Instructor Assessment of Adult CPR Skills:

A Comparison Between Subjective and Objective Measures

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INSTRUCTOR ASSESSMENT OF ADULT CPR SKILLS:

A COMPARISON BETWEEN SUBJECTIVE AND OBJECTIVE MEASURES

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Abstract

Providing accurate feedback is an important component of teaching CPR skills. An important part of providing accurate feedback is being able to accurately assess specific skills. In a cross-sectional experimental design, 33 CPR instructors were recruited to assess six 2-minute pre-recorded videos of 2-person CPR skills. The subjective assessment measures were compared to the objective manikin measures from a Laerdal Resusci-Anne® QCPR manikin. Results indicated statistically significant differences between the subjective and objective measures in all skills assessed (chest compression rate, chest compression depth, chest recoil, hand placement, ventilation volume, and total cycles). Instructor teaching experience (in years and classes taught) was also discovered not to be statistically significant in instructors' ability to accurately assess CPR skills. Results of this study appear to support the AHA's requirement for use of chest compression depth and chest compression rate feedback devices in CPR classes beginning January 2019. Continued research on this topic is warranted.

Chapter 1

Introduction

In the year 2015, the American Heart Association (AHA) and their Emergency Cardiovascular Care Program trained over 18 million people worldwide (AHA, 2015). The number of people trained is astounding, although not surprising considering how convenient CardioPulmonary Resuscitation (CPR) certification has become with numerous instructional methods available. These methods include traditional Instructor-Led (IL) courses along with non-traditional formats incorporating self-instruction and Internet-based instruction. Based on prior research, there is some indication that non-traditional courses improve skill acquisition as well as or better than traditional IL techniques. One explanation for this is non-traditional courses incorporate an objective feedback component which is often lacking in the IL courses (Brennan, Braslow, Batcheller & Kaye, 1996; Donnelly, Lester, Morgan & Assar, 1998). Other reasons are directly related to instructor inconsistencies and biases (Brennan & Braslow, 1995; Kaye et al., 1991; Lynch, Einspruch, Nichol, & Aufderheide, 2008; Wik, Thowsen & Steen, 2001).

Traditional IL CPR classes in the southern Virginia city where this research was conducted, make up about 97% of the CPR courses with the remaining 3% being administered through non-traditional Internet-based instruction (J. Shirey, personal communication, November 6, 2018). During the IL courses, the AHA recommends no more than six learners per instructor for a new certification course lasting about four hours, and no more than eight learners per instructor for a recertification course lasting about two hours. Along with the instructor, there is a standardized video that provides additional instruction, demonstrations, and practice opportunities for the learners. The less common Internet-based course, named “Heartcode®”

Basic Life Support (BLS), is a two-part course that provides flexibility in the independent review of CPR knowledge. The online portion of the course is completed at a time convenient to the learner, then the learner must schedule and pass a skills test with an AHA instructor or by a voice assisted manikin system (AHA, 2017). Each of these methods for CPR certification is valid for two years from the time of successful completion; however, the AHA recommends reviewing the material and practicing the life-saving skills annually. Table 1 includes the definition of research terms used throughout this paper.

Table 1

Research Definitions

Term	Definition
Basic Life Support (BLS)	A level of medical care used for victims of life-threatening illnesses or injuries until they reach a hospital to receive definitive care. BLS can be provided by trained healthcare professionals.
Cardiopulmonary Resuscitation (CPR)	An emergency procedure consisting of external chest compressions and artificial respirations; immediate care for a victim who has collapsed, has no pulse, and is not breathing; an attempt to restore circulation of oxygenated blood to the vital organs.
CPR Instructor	An American Heart Association instructor who has gone through the appropriate course and has met the minimum requirements to maintain certification status.
Learner	A person taking any initial or recertification CPR course.
Assessment	Collecting information about individual CPR skill performance.
Evaluation	Utilizing assessment information to make a judgment about the quality of overall learner CPR skill performance.
Subjective Feedback	Information provided by an instructor regarding the learner's performance, typically in the form of a checklist indicating "adequate" or "inadequate."
Objective Feedback	Information provided by a mechanical device (often as numbers or percentages) regarding the learner's individual CPR skill performance.

The importance of feedback during CPR training is well documented and understood. Multiple studies have stated feedback, in various forms, is helpful in improving CPR skills (Beesems & Koster, 2014; Kirkbright et al., 2014; Wee et al., 2014;). The feedback can be provided by many different devices available on the market. Table 2 lists the feedback devices, provides a brief description of each device, and indicates the skills for which feedback is provided. These feedback devices are further discussed throughout the literature review in Chapter 2.

Table 2

CPR Objective Feedback Devices

Device	Description	Feedback Provided (Skills)
Voice Advisory Manikin (VAM)	Partial manikin that provides verbal feedback and prompts during training	Number of correct ventilations (volume, flow rate, open airway) Number of correct chest compressions (CC) depth, recoil, hand placement
Skillreporter Manikin (discontinued in 2013)	Partial manikin with separate feedback monitor for displaying performance	Average CC depth CC rate Percentage of correct CC Average ventilation rate & volume Percentage of correct ventilations
AED audiovisual	Sensory pad attached to chest where CC are performed	CC rate CC depth
True CPR	Chest pad and a back pad to sense pressure of CC	CC depth CC rate Chest recoil
iCPR	iPhone application providing audiovisual feedback	CC rate
CPREzy	Chest pad providing audiovisual feedback (lights and tone)	CC rate CC depth Chest recoil
QCPR	AED Pads and a monitor providing verbal and visual feedback	CC rate CC depth Ventilation rate

Often feedback provided to learners is in the form of instructor's subjective evaluation (Lynch et al., 2008; Wik et al., 2001). The concern with subjective feedback alone is whether instructors are accurate in evaluating these important and precise CPR skills, specifically the chest compressions and ventilations.

Problem Statement

While there is evidence that feedback is important for learning CPR skills, there is limited research that indicates accuracy of the instructor's subjective assessment. If CPR instructors do not accurately assess chest compressions and ventilation skills, the instructors would require an objective feedback device to assist in providing information about learners' performance. This investigation focuses specifically on instructor subjective assessment of chest compressions and ventilations during multiple pre-recorded two-rescuer video scenarios.

Purpose of Study

Studying CPR instructors' evaluation accuracy in their assessment of life-saving skills is critical in determining whether subjective instructor feedback alone is sufficient for CPR skill acquisition. Of the more common traditional IL CPR courses, many do not utilize an objective feedback device to provide performance feedback to learners. If the instructor's subjective assessment of CPR skills is insufficient, then an objective feedback device would be necessary. Currently, it is only *recommended* that CPR courses be taught using an objective feedback device, but the AHA is requiring a feedback device that provides chest compression depth and rate information beginning in January 2019. The conclusions of this study may shed light on this significant change in how CPR skills are assessed. The purpose of this study is to investigate the accuracy of AHA Basic Life Support CPR instructors' subjective assessment of adult CPR skills by comparing their assessments to objective measurement data retrieved from a Laerdal Resusci-Anne® QCPR feedback manikin.

Research Questions and Hypotheses

1. How do CPR instructors' subjective assessment of learners' skills compare to the objective assessment of learners' skills?

2. Does instructor CPR teaching experience (in number of years) predict accuracy of instructor's subjective skill assessment?

3. Does instructor CPR teaching experience (in average number of classes taught per year) predict accuracy of instructor's subjective skill assessment?

H_1 - There is a statistically significant difference in accuracy between subjective assessment of CPR skills by AHA CPR Instructors and objective assessment of CPR skills by a Laerdal Resusci-Anne® QCPR manikin.

H_2 - Years of CPR teaching experience will be a predicting factor affecting CPR skill assessment accuracy.

H_3 - The average number of CPR courses taught per year will be a predicting factor affecting CPR skill assessment accuracy.

Significance of the Study

High-quality CPR can improve survival rates for victims of cardiac arrest. The 2018 annual report from the American Heart Association (AHA) and American Stroke Association indicated that sudden cardiac arrest was the cause of death for 347,322 people in the U.S. In past reports fewer than half of the people who sustain cardiac arrest receive CPR immediately, which could have increased survival rates by threefold (American Heart Association, 2015). For optimal survival, a victim of cardiac arrest needs CPR immediately with an Automatic External

Defibrillator (AED) used as quickly as possible. According to the AHA, there are many components to high-quality CPR.

The following components are considered essential for high-quality chest compressions according to the American Heart Association (2015). Correct hand placement is considered two hands on the lower half of the breastbone (sternum) with the heel of one hand two finger widths above the xiphoid process. A second component to high-quality chest compressions is a rate between 100 and 120 compressions per minute. Higher compression rates are associated with increased survival whereas lower compression rates correspond to decreased survival. Adequate depth is the third component of high-quality chest compressions. A depth of 2.0 to 2.4 inches is recommended to provide critical blood flow and oxygen delivery to the vital organs (heart and brain). The last component is allowing the chest to return to normal position (full chest recoil) between each chest compression. This full chest recoil allows the heart to refill with oxygenated blood between compressions and must occur for the compressions to be effective. These elements are essential in providing high-quality chest compressions during CPR.

Proper ventilations (breaths) are to be brief, lasting approximately one second with enough volume to make the adult victim’s chest rise visibly. Each breath cannot be too forceful, too lengthy, or too deep that would cause air to enter the stomach (gastric inflation) or cause an excessive amount of pressure in the chest. This excessive pressure in the chest can prevent the heart from refilling with blood between chest compressions (AHA, 2015).

The importance and precise nature of these lifesaving skills creates a clear need for accuracy in evaluation. Previous research studies have focused on many different high-quality CPR components incorporating a variety of evaluation methods, making comparisons between studies particularly difficult. In addition, there is little research on the accuracy of instructor’s subjective evaluation techniques compared to objective measurements. Further research related to CPR instructors is necessary to determine if instructors themselves are sufficient in providing accurate CPR skill evaluation and if CPR teaching experience affects the accuracy of instructors' CPR skill evaluation. The following chapter explores past research regarding subjective and objective assessment measures of CPR skill acquisition and retention.

Chapter 2

Review of Literature

This chapter reviews the literature pertinent to CPR instruction and evaluation of learner performance of CPR skills. It is organized into three sections: the first section discusses American Heart Association information regarding instructor training requirements, skill guidelines for learners, and types of classes available. The second section explores the prior research involved with CPR skills and the various feedback methods, and the third and final section includes an educational theory that could help determine requirements for optimal motor skill learning.

American Heart Association Information

The following section is based on the most recent 2015 AHA Guidelines for Basic Life Support (BLS) instructor requirements, CPR Guidelines, and BLS certification course options. This information is derived directly from the AHA website.

BLS instructor requirements.

There are specific requirements in order to become an AHA BLS Instructor. Before enrolling into a BLS instructor course, the AHA requires individuals to complete the Instructor Candidate Application and to be approved by the local AHA Training Center Coordinator (TCC). Each applicant must also be currently certified in AHA BLS CPR and they must demonstrate proficiency in all skills and Basic Life Support course content listed in Table 3. There are two sections to complete for the instructor course, an online portion (two hours) and a classroom practice session with a certified faculty instructor (five hours). An 84% or higher score on the written exams for each section is considered passing.

The instructor candidates are required to review both the instructor material and the student manual for each course taught. The main course levels are outlined in Table 3. Once the applicants have passed all required components, they are then required to teach a course within six months of certification. This initial course is co-taught with a more experienced instructor who completes a peer-evaluation form, which is kept on record at the training center. Instructors, like providers, need to update their instructor certification every two years. To renew their status, instructors must teach at least two courses per year and complete any instructor updates required by the AHA. Once instructors submit the appropriate documentation for these requirements, their status will be renewed by the TCC. Throughout their teaching experience, instructors are also encouraged to refer to the latest updates on the AHA website, current CPR research, and other sources of relevant information (AHA, 2017).

Table 3

American Heart Association CPR Courses

Title	Audience	Skills/Content
Heartsaver® CPR/AED	Non-medically trained people (police officers, teachers, administration, etc.)	Lay person adult and/or pediatric (child & infant) CPR; Basic AED use
Basic Life Support (BLS)	Healthcare providers in pre-hospital (first responders, athletic trainers, fire fighters, etc.) or in-facility (dentists, nurses, physicians, etc.) environments	Adult, child, and infant CPR and AED use
Advanced Cardiac Life Support (ACLS)	Healthcare professionals who direct or participate regularly in the Management of cardiovascular emergencies	Recognition and intervention of cardio-pulmonary arrest, immediate post-cardiac arrest, acute dysrhythmia, stroke, and acute coronary syndromes

Note. Adapted from https://cpr.heart.org retrieved November 23, 2018

CPR guidelines.

As of October 2015, some of the AHA guidelines for CPR changed. Since 2005, the AHA has updated the guidelines every five years based on research findings examining the optimal depth and rate of compressions (Stiell et al., 2012). Table 4 reflects the most recent performance guidelines for chest compressions and ventilations, and the optimal outcome for those skills. It also reflects the standards for the current research study and with what the participants' evaluations will be compared.

Table 4

2015 AHA CPR Performance Guidelines & Researchers Performance Guidelines for Chest Compressions (CC) and Ventilations

Skill	AHA Guidelines	Research Guidelines
CC Depth	adequate 2 - 2.4 inches (50 - 60 mm)	80 - 100% adequate 2 - 2.4 inches (50 - 60 mm)
CC Rate	100 - 120 compressions/minute	100 - 120 compressions/minute
Full Chest Recoil/Release	adequate	80 - 100% adequate
Correct hand position	adequate 2 finger widths above xiphoid process	80 - 100% correct
Ventilation volume	adequate	80 - 100% adequate
Ventilation rate	2 breaths/5 seconds	Not Assessed
Total Number of Cycles	5	5
Overall Assessment	Pass or Needs Remediation	Pass or Needs Remediation

BLS provider certification course options.

In order to become AHA BLS CPR certified, a healthcare provider has the choice of two course formats. The first option is a traditional classroom course with 100% BLS IL training including video instruction, hands-on skill practice, and testing. There is also a written exam on the course content with this traditional format. The second format is named "HeartCode® BLS" which blends online training with hands-on skills practice and testing sessions (within 60 days of each other) with an AHA Instructor or Voice Assisted Manikin (VAM).

Effective CPR instruction, regardless of the format, is important for CPR skill knowledge and performance. There have been many studies that have concluded that each type of course, IL and HeartCode® BLS (or other self-directed), have both beneficial and detrimental results regarding learner performance. A systematic review of 22 studies by Hsieh et al. (2016) revealed that each study examined different CPR components as well as used different subjective checklists and passing criteria. The mixed results have compounded the difficulty of establishing best practice guidelines. This review concluded that the learning effects from traditional instruction or self-instruction were very similar and if time and resources were limited, self-instruction would be an effective alternative. The following sections will further analyze individual studies within the scope of this research to justify the need for specific examination of CPR instructor effectiveness.

Feedback

While multiple definitions for feedback exist, the fundamental purpose of feedback is improvement. "Immediate feedback is also a cornerstone of medical simulation" (Weinstein 2015, p. 559). The New Oxford American dictionary defines feedback as the "information about reactions to a product, a person's performance of a task, etc., used as a basis for improvement" (p. 620). It should be an ongoing, cyclical process for instructor and learner until a standard of performance is met. Van de Ridder, Stokking, McGaghie, and Cate (2008) proposed a standard operational definition for the term "feedback." They defined feedback as "specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance" (p. 189). Providing quality information in the form of accurate feedback to students is important to ensure student learning (Al-Bashir, Kabir, & Rahman, 2016). Feedback takes many forms, but for the purposes of this research, subjective and objective feedback will be the focus.

With skill performance feedback specifically, the subjective feedback relies heavily upon instructor opinion, interpretation, and judgment, whereas objective feedback is measured data specific to the skill being assessed. For instance, chest compression depth can be specifically measured by objective devices much easier than by instructor judgment. A meta-analysis by Hattie and Timperley (2007) discovered some of the most effective feedback is in the form of "video-, audio-, or computer-assisted instructional" (p. 84). Within research specifically on CPR skills, there are many types of objective feedback devices available (noted on Table 2 in Chapter 1) and many will be discussed in a later section.

Subjective feedback only.

During many CPR classes, the instructor is the only source of skill performance assessment due to limited availability of instrumented feedback devices (Birnbaum et al., 2005; Brennan et al., 1996). The instructor must rely upon subjective assessment skills to provide feedback to learners, which require judgment on the instructor's part (Brookhart, 2004). Accuracy of feedback is essential in order to promote learning, and there are very few studies targeting feedback accuracy. There is, however, conflicting research comparing the quality of instructor feedback to objective measurement feedback. The following section will review this opposing literature on the topic of instructor subjective feedback and evaluation techniques.

Lynch et al. (2008) provided evidence that indicated certain CPR skills are assessed more accurately by instructors. In this study, 13 instructors assessed five skills that included assessing responsiveness, calling 911, delivering ventilations with adequate volume, correct hand placement while performing compressions, and compressing at an adequate depth. Instructors assessed ventilation performance with high accuracy, but the other skills were inconsistently assessed. They found inadequate compression depth detection approximately 17% of the time so they concluded that “both instructors and learners would benefit from objective feedback on compression performance during CPR courses” (p. 241).

Another investigation of IL CPR courses was conducted by Seraç and Ok (2010) who placed 90 participants into three equal groups using random assignment. Group 1 was a traditionally instructed class with face-to-face lecture and skill practice. Group 2 was also provided with face-to-face instruction, but additional scenario-based learning was used to practice skills. Group 3 participants were taught through an Internet course with a CPR manikin and other supplies required to practice independently. This Internet course group performed sub-optimally in numerous skills (compression depth, hand position, and ventilation volume) in comparison to the other two groups that received face-to-face instruction. The researchers concluded that although self-learned CPR methods are practical, the instructor feedback, motivation and expert knowledge were valuable components of learning CPR skills (Seraç & Ok, 2010).

On the other hand, instructor judgment can also be inaccurate and based predominantly on intuition (Kaye et al., 1991). Most methods of subjective instructor evaluation during CPR training utilize performance checklists to assess learner skills. These checklists include all the required skills yet are simplified into an “adequate” or “inadequate” determination for each skill. There are multiple challenges with this dichotomous method of skill evaluation. First, instructors must be able to identify a minimally competent skill that warrants a passing check mark. If instructor judgment is incorrect about an individual skill, a learner could pass that skill without demonstrating competency. Second, it is difficult for the instructor to visually assess certain skills like chest compression depth and ventilation volume (Brennan et al., 1996). The latest 2015 AHA Guidelines specify chest compression depth between 2 and 2.4 inches and the acceptable ventilation volume range is 500 to 600 ml (AHA, 2015). Both skills are difficult to subjectively assess consistently.

Along with the difficulty of subjective skill assessment, there are other challenging circumstances that instructors may face during a CPR course. These situations include variations in learning styles, inadequate skill practice time, instructional guideline deviation, and lack of teaching experience (Braslow, 1985; Chamberlain et al., 2001; Lynch et al., 2008; Weinstein, 2015). These issues highlight the inefficiency and inaccuracy of traditional IL CPR courses (Brennan & Braslow, 1995; Kaye et al., 1991; Lynch et al., 2008; Todd et al., 1998).

In addition, the instructor is likely assessing multiple students at once and referring frequently to the checklist itself instead of focusing on the performance of the learner. Birnbaum et al. (2005) found that instructors, when using checklists to evaluate, tend to down-weigh certain skills and may even overlook out-of-sequence skills. The research reported the most commonly de-emphasized CPR skills were assessing responsiveness and calling 911. Although these skills are considered independent of the learner's capability of performing compression or ventilation skills, a delay or omission of these skills could be detrimental in overall survival of the victim.

A consequence of incorrect instructor feedback is the inaccurate overall performance evaluation given to the learners. Kaye et al. (1991) investigated instructors and the methods they used in CPR courses. They discovered through case studies that, despite poor performance of learners, instructors' tendencies were to overestimate correct performance and pass the learners despite inadequate skills. The reliance on instructor "intuition more than measurable criteria or objective measure" was detrimental to skill performance (p. 81). Inconsistent subjective assessment and/or unstandardized teaching methods was negatively related to high-quality CPR skill performance, which ultimately indicates the need for more objective data when assessing CPR skills (Kaye et al., 1991).

The results of the Kaye study indicated five key findings, two of which are relevant to the current study. First there was limited skill practice time and performance errors were not corrected. Second, the instructors passed the learners while independent observing instructors found learners' skills unacceptable. This instructor bias was demonstrated in this study and others and was found to be detrimental to learning CPR skills when learners were given the benefit of the doubt rather than their skills being declared inadequate (Brennan et al., 1996; Chamberlain et al., 2001; Lynch et al., 2008). Optimally, if learners perform poor-quality skills there can be remediation of those skills and further practice results in high-quality skills.

Even more research indicates that instructors tolerate inadequate skills (shallow chest compressions and/or ventilations) and excuse sequencing errors when assessing CPR and AED skills for overall competence (Brennan & Braslow, 1995; Birnbaum et al., 2005). These ineffective instructional methods are certainly not supported by any training organization, and even with standardized instructor training, monitoring every class is unreasonable.

While effective teaching methods include accurate feedback, based on the challenges noted, it can be difficult to recognize performance errors with instructor subjective feedback alone. Based on the research discussed thus far, there are few instructors who provide effective subjective feedback. There are also studies that have investigated objective assessment devices, and while these devices are not perfect for teaching all CPR skills, they have been shown effective in learning and retention of certain CPR skills. Without accurate evaluation including feedback (subjective and objective), learners may not perform CPR skills effectively while practicing during a course.

Objective feedback only.

There is a considerable amount of previous research indicating improved CPR skill performance with objective feedback devices. The studies reviewed in this section, however, have investigated various feedback devices in addition to diverse CPR skills, which makes comparisons among them difficult. Overall, research on objective feedback has shown evidence to support the use of most devices, with a few examples of reduced performance level.

Voice Advisory Manikin (VAM) systems have been studied in the effort to eliminate IL CPR classes. Wik et al. (2001) evaluated 24 paramedic students 11 months after initial CPR training with and without a VAM system. They concluded that this device improved skill performance immediately with the VAM group in comparison to the control group. Specifically, ventilation rate, percentage of correct ventilations, and correct compressions were the skills significantly improved with the feedback device.

Allan, Wong, Aves, and Dorian (2013) conducted a randomized control study with nursing and medical students that provided evidence that using an audiovisual feedback defibrillator along with a debriefing of objective data from the feedback device can improve CPR skill quality along with retention of skills. Participants were randomly assigned to the control group with no feedback training or testing, group one with feedback training and testing, or group two with feedback training and no feedback testing. Both groups with feedback training achieved significantly greater depth (closer to standard) during both training and testing versus the control group. This significant difference between groups was not found with other skills, including chest compression rate and ventilation volume. This study provides evidence that supports the use of objective feedback devices to improve depth of chest compressions, which is an essential component of high-quality CPR.

Other researchers studied acquisition and retention of CPR skills using two instructional methods. One group was trained using an objective feedback SkillReporter Manikin and the other group was trained using a non-feedback conventional manikin. After training, each group was initially tested on various CPR skills. The results indicated that the feedback group performed significantly better with chest compression depth (p=0.018) and percentage of correct chest compressions (p=0.023) than the non-feedback group. Six-week retention outcomes found significantly higher results only in the percentage of correct chest compressions in the feedback group (p=0.039) (Spooner et al., 2007).

More recent studies have compared objective feedback devices and their role in assisting learners perform quality CPR skills. Yeung, Davies, Gao, and Perkins (2014) were the first to study three different objective feedback devices to compare and measure the quality of chest compressions. Results varied for each device. The CPREzy pressure-sensing device improved chest compression depth, the metronome was effective in improvements with chest compression rate, and the QCPR accelerometer device showed decreased chest compressions to a suboptimal depth.

Truszewski et al. (2016) also compared three feedback CPR devices (TrueCPR, CPREzy and iCPR) in the nursing student population. TrueCPR device showed the best performance with compression depth and compression rate. Studies comparing effectiveness of different feedback devices show that while there are multiple devices available, there is evidence to suggest they are not equally effective at improving skills.

Automatic External Defibrillators (AED) often have built-in feedback devices and they have also been researched regarding performance outcomes of learners. A study involving the AED audiovisual feedback device found that chest compressions performed without objective feedback resulted in less than 40% performed at target depth (Wee et al., 2014). When there was feedback available, the percentage increased to 47% of the chest compressions performed within the target depth. Target rate for compressions also improved with the feedback device. Another study by Fischer et al. (2011) used the AED audiovisual feedback device enabled for the feedback group and disabled with the control group. The compression rate was improved in the feedback group while the depth was improved in the control group. Overall effectiveness of compressions (including hand position and complete decompression) were more frequent in the feedback group. Interestingly, the mean ventilation rate was higher in the control group, which was closer to the recommended rate (Fischer et al., 2011).

In 2009 Peberdy, Silver, and Ornato studied the effects of audiovisual feedback on chest compression skills performed by 754 hospital personnel from 17 states. This first testing session used a skill-recording manikin with the feedback feature disabled. A second chest-compression skill test was performed on 135 participants from the same group, only this time a feedback feature was enabled. Significant results favored the group of participants who received feedback during testing. The mean depth of compressions, the mean rate of compressions, and the percentage of target depth and rate were significantly higher for the group who received feedback.

While there is considerable evidence to support the benefits of objective feedback devices, not every feedback device has been shown to significantly improve CPR skills. In addition, there have been other methods found to be effective in learning CPR skills that will be discussed in the following sections.

Learner self-evaluation.

If instructors do not provide consistent and accurate feedback to learners, the learners' ability to recognize and correct their performance errors decreases. The responsibility to recognize performance errors often lies completely with the instructor because most learners are unable to self-evaluate. In 2007, research was completed on medical students' abilities to self-evaluate with feedback and benchmarks before or after watching a video-recording of themselves. This feedback and benchmark intervention prior to self-evaluating likely assisted the students with the interpretation of the objective standards (Srinivasan, Hauer, Der-Martirosian, Wilkes, & Gesundheit, 2007).

Ochoa, Ramalle-Gmara, Lisa, and Saralegui (1998) found that healthcare providers not only fatigued quickly but were unable to detect how their fatigue was negatively affecting the quality of chest compressions they performed. Most of the participants (76.3%) performed incorrect chest compressions after one minute due to inaccurate self-evaluation. The researchers specifically looked at how chest compression performance was affected by fatigue and when the participants noticed their chest compression performance deteriorating. The average amount of time it took participants to identify fatigue-induced sub-standard chest compressions was 186 seconds (with a minimum of 60 seconds and a maximum of 300 seconds). That equates to between one and five minutes of inadequately performed chest compressions by healthcare providers. This clearly indicates the importance of providing precise feedback, whether by instructor or objective feedback device, to correct faulty CPR skills.

Hightower, Thomas, Stone, Dunn, and March (1995) found similar results regarding self-evaluation of participants. This study focused on whether participants could recognize the effects of fatigue on compression adequacy. Over a five-minute time frame, compression adequacy declined significantly. Specifically, the percentage of correct compressions decreased from 92.9 during the first minute, to 18 during the fifth minute. What was even more interesting was that the *perceived* compression adequacy percentage by the participants was at least 90 percent, well into the fifth minute of compressions. Despite a significant drop in compression adequacy, the participants were unable to detect the drop in their performance.

Without any type of feedback, learners tend to misinterpret their CPR skill performance. Often learner fatigue is unidentified, and perception of skills is thought to be adequate. While incorrect self-evaluation can be detrimental to learning, it can also be avoided with accurate instructor and/or objective feedback.

Subjective versus objective feedback.

There have also been studies conducted to compare skill performance and course length between subjective IL and objective automatic teaching methods. Back in 1990, Mancini and Kaye provided evidence relating to inconsistencies between instructor checklists and manikin strip (objective) data in CPR skill assessment. The manikin strip is the printed objective results of CPR skills performed. These researchers studied over 190 lay public and healthcare providers both in CPR skills and found the correlation between a subjective checklist and objective manikin strip was poor. This evidence suggested the need for objective skill assessment in CPR courses although objective feedback devices are not consistently used almost 30 years later.

Chamberlain and Hazinski (2003) agreed that the use of the checklist without an instrumented manikin could produce misleading results.

In 1996, Brennan et al. argued that “assessment of quality of chest compressions and ventilations must be made by an instrumented manikin” (p. 89). There are certain skills, such as chest compressions, that simply are more difficult to subjectively judge than others. In 2007, Spooner et al. compared a Skillreporter manikin (objective feedback) group to a control group (subjective instructor feedback) and found that the objective feedback group performed significantly better in depth of compressions (p=0.018) and percentage of correct chest compressions (p=0.023) immediately after training. While the six-week retention testing revealed both groups decreased skill performance over time, the objective feedback group performed a higher percentage of chest compressions (p=0.039) than the control group.

Mpotos, De Wever, Valcke, and Monsieurs (2012) made a similar conclusion that “acquiring objective data from recording manikins provides more accurate information about skills mastery than instructor judgment” (p. 1). These researchers assessed the effectiveness of a fully-automated CPR testing station (without an instructor) to investigate the effectiveness and efficiency of this method. The participants reported a positive experience. Average time spent by the participants in the testing station was 7.5 minutes, compared to the average IL BLS recertification course that lasts two hours. This study focused primarily on the organization and usability of the testing station from the learner’s perspective. While the researchers did not investigate how the learners performed, they did find evidence to indicate positive perceptions regarding automatic skills testing stations.

In 2008, Isbye et al. compared CPR skill performance between medical students taught by an instructor and medical students taught by a Voice Advisory Manikin (VAM). The significant finding in this research was that the VAM was ineffective at teaching the bag mask valve (ventilation device) and the scores related to that skill decreased the overall scores. Even with this overall score decrease, the results indicated that VAM caused an immediate, but not long term, improvement in CPR skills. It was concluded that alternate methods of CPR training can be as effective as well as accomplished in much less time than traditional IL training and should be considered for re-training purposes.

One alternative form of CPR training was found to yield comparable or better CPR skill performance than a standard 4-hour course (Todd et al., 1998). The 34-minute Video Self Instruction (VSI) method was developed to provide an inexpensive at home training program for adult CPR. This study of 91 medical students indicated the effectiveness of the program by conducting a single-blind, randomized, controlled trial of VSI versus traditional CPR instruction. While results between groups were similar, the VSI group was slightly better at eleven of fourteen (79%) assessed skills than the traditional group, indicating that self-instruction could be a comparable way to train medical personnel. This led the researchers to conclude that in less than an hour, the VSI was an effective technique for teaching CPR without the need for an instructor and would eliminate the inconsistencies that can accompany traditional courses.

A more recent study by Oermann et al. (2010) produced evidence that nursing students perform better CPR skills when completing the Internet-based Heartcode® BLS course versus a traditional IL class. The participants were randomly placed in either the Heartcode® BLS course or IL course and after passing the course, participants were skill tested with a Laerdal PC SkillReporter System. Heartcode® BLS students who practiced on a VAM has significantly better skill performance than the students who had the traditional IL course without a VAM. “The benefits of continuous feedback and prompting were apparent in the outcomes of this study" (p. 306). The researchers explained possible reasons being limited practice time, inaccurate assessment, or performance correction errors during an IL course.

While IL CPR courses are more prevalent, there is evidence supporting more automatic and self-regulated courses. The positive relationship identified in these studies between objective feedback and skill performance certainly justifies further research into whether instructor subjective feedback alone is as accurate as objective feedback. If instructors can consistently and accurately provide subjective feedback to learners during a CPR course in addition to objective measures, it may further enhance skill acquisition of learners.

Subjective and objective feedback combination.

This section discusses research on the combination of subjective and objective feedback during CPR courses. The studies in support of a combined feedback approach for CPR courses are surprisingly limited. Both subjective and objective feedback has been found beneficial to skill acquisition and retention. Again, the objective devices used in these studies vary from simulation manikins to cell phone applications. Isbye et al. (2008) concluded that for initial CPR courses both instructor and an objective feedback device would be valuable. Instructors were able to more effectively teach ventilation skills in this study, which resulted in a significantly better overall score for learners in immediate testing ($p=0.0008$) and after three months ($p=0.02$).

Dine et al. (2008) compared performance results between two homogenous groups of nurses. The debriefing only group performed two more trials of CPR skills that included instructor review of participant's performance and counseling on skill improvement based on AHA resuscitation guidelines. The feedback group received audio-visual feedback while performing two more trials of CPR skills, but after the first feedback trial, instructor debriefing was included. Results indicated that when used independently, the instructor debriefing or the audio-visual feedback improved skill performance. However, both techniques used in combination with one another produced even greater skill performance. In fact, the synthesis of these two instructional methods doubled the number of participants providing adequate chest compression depth and rate, thus supporting the use of both subjective and objective feedback methods.

Even with the positive results from these few studies combining feedback approaches, more research is necessary to provide more evidence to determine the effects of a blended feedback method.

Retention of CPR skills.

While retention of CPR skills is not the focus of this research study, it is important to discuss prior research involving retention assessment. For most healthcare professionals, CPR is not a skill that is performed regularly. While initial learning of these skills is important, retaining these skills is even more critical due to the time lapse between initial certification and recertification. Once certified by the AHA, healthcare providers must recertify within two years. That is a long time to remember and perform high-quality life-saving skills. Interestingly, some of the studies previously mentioned (Isbye et al., 2008; Todd et al., 1998) as well as the systematic review by Hsieh et al. (2016), revealed that CPR skill retention results were similar between traditional IL classes and various forms of self-directed objective feedback devices. It should be noted that the time between initial skill acquisition and retention evaluation was anywhere between one month to one year.

Skill Learning Theory

With any type of learning (skill or general knowledge) to occur, certain conditions need to be met. Among the types of skills one might learn in a CPR class, motor skills are the most prevalent and important. Since most components of CPR require motor skills, it is critical to understand what conditions could optimize motor skill learning. According to Robert M. Gagné (1985) and his Theory of Learning, the three optimal conditions specific to motor skill learning are observation of a model performing the skill correctly, opportunity to practice skills involved, and receiving feedback on performance (what to change and how) (Gagné, 1985). Traditional IL CPR courses incorporate all these conditions with a video providing correct skill demonstration; learners practicing each skill individually and in pairs; and instructors providing feedback (in various forms) to learners regarding their skill performance. Technically, the IL CPR course, with all three learning conditions met, should create the ideal learning environment according to Gagné's theory. The current study applies this theory specifically to the instructor feedback component of motor skill learning. If the assessment of CPR skills is inaccurate, necessary feedback given to the learners would also be inaccurate. Inaccurate feedback can create negative consequences for learners because "errors are uncorrected, good performance is not reinforced and clinical competence is minimally achieved" (Abraham & Singaram, 2016, p. 121).

With much of the literature supporting the use of objective feedback devices to improve CPR skill acquisition, and with the issues related to subjective feedback, instructors still need to be able to recognize adequate versus inadequate CPR skills to remediate or pass the learners. This ability to accurately evaluate CPR skills may depend upon years of teaching experience or perhaps frequency and types of classes taught. With the current evidence, including multiple training organizations, focusing on different CPR skills and feedback devices, more consistency is needed to compare results. This study will provide information on one training organization's instructors, specific CPR skills, and one evaluation tool. Furthermore, the relationship between instructor accuracy and level of experience will be measured to provide valuable information for determining reliance upon objective feedback devices for courses.

Chapter 3

Methodology

This research study considers the previous research on the various methods of subjective and objective measures for CPR-skill performance. It is important, however, to take a step back from the CPR-skill performance and look at the skill assessment method. The existing literature provided evidence to support both subjective and objective measurements when applied to certain skills, so this study sought to compare the instructor's subjective assessment data to that of the objective assessment data. This study also explored whether any relationship exists between accuracy of subjective assessment and CPR-teaching experience.

Research Questions

1. How do CPR instructors' subjective assessment of learners' skills compare to the objective assessment of learners' skills?

2. Does instructor CPR teaching experience (in number of years) predict accuracy of instructor's subjective skill assessment?

3. Does instructor CPR teaching experience (in average number of classes taught per year) predict accuracy of instructor's subjective skill assessment?

Research Design

A cross-sectional design was implemented to assess the accuracy level of CPR instructors' evaluation measures. Levin (2006) describes cross-sectional research as "a 'snapshot' of the outcomes and the characteristics associated with it, at a specific point in time" (p. 24). This design was chosen because participants were required to attend only one research session to assess their ability to assess pre-recorded CPR skills. Each research session was conducted with a maximum of six participants at a time, with a goal of including data from 50 participants.

The 2015 American Heart Association (AHA) Basic Life Support (BLS) Cardiopulmonary Resuscitation (CPR) performance guidelines were used to evaluate instructor accuracy. Each CPR instructor (participant) watched and evaluated six two-minute videos (in random order) of two-rescuer adult CPR. Participants were not allowed to rewind the videos once the viewing began. They could watch any or all videos a second time if needed.

The videos were recorded with four camera viewpoints to optimize visualization of CPR skills for participants. The four camera viewpoints attempted to recreate the different viewpoints an instructor would have during an actual course. The participants assessed the recorded two-rescuer skills with the instrument located in Appendix A. Written consent was obtained by the video models prior to recording. The six videos were uploaded to a Google Site that would allow independent viewing at multiple computers.

Setting and Participants

While 50 participants were sought, a sample of 33 AHA BLS CPR instructors who were at least 18 years of age and resided in a southern Virginia city or surrounding county. These participation criteria were required for this research to study one group of CPR instructors. Instructors trained through other organizations, such as American Red Cross or American Safety and Health Institute, were not included because of discrepancies in instructor training requirements. Other reasons for choosing AHA instructors included researcher's familiarity with AHA and availability of AHA instructors in the research area. According to the local AHA Training Center Coordinator, there are approximately 460 BLS CPR instructors in the research vicinity (J. Shirey, personal communication, November 6, 2018).

The list of all training sites in this region and the training site coordinators' emails were obtained from a local Training Center. A recruitment email was sent to each training site coordinator explaining the details of the study, directions for how to participate, and the process for requesting additional information. The training site coordinators were then asked to forward the recruitment email to all BLS instructors associated with the training site. Additionally, this email was sent to BLS instructors familiar to the primary investigator. Follow-up emails to the training site coordinators and all other instructors were sent every seven days (for four weeks) after the initial email.

Each participant who scheduled an appointment to participate was required to sign the informed consent. The demographic information collected included: age, sex, profession, total number of years teaching Basic Life Support CPR, and average number of new and re-certification BLS CPR classes taught per year (Lynch et al., 2005). The entire CPR Instructor Information Form is in Appendix B.

An incentive was offered for any participant choosing to enter a drawing for a chance to win one of ten 50-dollar gift cards. Once the participants completed the demographic form, they filled out the Optional Drawing Entrance Form (in Appendix C). Drawing for the 10 gift cards was done once all data was collected. Winners were sent a gift card through priority mail to the address provided on the form.

Instrumentation

An evaluation tool was developed specifically for this research study and is in Appendix A. The research evaluation tool was created because the current AHA CPR checklist requires only that the instructor indicate "adequate" or "inadequate" on skill performance. More specific evaluation criteria were necessary to determine the precision of instructors' assessment methods.

The researcher consulted three experts in CPR instruction to review the videos and evaluation tool to establish validity of the instrument. A pilot test was not performed. Expert 1 has been a CPR instructor for various organizations since 1985. Further, Expert 1 taught for American Red Cross for four years, transitioned to American Heart Association for another 11 years, and is currently an American Safety and Health Institute instructor. Additionally, Expert 1 has also been an Instructor Trainer for three years, and Emergency Medical Technician (EMT) for 32 years and was a paramedic for four years. Expert 1 also is an EMT instructor and Professor of Emergency Management at a Virginia college.

The second expert reviewer (Expert 2), has taught American Heart Association CPR courses for 15 years, has been a Certified Athletic Trainer since 1997, holds a terminal degree in healthcare, and has been a professor at a Virginia college since 2002. The third expert reviewer has been a CPR instructor since 2001, serving AHA specifically since 2005. Expert 3 has taught for the American Red Cross and the National Safety Council, has been a Certified Athletic Trainer since 2001, and has taught multiple courses in emergency response for healthcare providers as well as lay people. After viewing the videos independently, each expert agreed with the parameters to be evaluated and believed it to be a valid measurement of assessment abilities.

Procedures

Participants met in a reserved computer lab at the University of Lynchburg (formerly Lynchburg College) in small groups or individually. For those participants unable to travel to the University of Lynchburg, the researcher travelled to individual or small groups of participants. In every case, each participant was seated at their own computer (or laptop) for the entire session and was provided a pair of noise-reducing earplugs during the research session. The first 10 minutes included a brief introduction to the study and each participant signed an informed consent form. It was made clear both written and verbal that the participant could choose to discontinue their participation at any time. The evaluation tool was reviewed, and a short video clip was shown to familiarize participants with the various camera angles/views available to assess the CPR performances. Then there was a question and answer session to clarify directions if needed.

Each participant independently viewed and assessed a series of video performances made available on a Google Site. A total of six pre-recorded videos of two-rescuer CPR performance (four views of the CPR performance concurrently) were shown to each participant. The four different views provided the participant with options regarding preferred camera angle to best visualize the CPR skills and overall performance. The six videos were assessed in random order by each participant. Each video was two minutes in length and the rewinding and pausing capabilities were disabled, but the participants had the option of watching any or all videos a second time. This inability to rewind or pause during the videos more closely simulated a real class where the instructor does not have the ability to pause and/or rewind the learners' performance. Furthermore, in a live class setting the learners can repeat their skill performance for the instructor to assess. One completed evaluation form was required for each of the two-minute videos, for a total of six evaluation forms per participant. When participants finished assessing all six videos, they completed the CPR Instructor Information Form (Appendix B).

The Laerdal Resusci-Anne® QCPR (Figure 1) manikin used during the videos has been found to accurately measure all CPR skills performed. Schober et al., 2012 analyzed the reliability of the QCPR manikin and found minimal error when the manikin was placed on a hard surface. The manikin was found to "slightly underestimate compression depth" (p. 190) with limits of agreement equaling 95%. A photo of the SimPad with SkillReporter used with the

QCPR Manikin is in Figure 2. This device records the objective data from the CPR skills to compare them to each of the instructors' assessment of the same CPR skills.

Figure 1. Resusci-Anne® QCPR manikin. This is the feedback manikin used in the videos assessed by participants.

Figure 2. SimPad with SkillReporter. This is connected to the feedback manikin that displays results of the CPR skills assessed.

Critical Skill Descriptions

According to the AHA 2015 CPR Guidelines, there are six critical skills assessed during a BLS course. Each one has specific aspects which need to be performed to pass that skill. For this research, only compressions and ventilations were assessed since those skills are the primary components of high-quality CPR performance.

1. Performs high-quality chest compressions
    a. Correct hand placement - lower half of sternum, two-handed
    b. Compression rate of 100 - 120 per minute (30 compressions in 15-18 seconds)
    c. Compression depth (2 - 2.4 inches)
    d. Full chest recoil/release between compressions
2. Provides two breaths by using a barrier device
    a. Opens airway adequately (head tilt/chin lift or jaw thrust)
    b. Delivers breaths that produce visible chest rise (between 500-600 mL)
    c. Avoids inadequate ventilation (less than 500 mL) or excessive ventilation (over 600 mL)

Assumptions

Because only AHA CPR Instructors were used in this study, one assumption is the consistency of instructor training. All participants have completed a standard CPR instructor certification course. To maintain instructor status, the AHA requires all instructors to be evaluated by a designated faculty member within the training center's jurisdiction at least once every two years. The documents regarding initial instructor certification and any renewal paperwork are secured in the office of the local AHA training center with the training coordinator. Another assumption is the instructors not only evaluate each CPR learner in their classes, but they also provide feedback to the learners, whether objective and/or subjective. The importance of feedback to enhance skill development is well documented in prior research as discussed in Chapter 2.

Delimitations and Limitations

There were limitations and delimitations to this study. One limitation was that CPR instructor participants assessed video performances of CPR skills and not live performances. In a typical assessment situation, instructors would be watching multiple learners perform CPR skills in person and would move around to observe at different angles. The videos were used to control for distractions that a normal classroom environment could produce, along with consistency of CPR skill performance. Even though this format is not realistic for teaching purposes, the videos allowed the instructors to focus on assessing only two learners at a time. Having four different camera viewpoints was intended to decrease the effect of this video-based limitation. Video analysis is common with activity-based skills to provide feedback on mechanics. Video based assessment can also be beneficial for the instructor in providing objective information to enhance skill performance (Mango et al., 2010; Sgrò et al., 2013).

An additional limitation was the participants' lack of familiarity with the Laerdal Resusci-Anne® QCPR manikin used for the video skill demonstrations. This manikin is costly, which prevented most of the participants from being exposed to it prior to this study. This unfamiliarity could result in a decreased accuracy of measurement outcomes. Due to the bright overhead lights where the videos were recorded, the manikin wore a light-colored tank top. This may have interfered with hand placement assessment, however, it was necessary to add the glare-reducing clothing to visualize the chest movement of the manikin.

Another limitation was the potential for instructor bias. Several studies have indicated that bias exists in instructor assessment of students in live courses (Kaye et al., 1991; Lynch et al., 2008; and Vivekananda-Schmidt et al., 2007). One of these studies compared the assessment of medical students' evaluation skills live versus video recorded. Instructors in this study consistently rated the live skill performance higher than the video-recorded skill performance. The researchers attributed this to instructor bias and still found a moderate level of interrater reliability between the live evaluations and the video recorded evaluations (Vivekananda-Schmidt et al., 2007). While the potential for instructor bias exists, a video recording of CPR skills offered consistency with performance for all instructors.

While efforts were taken to ensure consistent instructor training by selecting only AHA taught instructors, consistent instructor training was also a limitation. There is no method to determine the standardization of American Heart Association instructor training. It is possible that instructors were exposed to various procedures while learning instructional techniques. The training centers make every effort to ensure consistent training, however differences may still exist.

A delimitation to this study was that only AHA instructors in Virginia participated, which means these instructors are certified to teach healthcare providers Basic Life Support CPR courses, but also lay person CPR courses. This suggests that instructors may have varying degrees of experience teaching the BLS class specifically while still maintaining their certification to teach both types. This may limit the generalizability of the results; however, it still provided information regarding accuracy of currently certified instructors' assessment skills.

A second delimitation was eliminating the audio component of the videos. Muting the manikin sounds made during ventilations and compressions could make assessment of skills more difficult, especially when instructors evaluate certain skills based on consistent manikin sounds. This choice was made to decrease the distractions from video production. The extraneous noise far exceeded the potentially helpful manikin sounds therefore the volume was muted.

Data Analysis

Descriptive statistics were collected on the CPR Instructor Information Form (Appendix A). Information collected included age, sex, profession, years of CPR teaching experience, average number of new and recertification CPR classes (both healthcare provider and lay person) taught per year, and the instructors' current and past utilization of objective feedback devices. Each participant was assigned a research number and this number linked the CPR Instructor Information Form (Appendix B) to the CPR Instructor Evaluation Forms (Appendix A).

Four of the six skills required the instructor to provide an adequate percentage for the evaluation. During each two-minute video, participants assessed what percentage of each skill was adequately performed. These four skills were chest compression depth, chest recoil, hand placement, and ventilation volume. The participant scores were compared to the feedback manikin data scores to determine accuracy level. An instructor score of plus or minus five percentage points from the manikin score was considered accurate. Any score further than five points from the manikin score in either direction was considered inaccurate.

Two of the six skills were assessed with a specific number, not a percentage like the previous skills discussed. For chest compression rate, each participant provided a number corresponding to the chest compression rate they witnessed for each video. Adequate chest compression rate is between 100 and 120 compressions per minute, so if participants assessed that skill anywhere within that range, they were considered accurate if it matched the manikin data. The other assessment requiring a specific number was the number of completed cycles. If the participants correctly assessed the exact number of cycles completed in each of the two-minute videos, they were recorded as accurate. Anything other than the exact number of cycles was recorded as an inaccurate assessment.

An independent sample t-test was run for each dependent variable (six CPR skills assessed) and each of the six videos. Once accuracy for each skill was determined, a multiple regression was used to determine if the instructor's total years of teaching or average number of classes taught per year related to accuracy. Data was analyzed using IBM SPSS version 25 and p-values < 0.05 were considered statistically significant. From the approximate population size of 460 (J. Shirey, personal communication, November 6, 2018), the number of instructors who participated was 33.

Ethical Considerations

The American Heart Association CPR Instructors who volunteered to participate in this study were provided an information session and were fully aware of the procedures by reading and signing an informed consent form. All volunteers were 18 years or older and at minimal risk to participate in this study. Once the data were gathered, it was stored in a password-protected computer locked in a private on-campus office to which only the primary researcher has access.

The participants were not provided with any individual feedback on how accurate their CPR skills evaluations were at the time of data collection. After data were collected and analyzed, the researcher sent each training site coordinator the aggregate data. The coordinators could then share the quantified results with instructors associated with the training site. At no time were individual instructors provided with any personal skill assessment results.

Summary

Because the literature justifies both IL and non-traditional methods for acquiring CPR skills, accuracy must be considered. The methodology chosen for this study can assist in identifying skill assessment accuracy. By having consistent video-recorded CPR skills for participants to assess, the differences in performance is eliminated. In addition, having both adequate and inadequate skill performance will further determine participants ability to detect skill quality. Finally, participant selection from only one organization decreases the inconsistencies with instructor training.

Chapter 4

Results

This cross-sectional quantitative study sought to compare the subjective instructor assessment of CPR skills to the objective manikin assessment to determine instructor assessment accuracy. Teaching experience was also investigated to determine if experience was related to accuracy of instructor assessment. The sample size goal for participants was fifty AHA trained CPR instructors, who would perform a series of six video-based assessments of specific life-saving CPR skills. The specific skills each participant assessed included chest compression (depth, recoil, rate, and hand placement), ventilation volume, and completed cycles of 30 compressions and two breaths. Once assessments were complete, demographic data were collected. Along with details of the results of this data, the research questions are revisited, and the operational definitions are included for clarification.

Participant Demographic Information

Participants in this study were 33 American Heart Association CPR instructors between the ages of 22 and 60. Of the 33 participants, 21 identified as female and 12 identified as male. Out of the 33 participants, seven indicated working in a non-healthcare related field, nine reported working in healthcare but not currently clinically active (i.e. professor, instructor, etc.), and 17 indicated they currently worked as healthcare clinicians (nurse, athletic trainer, etc.). In addition, 12 of the 33 (36.4%) participants indicated that teaching CPR was a part of their job description while the other 21 (63.6%) were not required to teach CPR for their job.

Teaching experience for this research was based on total years of teaching CPR and the mean number of CPR classes taught per year. The years of CPR teaching experience in this group ranged from six months to 24 years (M = 7.3, SD = 7.5) and the range of CPR classes taught each year was between 2 and 160 (M = 10, SD = 27.4). All participants were certified to teach at the healthcare provider level (BLS), but many also had experience teaching layperson CPR. The mean number of basic life support courses taught per year was 5.67 with a standard deviation of 13.98 and the mean number of layperson courses taught per year was 4.24 with a standard deviation of 13.73. Since the CPR skills that were assessed are taught in both BLS and layperson CPR courses, this research study included both types of classes in the total classes taught per year for the participants.

Research Questions

1. How do CPR instructors' subjective assessment of learners' skills compare to the objective assessment of learners' skills?

2. Does instructor CPR teaching experience (in number of years) predict accuracy of instructor's subjective skill assessment?

3. Does instructor CPR teaching experience (in average number of classes taught per year) predict accuracy of instructor's subjective skill assessment?

In order to answer the first research question of how the instructors' subjective evaluations compare to the manikin's objective evaluations, defining the terms "accurate" and "inaccurate" was necessary. The expert panel referenced in chapter three was consulted and unanimously agreed that a score that was greater than plus or minus 5% away from the objective measurement would be "inaccurate," while a score that fell within 5% from the objective measurement would be "accurate." This 5% rule was used to determine accuracy for chest compression depth, chest recoil, hand placement, and ventilation volume. Participants scored each of these skills as a percentage during each two-minute video.

Two skills were assessed differently. Chest compression rate was scored as number and was determined accurate if that number was anywhere within the acceptable range. If the CPR video performance of chest compressions was within the acceptable range of 100 to 120, to be accurate in assessment the participant could indicate a score anywhere within that range. Likewise, if the performance was inadequate (either lower than 100 or higher than 120) and the participant indicated a value outside of the acceptable range, he/she was considered accurate. Accuracy for total cycles was also determined differently than the other skills. The participant had to correctly evaluate the exact number of cycles each of the videos portrayed in order to be considered accurate. The objective measurement data to which each subjective skill assessment data was compared were provided by the Laerdal Resusci-Anne® QCPR feedback manikin used in the research videos.

Operational Definitions

Table 5 describes each of the skills considered essential for high-quality CPR according to the American Heart Association (2015). The second group of definitions will explain terminology used in data analysis and is in Table 6.

Table 5

High-Quality CPR Skill Definitions

Skill	High-Quality Definition and/or Ideal Assessment
Chest compressions rate (CC rate)	Speed at which chest compressions are performed (100 – 120 per minute)
Chest compression depth (CC depth)	Depth at which chest compressions are performed (2.0 to 2.4 inches or 5 - 6 centimeters)
Chest compression recoil	Allowing the chest to return to normal position between each chest compression

Table 5 (continued).

Hand position	2 hands on the lower half of the breastbone (sternum) with the heel of one hand two finder widths above the xiphoid process (base of sternum)
Ventilation volume	Each rescue breath is approximately one second in duration with enough volume to make the adult victim's chest rise visibly.
Total cycles	Each cycle consists of 30 chest compressions and two rescue breaths. Five cycles should be completed within a two-minute period.

Table 6

Data Analysis Definitions

Term	Definition
True positive (TP)	An assessment where the instructor correctly identifies an error in a CPR skill when an error was present.
False positive (FP)	An assessment where the instructor incorrectly identifies an error in a CPR skill when an error was not present.
True negative (TN)	An assessment where the instructor correctly identified no error in a CPR skill when no error was present.
False negative (FN)	An assessment where the instructor incorrectly identified no error in a CPR skill when an error was present
Sensitivity	The ability to detect an error in a CPR skill when an error is present (TP/(TP+FN)) with the ideal value as close to 1.0 as possible.
Specificity	The ability to detect no error in a CPR skill when no error is present (TN/(TN+FP)) with the ideal value as close to 1.0 as possible.
Positive predictive value (PPV)	The percentage of times an error was assessed when an error was present (TP/(TP+FP)).
Negative predictive value (NPV)	The percentage of times an error was not assessed when an error was not present (TN/(TN+FN)).
False Negative Rate (FNR)	The percentage of times an error was not assessed when an error was present (FN/(TP+FN)).

Data Analysis

The subjective instructor data for each of the six CPR skills for all six videos (a total of 36 individual skill measurements) were compared to the objective measurements of the same 36 CPR skills. An independent sample t-test was run using IBM SPSS (version 25) for this analysis with results included in Table 7. The objective measurement score (number or percentage) for each skill assessed per video, and the significance of the difference between the objective measurement and the aggregated subjective measurement (*p* values) in grey are detailed in Table 7. The single asterisk indicates a significance value less than 0.05, while a double asterisk represents a significance value of less than or equal to 0.01.

Table 7

Manikin Values and Significance Values Between Manikin and Subjective Measures

Video	CC Rate (per minute)		CC Depth		Recoil		Hand Position		Ventilation Volume		Total Cycles	
	#	*p*	%	*p*	%	*p*	%	*p*	%	*p*	#	*p*
1	119	.156	72	.568	77	.096	100	.012*	0	.000**	6	.280
2	122	.017*	80	.008**	40	.004**	100	.011*	0	.000**	6	.063
3	114	.008**	100	.000**	96	.012*	100	.009**	100	.000**	6	.216
4	96	.036*	100	.000**	100	.000**	72	.022*	0	.000**	5	.070
5	117	.004**	16	.000**	92	.000**	100	.035*	80	.076	5	.177
6	117	.090	100	.000**	100	.000**	100	.030*	83	.000**	6	.280

Note. *$p \leq 0.05$, **$p \leq 0.01$

Every skill, other than total cycles, indicated a statistically significant difference between subjective and objective measures at the 0.01 or 0.05 level. The three skills that had significance levels measured at 0.01 were chest compression depth (CC Depth), chest compression recoil (CC Recoil), and ventilation volume. Five out of six (83%) video assessments for CC Depth found differences at the $p \leq 0.01$ significance level. Recoil and ventilation volume were similar with four of the six videos (67%) revealing significant differences at the $p \leq 0.01$ level. Considering all the CPR skill assessments, again excluding total cycles, 17 of 30 (57%) were statistically significantly different at the $p \leq 0.01$ level and eight of 30 (27%) were statistically significantly different at the $p \leq 0.05$ level. The total number of statistically significantly different skill assessments was 25 out of 30 or 83%. High-quality CPR includes all these skills, along with chest compression rate and correct hand placement, to ensure the best possible chance of survival for victims of cardiac arrest. These six skills are essential components for high-quality CPR and should be assessed as accurately as possible.

All videos were assessed with statistically significant differences between subjective and objective skill measurements. Video three, which was a "no error" video (all skills met AHA standards), had the most skills (4/5 or 80%) assessed at the significantly different level $p \leq 0.01$. Videos two, four, five, and six had three skills each (60%) that met the significant difference at the $p \leq 0.01$ level. Video one had the least number of skills that were assessed with statistically significant differences between subjective and objective measures. This video would be the most "accurately" assessed video by instructors.

Research questions two and three respectively sought to answer if the average number of classes taught per year or total years teaching CPR were predictive factors in participants' abilities to accurately assess CPR skills. A multiple linear regression calculation was utilized to answer these two research questions. Five skills were used in the regression analysis: chest compression rate, chest compression depth, chest recoil, hand placement, and ventilation volume. The regression analysis results of these 30 calculations are presented in Table 9 in Appendix D. Out of the 30 regressions calculated only one indicated statistical significance, the chest recoil in Video 1 ($p \leq 0.013$). Otherwise, there was no indication that instructors who taught a higher number of CPR classes on average per year were any more accurate in CPR skill assessment.

There was also no statistically significant correlation to number of years teaching CPR and accuracy assessing CPR skills. All statistically non-significant *p* values are also included in Table 9.

Once instructor subjective data was gathered for each of the skills on each of the six videos, a "difference" variable was calculated for chest compression depth, chest recoil, hand position, and ventilation volume. This new "accuracy" variable was determined by expert reviewers to be plus or minus five percent from the manikin objective percentage value. For example, if the manikin data indicated that 90% of chest compressions performed had adequate depth, instructors' subjective assessment would be considered accurate if they chose between 85% and 95%. Two skills assessed, chest compression rate and total number of cycles, were treated differently than the other four skills just explained.

Chest compression rate has an acceptable range that is 100-120 chest compressions per minute. Therefore, if the instructor assessed the rate within the acceptable range and the manikin objective value was also within that range, the instructor was considered accurate. Likewise, if the instructor assessed the rate as outside of that range and it was outside the acceptable range, again, the instructor was accurate. For a true positive (detecting an error when there was an error) assessment in chest compression rate, the participant had to identify if the rate was lower or higher than the acceptable range. For example, during Video 2, the objective chest compression rate was 122 compressions per minute. This compression rate was higher than the acceptable range (100-120 compressions per minute), so in order to be considered accurate, the participant had to indicate a number above 120. To clarify, even though 120 compressions per minute is above the ideal range, if participants indicated a higher than acceptable number, they would still be considered accurate in their assessment. The other skill in which accuracy was calculated differently was for Total Cycles. Total Cycles is the number of cycles (30 compressions and two breaths) that were performed in each of the two-minute videos. Instructor's assessment of Total Cycles was either correct (accurate) or wrong (inaccurate).

Table 8 is a summary of the sensitivity, specificity, positive and negative predictive values, and false negative rates for each CPR skill assessed. These terms were defined in Table 6 above. Only chest compression rate had results over 50% for both sensitivity and specificity (ideal is 100% for both). Based on the extremely low sensitivity percentages, it seems instructors are not able to detect poor quality (positive for errors) in CPR skills when they occur. While the specificity scores are only slightly higher than the sensitivity scores, it seems that participants also found it difficult to detect good quality (negative for errors) CPR skills when they occurred. With lower sensitivity scores, it makes sense that the false negative rates are high for each skill. A false negative rate is what percentage of the CPR skills were assessed as correct (negative for error), when in fact, there was an error with the skill.

Table 8

Accuracy of Subjective CPR Skill Assessment (all videos)

Skill Evaluated	Sensitivity (%)	Specificity (%)	Predictive Values (%) Pos	Neg	False Neg Rate (%)
CC Rate	43.94	56.82	33.72	66.96	56.06
CC Depth	14.29	35.61	10.53	43.93	85.71
Recoil	10.61	40.15	8.14	47.32	89.39
Hand Position	12.12	74.55	8.70	80.92	87.88
Ventilation Volume	6.06	5.21	3.19	9.71	93.94

Total Cycles	56.57% correct 43.43% incorrect

Overall, the false negative rate for each of the CPR skills was over 80%, the only exception being chest compression rate at 56.06%. These percentages indicate the percentage of

CPR skill errors that were not detected by participants. This demonstrates that participants assessed all six high-quality CPR skills as adequate over half of the time when, in fact, the skills were being performed improperly.

In summary, the first aspect of this research compared the measurements of subjective versus objective CPR skill assessment data. The results of this comparison indicated statistically significant differences between the objective and subjective measures, indicating statistically significant inaccuracy of the subjective instructor assessments.

Furthermore, the data were correlated with two separate variables indicating CPR teaching experience of each participant. These variables consisted of years of CPR teaching experience and average number of CPR classes taught each year. The first correlation of years of CPR teaching experience did not indicate statistical significance concluding that experience did not influence how accurately an instructor assesses certain CPR skills. The second correlation calculated the average number of classes taught each year did not indicate statistical significance concluding that experience did not influence how accurately an instructor evaluates certainly CPR skills. The next chapter will include in detail, the implications and generalizability of these results.

Chapter 5

Discussion

This chapter provides an overview of the investigation on CPR instructors and the conclusions drawn from the findings. A comparison between CPR instructor subjective assessment measurements and objective manikin assessment measurements was performed along with determining whether CPR teaching experience was a factor in assessment ability. Implications for current practice and future research directions are also discussed.

Research Study Summary

Organizations such as the American Heart Association are consistently updating requirements to improve CPR skill performance based on best practices and current research. One challenge with that responsibility lies with confirming the accuracy in assessment of learner CPR skills with IL courses. According to the Training Center Coordinator, since February 2018, 97% of CPR (BLS and Heartsaver) classes were IL (J. Shirey, personal communication, November 6, 2018). With 461 instructors in the Lynchburg Statistical Area alone, the sheer number of IL CPR courses offered can be overwhelming for the Training Center. The goal is to ensure quality and consistent instruction. This study sought to determine if a sample of CPR instructors was able to accurately assess life-saving CPR skills compared to an objective feedback manikin.

Problem overview.

If CPR learners are not given accurate feedback during their skill training, it is possible that high-quality CPR skills are not being acquired. Furthermore, if high-quality CPR is not being practiced, it may be suggested that high-quality CPR is not being performed. The American Heart Association emphasizes the need for high-quality CPR initiated immediately to increase survival rates of cardiac arrest victims. Therefore, it is imperative that learners gain competence in high-quality CPR skills by practicing at an appropriate level and being assessed accurately.

Research questions.

This study attempted to answer three questions regarding CPR instructor assessment:

1. How do CPR instructors' subjective assessment of learners' skills compare to the objective assessment of learners' skills?
2. Does instructor CPR teaching experience (in number of years) predict accuracy of instructor's subjective skill assessment?
3. Does instructor CPR teaching experience (in average number of classes taught per year) predict accuracy of instructor's subjective skill assessment?

Conceptual Model.

Figure 3 represents the conceptual model developed for this study. According to this model, instructor assessment of CPR skills is either accurate or inaccurate. If the instructor assessment is accurate, the accurate feedback will ultimately improve CPR skill performance. However, if the instructor assessment is inaccurate, an objective assessment of CPR skills is required for the instructor to provide accurate feedback for skill performance improvement. If Gagne's Learning Theory (1985) is applied to CPR skills, for a motor skill to be learned, there needs to be correct modeling of the skill, practice of the skill, along with feedback on skill performance. It is imperative that this performance feedback is accurate, whether subjectively or objectively delivered.

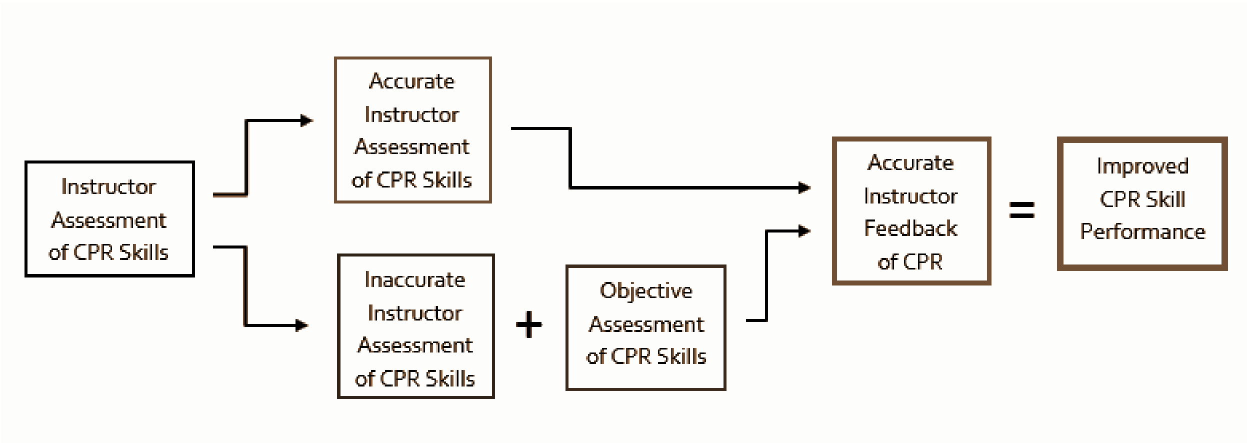

Figure 3. Conceptual model.

Effective CPR instruction, including accurate assessment, is critical to providing essential feedback to anyone learning these life-saving skills. Performing high-quality out-of-hospital CPR can double or triple cardiac arrest victims' chances of survival. According to the AHA, more than 350,000 cardiac arrests occur outside of the hospital each year (2018). If the CPR instructors are ineffective in assessing the performance of their students, those individuals are potentially not learning and/or reviewing correctly performed life-saving skills. If instructors are ineffective in detecting and correcting improper CPR techniques, they are likely to reinforce inaccuracies (Al-Rasheed et al., 2013). Inaccuracies in learning CPR could, in turn lead to inaccurate performance in real-life CPR situations.

Methodology overview.

A quantitative cross-sectional design was used to collect demographic and subjective participant assessment data. Participants were local CPR instructors who assessed pre-recorded 2-person CPR skills during a single hour-long session. The assessment instrument was developed by the researcher and approved, along with the pre-recorded videos, by a panel of three experts. As careful as the researcher was in design and consistency with details including instructions and test settings, there may have been unforeseen extraneous variables.

Although the researcher provided consistent instructions and conducted the research in similar settings, there may have been participants who needed additional instructions and/or may have been distracted during the session that could have affected their assessment results. The sample size obtained is another threat to the results of this study. Due to the limited number of participants, the results are not generalizable to CPR instructors. With roughly 460 instructors in the research vicinity, the response rate was 7%, with 33 participants. The target response rate was 10% with 46 participants. The sample was also conveniently obtained through the network of local AHA instructors, so it is possible that the instructor training was completed through the same Training Center, and therefore was consistent. Regardless of training, the small sample size is most likely not representative of the overall instructor population locally or worldwide.

An important delimitation to discuss was the assessment of video-based CPR skills. Many of the participating instructors were concerned about the four views not being optimal for skill visualization. Other comments from participants included the desire for audio feedback (all videos were muted to decrease background noise and verbal prompting), the lack of familiarity with the manikin used in the videos, and that the shirt on the manikin increased the difficulty of hand position assessment. Many instructors utilize certain manikins and become familiar with the various noises the manikins (can provide positive or negative feedback) make during CPR skill practice. When unable to hear these helpful sounds, instructors may have more difficulty in skill assessment. The decision for the manikin to wear a shirt rather than no shirt was made in order to decrease the glare from the overhead lights where filming took place. Researchers decided it was more important to be able to see movement in the chest (depth, recoil, ventilations) than to visualize certain landmarks for hand position.

In order to establish consistency, video recorded skills (with and without errors) were required using the objective manikin data for comparison purposes. The errors in four of the six videos were somewhat arbitrary, but each video had a pre-established performance range for all skills. Once all skills were performed within the established range for each video, the video was considered ready for research purposes.

Analysis overview.

The data retrieved from this study were analyzed in an attempt to answer each research question. CPR skill assessment accuracy of participants was compared to the assessment of the objective manikin. A t-test was calculated in order to determine if there were statistically significant differences in these assessments. A multiple regression was also conducted to determine if a relationship existed between CPR teaching experience and accuracy in assessment. CPR teaching experience was defined as number of years teaching CPR and an average of CPR classes taught each of those years.

Major findings.

Multiple findings were taken from the data analysis. It was anticipated that certain skills would be more difficult to subjectively assess, such as chest compression depth and ventilation volume. However, in this study, every skill assessed, except for total cycles, had statistically significant differences between the subjective and objective measurements. Chest compression rate was assessed inaccurately in four of the six videos, while chest compression depth, recoil, and ventilation volume were assessed inaccurately in five of the six videos. Hand position was assessed inaccurately in all six videos, and the only recorded hand position error was Video 4. As stated previously, some instructors mentioned the difficulty of hand position assessment due to the clothing. This could indicate instructors may be more inclined to assess hand position as correct when the manikin is wearing clothing and landmark visibility is limited.

The false negative rates on the subjective assessment measurements was perhaps the most clinically relevant result of this study. If CPR instructors are, more than 50% of the time, not detecting incorrect CPR skills, they will fail to address skill correction. This failure to provide accurate feedback, especially in faulty skills, could result in poor CPR skill acquisition.

Findings Related to Previous Research

Previous research related to instructor assessment of CPR skills has shown mixed results regarding skill assessment ability. In certain cases, CPR instructors were shown to assess ventilation performance accurately (Lynch et al., 2008) and provide valuable motivation and knowledge (Seraç & Ok, 2010) to learners. In other research, instructor judgment was found to be inaccurate (Kaye et al., 1991), especially with chest compression depth and rate (Brennan et al., 1996).

Results of this study indicate that AHA CPR instructors were inaccurate with their subjective assessment of video-based CPR skills. Experience in years teaching CPR and classes taught was not found to be related (positively or negatively) to accuracy in the subjective assessment of CPR skills. New and experienced instructors have similar skills for CPR assessment accuracy. Based on limited previous research on CPR instructors, similar results were reported in instructors assessing CPR performance as adequate (passing) when the skills were unacceptable (Brennan et al., 1996; Chamberlain et al., 2001; Lynch et al., 2008; Kaye et al., 1991). Optimally, when CPR performance does not contain high-quality CPR skills, there would be remediation of those skills until the quality met AHA standards. These critical CPR skills, as found in this study, are difficult to subjectively assess. A few of the high-quality skills especially challenging to assess were the chest compression depth of 2 to 2.4 inches (5 to 6 centimeters), chest compression rate of 100 to 120 chest compression per minute, and enough ventilation volume to make the chest rise visibly (between 500 and 600 milliliters).

Unexpected Findings

Based on previous CPR skill assessment research, difficulty with chest compression depth and recoil was expected. The unfamiliarity with the manikin used in the videos also made ventilation volume and hand position assessments challenging. An unexpected result was the trouble with assessment of total cycles. The AHA states that in a two-minute time frame, there should be a total of five cycles of 30 chest compressions and two breaths. Though the instructors' subjective assessment of total cycles was not statistically significantly different than the actual number of total cycles, it was still surprising that total cycles was miscalculated 43.43% of the time. It is possible that instructors were more focused on the other skills during the videos, or simply lost track of counting the cycles.

Another unexpected result was that CPR teaching experience (in years and number of classes taught) had no relationship to accuracy of instructor assessment. While experience could enhance familiarity with the material, there is more to quality skill instruction than merely years and number of classes. Successful educational practices include time on task, student/faculty interaction, high expectations, and active learning (Jeffries, 2005).

Implications for Practice

Probably the most significant finding was the high occurrence of false negative rates. The difficulty in assessment did not lie within a couple individual CPR skills, instead CPR instructors consistently assessed most individual CPR skills inaccurately. With the large margin of error with skill evaluation noted, it could be suggested that instructors should be monitored more often than current protocols require. New instructors are required to be monitored by an AHA faculty member for their first class within six months of being certified to teach. Other instructor requirements include teaching at least two CPR courses each year, recertification instructor status every two years, and complete AHA instructor updates as available. Maintaining proficiency in any skill, including teaching, requires practicing those skills regularly.

As of January 2019, all AHA CPR classes will be required to implement objective feedback for chest compression depth and chest compression rate. This feedback can be provided by a feedback manikin or a feedback device used with a non-feedback manikin. This change in AHA requirement is supported by the evidence obtained by this research study. The difficulty of providing accurate subjective feedback is reliant upon accurate subjective assessment ability. If the subjective assessment is inaccurate, an objective assessment is necessary for accurate feedback. This is outlined in the conceptual model shown in Figure 3.

Further Research

Decreasing the effects of limitations is a challenge and goal for all research projects. One considerable delimitation in this study was the use of video recorded CPR performances. In order to minimize the effects of video recorded sessions, future research could have live CPR performances evaluated by instructors. This would eliminate any issues with viewing angles because instructors would be free to watch from any position. Live skill assessment could also include audio feedback for instructors. Finally, instructors would not be distracted by seeing simultaneous recordings of the four camera views. Focusing on a preferred view could improve skill assessment.

Conclusions

As the demand for high-quality CPR performance continues to increase, so does the importance of high-quality CPR instruction. Instructor-led CPR courses remain the most popular method of learning CPR, and it is imperative instructors teach at a high-level so learners are effectively trained. Part of teaching effectively is providing accurate feedback to learners. Along with the pressure to develop and train quality CPR instructors, organizations are challenged to provide consistent training for CPR instructors. The implementation of required objective feedback devices will certainly facilitate more accurate skill assessment, which will increase the accuracy of feedback provided to learners. Feedback accuracy is essential for developing skills, in this case *life-saving* skills, which directly increases survival rates of the 347,000 annual cardiac arrest victims.

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Appendix A

CPR Instructor Evaluation Form

For each video scenario, assume the rescuers have already insured scene safety, checked for responsiveness (victim is unresponsive), instructed another person to call 911 and get an AED if available, and has checked the victim for breathing and circulation (neither are present).

For each skill, indicate how well it is being performed with a specific number or percentage, and lastly whether you believe these two rescuers need remediation or pass (circle your choice).

CC = Chest Compressions

Video #

Number of CC per minute (Average CC rate)		
Percentage of CC with full depth (2 - 2.4 inches)		
Percentage of CC with full chest *recoil* or full chest *release*		
Percentage of CC with proper hand position		
Percentage of Breaths with Adequate Volume (500-600 ml)		
Number of cycles (30 CC: 2 breaths) COMPLETED		
Needs Remediation or Pass	Needs Remediation	Pass

Appendix B

CPR Instructor Information Form

Participant # _____

I appreciate your time and willingness to participate in this research project! If you would please complete this brief instructor information form, it will provide important background information for my study.

1. Date of Birth (month/year) ____________
2. Sex ____________
3. Profession ____

4. **Total** Years of *AHA CPR Teaching* Experience _______
5. Average number of **BLS** (Healthcare Provider) Courses taught per year _______
   - How many of those were NEW classes _____
   - How many of those were RE-CERTIFICATION classes _____

6. Average number of **Heartsaver** (layperson) Courses taught per year _______
   - How many of those were NEW classes _____
   - How many of those were RE-CERTIFICATION classes _____

7. Is CPR Instruction part of your current job responsibilities? Yes No
8. Do you use an objective feedback device to teach CPR courses? Circle one: Yes No
9. Have you used an objective feedback device in the past to teach CPR courses? Yes No

If you indicated Yes for either 8 or 9, please indicate which type of feedback you have used or currently use. If you can list specific brands, please do so.

Feedback Manikins Feedback Devices

NOTE: The information on this form will be kept confidential throughout the completion of this study and then properly destroyed.

Appendix C

Optional Drawing Entrance Form

Dear participant,

THANK YOU very much for your participation in my research study!!

If you wish to be entered into a drawing to win **one of ten $50 gift cards** (of your choice), please provide your information below. By providing this information, you are permitting the Primary Investigator (Emily Evans) to contact you if you are one of the ten chosen prize winners.

Once the drawings are held, this form will be destroyed, and your information will no longer be accessible. Email address will only be used for notification purposes, and address will only be used to send the gift card.

Name: ______________________________________

Email Address: ______________________________________

Address to send gift card: ______________________________________

____

Circle Gift Card Choice:

Kroger	Food Lion
Walmart	Target
Fresh Market	Amazon

Other: ________________________________

Appendix D

Table 9

Table 9

Regression Results by CPR Skill

	Frequency		Standard B (*p*)		Model *p*	Model R^2
	# Acc	# Inacc	TYT	NC/Y		
Rate Accuracy						
Video 1	17	16	.100 (0.622)	-.221 (0.277)	.549	.039
Video 2	6	27	-.040 (0.847)	.069 (0.739)	.944	.004
Video 3	22	11	.350 (0.079)	-.242 (0.220)	.187	.106
Video 4	23	10	.038 (0.852)	-.100 (0.624)	.885	.008
Video 5	19	14	-.005 (0.979)	-.152 (0.457)	.697	-.041
Video 6	17	16	.101 (0.618)	-.215 (0.291)	.567	.037

TYT = Total years teaching
NC/Y = Average number of classes taught per year

	Frequency		Standard B (*p*)		Model *p*	Model R^2
	# Acc	# Inacc	TYT	NC/Y		
Depth Accuracy						
Video 1	4	29	-.093 (0.651)	.126 (0.538)	.808	.014
Video 2	9	24	.075 (0.705)	-.293 (0.146)	.326	.072
Video 3	18	15	.077 (0.702)	-.221 (0.277)	.545	.040
Video 4	18	15	-.098 (0.623)	-.177 (0.379)	.418	.056
Video 5	2	31	.063 (0.758)	.013 (0.948)	.928	.005
Video 6	15	18	-.012 (0.953)	-.156 (0.444)	.672	.026

TYT = Total years teaching
NC/Y = Average number of classes taught per year

	Frequency		Standard B (*p*)		Model *p*	Model R^2
	# Acc	# Inacc	TYT	NC/Y		
Recoil Accuracy						
Video 1	6	27	.175 (0.348)	-.485 (0.013)	.042*	.190
Video 2	1	32	.128 (0.532)	-.005 (0.980)	.787	.016
Video 3	14	19	-.175 (0.379)	-.139 (0.485)	.328	.072
Video 4	18	15	.142 (0.478)	-.275 (0.175)	.389	.061
Video 5	5	28	-.306 (0.095)	-.276 (0.129)	.015*	.245
Video 6	16	17	-.102 (0.613)	.236 (0.246)	.505	.045

TYT = Total years teaching
NC/Y = Average number of classes taught per year

Table 9 (continued).

	Frequency		Standard B (*p*)		Model *p*	Model R^2
	# Acc	# Inacc	TYT	NC/Y		
Hand Position Accuracy						
Video 1	26	7	-.017 (0.935)	-.095 (0.641)	.850	.011
Video 2	23	10	.106 (0.594)	.207 (0.299)	.317	.074
Video 3	24	9	-.053 (0.793)	-.095 (0.640)	.779	.016
Video 4	4	29	-.208 (0.307)	.146 (0.470)	.563	.038
Video 5	25	8	-.068 (0.737)	-.086 (0.674)	.770	.017
Video 6	25	8	.023 (0.912)	-.087 (0.672)	.909	.006

TYT = Total years teaching
NC/Y = Average number of classes taught per year

	Frequency		Standard B (*p*)		Model *p*	Model R^2
	# Acc	# Inacc	TYT	NC/Y		
Volume Accuracy						
Video 1	0	33				
Video 2	0	33				
Video 3	2	31	-.303 (0.133)	.124 (0.531)	.317	.074
Video 4	6	27	.120 (0.557)	-.017 (0.933)	.823	.013
Video 5	6	27	.090 (0.660)	.063 (0.756)	.772	.017
Video 6	2	31	.018 (0.931)	.020 (0.924)	.985	.001

TYT = Total years teaching
NC/Y = Average number of classes taught per year