groups and no consistent pattern associated with a decrement in skill retention.



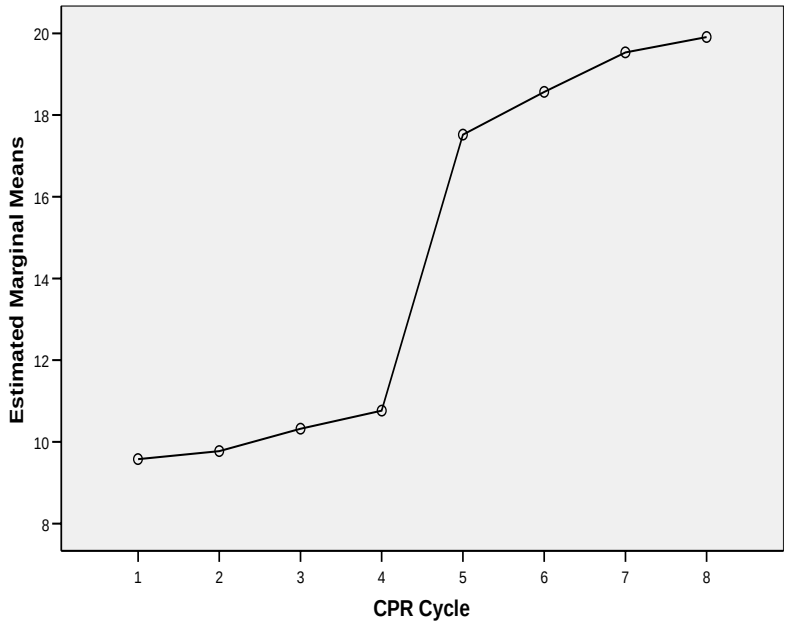
In summary, the number of days since completion of CPR training did not affect performance related to the number of ventilatory attempts that were made. There was however a linear

decrease in the number of ventilatory attempts made regardless of time since training. In other words, with each successive cycle, subjects made fewer ventilatory attempts regardless of when they were trained.

8x8 General Linear Model Repeated Measures ANOVA with Compressions as the within factor and Time Since Training (8 time periods) as the between factor. The compressions variable was created by calculating the number of compressions away from the number the participants were trained to do. As some participants were trained to perform 15 and others 30 compressions, those trained at 15 were scaled by a factor of 2. It must be stated that for a small number of participants, training targets were estimated based on when training occurred and when rules changes for number of compressions were initiated. ANOVA results for compressions away from target and days since training demonstrate an Observed Power for each test performed of 1, indicating that statistical power was sufficient for each test. Box's Test of Equality of Covariance Matrices was significant (Box M = 1355.856, F = 4.684, p = .000) and the null hypothesis that the observed covariance matrices of the dependent variables were equal across groups was rejected. As a result, Dunnett's T3 was utilized for all post-hoc paired contrasts. Wilk's Lambda (.657) indicated a significant multivariate effect F(7, 244 = 17.304, p=.000, Partial Eta^2 = .343) for the number of compressions away from the target over the eight cycles. The multivariate effect for number of compressions away from the target by time of training was also significant; Wilk's Lambda = .665, F(49, 244 = 2.021, p = .000, Partial Eta^2 = .057) however this result had a very small effect size. Mauchley's test of Sphericity was significant and a Greenhouse-Geisser correction for degrees of freedom was utilized to test within subject effects. There was a significant within subject effect F(2.194, 244 = 75.074, p = .000, Partial Eta^2 = .240) indicating a significant change in the number of compressions away from the target value over the eight cycles. There was a significant linear effect F(7, 238 =

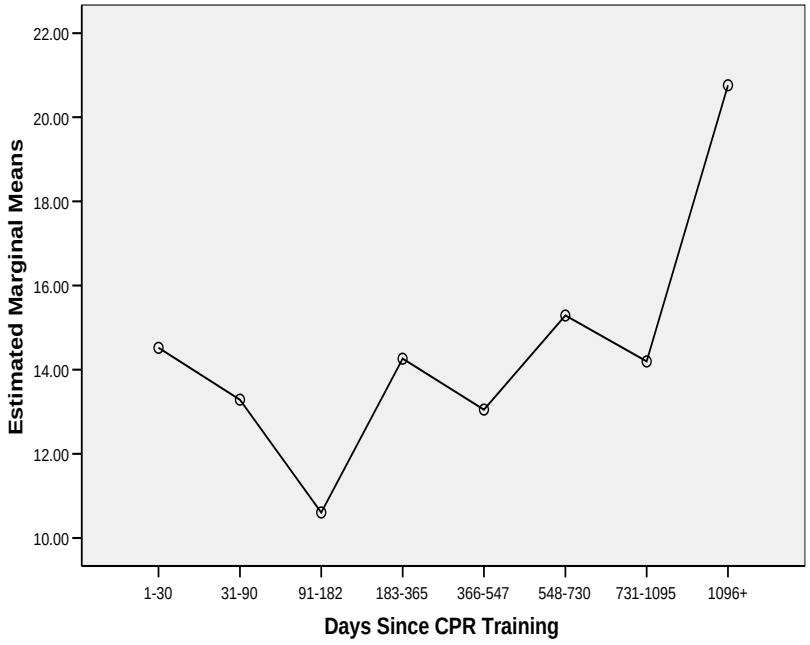
120.176, *p*. 000, Partial Eta^2 = .336) indicating a linear trend in the data for the number of compressions away from the target at each cycle. The number of compressions away from the target at each cycle is shown in the figure 6.11. There is a distinct increase in errors for compressions following cycle four independent of time since training.

Figure 6.11. Errors in the number of compressions performed from the target at each CPR cycle



The between subjects effect was significant $F(7, 238 = 2.328$, $p = .025$, Partial Eta$^2 = .064)$ indicating that the deviations in the number of compressions performed from the target value changed with time since training. One significant post-hoc contrast was observed using Dunnett's T3. The number of compression errors from the target value was lower for CPR participants trained between 91-182 days prior to retesting compared to those participants trained 1096 or greater prior to the test date. Figure 6.12 demonstrates this difference. These results suggest that the number of compressions that deviated from the target increased with the number of days since CPR training occurred. It must be cautioned that the effect size was small and the results should be interpreted with caution.

Figure 6.12. The number of compressions from target increased with time since training.



Two-tailed Pearson correlations (0.05 sig. level) were performed with the actual number of days since training versus the number of compression errors that occurred at each cycle. Eight correlations were performed and a strict Bonferroni correction for the number of correlations was utilized (0.05/8 = .00625 for significance). Four of eight correlations were significant with this correction. The number of days since training was significantly correlated with the number of compression errors for CPR cycle 1 (n = 246, r = .215, p = .001), CPR cycle 2 (n = 246, r = .201, p = .002), CPR cycle 3 (n = 246, r = .248, p = .000), and CPR cycle 4 (n = 246, r = .302, p = .000).

The results suggest that the number of CPR errors from the trained target increase with time since training for CPR cycles one through four. In support of these data, there was a small between subjects effect suggesting that a decrement in CPR skills occurred in the number of

compressions administered at each cycle. However, for CPR cycles five through eight, all participants performed poorly and the number of errors from target increased substantially independent of time since training.

Correlations of actual days since training with an aggregate variable comprising pulse and breathing checks and patient placement. An aggregate score was created from the variables:

- Pulse is present (performed after cycle 4)
- Breathing is present (performed after cycle 4)
- Pulse is present (performed after cycle 8)
- Breathing is present (performed after cycle 8)
- Place patient in recovery position (performed after cycle 8)

The highest score on this aggregate variable was 5 with one point assigned for each of the variables performed at the designated time points. A Pearson correlation was used to determine whether a linear relation existed between the variables. The variables were weakly negatively correlated (n=244,r=-.166, p=.009). The number of days since CPR training was completed was significantly correlated with decreased performance of checks for breathing, positioning, and placement at the appropriate times.

General Summary

The results of the statistical analyses suggest that specific CPR related skills diminish over time. A significant negative correlation was observed between days since training and a pre-CPR safety check variable (e.g. skills such as remembering to “tap or gently shake the patient” or “ear over mouth, observe chest: look, listen, and feel for breathing”). Similarly, a significant negative correlation was observed between days since training and periodic checks for

breathing, positioning, and patient placement. Deviations in the number of chest compressions from a trained target also increased with time since CPR training for CPR cycles one to four.

The results also suggest that some CPR training is poorly retained independent of time since training. For example, CPR cycles five to eight were performed poorly regarding the number of compressions from the trained target and the number of ventilations attempted independent of time since training. The focus for future CPR training related to skill retention should focus on all CPR cycles (one to eight) and safety checks prior to and during CPR administration.

Chapter 7

Recommendations

Despite wide-spread training initiatives in Canada and the US to train health care providers and laypersons alike, the number of lives saved through the initiation of basic life supporting first aid remains suboptimal. In both Europe (VanHoeyweghen et al., 1993) and the United States (Jackson and Swor, 1997) bystander initiated CPR is reported to occur in less than 30% of all cases when warranted; However, a bystander or workplace first aid provider able to deliver CPR, followed quickly by advanced cardiac life support, improves both survival rate and recovery (Gilmore et al., 2006).

To this end, properly performed bystander initiated CPR increased a victim's chances of survival in cases of ventricular fibrillation from 20 to 40 percent (Pearn, 2000). The ability of trained personelle in an employment setting to deliver CPR is paramount to the safety of their employees. With two year renewal dates, the ability of these trained personele to provide this critical lifesupporting first aid has been questioned. However, our present data suggests that repetition may be more important than days since last trained. For example, a person who trained 90 days prior to testing who was recertified 7 or more times outperformed those who were only certified once previously on most tasks. Identifying simple and cost effective strategfies for updating skills and knowledge may prove to be beneficial.

Short and Long Term Benefits of the Findings

Short Term Benefits:

The information contained within this report can be used to support policy decisions concerning training and renewal of both CPR and First Aid. As repetition of training is a significant co-variant in many of the analyses, these results may also guide the development of simple and cost effective ways to have repeated exposures to the material learned in class between re-training sessions.

Long Term Benefits:

This data provides a baseline for future research so that the impact of changes in policy and training practice can be evaluated. To date very little information exists concerning the ability of those in a service or industrial settings who are trained to provide first aid and CPR to actually provide such emergency life-saving service. Baseline data allows for the evaluation of new training strategies, or changes in criteria to be evaluated.

Further Research Required

Studies of CPR knowledge and skill retention suggest a rapid deterioration of psychomotor skills post-training, with a slower, but progressive loss of CPR knowledge. The performance of CPR requires approximately 50 separate psychomotor skills applied in a specific sequence (Flint et al., 1993). With such a complex task, regardless of teaching methods, one must expect CPR skills and knowledge to decay. Studies of CPR knowledge and skill retention suggest a rapid deterioration of psychomotor skills post-training, with a slower, but progressive loss of CPR knowledge.

The skill and knowledge components of CPR have been separated out in several studies of CPR retention. CPR skills include correct rate and depth of ventilations, and rate, depth and hand placement during compressions; CPR knowledge is typically represented by the demonstration of the proper sequence of events, regardless of their effectiveness. Previous work suggests that CPR skills decline rapidly, with significant decline in CPR skills occurring as early as two weeks post-training. To improve skill retention, and hence, survival rates following bystander initiated CPR, strategies are required to reduce skill deterioration that are simple and effective, independent of time and place, and that cause minimal disruption of one's working day.

As training appears to be a significant variable in skill retention, such as the number of renewals one has participated in, strategies for increasing the repetition of the skills and knowledge should be explored. If one could provide the repetition in a convenient manner that did not disrupt the workplace, it may be possible to retain the skills and knowledge longer. Efforts should be made to investigate skill deterioration, and determine if simple and cost effectivce updating strategies (email, web-based scenarios that will include video and/or text, posters) can reduce the rate of decay. This can be done by training individuals in the service

and industrial settings, measuring the immediate skills, and then monitoring skill deterioration at 3, 6 and 12 months in groups that are provided no refresher content, and groups that receive messages and scenario-based reminders. The ultimate goal of such work should be to identify strategies for enabling or enhancing skill and knowledge retention which are not costly to employers in the form of fixed costs or productivity (not requiring large periods of time away from their work, such as retraining days).

Dissemination

This work will be submitted for publication in peer reviewed journals. It is anticipated that 4 articles could be submitted, including two review articles, and two research articles (one each on First Aid and CPR).

The two primary research portions of this study will be presented at either a national or international conference. Our team also expects to present this information to the training branch of WCB who are responsible for first aid and CPR training programs.

The executive summary of this report can be used by WorkSafeBC to disseminate the information via their webpage.

Appendix A

Time Stamp for the Choking Scenario

Adult Choking: Conscious 2000

Candidate #:

Date:

"You are in a restaurant, you see a person in a wheelchair grabbing their throat and attempting to cough. The person is apparently unable to cough. No one knows what happened. Everything is as found unless we tell you otherwise. "

	Step	Time	Skill Performance
1	Scene Safety		
		09:42:45	Ensure No Danger
		09:27:16	Use barrier devices (gloves and pocket mask)
2	AIRWAY		
	"Patient can not speak or cough"	10:54:08	Ask “Are you choking”
		09:27:19	Determine if patient can speak or cough
3	Clear the Airway		
		10:54:29	Stand behind the patient
		10:54:31	Wrap arms around the patient
		10:54:35	Make a fist with one hand and place the thumb side of one hand just above the belly button and below the xiphoid process
		10:54:36	Grasp the fist with the other hand
		10:54:36	Thrust into the patient’s abdomen with quick, sharp thrusts
		10:54:38	Repeat thrusts until airway is cleared or the patient becomes unconscious
	PATIENT WITH OBSTRUCTED AIRWAY BECOMES UNCONSCIOUS		
	"Patient goes limp"	10:55:16	
4	EMS		
	"Yes I can call 911"	10:55:19	If alone activate EMS
		10:55:20	If help is available, have them activate EMS
5	AIRWAY		
		10:55:26	Use the head-tilt / chin-lift technique
		10:55:27	Use tongue-jaw lift to open mouth
	"You see nothing"	10:55:29	Look in mouth for foreign body
6	Breathing		
		10:56:01	Seal pocket mask properly
	"Breaths do not go in"	10:56:04	Attempt to ventilate
		09:42:16	If breaths don’t go in, reposition the head
		09:42:17	Re-attempt to ventilate
7	Clear the Airway		
		10:56:17	Rescuer kneel beside patient
		09:42:19	Landmark check prior to hand placement
		09:42:20	15 chest compressions of 1 ½ to 2”
8	Airway		

		10:56:33	Open the airway with a head-tilt / chin-lift
	"You find a mentos"	09:42:21	Look in the mouth, remove object when seen
9	ABC's		
	"Patient has a pulse"	10:56:50	Check patient's pulse
	"Patient is not breathing"	10:56:54	Check patient's breathing
10	Perform assisted ventilations		
		09:42:24	Ventilate 1 breath every 5 seconds
		09:42:24	Time Stopped after 3 separate ventilations

Appendix B

Time Stamp for the CPR Scenario

Adult One-Rescuer CPR 2000

Candidate #:
Date:

"You are called to a scene by a fellow worker. The worker said that the patient fell to the ground and was
shaking. No one knows what happened. Everything is as found unless we tell you otherwise."

	Step		Time	Skill Performance
1	**Scene Safety**			
			15:14:17	Ensure No Danger
			15:14:17	Use barrier devices (gloves and pocket mask)
2	**Level of Consciousness**			
			14:52:02	Tap or gently shake shoulder
			14:52:03	Shout “Are you Okay?”
3	**EMS**			
	"Yes I can call 911"		14:52:04	If alone phone EMS immediately
			14:52:04	If another person is available, have them activate EMS
4	**Airway**			
			10:17:09	Use the head-tilt / chin lift technique
			08:31:16	Use the modified jaw-thrust technique, if a spinal injury is suspected
5	**Breathing**			
			08:32:01	Maintain open airway
			08:32:02	Ear over mouth, observe chest: look, listen, and feel for breathing
	"You feel no air moving"		08:32:06	Maintain an open airway
			08:32:09	Seal pocket mask properly
			08:32:13	Ventilate 2 times (2 seconds per breath)
			08:32:14	Observe chest rise and fall between breaths
			08:32:16	Allow deflation of chest between breaths
6	**Circulation**			
			09:00:23	Assess for visible signs of circulation and carotid pulse
	"You feel no pulse"		09:00:24	Rescuer kneels beside patient
			09:00:25	Landmark check prior to hand placement
			09:09:44	Rescuer’s shoulders over patient’s sternum
7	**Cycle #1**		09:11:49	15 Compressions of 1 ½ to 2 “
			09:11:48	Compression rate: 100 / min
			09:11:48	Followed with 2 ventilations
8	**Cycle #2**			
			09:11:47	15 Compressions
			09:11:46	2 ventilations
9	**Cycle #3**			
			09:11:42	15 Compressions

		09:11:40		2 ventilations
10	**Cycle #4**			
		09:11:39		15 Compressions
		09:11:39		2 ventilations
11	**Assess ABCs**			
	"Pulse is NOT present"	09:11:37		Check Pulse
	"Breathing is NOT present"	09:11:37		Check Breathing
12	**Cycle #5**			
		09:16:56		15 Compressions of 1 ½ to 2 "
		09:16:57		Followed with 2 ventilations
13	**Cycle #6**			
		09:16:58		15 Compressions
		09:17:02		2 ventilations
14	**Cycle #7**			
		09:18:14		15 Compressions
		09:18:15		2 ventilations
15	**Cycle #8**			
		09:18:17		15 Compressions
		09:18:17		2 ventilations
16	**Assess ABCs**			
	"Pulse is present"	09:18:19		Check Pulse
	"Breathing is present"	09:18:20		Check Breathing
17	**Position**			
		10:17:13		Place patient in recovery position

OVERALL PERFORMANCE

Did they complete the task in sequence?
Were tasks performed correctly?
Were tasks done in a timely manner?

*If the circulation is present, open the airway and check for breathing. If breathing is present, place patient into the recovery position. If breathing is not present, perform rescue breathing at a rate of 1 breath every 5 seconds and monitor circulation.

If asked a question by candidate, answer "scene is as you find it"

Appendic C

First Aid Multiple Choice Exam

Written First Aid Assessment

Level One or equivalent -complete only questions 1- 10
Level Two or equivalent -complete only questions 1- 15
Level Three or equivalent -complete all questions 1- 20

1. When rolling the patient from prone position, what are the purposes of stopping in the lateral position?

1. change hand position
2. check the patient's back
3. perform the primary survey
4. assess the patient's airway
5. attempt to ventilate the patient

(a) 1 and 2 (b) 2 and 3 **(c) 1 and 4** (d) 4 and 5 (e) 3 and 5

2. What information does assessing the temperature, colour and moisture of a patient's skin provide you with?

(a) an observable indication of how the body is reacting to an injury
(b) an approximation of a patient's blood pressure
(c) an understanding of how the circulatory system is functioning so you do not have to assess the pulse
(d) an indication of the ability of the body to react appropriately with the environment
(e) provides information on the mechanism of injury

3. When you assess a patient's breathing rate you determine that the patient requires assisted ventilation. In spite of your efforts to train an assistant to vent using a pocket mask, the assistant is unable to do it effectively. You should:

(a) tell the assistant "Do the best you can!" and proceed with preparing the patient for rapid transport
(b) leave the assisted ventilation until after you get the primary survey completed
(c) take over the assisted ventilation and wait until trained help arrives to prepare the patient for transport
(d) assist the ventilation and direct your helper to complete the primary survey
(e) have the assistant lay supine to change the angle for ventilations

4. Access to first aid records may be required for the following reason(s):

1. injury and patient follow-up
2. workplace health & safety inspections
3. accident investigations
4. compensation claims processing and appeals
5. gathering of statistics for the workplace health & safety program

(a) 1 and 3 (b) 2 and 4 (c) 3 and 5 (d) 3 and 4
(e) all of the above

5. It is important to give clear instructions to helpers. When instructing untrained helpers to maintain C-spine control you must tell them:

1. to keep elbows firmly braced on knees or ground
2. to tell you if they are having any difficulty
3. not to talk to the patient
4. it is important that the patient's head doesn't move
5. to move quickly out of the way when the ambulance arrives
6. to move their hands when you are conducting an RBS

(a) 1, 2 and 4 (b) 1, 3 and 5 (c) 2, 3 and 6 (d) 4, 5 and 6
(e) 3, 4 and 5

6. The primary objective in treating shock is:
   (a) controlling all external bleeding
   (b) early recognition and prompt medical aid
   (c) applying oxygen at 10 lpm
   (d) providing warmth and reassurance
   (e) ensuring an ambulance is responding

7. Which structure in the airway prevents liquids and solids from entering the lungs?
   (a) Uvula
   (b) Epiglottis
   (c) Trachea
   (d) Esophagus
   (e) Carina

8. Before beginning a primary survey, you should first-
   (a) position the victim so that you can open the airway
   (b) check for consciousness
   (c) survey the scene
   (d) call more advanced medical professionals for help
   (e) hand out gloves to all the helpers

9. Air will go into the victim's stomach during rescue breathing if you-

1. breathe only until the chest rises
2. breathe too forcefully
3. fail to tilt the head back
4. fail to seal the pocket mask appropriately
5. don't time your ventilation with the patient's effort to breath

(a) 1 and 3 (b) 2 and 4 (c) 3 and 5 (d) 3 and 4
(e) 2 and 3

10. The first step in managing an arterial bleed is to apply?
(a) bulky dressings to reinforce blood-soaked bandages
(b) pressure at a pressure point to decrease blood flow
(c) direct pressure with a clean or sterile pad
(d) a pressure bandage to hold gauze pads in place
(e) a dressing and tie off a tourniquet

Level 1 or Equivalent – Please stop here – Do not Proceed

Level 2 and Level 3 please proceed with the following questions

11. Which of the following is often difficult for a single rescuer using a bag-valve-mask resuscitator?
    (a) assembling the device for use with supplemental oxygen
    (b) squeezing a sufficient volume of air from the bag to effectively ventilate the victim
    (c) maintaining a tight enough seal and open airway
    (d) seeing the area of the victim's face under the mask clearly enough to detect vomiting if it occurs
    (e) attaching an oxygen tank with an appropriate litre flow

12. A woman has full-thickness burns covering the front of her chest, abdomen, and her back. Using the Rule of Nines, what percentage of her body is burned?
    (a) 9%
    (b) 18%
    (c) 27%
    (d) 36%
    (e) 44%

13. The purpose of the secondary survey is to:
    (a) find injuries or conditions that may not be immediately life-threatening
    (b) discover any immediate life-threatening injuries
    (c) provide prompt care within the scope of an attendant's training
    (d) objectively record observed or reported signs or symptoms
    (e) survey the scene for hazardous conditions

14. A blue skin color that results from too little oxygen in the blood is:
    (a) hypoxia
    (b) cyanosis
    (c) anaphylaxis
    (d) edema
    (e) mottling

15. What type of sudden illness may be preceded by an aura?
    (a) fainting
    (b) seizure
    (c) diabetic coma
    (d) heart attack
    (e) hypothermia

Level 2 or Equivalent – Please stop here – Do not Proceed

Level 3 please proceed with the following questions

16. How would you provide care for a seizure victim?

1. place something between the victims teeth
2. position the victim on one side to maintain a clear airway if victim is vomiting
3. restraining the victim's movements
4. protect the victim from injury
5. assist the victims breathing

(a) 1 (b) 1, 2 and 4 **(c) 2 and 4** (d) 1 and 4 (e) 3 and 4

17. The signs and symptoms of heat exhaustion are often nearly identical to those of:

(a) narcotic overdose
(b) diabetic coma
(c) stroke
(d) shock
(e) allergic reaction

18.A patient has fallen three storeys. The patient's eyes have flickered open several times during the primary survey. When you ask "look at me, can you open your eyes", the patients eyes do not open. When you apply a pain stimulus to the right index finger, the eyes flicker, the patient gives a low moan and the finger tries to pull out of your grasp. Their Glasgow Coma Scale for this patient is:

(a) 7
(b) 8
(c) 9
(d) 10
(e) 11

19. Which of the following would be the best describe the immobilization of a suspected forearm fracture?

(a) A rigid splint secured from the site of the injury to the hand
(b) A rigid splint secured from the joint above the injury site to the hand
(c) A sling to support the arm with a broad bandage across the chest
(d) A sling to support the arm with a loop tie across the chest
(e) A rigid splint secured from the site of the injury to the hand and supported with a sling

20. A patient who is thought to have suffered a stroke, is found slumped at their desk. The patient is unresponsive and breathing normally. Which of the following describes how the patient should be packaged for transport?

(a) hard collar, legs tied together and secured on a spine board supine
(b) hard collar, legs tied together and secured on a spine board lateral
(c) **secured on a spine board in the recovery position**
(d) placed on a stretcher in the semi-reclining position.
(e) placed on a stretcher in the supine position

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