

**The development and testing of a training
intervention designed to improve the
acquisition and retention of CPR knowledge
and skills in ambulance paramedics**

By

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DECLARATION

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ABSTRACT

Despite several therapeutic advances in cardio-pulmonary resuscitation (CPR), there has been little overall improvement in the out-of-hospital, cardiac arrest (OHCA) survival rates. Reports indicate that, although the incidence and outcome of OHCA vary across the globe, the median reported rates of survival at hospital discharge have remained below 10% for the 30 years preceding this study.

One of the factors associated with this low survival rate is the deficient quality of the CPR provided during an OHCA by paramedics. Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, paramedic-delivered CPR (pdCPR) during OHCA is reported to be both inadequate and rarely in line with established resuscitation guidelines.

International resuscitation bodies such as the International Liaison Committee on Resuscitation (ILCOR) postulate the need for tailored CPR training interventions in order to improve CPR performance. The aim of this study was to investigate the impact of a tailored pdCPR training intervention on pdCPR performance.

Methods The study was conducted in four phases and, using a mixed-method, multiphase design the study developed, implemented and evaluated the impact of a pdCPR training intervention which had been designed and tailored to improve the acquisition and retention of knowledge and skills by ambulance paramedics (AP). The primary outcome measure used in the study was the achievement of a competent rating which reflected the ability of the AP in question to perform high-quality, effective CPR as determined and evaluated by a 26 measure CPR Rapid Evaluation Tool predicated on variables derived from the globally accepted Cardiff list. Each of the 26 measures represented a treatment element within a pdCPR care bundle and which had been shown to contribute to successful resuscitation.

Results The total proportion of participants rated as competent, as reflected by the evaluation tool, was 92.3% (144/156) for the paramedics who attended the *tailored* pdCPR training intervention and 13% (13/100) for the group who attended the *conventional* pdCPR training intervention ($p < 0.01$). Repeat tests conducted after 1, 3 and 6 months showed a degeneration in the number of APs rated as competent from 92.3% at the conclusion of the initial training to 33.3% at the final testing six months later. In addition, there was significant degeneration ($p < 0.01$) across individual process measures as early as three months after initial training.

Conclusion The results showed that while the proportion of CPR performances rated as competent was significantly higher when training was received from a tailored CPR training intervention, degeneration in skills occurred as early as 3 months after initial training and in a similar manner to non-tailored conventional training interventions. This provides a clear indication that, despite the type of training paramedics receive, it is likely that the traditional two-year period before retraining will contribute to significant skill deterioration, which may be a factor in the widely recognised quality of prehospital care for OHCA.

LIST OF OUTPUTS ASSOCIATED WITH THIS STUDY

Articles:

1. Govender P, Hahnle K, Wallis, Pillay Y. Comparison of two training programmes on paramedic delivered CPR performance. *Emergency Medical Journal* 2015; 12:1-6. Doi: 10.1136/emered-2014-204404

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DEFINITION OF TERMS

Ambulance services

Ambulance services are a type of emergency medical service dedicated to providing out-of-hospital medical care and transportation to people with acute or life-threatening conditions. They also provide a range of other urgent and planned health care and transport services to patients with illnesses and injuries which prevent the patients from transporting themselves. A standard ambulance is equipped with a variety of emergency care equipment including an ECG monitor/defibrillator, oxygen, intravenous fluids, spinal and traction splints and a range of medications.

Ambulance service personnel

Ambulance service personnel may include a range of medical staff with various levels of training and clinical scope of practices. At the Hamad Medical Corporation Ambulance Service – the setting for this study – there are three types of ambulance personnel, namely, a transport paramedic (TP), an ambulance paramedic (AP) and a critical care paramedic (CCP).

Ambulance paramedic (AP)

Characteristically referred to as mid-level ambulance personnel because their training is neither Basic Life Support (BLS) nor Advanced Life Support (ALS), APs are registered to practise under supervision and are licensed to provide such care as maintaining a patient's airway using supraglottic airway devices, establishing peripheral intravenous access and administering drugs such as 50% dextrose in hypoglycaemic patients, nebulised bronchodilators in patients with bronchospasm, and epinephrine and amiodarone in patients in cardiac arrest. The APs comprise the bulk of the ambulance service workforce and are typically the first to arrive on the scene in the majority of out-of-hospital emergencies in the state of Qatar. It is this category of paramedics who comprise the study population for this investigation. Hereafter these paramedics are referred to as ambulance paramedics (AP).

Cardiac arrest

Cardiac arrest refers to the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation.

Cardiopulmonary resuscitation

Cardiopulmonary resuscitation (CPR) is defined as the application of external cardiac compressions, with or without artificial ventilation, in victims with cardiac arrest in order to provide adequate circulation to support life.

Critical care paramedic (CCP)

The CCP is a paramedic who is licensed to practise independently and who has trained in the provision of advanced life support (ALS) and is qualified to provide such care as advanced airway, breathing and circulatory management and to administer narcotics such as morphine and those drugs that may temporarily paralyse patients in order to facilitate advanced prehospital care.

Emergency medical services

Emergency medical service (EMS) personnel respond to a medical emergency in an official capacity and as part of an organised medical response team. In terms of this definition, physicians, police officers, firemen, nurses, or paramedics who witness a cardiac arrest and initiate CPR, but who are not part of the organised rescue team, are characterised as bystanders and are not deemed to be part of the EMS system.

Paramedic-delivered CPR

In the context of this study paramedic-delivered CPR (pdCPR) is defined as a cardiac arrest treatment bundle that includes CPR, defibrillation, airway and ventilator support, advanced cardiac life support (ACLS) as well as the drug management that is provided by ambulance paramedics who respond to an OHCA in their official capacity as part of an ambulance service respond team.

PdCPR training intervention

A pdCPR training intervention is a structured series of learning activities which designed and sequenced specifically to improve the acquisition and retention of CPR knowledge and skills on the part of ambulance paramedics.

PdCPR competence

Competence is defined as the ability to perform an activity to a prescribed standard and, thus, an individual who demonstrates “competence” is performing successfully in accordance with the prescribed standard. For the purposes of this study **pdCPR competence** is an operational definition and was measured against the standard prescribed by the pdCPR Rapid Evaluation Tool (RET).

Transport paramedic (TP)

The TP is primarily responsible for transporting stable patients between health care facilities. They are trained in Basic Life Support (BLS) and, thus, they are registered to practise under supervision and provide such care as maintaining a patient’s airway and providing breathing and circulation support without the use of equipment or drugs other than a simple airway device and oxygen. TPs are also capable of providing CPR and defibrillation using an AED.

Training intervention

A training intervention represents a set of desired learning objectives, learning experiences, instructional resources and assessments that represent a specific educational goal. In addition, a training intervention represents an articulation of what students should know and be able to do. As such, it assists teachers in achieving the desired goals.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1. INTRODUCTION

Every year hundreds of thousands of people experience sudden cardiac arrest (SCA), making it a major cause of mortality [1-3]. SCA occurs when the heart unexpectedly stops or becomes ineffective at pumping blood to the brain and other vital organs [4,5]. While distinct from a sudden heart attack which typically involves an interruption of blood flow to a portion of the heart muscle, a sudden heart attack may result in a SCA. In the absence of immediate treatment, death from SCA is almost certain [6-8].

Although SCA was previously believed to be more prevalent in individuals over 40 years of age, epidemiological data indicates that young, athletic and healthy individuals are also at risk of SCA [7, 9, and 10]. In the United States alone more than 380 000 people die each year following SCA [9, 11] while, in Europe, similar statistics have been reported [12, 13]. Although SCA statistics from the developing and smaller industrialised countries are less available, epidemiological data estimates the global incidence of SCA at 83 cases per 100 000 persons per year, with 70% occurring outside of a hospital [14-16]. SCAs that occur outside a hospital are characteristically defined as out-of-hospital cardiac arrests (OHCA) [6,10,17].

1.2. OUT-OF-HOSPITAL CARDIAC ARRESTS (OHCA)

Approximately one half to two-thirds of OHCA victims in the developed countries receive resuscitation attempts provided by emergency medical services (EMS) [10]. The majority of EMS treated OHCA victims (70–85%) are cardiac in origin although they may also result from non-cardiac causes (i.e., trauma, drowning, drug overdose, asphyxia, electrocution, primary respiratory arrests and other non-cardiac aetiologies) [18]. Although OHCA survival rates vary widely between countries and between communities, within countries the overall survival from OHCA appears to be low [10,19] with reports indicating that, in the previous two decades, the OHCA survival to hospital discharge was between 6 and 9% with the majority of victims (> 90%) dying even before they reached hospital [1,10,20]. Reports further reveal that

of those who survived, almost 10% suffered varying degrees of cognitive impairment [21,22].

1.2.1. Treatment of OHCA

While cardiopulmonary resuscitation (CPR) and rapid defibrillation remain the standard first line treatment of OHCA, successful resuscitation requires an integrated set of five coordinated events [23]. These five interdependent events are represented by the links in a chain of survival (Figure 1.1) [24,25] and include the following:

- a. Immediate recognition of cardiac arrest and early activation of EMS;
- b. Prompt initiation and continuation of CPR by bystanders and/or arriving EMS;
- c. Early defibrillation by bystander and/or arriving EMS;
- d. Timely advanced cardiac life support (ACLS); and
- e. Early and appropriate post-cardiac arrest care.

Figure 1.1: The chain of survival



Source: Adapted from Travers et al. Part 4: CPR Overview [24].

Despite the changing demographic characteristics of patients (i.e. aging population, higher rates of communicable and non-communicable diseases than previously, lower proportion of patients with an initial shockable rhythm), reports indicate that OHCA outcomes may be improved by strengthening the links of the chain of survival [26–28]. Countries and communities that have optimised the effectiveness of a strong chain of survival have reported OHCA survival rates far beyond the global benchmark of 6 to 9% [29]. In such countries and communities, following the implementation of improvement programmes aimed at revising, strengthening and enforcing each interdependent link in the chain of survival, survival rates of up to 45% were seen in OHCA patients presenting with an initial shockable rhythm (i.e. ventricular fibrillation (VF) and/or ventricular tachycardia (VT) on first contact), and

survival rates of almost 20% across all other first monitored rhythms [29,30]. These notable successes provide countries and communities in which the OHCA survival rates have remained low and have also not changed for decades with irrefutable evidence that improved adult OHCA survival rates are possible.

1.2.2. The chain of survival and adult OHCA survival rates

The direct implications of improvements in the chain of survival depend, in part, on the extent to which each link in the chain of survival contributes to the overall OHCA outcomes [31]. On the basis of the fact that a uniform definition of OHCA appeared not to exist for several years, it is logical that there would be a notable void in chain of survival data [32]. The available evidence suggests that it was only in 1991, when the first Utstein guidelines for common definitions were published and which promoted the uniform reporting of OHCA data, that reproducible quality chain of survival data began to emerge[17]. However, it was the American Heart Association's (AHA) renewed call in 2008 for both widespread data surveillance and for making OHCA a reportable condition that resulted in more frequent chain of survival data [33].

The data gathered from ensuing studies indicated that the time to recognition and access (i.e. the first link), the time to CPR combined with defibrillation (i.e. the second and third links) and the time to ACLS and early post-cardiac arrest care (fourth and fifth links) also contributed in varying degrees to OHCA patient outcomes [34]. Links one to three were shown to have the most positive impact on patient outcomes while links four and five tended to contribute more to the cognitive functioning and neurological status of patients post discharge. The overall impact of links four and five were, however, unequivocally dependent on the promptness, quality and effectiveness of the first three links [23,35].

Chain of survival data not only reported on the contributory impact of each of the five links of the chain of survival on patient outcomes but also provided evidence of the growing incidence of CPR performed by the EMS across the recorded OHCAs, in particular, paramedic-delivered CPR (pdCPR) provided by ambulance services [6,13,18,36].

1.3. PDCPR DURING OHCA

For the purposes of this thesis pdCPR is defined as a treatment bundle that includes chest compressions, defibrillation, airway and ventilatory support as well as the advanced cardiac life support (ACLS) drug management that is provided by paramedics to persons who are victims of OHCA. This definition is not intended to replace previous definitions but to provide the context for the discussion in subsequent chapters. While the process of pdCPR may vary depending on local and regional cardiac arrest treatment protocols, the basic premises of pdCPR include recognising cardiac arrest at an early stage, providing high quality chest compressions (as presented in Table 1.1), maintaining and securing a patient’s airway, recognising and treating dysrhythmias as directed by established resuscitation guidelines, and complying with local patient disposition protocols [14, 27, 32–34].

Table 1.1 Components of high quality CPR

1. Ensuring chest compressions of adequate rate.
2. Ensuring chest compressions of adequate depth.
3. Allowing full chest recoil between compressions.
4. Minimizing interruptions in chest compressions.
5. Avoiding excessive ventilation

Source: Adapted from Neumar et al. [37]

1.3.1. PdCPR performance during OHCA

OHCA epidemiological studies as well as studies conducted specifically to monitor and describe pdCPR performance have, in recent years, increasingly revealed that the CPR delivered by paramedics is rarely in line with established resuscitation guidelines [38,39]. (**Appendix A** provides a snapshot of randomly selected studies predicating these claims). Kirves et al. highlighted the extent of the non-compliance by demonstrating that less than 50% of the OHCA’s investigated had received CPR that was in line with the established resuscitation guidelines [40]. In view of the fact that, as demonstrated by McEvoy et al, [41], adherence to resuscitation guidelines is correlated with improved survival, poor pdCPR performance, although untoward, presents an opportunity for improvement and, therefore, an opportunity to save more

lives [3] than may otherwise be the case. On the basis of the evidence currently available it seems fair to suggest that these opportunities have not been realised for more than two decades and in the majority of countries and global communities.

1.3.2. Rationalising the paucity of pdCPR improvement programmes

In 1979 Eisenberg et al. [42] reported that, when CPR was initiated within four minutes and defibrillation provided within eight minutes after non-traumatic cardiac arrest, 43% of the patients investigated had survived. Eisenberg and colleagues went on to add that, if either time was exceeded, the chances of survival fell dramatically. In 1992 a study conducted by the University of Washington demonstrated results consistent with the findings of Larsen et al. [5]. On this occasion, based on the results, the researchers produced a mathematical model to predict cardiac arrest survival rates and also to measure the effectiveness of the various EMS systems [5]. This mathematical formula came to be known as the Eisenberg model.

According to the Eisenberg model, subsequent to a 10 minute ambulance service response interval (i.e. time from dispatch to arrival on scene) it is possible to predict a survival rate after OHCA of 4.6% in the absence of bystander CPR. A reduction in response time by two minutes increases the predicted survival rate from 4.6% to 12.4%, while a four-minute reduction increases the predicted survival rate to 34%. Thus, the model implies an estimated decline in the OHCA victim's chances of survival of 7 to 9% for every full minute the arrival of the ambulance services is delayed. In the presence of bystander CPR this decline is slower and is estimated at 3 to 6% for every full minute the arrival of the ambulance services is delayed [43-45]. While the model highlights the effect of ambulance service response times on predicted survival rates, it may also rationalise, in part, statutory decisions taken in the past to direct resources towards improving OHCA bystander participation rather than funding pdCPR quality improvement programmes[28].

In terms of ambulance services, a performance indicator indicative of the quality of the service delivered to communities is a response interval standard (i.e. an acceptable time in which to respond and arrive at patients) [46,47]. While many global response interval standards are known to exist, all primarily dependent on local, regional and national level agreements, there is, however, no universally agreed standard [48].

Nevertheless, in urban areas, the most commonly used ambulance service response interval standard is arrival at 90% of life-threatening calls (priority 1, i.e. with lights and sirens) in less than nine minutes [48]. This response time standard is the goal in terms of which ambulance services generally develop their ambulance deployment strategies, despite the need for even shorter times (approximately 4–6 minutes) in order to achieve any notable impact on OHCA outcomes [49,50]. Premised on the data that demonstrates that shorter response times have no significant impact on patient outcome in trauma, and with response time standards of less than eight minutes often deemed to be unrealistic and likely to place ambulance crews at risk, improving the overall value and benefit of pdCPR quality improvement programmes has, in the past, been considered an investment less likely to yield any returns [51–53]. The main theoretical premise behind this idea is that, as the response interval standard expected of an ambulance to reach a patient is nine minutes, pdCPR is then, inevitably, likely to be provided only outside the critical time frame, which impacts on survival. Accordingly, regardless of the quality and effectiveness of pdCPR, its possible impact on patient outcomes is premised on the assumption that it will, in all probability, be inconsequential.

1.3.3. Implementing a pdCPR improvement programme

It is not the intention of this study to challenge the benefit of strategies that are primarily aimed at improving bystander CPR participation in OHCA and neither is it the intention of the study to challenge those strategies that are aimed primarily at improving access to pdCPR. The study merely aims to expand the boundaries of those strategies that are aimed at improving OHCA survival rates, especially now when ambulance services are able to reach patients within the critical time frame during which survival is the most likely to be at stake [54]. A study conducted by the Ontario Prehospital Advanced Life Support (OPALS) demonstrated this by reporting an overall improvement in survival to hospital discharge from 3.9 to 5.2% when the proportion of cases meeting the 8 minute response criterion increased from 76.7 to 92.5% [55].

Strategies to improve OHCA outcomes have been expanded in the past specifically to prioritise target improvements in pdCPR performance [29] with Seattle and King County, Washington [56] Rochester, Minnesota [57] Philadelphia, Pennsylvania

[58,59] and Richmond, Virginia [60] representing communities that have reported notable OHCA survival rate increases far beyond the global benchmark of 6 to 9% following the implementation of programmes that focused on improving the quality and effectiveness of pdCPR. In these communities, subsequent to ambulance service led pdCPR quality improvement programmes and new or revised pdCPR protocols, survival rates between 30 and 49% were reported for witnessed OHCA in patients presenting with VF and survival rates of almost 15 to 20% across all other first contact and monitored rhythms [29].

1.3.4. Possible benefits of a pdCPR improvement programme

The obvious reason behind the investment in efforts to improve pdCPR performance is to improve the quality and effectiveness of pdCPR and, subsequently, OHCA survival rates [54,61]. In addition, the development and implementation of pdCPR quality improvement programmes are likely to enhance accountability in the overall performance of ambulance services and this, in turn, is likely to enhance the investment of paramedics in their jobs, ultimately raising the clinical standards for professionalism in pre-hospital care.

No quality improvement programme is ever complete without a corresponding monitoring system that evaluates the adaptation of the programme and measures performance post-implementation [24] Thus, the data obtained from the monitoring system, particularly the data from tracking the pdCPR improvement interventions which have either worked or not worked, establishing those areas which require attention and determining where gaps exist, will inevitably contribute to the body of science that aims to refine CPR techniques in general and, thus, influence the overall goal of improving OHCA survival rates.

1.3.5. The success of current CPR training

CPR training began in the early 1960s [62-64] in the United States and then proliferated to the rest of world, firstly to health care professionals and then to lay people [65]. Ever since the commencement of CPR training and despite the fact that CPR has been taught to millions of people throughout the world there has always been much discussion about whether these training programmes have, in fact, been effective [66-68]. Mancini et al. argue that, although CPR training has evolved within

a framework of established teaching and learning goals, there is no way in which to confirm whether trainees actually learn anything, whether the training affects performance in actual resuscitation and, most importantly, whether patient survival improves as a result of the training [68]. On the basis of the evidence currently available it appears fair to suggest that all of those questions remain unanswered [69].

The primary aim of CPR training programmes is to facilitate the transfer of relevant knowledge and psychomotor skills to students and to prepare them to be able to deal with an actual cardiac arrest situation [68]. However, it would appear that, in practice, this is more difficult than it appears [68,70]. There is overwhelming evidence corroborating the notion that, regardless of the population under investigation, i.e. lay people or health care professionals, or the type or duration of the CPR programmes being taught, the retention of CPR knowledge and skills post-training is poor [71,72]. Data also reveals that, while students may exhibit notable levels regarding the acquisition of CPR knowledge and skills during the CPR courses, it would appear that a significant number fail at the end of the course [73–75].

1.3.6. Challenges with CPR training

CPR requires proficiency in terms of both knowledge and the psychomotor skills required. This, in turn, renders CPR training intrinsically difficult because the time required to acquire the level of such knowledge and skills that would ensure proficiency varies greatly between learners [71]. In addition, the relationships between the instructor, the learner and the learning objectives, and the challenges that arise from asynchronous relationships, contribute significantly to the poor acquisition, retention and overall performance of CPR [76,77]. There is some evidence to indicate that training outcomes are improved if training is tailored to the needs and learning styles of the learners [69]. The aim of such tailored training is to promote the improved acquisition and retention of resuscitation knowledge and skills by aligning the training methods used to the way in which the students usually learn. Another way in which these challenges are likely to be overcome is by ensuring that those individuals who perform CPR on a regular basis receive updated training as frequently as those who do not perform CPR on a regular basis and also that those who usually provide CPR within the context of a multiprofessional response team receive more complex training, including training in both technical and non-technical

skills (e.g. leadership and scene control skills, effective structure communication and situational awareness skills)[66,68,78]. Data also suggests that training should include experiences and skills that enable the students to make the transition and assimilate the knowledge acquired from classroom simulated scenario performances in real-life performances [73,81,82]. One way in which this may be done is customising simulated, scenario-based training to the situations that students are likely to actually encounter in their everyday clinical practice [69,81,82].

1.3.7. The need for PdCPR training to change

Although paramedic education and training has progressed in the previous two decades from short, predominantly skills-based certificate courses to fully established university and technical degrees, the documented mismatch between paramedic course teachings and operational case-mix still prevails [83–85]. In addition, it would appear that progression of paramedic education has been steered primarily towards diversifying, increasing or improving already established teaching methods rather than ensuring that paramedic education and training remain clinically relevant and translate into the knowledge and skills required to meet the evolving and immediate needs of patients within the pre-hospital environment [86]. This learning and case-mix mismatch seems to have resulted in a gap between the current knowledge of pdCPR quality and the optimal implementation of such knowledge in real life [89–92]. This gap, in turn, signals a significant opportunity to improve paramedic training and, thus, subsequent pdCPR performance, with this being likely to translate to improved OHCA survival rates [90].

1.3.8. Opportunities for pdCPR training to change

As early as 1995, Perkins et al. reported that it was not only possible to change institution-commissioned CPR training programmes but that this was also often necessary [91]. In many ways such change has always been encouraged and is still encouraged. However, it would appear that, in the absence of clear guidelines on how such change should occur, there has been a tendency to adopt a “wait and see” or “someone else with do it” approach [75]. There have been ambitious attempts at restructuring or remodelling training in order to improve the acquisition and retention of CPR knowledge and skills but, unfortunately, none have lasted [92–95]. In fact, according to the 2010 ERC guidelines, there is limited research into the impact

of resuscitation training on actual patient outcomes [69]. Moreover, despite the development and advances in training, there is still insufficient evidence either for or against the use of any specific training intervention that ensures that learners acquire and retain the skills and knowledge that will enable them to act correctly in actual cases of cardiac arrest and, ultimately, improve patient outcomes [69].

In 2003, in response to reports that, despite training, health care professionals were not uniformly proficient in simple CPR skills (i.e. improper patient assessment and CPR performance, difficulties with leadership and control, difficulties with equipment and overall failure to follow correct treatment algorithms), Chamberlain et al., through the ILCOR Advisory Statement, suggested several critical areas for improvement in resuscitation education [70]. The basic premises of these recommendations were that students never actually acquired CPR skills because the instructors were inadequately trained and that there was inadequate practice time during CPR classes. The overarching and, in many ways, the principal recommendation of the advisory statement was that CPR training should be tailored to suit the learner's setting (pre-hospital vs in-hospital), individual operational role (lone rescuer, team member, team leader) and educational background (doctor, nurse or paramedic) [70,96].

This recommendation implies a situation in which the elements of a course for a specific health care professional would vary in terms of format, content and style as compared to a course which had been designed to train another type of health care professional [70]. However, to ensure uniform proficiency, it was further recommended that the objectives, outcomes and cognitive and psychomotor evaluations remain the same for all courses [72, 81]. Nevertheless, just over a decade after the publication of Chamberlain et al.'s advisory statement, pdCPR education and training is still unchanged and remains a fortuitous truncation of doctor/nurse/team-based, formal CPR courses [97]. With the release of the 2010 resuscitation guidelines, the need for tailoring training to promote the improved acquisition and retention of resuscitation knowledge and skills was, predictably, reemphasised [69] while, in 2013, following the AHA consensus statement (Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation

Outcomes), it appeared that the gap between the body of scientific evidence surrounding resuscitation guidelines and their optimal implementation still prevailed [37] and that, in the continued absence of convincing, unambiguous, step-by-step instructions on how this gap could either be narrowed or bridged, the gap would, in all probability, remain.

1.3.9. A framework within which change may occur

It is suggested that the goal of pdCPR training should be steered towards preparing paramedics to manage the first 10 minutes of OHCA as this represents the critical time window during which treatment is likely to have a positive physiological effect [77,78,100]. If CPR training is to effectively transition the science of resuscitation into classroom performance, then to skill mastery and, ultimately, to actual performance, the data appears to suggest the need for appropriately structured learning experiences which are tailored to the learner needs of the CPR provider cohort, adequate time for the acquisition and practice of psychomotor skills, mechanisms that allow for immediate corrective feedback and refresher training experiences that ensure continued honing of skills [68,70].

In view of the fact that it is not possible to locate any literature reporting on factors that specifically influence the acquisition and retention of CPR knowledge and skills in paramedics, it is difficult from the outset to identify the constructs of a framework on which a new pdCPR training programme may be based. However, it is reasonable to assume that the following should be taken into account in identifying such constructs:

- *Programme governance*

This involves identifying who should be responsible for overseeing and managing CPR courses for paramedics. This may include the identification and recruitment of specialist committees from within the regional, national or local ambulance services with such specialist committees being responsible for registering, regulating and ensuring attendance in respect of pdCPR training and updates.

- *Instructor requirements*

This involves identifying the teaching and experience requirements for pdCPR course instructors. This may also include aspects relating to the language of instruction and the material provided to students.

- *Admission requirements*

This refers to identifying the need for a formal application process for potential candidates and the possible need to assess candidates' prior knowledge

- *Course duration and format*

This involves identifying the length of courses and their format, i.e. primary course versus refresher course. It may also include identifying the ideal theory-to-practice time ratios as well as ideal venues and instructor-to-candidate ratios.

- *Operational logistics*

This refers to identifying the logistical obstacles associated with requiring large cohorts of paramedics to attend classroom learning and the effect such classes may have on ambulance service operations.

- *Course content*

This involves specifically identifying the course content that paramedics should know and that would most likely result in successful resuscitation during an OHCA. This may include daily equipment checks prior to being dispatched to a cardiac arrest, how to function effectively within a multi-agency pre-hospital environment and using non-verbal skills to communicate in cases of language barriers.

- *Barriers and facilitators to learning*

This refers to identifying psychological, physical and behavioural barriers as well as facilitators to learning that are specific to both paramedics and the ambulance service.

- *Training and educational interventions*

This involves identifying and tailoring training and educational interventions to challenge the preconceptions relating to OHCA pdCPR and also to improve the

acquisition and retention of knowledge and skills to ensure that the set pdCPR learning objectives which have been set are effectively realised.

- *Evaluation*

This refers to identifying and tailoring non-discriminatory, non-threatening evaluation methods that reliably measure the candidates' CPR performances and also promptly identify weaknesses and strengths that may manifest during classroom performance and act as a guide to immediate corrective feedback.

- *Establishing refresher training intervals*

This involves identifying the frequency with which candidates should attend updates and refresher courses in order to remain clinically current.

1.3.10. The different facets of learning

Training refers to the acquisition of knowledge and skills that relate to a specific useful competency [98] while education, on the other hand, refers to any act or experience that has a formative effect on the mind, character or physical ability of an individual [98]. Thus, while training involves teaching someone how to perform a task, education means teaching that same someone how to think through the way in which to perform a particular task [99]. Although training and education may both have a place in a pdCPR training programme; the need for each and the extent to which each may be utilised is not known [69]. Whether a programme includes training or education or a combination of both will depend on the required contribution of the programme to a series of learning activities which have been identified as the most suited to promoting and likely to promote adherence to clinically relevant knowledge, skills, behaviours and attitudes that, in turn, would ensure consistent, early, high-quality pdCPR during an OHCA.

1.3.11. The likely effect of an effective pdCPR training intervention

The degree to which pdCPR education and training contributes to the variability in OHCA survival rates globally and between communities has not yet been established [69]. Nevertheless, it has been established that the non-adherence of the CPR performed to established, evidence-based CPR guidelines dramatically reduces the

chances of the return of spontaneous circulation (ROSC) and overall OHCA survival [38,41].

Ensuring that pdCPR consistently adheres to established, evidence-based CPR guidelines is a complicated process and one that requires a significant investment as the process extends far beyond merely developing a new, cardiac arrest, CPR treatment protocol. However, in view of the fact that surviving OHCA is not determined solely by the quantity and quality of the scientific evidence supporting resuscitation guidelines but, also and often more so, by the level of adherence to such resuscitation guidelines as they are applied in clinical practice, the return on such an investment may be substantial [69,80].

1.4. PROBLEM STATEMENT

Despite several significant advances in technology and resuscitation science, there has been little overall improvement in the worldwide OHCA survival rates. Reports indicate that, although OHCA incidence and outcome vary across the globe, median reported rates of survival to actual hospital discharge have remained less than 10% (range 2–22%) for the last 30 years, with the majority of victims dying before they reach hospital.

One of the reported factors associated with this low and virtually unchanged survival rate is the deficient quality of the CPR which is routinely provided by paramedics during an OHCA. Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, it would appear that pdCPR performance during an OHCA remains largely inadequate and is rarely in line with established resuscitation guidelines.

1.5. THE AIM OF THE STUDY

The aim of this study is to investigate the impact of a tailored CPR training intervention on paramedic-delivered CPR performance.

1.6. THE RESEARCH OBJECTIVES

The four research objectives include the following:

- (1) Determine and describe the pdCPR performance of ambulance paramedics (APs) (*see definition of terms*) who received training during conventional pdCPR training interventions.
- (2) Identify the factors that influence the acquisition and retention of CPR knowledge and skills of APs.
- (3) Develop a tailored pdCPR training intervention designed to improve the acquisition and retention of CPR knowledge and skills of APs.
- (4) Implement the tailored pdCPR training intervention and then determine and describe pdCPR performance in the APs in question immediately after training and at specified time intervals subsequent to such training.

1.7. OVERVIEW OF THE RESEARCH METHODOLOGY USED

This fixed-mixed method, multiphase study was conducted in four phases with each of the phases aiming to address one of the four interconnected objectives of the study. This design proved to be the only mixed method design suitable as it was able to provide a robust overarching and multifaceted framework that not only supported the fixed and predetermined mixed method techniques used in the study but also provided the flexibility required to address any new and unexpected questions that may have emerged during the multiple phases of the study. A detailed account of the methodology used is presented in Chapter Three.

1.8. DELIMITATIONS OF THE STUDY

Unlike a study's limitations, which refer to potential weaknesses of a study and which are usually beyond the researcher's control, the delimitations of a study are those characteristics that limit the scope of the study and serve to clearly define its boundaries. Such delimitations are within the researcher's control. The delimitations of this study are intentionally stated so that, from the outset, the reader is aware of the scope of the study, its limits, its range and its depth of investigation.

1.8.1. The focus of the study

The focus of this study was on investigating the impact of pdCPR training on pdCPR performance in a simulated OHCA. Although the study acknowledges that pdCPR is an important component of the process of care which impacts on OHCA patient outcomes it does not specifically investigate either the presence or strength of such

impact. Instead, the study restricts itself to an investigation into the CPR provided by paramedics in a simulated cardiac arrest scenario and, more specifically, the CPR provided by paramedics with the education level and the clinical scope of practice of a mid-level ambulance paramedic.

1.9. Applicability of the study

The site of the study was the National Ambulance Service of the state of Qatar. Nevertheless, it is possible that the results of the study will have a broader applicability across ambulance services globally, particularly ambulance services with organisational structures, administrative characteristics, clinical remit and scope of practice levels, tiered emergency dispatch and response systems, and staff and training structures inherently similar to that of Qatar. The South African Emergency Medical Service (SAEMS) and the National Health Service (NHS) Ambulance Service Trust in London, England are examples of ambulance services which are similar to the National Ambulance Service of the state of Qatar.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents a review of relevant literature in order to provide a theoretical basis for the study. The primary aim of this literature review is to reduce bias and provide a comprehensive body of knowledge as well as to discuss how existing literature relates to the study. Accordingly, the review also discusses what has already been written about the subject of the study, as well as that which has not been written, or which has been written in such a way that it appears conceptually or methodologically inadequate.

2.1. SEARCH STRATEGY

The literature review was conducted using a set series of stages. The first stage involved defining the overall search boundaries of the review. As the research and knowledge base relating to OHCA appeared to be boundless, six knowledge base subdivisions central to the aim of the study were identified in order to direct and then steer the overall literature review process. Each subdivision comprised a defined point of departure in the form of a leading question. The aim of each leading question was to direct the review process for each knowledge base subdivision and, thus, to help to diminish the potential of the focus of the review from becoming too diluted or, worse, lost. The leading questions are presented in Table 2.1

Table 2.1 Leading questions used to direct and guide the review process

1. What is the role of the paramedic in a healthcare system response to OHCA?
2. What are the specific needs or problems with pdCPR training and that should be addressed?
3. What constitutes important and clinically relevant pdCPR training content?
4. What training methods should ensure that the pdCPR learning objectives are realised?
5. What factors influence learning in paramedics?
6. What teaching methods are likely to relate classroom performance to actual performance?

2.2. SEARCH TERMS AND LITERATURE SOURCES

Stage two of the literature review process involved identifying the databases and search engines, as well as journals and other sources that were relevant to the subject area. This stage also included identifying the actual search terms and phrases which were to be used to interrogate both the search engines and databases for each knowledge base subdivision. In addition to the keywords used in the actual leading question, variations in common terms were also used; for example:

Leading question 1, namely, "What is the role of the paramedic in a healthcare system response to OHCA?" was researched using the phrases: role of paramedic in cardiac arrest, role of ambulance personnel in cardiac arrest, role of emergency medical technician in cardiac arrest, CPR by paramedics in out-of-hospital cardiac arrest, CPR in ambulances in cardiac arrest and types of paramedics and CPR provided. In addition, variations of the phrases ambulance service CPR clinical practice guidelines, ambulance service CPR protocols, and out-of-hospital cardiac arrest treatment guidelines were also used. Stage three involved decisions on the filters that were to be used for the inclusion and exclusion search criteria while, by repeating the overall filtering process, the fourth stage provided assurances that the articles collected from the searches conducted were representative.

2.3. EVALUATION AND SYNTHESIS OF LITERATURE

The literature review was conducted over the course of 52 months and continued up to the final stages of the study. Articles were filtered according to whether or not they discussed the role of the paramedic in a healthcare system's response to an OHCA, deficits or problem areas in the current pdCPR training and theories and methods underlying effective CPR training. Articles that had not been peer reviewed were excluded as were commentaries and articles that did not constitute research articles. Online searches were initially conducted using electronic databases and online journals. The search was then extended to the use of the internet search engines of Google and Google Scholar. The databases that were researched included the Cochrane database for systematic reviews; the Central Register of Controlled Trials; MEDLINE; EMBASE; CINAHL; ProQuest; Biomed Central; Science direct; PubMed and the reference libraries of Mendeley; and EndNote. The latter is collated by the American Heart Association (AHA).

2.4. LEADING QUESTION NO 1

2.4.1. History of pre-hospital CPR

The concept of CPR emerged more than 50 years ago, shortly after Kouwenhoven et al. [64] and Safar et al. [62,101] had published their landmark papers describing the advent of closed-chest resuscitation and mouth-to-mouth ventilation as a way of treating cardiac arrest. A few years later, in 1966, concerned by the fact that the majority of cardiac arrests occurred outside of hospitals, Dr Frank Pantridge, a cardiologist from Belfast, decided to take CPR to patients instead of them being brought to the hospital for CPR. At the time this was regarded as a novel treatment [102-105]. As a result of this innovation Pantridge reported that, of the 10 victims of cardiac arrest to whom he had responded to with his mobile cardiac arrest unit, six had subsequently survived [105]. Within a year, other physician-manned ambulances providing similar levels of pre-hospital care emerged throughout the world [106].

2.4.2. The introduction of non-physician delivered pre-hospital CPR

In 1967, in an attempt to improve the accessibility of CPR, the Irish Heart Foundation sponsored training for the first group of non-physician ambulance personnel [107]. Following the success of this initiative, the advent of non-physicians providing pre-hospital CPR became more widely accepted than had previously been the case, with some cities removing physician-manned ambulances altogether. Seattle in the United States was one of the first communities in the world to adopt a two-tiered, non-physician ambulance service that responded to the same range of medical emergencies to which the physician-manned ambulances had responded in the past [108]. The first-tier response was made up of fire-fighters who had been trained in basic life support (BLS) and who would respond to medical emergencies with the aim of being at the patient's side within minutes of the receipt of the call. This was then followed by the second-tier response, consisting of specially trained paramedics with more advanced skills and equipment, including defibrillators and ACLS drugs, as compared to the first-tier response. The introduction of the two-tiered, non-physician response, together with a tailored pdCPR cardiac arrest protocol, resulted in a dramatic improvement in Seattle's OHCA outcomes. In fact, Seattle is currently

recognised as one of the global communities in which the OHCA survival to discharge rate is among the highest in the world [29].

2.4.3. Non-physician based systems and CPR

Non-physician-based EMS systems gained momentum during the 1970s in the Anglo-American countries while the tradition of including physicians in pre-hospital care was maintained in many of the European EMS systems [109]. The primary difference between the two systems in respect of CPR was often limited to the decision as to whether resuscitation would be terminated at the scene or would be continued to the hospital. Physician-based systems tended to terminate CPR when it was regarded as futile while paramedic-based systems often lacked the authority to make such high-level decisions and transported patients to hospital, even when CPR was regarded as futile [110]. Some EMS systems, particularly those in the Scandinavian countries, are without physicians but include paramedics who are authorised to terminate resuscitation [111]. These systems propound the view that, since survival rates for OHCA patients receiving ongoing CPR to hospital are reported at less than 1%, partly because CPR in the back of a moving ambulance is both ineffective and also extremely hazardous to ambulance personnel and to other road users, the risk in transporting these patients to hospital outweighs any recorded benefit and may, therefore, be considered unethical [112–120]. The underlying argument in favour of non-physician care is further supported by Olasveengen et al. [121] who revealed that it would appear that physicians are unable to offer any additional treatment options for OHCA patients as compared to advanced, skilled paramedics.

2.4.4. Paramedic-delivered CPR

The ability of paramedics to manage OHCA victims competently is of the utmost importance for a number of reasons. The most important of these reasons is the fact that paramedics, by the nature of their work, are the first responders to commence resuscitative efforts in the majority of OHCAs [10,13]. The second reason is, unfortunately, a consequence of the growing infrequency of bystander provided CPR. Despite the survival benefits of early CPR, there is increasing evidence that the majority of patients in OHCA do not receive bystander provided CPR [28,122,123]. It would appear that the main barriers to bystanders initiating CPR include panic as

well as an overwhelming fear of either contracting disease or further harming victims through CPR that may be performed incorrectly [122,124–126]. This growing infrequency of bystander provided CPR has exerted increasing pressure on health systems to adjust their responses to OHCA in anticipation of absent or less frequently performed bystander CPR than was previously the case. Examples of these adjustments include streamlining dispatcher-assisted CPR processes to provide the simpler to perform compression only CPR, positioning ambulances strategically to decrease response times and adjusting pdCPR treatment protocols to cater for the absence of pre-arrival bystander-CPR [25,126,131–134].

Although less than 20% of OHCA victims receive bystander CPR, those who do are nearly four times more likely to survive to hospital discharge than those who do not receive such support [122,130]. For this reason pdCPR will never replace the immense benefit that immediate bystander-CPR offers. However, in view of the growing infrequency of bystander CPR, the role, value and importance of pdCPR has increased. In fact, pdCPR has evolved to the point that its contribution in the pathway of OHCA care has become so valuable that healthcare systems now consider pdCPR both as an integral component of the chain of survival and also a determinant in OHCA patient outcomes [29]. Much of this has to do with that the fact that ambulance services are now finally capable of achieving the shorter response intervals of 5-8 minutes from call to patient-side and which are inside of the window of opportunity during which CPR is likely to have a positive effect. In addition, with the skill remit of paramedics expanding, ambulance services are now capable of providing all the required OHCA treatments which have been proved by scientific evidence or expert opinion either to result in or contribute to successful resuscitation [34, 60,117,118].

2.5. LEADING QUESTION NO 2

What are the specific needs or problems with pdCPR training and that should be addressed?

2.5.1. The history of CPR training

Chest compression and mouth-to-mouth ventilation were formally integrated to form what is now known as modern CPR during a plenary session with Safar, Kouwenhoven and Jude at the Maryland Medical Society on September 16, 1960 [131]. It was at this time that the mainstream medical community became convinced that

CPR should become the standard first-line treatment for cardiac arrest [132,133]. The definitive steps that led to the commencement of CPR education and training included a worldwide dissemination of reports on CPR, an international tour to present evidence of the effectiveness of CPR, and a partnership with the Norwegian toymaker, Asmund Laerdal, to create the world's first CPR manikin, Resusci-Anne [134]. Other contributions included the educational film entitled *Pulse of Life* and which described the ABC approach of performing CPR. However, it was only in 1966, when the *Journal of the American Medical Association (JAMA)* formally introduced the guidelines for BLS and ALS, which then became the cornerstone and primary content source of CPR and its training, that CPR training began to expand to worldwide proportions [135].

2.5.2. The goal of CPR training

The goal of CPR training is to transfer CPR knowledge and skills to students to enable them to provide this lifesaving service without either supervision and/or real time instruction whenever they are required to do so [68–70]. Nevertheless, although CPR training has evolved and grown to become increasingly formalised, defined, specialised and robust over the last four decades, the gap between what should be done during the majority of cardiac arrests and what is actually done remains unacceptably wide [24,136]. Brennan et al. [137] revealed the extent of this gap in a classroom setting when the CPR performance of 226 subjects was examined directly after they had completed a standardised CPR course. Brennan and colleagues demonstrated that half of the participants (50%) only were able to assess breathing and pulse correctly during the initial steps involved in recognising cardiac arrest, that 50% of the participants only were able to perform both compressions and ventilations correctly and that 35% only managed to achieve a compression rate of between 80 to 100 per minute – all factors that impact negatively on cardiac output during CPR. Furthermore, nearly half of all the participants in the study made at least four errors in the sequencing of skills. In addition, these errors were all reportedly associated with poor patient outcomes [41].

Nevertheless, this study of Brennan et al. was not unique and, in many ways, the findings were consistent with previously published data. For example, Kaye et al. [78] had reported that in their study 38% of the students only had managed to follow the

correct sequence of CPR steps after training, 48% had been able to achieve accurate hand placement, 38% proper rate and depth while 57% only the correct compression and release ratio. Kaye and colleagues went on to reveal that their study findings confirmed that, over the years, CPR training had not improved to the point of its ensuring proficiency as there appeared to be no differences between the findings of their study and those of 35 other CPR retention studies which had been conducted earlier between 1966 and 1990 [78].

Overall, the studies of Brennan et al. [137] and Kaye et al. [78] revealed that, in general, CPR performance remained poor after training and that there was sufficient evidence to support the argument that inadequate teaching, lack of proper instruction and limited hands-on practice were the probable causes of this poor performance rather than learners experiencing difficulties in remembering and performing CPR.

The degeneration that takes place from skill acquisition to performance is not limited to the learning that results from classroom activities. Data from actual cardiac arrests where actual resuscitation was attempted reveals that the mean no flow fraction (i.e. fraction of the entire cardiac arrest event time when compressions were indicated but not performed) was 24% for in-hospital cardiac arrests and almost 50% for OHCA [138,139]. Both Abella et al. and Wik et al. went on to reveal that, of those compressions that were performed when indicated, a high proportion were either too shallow or too slow, thus further impairing cardiac output [138,139]. As indicated by Chan et al. poor resuscitation performance extends further than merely poor quality CPR with Chan and colleagues revealing that up to 30% of the patients who presented with an initial shockable rhythm did not receive defibrillation within the recommended two-minute interval, with worsening outcomes for each passing minute that elapsed [140]. It would, thus, appear that the available evidence suggests that, regardless of the cohort of CPR providers trained and the CPR programme used, in most cases the primary goal of CPR training is not achieved.

2.5.3. Provider-specific CPR goals

In the main prescribed treatment goals that reflect both optimal and expected CPR performance across the different types of CPR providers are non-existent [69]. Provider-specific treatment goals represent an OHCA treatment bundle that has been

proved by scientific evidence and/or expert consensus to be the most likely to contribute to successful resuscitation when delivered by a specific type of CPR provider [15,141,142]. These treatment goals are also representative of the quality standard against which the effectiveness of provider-specific CPR performance may be reliably measured [68,70]. Chamberlain and colleagues reveal that a cohort-specific CPR quality standard not only broadly outlines the scope of a cohort-specific CPR training course and the content that is to be delivered, but it also guides educationalists on how training needs and problems should be addressed within the context of that specific provider cohort [70]. Mancini et al. [68] and Nolan et al. [96] support Chamberlain's views, maintaining that cohort-specific training courses are advantageous because they are intrinsically structured to do more than merely introduce new or enforce existing knowledge. The reason for this is that in their design they inevitably emphasise areas and problems which are inherent in or common among specific types of CPR providers. This appears to be an identified deficit of blanket CPR training courses that currently exist [79].

2.5.4. Achieving the goal of CPR training

Current training methods typically make use of a high dose, low frequency methodology to achieve the goal of CPR training (i.e. to ensure that learners are able to provide CPR without either supervision and/or real time instruction whenever they are required to do so) [143]. This method, in turn, requires that learners attend and complete one to two days of intense training (high dose) every two years (low frequency). However, despite the popularity of this method, Schmidt et al.[144] are of the opinion that this methodology is likely to assist learners with the cognitive phase of learning only, thus enabling the learners to pass the initial assessment quickly and successfully. However, it would appear that they also tend to forget the skill they have acquired within a few months, especially when the skill is not used again. According to Arthur et al., one way in which to ensure that skill retention extends beyond the cognitive phase of learning is through more practice time during the initial acquisition of the knowledge and skills [145].

There are multiple other factors which also contribute to the effectiveness of training [70]. Vaillancourt et al. [129] reveal that learner engagement, a primary determinant

of the ultimate effectiveness of the training provided, is dependent on the learners' perception of the course relevance and also whether the course ensured the efficient use of their time. Among the demographic characteristics of the learners, the age of the learner is also a factor that appears to impact significantly on the effectiveness of the learning [146]. Meier et al. discuss the belief that adult learners differ from their younger counterparts in that they generally demonstrate a greater inherent need to know the reason why they are required to learn something. This is therefore likely to influence adult learners' learning activities and they are less tolerant of traditional teaching methods such as passive, emotionless lectures [146].

The main factors that appear to contribute to the effectiveness of training include the integration and utilisation of evidence-based, educational best practices which are used to teach and deliver CPR content to learners [151]. According to Chamberlain et al. and Soar et al, although investments made in improving access to CPR training are important, it is the identification of the appropriately structured learning experiences required to improve the acquisition and retention of knowledge and skills and encourage skill mastery through extensive practice and immediate corrective feedback and which are capable of relating classroom performance to actual performance, which is equally and sometimes more important than such investments, and which are also likely to yield greater returns than would otherwise be the case [68-70]. Studnek et al's findings support to this claim by revealing that increased hours invested by paramedics in continuing education and practice frequency were not significantly associated with success during the examinations set by the National Registry of Emergency Medical Technicians (EMTs) [147].

2.5.5. PdCPR training and likely deficits

An examination of the existing information indicates that the literature on CPR training focuses primarily on the training of bystanders, physicians in the various specialities and nurses [73,148-151]. Consequently there is a marked paucity of studies that report specifically on CPR training for paramedics or allied health workers in general [143]. It would appear the evidence available suggests that pdCPR training, like CPR training in general, is unlikely to include completely integrated key educational concepts which are indicative of best educational practices [143,152-155].

These key educational concepts include, but are not limited to, tailored training that is locally relevant and recognises the needs of learners [69], the integration of immersive stimulated scenarios [156–158], aligning learning to the context within which taught skills are performed, providing learners with sufficient deliberate practice iterations and targeted corrective feedback until such skills are mastered [167–169] and applying reproducible, and congruent assessment methods [160].

2.6. LEADING QUESTION NO 3

What constitutes important and clinically relevant pdCPR content?

2.6.1. Provider-specific CPR treatment guidelines

The most widely adopted approach informing the way in which CPR is performed by both health care professionals and non-health care professionals (i.e. laypersons) is based on the information provided in the latest versions of the resuscitation guidelines published by the American Heart Association (AHA) and the European Resuscitation Guidelines (ERC) [35,96,97]. However, while both sets of guidelines are broadly consistent and are a result of the ILCOR's Cardiopulmonary Consensus on Resuscitation Science and Treatment Recommendations (CoSTR), subtle differences between the two sets do exist. For example, the AHA guidelines recommend the use of vasopressin instead of, or in addition to, adrenaline, but the ERC do not include such a recommendation [96]. In addition, while the AHA recommends the administration of adrenaline after the second shock in cardiac arrest, the ERC recommends that adrenaline should be given after the third shock only [161].

Nolan et al. [97] claim that the failure to establish truly universal guidelines is often a result of the fact that high-level evidence is not widely available for all interventions across the globe. In addition, such failure may also be due to the fact that evidence may sometimes be inconsistent, imprecise, contradictory or even unreliable, especially when studies are based on animal models [97]. Nevertheless, differences between sets of guideline are not unique. The ILCOR CoSTR process also failed to reach consensus on several topics either because data was lacking or there was disagreement on the interpretation of data [162,163]. The CoSTR process was also marked by some controversy as many authors failed to deliver their reviews on time while others failed to complete their reviews [97]. This, in turn, cast doubt on whether

CoSTR was the result of reviewing either all the evidence or that evidence that was available for review only. Nevertheless, despite these controversies the current guidelines remain the primary source of evidence-based treatment algorithms for CPR for all types of providers.

2.6.2. Variations in provider-specific CPR treatment guidelines

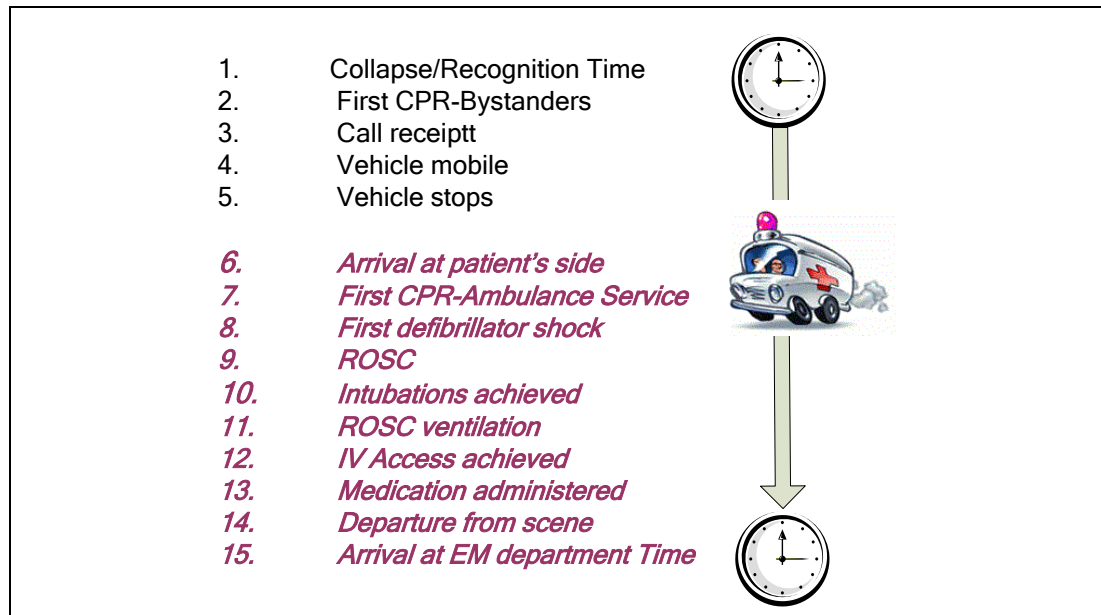
CPR treatment algorithms are categorised as either basic or advanced depending on the utilisation or non-utilisation of equipment and drugs. Basic CPR is usually performed by laypersons or lower level first responder staff (i.e. police officers, firefighters), while advanced CPR is typically provided by ambulance personnel [24,164]. There are also variations in the CPR algorithms depending on the age of the victim (paediatric versus adult), the extent of the injuries and whether, for example, the victim is pregnant or hypothermic [165–167]. However, despite these conditions and situation specific variations, the goal of CPR remains the same; namely, the maintenance of circulation and delivery of oxygen to the vital organs in order to sustain basic life functions [64,174]. The variations in the CPR algorithms aim to optimise the delivery of CPR in patients who present with conditions that would extend beyond the therapeutic effect which standard care is likely to provide [15,97,127,168–170].

2.6.3. Components of PdCPR treatment guidelines

In 1991, following an attempt to solve the problem of the many events associated with OHCA having different terms and meanings for different people, recommended guidelines for the uniform reporting of events associated with OHCA were formulated [17,25]. Termed “the Utstein Style” reporting template and approved by the AHA and the ERC, as well as the Heart and Stroke Foundation of Canada and the Australian Resuscitation Council, the template identified 15 core events that were associated with OHCA and resuscitation attempts. According to the template and as illustrated in Figure 2.1, pdCPR extends from the time paramedics arrive at the patient’s side through to patient handover at the hospital emergency department. Over the years there has been much debate on the added benefit of many of the recorded core events provided during pdCPR efforts, including intubation, IV access and medication administered [15]. However, besides chest compressions combined with ventilations and defibrillation, to date no other core events have been proved to

have a positive impact on survival. These events are still, although cautiously, included in current ERC and AHA CPR resuscitation guidelines [15,163,164].

Figure 2.1 Events associated with OHCA resuscitation attempts



Source: Adapted from Uniform Reporting of OHCA Data: The Utstein Style [17]

2.6.4. CPR and coronary perfusion pressure

The success of pdCPR is fundamentally dependent on the time that elapses from collapse to the initiation of CPR and the adequacy of the myocardial oxygen delivery and myocardial blood flow that is generated during the performance of CPR [171]. Coronary perfusion pressure (CPP), the difference between aortic diastolic and right atrial diastolic pressure, is the primary determinant of myocardial blood flow during CPR [172–174] and, thus, maximising CPP is the primary physiological goal of CPR [173]. Accordingly, the focus of pdCPR or CPR in general should be steered towards enhancing the specific components of CPR that have been shown to maximise CPP and/or support either better haemodynamics or overall human survival [37].

The main components of CPR that are likely to impact on CPP, myocardial blood flow and patient outcome during OHCA include: (1) chest compression fraction, (2) chest compression rate, (3) chest compression depth, (4) leaning while performing compressions and (5) ventilations during compressions [37]. An understanding of the

importance of these components and their relative relationships is, therefore, essential for the providers of CPR who attempt to improve outcomes for individual patients, for CPR course developers and for CPR instructors who are endeavouring to improve the quality of CPR training [68], and also for health system administrators who attempt to monitor CPR performance by measuring processes that reflect high-quality pdCPR [21,150,151].

2.6.5. Chest compression fraction (CCF)

Cardiac arrest is defined as the cessation of cardiac mechanical activity which is confirmed by the absence of a detectable pulse, unresponsiveness and apnoea (or agonal, gasping respiration) [17]. For the purpose of Utstein-style uniform reporting, no comment on the time or “suddenness” is recommended. The duration of cardiac arrest is defined as the time at which the cardiac arrest is first identified until the time of first return of spontaneous circulation. On the other hand, CCF is the proportion of time during which chest compressions are performed during the entire duration of a cardiac arrest event. Evidence indicates that a CCF > 80% is associated with the best probability of achieving ROSC [37]. Christenson et al. [177] showed that an increased CCF is independently predictive of better survival in patients who experience ventricular fibrillation/tachycardia during OHCA cardiac arrest while Vaillancourt et al. [8] used data from the Resuscitation Outcomes Consortium (ROC) Cardiac Arrest Epistry to report that similar results were also seen in non-VF OHCA patients.

2.6.6. Chest compression rate of 100 to 120 per minute

Animal studies show that blood flow and survival rate increase when compression rates are faster [178]. Kern et al. [179] and Abella et al. [180] reported similar findings in human beings, demonstrating that higher chest compressions were significantly correlated with higher mean end-tidal carbon dioxide levels and higher initial returns of spontaneous circulation. Studies report that rates between 100 and 120 per minute are associated with an increase in blood flow with no increase in associated chest compression-related trauma when compared to a compression rate of 60 per minute. Studies have also reported that, when compressions increased from 120 to 140, as observed in machine-performed CPR on human beings, no overall benefit in haemodynamics was seen [34,181]. The data yielded by these and other similar context studies [182] provides strong evidence that a compression rate of at least 100

and not more than 120 per minute is recommended to generate a CPP sufficient enough to sustain myocardial blood flow during cardiac arrest [179].

2.6.7. Interruptions in chest compressions

In view of the fact that interrupting chest compressions during CPR is associated with negative outcomes, frequent and protracted interruptions during compressions are discouraged [37]. Studies show that pauses during compressions not only cause aortic diastolic pressures to fall, thus dramatically reducing CPP and myocardial blood flow [15,37] but that such pauses have been directly associated with a decreased chance of successful defibrillation [183]. Furthermore, during interruptions blood accumulates in the right ventricle, causing it to enlarge and flatten out the inter-ventricular septum and this, in turn, results in a reduction in left ventricular volume – a phenomenon known as ventricular interaction [184]. This phenomenon is likely to reduce left ventricular muscle cell stretch and is, therefore, particularly harmful at the time immediately preceding the delivery of a shock as the heart is less likely to recover after defibrillation and generate a normal perfusing contraction [189,192,193].

Despite significant changes in the resuscitation guideline in the last decade, [69,96,97] and equally significant attempts to improve outcomes by minimising interruptions in chest compressions [37], several studies still report that chest compressions are frequently and often unnecessarily interrupted during CPR [39]. Interruptions during pdCPR occur for a variety of reasons including provider fatigue and, at the time of switching compressors during ventilations, placement of invasive airways, application of CPR devices, pulse and rhythm checks and vascular access placement and during patient transfers to the ambulance [37].

2.6.8. Chest compression depth

Although optimal compression depth may depend on factors such as patient size, compression rate and environmental features such as the presence of a underlying mattress, [187] a compression depth of 5 cm or at least one-third of the AP diameter of the chest have been found to improve the success of defibrillation and ROSC[15,34]. Data from the ROC Epistry revealed that patients with compression depths of more

than 3,8 cm had improved chances of achieving ROSC, improved one-day survival rates and improved chances of surviving to discharge [36,38,188–190].

Measuring chest compression depth during actual CPR is difficult. As a result, during attempts to improve chest compression depth, rescuers typically begin by increasing the compression rate rather than by compressing harder and deeper [37] despite studies demonstrating that higher compression rates are typically associated with lower compression depths [191]. Although studies have demonstrated a strong association between survival outcomes and increased compression depth, there is, however, insufficient evidence either to support or to refute the 2010 AHA and ERC guidelines recommendations of a compression depth of 5 cm [188], thus implying that, although compression depth is an important component of CPR and should be measured routinely, the most effective chest compression depth remains unknown [190].

2.6.9. Chest recoil and residual leaning

Incomplete chest wall release occurs when the rescuer providing the compressions does not allow the chest to recoil fully on completion of a compression [192,193]. This may occur when a rescuer leans over the patient's chest, thus impeding full chest expansion [194]. Leaning has been shown to decrease the blood flow throughout the heart and may also decrease venous return and cardiac output [193]. Although data is sparse regarding the outcomes related to leaning, animal studies have shown that leaning increases right atrial pressure and also decreases cerebral and coronary perfusion pressure, cardiac index and left ventricular myocardial flow [195]. While expert consensus is that leaning be avoided during CPR, human studies show that a majority of rescuers continue to lean and do not allow the chest to recoil fully [24,172,203]. There is, however, insufficient evidence to determine an optimal method of achieving complete chest recoil without compromising other aspects of CPR [29,196].

2.6.10. Excessive ventilation

Oxygen delivery is essential during CPR. However in arrhythmic cardiac arrests the oxygen content at the time of arrest is initially sufficient to allow for compressions in

order to circulate oxygenated blood throughout the body [197,198]. As the cardiac arrest duration lengthens and the oxygen reserves become depleted, the need for supplemental oxygen and assisted ventilations increases [199]. In asphyxial cardiac arrest, where hypoxia is usually the cause of arrest, the appropriate timeframe for interventions aimed at supplementing the existing oxygen in the blood is unclear and is likely to vary with the time from arrest [127]. Providing sufficient oxygen to the blood without hampering perfusion becomes the goal of assisted ventilation during CPR [15].

While studies on both animals and humans suggest that compressions without ventilations may be adequate early in non-asphyxial arrests, asphyxial arrests have been shown to achieve improved outcomes when both assisted ventilations and high-quality chest compressions are delivered from the onset of resuscitation [200]. The concern about positive-pressure ventilation (PPV) is its resultant negative effect on myocardial blood flow [201]. Studies show that PPV reduces CPP during CPR and, because the provision of PPV requires interruptions in compressions, it also reduces CCF [202]. There is currently not enough evidence to define when, and at what rate, ventilations should be given and neither is there evidence to support an optimal inflation pressure [196]. However, the 2010 AHA Guidelines for CPR and ECC recommend a ventilation rate of < 12 breaths per minute in order to minimise the impact of PPV on blood flow [24,203].

2.6.11. Achieving the components of pdCPR

There is no compelling reason to argue that the goal of pdCPR is or will be in any way different from the goal of CPR in general. Accordingly, the components of pdCPR which are necessary in order to achieve the goal of CPR will be the same as the components identified for all other providers of CPR. However, identifying the components of high-performance pdCPR is only the starting point. The next step involves identifying the process which will ensure consistent application of the components of high-performance pdCPR during actual OHCA's [204]. Although there has been relatively little research conducted on both pdCPR and on how paramedics may achieve the components of high quality CPR, available evidence appears to suggest that locally relevant quality improvement projects that consist of iterations of

benchmarking, evaluating and focused actions are likely to address existing challenges and deficiencies in CPR [29]. Ambulance services that have already instituted such improvement programmes have reported notable successes [50,129].

2.6.12. Identified challenges and deficiencies in respect of CPR performance

Table 2.2 presents some of the key challenges that continue to diminish attempts at achieving the components of high-quality and effective CPR. In the absence of clear data describing the interactions between the components of high-quality CPR, and the effect that altering one component is likely to have on another component, the order in which the components should be altered during attempts to enhance CPP is not known [37,97,205]. Resuscitation experts claim that, while attempts to alter one component may be at the expense of another component [191], if patients are not responding to resuscitative attempts, evidenced by an end tidal carbon dioxide level of < 20 mmHg, the components of high-quality CPR performance should be altered in the interests of improvement in the following order: (1) CCF and avoiding interruptions, (2) chest compression rate, (3) chest compression depth, (4) avoiding excessive leaning and (5) avoidance of excessive ventilation.[37]

2.6.13. Achieving a chest compression fraction $>80\%$

Expert consensus is that a CCF $> 80\%$ is achievable in both OHCA and in-hospital cardiac arrests [15,37]. The prompt recognition of cardiac arrest, initiation of CPR and minimising both the frequency and duration of interruptions are recognised as the first steps towards achieving a CCF > 80 [24]. Reports indicate that non-technical skills in the form of sound leadership, good scene control, effective communication and good situational awareness also play a significant role in minimising pauses during CPR [206,207]. Accordingly, there is growing support for the claim that each resuscitation event should be coordinated and led by a designated team leader [215]. The role of such a team leader is to direct all components of the resuscitation process with the central focus on delivering high-quality, continuous CPR [216]. It is also recommended that any tasks that may be effectively accomplished during ongoing chest compressions should be performed without pauses. These tasks include defibrillation, intubation, IV placement and packaging and transporting of patients [170,207,210].

Table 2.2 Key challenges to achieving the components of high-quality pdCPR

CPR component	Key challenges
Recognition	<ul style="list-style-type: none"> • Failure to recognise gasping as a sign of cardiac arrest • Unreliable pulse detection
Initiation of CPR	<ul style="list-style-type: none"> • Prolonged time to identify rescuer duties
Compression position	<ul style="list-style-type: none"> • Unreliable technique to identify chest compression position
Compression rate	<ul style="list-style-type: none"> • Compression rate either too slow or too fast • Rescuer fatigue
Compression depth	<ul style="list-style-type: none"> • Shallow compressions • Rescuer fatigue
Chest wall recoil	<ul style="list-style-type: none"> • Rescuer leaning on the chest • Rescuer fatigue
Chest interruptions	<ul style="list-style-type: none"> • Excessive interruptions for <ol style="list-style-type: none"> 1. Rhythm and pulse checks 2. Ventilations 3. Defibrillation 4. Intubation 5. Intravenous access 6. Drug administration 7. Loading patients
Ventilation	<ul style="list-style-type: none"> • Ineffective ventilations • Prolonged interruptions in compressions to deliver breaths • Excessive ventilation (especially with advanced airway)
Defibrillation	<ul style="list-style-type: none"> • Prolonged time to defibrillator availability • Prolonged interruptions in chest compressions both pre-and post-shocks
Team performance	<ul style="list-style-type: none"> • Poor non-technical skills (leadership, communication) • Poor scene control and situational awareness • Delayed rotation leading to rescuer fatigue • Deterioration over time in compression quality • Differently trained and skilled rescuers at same scene

Source: Adapted from Travers et al. Part 4: CPR Overview.[24]

2.6.14. Avoiding interruptions

Other aspects that contribute to unnecessarily long pauses in CPR include pauses in compressions during the charging phase just before a shock is delivered and also during pulse checks [15]. There is overwhelming evidence corroborating the notion that pulse checks take too long and are often unreliable. In addition, because the presence of a pulse does not automatically mean that adequate sustained perfusion is present, the value of performing a pulse check at the risk of decreasing CCP is diminished [211–215]. The pre-shock phase is characterised by extreme vulnerability to interruptions of chest compressions as it is during this time that attempts to clear the patient and create a safe environment for rescuers are usually undertaken [216]. Current recommendations are that these pre-shock phases be minimised because outcomes are improved if the pause between the stoppage of CPR and the delivery of shock is kept to less than 10 seconds [184,217]. Studies reveal that chest compressions that start immediately after a shock and extend to at least two minutes in duration are likely to achieve and sustain adequate myocardial blood flow and, as a result, improved survival outcomes [174,176,201,203,221].

2.6.15. Achieving an adequate compression rate

While a compression rate of above 100 and below 120 should be achieved [196], a rate of 140 provided by mechanical chest compressors has showed CPP to be at its highest. However, this is likely to be at the expense of reduced depth of chest compressions and increased residual leaning when CPR is performed manually [92,187,200]. Real-time feedback appears to be one of the most effective and practical ways in which to ensure an adequate compression rate [219–221]. The use of metronomes and background music may also be helpful although these devices may be distracting. In addition, while music may provide the correct compression rhythms, the playing of music during a tragic event such as a cardiac arrest is largely discouraged [169,222].

2.6.16. Achieving a compression depth of 5 cm

While adequate depth of compressions has been shown to be associated with improved outcomes [190], this is one of the components of CPR that is the most

difficult to achieve [37]. Performing CPR on a hard surface and using mechanical chest compression devices are some of the strategies that may ensure adequate compression depth [223–226]. In view of the fact that compression mechanics degrade over time as a result of rescuer fatigue or during patient transportation to hospital, the use of mechanical chest compression devices may be considered [227,228]. Although, in the past, data has failed to demonstrate a consistent benefit in patient outcomes resulting from these devices [229,230], more recent studies have demonstrated that the ability to achieve ROSC with mechanical chest compression devices is significantly improved when compared with manual chest compressions [204, 205]. In the absence of mechanical chest compression devices the use of feedback devices has been found to help to counteract the degradation of manual CPR mechanics [95,233,234].

2.6.17. Avoiding leaning during chest compressions

Increasing compression depth and rate is often accompanied by increased leaning [235]. Accordingly, it is recommended that, as attempts are made to improve rate and depth, significant consideration must be given to avoiding leaning [193,235]. There is, unfortunately, insufficient evidence to determine an optimal method to avoid leaning without compromising other components of CPR [195]. For example, one technique to ensure complete chest recoil is to remove the heel of the hand slightly, but not completely, off the chest wall after each compression as this has the intended effect of causing the chest to recoil completely as there is no longer any downward pressure on it. However, it has been found that this technique, over time, may result in an overall reduction in compression depth as a result of rescuer's hands unintentionally moving away from the compression point [236,237].

2.6.18. Avoiding excessive ventilations

While methods to regulate the ventilation rate in CPR include the use of metronomes and automated electrical defibrillators that prompt when ventilations should be delivered, there are few methods available to limit excessive tidal volumes and inspiratory pressures. Recommended methods include the use of smaller resuscitation bags, manometers and direct observation [238].

2.6.19. Important and clinically relevant pdCPR content

One half to two-thirds of OHCA victims receive resuscitation attempts which are provided by the emergency medical services [10]. Accordingly, in order to ensure patient survival, the need for paramedics who are often the first responders in OHCAs to be proficient in CPR is mandatory. So as to ensure good results and optimise survival to discharge, pdCPR that is commenced early and consists of clinically relevant treatment elements which have been shown by scientific evidence or expert opinion to contribute to successful resuscitation is required. The delivery of these treatment elements may be optimised through a structured series of essential and sequential steps which are contextualised to the scope of practice and clinical remit of the paramedics.

2.7. LEADING QUESTION NO 4

What training interventions should ensure that the pdCPR learning objectives are realised?

With the prevalence of poor CPR performance, often immediately after training, several attempts have already been made to identify those teaching methods that are likely to promote the improved acquisition and retention of CPR knowledge and skills [71,242]. While some of these methods have been shown to be more effective than others, the added benefit of any one single method remains insufficient to consider it as an universally accepted and recommended effective CPR teaching method [70,71].

2.7.1. Existing training interventions

While a myriad of different training methods already exist the more common ones include, inter alia, self-instructional videos [66,93,239], interactive self-learning online courses [240], visual aided real-time feedback and directed courses [241] and automated voice advisory manikin-based courses [153]. Training methods that have demonstrated some improvements in the retention of skills include the use of a simplified CPR process with the emphasis on the number and depth of compressions to facilitate forward blood flow rather than on CPR ratios or specific, sequenced steps [242], and shorter self-learning courses [243,244]. Changes have also occurred in content delivery, with more engaging modalities such as gaming, action cards, peer

instruction, computer-assisted learning and platforms that provide audio-visual feedback [245–249]. However, as stated earlier, the additional benefit of any of these various methods for improving the acquisition and retention of CPR knowledge and skills across all providers remains unknown [71,245].

2.7.2. EIT recommendations

During the Resuscitation Guideline 2010 evidence evaluation process, the Education, Implementation and Teams (EIT) task force of ILCOR promulgated certain key recommendations in respect of CPR training and educational interventions [242]. According to the EIT, all learners, regardless of their provider status (health care or non-health care professionals), should undergo training and educational interventions that have been evaluated to ensure that realising the set learning objectives is possible. Consistent with the recommendations previously suggested by Chamberlain et al.[79] and Nolan et al.[96], the EIT also propounded the view that educational interventions must be tailored to learner preferences in order to promote the improved acquisition and retention of knowledge and skills. The EIT also revealed the growing value of instructor-led courses but also advocated the use short video/computer self-instruction courses combined with hands-on practice as an effective alternative if operational resources and the number of trained instructors were limited. Consistent with the findings of Yeung et al. [95], which showed that CPR prompt or feedback devices had demonstrated improved CPR skill acquisition and retention, the EIT task force recommended that real-time corrective feedback in the form of either mechanical, audible devices or peer engagement activities be considered during CPR training for all cohorts of learners. Finally, because non-technical skills such as leadership, teamwork and situational awareness had, over the years, been associated with improved CPR performance [243,244], the EIT recommended that additional emphasis be placed on such non-technical skills during CPR training.

2.7.3. Current training deficits

It would appear that current CPR programmes have paid little attention to studies that have shown that there are certain teaching methods that are associated with both poor initial skill acquisition and also long-term skill retention [96]. In addition, the

majority of novel teaching methods appear to be focused primarily on improving access to CPR training rather than also ensuring that CPR programmes remain clinically relevant and learner objectives are reliably achieved [240]. Furthermore, although there is evidence validating the view that the aim of training programmes that focus on pre-hospital CPR programmes should be to prepare learners to manage the first 10 minutes of cardiac arrest, it appears that this rarely takes place as too much extraneous material is still included in programmes [66,68,77].

The key to identifying effective training methods appears to be in defining the learner requirements of each specific cohort of learners that are to be trained [70]. In other words, as Chamberlain et al. articulate; different cohorts of learners will probably require different training methods in order to achieve the same intended outcome. However, in the absence of sufficient evidence for or against the use of specific training methods that focus on specific populations of rescuers, the possible training methods that could be used during pdCPR remain unknown [69]. According to Soar et al. [69] and Chamberlain et al. [70], identifying such training methods may not be an easy task although the benefits of such methods are likely to include the improved acquisition and retention of knowledge and skills, improved CPR performance and, ultimately, better patient outcomes than is currently the case.

2.7.4. Optimising pdCPR training effectiveness

There is general agreement that resuscitation training should be based on real-life scenarios using current evidence-based guidelines and that this training should include a variety of immersive, simulated cardiac arrest scenarios [245]. Hamilton et al. reveal that simulated cardiac arrests or “mega-codes”, a concept developed by Kaye and colleagues as early as 1981 [78], helped to familiarise staff with the equipment used in their own environments, facilitated team training and improved overall documentation, and raised confidence levels [251]. A finding that continues to be reported [140,252–254]. The use of contextualised mega-codes is likely to ensure that the training provided reflects the potential situations that health care professional may face in actual practice [156,158]. Other methods that have optimised the effectiveness of learning include the use of low dose, high frequency training which involves short but frequent refresher courses. This was corroborated by data

generated by Niles et al. [246] which revealed that health care professionals who completed two or more short refresher courses per month performed CPR significantly better than those who practised CPR less than twice a month.

Exposing health care professionals to performance data and examples of cases in which even experienced providers neglected to perform important resuscitation manoeuvres is another way in which to optimise training effectiveness [136]. The use of actual OHCA cases may also be a way in which to motivate those health care professionals who are frequently involved in managing OHCAs but who may not believe that their resuscitation knowledge or skills require regular updating [136].

2.8. LEADING QUESTION NO 5

What factors, characteristics and learner styles influence learning in paramedics?

Adult learners of CPR, both health care and non-health care professionals, differ from the younger students in that, as compared to the younger students, they appear to possess a greater inherent need to know why they are required to learn something [247]. Adult learners also bring with them rich life experiences that may serve as potent sources of learning although it is these same life experiences that make groups of adult learners more heterogeneous than may otherwise have been the case. While heterogeneity may be an advantage in a variety of situations it often precludes the use of a one-size-fits-all teaching strategy [253]. Adult learners are also typically ready to learn things when real-life problems demand new knowledge and skills, they are usually self-directed and they are often extremely responsive to internal factors as motivators for learning [248,250]. As a result adult learners prefer to influence their learning activities themselves although this, in turn, often makes them less tolerant of traditional teaching methods which are largely inflexible [146]. The extent and manner in which learning activities are influenced, however, depends on the characteristics, personality traits and learning styles of the individuals or similar groups of individuals in question [146,247].

2.8.1. Human characteristics and clinical-decision behaviour

Characteristics may be defined as noticeable features, qualities or traits belonging either to a person or to a cohort of persons [251]. These features are often so noticeable

that the persons or groups become identifiable by them [251]. Characteristics are usually intrinsic and are responsible for steering individuals towards certain decisions which are taken in life, including choosing what to wear to more complex life-altering activities such as choosing a specific profession. However, characteristics also develop over time, particularly in cases in which there is constant engagement with individuals belonging to a certain social circle, profession or cultural group or when there is constant exposure to a specific experience or activity [252,253].

2.8.1.1. The different types of characteristics

Characteristics are usually categorised into personality and demographics. The types of personality characteristics which people exhibit may differ in terms of their definitions and depending on the literature source of such definitions. However, they usually include the following basic factors of personality, namely, *“neuroticism/nervousness, extroversion, openness to experience, restraint/orientation towards norms/control, altruism/helpfulness, and readiness to take risks/search for competition”* [254]. On the other hand demographic characteristics include factors such as age, race, gender, length of clinical experience, background, education, operational scope of practice etc. [252]. It has long been observed that both personality and demographic characteristics impact on the decision-making process of health care professionals and their preferences with regard to treatment strategies, particularly in critical care situations such as CPR [253,255,256]. Nightingale et al. [256] revealed that there is a correlation between health care professionals with risk-seeking personalities and a marked preference for intubation and a longer duration of resuscitation efforts than may otherwise have been the case. However, it appears not to be possible to predict a risk-seeking personality by healthcare specialty or gender although, as revealed by Nakata et al., increasing age was found to be associated with more risk-averse behaviour [257].

2.8.2. Paramedic characteristics

While there are studies which report on the emotional attributes of paramedics and the effects of burnout and stress in paramedics, there is a general paucity of studies that specifically investigate the characteristics demonstrated by paramedics and how these characteristics impact on decision-making during CPR [257,258]. A possible reason for this paucity of studies may lie in the fact that the paramedic cohort is typically included in the emergency medical personnel (EMP) cohort and stratification into specific roles rarely occurs. The EMP cohort includes all first responders such as police officers and firemen, and may extend to include nurses and physicians working in emergency care units. Although to some extent this may be appropriate, the data generated by Pajonk et al. provided evidence to indicate that the personality characteristics of paramedics were, in fact, not analogous with

emergency physicians and, as a result, stratification of EMP may actually be necessary [253].

There is no evidence to indicate that the way in which a paramedic is likely to behave and engage in clinical practice (simulated and/or real life) is in any way dissimilar to that of other EMPs and neither is it influenced by characteristics which may be conditioned and enforced by their background education, current knowledge, experience, jobs and stage of human development. Human development refers to the way in which individuals grow and develop in stages – physically, socially, emotionally, mentally and vocationally [265]. Developmental theories suggest that particular types of learning and developmental needs or traits occur at particular stages and, thus, learning is likely to be most effective when the activities that are used to transfer knowledge and skills are appropriate to a particular stage [259,260].

Papalexopoulou et al. provided evidence demonstrating this revealing that, in both simple and longitudinal analyses, age was found to have a negative effect on the CPR performance of rescuers per year of age increase, although primarily in practical evaluations [261]. The study revealed that, with age, people became less familiar with computer-based presentations, protracted flow processes and technical equipment such as high fidelity manikins [262]. In addition, the study also showed that prior formal education positively influenced performance in written CPR evaluations – a finding that is consistent with the findings of previous studies [147,263]. According to Dyson et al. [262], the most likely reason for this is that individuals with formal education are more familiar with written examinations than individuals with no or lower levels of formal education.

2.8.3. Impact of learner needs on effective learning

The learner needs of a person represent the gap between what a person wants to gain from a learning experience and the person's current state of knowledge, skill and enthusiasm [264]. However, the debate is still ongoing as to whether learning is a process of acquiring and perceiving information and then processing such information and, therefore, that learning is a result of possessing knowledge and skills not known before the learning event or whether learning is merely a series of

inputs and outputs [265]. There is, however, consensus about the fact that learning underpins everything and, as people always need to learn in order to develop and grow to adapt to changing circumstances, learning is, therefore, continuous [264].

Learning varies from person to person and across groups of people. In the same way in which people differ in terms of shape and size and possess different personality characteristics, they also develop preferences about the way in which they like to learn [266,267]. This is of particular importance in respect of the academic route of a paramedic from layperson to professional as compared to the route of an EMP in the form of an emergency physician. The route a paramedic takes is typically geared towards technical training and is premised on the acquisition of knowledge and skills that relate to specific useful competencies [88]. Once such useful competencies have been attained, paramedics are sent out into clinical operations as observers. This usually happens within weeks of entering training. Within months of entering training paramedics are typically allowed to engage in unsupervised clinical practice [268]. When this is compared to the route that an emergency physician is likely to take and in terms of which learning is broadly premised on education, with at least three years being invested in classroom time before actual patient contact is allowed [269], it is clear that the training routes from profession entry to profession practice for paramedics and physicians are, indeed, different.

In both cases the experiences of learning are, in broad terms, different as the one is geared towards education while the other is geared more towards training. While neither approach is wrong, available evidence seems to suggest that the approach to learning taken during the formative years is likely to inform the mind and character of individuals and also to influence the way the way in which they approach learning in the future [270]. Current CPR courses are, by design, intended to supplement foundational knowledge and, as a result, may not be sufficient to cater for cohorts that lack the degree of foundational knowledge and learning style preferences that are expected in all EMPs [68]. Seraj et al. [271] demonstrated this to some degree by showing that the cohorts of EMPs who perform the best in the theoretical, knowledge-based CPR tests were physicians with the least experience but with a strong foundational and theoretical knowledge base – a result of their formative education. Paramedics, on the other hand, scored the lowest in these theory tests despite the fact that, on the whole, they were EMPs who had probably encountered cardiac arrests

on a daily basis. Similar results were revealed by Gass et al. [263] who investigated the retention of knowledge and skills on the part of physicians and nurses after CPR training. The study showed a better overall retention in the physicians as compared to nurses and suggested that these results were perhaps a consequence of previous training. Gass et al. [263] then suggested that the content of training programmes should, therefore, perhaps be different for physicians and nurses and should build on their previous knowledge and professional training.

On the other hand, learning itself is learnt, as is a preferred learning style. Consequently, learning is malleable and not fixed and may change or be adapted to a particular situation [267]. Nevertheless this is often taken for granted and, as a result, people often interpret a dislike of certain study material or an inability to retain certain subject content as a result of their not being effective learners [272]. However, the problem may not be that people are ineffective learners but it may simply mean that the subject content in question was presented to them in a style that differed from the set of personal, or related beliefs that influenced how they traditionally learnt [231,257]. Educationalists term this set of related beliefs as an educational philosophy or positionality. This philosophy represents a learner's views about the purpose of teaching and learning, the teacher's role, what should be taught and what methods should be used.

2.8.4. Different educational philosophies

Sadker [273] and Wiles et al. [274] discuss five broad philosophical categories that are found among learners, particularly adult learners. These include the educational philosophies of perennialism, idealism, realism, experimentalism and existentialism.

2.8.4.1. Perennialism

This educational philosophy is considered to represent the most conservative and inflexible approach to education. Individuals who ascribe to this philosophy rely on the classical definitions of education and believe that education is a constant and, thus, that change is unwarranted. The attitude of perennialistic learners is that the function of instructors is to interpret information and recite it to the student who is the passive learner.

2.8.4.2. Idealism

Idealism is a philosophy that prefers the teaching of content that builds the mind and improves behaviour with the instructor representing the model of ideal behaviour. Idealists believe the function of teaching is to present historical wisdom and models of preferred behaviour. The attitudes of idealists are similar to those of perennialistic learners as regards the belief that students are merely passive learners as they receive and memorise information which is provided by the instructor. In addition, in common with philosophy of perennialism, idealists believe that changes in teaching are unnecessary and, in fact, they are disruptive to the process of education.

2.8.4.3. Realism

Realists perceive the world as it is in the present, with reality and truth being based on observation. Realists prefer teaching that concentrates on the facts and science behind the subject matter. The rationale behind this philosophy is that information based on fact renders a learner more proficient in knowing. Although realists prescribe a disciplined and orderly learning environment with a level of passive learning, changes in teaching and content delivery methods are encouraged as these changes embrace the natural evolution of learning.

2.8.4.4. Experimentalism

Experimentalists accept and encourage change but go even further by constantly seeking new ways in which to improve society. According to experimentalists truth changes and what is believed is what is currently in place. They believe that learning should be based on life experiences and problem solving and studies on cause and effect. Experimentalists are of the opinion that instructors should be mere facilitators who aid learners in questioning and discovering their world and new content.

2.8.4.5. Existentialism

For existentialists structured training would probably not exist. They believe that structured teaching should serve the purpose of assisting students to learn about themselves with learners being allowed both to choose what they want to learn and to interpret subject matter according to their views. Existentialism believes that

instructors should merely provide assistance with learning and not interpretation of subject matter. Existentialism is the most boundary-free philosophy with change in training occurring all the time and often unplanned.

2.8.5. The nature of the learning process

Learning may be defined as a change in behaviour which occurs as a result of either practice or experience [275]. The concept of a “change in behaviour” in educational psychology has been taken to mean that a person acquires the ability to carry out a task or procedure in a natural and relatively effortless way and also as effectively as such task or procedure were an innate aspect of his/her behavioural pattern [275]. The way in which such learning comes about is, however, dependent on the exact nature of the task or procedure that is being learned [276]. In the case of a relatively simple cognitive task where the learner, for example, may only be required to know the names of the various parts of the human body, the process of learning may simply involve scanning the material sufficiently often to allow it to pass through the short-term memory into the long-term memory. However, in the case of a more complicated learning task that may involve more higher-level cognitive activities (e.g. a paramedic treating a sick or injured person in an emergency situation), the learning process is likely to involve actually carrying out the task of treating a sick or injured person in an emergency situation sufficiently often to ensure that the behaviour patterns required to perform such a task without difficulty become firmly established [275, 276]. This process is referred to as repetition and is a major component in effective learning. [276]

While there is general consensus that learning occurs as information passes through the various sensory channels, there have been several models of learning developed by educational psychologists and educationalists over the years and describing the theory of learning, as well as the unique ways in which people learn, master learning, solve problems, think or simply react in pedagogical situations. The models that have probably proved to be the most popular and influential over the years include those proposed by Robert Gagne, Benjamin Bloom, Richard Felder and Barbara Soloman, David Kolb, Phil Race, and Honey and Mumford.

2.7.5.1. The taxonomy of learning – Robert Gagne

Perhaps one of the most popular and influential learning taxonomies in the field of instructional design is Gagne's taxonomy of learning which was developed by the American educational psychologist, Robert M. Gagne, in 1972 [276]. According to Gagne's theory, there are several types and levels of learning. Each of these types and levels requires instruction that is tailored to meet the needs of the learner.

According to Gagne [277], the five types of learning are demonstrated by:

- *Intellectual skills.* This category of learning includes four sub-categories, i.e., discrimination, concrete concept, the use of rules and problem solving. In this category of learning the learner displays individual competence and is capable of responding appropriately and effectively to stimuli which the learner has never before encountered, for example, distinguishing the different pitches in a siren heard for the first time, or calculating the time it would take for a full tank of oxygen to run empty.
- *Cognitive strategies.* In this category the learner displays the ability to learn, think, and remember, for example; devising a corporate plan to improve cost cutting measures.
- *Verbal information.* In this category the learner displays the rote memorisation of names, faces, dates, telephone numbers, etc., through the process of memorisation through repetition, for example, listing the clinical features of cardiac arrest.
- *Motor skills.* This category of learning refers to bodily movements involving muscular activity, for example; starting a car, shooting a target, swinging a golf club, riding a bike, drawing a straight line, etc.
- *Attitudes.* Attitudes refer to a person's internal state that affects their choice of action in response to an idea, an object, a person, or an event, for example, choosing to visit an art museum.

According to Gagne, different internal and external conditions are necessary for each of the five types of learning to be realised. For example, for verbal information to be

learned there must be the opportunity to practice in various situations and environments while, for cognitive strategies to be learned there must be the opportunity to practise new solutions to problems. According to Gagné's theory, good instruction was a condition for effective learning. He maintained that good instruction required sound planning. Gagne then went on to propose the specific steps involved in planning instruction.

According to Gagne [277,278], the nine steps of planning instruction include the following:

- *Identifying the types of learning outcomes.* During this first step instructors identify exactly what they want the student to learn. Each outcome may involve prerequisite knowledge or skills that must be identified at the outset.
- *Identifying learner prerequisites to learning.* Step two involves the instructors identifying the internal conditions or processes the learner must possess in order to achieve the outcomes identified in step one.
- *Identifying instructor prerequisites.* During step three the instructor identifies the external conditions or instruction needed to achieve the outcomes identified in step one.
- *Specifying the learning context.* Step four involves informing learners why they need to learn a particular subject and also in what such situations they may be required to use such learning in their lives.
- *Recording the characteristics of the learners.* During step five the various types of learners that will be taught are identified as different types of learners require different types of instruction.
- *Selecting the media for instruction.* The sixth step involves identifying the type of delivery methods; books, video presentations and handouts that will be used to teach the class.

- *Planning to motivate the learners.* The seventh step focuses on ensuring that the learners are excited about the content and motivated to learn it.
- *Testing the instruction with the learners in the form of formative evaluation.* The eighth step involves evaluating the training with a small of group of learners prior to using the instruction in the context of the entire group.
- *After the instruction has been given step nine involves conducting a summative evaluation to judge the effectiveness of the instruction.*

In addition, the theory also lists and describes nine instructional events which Gagne asserts are imperative in order to ensure effective learning [278]. These events include the following:

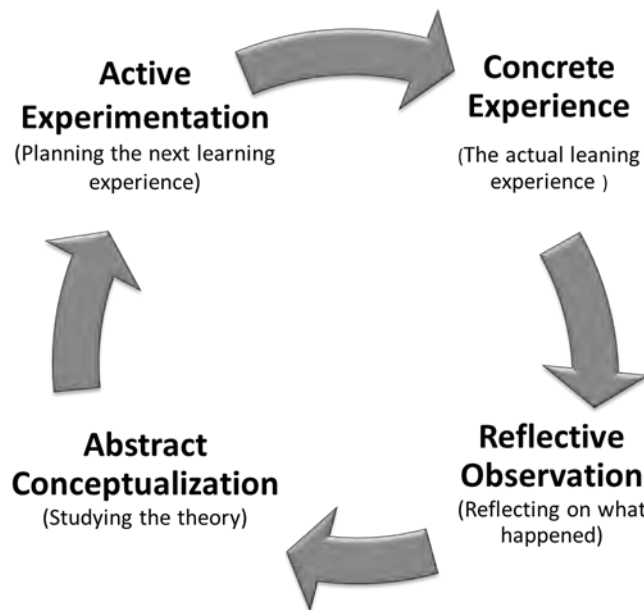
- *Gaining the learner's attention.* Present an interesting problem or a new situation in a stimulating and engaging way. Examples include an infographic presenting information that demonstrates to learners the reasons why specific training may be useful.
- *Informing learner of objectives.* Describe the learning outcomes, the aims and objectives of the session, the skills that will be acquired and how the learner would be able to use the knowledge. Conduct a demonstration, if appropriate.
- *Stimulating the recall of prior learning.* Remind learners of prior knowledge relevant to the current lesson (facts, rules, procedures or skills). Show how the sessions are connected. Provide the learners with a framework that helps learning and remembering. Tests may be included.
- *Presenting stimulus material to be learned.* Use a mixture of media e.g. text, graphics, simulations, figures, pictures, sound, etc. Follow a consistent presentation style and also utilise the chunking of information.
- *Providing learner guidance.* Use examples and demonstrate the relevance of the materials. Use different approaches to convey the same information.

- *Eliciting performance.* Provide the learners with the opportunity to do something with the newly acquired behaviour by practising the newly acquired skills or applying the newly acquired knowledge.
- *Providing informative feedback.* Highlight the correctness of the learner's response, analyse the learner's behaviour (or allow the learner to do this) and perhaps present a good (step-by-step) solution to the problem via a model answer.
- *Assessing performance.* Test whether the lesson has been learned. In addition, sometimes provide general progress information in the context of the course as a whole.
- *Enhancing retention and transfer.* Give examples of similar problems or situations and provide additional practice. Place the learners in a situation where they have to apply the knowledge acquired earlier.

2.7.5.2. The Experiential Learning Cycle - David Kolb

Research has shown that all ages of learners tend to learn much more effectively if they are actively involved in the learning process rather than merely being the passive recipients of instruction [279]. Accordingly, there has, in recent years, been a progressive move away from traditional, teacher-centred, expository instruction towards student-centred, experiential learning of one form or another. In 1984 David Kolb presented a different theory to learning in the form of a cyclical model of experiential learning. According to Kolb, learning theory works on two levels, namely, a four stage cycle of learning and four separate learning styles [280]. Kolb reported that learning involves the acquisition of abstract concepts that may be applied flexibly in a range of situations. Kolb viewed “learning as a process whereby knowledge is created through the transformation of experience” and, therefore, the learner had to “touch all the bases” (the four stages of the experiential learning cycle) if experiential learning were to be fully effective (Figure 2.2).

Figure 2.3 Kolb’s experiential learning cycle.



Source: Adapted from Kolb et al. [280].

The four stages of Kolb's [280] experiential learning cycle includes the following:

- **Stage 1: Active experimentation.** Kolb believed that the learner must be involved in the planning of the learning experience if experiential learning were to be fully effective. This may be done through either action planning or preparing a learning contract. The former may involve nothing more than jotting down a set of things for the learner to do, or discussing the proposed procedure with the instructor. In either case, it is useful for individual learners to set their own objectives for inclusion in the action plan. If a formal learning contract is used, this should be drawn up using a standard check list and should be agreed upon with the instructor before it is implemented.
- **Stage 2: Concrete experience.** Kolb maintained that learners should become actively involved in the exploration of the learning experience if they were to gain the maximum possible benefit from the experience. This again may involve drawing up a check list of things that the learner should try to do, e.g. active observation of what

is going on, producing a log or record of some sort, and formulating appropriate questions.

- Stage 3: Reflective observation. This is generally acknowledged to be the most difficult stage of the Kolb cycle but is probably the most crucial of all the stages. Students and practitioners should reflect on what they have learned, how they learned it, why they learned it and whether the learning experience could have been more effective, etc. Discussions of these reflections with the instructor may prove to be extremely helpful as can discussion with the learner's peers, either informally or during a formal debriefing session.
- Stage 4: Abstract conceptualisation. This stage is often left out of experiential learning programmes. However, it is extremely important if the learners are to gain the maximum possible benefit from such programmes. The main object of this stage is to link the actual learning experience with the theories that were intended to underpin it, and/or provide a greater understanding of the theories that the learning experience was designed to illustrate. Again, discussion with the instructor can prove to be extremely helpful during this stage of the Kolb cycle as will discussion with fellow learners.

Kolb viewed learning as an integrated process with each stage being mutually supportive of and feeding into the next stage [396]. Accordingly, while it is possible to enter the cycle at any stage and follow the cycle through its logical sequence, effective learning occurs only when a learner is able to execute all four stages of the model. Thus, no one stage of the cycle is as effective as a learning procedure on its own.

2.7.5.3. The taxonomy of the cognitive domain – Benjamin Bloom

Another model of learning that remains as an essential foundation within the educational community is Benjamin Bloom's taxonomy of the cognitive domain [282]. Bloom was an American educational psychologist who, at the time, was chairing an educational committee that aimed at improving the communication between educators who were developing curricula and those who were developing examinations. In 1956 he proposed a classification of the different levels of intellectual

behaviour which were important in the learning process. This classification or taxonomy identified the following three (overlapping) domains of educational activities:

- Cognitive (i.e. the mental skills of humans)
- Affective (i.e. feelings/emotions – attitude)
- Psychomotor (i.e. manual or physical skills)

With work on the cognitive domain completed first, Bloom proposed that a learner's cognitive abilities may be measured along a continuum ranging from the lowest level (simple recall or recognition of facts) through increasingly more complex and abstract mental levels to the highest order which is classified as evaluation [282]. Bloom's view was that cognitive learning is demonstrated by both knowledge recall and intellectual skills such as the following:

- Comprehension of information and recall or recognition of specific facts
- Organising ideas and procedural patterns
- Analysing and synthesising data
- Applying knowledge
- Choosing among alternatives in problem-solving, and
- Evaluating ideas or actions.

According to Bloom [282,283], cognitive capabilities are classified into six major categories, starting from the simplest behaviour to the most complex. The categories are construed as the degrees of difficulties at the first level and which have to be mastered first before moving onto the next level.

Bloom's six categories of cognitive learning include:

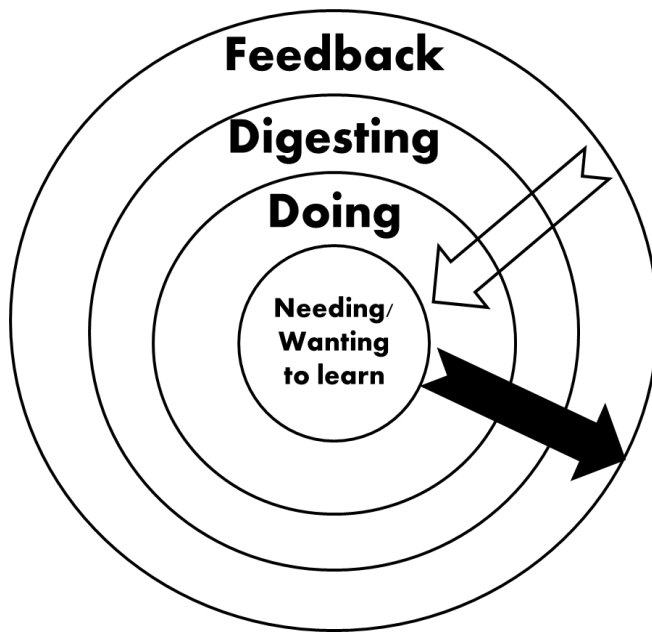
- *Level 1 – Knowledge.* This includes retention and retrieval of terminology, facts, data and dates, etc. An example of the intellectual activity at this level is that of a learner being able to list the common signs and symptoms of influenza.

- *Level 2 – Comprehension.* This includes understanding instructions and problems. An example of the intellectual activity at this level is that of a learner being able to describe and explain a problem in their own words or in another format.
- *Level 3 – Application.* This includes recognition of knowledge elements applicable to the specific situation and applying them correctly them. An example of the intellectual activity at this level is that of a learner being able to demonstrate either the use of a concept in a new situation or the unprompted use of an abstraction.
- *Level 4 – Analysis.* This includes describing the logic behind a process, etc. An example of the intellectual activity at this level is that of a learner being able to distinguish between facts and inferences.
- *Level 5 – Synthesis.* Building from diverse elements and integrate the parts to form a whole. An example of the intellectual activity at this level is that of learners being able to develop a new theory from known ideas and observations.
- *Level 6 – Evaluation.* Inventing and defending new structures based on the observation of phenomena which do not fit into existing frameworks.

2.7.5.4. An alternative experiential learning model - Phil Race

In 1993, the British educational and training developer, Phil Race, proposed an alternative experiential model of learning [284]. At the time Race, who was actually involved in the delivery of education and training, become increasingly concerned by the realisation that most of what had already been written about the theory of learning was presented in language that reflected the way in which educational psychologists thought rather than the way in which the majority of people learn. As a result Race proposed a much simpler model of learning to which he felt practising educators and trainers would be relate more easily. Race's model was based on the premise that the most effective form of learning is experiential learning or, as he described it, “learning by doing” [285]. The experiential model (Figure 2.3) described four processes. However, rather than progressing through a cycle the four processes interacted with one another like ripples in a pond, starting with “wanting” or “needing” to learn.

Figure 2.4: The experiential learning model



Source: Adapted from Race [284]

Phil Race's "ripples" model of learning includes:

- *Wanting*. At the heart or centre of the model is the internal motivation that makes a person want to learn something in the first place. According to Race, effective learning requires motivation and the desire to learn. Placing "needing/wanting" at the centre of the schematic representation of his model also symbolises its internal origin within the learner.
- *Doing*. The model is all about learning by doing. Race's view is that, if one is to learn a task or procedure effectively, then one actually needs to carry out the task or procedure as it is through practice, trial and error that learning is achieved.
- *Digesting*. Effective learning requires time for reflection and thinking. Spending time to make sense of the task or procedure and gaining ownership of the learned experience is as important as actually performing the required task or procedure. Doing and digesting are regarded as overlapping processes that are

continuously influenced by both internally-generated “needing/wanting” and by externally-generated “feedback”.

- *Feedback.* Feedback is integral to effective learning. This includes intrinsic feedback from within as well as extrinsic feedback from others. Race places feedback in the outer circle of the schematic model to symbolise that feedback is mainly external in origin (instructors, fellow learners, etc.)

Race's model of learning is similar to that of Kolb in that it is based on experiential learning and is dynamic in nature. However, Race's model differs from that of Kolb in that its various elements are not regarded as constituting a sequential cycle [280] and, instead, they are regarded as constituting an integrated, interacting “whole”. Since it was first presented Race's model of learning has become one of the standard models in the field of educational psychology.

2.8.6. Styles of learning

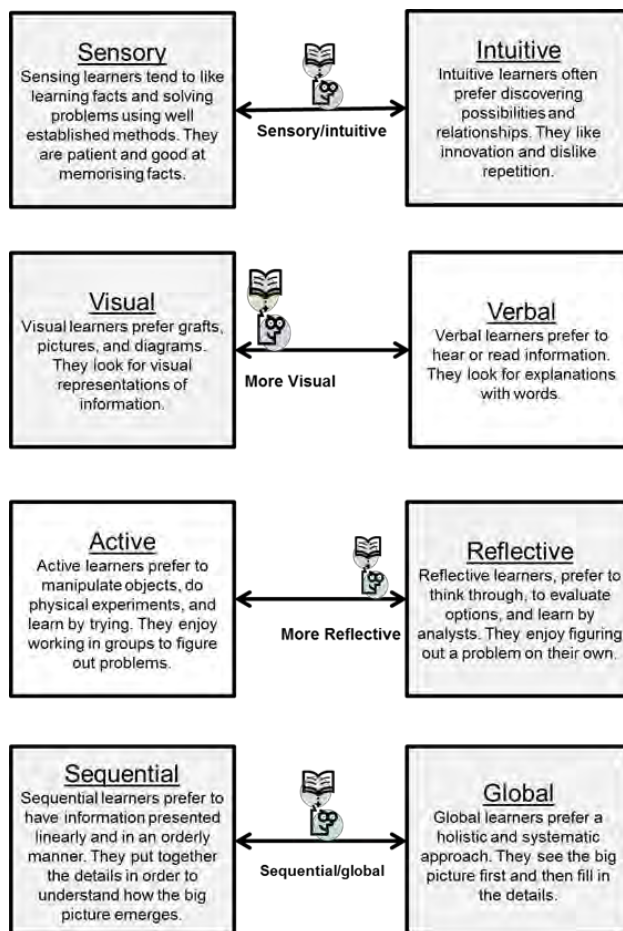
Different people have different learning needs, they bring their own individual knowledge, experience and resources to the learning process and they learn in different ways. This difference or preferential mode through which a student prefers to master learning is referred to as the student's learning style [286]. In view of the fact that there are different learning styles, it is incumbent on all teachers and trainers to make an effort to cater for as many of them as possible when planning their instructional programmes. While there are several approaches to describing the many learning styles, perhaps the most popular are the approaches proposed by Felder and Soloman [287], Kolb [286] and Honey and Mumford [289].

2.7.6.1. The Index of Learning Styles™ - Richard Felder and Barbara Soloman

The Index of Learning Styles™ was developed by Dr. Richard Felder and Barbara Soloman in the late 1980s [287]. According to the index (which Felder revised in 2002) there are four dimensions of learning styles, namely, the Sensory-Intuitive, Visual-Verbal, Active-Reflective and Sequential-Global dimensions (Figure 2.5). Using the model as a learning continuum from right to left, learners are able to identify where their learning style preferences lie in each of the four dimensions. If learners find that they are too far on any one side of the learning dimension continuum it is highly likely

that they will be limited in their ability to take in new information and also to make sense of it quickly, accurately, and effectively. The model helps learners to identify strong learning style preferences but also affords them the opportunity to stretch beyond those preferences and develop a more balanced approach to learning.

Figure 2.5 Index of learning styles



Source: Adapted from Felder et al, [287,288]

In order to use the Index of Learning Styles to develop learning skills, learners should first identify their own learning preferences for each learning dimension. This is best done using a learning style questionnaire that quantifies the learners' learning style preferences in respect of various stimuli. Once learners have identified within which dimensions their learning styles lie, they may then determine whether they are out of balance within an identified dimension; that is, displaying a stronger preference for only one of the two styles within a specific learning dimension. Learners who find themselves out of balance may be directed towards certain specific activities with the aim of improving their learning skills in those areas that require development. These

activities (listed below) which may help learners to bring balance to their identified learning dimensions include:

- *Sensory learners.* Learners who rely too much on sensing may tend to prefer what is familiar and concentrate on facts that they may know already instead of being innovative and adapting to new situations. These learners should seek out opportunities to learn theoretical information and then bring in facts either to support or negate these theories.
- *Intuitive learners.* Learners who overly rely on intuition may risk missing important details and this may, in turn, lead to poor decision-making and problem solving. These learners should be forced to learn facts or memorise data that may help them either to defend or criticise a theory or procedure with which they are working. In addition, it is essential that they slow down and take into account detail they would otherwise typically skim
- *Visual learners.* If learners concentrate more on pictorial or graphical information than on words, they are at a distinct disadvantage because verbal and written information is still the main preferred choice for the delivery of information. These learners should practise note taking and seek out opportunities to explain information to others using words.
- *Verbal learners.* When information is presented in diagrams, sketches, flow charts, etc., these are designed in such a way so as to facilitate quick understanding. If learners develop their verbal skills they may significantly reduce the time spent on learning and absorbing information. Such learners should seek opportunities to learn through audio-visual presentations (such as CD-ROM and Webcasts.) In addition, when making notes, they should group information according to concepts and then create visual links with arrows going to and from such concepts. These learners should also take every opportunity they are offered to create charts, tables and diagrams.
- *Active learners.* Learners who act before they think are apt to make hasty and potentially ill-informed judgements. These learners should concentrate on

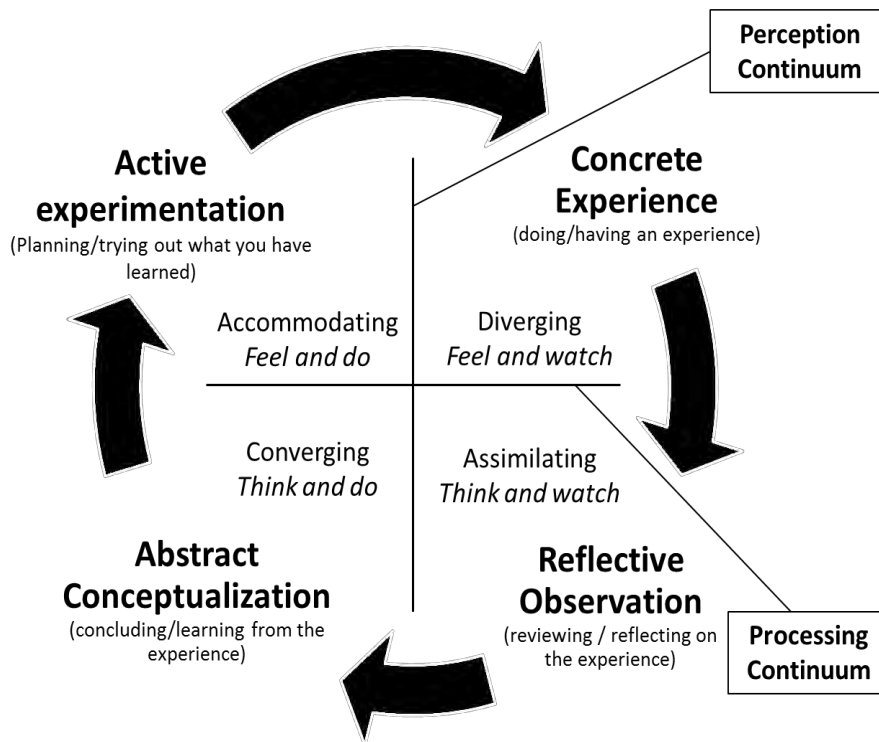
summarising situations and taking the time to sit by themselves in order to digest information they have been given before jumping in and discussing such information with others.

- *Reflective learners.* Learners who think too much are at risk of doing nothing. There comes a time when a decision has to be made or an action taken. These learners should involve themselves in group decision-making whenever possible and try to apply the information that they have been given in as practical a manner as possible.
- *Sequential learners.* Learners who break things down into small components are often able to move quickly onto problem solving. This may appear to be advantageous but it may often be unproductive. It is essential that these learners slow down and understand why they are doing something and also how what they are doing is connected to the overall purpose or objective. In other words, they must be forced to to ask themselves how their actions are going to help them in the long run. They would then realise that, if there is no practical application for what they are doing. This, in turn, would force them to stop and carry out "big picture" thinking.
- *Global learners.* Learners who find it easy to grasp the “big picture” are often also at risk of wanting “to run before they are able to walk”. These learners may realise what is needed but they may not take sufficient time to learn how best to accomplish it. It is vital that these learners take the time to ask for explanations and force themselves to complete all the problem-solving steps. Global learners must reach a point at which they are able to explain what they have done and also the reason why they did it. If they are not able to do this they may have missed critical details

2.7.6.2. Kolb’s learning styles

David Kolb developed his learning style inventory from his learning styles model. According to Kolb, while various factors influence a person’s preferred learning style, the preference itself is actually the product of two pairs of variables or two separate “choices” that people make. Kolb presented these choices as lines of axes, each with “conflicting” modes at either end (Figure 2.6).

Figure 2.6 Kolb's learning styles model



Source: Adapted from Kolb et al [286]

Kolb's two continuums are the east-west axis, which is referred to as the Processing Continuum (how we approach a task) and the north-south axis, which is referred to as the Perception Continuum (our emotional response, or is how we think or feel about a task). Table 2.3 is presented in order to facilitate an understanding of the construction of Kolb's learning styles in terms of a two-by-two matrix [286]. Each learning style represents a combination of two preferred styles. The table also introduces Kolb's terminology for the four learning styles, namely, diverging, assimilating, converging and accommodating.

Table 2.3 Learning styles of David Kolb

	Doing (Active Experimentation - AE)	Watching (Reflective Observation - RO)
Feeling (Concrete Experience - CE)	Accommodating (CE/AE)	Diverging (CE/RO)
Thinking (Abstract Conceptualisation - AC)	Converging (AC/AE)	Assimilating (AC/RO)

Kolb et al's, [286] four learning styles include:

- Diverging (feeling and watching - CE/RO)

Such people are able to look at things from various perspectives. They are also sensitive. In the main, they prefer to watch rather than do, tending to gather information and use imagination in order to solve problems. They are best at viewing concrete situations from several different viewpoints. Kolb called this style "diverging" because these people perform better in situations that require the generation of ideas, for example, brainstorming. People with a diverging learning style usually have broad cultural interests and like to gather information. They are interested in people, they tend to be imaginative and emotional and they tend to be strong in the arts. People with the diverging style prefer to work in groups, to listen with an open mind and to receive personal feedback.

- Assimilating (Watching and thinking - AC/RO)

The assimilating learning preference involves a concise, logical approach with ideas and concepts being more important than people. These people require a sound, clear explanation of something rather than a practical opportunity to do it. They excel at understanding wide-ranging information and organising it into a clear, logical format. People with an assimilating learning style are less focused on people and more interested in ideas and abstract concepts. People with this style are more attracted to logically sound theories than approaches based on practical value. This learning style is important for effectiveness in information and science careers. In formal learning situations people with this style prefer reading, lectures, exploring analytical models and having the time to think things through.

- Converging (Doing and thinking - AC/AE)

People with a converging learning style are able to solve problems. They will use their learning to find solutions to practical issues. They prefer technical tasks and are less concerned with people and interpersonal aspects. People with a converging learning style are best at finding practical uses for ideas and theories. They are able to solve problems and make decisions by finding solutions to questions and problems. People with this learning style are more attracted to technical tasks and problems than social or interpersonal issues. A converging learning style enables specialist and

technological abilities. In addition, people with a converging style like to experiment with new ideas, to simulate and to work with practical applications.

- Accommodating (Doing and feeling – CE/AE)

The accommodating learning style is “hands-on”, with people with this learning style relying on intuition rather than logic. These people use other people's analyses, and prefer to adopt a practical, experiential approach. They are attracted to new challenges and experiences, and to carrying out plans. They commonly act on “gut” instinct rather than on logical analysis. People with an accommodating learning style tend to rely on others for information then carry out their own analysis. This learning style is prevalent within the general population.

2.7.6.3. Honey and Mumford's learning styles

Another useful approach to describing and classifying learning styles is the four dimensional scheme developed by Peter Honey and Alan Mumford in the mid-1980s [289]. Based upon the work of Kolb, Honey and Mumford identified four distinct and basic types of learners. These four types of learners are characterised by a preference for active, reflective, theoretical or practical learning. The basic characteristics of Honey and Mumford's four types of learners include the following:

Activists

- These are individuals who are able to think and react quickly.
- They are usually enthusiastic and welcome new challenges and experiences.
- They typically like to take direct action and are interested in the here and now.
- They are always ready to try things out.
- They grasp opportunities to initiate things.
- They like to be the centre of attention and prefer plenty of variety.
- They prefer short teaching sessions.
- They love to have fun while participating in training.

Reflectors

- They typically like to think about things in detail before taking direct action.
- They display a thoughtful approach to tackling tasks.
- They are good listeners who prefer to adopt a low profile.
- They are prepared to read and re-read training material and they welcome the opportunity to repeat information.
- They prefer to research and evaluate and to make decisions in their own time.

Theorists

- They typically prefer to understand how things fit into an overall pattern.
- They are logical and objective systems people.
- They prefer a sequential approach to problems.
- They are analytical, pay great attention to detail and tend to be perfectionists.
- They prefer concepts and theories.
- They like to be intellectually stretched.
- They prefer structure and clear objectives.
- They like the logical presentation of ideas.

Pragmatists

- These individuals prefer to see how things work in practice.
- They enjoy experimenting with new ideas.
- They are practical individuals who enjoy solving problems.
- They appreciate the notion of trying out what they have just learnt.
- They want to see the relevance of their work.
- They seek credible role models.
- They prefer techniques that have been tried, tested and proven to work.

According to Honey and Mumford [290], the four styles represent learning approaches that individuals naturally prefer in order to maximise their own personal learning therefore learners ought to not only understand their learning style but seek opportunities to learn using that style. The aim for teachers is to cater for all styles when planning their teaching/learning programmes, and try to help learners to adopt different learning styles in different types of situations.

2.8.7. Tailoring teaching to learning styles

An awareness of the characteristics and learner needs of paramedics is likely to provide valuable input and also to steer the process of customising the instructional interventions that best enable paramedics to reach and exceed their personal as well as the pdCPR course outcomes. However, Honey and Mumford [290] claim that using a traditional approach to identify learning styles via common sensory channels limits the type and range of educational and instructional options that become available in order to deliver the content matter. Honey and Mumford and also Fleming et al [291] claim that an alternative and more appropriate approach includes identifying the characteristics of learners who demonstrate particular learning styles as such an approach would mean that more options as regards to information transfer would become available than would otherwise be the case.

2.8.8. Matching learner characteristics to learner styles

In view of the fact that different learning styles are likely to exist, even within a specific CPR provider cohort, a variety of methods in order to transfer information and teach concepts would probably reach a wider audience than may otherwise be reached. This, in turn, would ensure that information and skills would be acquired more quickly, retained for longer and used appropriately by more students – the essence of effective teaching [292,293].

2.8.9. Other factors that may impact on learning

There is sufficient evidence to indicate that the delivery of knowledge and skills may be optimised when teaching and instructional interventions are sensitive to the human development stage, learner characteristics, background, educational levels, literacy levels and learner style characteristics of the specific CPR provider cohort. In addition to these considerations, learning is likely to be further optimised when the factors that impact on overall learning in adult cohorts are also taken into account [291]. The four categories of factors that are likely to impact on the acquisition and retention of CPR knowledge and skills and as adapted from Honey and Mumford.[292] and presented in Table 2.4.

Table 2.4 Factors that may impact on learning

<p>Factors involving the learner</p> <p>Their previous personal experiences of learning, whether favourable or unfavourable</p> <p>Their motivation, why and how eager are they to learn</p> <p>Their familiarity with the subject matter</p> <p>Whether they regard the learning subject matter as relevant and beneficial</p> <p>Whether they are equipped to self-manage their learning unsupervised</p>
<p>Factors involving the situation</p> <p>The extent to which learning is encouraged and supported</p> <p>Whether learning is a requirement or whether it is being undertaken voluntarily</p> <p>Whether the learner needs have been identified accurately</p> <p>How learning is assessed</p> <p>Whether the learning environment is conducive to learning</p> <p>Whether learning is urgent</p> <p>The ease with which learning may be assessed</p>
<p>Factors involving the subject matter</p> <p>Whether the learning is primarily aimed at increasing knowledge or developing skills</p> <p>Whether learning is broken down into manageable chunks appropriate to learner needs</p> <p>The extent to which the learner finds the subject matter comprehensible and meaningful</p> <p>Whether the learning is superficial or requires a full understanding</p>
<p>Factors involving the methods employed</p> <p>The appropriateness of the delivery method</p> <p>The extent to which the learners find the learning methods helpful or engaging</p> <p>The extent to which the learning is supported and reinforced</p> <p>Whether the methods require the learners to learn by themselves or with others</p> <p>The extent to which the methods are either passive or active</p> <p>Whether the methods provide the learners with timely and effective feedback</p>

Source: Adapted from Honey and Mumford. How to become a more effective learner [292].

2.9. LEADING QUESTION NO 6

What methods are likely to relate classroom performance to actual performance?

There is growing support for the claim that the acquisition and retention of CPR knowledge and skills are improved when the teaching methods are tailored to match the characteristics and learner needs of the CPR provider cohort [69,79,294]. However, according to Kneebone et al., for CPR training to be the most effective, it also needs to be contextualised and aligned to the operational patient case mix and the role of the CPR provider within a healthcare system's response to OHCA [295]. If this is to be achieved such an alignment there must be a close link between task-based practice and actual real-life clinical practice [296].

2.9.1. Classroom performance and actual performance

The assessment of competence during actual real-life resuscitations is not always possible and it is also largely discouraged as it carries an increased risk of both patient and rescuer harm [297]. As a result assessing competency in CPR performance both during and after training is usually restricted to simulated scenarios using CPR training manikins [298,299]. Over the years simulated assessments, particularly high-fidelity simulations, have successfully facilitated both training and the assessment of learner performances in OHCA scenarios as well as during the undertaking of complex resuscitation skills in realistic environments and without putting the patients at risk [297]. In broad terms, a simulation is "a set of techniques that replace or amplify real experiences with planned immersive experiences that aim to evoke or replicate substantial aspects of the real world in an interactive fashion" [300]. The term "immersive" in the cardiac arrest context conveys the sense that the participants are immersed in a task, scenario or setting as if it were the real world during a real cardiac arrest situation [300–302]. However, it would appear that, over the years and with the growing popularity of simulation, many people tend to use the term "simulation" either in too broad a context or inappropriately [303]. A detailed examination of the applicable data indicates that, in its truest sense, simulation extends further than merely the use of human-like manikins, a make-believe real-life setting and a realistic atmosphere. Simulation in its purist form requires the trainees to be actively involved in trying to solve the problem which has been presented to

them by interacting and communicating with their peers, the environment, the equipment, bystanders, family members and, most of all, the patient [81,304–306].

Alinier [81] claims that the misuse of the word “simulation” may give trainees a false impression, causing them to believe that they are fully prepared to confront reality. Alinier further claims that trainees may believe that a session in which they are requested to demonstrate certain skills using some form of simulation technology is an actual, full-scale, high-fidelity simulation which has the potential to prepare the individuals to face real-life crisis situations. This belief, in turn, may cause them to become over-confident and, when faced with reality, they may perform poorly. Similarly, when using video recordings to demonstrate ideal practice, it is essential that trainees are able to relate to and simulate the actors, the settings and the equipment [307–310].

2.9.2. Simulation as an assessment tool

The cornerstones of successful CPR performance during simulated assessments include adhering to established resuscitation guidelines or locally tailored cardiac arrest algorithms, sound technical and non-technical skills, effective communication, prompt and correct utilisation of equipment and the achievement of competency-based outcomes [311-313]. In addition, simulation may be used to identify errors and deficiencies that may be targeted with prompt feedback and resuscitation training [314]. For example, when White et al. assessed the performance of paediatric residents using simulated cardiac arrest mock scenarios, more than 80% of the trainees achieved the primary endpoint for all the resuscitation skills that were measured but performed poorly on the subcomponents of those same skills. Although 87% of the paediatric residents were able to place the endotracheal tube into the manikin trachea, 27% only checked for functioning suction equipment while 15% only assured that bag-valve mask equipment was available before intubation. When the scenario required defibrillation, the majority of the residents were able to discharge the defibrillator (89%) but only 12 (25%) chose the asynchronous mode for a patient in ventricular fibrillation [315]. Hunt et al. reported similar findings during 34 mock, in-hospital cardiac arrest simulations which were conducted over a 40 month period. Hunt and colleagues found that, although all end-point outcome measures were

achieved, the rescuers took too long to initiate compressions and request a defibrillator – actions that are crucial to patient outcome [316].

2.9.3. Simulation as an instructional strategy

According to Miller et al., mock simulations bridges the gap between the rescuers knowing how to perform key skills and being able to perform them in real life [307]. Opiyo et al.[317] and Wayne et al.[318] support this claim of Miller et al., thus validating simulation-based training and the effectiveness of this training method in the transfer of knowledge and skills to students. According to Issenberg et al. [314], simulation-based training achieves this not only by mitigating inherent training deficiencies by allowing instructors to emphasise deliberate practice using on-demand, risk-free training but also by challenging learners to apply the higher level cognitive and psychomotor skills in lifelike, clinical situations. Issenberg et al. are not alone in making this claim as Meller et al.[309], Combs et al.[311] and Kahol et al.[308] all support the use of simulations during training. However, they all also add that the use of simulations as an instructional strategy is optimised when it is accompanied by immediate and targeted feedback, repetitive practice until mastery is achieved and progressive and controlled escalation in difficulty levels and also when it is indicative of realistic scenarios with defined learner outcomes.

2.9.4. Alternative instructional strategies

There is always the risk that trainees may become more skilled at dealing with the training technology than with actual patients. According to Alinier [81], one way in which to prevent this from happening is to consistently monitor that the skills assimilated by the trainees are not becoming automatic procedures that can be performed using a given model and under certain circumstances only. Meller et al.[309] support this claim, adding that exercises or scenarios should be varied in difficulty and in sequence as this allows the trainees to experience a range of situations and patient behaviour or responses, thus recognising that there is no one “average” patient. However, although the use of multiple simulated scenarios may be beneficial, it may not always be possible in light of shorter course durations, costs, untrained simulation operators, etc. This, in turn, highlights the fact that there is a need for alternative instructional strategies that require trainees to rely as much on

their imaginations as on their knowledge while such alternative instructional strategies may also require learners to think and recreate mentally the environment and circumstances in which the action or skills would be likely take place.

2.9.5. Non-technical skills

Over the years, non-technical skills or human factors (as many did and still refer to them) have been recognised as impacting significantly on CPR performance during cardiac arrest [79]. The burgeoning interest in non-technical skills has resulted in numerous studies being conducted with the aim of specifically the understanding of the impact of non-technical skills on patient outcome [243,319,320]. The data generated from the study conducted by Marsch et al. is typical of such a study [208]. Marsch et al. demonstrated that the non-technical skill of leadership had a positive impact on performance, particularly at the onset of a simulated cardiac arrest. They showed that, of the 16 teams that were tasked with responding to and treating a cardiac arrest patient in ventricular fibrillation, six teams only were successful in meeting the performance criteria of providing defibrillation during the first two minutes. Although all the teams possessed sufficient theoretical knowledge the six teams that were successful showed significantly more leadership behaviour and explicit task distribution as compared to the unsuccessful teams. In addition, the six successful teams also demonstrated a trend towards better information transfer and fewer conflicts as compared to the other six teams.

Cooper and Waklam [321] reported similar findings when they investigated the relationship between leadership behaviour, team behaviour and task performance. They showed that the leadership of team members was associated not only with greater cooperation within the team but also with better task performance. Similarly, when Hunziker et al. [298] assessed the impact of non-technical skills during training by randomly assigning 237 medical students to receive either an additional 10 minutes leadership instruction or a strictly technical instruction, they found that, compared to the technical-instructed students, the leadership-instructed students showed significantly better team performance and better overall results with regard to relevant CPR specific-outcome measures such as beginning CPR, hands-on time and appropriate chest compression rate. They also noted that this improvement

remained at an evaluation which was repeated four months later, thus documenting the sustained efficacy of this short instruction.

Over the years the investigation into the impact of non-technical skills on patient outcome has expanded beyond manikin-based studies. For example, Andersen et al.[305] studied the errors related to cardiac arrest management that were reported to the Danish Patient Safety Database, a reporting system that receives critical incident reports submitted by hospital personnel. Andersen et al.[322] showed that the following four recurring themes were identified as the root causes of the problems, namely, organisational problems (related to team dynamics, in particular poor communication, unclear leadership, people interrupting one another and a lack of knowledge of guidelines); equipment issues (lack of equipment and malfunction of equipment); inability to use equipment; and a lack of space in which to work safely. They concluded that the critical incidents related to cardiac arrest were not solely a result of logistical, technical and knowledge problems but also human factors such as a lack of teamwork and leadership. This information resulted in changes being made to future CPR education and resuscitation practices by the inclusion of learning content that specifically addressed these problem areas.

2.9.6. CPR training videos

The value of CPR videos as an instructional training method has been demonstrated, particularly in regards to reducing the reliance on CPR instructors and cutting down on total classroom time [93,307]. Studies have demonstrated that video self-instruction produces CPR of a comparable quality or “at least as good” as that produced by traditional training methods [239,240]. However, as shown by both Braslow et al. [66] and Todd et al. [93], this benefit is most notable when the focus of the video-demonstrated practice is on skill competence, when it is contextualised to the provider environment in order to promote relatedness, learner assimilation and, also, as revealed by Nishiyama et al. [323], when the videos are accompanied by actual and sufficient hands-on practice.

2.9.7. A reliable and valid CPR performance evaluation tool

It has long been established that even experienced instructors using standardised checklists experience difficulties in identifying and remediating significant errors in the CPR performance of learners [67,68,77]. In addition, as Mancini et al. reveal, the evaluation tools available may be inadequate in their rudimentary form to measure the CPR performance reliably and consistently across all CPR providers [67]. Mancini et al. made this claim following the conclusions they drew from their study in which they evaluated the single-rescuer CPR of 255 subjects using two different assessment instruments, namely, a checklist and manikin strips. The study revealed that the CPR was judged to be correct twice to four times more frequently according to checklists than when judged by the manikin strips. This overestimation of competency lends support to the claim that performance which is rated as competent during simulated practice may not necessarily guarantee competency during actual performance.

The adequacy of an instrument to assess simulated CPR performance and relate those outcomes to actual performance outcomes depends on both the validity and the reliability of the instrument as a tool with which to measure CPR performance [324,325]. Validity in this context refers to the degree to which the instrument accurately reflects or assesses CPR performance, while reliability refers to the accuracy of the actual measuring instrument or procedure [326]. In other words, is the instrument measuring what it is intended to measure and would it be able to yield the same results with repeated tests? The data supports the notion that, if the CPR performance during actual, real-life resuscitations is to improve, the CPR training outcomes should be contextualised and they should be consistent with the actual outcomes that health care professionals are expected to achieve during their role in healthcare system responses to an OHCA [69,79] Training outcomes that differ from the outcomes which expected in actual practice are likely to increase the gap between classroom performance and actual performance [136].

2.9.8. Instructional design process

Perhaps one of the most influential processes in closing the gap between classroom performance and actual performance involves creating “instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing” [327]. This process of systematically designing instruction is referred to

by educationists as instructional design. The general process that instructional designs use is known as the ADDIE process. This process involves the following:

A - Analyse. In the analysis phase the instructional problem is clarified, the instructional goals and objectives are established and the learning environment as well as the learner's existing knowledge and skills are identified. The questions that are addressed during the analysis phase include:

- Who is the audience and what are the characteristics of the audience?
- What is the new behavioural outcome?
- What types of learning constraints exist?
- What are the delivery options?
- What are the pedagogical considerations?
- What is the timeline for project completion?

D - Design. In this phase the learning objectives, assessment instruments, exercises, content, subject matter analysis, lesson planning and media selection are formulated. The design phase used a logical and orderly method of identifying, developing and evaluating a set of planned strategies targeted at attaining the project's goals. The steps that are used in the design phase include:

- Documentation of the project's instructional, visual and technical design strategy.
- Application of instructional strategies according to the intended outcomes.
- Creation of storyboards.
- Design of the user interface and user experience.
- Prototype creation.
- Application of visual design (graphic design.)

D - Development. During this phase the developers create and assemble the content assets that were created in the design phase. Programmers develop and/or integrate technologies while testers perform debugging procedures. The project is reviewed and revised according to any feedback given.

I - Implementation. During the implementation phase a procedure for training the facilitators and the learners is developed. The facilitators' training should cover the

course curriculum, learning outcomes, method of delivery and testing procedures while the preparation of the learners should include training them on, among other things, new tools (software or hardware) and student registration.

E - Evaluation. The evaluation phase consists of two stages, namely formative evaluation and summative evaluation. Formative evaluation is present in each stage of the ADDIE process while summative evaluation consists of tests designed for domain specific, criterion-related, referenced items and also providing opportunities for feedback from the users.

There is tremendous value in measuring the effectiveness and impact of training through feedback, especially when substantial resources have been invested in developing and implementing the training. One of the most popular models used to undertake this evaluation is a training evaluation model which allows for the effectiveness and impact of training interventions to be objectively analysed.

2.9.9. Measuring the effectiveness and impact of training

One of the more widely used models for evaluating training is the Kirkpatrick four-level training evaluation model [328]. Developed by Donald Kirkpatrick in 1959, and updated in 1975, and again in 1994, the model proposes four levels in terms of which training should be evaluated.

The first level measures the way in which the audience or trainees (people being trained) react to the training presented to them. According to Kirkpatrick [328], by enquiring how the trainees feel about the instructor, topic, material, its presentation, the learning activities and the venue where the training was provided, the developers of the training are provided with feedback from the end user. This feedback, in turn, helps in the identification of areas that have the potential to hinder training in the long term. The identification of these areas before the full roll out of the training programme provides an opportunity to improve the training by means of focused solutions, thus saving time and resources.

The second level in this model is that of learning. At this level the goal is to measure the amount of learning that has actually occurred as a result of the training. In order

to measure this reliably, a list of specific learning objectives is identified at the outset of the training and the expected output of the training (i.e. trainee knowledge, skills or attitudes) are measured against this list both before and after the training. Level three focuses particularly on the way in which trainees have changed their behaviour as a result of the training. Specifically, this level examines how trainees apply the information they have learned. The final level is that of results where the intended change in behaviour as a result of the learning acquired through the training is measured.

The Kirkpatrick model is both popular and widely used. Nevertheless, there are a number of issues that must be taken into account when using the model. The first issue is the fact that the model requires a substantial investment of time and resources. This, in turn, means that it is often not feasible to apply the model every time training is conducted. The second issue is the fact that the model assumes that each of four level's importance is greater than that of the previous level and that all the levels are linked. Thus, this implies that reaction (level 1) is less important, ultimately, than results (level 4), and that reactions (level 1) must be positive for learning to take place. Furthermore, behaviour (level 3) changes only if conditions are favourable and this may not actually be the case. For example, while levels 1 and 2 may have produced positive results, behaviour may possibly remain unchanged. This may not necessarily mean that the training has not been successful as it may simply mean that certain factors, independent of the training have inhibited a change in behaviour, for example, the existence of a directive prohibiting staff from behaving in the way they have learned, or a lack of specialised equipment or material that precludes a certain new behaviour. Kirkpatrick's model is extremely effective as regards trying to evaluate training in a "scientific" way. However, it is also possible that several variables may be changing in fast-changing organisations and, thus, the analysis at level 4 may sometimes be limited in its usefulness.

2.10. CONCLUSION

There is sufficient evidence to support the claim that pdCPR is an integral component of the chain of survival and also a growing determinant of OHCA patient outcomes. Nevertheless, it would appear that, in general, pdCPR performance is poor and that it is not in line with established resuscitation guidelines. While several obstacles have

been identified as playing a role in this poor performance, the available literature seems to suggest that the gap that exists between expected pdCPR performance and actual performance may be narrowed by strategic improvements in pdCPR training. On the basis of the evidence currently available, it appears reasonable to suggest that such improvements may include the omission of extraneous material during training, emphasising the impact and value of sound non-technical skills, focusing on those CPR components that are directly related to saving a life, using a combination of various educational interventions to ensure that the set learning objectives are reliably achieved as well as using simulation-based training and video demonstrations of the expected CPR, checklists to provide real time corrective feedback and also competency evaluation tools that are adequate and appropriate with regards to relating classroom performance to expected actual performance during real-life resuscitation.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

This chapter discusses the research design and the research methodology used to collect the data required for the study. The chapter presents an overview of the study setting, describes the population and sample used in the study, justifies the study design which was deemed appropriate and discusses the ethical considerations which were taken into account during study. The chapter also describes the various research methods which were used during the four phases of the study in order to realise each of the four interconnected research objectives. The aim of the chapter is to provide a clear understanding of the research process which was undertaken during the study by describing how the requisite data was collected, validated and analysed.

3.2. STUDY DESIGN

3.2.1. Choosing the correct research design

The study used a mixed method research design which incorporated a combination of both qualitative and quantitative research techniques. On the basis of the evidence currently available, the mixed method design was deemed to be the most suited to address the overall research problem [329–333]. The researcher then decided on the specific type of mixed method design that would best suit the research problem and the objectives of the study. As discussed by Creswell et al. [324] and Onwuegbuzie et al. [335], despite the significant advances that have been made in research processes over the years, the choice of the correct research design remains a challenge in both qualitative and quantitative research studies. Creswell and colleagues further revealed that the research process becomes even more challenging when the decision is made to use a mixture of both qualitative and quantitative methods [333].

The reason for this appears to originate in the belief that, because each individual major method is characterised by its own history, purpose, considerations, philosophical assumptions, procedures and challenges, the task of mixing methods is, by design, intrinsically more complex [334,335]. Accordingly, in order to ensure that this study employed the most appropriate mixed-method design available, the

researcher drew up a list of the several available designs which are commonly used in practice. A mixed method, multiphase design was deemed to best suited to the research problem and supported the reasons for mixing methods. Moreover, it provided a framework that was adequately suited to guide the implementation of the predetermined research methods. This design also meant that the study was both manageable and simple to carry out and describe.

3.2.2. Fixed mixed methods

Multiphase mixed-method designs may be fixed and/or emergent or such designs may even fall somewhere in between, with both fixed and emergent aspects [334]. As regards a fixed mixed method design makes use of quantitative and qualitative methods that are predetermined and planned at the start of the research process and then implemented as planned [336]. On the other hand in emergent designs the use of mixed methods arises during the research process. A design that lies in between fixed and emergent often starts off as a fixed mixed method but requires changes as the predetermined methods are found to be inadequate during the research process [335].

For the purposes of this study the decision to choose a mixed-method approach was based on the fact that the researcher was of the opinion that a combination of various data sources and research methods would provide a better and more holistic and representative understanding of pdCPR as compared to a single research method. This was deemed to be especially important in light of the notable paucity of research and published literature on pdCPR performance and training. In addition, as Onwuegbuzie et al. [335] discuss, mixed-methods research designs have, over the years, come to be recognised as a more pragmatic approach to developing knowledge, particularly as the limitations of one particular method are likely to be offset by the advantages of the other method. Triangulation and complementarity mean that the mixed-method approach provides an opportunity both to combine quantitative and qualitative research and, thus, to triangulate the research findings so that the findings may be mutually corroborated as well as to seek elaboration, enhancement, illustration and clarification of the results arising from the various methods used. In addition, as discussed by Golfshani et al [326] and Creswell et al

[336], both the qualitative and quantitative research techniques have their own strengths and weaknesses and, thus, combining these techniques enables a study to offset the weaknesses of both approaches as well as to optimise their strengths.

The mixed-method approach also enabled a more comprehensive account of pdCPR performance and training than may otherwise have been the case as it allowed the study to address the various research objectives by using a combination of methods. This was particularly useful as quantitative research is inherently more inclined to provide an account of structures in social life whereas qualitative research tends to provide a sense of process [332]. In addition, a mixed-methods approach has been found to be increasingly beneficial when the researcher is attempting to gain a better understanding of the unexpected or novel results generated by a single method. If it is not used to clarify or explain unexpected results, data which reflects the same theme, element or variable which has been generated through various research techniques ultimately contributes to enhancing the trustworthiness of unexpected or novel results.

3.2.3. The fixed method multiphase design

Subsequent to an assessment of the various mixed-method designs, the more commonly used and basic mixed-method designs (e.g. convergent, explanatory, exploratory, embedded and transformative) [337-339] were found to be inadequate with regards to the development, adaptation, implementation and evaluation of a training intervention designed and tailored to improve the acquisition and retention of pdCPR knowledge and skills. The multiphase design was found to be the only design with a sufficiently strong overarching framework that not only supported the mixed-method elements which had been determined before commencement of the study (fixed methods), but which also possessed the flexibility required to address the new and unforeseen questions that were expected to emerge during the multiple phases of the study.

One of the main strengths of the mixed-method multiphase design is its capacity to allow for each phase of a study to address a specific, incremental objective and, thus, to progress towards addressing the overall aim of the study [337]. However, this

strength also presents as a challenge in that significantly more resources, time and effort are required than would otherwise be the case in order to successfully implement the multiple phases within the allocated time frame. This was particularly evident when it became necessary to translate the research findings into practice by developing training videos, instructional materials, instructors and pilot training programmes. Nevertheless, with support from Hamad Medical Corporation, the organisation in which the study was conducted, the researcher was able to address these resource challenges adequately. However, this support was provided based on the condition that, in addition to the supervision provided by the academic institution which was administering the study, the entire research process, the data collected and the research results arising from the study would be made available for audit by the organisation's Institutional Review Board and the Standard and Guidelines Committee. Although the extra level of supervision caused notable delays in the study, it also contributed to enhancing the overall validity of the findings.

3.3. STUDY SETTING

Permission was granted to conduct the study at the Hamad Medical Corporation Ambulance Service (HMCAS), the national ambulance service of the State of Qatar. Qatar is located on the west side of a peninsula in the Persian Gulf and north of Saudi Arabia. Qatar has a population of just over 2.3 million people with the indigenous Qataris accounting for 30% of the population while the remainder (70%) comprises expatriates [340]. The local language is Arabic although, in view of the diverse population, a wide range of other languages are spoken. Urdu (spoken by the Indian and Pakistani residents) and Tagalog (spoken by the Filipino residents) are two of the more common languages used. English is less commonly used and is rarely spoken by members of the general public although it remains the standard accepted language of communication between health care professionals and patients.

In 2010 Qatar embarked on a massive restructuring of the country's ambulance service in preparation for the 2022 Soccer World Cup. Using a hub and spoke model HMCAS is able to dispatch 65 ambulances, 10 rapid response vehicles and two helicopters across the country with the aim of reaching any patient in urban Qatar within a 10-minute response interval and any patient in the rural and outlying areas

within 15 minutes. HMCAS currently employs approximately 600 operational staff and responds to an average of 500 calls per 24-day cycle [341].

3.4. STUDY POPULATION

The study population comprised the 353 operational ambulance staff members working as ambulance paramedics (AP) in Qatar. Table 3.1 provides an overview of the total AP composition with regard to their ethnicity, education and primary language. Ambulance paramedics are registered to practise under supervision and are licensed to provide care which includes maintaining a patient’s airway using supraglottic airway devices; establishing peripheral intravenous access; and administering dextrose solution, nebulised bronchodilators, epinephrine and amiodarone to patients in cardiac arrest [342]. This cohort of paramedics (i.e. mid-level trained HMCAS ambulance personnel) made up the population for the study.

3.5. PHASE 1 – OBJECTIVE 1

Determine and describe the pdCPR performance of ambulance paramedics (APs) (see definition of terms) who underwent training during conventional pdCPR training interventions.

3.5.1. Study participants

The study used probability sampling in the form of simple random sampling to select participants from the study population of APs working at HMCAS at the time of the study. The lottery method was used [343] in order to select the sample (Table 3.2). All the APs working at HMCAS were assigned a unique number. These numbers were then placed in a bowl and thoroughly mixed. A blindfolded independent research aid then selected 100 individual numbers. The APs who had been assigned those numbers were selected and included in the sample.

Table 3.1 Country of origin, education and primary language of APs

	AP population (353)
Expatriate (native country NOT Qatar)	100%

India	42% (148)
Tunisia	30% (107)
Philippines	23% (81)
Other (Morocco, Yemen, Pakistan, Egypt)	5% (17)
Percentage with English as a first language.	0% (0/353)
Percentage with English as a second language.	70%
Percentage with English as a third language.	30%
Percentage that received their EMS training in English	71% (250)

3.2.1. Sample justification

At the time when the sample was collected there were 353 APs working at HMCAS. Using the confidence interval approach to sample size estimation, it was calculated that a sample of 100 APs would, at a confidence interval of 8.31, generate the range within which the true value for the effect at 95% would be likely to fall [344]. As demonstrated in other studies this margin of uncertainty is considered to be acceptable [95,345]. Operational and logistical requirements as well as financial constraints precluded the possibility of the sample being any larger. The use of the simple random sampling technique meant that each individual AP working in the HMCAS had an equal chance of being selected to participate in the study [343]. Table 3.2 presents the demographics, education and experiences of sample of APs chosen for this study.

Table 3.2 Demographics, education and experience of the participants

	(n=100) Sample 2
Percentage male	98%

Percentage female	2%
Combined mean age*	30.97 (7.28) [24-51]
Percentage with four year healthcare related degree.	73% (73/100)
Years of experience in healthcare*	8.85 (7.26) [2-29]
Percentage with valid BLS certification.	100% (100/100)
Percentage with valid ACLS certification.	29% (29/100)
Months from last CPR training *	11.33 (8.00) (1-30)
Number of times CPR delivered [Simulation]*	7.77 (2.46) [4-14.67]
Number of times CPR delivered [Real Patients]*	10.08 (9.89)

*Expressed as a mean (S.D.)

3.5.2. Phase one data collection pre-requirements

In order to ensure that objective 1 was realised, an operational definition of a standard against which CPR performance could be measured was required as was an assessment tool with the capacity to accurately (validly) and consistently (reliably) evaluate all treatment actions, activities and procedures which would reflect that standard. However, despite an extensive review of the available literature, it was not possible to locate both a standard which reflected competent pdCPR performance or a tool capable of accurately and consistently evaluating the treatment elements which reflected such a standard.

3.5.3. Systematic consensus methods for establishing a PdCPR standard

The possibility of an established pdCPR standard not existing could not be ruled out, particularly as there appeared to be little, high quality evidence from rigorously conducted research on much of paramedic delivered care [347]. In the absence of such evidence, or where the evidence is incomplete, systematic consensus methods are regularly used to aggregate the opinions of experts in a particular area in order to formulate a single opinion on a specific topic [348,349]. There are significant advantages to systematic consensus methods (Table 3.3) and, as result, they are extremely popular among those who are either involved or interested in engaging in research, evaluation, fact-finding, exploration of issues or discovering what is actually known or not known about a specific problem [350-353].

3.5.4. Systematic consensus methods for establishing PdCPR evaluation tool

The majority of studies on CPR performance in a simulated training environment have relied on the “performance checklists or skill sheets” published by the European Resuscitation Council, American Heart Association and the American Red Cross [354-356]. However, these checklists, which are intended for determining CPR proficiency and correcting performance, pose several challenges when evaluating subjects for research purposes [354]. The first such challenge involves identifying where newly introduced performance measures should be positioned on the checklist while the second refers to interpreting the minimum threshold meriting a check for a particular performance measure, particularly those newly introduced. The third challenge involves the conducting of a visual assessment of difficult-to-measure skills, such as volume of ventilations and compression depth. Fourthly, the examiner generalises the performance of a skill that is typically repeated into a single outcome, for example, compressions, ventilations or defibrillation while, fifthly, either the examiner spends considerable time not observing the subject in order to complete a long, multiple page checklist instead of carefully observing the subject or else the examiner may watch the subject carefully and then have to rely on recall in order to complete the checklist after the observation. Needless to say, the majority of these performance checklists do not achieve the validity and reliability levels generally accepted for the purposes of research [354]. Checklists that do demonstrate both validity and reliability, such as the Cardiff list, presented by Whitfield et al [325], and the item checklist of Brennan et al [354], are suitable for research studies that aim to report comparable data. However, they, like the traditional checklists, also pose the challenges of determining where new performance measures should be positioned, and also interpreting the likely impact of such new measures on the already established validity and reliability.

3.5.5. The Delphi technique

The Delphi technique, which was introduced by the Rand Corporation in the 1950s, is a widely used and accepted method for achieving consensus through a convergence of the opinions obtained from experts in a specific field [353]. This technique guarantees the anonymity of the respondents, it is a controlled feedback process and it is designed to offset the shortcomings of the conventional means of pooling the

opinions which are often obtained from a group interaction (i.e., influence of dominant individuals, noise and group pressure in respect of conformity) [351-353]. The anonymity offered by the process reduces the influence of dominant individuals and which is often a concern when group-based processes are used to collect and synthesise information [353]. In addition, confidentiality may also be enhanced by the geographic dispersion of the subjects as well as by the use of electronic means of communication such as e-mail in order to solicit and exchange information. Accordingly, certain of the disadvantages which are often associated with group dynamics, for example, manipulation or coercion to conform or adopt a certain viewpoint are minimised [352].

Table 3.3 Advantages of formal consensus methods

- Groups are less likely to arrive at an “incorrect” decision as compared to individuals.
- Consensus that has been reached through formal methods has scientific credibility.
- A structured process often minimises the negative aspects of group decision-making such as the disproportionate influence of specific individuals within the group.
- A nominated, purposively selected group of individuals is able to develop an authoritative consensus.

3.5.6. Modification and stages of the Delphi Process

The Delphi process traditionally begins with the administration of an open-ended questionnaire designed to solicit specific information from the Delphi subjects. This information is then analysed and converted into a structured questionnaire which is used as the survey instrument for the proposed second round of data collection [357]. An acceptable and common modification to this round of the Delphi process is the use of a structured questionnaire based on an extensive review of relevant literature [358,359] However, this modified Delphi process is appropriate only if basic information concerning the target issue is both available and usable [359].

In the second round of the Delphi process, each subject receives a second questionnaire and is asked to review the items that have been summarised by the investigators and based on the information provided from first round. This round may also require the subjects to rate or “rank-order “ items in order to establish preliminary priorities as regards the items [360]. This round may also sometimes require the participants to indicate their rationale concerning their ratings of priorities among the items [360].

In the third round, each Delphi subject is sent a questionnaire that includes the items with their mean ratings and that have been collated and analysed by the investigators. The subjects are asked to review the rankings and provide reasons if they choose to

remain outside of the consensus on the item ratings [361]. This round gives the Delphi participants an opportunity to further clarify both the information and their judgments of the relative importance of the items. Consensus begins to form in round two while, in round three, the products of the consensus are presented to the subjects [362].

In the fourth round, the list of remaining items, their ratings and minority opinions are presented to the Delphi subjects. This round provides the participants with a final opportunity to revise their judgments. The Delphi process may be repeated until consensus is deemed to have been achieved. This process could include up to five rounds [361]. However, Custer et al.[357], Gordon et al.[358] and Paul et al. [359] point out that three iterations are often sufficient to collect the required information and to reach a consensus with acceptable scientific credibility.

3.5.7. Choosing subjects for the Delphi process

In view of the fact that the Delphi process is based on aggregating the opinions of a group into a single collective opinion, choosing the appropriate subjects to be part of the group is the most important step in the entire process because it relates directly to the quality of the results that will be generated [351,353]. Although it may seem appropriate to choose individuals who are knowledgeable about the target topic this may not, however, be sufficient and is, in fact, typically not recommended [335]. Delphi participants should be highly skilled and competent within the specialised area of knowledge but they should also be representative of a wide range of stakeholders [353,357]. Cuhls et al. [363], Hasson et al. [353] and Hsu [351] all support the claim that the three groups of people that should be regarded as being most suited to be subjects of a Delphi study should include:

- Top management who will use the outcomes of the Delphi technique.
- Professional staff members together with their support teams.
- The respondents to the Delphi questionnaire and whose judgements are being sought.

3.5.8. Using the Delphi technique in this study

Two exclusively different rounds of Delphi systematic processes were conducted in this study. The objective of the first Delphi process was to solicit consensus on the following:

- (1) A operational definition of *competent pdCPR performance*
- (2) A *pdCPR care bundle* consisting of treatment elements, procedures and processes proven by scientific evidence or expert consensus to be the most likely to contribute to successful resuscitation.

The objective of the second Delphi process was to solicit consensus on the following:

- (3) A *rapid evaluation tool (RET)* consisting of process measures representing either a single or a group of treatment elements within a pdCPR care bundle and proven by scientific evidence or expert consensus to be the most likely to contribute to successful resuscitation.

In **Delphi process 1 - Round 1** an open-ended questionnaire was sent to 20 individuals who had been nominated as being highly trained and competent within the specialised area of knowledge pertaining to paramedic CPR training, ambulance service organisational learning, pre-hospital emergency medicine, cardiovascular care and resuscitation. Table 3.4 provides an overview of Delphi subjects which will, henceforth, be referred to as Sample 1. In keeping with the anonymity the Delphi process offers to subjects, any information that could be used to identify subjects is omitted.

Table 3.4 Composition of Delphi subjects

	(n=20) Sample 1
Cardiologist	1
Emergency department physicians	3
Intensive care physician	1
Patient health and safety advisors	1
Adult education [develops/instructs/moderates]	1
Ambulance paramedic educator preceptor	2
Consultant advanced life support paramedics	2
Critical care paramedics – instructors	7
AHA accredited BLS, ACLS instructor	1
Ambulance paramedic educator	1

The questionnaire included two instructions to the respondents:

(1) Complete the following sentence:

Paramedic-delivered CPR competence may be defined as the ability....

(2) List all the treatment elements i.e. activities (e.g. assessing breathing), actions (e.g. administering epinephrine) or procedures (e.g. establishing intravenous access) which have been proven by scientific evidence or expert consensus to be the most likely to contribute to successful resuscitation in an OHCA.

The Delphi subjects were informed that the aim of the examples provided in instruction number (2) was to provide clarity and if they felt that assessing breathing, administering epinephrine, or establishing intravenous access did not contribute to successful resuscitation in an OHCA, they should not include such examples in their answers.

In **Delphi process 1 – Round 2** a structured questionnaire based on the responses from the open-ended questions in round one was sent to the 20 Delphi subjects. This questionnaire included a preliminary operational definition of competent pdCPR and also a list of treatment elements.

The instructions to the subjects included the following:

- (3) To review the operational definition of competent pdCPR and that had been established by the study investigators after they had summarised the collective opinions of the subjects solicited in round one and,
- (4) to indicate their reason(s) for not agreeing with either certain parts of or the entire proposed operational definition.
- (5) The participants were then asked to rate, using a Likert scale of 1 to 4 (*1 = minor importance, 2 = somewhat important, 3 = very important and 4 = critical importance*) the importance of including each individual treatment element in a CPR treatment bundle that would be the most likely to contribute to successful resuscitation in an OHCA.
- (6) The participants were further requested to offer suggestions regarding the treatment elements, for example, additions, deletions, and/or modifications of diction.

In **Delphi process 1 – Round 3** a third questionnaire was sent to Sample 1. The questionnaire included the revised operational definition of competent pdCPR and based on the comments received from Delphi process 1 – Round 2 and the calculated mean rankings of each treatment element.

- (7) In this round the subjects were informed that the treatment elements with a mean ranking of ≥ 3 would remain on the list while those with a mean ranking < 3 would be removed.
- (8) The participants were requested to indicate their reasons for wishing to include treatment elements with a mean ranking of < 3 or to remove treatment elements from the list with a mean ranking ≥ 3 .

In **Delphi process 1 – Round 4** the items reaching consensus were distributed to the Delphi subjects. This provided the subjects with a final opportunity to revise their judgements. In keeping with suggested recommendations [357,359], the entire Delphi

process took two months to complete with the subjects being given a maximum of 14 days in which to respond in each round.

In view of the multiple feedback processes that took place in Delphi process 1, there was a possibility that the subjects would have preferred not to participate in **Delphi process 2** or, worse, that they would consent to participate but would withdraw as the process progressed. Hasson et al. [353] and Hsu [351] reveal that low response rates in the Delphi processes may result in the quality of the provided information being challenged, discounted or, at least, critically scrutinised. Accordingly, the motivation of subjects is key to the successful implementation of a Delphi study in ensuring a high response rate [357]. In anticipation of a possible low response rate during Delphi process 2, the study investigators re-established contact via telephone calls to the 20 subjects before the emails were sent out. The telephone calls were brief but involved a reintroduction, thanks for having participated in the first Delphi process and feedback on the progress of the study. These private calls were regarded as more personal than emails would have been and also provided an opportunity to express appreciation to the subjects. Once the subjects had indicated their recommitment to the study, in similar fashion to Delphi process 1, a further open ended questionnaire was sent to the 20 subjects.

This questionnaire was simple and contained just seven questions which related specifically to the development of a Rapid Evaluation Tool (RET). The aim of the RET was to evaluate pdCPR performance as referred to in the newly agreed upon operational definition and as represented by the consensus agreed upon list of treatment elements. The open ended questions included the following:

- (1) Who will the RET assess?
- (2) What will the RET assess, and why?
- (3) Who would be able to use the RET?
- (4) When could the RET be used?
- (5) How should the RET be interpreted?
- (6) What else should the RET offer and facilitate?
- (7) How could the reliability and validity of the RET be demonstrated?

In **Delphi process 1 – Round 2** and based on the collective responses to the open-ended questions in **Delphi process 2 – Round 1**, the consensus relating to the five questions (Table 3.5) as well the list of process measures (Table 3.6) which Delphi subjects had collectively indicated should be included into the RET were presented to the subjects. The process measures reflected a summary list of responses specific to question 2, namely, what will the RET assess, and why? Table 3.4 presents the consensus relating to the five questions sent to the subjects in round 2, Table 3.5 presents the consensus regarding the list of process measures relating specifically to question 2.

Table 3.5 Items consensus sent to subjects in Delphi process 2 – Round 2

Round 1 Open ended questions	Round 2 Answers reflecting the collective responses
Who will it assess?	It needs to assess the performance of an individual paramedic.
What will it assess, and why? (Answers in Table 3.5)	It needs to encompass both the technical and non-technical skills that directly influence the care bundle which has proven by scientific evidence or expert consensus as being the most likely to contribute to survival to hospital discharge.
Who would be able to use it?	It needs to be accessible to CPR facilitators, examiners and tutors. It must also be concise, explicit, easy to administer, and require very little or no instruction.
When could it be used?	It needs to be able to capture CPR skills, in real time, through observation and in a simulated clinical environment.
How should it be interpreted?	It should facilitate the easy identification of strengths and weaknesses, and determine a pass or fail.
What else should it offer and facilitate?	It should have the ability to facilitate appropriate constructive criticism, thus promoting learning.
How could its reliability and validity be demonstrated?	Face and content validity should be ensured and tested. It should also demonstrate high stability across the same repeated observations as well as across different observations across different raters.

Table 3.6 List of process measures sent to subjects in Delphi process 2 – Round 2

	Round 2 Consensus on the list of process measures to be included in the RET
What will it assess?	<ol style="list-style-type: none"> 1. Response priority to scene 2. Primary response equipment taken to scene 3. Time taken to arrive at patient side 4. Loud shaking and shouting 5. Assess breathing 6. Assess pulse 7. Call for help 8. Obtain history leading up to collapse 9. Start of compressions 10. Correct position

	11.	Correct depth
	12.	Correct ratio
	13.	Correct rate
	14.	Pause for rhythm analysis
	15.	Correct rhythm analysis
	16.	Correct response to analysed rhythm
	17.	Start compressions
	18.	Determine adequacy of compressions with feedback
	19.	Check pulse during compressions
	20.	Check EtCo2 during compressions
	21.	Check wave amplitudes on ECG during compressions
	22.	Visual inspection of airway
	23.	Suction and clear airway
	24.	Open airway
	25.	Insert oropharyngeal airway
	26.	Ventilate twice with BVM
	27.	Establish intravenous access
	28.	Provide fluid bolus
	29.	Provide epinephrine at 3-5 minute intervals
	30.	Provide amiodarone for shock refractory rhythms
	31.	Treat all reversible causes
	32.	Move patient on to scoop stretcher for transportation
	33.	Leadership skills
	34.	Situational awareness
	35.	Communication skills
	36.	Appropriateness of overall sequence of events
	37.	Any overall interruptions are < 10 seconds
	38.	Position of compressions correct throughout CPR attempts
	39.	Defibrillation safe
	40.	Defibrillation at correct dose
	41.	Defibrillation at correct time
	42.	Post cardiac arrest care management correct
	43.	Transportation to appropriate facility

Similar to **Delphi process 1 - Round 2**, the subjects were first asked to review the consensus relating to the five open-ended questions and to state their reasons if they did not agree either with certain parts of or the entire answers to each of the five questions. The participants were then asked to rate, using a Likert scale of 1 to 4 (*1 = minor importance, 2 = somewhat important, 3 = very important and 4 = critical importance*) how important it was to include each of the 43 process measures in the pdCPR RET. The subjects were also asked to consider the consensus relating to the five questions when rating the importance of each process measure. In addition, the subjects were also requested to offer suggestions regarding the process measures, for example, additions, deletions and/or modifications of diction.

In **Delphi process 1 - Rounds 3 and 4**, the process measures with their calculated mean rankings were sent to the Delphi subjects. The subjects were informed that treatments elements with a mean ranking of ≥ 3 would remain on the list while with those with a mean ranking of < 3 would be removed. The participants were asked to indicate their reasons for including treatment elements with a mean ranking of < 3 or removing treatment elements with a mean ranking ≥ 3 from the list. In the fourth and final round the list of process measures that were to be included in the RET were sent to the subjects in order to provide them with a final opportunity to revise their judgements.

3.5.8. Pilot test of the RET (n = 12)

Twelve individuals who were representative of pdCPR instructors, pdCPR students, and pdCPR administrators were purposively chosen to pilot test the RET. In line with the recommendations of Cuhls et al. [363], these three groups were deemed to be the most suited to represent collective opinion on the topic in question. Each of the twelve individuals was given a copy of the RET together with instructions on how to administer the RET. They were also given the details of an OHCA scenario and a script in order to stimulate or cue responses to ascertain their proficiency in non-technical skills. The aim of the pilot test was threefold:

- (1) To determine whether the RET had the capacity to effectively and promptly identify if all the process measures indicative of competent pdCPR had been achieved or if they had not been achieved;
- (2) To promptly recognise weaknesses that had contributed to the processes measures not being achieved; and
- (3) To determine whether the RET had the capacity to provide specific information which would facilitate constructive and prompt feedback with the aim of promoting remediation and learning.

3.5.9. The RET pilot test findings

The first pilot test proved beneficial in that the administrators of the tool agreed on three fundamental inadequacies of the RET. These included the following:

- (1) The RET spanned numerous pages, presenting the practical challenge of tracking the simulation in real time whilst paging back and forth;
- (2) Timekeeping proved to be extremely difficult as the administrators had to watch the OHCA simulation and document the findings simultaneously;
- (3) The headings which had been used to group and represent non-technical skills, i.e. communication and leadership, appeared to be ambiguous and required continual clarification and explanation.

As a result of these findings, the tool was reconstructed to fit onto one page (portrait orientation), continuous time-keeping was amended to monitoring whether the key process measures were achieved within the specified time frames, and the non-technical skill headings were made clearer by the inclusion of short, concise phrases, thus minimising confusion. After these changes had been made, the tool had to be re-piloted.

The second round of pilot testing showed better and more consistent results as compared to the first pilot test. Although the second group of administrators (n = 8) were similar to the first group (n=12) in terms of representation, the second group consisted of eight different individuals. The revised RET was also sent back to the first pilot group to determine whether their opinions had changed and whether their opinions were consistent with those of the second group (n=8) after the changes had been effected. The overall feedback was positive and consistent for both groups. Thus, the RET – a Shockable Rhythm version and a Non-Shockable version – was then ready for the next phase, which included establishing its reliability.

3.5.10. Establishing the reliability of the RET

The reliability of a tool refers to the consistency with which a tool measures a particular attribute [365] In other words, in the context of the RET, it refers to the ability of the RET to yield consistent results each time it is administered. Since the RET(s) had been developed specifically for the purposes of this study its reliability was not known and, therefore, it had to be tested. In order to do this, five scripted OHCA simulations were recorded on video. They were all identical in terms of scenario but varied with respect to the actors, patients and bystanders in each video.

A group of 15 assessors consisting of pdCPR instructors, pdCPR students and pdCPR training administrators (not those from the pilot test groups of (n = 12) and (n = 8) were purposively chosen to assess the inter-rater agreement of the RET and then its intra-rater reliability.

In order to test the RETs *inter-rater agreement* each assessor was given five different recorded simulations and five RETs. Each RET was supplied with an assessment rubric (**Appendix C and D**). The assessors were instructed to watch the recorded simulation (without stopping and/or replaying any part thereof) and then to assess the CPR performance of the paramedic in each recording using the RET. They were asked not to discuss either the recordings or their assessments with anyone and to return the completed RETs to the researcher immediately after each assessment had been completed.

In order to test the RETs **intra-rater reliability**, each of the 15 assessors was sent one of the returned, randomly chosen, recorded simulations that they had already assessed using the RET and asked to repeat the evaluation. This was done one month after the initial evaluation. As before, they were asked not to discuss either the recordings or their repeat assessments with anyone and to return the completed RET to the researcher immediately after each repeated assessment had been completed.

3.5.11. Data analysis of the reliability of the RET

The kappa statistical measure was used to measure the concordance or level of agreement between the assessors. The kappa statistic may be applied to data that is not normally distributed [366]. It is best suited to a closed-ended, ordinal scale data such as the 5-point Likert Scale but it may also be used for binary data [365]. As the RET had been designed to collect binary data (i.e. "1" if a process measure had been done and indicated by a tick and "0" if it had either not been done or it had been incorrectly done and indicated by a cross), the use of the kappa statistical measure, specifically Cohen's kappa, was deemed to be acceptable [344,366]. There are two ways of calculating Cohen's kappa. Both produce different results using the same data set. The first way involves using Cohen's original 1960 algorithm, now generally known as the unweighted kappa while the second involves the weighted method,

described by Cohen in 1968, and which includes the influence of the number of categories of scores [366]. Cohen claimed that the weighted kappa should be used specifically if the variables had more categories than binary (more than just a yes (1) or no (0)) because the distance from agreement should be taken into consideration). In view of the fact that the RET collected binary data only, Cohen's original unweighted algorithm to measure concordance was used to measure the intra-rater reliability.

In order to check the level of agreement between the 15 assessors and their assessment of each RET and its process measures in the five videos, the Fleiss' kappa statistical measure was used [365]. While a simple percentage of overall agreement or Cohen's kappa are two of the more commonly used tests in these situations, both tests proved to be inadequate with regards to testing the inter-rater agreement across multiple raters.

By design, the percentage of overall agreement test does not take into account the fact that assessors are expected to agree that a rater may have achieved a process measure solely by chance [366]. On the other hand, Fleiss' kappa not only calculates agreement across multiple raters but it also calculates the degree of agreement in classification over that which may be expected by chance by assuming specifically that, although there are a fixed number of raters, different items are rated by different individuals.

The values of Cohen's and Fleiss' kappa statistical measures may range from -1.0 to 1.0, with -1.0 indicating perfect disagreement below chance, 0.0 indicating agreement equal to chance, and 1.0 indicating perfect agreement above chance. In the main a kappa score of .70 and above indicates adequate agreement [214,365].

3.5.12. Collection of Phase 1 data

The study participants (n = 100) as depicted in Table 3.2 and henceforth referred to as **Sample 2** were requested to attend the HMCAS CPR training intervention which is traditionally used to train all new paramedic recruits in CPR as well as existing paramedics who require CPR refresher training every two years. Table 3.7 presents

an overview of the traditional CPR training intervention. One fundamental change which was made to the traditional intervention as a result of this study was the inclusion of the revised CPR treatment protocol which reflected the new operational definition of competent pdCPR (**Appendix B**).

Table 3.7 Overview of the traditional pdCPR training intervention

Traditional pdCPR training programme	
Admission to training programme	<ul style="list-style-type: none"> New recruits to HMCAS Last CPR training > 2 years while employed at HMCAS (Refresher)
Duration of programme	1 full day programme (6-8 hours)
Required instructor to candidate ratio	<ul style="list-style-type: none"> No prescribed instructor to candidate ratio (Minimum of 6 for programme quorum)
Candidate's pre-course work or reading	None
Programme overview	<ul style="list-style-type: none"> Course registration Presentation of theory component Skills practice component Practice sessions with various full length, simulated OHCA scenarios Competency assessment includes a full length OHCA simulation
Theory component	<ul style="list-style-type: none"> Key changes in CPR from 2005-2010. Evidence supporting changes. Related pharmacology (OHCA and IHCA) Non-technical skills
Skills component	<ul style="list-style-type: none"> Supraglottic airway device insertion IV line insertion LUCAS application
Practice component	<ul style="list-style-type: none"> Candidates placed in groups of 4. Candidates undertake full length, simulated OHCA scenarios Each candidate to perform as team leader in at least 1 OHCA scenario Post-practice feedback and support provided by instructor
Programme competency assessments	<ul style="list-style-type: none"> Final assessment Simulated OHCA assessment using a programme-specific assessment. 100% of total mark.

The other change introduced was the introduction of the pdCPR RETs which were made available to all the sample 2 participants as part of the course material (**Appendix C and Appendix D**). While the revised protocol prescribed the new standard which reflected a competent CPR performance, the RETs prenotified the

participants of the treatment elements that would be evaluated to determine whether that standard was achieved. No other changes were made to the programme. The traditional training intervention's educational philosophy, design and format, teaching methods, skill sets, clinical procedures, resuscitation training equipment, manikins, and instructors for the intervention remained the same as before. It was essential that the content was delivered in exactly the same way it had been done traditionally in order to ensure that Objective One had been reliably achieved.

3.5.13. Collection of Phase 1 data - the study procedure

The participants were informed about the study and their consent to participate was requested on the day that they attended their CPR training at the beginning of their competency assessment (**Appendix E**). Each individual participant was instructed to enter a skills assessment room with their primary response equipment only at hand. This included a primary response bag, an oxygen cylinder and regulator, a Lifepak® 15 monitor/defibrillator, and a LUCAS® mechanical chest compression device (Figure 3.1). The participants were also informed that, when they entered the assessment room, they would see their CPR training intervention instructors, both of whom were there to administer the simulated assessment. The participants were also told that the instructors would answer any questions about the patient's condition that could not be obtained from the particular type of manikin, for example, "Yes or No" to the question "Is the patient breathing?"

On entering the room the participants encountered a simple resuscitation manikin connected to an ECG rhythm generator. They were asked to imagine that the resuscitation manikin was a 50-year-old male patient who was lying supine on the floor. They were informed that there were no signs of trauma, no bystanders and that no other history was either available or obtainable. Each participant was accompanied by a BLS partner. The partners were to act on instruction only and were not allowed to perform any skills outside of their clinical scope of practice. The participants were instructed to perform all skills and activities as if the manikin were a real patient. This included the insertion of airways to the delivery of shocks, establishment of intravenous lines, and loading the patient for active transportation onto the long back board and stretcher provided. The simulation briefing was

essential as it provided the participants with clarity with regards to what they should either simulate or actually do [15].



Figure 3.1 Primary response equipment and manikin used in Phase One

3.5.14. Collection of Phase 1 data - the study investigator

The investigator who collected phase 1 data also worked at HMCAS as an instructor but had not participated in CPR training at any time in the past nor had he been involved in the development of the tailored CPR training intervention. The investigator had attended a training session in which he had received detailed instructions on how to evaluate CPR performance using the RET and he was, therefore, qualified to be an assessor [365]. The investigator was provided with further help in the application of the RET by being given a RET assessment rubric which he had on hand during every evaluation (**Appendix C and D**). The RET required the investigator to merely annotate the dichotomous ratings by inserting either a tick if a process measure had been achieved or a cross if it had not been achieved. The investigator was in an adjoining room and viewed the simulation via

the Scotia Medical Observation and Training System (smots) ® and which offers a high quality, 360° live video from multiple cameras mounted in the room in which the simulation was taking place (Figure 3.2). It had been decided to use the same investigator to score the RET for all 100 of the participants as a way of attenuating possible measurement bias despite the fact that it would have been acceptable to use different raters, as identified by the RET's acceptable intra-rater agreement and inter-rater reliability scores.

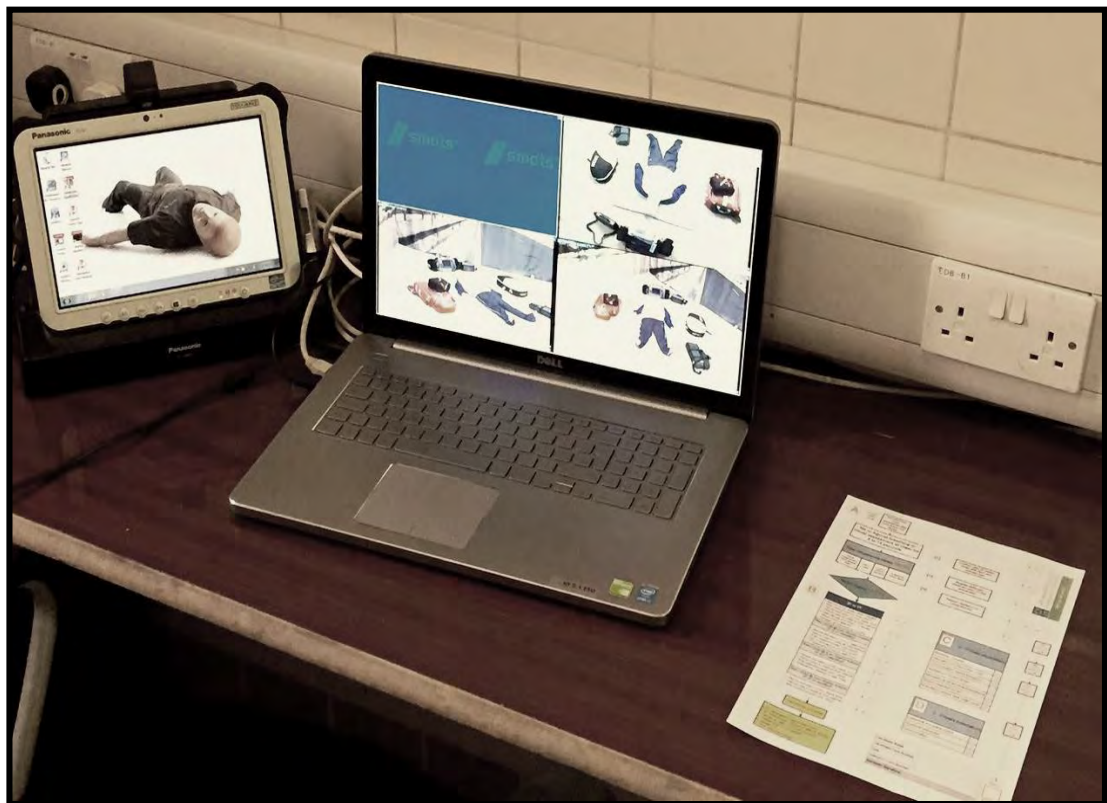


Figure 3.2 Location of investigator and the SMOTS® setup used in Phase One

3.5.15. Collection and statistical analysis of the Phase 1 data

Using the RET, which had been developed specifically for this study, categorical data (i.e. dichotomous variables – tick for “achieved” and cross for “did not achieve” and/or “blank”) were gathered as proportions. Chi-squared (χ^2) tests were then conducted to determine whether the variations between the observed and expected or predicted proportions of the process measures “achieved” were significant. In the absence of similar studies from which expected proportions may have been derived, the expected values were predicted to be 50/50 (i.e. 50% achieved and 50% not

achieved). This is consistent with previously published and similar context studies [367,368].

3.5.16. Alternative data sources which reflected pdCPR performance

In addition to the pdCPR performance in the simulated OHCA scenario, data from patient care reports, clinical reviews, death in care investigations and root cause analyses which reflected actual pdCPR performance in OHCA (Table 3.8) were extracted using qualitative research techniques. The qualitative data analysis process (discussed in greater detail later in this chapter) comprised established formal processes to reduce, present and verify the data [369,370].

Table 3.8 Sources of data which reflected actual pdCPR performance

Data sources	<i>n</i>
Patient care report (PCR) forms from actual cardiac arrests where pdCPR was provided	120
Randomly selected snap shot clinical reviews of pdCPR performance	15
Death in care (DIC) investigations undertaken by the HMCAS organisational risk section	13
Root cause analysis following patient harm/process failures or deviation from CPG	7

As discussed in the introduction to this chapter and depicted in Figure 3.3, the data collection process took place in four phases. Each phase was aligned and attempted to address one of the four interconnected research objectives.

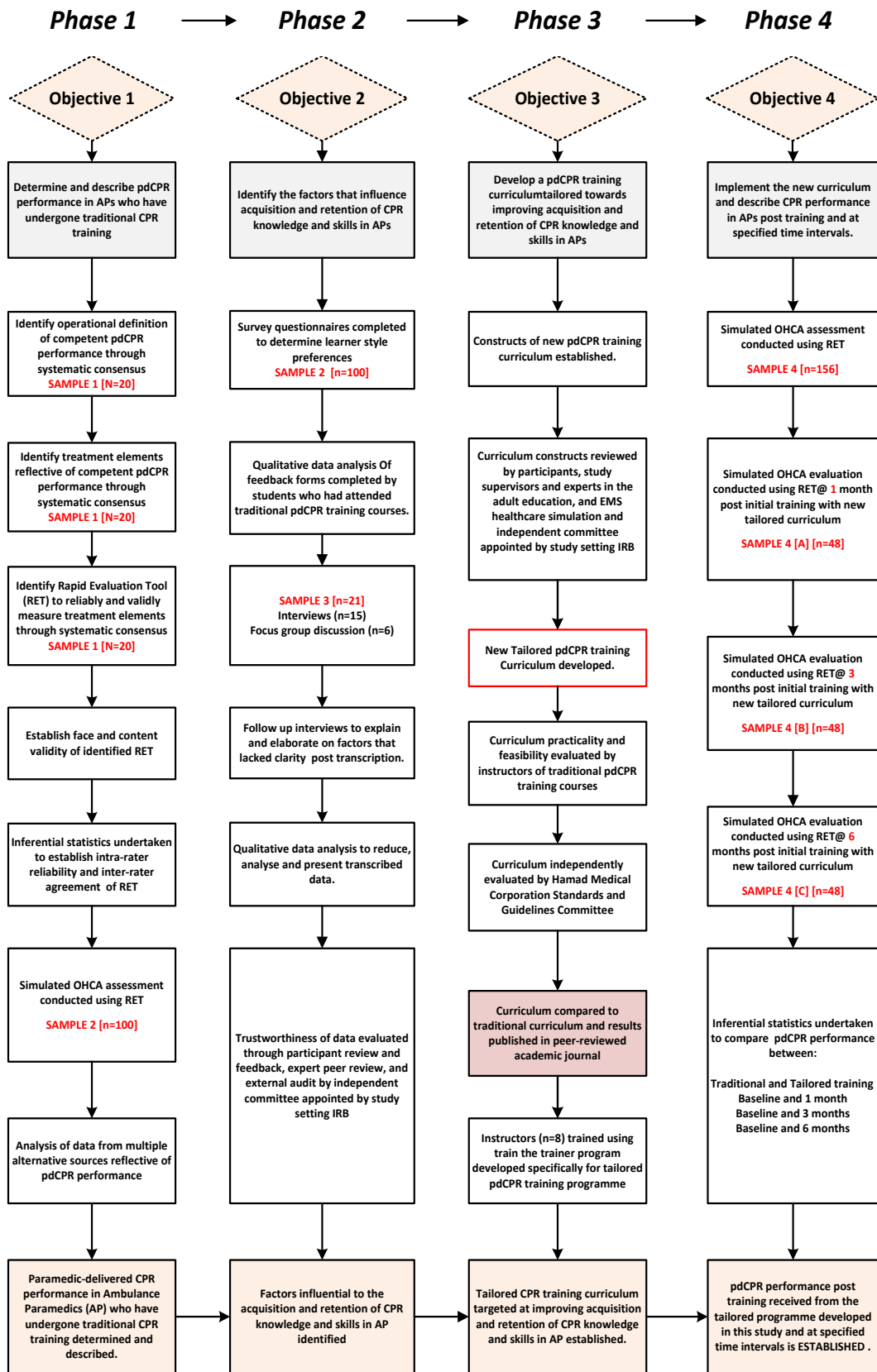


Figure 3.3 Overview of the four phases of the study

3.6. PHASE 2 - OBJECTIVE 2

Identify the factors that influence the acquisition and retention of CPR knowledge and skills of APs.

3.6.1. The two parts of Phase 2

Phase 2 (Part A) included:

- a survey using the questionnaires sent out to Sample 2 (n = 100)

Phase 2 (Part B) included:

- a documentary analysis of the data sources which reflected pdCPR training, and
- interviews (n = 15) and focus group discussions (n = 6) with a purposively chosen sample.

3.6.2. Phase 2 Part A - Survey using questionnaires

Immediately after the Sample 2 participants (n = 100) had completed their simulated cardiac arrest assessments (discussed in section 3.5.14), they were requested to complete a survey questionnaire (**Appendix F**). The participants were first given a few minutes in which to gather their thoughts and rest in a vacant, adjoining classroom. Once settled in they were given a brief explanation of the purpose of the questionnaire. They were also reminded that they were not required to provide either their names or any identifiable information on the questionnaires. They were also requested to complete the questionnaire without input from other people. They were also informed that an Arabic version of the questionnaire was available at their request (**Appendix G**). The aim of the questionnaire was to collect information which would specifically address Objective 2 of the study, namely, *Identify the factors that influence the acquisition and retention of CPR knowledge and skills of APs.*

The questionnaire was also designed to capture data that reflected the APs' perceptions of the components of a CPR training intervention, and enquired about the importance of these components in influencing the acquisition and retention of pdCPR knowledge and skills. In view of the fact that the accuracy of the results depended on how honest the candidates were, it was decided to allow participants sufficient time to complete the questionnaires. The study investigators were of the

opinion that an unreasonably short time limit would probably create a sense of urgency and cause participants to rush through the questionnaires without thinking carefully about their answers. Accordingly, the participants were allowed to take the questionnaires away but not to show or discuss them with anyone and to return them to a drop box in the envelopes provided at the end of the day.

3.6.2.1. The survey questionnaire

The survey questionnaire comprised two sections:

- Section one was aimed at determining the learning style of the APs as represented in the sample under study. The Honey and Mumford Learning Styles questionnaire® was used to determine and measure the learning style preferences of the participants. This 40-item tool has been used numerous times in similar studies conducted globally and has proven reliability and validity [289,290]. Based on the responses to the questions posed in the survey questionnaire it was possible to categorise the respondents into four groups according to the learning styles which had been identified. These categories included the activist group, the reflector group, the theorist group and the pragmatist group.
- Section two of the questionnaire evaluated the respondents' perceptions of those components of a CPR training intervention that are generally taken into account during the development of a training intervention as well as those components that are not often considered but which, according to existing literature, are influential to the acquisition and retention of the requisite knowledge and skills.

3.6.2.2. Strategies to promote the survey questionnaire response rate

Based on the investigator's previous experiences with the cohort under study, two known realities were taken into account, namely, the fact that English was not the first language of a large proportion of the participants and also that, in the past, participants had typically refrained from giving detailed answers to open-ended questions because they had believed that there was a possibility that lengthy written answers would reveal their identities and, as a result, they would face reprisals if their responses were viewed as complaints or as disparaging to the organisation.

In order to address these problems the questions posed in the questionnaire were designed to extract the required information but they were also sufficiently general to avoid the likelihood of revealing the participants' identities. The wording of the

questions was premised on the principles of clarity, simplicity, sensitivity to the respondents' psychological state and, above all, avoiding bias [349]. In addition, the questionnaire was made available in both English and Arabic, thus giving participants the opportunity to answer in their preferred language.

3.6.2.3. Data analysis of the questionnaires

After each questionnaire had been checked for completion and legibility they were assigned a unique sorting number. This was necessary to keep track of the documents [370]. The questionnaires were designed in such a way that the data extracted would be both specific and also easily quantifiable into proportions [290]. In other words, it would be possible to evaluate the analysis of the proportion of responses that demonstrated a certain attribute or response of the total responses by using a frequency distribution. Section two of the questionnaire evaluated the participants' perceptions using a 5 point Likert scale.

3.6.3. Documentary analysis of the multiple data sources

In addition to the questionnaires, more explanatory and descriptive data was sought from sources that already existed. This was similar to the use of the alternative data sources which reflected pdCPR performance to determine and describe performance and as discussed in section 3.5.17.

3.6.3.1. Sources which referred to existing CPR training interventions

Feedback forms that paramedic learners had submitted after attending traditional CPR training interventions (n = 97) between 2009 and 2011 were reviewed. The aim of this review was to investigate the comments, critiques, explanations, concepts and propositions of several different cohorts of paramedic learners regarding traditional CPR training that currently existed. These feedback forms included both open-and closed-ended questions with the latter being Likert scale based. While the Likert scale based questions were easily quantified into proportions, it was necessary to conduct a qualitative data analysis of the responses to the open-ended questions (which consisted of hand-written, narrative data). This qualitative data analysis process is discussed in greater detail later in this chapter.

3.6.4. Interviews and focus group discussions – Sample 3

As discussed by Polit et al. [343] and Patton [373] there are no established rules for the sample size in qualitative research with the purpose of the inquiry and the information requirements of the study typically dictating the size of the required sample. In this study the information requirements included obtaining clarification, elaboration and corroboration regarding:

- The responses in the questionnaires completed by Sample 2 participants in **Phase 2 – Part A** and which had assessed the learning preferences and perceptions of those components that were likely to impact on the effectiveness of pdCPR
- The new knowledge that was likely to emerge only from an emic perspective (an emic perspective presents the view of the phenomenon under study from those people who live, embrace, experience or may be defined by the phenomenon itself [369]). This perspective was considered to be essential in the development of a locally relevant, CPR training intervention which was tailored to improving the acquisition and retention of CPR knowledge and skills of APs.

For the purpose of the interviews and focus group discussions, purposive, maximum variation sampling was used [349]. This qualitative sampling technique involved purposefully selecting participants based on the information needs that had emerged from **Phase 1** and **Phase 2 – Part B** of the study. The participants were chosen on the basis that they were individuals who were deemed to possess rich information about ambulance service training, CPR performance in paramedics, adult education, and training intervention development.

Twenty individuals were identified and they were asked to participate in the study. Sixteen agreed and provided the process consent requested (**Appendix E**). In process consent, the study investigators are allowed to continuously renegotiate their consent, thereby allowing the participants to play a collaborative role in the decision making process regarding their ongoing participation in a study [370]. This option was deemed to be appropriate as at the time of the initial request regarding participation in the study as the investigator was unaware of how the study was going to evolve, the exact nature of the data to be collected, and the time and commitment that would be required on the part of the participants.

3.6.5. Interviews sample size and sample realisation

Phase 2 - Part B was guided by the principle of data saturation. During the latter stages of the collective interviewing process, it was established that the selected participants were all satisfactory informants. They reflected on their own experiences and they possessed the ability to communicate effectively. From participant-interview nine onwards, it became evident that no new information was being obtained and that, in the main, information was being repeated. According to Thomas [374], redundancy in information is a clear indicator of data saturation. Polit and Beck agree with this view and state that, in qualitative research, when data saturation has occurred, there is no need to recruit further participants [370]. Nevertheless, in view of the fact 16 of the 20 had indicated that they willing to participate and had already provided their consent, it was decided to continue and to interview all 16 participants. However, during the last weeks of the interviews participant 16 could not be located and nor did she respond to numerous e-mails, telephone calls and Skype messages. Accordingly, it was decided to not include her and, because data saturation had already been reached, there was also no need to find a replacement. Thus, a total of fifteen participants were interviewed.

3.6.6. Focus groups

Focus groups are also a form of qualitative research. Focus groups are essentially group interviews although not in the sense of there being an alternation between the investigator's questions and the participant's responses [375,376] Instead, the emphasis is on interaction within the group with this interaction being based on topics supplied by the investigator who typically takes on the role of a moderator. The hallmark of focus groups is the explicit use of group interaction to produce data and insights that would probably be less accessible without such group interaction.

The aim of the focus group discussions used in this study was to draw out the attitudes, feelings, beliefs, experiences and reactions of purposively chosen individuals in a way that would not have been feasible using alternative methods. These attitudes, feelings and beliefs were more likely to be revealed in social gatherings and with the interaction which is a feature of a focus group. As compared

to individual interviews which aim to obtain information about individual attitudes and feelings, focus groups elicit a multiplicity of views and emotional processes within a group context.

In order to ensure that the focus group produced a set of rich data, with all the participants building on each other's ideas and views, it was decided to use a stratified focus group comprising purposively chosen individuals who were known not to be overbearing and/or not to possess authoritative views on specific concepts or topics. Table 3.9 presents the demographics of **Sample 3**.

Table 3.9 Demographics of participants - (Sample 3)

	Interviews (n = 15)	Focus groups (1 group of 6 members)
Male	87%	100%
Combined mean age	34.9	34.16
Experience in paramedics CPR training (years)	10.9	8.5
Experience in curriculum development (years)	5	3.66
Experience in training management (years)	5.53	9.83
Formal degree education in training	67%	83%
Mean time from last pdCPR training	10.9 weeks	5.5 weeks
Previous CPR evaluation experience [Simulated OHCA scenarios]	337	280
Previous CPR delivery experience [Real patients]	40.3	19.16

3.6.7. Data collection from the interviews and focus groups

All the participants who had been selected to participate in the interviews were contacted telephonically. In view of the geographic dispersal of participants, this was deemed to be the most efficient and economically suitable option. Two telephone calls were made to each participant. The aim of the first call was to establish contact and to invite the participant to take part in Phase 2 of the study, while the second call was the actual interview subsequent to the participant having given consent. **Appendix**

H comprises the semi-structured interview guide that was used to stimulate discussion during the interviews. According to de Vos, et al. [377], semi-structured interview guides are especially suitable where the researcher is particularly interested in complexity or process, or where the issue concerned is controversial and personal. Polit et al. support this view and state that, despite the fact that the investigator uses a set of predetermined questions to steer the participant in the direction that the interview is intended to take, there is, nevertheless, sufficient opportunity to introduce issues that may not have occurred to the researcher. As discussed in section 3.6.4, this was the intended outcome of Phase 2, namely, to explain and clarify the findings that had emerged from Phase 1, but also to search for and examine issues that had not yet emerged.

The interviews lasted an average of approximately 34 minutes each. A memo was kept open during the interviews to enable the investigator to note down statements of particular interest or facts or references mentioned by the interviewee (participant). At the end of the interview, the interviewees were asked to expand upon or clarify these statements. All the interviews were voice-recorded and transcribed immediately after the actual interview. This was necessary because, in the event that the respondent had to be contacted again in order to clarify or expand upon certain issues, minimum time would have elapsed. It was, however, not necessary to re-contact any of the respondents.

The focus group discussion lasted approximately three hours with two 15 minute breaks. After the participants had introduced themselves and the ground rules had been set the same semi-structured interview schedule that had been used for the individual interviews was used to cue and stimulate discussions (**Appendix I**). As had happened during the interviews, a memo was kept during the discussion and the voice-recording of the focus group was transcribed immediately after the event.

3.6.8. Positionality of the interviewees and focus group members

The term “positionality” in the research context describes an individual’s philosophy and the position which the individual chooses to adopt in relation to a specific research task [378]. In this study, in addition to the investigators acknowledging their

own positionality and making allowance for it during the research process, it was also important to establish the positionality of the individuals whose collective opinion was used, in part, to guide the development of a pdCPR training intervention in the study. It is often difficult to articulate one's positionality and, thus, all the interviewees and focus group participants were asked to either *agree*, *disagree* or state *no comment* to a list of 15 questions which had been adapted from Wiles et al. [274] and that would reveal their positionality regarding CPR education and training.

3.6.9. Qualitative data analysis

The qualitative data analysis was used to present, analyse and verify the transcribed narrative text data which had been obtained during

- the documentary analysis of the multiple data sources that had been identified as reflecting current pdCPR performance
- the documentary analysis of the multiple data sources that had been identified as reflecting the CPR training interventions (traditionally used to train paramedics) and the data generated from the interviews and focus group discussions.

3.6.9.1. Organising and indexing the data

The first stage of the qualitative data analysis process involves the preparation of the data. For the purposes of this study this involved the transcription of data as discussed in section 3.6.7. The next stage in the process began with rereading the transcribed narrative data in its entirety and then closely examining the data for single items, lines of text, or events that reflected a particular underlying idea, behaviour, action or process (*data elements*) [379]. Once these data elements had been identified they were highlighted and indexed. The indexing system consisted of a prefix detailing the data source and followed by a natural number (i.e. 1, 2, 3 etc.).

In order to guide this step, a study data organisational framework was developed [380]. The data organisational framework selected determined whether the aim of the investigators managing the data was to look for data elements which reflected certain pre-determined data elements (i.e. explanatory) or whether the data elements embedded in the data sources were allowed to emerge by themselves (i.e. exploratory) [378-381]. The exploratory framework was chosen for the purposes of

this study and, thus, the investigators did not search for data elements which reflected certain specific, pre-determined actions, patterns of behaviour, or processes but, instead, they highlighted and indexed all the data elements that emerged from the data.

3.6.9.2. Sorting data with shared commonalities into categories

This step involved grouping and comparing similar or related data elements, thus formally representing analytical thinking [381]. During the documentary analysis of the data which reflected pdCPR performance (**Phase 1**) and pdCPR training (**Phase 2 - Part A**), the data elements with shared commonalities were aggregated together to form categories. The category titles were chosen on the basis that they were sufficiently descriptive of the shared commonalities despite the variant manifestations in appearance (i.e. diction) of the data elements across the various data sources.

This process of sorting data began with matching sections of the transcripts into the corresponding questions which had been asked in the semi-structured interview guide although it is important to note that the analysis was not limited by the question. For example, all the data segments pertaining to Question 3 of the semi-structured interview guide (**Appendix I**), namely, "*What could be done to improve overall CPR performance in APs?*" were identified and indexed for all the transcribed interviews and the focus group discussion. Creswell et al. [336] and Polit et al. [343] advocate this method as the preferred way of gaining access to parts of the data without having to reread the data in its entirety repeatedly. The segments identified were then copied into unique worksheets labelled with the name of the question involved. If a data segment was identified as bringing meaning or information to another question although the participant had discussed this when a different question had been asked, the data segment was moved to the question involved. Segments that did not fit into any of the established worksheets were identified as new or emergent data and assigned to worksheets with a label that best reflected the shared commonality that had emerged from the group of data segments. This was in line with the exploratory data organisational framework [380-382]. When all the data segments had been assigned to corresponding questions the *data elements* within those *data segments* with shared commonalities were grouped together to form categories.

3.6.9.3. Hierarchical analysis of data : overview of themes

The next step in the qualitative data analysis involved relating the different categories to the overarching sub-themes and the overall core themes with the aim of according a deeper meaning to the data. Once this had been completed, the final step involved drawing conclusions and verifying the data.

3.6.10. Trustworthiness of the data

The trustworthiness of qualitative research is often questioned, perhaps because it is not as easy to address the concepts of reliability and validity as it is in the case of quantitative research. However, according to Lincoln and Guba [383], qualitative investigators in pursuit of a trustworthy study should consider the following criteria for establishing the trustworthiness of qualitative data.

3.6.10.1. Credibility

Ensuring the credibility of both the data and the data analytical process is one of the most important factors in establishing trustworthiness [383]. The aim of credibility is to demonstrate that the enquiry has been conducted in such a manner as to ensure that the subject in question was accurately identified and described [343]. According to Lincoln and Guba, the strength of the qualitative study, which is its credibility, is primarily dependent on prolonged engagement which provides scope, persistent observation and depth [383]. This study made specific provisions to ensure that the data was accurately identified and described. These included:

- The use of appropriate, recognised stakeholders and independently vetted research methods.
- In view of the fact that the primary investigator (PI) had worked with the study participants and at HMCAS, there was a sense of familiarity, trust and rapport between the PI, the research aides and a large proportion of the participants who represented the population under study.
- Triangulation was ensured through the use of various methods and different types of data sources as well as the use of different, information rich participants from all over the world.

- The PI continually emphasised his role and independent status, reassuring the participants that anything that was reported during the study would not be linked to the participants in any way and that they were free to withdraw from the study at any time.
- The PI held regular feedback and debriefing meetings with the study supervisors who were experts in the fields of research and emergency medical care.
- Permission to undertake the study at HMCAS, Qatar's national ambulance service, was granted on the condition that the PI held regular feedback and update sessions with the appointed standard and guidelines audit committee. The purpose of these committee meetings was to review, examine and ensure that the data collection and the ethical considerations taken into account during the study were in compliance with the study proposal which had been submitted to the IRB at HMCAS.

3.6.10.2. Transferability

Transferability refers to the extent in which the findings arising from the data collected may be transferred to other settings or groups. Transferability is, thus, similar to the concept of generalisability in quantitative research. Chapters One, Two and the first half of Chapter Three all provide sufficient background data and information to establish the context of the study and the population under study to allow comparisons to be made.

3.6.10.3. Dependability

Dependability refers to data stability over time and in different conditions [383]. According to Polit et al. [343], enquiry audits may be conducted to establish the dependability of a study. Enquiry audits usually involve the systematic collection of documentation that allows an independent auditor to come to conclusions about the data. All the raw data, interpretations and conclusions in this study were independently reviewed and monitored by HMCAS's Standard and Guidelines Audit Committee appointed by the Hamad Medical Corporation as well as by the Centre for Evidence-Based Health Care [344], an independent biostatistics unit.

3.6.10.4. Confirmability

Confirmability refers to the objectivity or neutrality of the data, for example, that two or more independent people would agree about the relevance or meaning of the data [343]. The study used established, globally vetted questionnaires to address the issue of potential investigator bias [283]. In addition, the use of constant participant involvement to confirm and contest the consensus established during both Delphi processes as well as to examine the notes transcribed of the interviews and focus groups helped to ensure as far as possible that the study's findings were the result of the participants' experiences and ideas and not the characteristics and ideas of the investigator. Furthermore, the use of multiple data sources to triangulate the findings as well as allowing the data to be viewed by an independent external organisation (i.e. HMCAS), while maintaining participant confidentiality, promoted the confirmability of the study.

3.7. PHASE 3 - OBJECTIVE 3

Develop a tailored pdCPR training intervention designed to improve the acquisition and retention of CPR knowledge and skills of APs.

As illustrated in Figure 3.3, the data extracted from **Phase 1 and Phase 2 (Part A and B)** were used to inform the development of a tailored CPR training intervention designed to improve the acquisition and retention of CPR knowledge and skills. Once the extracted data had been apportioned into meaningful constructs which could be used to develop the tailored training intervention, a globally accepted, six step process was used to create the tailored training intervention [384-386]. Under the close supervision of the study supervisors, a curriculum designer who specialised in adult education and evidence-based academic research, and training and credentialing officer who specialised in programme evaluation and accreditation for continued professional development (CPD), a new, tailored pdCPR training intervention was created. Presented in detail in Chapter Four, the process involved in developing the training intervention included the following six steps:

- Step 1 - Identifying the purpose of the pdCPR training intervention
- Step 2 - Identifying the aim of the pdCPR training intervention
- Step 3 - Identifying the objectives of the pdCPR training intervention
- Step 4 - Identifying the needs of the learners

- Step 5 - Training intervention alignment
- Step 6 - Training intervention activities and instruction

3.7.1. Pilot test (n = 12) and chosen instructors

As soon as the training intervention had been completed it was sent to HMCAS's Standard and Guidelines Committee for independent review. The committee gave permission for the study investigators to pilot test the intervention while it underwent review. Twelve randomly chosen, newly recruited paramedics with comparable backgrounds and experience levels were enrolled to participate in the pilot study. The programme instructors for the pilot study included the researcher and a research assistant. Although this was not ideal, they were the only individuals who were familiar with the training intervention at the level required to instruct or to facilitate it at the time.

3.7.1.1. Results of the pilot test

The successful completion of the pilot CPR training programme depended on the participants reading and studying an essential pre-training intervention document. It emerged from the pilot test that three of the twelve pilot candidates only had read the documents. It appeared that the candidates had not realised the importance of the pre-training intervention document and, as a result, they did not read it. This, in turn, resulted in the theory and discussion components taking longer than had been planned as the time allocated had to be extended. This then affected the duration and outcomes of the training intervention.

3.7.1.2. Changes to the pdCPR training intervention

In order to ensure that candidates read the document it was decided to make the document available to them at least seven days prior to their admission to the course. Those candidates who either confessed to not reading the document or who had received it less than seven days prior to admission were asked to reschedule and attend the training on another day. In addition, the candidates were also given a pre-training assignment and they also had to complete a pre-training test which covered aspects of the pre-training reading. These changes were, by design, structured to compel participants to read through the pre-training document. Both the pre-training assignment and the pre-training test contributed to their overall course mark.

3.7.2. Additional testing

It took the HMCAS Standard and Guidelines Committee three sittings over a period of more than three months to make a decision as to whether the new CPR training intervention was suitable in regards to its proposed claims of optimising the effectiveness of pdCPR training. With no consensus having been reached at the end of the three months, it was decided to undertake further testing to determine whether the benefit of the training intervention were sufficient to outweigh the possible risk involved in exposing APs (n = 149) to a novel and, in many ways, experimental CPR training intervention. The committee feared that, because the sample was large and represented almost half the population of APs at HMCAS, the risk, consequences and impact on operations would be considerable and might even compromise CPR quality if this largely untested new CPR training intervention did not work as proposed. The committee requested a smaller project in which the training intervention created for the purposes of the study and the effect of this intervention on pdCPR performance were compared to the pdCPR performance of a group of paramedics with comparable background and education who had attended the training intervention traditionally used by HMCAS.

In this smaller project the CPR performances of 63 newly recruited paramedics were evaluated following their attendance and participation in the conventional CPR training intervention. This evaluation was done using a Laerdal ResusciAnne and the 26-item pdCPR Rapid Evaluation Tool (RET) developed in this study. A rating of

"competent" was calculated across the following four categories of process measures: (1) basic life support skills; (2) condition specific skills; (3) specific overall skills; and (4) non-technical skills. The test protocol was then repeated on a second group of newly recruited paramedics (n = 86) who had been trained in the CPR training provided by the new, tailored training intervention developed for the purposes of the study. The results showed that those paramedics who had been trained using the tailored intervention were rated competent 70.9% of the time according to the RET as compared to the paramedics who had undergone the conventional training and who had achieved a competency rating 7.9% of the time ($P < .001$). This overall finding led to the conclusion that the CPR performance which was rated as competent in a simulated, out-of-hospital cardiac arrest (OHCA) scenario was significantly higher when the tailored training intervention developed in this study was used. Specific improvements were seen in simulated cardiac arrest detection time; chest compression rate, position, ratio and depth; and time to first monitored rhythm and delivered shock (published article - *see page IV*).

During the time in which this smaller project was undertaken, an instructor course for the tailored pdCPR training intervention was also developed. The instructor course included in-depth and step-by-step guidance on how the tailored pdCPR intervention should be conducted from the stage of initial preparation, to ensuring that the learning objectives and milestones were achieved in the apportioned timeframes, to facilitating skills feedback, mental practice and modelling cycles, to undertaking simulated assessments in a standardised fashion (**Appendix J**).

3.8. PHASE 4 - OBJECTIVE 4

Implement the tailored pdCPR training intervention and then determine and describe the pdCPR performance of APs immediately after training and at specified time intervals after such training.

Following the results of the project as discussed in section 3.8, the HMCAS Standards and Guidelines Committee approved the new CPR training intervention developed in the study and allowed the researcher to train newly recruited APs or existing APs with a more than two-year interval from their previous CPR training. A total of 156

APs were trained over the course of 10 weeks. The participants (henceforth referred to as **Sample 4**) were trained by eight instructors who had attended and successfully completed the new pdCPR training intervention instructor course. The test protocol for Objective 4 comprised the following:

- (1) All 156 of the newly recruited participants were assigned a unique number. Through the process of simple random sampling using the lottery method the participants were assigned to groups of 12 and allocated a day on which they would be required to attend the Tailored CPR Training Intervention (**TailoredCPRInt**). No one except the researcher, the study supervisors and the two assistants had access to this information.
- (2) All the participants received their pre-training document seven days before the day on which they were scheduled to attend the **TailoredCPRInt**.
- (3) The participants attended the **TailoredCPRInt** in groups of 12 as scheduled and undertook all the competency assessments.
- (4) Within 10 weeks all 13 of the groups of participants had attended and completed the **TailoredCPRInt**. Those participants who had successfully completed the CPR training were released into active operational duty.
- (5) In anticipation of the repeat test at specified time intervals, the first group of participants who had received the CPR training were scheduled to return to the HMCAS training section on a date exactly 30 days after they had attended their initial **TailoredCPRInt** training. The participants were not informed what training was scheduled and neither was any additional pre-training material provided.
- (6) On arrival the participants were placed in a room and then called one at a time to undertake the same OHCA scenario they had undertaken 30 days earlier.

- (7) Immediately before the simulation the participants were informed about the study and their informed written consent to participate in the study was requested. The participants were assured that the outcome of the simulation would in no way have any bearing on their work situation. In addition, the participants were also requested to keep the simulation confidential and not to discuss it with anyone.
- (8) The retest had to be concealed up until the day it was to take place, as it was anticipated that if participants knew that they were going to be recalled to undertake a repeat simulation, there would be an increased possibility that they would either practise or undertake extra work in order to improve their performance.
- (9) The first four groups of participants (numbered 1 to 48) were enrolled for a repeat assessment 30 days after the date on which they had attended and completed their initial training [**1 month**].
- (10) The second four groups of participants (49 to 96) were recruited to repeat their assessment exactly 90 days after the date on which they had attended and completed their initial training [**3 months**].
- (11) The final four groups of participants (97-144) were recruited to repeat their assessment exactly 180 days after the date on which they had attended and completed their initial training [**6 months**].
- (12) In order to keep classes even, 144 [**48 x 3**] of the 156 participants only were retested. Although the researcher had anticipated possible participant loss over time this had not happened.

3.8.1. Participant allocation (n = 156)

As stated above, in order to keep classes even, 144 [48 x 3] of the 156 only participants were retested. In addition, while it would have been beneficial to retest all 156 participants at each specified time interval, logistical and operational requirements

made this impossible. However, to ensure that the three groups of participants all received the same standard, prescribed TailoredCPRInt during their initial training all the instructors in the **TailoredCPRInt** had to undergo a TailoredCPRInt instructor class and complete a **TailoredCPRInt** checklist for each course (**Appendix J** pg254).

3.8.2. Data analysis

The categorical data (i.e. dichotomous variables – tick for “Achieved” and cross for “Did not achieve” and/or “Blank”) were gathered as proportions. Using SPSS, Version 17.0, Chicago, IL, USA, and the Fisher's exact test procedure was used to calculate an exact probability value for the relationship between the two proportions. The test procedure works in exactly the same way as the chi-square (χ^2) test for independence. However, the χ^2 test provides only an estimate of the true probability value and it is possible that this estimate may not have been very accurate if the proportions were small. In such cases and specifically for the purposes of this study where the repeat tests at one, three and six months involved samples of 48, the Fisher's exact test was chosen in preference to the chi-square test. In order to correct for the familywise error rate (FWER) or type 1 error given the multiple comparisons between the four aggregated categories as well as the overall rating (4+1 =5), the post hoc analysis of the Bonferroni correction was applied [387]. As a result significance is evaluated at a fifth of the standard 0.05 alpha level, thus $p < 0.01$ would signify significance.

3.9. ETHICAL CONSIDERATIONS THROUGHOUT STUDY

The researcher made every effort to ensure that the ethical considerations relevant to research on human subjects were not violated in any of the four phases of data collection [388].

3.9.1.1. Principle of beneficence – Freedom from harm and exploitation

In order to demonstrate to the APs that their chances of being included in the study were exactly the same as any other APs, the lottery simple random sampling technique was used. This technique had been used numerous times at the HMCAS to recruit participants for the purposes of clinical audit reviews or to select to attend morbidity and mortality presentations. It was, therefore, considered to be a sampling

technique that the APs would understand, relate to and trust. Other than the lottery technique, the only other possible way in which to select the participants would have been to use a computer generated list. However, this technique is frowned upon locally as those involved tend to challenge the authenticity of a prepopulated list with includes names on instead of physically witnessing the lottery sampling method.

In addition, an HMCAS manager in paramedic uniform and who has no conflict of interest or knowledge of the study explained to the sampled paramedics that participation in the study was totally voluntary. In addition, the manager emphasised the fact that nothing that took place or was observed during the study and that was specific to an individual's performance would be reported to HMCAS as HMCAS did not expect this from the study investigators, particularly as this would have been in violation of established ethical standards.

In order to further ensure that participants did not feel pressured into participating in the study, the research aid whose function it was to provide the participants with information about the study and to obtain the informed, written consent of the participants wore casual clothes and not a paramedic uniform with the prescribed hierarchical ranking. In addition, at no time were the participants' actual names recorded. The examiners who had been trained and who were used to evaluate the pdCPR performance of the participants were required to sign confidentiality agreements while only the researchers, the research aid and the study supervisors had access to the completed RETs and returned questionnaires. It was not possible to trace either the RET or the questionnaires back to any specific participant.

In keeping with that guarantee of confidentiality to all the study participants, the study provided a general background overview of the participants only. There were also no personal identifiers that could have compromised the confidentiality of the four samples. In addition, in all the phases of the study the participants were assured that they would come to no direct and/or indirect harm.

3.9.1.2. Principle of beneficence - Risk/benefit ratio

The research posed no immediate or long-term risks to the study participants as confidentiality was and would continue to be maintained at all times. The aim of the

study was to gain an understanding of pdCPR training and the possible effect of a tailored training programme on performance. It was anticipated that this understanding would benefit further training, performance and, ultimately, OHCA patient outcomes and survival rates.

3.9.1.3. Principle of respect and human dignity - Right to self determination

All the study participants were free to enter and leave the study at any time. In addition, they were not enticed, influenced, persuaded, or coerced in any way with regards to the Delphi processes, simulated assessments, completion of questionnaires and/or participation in the interview process and focus group discussions.

3.9.1.4. Principle of respect and human dignity - Right to full disclosure

The letters of information which were sent out to all the participants explained the study in detail in both English and Arabic. This was deemed to be necessary to enable the participants to make an informed decision about their participation in the study. In addition, the contact details of both the researcher and the research supervisors were made available to answer any queries that may have arisen.

3.9.1.5. Principle of justice

All the participants were treated fairly and their privacy was respected. The participants did not encounter any prejudice as a result of their not participating in or their withdrawal from the Delphi studies, simulated evaluations, questionnaires, interviews and focus group discussions. The signed consent of all the participants who took part in all the phases of the study was obtained; including that of the actors who took part participated in the videos that were used to establish the inter-rater reliability of the RET. In addition, the participants were made aware of how their responses would be analysed and how confidentiality would be maintained. There were no complaints lodged against the study.

3.9.2. Summary

This chapter contained a detailed description of the overall research design and the methodology that was used to collect and analyse the requisite data. By using pre-determined and fixed mixed methods, the multiphase design proved appropriate in

that it was able to support the development, adaptation, implementation and evaluation of a training intervention which was designed and tailored to improve the acquisition and retention of pdCPR knowledge and skills. The results arising from each of the four phases are presented in Chapter Four.

CHAPTER FOUR

RESULTS AND INTERPRETATION

The results of the study are presented and interpreted in this chapter. For the purposes of clarity, the results are presented and interpreted in terms of a linear investigative path aligned to the four interconnected study objectives.

4.1. OBJECTIVE 1

Determine and describe pdCPR performance of ambulance paramedics (APs) (see definition of terms) who received training during conventional pdCPR training interventions.

As discussed in section 3.5.3, in order to ensure that Objective 1 was realised, a standard against which CPR performance could be measured, a list of treatment elements which reflected that standard, and an assessment tool with the capacity to accurately (validly) and consistently (reliably) evaluate such treatment elements were required. The study used systematic consensus methods in order to meet these essential requirements.

4.1.1. The Delphi Process 1 – Outcome of iterative process

At the end of Delphi process 1 – Round 4 consensus was achieved with 17 of the 20 subjects (85%) agreeing on an operational definition of competent pdCPR performance (Table 4.1) on a nominal scale (agree/disagree). The absence of full agreement was predicated on arguments to remove the term “successful defibrillation” and also the term “non-technical skills” from the definition and to make specific reference to and include the term “chest compressions”.

Consensus regarding a pdCPR care bundle consisting of the treatment elements (clinical actions, process, procedures and processes) proven by scientific evidence or expert consensus to be the most likely to contribute to successful resuscitation in an OHCA that had undergone pdCPR attempts was achieved if the mean ranking score of the item was ≥ 3 . A score of ≥ 3 implied that the subjects cumulatively felt that the item was within the *very important and critically important range* (on a 4 point Likert scale) (Table 4.2).

Table 4.1 An operational definition of pdCPR competence

PdCPR competence is defined as the ability to provide up to date technical and non-technical resuscitative skills in a manner and at a level of quality likely to restore oxygen delivery, as well as to maintain circulation and the perfusion of vital organs, thus allowing for the return of spontaneous circulation (ROSC) and/or successful defibrillation

Table 4.2 Treatment elements with a mean ranking of ≥ 3

<i>Early recognition of cardiac arrest.</i>
<i>Correct pdCPR sequence – starting with compressions.</i>
<i>Early request for help and/or additional resources.</i>
<i>Achieving an effective chest compression fraction (CCF).</i>
<i>Early and effective use of non-technical skills to ensure effective CCF.</i>
<i>Achieving an effective chest compression rate.</i>
<i>Achieving an effective chest compression depth with the correct hand position.</i>
<i>Achieving an effective chest compression ratio with no leaning.</i>
<i>Ensuring consistent high quality compressions through real-time feedback.</i>
<i>Early and correct rhythm recognition.</i>
<i>Prompt and correct management of identified rhythm.</i>
<i>Defibrillation performed safely during compressions and in escalating joules.</i>
<i>Airway managed with blind insertion of supraglottic airway device during compressions.</i>
<i>Minimal ventilations provided slowly and during release of the chest.</i>
<i>Prompt intra-venous/osseous access established during compressions.</i>
<i>Correct drug, dose and administration interval.</i>
<i>Reversible causes treated.</i>
<i>Routine sugar testing and avoidance of hyperglycaemia.</i>
<i>Early ROSC management (Preventing hypoxia, hypotension and hypoglycaemia)</i>
<i>Patients taken to the appropriate hospital to ensure definitive care is provided</i>

4.1.2. The Delphi Process 2 – Outcome of iterative process

At the end of Delphi process 2 – Round 4 consensus was achieved on a Rapid Evaluation Tool (RET) consisting of process measures representing either a single or composite treatment elements within a CPR care bundle and proven by scientific

evidence or expert consensus to be the most likely to contribute to successful resuscitation in an OHCA that has undergone pdCPR attempts. Consensus was achieved if the mean ranking score of the item was ≥ 3 . A score of ≥ 3 implied that the subjects cumulatively felt that the item was within the *very important and critically important range* (on a 4 point Likert scale). It is important to note that, of the 43 initially identified process measures, consensus in relation to their importance in terms of their inclusion in the RET extended across only 26 of them. Twelve process measures achieved mean rankings below 3 and were, therefore, removed from the list (shaded out in Table 4.3). The process measures representing compressions, non-technical skills and defibrillation were combined into composite measures, namely, a collection of single process measures. Three process measures required simple modifications to the diction. At the end of Delphi process 2 – Round 4 and two rounds of pilot testing, two RETs (a shockable rhythm version and a non-shockable rhythm version) consisting of process measures representing either a single or composite treatment elements were developed (**Appendix C and Appendix D**).

Table 4.3 Mean rankings of RET process measures

Process measures	Mean ranking
1. Response priority to scene	2.52
2. Primary response equipment taken to scene	2.41
3. Time taken to arrive at patient side	2.7
4. <i>Loud shaking and shouting</i>	3.41
5. Assess breathing	3.94
6. Assess pulse	2.94
7. Call for help	2.82
8. Obtain history leading up to collapse	2.47
9. <i>Start compressions</i>	3.7
10. <i>Correct position</i>	3.58
11. <i>Correct depth</i>	3.52
12. <i>Correct ratio</i>	3.29
13. <i>Correct rate</i>	3.7
14. <i>Pause for rhythm analysis</i>	3.17

15. <i>Correct rhythm analysis</i>	3.11
16. <i>Correct response to analysed rhythm</i>	3.05
17. <i>Start compressions</i>	3.11
18. <i>Determine adequacy of compressions with feedback</i>	3.05
19. <i>Check pulse during compressions</i>	2.17
20. <i>Check EtCo2 during compressions</i>	2.94
21. <i>Check wave amplitudes on ECG during compressions</i>	1.7
22. <i>Visual inspection of airway</i>	2.52
23. <i>Suction and clear airway</i>	2.76
24. <i>Open airway</i>	2.29
25. <i>Insert oropharyngeal airway</i>	2.7
26. <i>Ventilate twice with BVM</i>	2.94
27. <i>Establish intravenous access</i>	3.17
28. <i>Provide fluid bolus</i>	2.88
29. <i>Provide epinephrine at 3-5 minute intervals</i>	3.35
30. <i>Provide amiodarone for shock refractory rhythms</i>	3.47
31. <i>Treat all reversible causes</i>	3.05
32. <i>Move patient on to scoop stretcher for transportation</i>	3.58
33. <i>Leadership skills</i>	3.64
34. <i>Situational awareness</i>	3.35
35. <i>Communication skills</i>	3.47
36. <i>Appropriate overall sequence of events</i>	3.17
37. <i>Any overall interruptions are < 10 seconds</i>	3.7
38. <i>Position of compressions correct throughout CPR attempts</i>	3.76
39. <i>Defibrillation safe</i>	3.88
40. <i>Defibrillation at correct dose</i>	3.94
41. <i>Defibrillation at correct time</i>	3.82
42. <i>Post cardiac arrest care management correct and appropriate</i>	3.58
43. <i>Transportation to appropriate facility for definitive treatment</i>	3.41

4.1.3. Intra-rater and inter-rater reliability of the RETs

The intra-rater reliability and the inter-rater agreement of the RETs were evaluated using five recorded simulated OHCA stimulations. Table 4.4 presents the results for Cohen’s unweighted kappa measured for observations made by the same rater on the same evaluation after a month, while the results for Fleiss’s kappa demonstrated the level of measured agreement for 15 raters on observations made regarding all five recorded simulations using a RET.

Table 4.4 Intra-rater reliability and inter-rater agreement of the RET

	Intra-rater reliability Cohen’s kappa unweighted	Inter-rater agreement Fleiss’s kappa for 15 Raters
Recorded Simulation 1	0.9222 SE = 0.0763 95%CI = 0.7725 to 1.0718	0.8178 SE = 0.0191 95%CI = 0.7803 to 0.8554
Recorded Simulation 2	0.9231 SE = 0.0754 95%CI = 0.7752 to 1.0709	0.7974 SE = 0.0191 95%CI = 0.7599 to 0.8349
Recorded Simulation 3	1.0000 SE = 0.0000 95%CI = 1.0000 to 1.0000	0.9036 SE = 0.0191 95%CI = 0.8661 to 0.9412
Recorded Simulation 4	1.0000 SE = 0.0000 95%CI = 1.0000 to 1.0000	0.9672 SE = 0.0191 95%CI = 0.9297 to 1.0047
Recorded Simulation 5	1.0000 SE = 0.0000 95%CI = 1.0000 to 1.0000	0.75 SE 0.0191 95%CI = 0.7201 to 0.7951

Both the Cohen and Fleiss kappa coefficients demonstrated scores ranging from 0.92 to 1.00 and from 0.75 to 0.96 respectively, thus indicating acceptable intra-rater reliability and inter-rater agreement.

4.1.4. Phase one results - CPR performance of APs

An established standard in terms of which to measure pdCPR performance and a tool with demonstrated reliability to measure the process measures which reflected that standard meant that it was possible to realise Objective 1 of the study. Using the test protocol discussed in section 3.5.14, the pdCPR performance in **Sample 2** (n = 100) for a simulated OHCA was evaluated. As indicated in Table 4.5, 13% only of the Sample 2 participants were rated as competent. The table also indicates the proportion of participants who achieved individual process measures which reflected competent

pdCPR performance as defined in this study. Significant differences in all four categories of process measures as well as the overall rating were demonstrated with a χ^2 test statistic with the post hoc analysis of the Bonferroni correction applied and where $p = < 0.01$.

Table 4.5 Observed proportions of process measures achieved

Process measures	(n=100)		P value post Bonferroni correction
	Achieved	Not achieved	
A1. Loud shout and shaking used to determine unconscious state in < 5s	100	0	P<0.01
A2. No or agonal breathing detected on visual inspection of chest in < 10s	91	9	P<0.01
A3. Compressions started < 15s from patient contact	75	25	P<0.01
A4. Chest compressions : 100 in total =< 1 minute	100	0	P<0.01
A5. Chest compressions : Correct position at lower half of the sternum	63	37	P<0.01
A6. Chest compressions : Correct ratio at 50 : 50 with no chest leaning	75	25	P<0.01
A7. Chest compressions : Correct depth at one third of chest depth	61	39	0.028
A8. Rhythm analysis < 1, 20s from patient contact	96	4	P<0.01
Aggregated basic life support skills(Sum of A1 through A8)	661	139	P<0.01
B1. Rhythm identification correct	65	35	P<0.01
B2. Composite process measures B2	94	6	P<0.01
B3. Composite process measures B3	100	0	P<0.01
B4. Composite process measures B4	82	18	P<0.01
B5. Composite process measures B5	96	4	P<0.01
B6. Composite process measures B6	98	2	P<0.01
B7. Composite process measures B7	99	1	P<0.01
B8. Composite process measures B8	47	53	0.549
Aggregated condition specific skills (Sum of B1 through B8)	681	119	P<0.01
C1. Correct sequence of events	78	22	P<0.01
C2. Interruptions in chest compressions < 10s	17	83	P<0.01
C3. LUCAS position correct throughout cardiac arrest event	75	25	P<0.01
C4. Ventilations < 10 per minute	48	52	0.689
C5. Medications correct: time/ dose/interval	82	18	P<0.01
C6. Rhythm treatment correct	35	65	P<0.01
C7. Defibrillation correct: time / safe/ joule	65	35	P<0.01
Aggregated condition specific skills (Sum of B1 through B8)	400	300	P<0.01
D1. Good leadership and scene control non-technical skills	70	30	P<0.01
D2. Good situational awareness non-technical skills	52	48	0.689
D3. Good communication non-technical skills	66	34	P<0.01
Aggregated Non-technical skills (Sum of D1 through D8)	188	112	P<0.01
Observed proportions achieved: Rated as overall competent	13	87	P<0.01

4.1.5. Alternative data sources reflecting pdCPR performance

Qualitative data analysis was used to collect, analyse and present the data which had been identified as trustworthy in relation to its reflection of pdCPR performance. Although varied in their manifestation across the multiple data sources (i.e. patient care reports, clinical reviews, death in care reviews and root cause analyses), the comments, actions, processes, behaviours and conclusions, henceforth referred to as **data elements**, with shared commonalities were aggregated to form unifying categories. Together these categories all contributed a deeper understanding and description of pdCPR performance during an OHCA than had previously been the case.

4.1.6. Results of the qualitative data analysis

Ten categories were identified as bringing meaning and identity and as being capable of unifying the data elements with shared commonalities in their reflection of poor pdCPR performance. These categories, which were coded as **poorCPR1 to 10**, are presented in Table 4.6 in no particular order.

Table 4.6 Categories of data elements reflecting poor pdCPR

Category	Code
Incorrect drugs; dose, time, route	poorCPR1
Excessive ventilation during CPR	poorCPR2
Inadequate compression fraction.	poorCPR3
Incorrect sequence of actions.	poorCPR4
Late recognition of cardiac arrest	poorCPR5
Non adherence to HMCAS Cardiac Arrest Clinical Practice Guidelines	poorCPR6
Poor non-technical skills and/or team based response to SCA.	poorCPR7
Late recognition of shockable rhythm and incorrect shock given.	poorCPR8
Non adherence to HMCAS CPR staff directives	poorCPR9
Delayed transfer of patient or patient transfer to incorrect hospitals	poorCPR10

For ease of presentation, the category titles were shortened but they remained sufficiently explicit to illustrate the shared commonality of the data elements which reflected poor pdCPR performance. In order to promote clarity and understanding,

Table 4.7 presents an excerpt of the actual data elements that were aggregated to form the category “*Incorrect drugs; dose, time, route.*”

Table 4.7 Aggregation of the data elements forming the category poorCPR1

Source legend		
PCR	Patient care report	
CL	Clinical review – Snap shot audit	
RCA	Root cause analysis	
DIC	Death in care review	
Source code	Actual data element	Category
PCR013	Epinephrine administered at 2 minute intervals	Incorrect drugs, dose, time, route
PCR016	50% dextrose given – not indicated as RBS > 4mmol	
PCR28	Magnesium Sulphate given – not indicated	
PCR35	Epinephrine administered – via endotracheal tube	
PCR36	Epinephrine administered – 2mg bolus	
PCR45	Epinephrine administered – infusion during arrest	
PCR47	Epinephrine administered – diluted	
PCR57	Dopamine administered – not indicated	
PCR58	Dopamine administered – not indicated	
PCR59	Amiodarone administered – not indicated	
PCR105	Amiodarone administered – not indicted	
PCR115	Epinephrine administered – not indicated	
PCR116a	Epinephrine administered at 1 minute intervals	
PCR116b	Amiodarone indicated but not administered	
PCR119	Epinephrine administered – not indicated	
CL02	Amiodarone given after 1 st shock	
CL05	Epinephrine dose incorrect”	
CL08	Atropine administered – not indicated	
CL08	Epinephrine administered at 1 minute intervals	
CL10a	Amiodarone administered – not indicated	
CL10b	Epinephrine administered – not indicated	

CL10c	Epinephrine administered - via endotracheal tube	
CL12a	Epinephrine administered at 1 minute intervals	
CL12b	Epinephrine administered - diluted	
CL12c	Dopamine administered - not indicated	
DIC03	Epinephrine not administered when indicated	
DIC05	Epinephrine not administered when indicated	
RCA07	Amiodarone administered not indicated	
RCA07	Epinephrine given intramuscularly	

Figure 4.1 presents the hierarchical relationships between the factors relating to poor pdCPR performance.

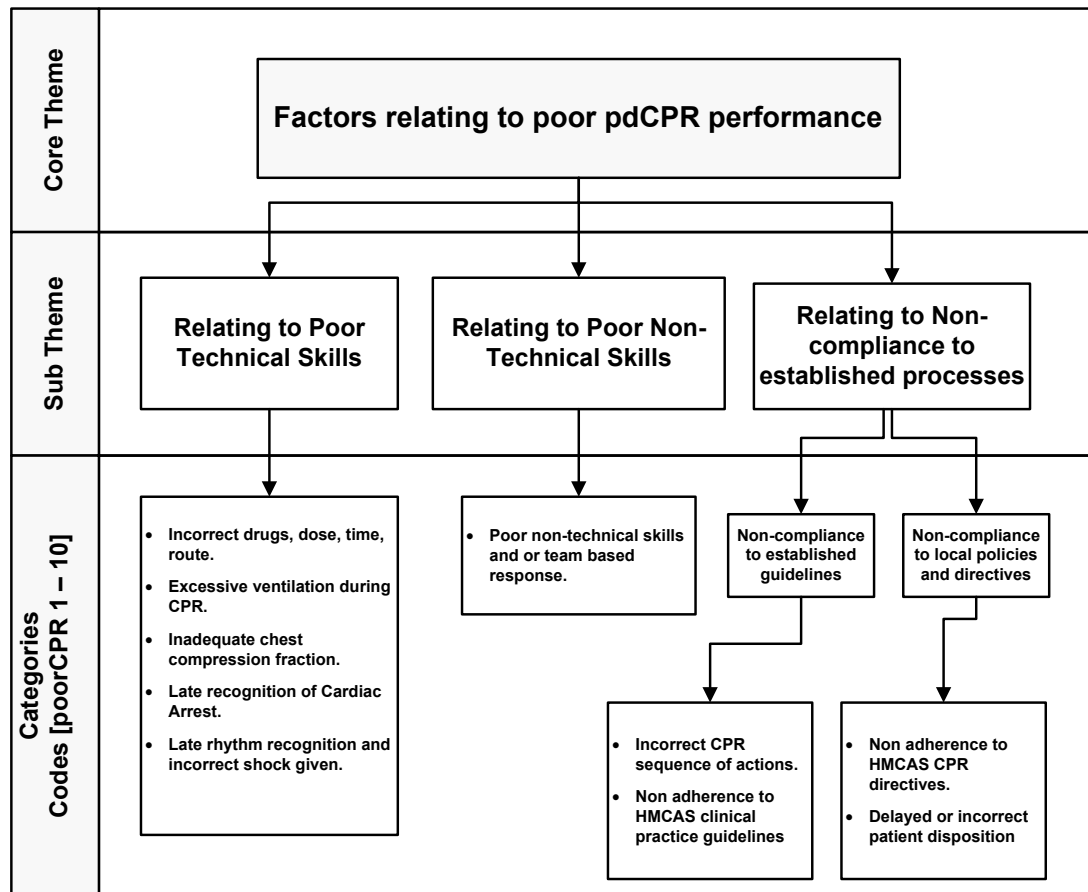


Figure 4.1 Hierarchical analyses of data relating to poor pdCPR performance

4.1.7. Summary - Objective 1

When the CPR performance of APs who had undergone traditional CPR training was evaluated using the simulated OHCA assessment and a pdCPR RET, 13% only were rated as competent. The RETs demonstrated Cohen's and Fleiss' kappa coefficients ranging from 0.92 to 1.00 and 0.75 to 0.96 respectively, thus indicating acceptable intra-rater reliability and inter-rater agreement. The RETs calculated the outcome measure of "competent" for the following four categories of process measures, namely, (1) basic life support skills; (2) condition specific skills; (3) specific overall skills; and (4) non-technical skills. In addition, three broad sub-themes of factors represented the reasons why the pdCPR performance was poor. These included categories of factors related to poor technical skills; poor non-technical skills, and non-compliance with established processes.

4.2. OBJECTIVE 2

Identify the factors that influence the acquisition and retention of CPR knowledge and skills of APs.

As discussed in section 3.6 pursuing Objective 2 included the following:

- (1) A survey using the questionnaires sent out to Sample 2 (n = 100)
- (2) A documentary analysis of data sources identified as reflecting pdCPR training.
- (3) Interviews (n = 15) and focus group discussions (n = 6) with purposively selected participants.

4.2.1. Results of the questionnaire survey

As discussed in section 3.6.2 the aim of the survey questionnaire was to identify AP learning style preferences and also to evaluate the APs' perceptions of the components that were often taken into in the development of a CPR training intervention. Figure 4.2 presents the proportion distributions of the 125 preferred learning styles that were found to exist among the **Sample 2** participants. Twenty five participants demonstrated more than one preferred learning style although the maximum number of learning style preference per any participant was two. Figure 4.3 presents the distribution of two of the learning style preferences identified among the APs.

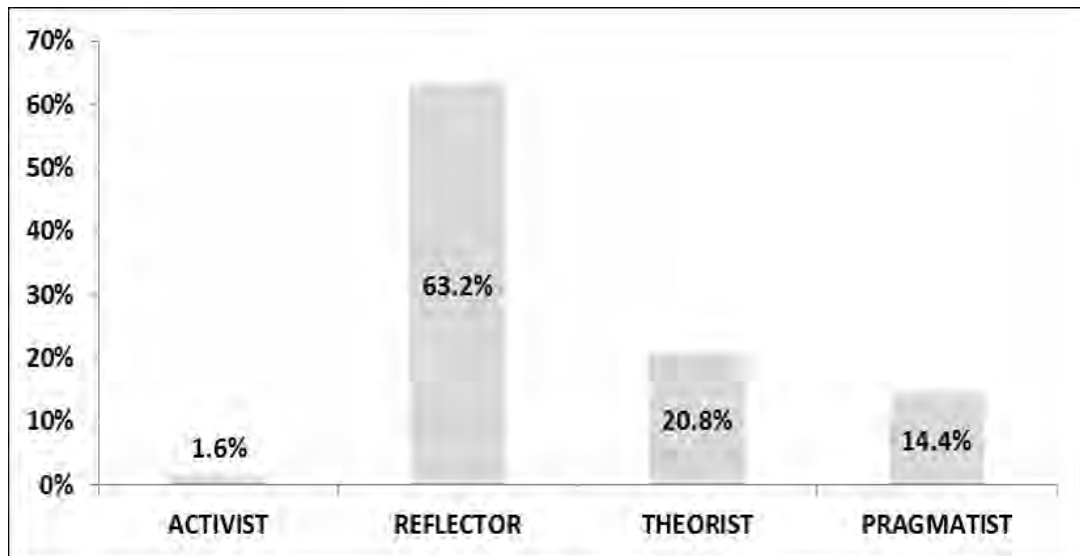


Figure 4.2 Distribution of learning styles across Sample 2 participants

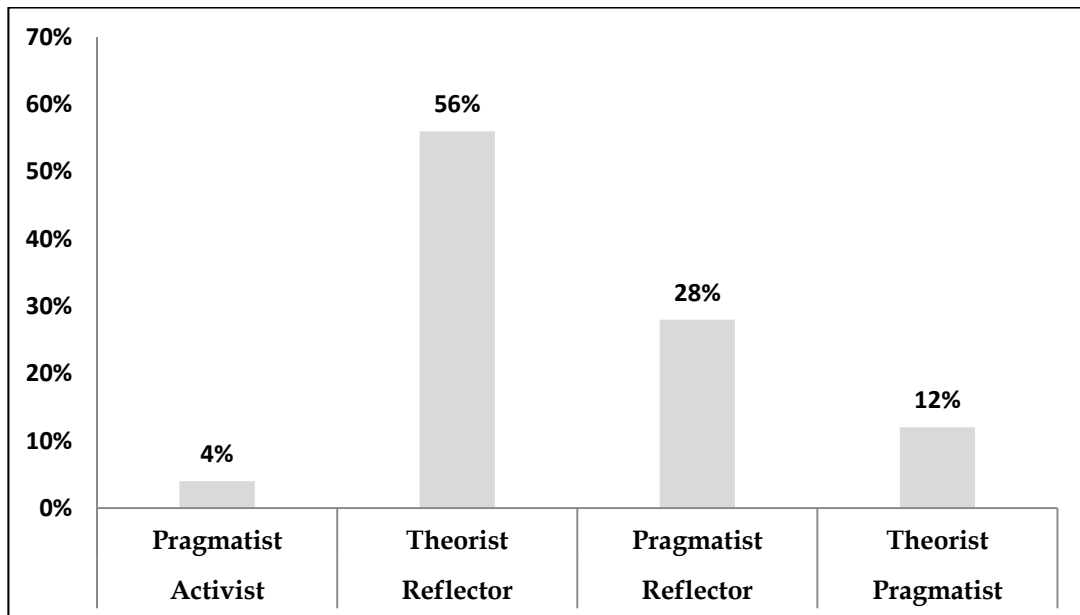


Figure 4.3 Distributions of two types of learning styles across Sample 2 participants

The participants' perceptions of those components that were generally taken into account during the development of a training intervention were evaluated using a 5 point Likert scale. The results are presented in their recoded form with *Strongly agree and Agree* being collapsed into the measure "Agree" while *Strongly disagree and Disagree* were collapsed into the measure "Disagree". Accordingly, the three recoded measures were Agree, Disagree and Neutral (Table 4.8).

Table 4.8 Participant perceptions of the components of CPR training intervention

Components	Proportion (n = 100)		
	Agree	Neutral	Disagree
Establishing specific timeframes for CPR training	91	8	1
Assessment to ensure competence	97	1	2
Course content and format	86	12	2
Venue and instructor to candidate ratio	94	6	0
Course duration and format	90	7	3
Pre-course requirements and selection of course	95	3	2
Instructor requirements	92	6	2
Curriculum governance	92	7	1

4.2.2. Data sources reflecting pdCPR training

Both quantitative and qualitative data analyses were used to collect, prepare, analyse and present the data which reflected traditional pdCPR training and that were contained in the feedback forms completed between 2009 and 2011. These forms, which had been completed by students who had attended traditional pdCPR programmes, evaluated the students' perceptions of the components that reflected the delivery and quality of the programme using a 5-point Likert scale. The results are presented in their recoded form with *strongly agree* and *Agree* having been collapsed into the measure "Agree" and *strongly disagree* and *Disagree* having been collapsed into "Disagree". Accordingly the three recoded measures were Agree, Disagree and Neutral with the latter reflecting neutral feelings on the part of the participants towards a certain component (see Table 4.9).

Table 4.9 Participant perceptions of current CPR training

Statements relating to traditional CPR training	Proportion		
	Agree	Neutral	Disagree
The pre-course workbook was helpful in preparing you for the course.	36.1	12.4	51.5
The learning materials contributed to your learning.	40.2	8.2	51.5

The lectures covered all areas of important work.	49.5	3.1	47.4
The time allocated to each subject was adequate.	47.4	9.3	43.3
The class and group discussions were insightful and productive.	15.5	7.2	77.3
The power point presentations were helpful to your learning.	36.1	9.3	54.6
Adequate time was allocated for the practical sessions.	46.4	2.1	51.5
The simulated scenarios were helpful in applying the practical skills.	50.5	8.2	41.2
The instructor was enthusiastic about the teaching.	49.5	5.2	45.4
The instructor was skilled in helping the students to master relevant concepts and skills.	48.5	7.2	44.3
The instructor was well prepared for each class session	47.4	9.3	43.3
The instructor made good use of training media such as power point presentations, whiteboard, etc.	46.4	2.1	51.5
The instructor presented the material in a clear manner.	44.3	8.2	47.4
The instructor was capable of answering questions.	47.4	1.0	51.5

The qualitative data analysis was used to collect, prepare, analyse and present the students' responses to the open ended questions on the traditional pdCPR training feedback forms. Fourteen categories were identified as bringing meaning and identity and being capable of unifying those data elements with shared commonalities that reflected poor pdCPR training. These categories are presented in Table 4.10 in no particular order.

Table 4.10 Categories of data elements relating to poor pdCPR training

Category	Code
Insufficient hands-on practice	poorTRAIN1
Inconsistent teaching methods	poorTRAIN2
Unrelated course content	poorTRAIN3
Too many participants per course	poorTRAIN4
Trustworthiness of information and content	poorTRAIN5

Complex instruction	poorTRAIN6
No ideal OHCA pdCPR treatment plan exists	poorTRAIN7
Delays between instruction and skills practice	poorTRAIN8
Lack of supervision	poorTRAIN9
Low instructor feedback regarding ways in which to improve	poorTRAIN10
Instructor knowledge and skills inadequate	poorTRAIN11
No motivation or accountability as regards staff and instructors	poorTRAIN12
Course information, guides and supporting evidence difficult to obtain	poorTRAIN13
No information and boundaries	poorTRAIN14

Figure 4.4 presents the hierarchical relationships between the categories of aggregated factors, the observed sub-themes and the overall core theme.

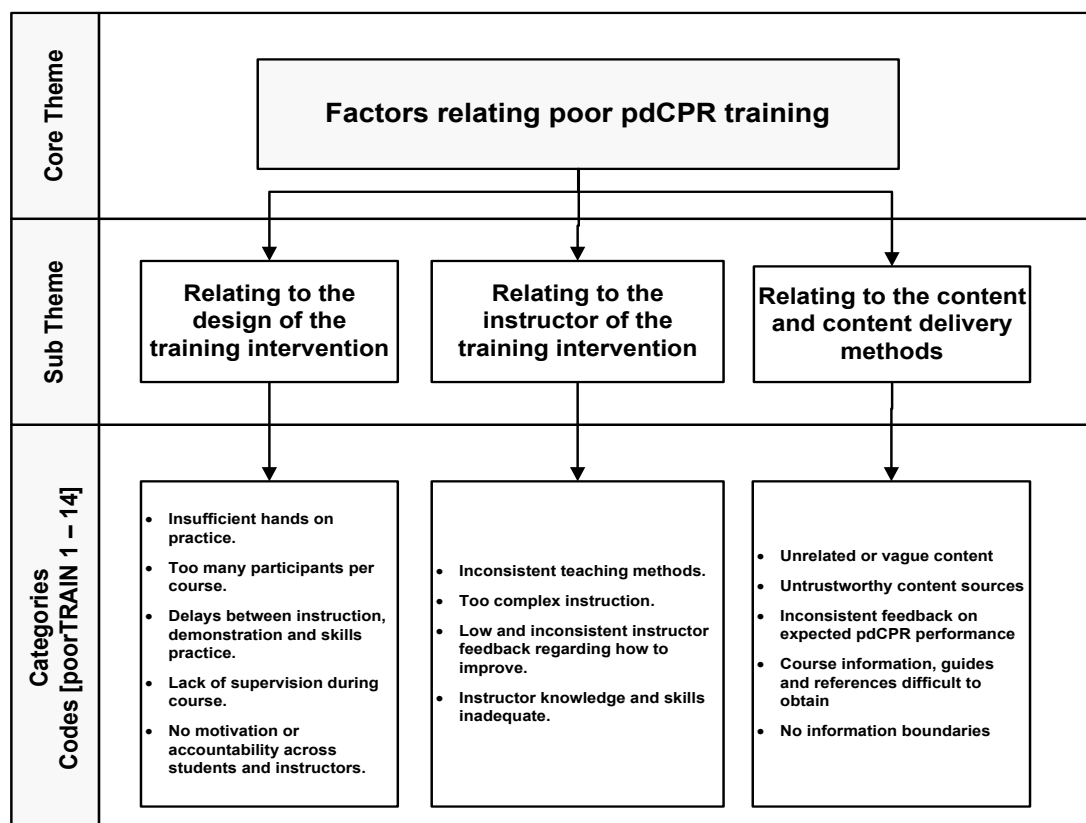


Figure 4.4 Hierarchical analyses of data for all core themes relating to pdCPR

4.2.3. Interviews and focus group discussions - Positionality of Sample 3

Although **Sample 3** was purposively chosen on the basis that the participants in Sample 3 were individuals who were believed to possess a wealth of information

about paramedic training, CPR performance in paramedics, adult education and curriculum development, the study investigators felt that it would be helpful to determine the positionality of the Sample 3 participants as regards how they viewed education and training in general. Table 4.11 presents the responses of Sample 3 (i.e. interviewees (n = 15) and focus discussion group (n = 6)) to questions aimed at evaluating their positionality on education and training.

Table 4.11 Participants' positionality on education and training (Sample 3)

Statements relating to positionality on education and training	Proportion (n = 21)		
	Agree	Neutral	Disagree
A structured and formal learning environment is extremely important.	82%	5%	14%
Teaching methods will change with time as this is a part of the natural evolution of learning.	77%	0%	23%
Teaching methods may change at any time, even during an actual course aimed at aiding learning.	86%	0%	14%
Instructors are there merely to assist when a student needs clarity.	9%	5%	86%
Knowing the facts and science behind the subject matter is very important.	86%	9%	5%
Non-specific information that builds the mind in general is more useful than information about a specific subject, knowledge area or skill is more useful.	0%	23%	77%
Teaching methods should be instructor dependent rather than student dependent.	9%	0%	91%
Students should choose what they want to learn and interpret subject matter according to their lived experiences.	18%	5%	77%
Teaching methods should be constant and never change.	9%	9%	82%
The instructor must always be the role model as regards ideal knowledge, skill proficiency and behaviour.	27%	5%	68%
The instructor's primary role is to interpret information and explain it to the student to enable them to memorise it easily.	14%	9%	77%
The student's role extends further than merely receiving information and memorising it.	95%	5%	0%
There is only one formal structured way in which teaching may occur.	14%	5%	82%
There is only one way in which learning may occur.	5%	5%	91%
Trying new ways of teaching and learning is counterproductive and, therefore, a waste of time.	0%	9%	91%

4.2.4. Interviews and focus group discussions – Results

Three core themes emerged from the qualitative data analysis of the interviews and focus group discussions. DeSantis et al. [389] define such themes as “abstracts or entities that bring meaning and identity to a current experience and its variant manifestations, as such, a theme captures and unifies the nature or basis of the experience into a meaningful whole”. The **three core themes** which emerged from this study include the following:

- (1) Determinants of poor pdCPR performance
- (2) Contributors to poor pdCPR performance
- (3) Improving pdCPR

4.2.5. Data triangulation

During the qualitative data analysis it became increasingly obvious that several of the indexed and coded data elements which were emerging from the *transcribed interviews and focus group discussions* were similar and also that they resembled those data elements that had emerged from the qualitative data analysis of the *alternative sources of data which reflected pdCPR performance and pdCPR training*, as discussed in sections 3.5.17 and 3.6.3. Table 4.12 presents the categories of aggregated data elements that emerged from the interviews and focus group discussions as well as from the alternative sources of data which reflected pdCPR performance and pdCPR training.

Table 4.12 Category origin of the aggregated data elements

<i>Category Source</i>		
<i>Category code</i>	Interviews and focus group discussions 1. <i>Transcribed interviews</i> 2. <i>Transcribed focus group discussions</i>	Data sources which reflected of pdCPR performance and training i.e. 1. <i>Patient care reports</i> 2. <i>Clinical reviews</i> 3. <i>Root cause analysis</i> 4. <i>Death in care reviews</i> 5. <i>Training feedback forms</i>
poorTRAIN1	☑	☑
poorTRAIN2	☑	☑

poorTRAIN3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN6	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN7	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN8	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN9	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN10	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN11	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN12	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN13	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorTRAIN14	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR5	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR6	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR7	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR8	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR9	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
poorCPR10	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

4.2.6. Remaining categories of aggregated data elements

In addition to **poorCPR1 to poorCPR10** and **poorTRAIN1 to poorTRAIN14** two other sub-themes of categories emerged from the qualitative data analysis of the interviews and focus discussion groups. These included categories with the codes **poorENVIR1 to poorENVIR9** and **improveCPR1 to improveCPR8**. These categories are presented in Tables 4.13 and 4.14. Figure 4.5 displays both the hierarchical analysis of the data pertaining to the three core themes and the relationships between the sub-themes identified and the categories of aggregated data elements with shared

commonalties. Figure 4.5 also illustrates the integration and triangulation of the results that emerged from the qualitative data analysis of alternative sources of data which reflected pdCPR performance and pdCPR training and discussed in sections 3.5.17 and 3.6.3.

Table 4.13 Categories of factors specific to OHCA environment

Category	Code
Weather and environmental stressors	poorENVIR1
Unknown, unsuitable and uneven surfaces	poorENVIR2
Confined spaces with limited access and aggress	poorENVIR3
Lack of information on events preceding the OHCA	poorENVIR4
Public and bystander interference	poorENVIR5
Panicky and emotional families	poorENVIR6
Noise, lack of light and safety and security concerns	poorENVIR7
Language, cultural barriers	poorENVIR8
Multi-agency response with varied skill and authority levels.	poorENVIR9

Table 4.14 Categories of factors specific to improving pdCPR

Category	Code
Organisation specific supervisory and regulatory body	improveCPR1
Programme design	improveCPR2
Pre-programme activities and admission requirements	improveCPR3
Duration of course and instructor to candidate ratio	improveCPR4
Venue and equipment	improveCPR5
Format and content	improveCPR6
Content delivery and assessment methods	improveCPR7
Ensuring competence	improveCPR8

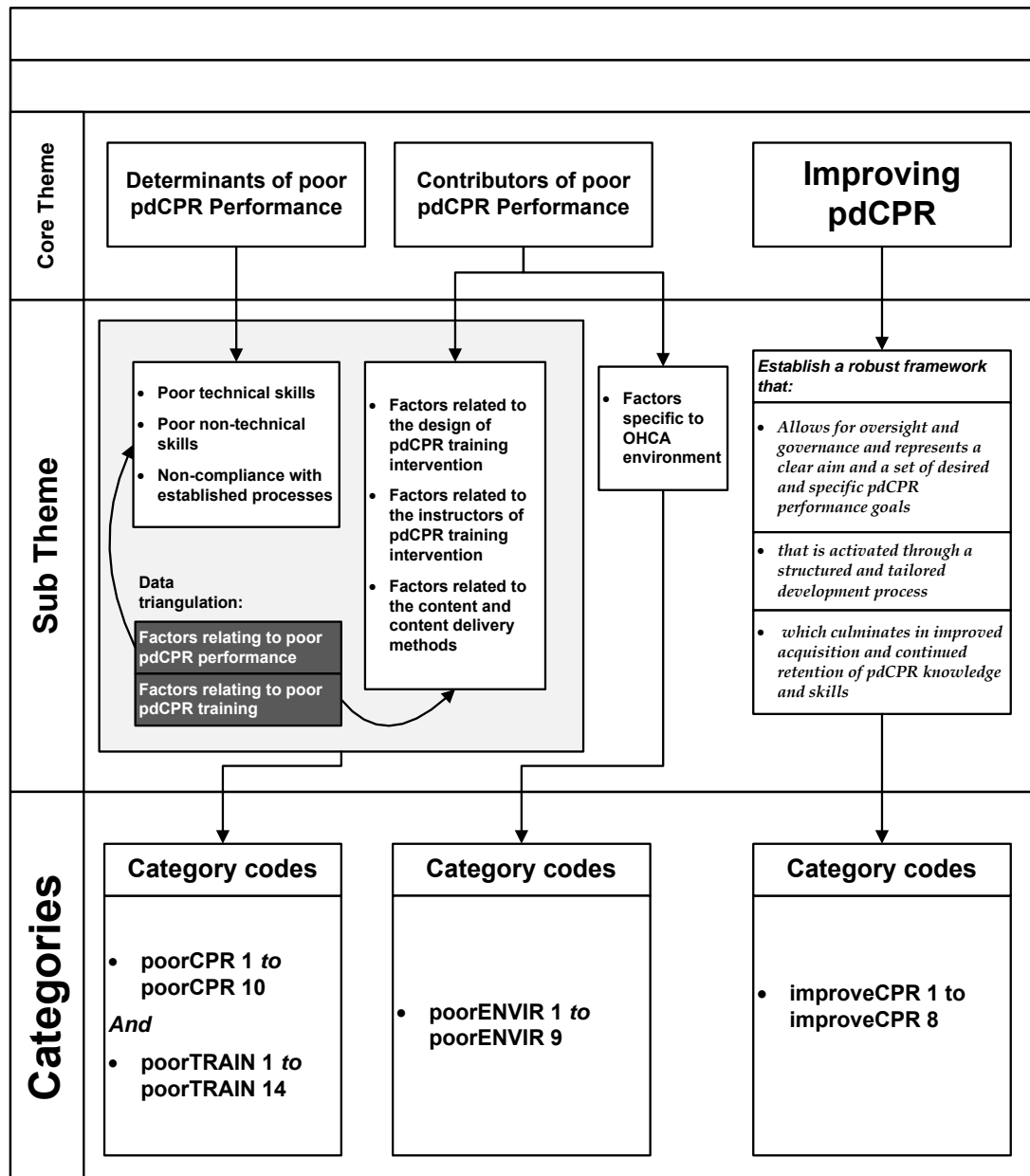


Figure 4.5 Hierarchical analyses of data for the all core themes relating to pdCPR

4.2.7. Improving pdCPR

As illustrated in Figure 4.5, the data from the interviews and focus group discussions was used to identify, from an emic perspective, a framework within which improvements to pdCPR performance could be made. In the framework a distinction is made between

- the provision of supervision and governance and the formulation of a clear aim and a set of desired and specific pdCPR performance goals
- that are activated through a structured and tailored development process

- which culminates in the improved acquisition and continued retention of pdCPR knowledge and skills

Table 4.15 presents the distribution of the categories of aggregated data elements for parts a, b and c of the framework

Table 4.15 Distribution of the categories in the framework

<i>Allows for supervision and governance and represents both a clear aim and a set of desired and specific pdCPR performance goals</i>	improveCPR1
	improveCPR2
	improveCPR3
	improveCPR4
	improveCPR5
<i>that are activated through a structured and tailored development process</i>	improveCPR6
	improveCPR7
<i>which culminates in the improved acquisition and continued retention of pdCPR knowledge and skills</i>	improveCPR8

4.2.7.1. Part (a) Categories improveCPR1 to improveCPR5

The data provided evidence that a statutory body that provided the supervision and governance of the process that promotes, ensures and maintains pdCPR competency was needed, particularly such a body at the organisational or local level. The participants repeatedly referred to the need for governance and monitoring not only to ensure that CPR training interventions conformed to established standards but also that paramedics were practising what was being taught.

Ia23 – *“Some of us have not attended training in 5 years; I myself only came for training now. The new guys that have just come now get more training than the old guys. I know for ALS course back home we attend every two years. We had to attend, if we did not attend we*

lost our certificate and then we couldn't work or apply for jobs – here is different, no training mafi mushkila – Kali Wali ” [Mafi MushKila and Kali Wali are common Arabic phrases for no problem, and not to care at all, or let it go].

Id2 – *“EMS protocols are still practised and based on incorrect information disseminated by senior management staff here and we cannot challenge them. They are Oscars and Deltas and, regardless of the training, we have to respect them. Many of them have not been for the training themselves, and what I see is many of them do CPR like they do it back in their home country or from what the AHA shows and not how we do it here – the 100 compressions first”.*

The data also identified the need for a standardised structured programme as the participants frequently mentioned the need for CPR programmes that were structured, detailed, transparent and clear on what was expected of the candidates.

Ia11 – *It must have structure and not change every time depending on who is teaching it”.*

Ib25 – *“I must be honest, it feels like a trap and they testing you but they don't give you enough material and stuff to prepare you. Especially when [name removed] teaches, I don't understand him and he gets angry all the time when we ask questions and do things wrong”.*

Id7 – *“I think that it should have a guide, like the AHA one, but it must be simple and must include what we need to do to pass the course. I don't see any reason why it should not include the actual assessment to help us practise for what's required as opposed to stress out from the start”.*

The duration of the CPR training, the venue, the equipment used and the number of candidates per class and the impact of these factors on learning were also repeatedly mentioned. The general view was that inappropriate and insufficient equipment and classrooms with large numbers of students hindered the overall acquisition and retention of knowledge.

Ib012 – “It causes the “forgotten student scenario” with large classes with many students and few instructors; many students inevitably get lost or are forgotten”.

Ig04 – “It’s rather trivial and may be simple but a room without soft carpeted floors – no one wants to kneel next to the manikin. Or if you have broken manikins like the one in classroom 2, those have landmarks draw on it, patients don’t have drawn on landmarks”.

Ig0- – “And using equipment that we have on the trucks and use during normal call outs is a must. And it has to be realistic – so doing CPR on a stretcher in a classroom is different from real life”.

4.2.7.2. **Part (b)** Categories improveCPR6 to improveCPR7

The data revealed two major groups of categories relating to the way in which a CPR training intervention could promote the improved acquisition of knowledge and skills. The first group represented categories reflecting specific changes to the overall format of the CPR training intervention and the content that should be presented while the second group of categories reflected the teaching and learning activities that should be used to deliver the content which had been identified and then to evaluate performance.

The data identified that the format of the training intervention, whether it be in the form programme, course or module should cover essential learning objectives only. [If10]. In addition, the course should also be contextualised and tailored to the needs of adult learners [If07,Ig13] and also contain locally relevant content so as to address the OHCA scenarios that frequently occurred in Qatar [Ic15,Ih24,ih25,F9,F10,F11]. The content covered should also be factual [Ia14,Id08], interactive,[Ib20], delivered in a way that facilitated learning [Ia15,Ig10], allow for sufficient practice time [If14] and be provided in short sessions rather than in a continuous, long, non-interactive lecture [Ia16,Im09,In09]. Smaller classes, shorter duration and sufficiently trained instructors who taught, facilitated and also provided corrective, standardised feedback during the classroom activities were considered essential [Ie09,F17,F23].

Ia14 – “... based on facts and evidence based medicine and all actions and procedures are explained and substantiated”.

Ia15 – “... should use educational techniques that we can understand and are used to”.

Ia16 – “... Use short recognised time frames that promote most effective learning, considering our attention span ...”

Ib20 – “assessments should aim to establish learner competency but also contribute to the whole learning experience”.

Ib21 – “It should be interactive with discussions based on best practice should be encouraged and not shot down”.

Ic15 – “An example of behaviour and a treatment standard should exist as a bench mark for students to copy or aspire to”.

Id08 – “... comprise factual content and assessments designed to increase overall CPR performance in APs ...”

Ie09 – “A combination of facilitation like assisting and instruction in the form of telling students what must be done should exist”.

If10 – ... borders for content like boundaries that prevent too much information and over learning. This dilutes important concepts and wastes time”.

If14 – “... must give students the opportunity to practise the tasks and skills that they will be tested on ...”

If07 – “Patience with slow students, not all of us are young anymore”.

Ig13 – “Like me English is my third language, French, Arabic are simple but some words are difficult to catch. As I say. Teaching should use simple words”.

Ih24 – “Prior experience or learning is the basis of knowledge. Sometimes is good and sometimes this is bad. Because what we learned back home is different from what we do here”.

Ih25 – “The experience must “fit” our abilities. Sometimes it is possible in class but not outside on the road”.

Ij10 – “Learning can happen through many experiences and can achieve the same objective”

Im09-- “... Different teaching methods and experiences enhance memory of skills.”

Im09-- “The learning experience should accomplish several learning outcomes.”

F9 – “Knowledge and skills acquisition and retention are faster when students can integrate their learning experience into actual experiences”.

F10 – “There must exist clarity on those sensitive issues like do not resuscitate (DNR) orders from families, police insisting you do CPR when the patient has rigor mortis, families are violent”.

F11 – “Our training must remain cognisant of the fact that bystanders’ or laypersons’ CPR in Qatar are largely non-existent”.

F17 – “APs require satisfying learning experiences to develop and maintain interest in learning; unsatisfying experiences could possibly hinder their learning and prevent them from returning”.

F23 – “AP prior knowledge is the starting point for new knowledge. Pre-reading and assignments standardise prior knowledge”.

4.2.7.3. Part (c) Improving pdCPR – Categories improveCPR8

The data provided evidence of several elements crucial to ensuring that optimal performance of pdCPR occurs consistently. These include clear and specific pdCPR

resuscitation algorithms [Ib34, F18], regular retraining and practice sessions [Ih33, Ie19]; functioning and well maintained equipment, resources and aid-memoirs to ensure consistent compliance with pdCPR resuscitation guidelines [In18, Im26, F33, F34].

Ib34 – *“The CPR flow processes in the CPGs [clinical practice guidelines] are confusing, there are too many grey areas. People go back to what they are used to when too many grey areas exist”.*

Ie19 – *Training, training and training, both CCPs and APs should practise the entire CPR protocol at least once every cycle”.*

Ih33 – *“There should be manikins at each hub so staff does not have to come to the training department and practise their skills. That way when they not doing any calls they can practise”.*

In18 – *“Even with regular training, we need something like a pocket card, like the trauma bypass criteria to remind us of which patient goes where. We should have that for CPR as well”.*

F18 – *“A clear step by step CPR protocol, in my opinion, is better than a guideline, as we know exactly what comes first”.*

F33 – *“In a stressful situation, if we had a laminated card to help us remember the steps, it would be better”.*

Im26 – *“Most of us work 192 hours maxing our overtime every month. So, when we come for training we don't get paid for it, sometimes it gets carried to the next month and sometimes it is lost. If we get paid for training then most of us will come”.*

4.2.8. Summary conclusion – Objective 2

The mixed data sources identified, including learner style preferences, factors related to governance, programme design and structure, the type and quality of instructors and the types of teaching methods that were used to deliver content as factors that

influence the acquisition and retention of CPR knowledge and skills of APs. In order to ensure that optimal pdCPR is provided consistently, the data identified the use of clear, specific pdCPR resuscitation guidelines, regular training and practice sessions as well as aide-memoirs to remind APs of the essential and sequential CPR steps as stipulated in the guidelines.

4.3. OBJECTIVE 3

Develop a tailored pdCPR training intervention designed to improve the acquisition and retention of CPR knowledge and skills of APs.

As indicated in the definitions of terms, a **pdCPR training intervention** is a structured series of learning activities designed and sequenced to specifically improve the acquisition and retention of CPR knowledge and skills of ambulance paramedics. In addition, it represents an articulation of what the students should know and be able to do and supports CPR instructors/teachers in knowing how to achieve these goals.

4.3.1. Step 1 - Identifying the purpose of the pdCPR tailored intervention

The purpose of the pdCPR tailored intervention is derived from the educational philosophy underlying the training intervention. As discussed in Chapter Two, it is this philosophy that serves as the basis for clarifying the values and beliefs behind the purpose, goals, and objectives of the training intervention. Wiles et al. [274] maintain that an effective educational philosophy is one that is common to those who develop and administer a training intervention as well as those at whom the intervention is targeted.

Based on the data presented in Table 4.11, it is reasonable to suggest that the educational philosophy common to those individuals who inform the development of the tailored CPR training intervention encompasses a combination of the characteristics of the educational philosophies of realism and experimentalism. The use of various sources and different methods of teaching and learning as well as the use of facilitators to guide learners with corrective feedback in active learning are both characteristics of experimentalism. On the other hand, content which is based on a foundation of facts and science and the encouragement of ongoing research in order

to improve best educational practices so as to optimise the effectiveness of training are characteristics of realism.

4.3.2. Step 2 – Identifying the aim of the pdCPR tailored intervention

The aim of a tailored intervention involves a clear statement reflecting the overall goals, outcomes or intentions of the intervention while the individual milestones that learners should reach on their way to achieving these goals are referred to as the objectives of the intervention [390]. As indicated in Table 4.1 the aim of this tailored intervention is to ensure that candidates who have attended and successfully completed the CPR tailored intervention exit with the... *“Ability to provide up-to-date technical and non-technical resuscitative skills in a manner and at a quality level that is likely to restore oxygen delivery, as well as maintain circulation and the perfusion of vital organs to allow for the return of spontaneous circulation (ROSC) and/or successful defibrillation”*.

4.3.3. Step 3 – Identifying the objectives of the pdCPR tailored intervention

The treatment elements and processes listed in Table 4.2 represent the objectives of the training intervention. Aimed at the cognitive, psychomotor and affective domains of learning the 20 treatment elements reflect what the AP learner should specifically know and be able to do as a result of their attendance at the pdCPR training intervention developed in the study. Each objective is presented with the clearly specified conditions under which the AP is expected to exhibit the desired behaviour (i.e. knowledge, skill or attitude), a measurable performance that will demonstrate that the intended objective has been attained as well as a standard describing the quality of the work required to achieve an acceptable level of performance. For the purposes of clarity and understanding Table 4.16 presents an example of learning objectives 1 to 5 and transformed to include a condition, performance and standard.

Table 4.16 Examples of PdCPR learning objectives

	Condition	Performance	Standard
<i>Early recognition of cardiac arrest.</i>	<i>During a simulated OHCA</i>	<i>The learner will be able to recognise the victim is in cardiac arrest</i>	<i>In less than 15 seconds</i>
<i>Correct pdCPR sequence – starting with compressions.</i>	<i>During a simulated OHCA</i>	<i>The learner will be able to perform the prescribed pdCPR steps in a standardised sequence</i>	<i>As determined by process measure C1 of the RET</i>

<i>Early request for help and/or additional resources.</i>	<i>During a simulated OHCA</i>	<i>The learner will confirm the case of cardiac arrest with the NCC and request help</i>	<i>As determined by process measure A2 of the RET</i>
<i>Achieving an effective chest compression fraction (CCF).</i>	<i>During a simulated OHCA</i>	<i>The learner will perform compressions</i>	<i>For more than 80% of the total cardiac arrest time as determined by process measures A4,B3,B5,B7 and C2 of the RET</i>
<i>Early and effective use of non-technical skills to ensure effective CCF.</i>	<i>During a simulated OHCA</i>	<i>The learner will use leadership and scene control non-technical skills, situational awareness and communication skills</i>	<i>As determined by D1,D2,D3 of the RET</i>

4.3.4. Step 4 – Identifying the needs of learners

The focus on learners’ needs is an important determinant of the success or failure of a training intervention. An assessment of the needs of the learner provides insights into the way in which outside factors and specific learner characteristics and styles of learning may affect the training intervention [288]. This inquiry may result in an adjustment of the goals, objectives and instructional techniques of the intervention [286,288]. The needs of participants, as they emerged from the data collected during the study, include the following:

As illustrated in Figures 4.2 and 4.3 of the study, the participants were primarily reflector and theorist in their learner style preferences. These individuals

- typically prefer to think about matters in detail before taking direct action
- usually adopt a more thoughtful approach to tackling tasks
- are good listeners who usually prefer to adopt a low profile
- are prepared to read and re-read information
- welcome the opportunity to repeat information
- prefer to research and evaluate and make decisions in their own time
- prefer to see how things fit into an overall pattern
- embrace logic
- prefer a sequential approach to solving problems
- are analytical and pay considerable attention to detail

- tend to be perfectionists
- prefer concepts and theories
- want to be intellectually stretched
- prefer structure and clear objectives
- prefer a logical presentation of ideas.

As shown in Table 4.8 and supported by the qualitative data that was coded and presented in Table 4.14, the majority of the study participants had agreed that specific overarching components influenced the educational effectiveness of a CPR training intervention. As a result, due consideration should be given to the following components during the development of training interventions:

- Curriculum governance or as coded as improveCPR1 and presented in Table 4.14
- Establishing specific timeframes for the CPR training or improveCPR6
- Assessment to ensure competence, improveCPR7 or improveCPR8
- Course content and format or improveCPR6 and improveCPR7
- Venue and instructor to candidate ratio or improveCPR5
- Course duration and format or improve CPR2
- Pre-course requirements and selection of course or improveCPR3
- Instructor requirements or improveCPR4.

As shown in Table 4.9, the majority of the paramedic learners who had attended traditional pdCPR training in the past agreed that:

- The pre-course workbook was NOT helpful in preparing the participants.
- The learning materials had NOT contributed to participant learning.
- The class and group discussions were NOT insightful or productive.
- The power point presentations were NOT helpful to the learning process.
- Inadequate time was allocated for the practical sessions.
- The instructor did NOT make good use of training audio visual media.
- The instructor DID NOT present material in a clear manner.
- The instructor was NOT capable of answering questions.

These findings are important as they identified the needs of learners outside of the study sample as well as opportunities for improvement that may not necessarily have been experienced by participants in the study. However, as shown in Table 4.10, several of the participants of this study re-affirmed many of these same needs. These included:

- Insufficient time for hands-on practice
- Inconsistent teaching methods
- Unrelated course content
- Too many participants per course
- Lack of trustworthiness as regards information and content
- Complex instruction
- No ideal OHCA pdCPR treatment plan exists
- Delays between instruction and skills practice
- Lack of supervision
- Low instructor feedback on ways in which to improve
- Instructor knowledge and skills inadequate
- No motivation or accountability on the part of staff and instructors
- Course information and supporting evidence difficult to obtain
- No information and boundaries
- No scheduled refreshers or aide memoirs to help combat skill attrition.

4.3.5. Step 5 – Intervention alignment

Perhaps one of the most popular and influential learning taxonomies in the field of instructional design is Gagne’s taxonomy of learning, as discussed in section 2.7.5.1. Gagné’s theory stipulates that, not only are there several types and levels of learning, with each type and level of learning requiring instruction that is tailored to meet the needs of the learner, but that different internal and external conditions are necessary if learning is to be achieved. According to this theory, good instruction is not just important but it is a condition for effective learning. Based on Gagne’s nine step framework for planning effective instruction, appropriate strategies and interventions were identified and aligned with the learner needs of the participants.

(1) Identifying learning objectives

Table 4.2 lists the 20 objectives that candidates who attend and successfully complete the new tailored pdCPR intervention are expected to realise. These objectives are a result of the systematic consensus agreement, as discussed in sections 4.1.1, and 4.3.2, and represent a list of learning outcomes including intellectual skills, cognitive strategies, verbal information, motor skills and attitudes. As discussed in section 4.3.3, each of the 20 learning objectives is presented with a clearly specified condition under which the learner is expected to exhibit the desired behaviour (i.e. knowledge, skill or attitude, etc.), a measurable performance that will demonstrate that the intended objective has been attained as well as a standard describing the quality of the work required to achieve an acceptable level of performance (see Table 4.16 for example).

(2) Identifying learner prerequisites to learning

As illustrated in Table 4.8, 95% of the participants agreed that there should be established pre-course requirements with pre-course reading. This need for pre-course work is supported by the reflector and theorist learning styles of the participants which were identified and then presented in Figure 4.2. However, as indicated by the results of the pilot tests (section 3.7.1.1.), in order to provide candidates with sufficient opportunity to read essential pre-training materials or complete assignments, they should receive such materials at least seven days before attending the course. In addition, it is essential that the pre-course material take into account the feedback provided by learners who have attended traditional training. These learners frequently indicated that the material used in these traditional training courses often contained unrelated course content (poorTRAIN3), lacked trustworthiness (poorTRAIN5), was difficult to obtain (poorTRAIN13), and lacked information boundaries (poorTRAIN14) – see Table 4.10.

(3) Identifying instructor prerequisites

Table 4.8 revealed that the majority of participants (92%) agreed that instructors had to be experienced, that they had to possess a formal and related qualification and that they also had to be proficient in the language of instruction – see Table 4.14. The need for experienced instructors is further supported by the reflector and theorists learning styles of the participants as illustrated in Figure 4.3. These types of learners thrive when working closely with an instructor who is experienced as they prefer learning

through observation and discussing their reflections and plans with a mentor who has real life experiences. In addition, as shown in Table 4.10; inconsistent teaching methods (poorTRAIN2), complex instruction (poorTRAIN6), lack of supervision (poorTRAIN9), low instructor feedback regarding ways in which to improve (poorTRAIN10), inadequate instructor skills and knowledge (poorTRAIN11) all constituted categories of the responses generated by the qualitative data analysis, thus emphasising the impact of the absence of a quality standard for pdCPR training instructors

(4) Recording the characteristics and learning style preferences of the learners

The Honey and Mumford learning styles questionnaire, which was used to determine and measure the learning style preferences of the participants, showed that the participants had exhibited primarily the reflector and theorist preferences for learning – see Figures 4.2 and 4.3. As discussed in section 4.3.4 these types of learners are associated with specific learner characteristics. The reflector learner is an individual who prefers to collect information and sift through such information. This type of learner is typically extremely cautious and thorough and prefers to observe rather than take the lead in carrying out a task. Such individuals are slow to make up their minds but, once they do, their decisions are usually very soundly based, not only on their own knowledge and opinions but also on what they have learned from watching and listening to others. On the other hand, the theorist learner lives in a world of ideas. Such learners have tidy, organised minds. They are not happy until they understand something. They then explain their observations in terms of basic principles. They want to know the logic behind actions and observations and dislike subjectivity and ambiguity.

Theorists also tend to be detached, analytical and dedicated to rational objectivity rather than to anything subjective or ambiguous. Their approach to problems is consistently logical. This is their “mental set” and they rigidly reject anything that does not fit this mental set. As a result they prefer to maximise certainty and feel uncomfortable with subjective judgements, lateral thinking and anything that is not serious. Providing theorists with factual evidence to support new changes to existing protocols is a condition of the extent to which they accept new theories and teachings. As illustrated in Table 4.8, 90% of the participants agreed that training interventions

should be of an established duration with a structured format and as shown in Table 4.14 also include pre-established times for breaks. The results of the pilot study and the additional testing as discussed in section 3.8 supported the proposal that classes of 6 candidates per instructor and no more than 12 candidates per class are appropriate. This was also revealed by the coded qualitative data category of poorTRAIN4 – see Table 4.10. The frequency with which the participants indicated, during the qualitative interviews, that training requirements should be built into the paramedics' rosters suggests their probable apathy should they be required to attend training scheduled during their off-time. Conducting training during their regular shift cycles may motivate paramedics to attend training updates more regularly, thus helping them to remain clinically current without working more than their normal allocated hours. As indicated in poorTRAIN12, this appeared to be a significant deficit in traditional training. Furthermore, as shown in Table 4.10 under both poorTRAIN1 and poorTRAIN8, it is imperative that proposed training interventions make provision for more actual hands on practice and reduce the time between instruction and skills practice.

(5) Selecting the media for instruction

Reflectors often think too much and, therefore, they are frequently at risk of doing nothing. These learners thrive when they are offered the opportunity to participate in group decision-making activities whenever possible and they try to apply the information that they possess in as practical a manner as possible. The ideal, however, is finding a group dynamic that removes the spotlight away from individuals but also allows and encourages input from all candidates. Audio-visual media works for reflectors but it should be reinforced by facts and locally relevant content as reflectors dislike ambiguity. As depicted in Table 4.8, 86% of the participants agreed that the training intervention should include established content that specifically covers the knowledge and skills which is the most likely to result in successful resuscitation during an OHCA (Table 4.8). As a result the media of instruction used should aim to reinforce such knowledge and skills but also not detract from existing, unrelated information. As indicated in poorTRAIN13, all the material required by learners should be provided by the training instruction and, ideally, emanate from a central source that keeps track of the extent and level of engagement which learners have with the material and learning media platforms provided.

(6) Planning to motivate the learners

As illustrated in Table 4.8, the majority of the participants (91%) agreed that the ambulance services themselves should be responsible for ensuring the consistent and optimal CPR performance of their paramedics. This finding is further supported by the qualitative data findings, as coded as improveCPR1 and presented in Table 4.14. Table 4.14 contained excerpts of narrative data in which the participants repeatedly mentioned the need for governance to monitor and regulate current CPR clinical proficiency by tracking, registering and regulating their paramedics and by ensuring that their paramedics attend both pdCPR training and regular updates. Thus, the motivation to attend and engage in learning should also arise from the ambulance services to enable them to ensure that their staff are trained. Motivation does not necessarily have to consist of rewards [285]. Often communicating to staff the value and benefit of training, publishing skill attrition studies and emphasising the types of assessments that will be conducted diminishes the stress and apprehension on the part of staff members as regards additional training [286].

(7) Ensuring that learners are excited and motivated to learn the content

If the resources are available, paying learners overtime for attending training may prove successful [285]. However, in most cases motivation may have to encompass more than just reward and include the concept of accountability in terms of which staff members realise that there may be repercussions if they either do not attend training or engage fully with the provided pre-course material [287]. An appropriate way in which to foster both motivation and also a sense of accountability is to combine pre-course material with assignments and measurable outcomes from the outset [276]. A further way is to publicise how the new training has been adjusted to meet the needs of learners as expressed in feedback forms [328]. As depicted in Tables 4.8, 4.9, and 4.10, there are numerous perceived deficits in respect of traditional training while new training interventions may improve on these deficits. In order to encourage learners to attend future training new training intervention notice boards that advertise such interventions should specify how the training interventions have been improved and also provide detailed information about the duration and structure of courses as well as how learners are likely to benefit from such courses

[327]. Thus, these notice boards should provide details of new information, updates, points attained for continuous professional development (CPD), etc.

(8) Testing the instruction with the learners in the form of formative evaluation

It is essential to evaluate the training with a small of group of learners before administering such training to the entire group. As discussed by Kirkpatrick [328], enquiring how trainees feel about the instructor, topic, material, its presentation, the learning activities, and the venue where the training was provided provides the developers of the training with feedback from the end user. This feedback helps with the identification of areas that have the potential to hinder training outcomes in the long term. Identifying these areas before the actual and full roll out of training interventions provides the opportunity to improve the training through focused solutions as well to save time and resources [276,328]. As discussed in section 3.7.2, while waiting for the HMCAS Standard and Guidelines Committee to assess the suitability of training programmes, a smaller project was initiated in which the training intervention created for the purposes of the study and the effect of this intervention on pdCPR performance were compared to the pdCPR performance of a group of paramedics with comparable backgrounds and education and who had attended the training intervention traditionally used by the HMCAS. The outcomes of this small project were accepted and published in the peer reviewed Emergency Medicine Journal (see Appendix L)

(9) Conducting summative evaluation to judge the effectiveness of the instruction

As illustrated in Table 4.8, 97% of the participants agreed that the training intervention should include established, non-discriminatory methods of assessment. ImproveCPR8, as presented in Table 4.14, further supports the addition of assessments as a reliably objective process with which to measure candidate competency. As discussed in section 2.8.8, perhaps one of the most widely used training evaluation models is the Kirkpatrick four level training evaluation model [328]. In view of the fact that pdCPR performance was measured in a simulated training environment it was measured at level two of the model. The goal of level 2 is to measure the extent of the learning that has actually occurred as a result of the training. In order to reliably and objectively measure competence though, as per the

requirements presented in Table 3.4, a tool that was able to address these requirements had to be developed and tested [354].

4.3.6. Step 6 – Training intervention activities and instruction

Identifying the structure, format, course duration and learning experiences is the final step in the developmental process to ensure that the intended aim of the training intervention was reliably achieved. Table 4.18 presents the tailored pdCPR training intervention as an end product. The main components of the training intervention include:

(1) Admission to the training intervention

Paramedic new recruits who will be required to perform CPR in adult patients with cardiac arrest will be expected to attend and successfully complete the training intervention. This intervention is also used as for CPR re-certification training that paramedics will need to undertake on an annual basis to remain clinical current and proficient in CPR at HMC Ambulance Service.

(2) Duration of the programme

To meet both operational needs, as well as limit costs on the ambulance service, the duration of the course will remain at 8 hours; however training dates will be scheduled during paramedic's normal shifts to encourage wakefulness and increased concentration during course attendance.

(3) Instructor to candidate ratio

To ensure that all candidates receive adequate facilitation and hands-on-practice time and corrective feedback from experienced and qualified instructors, one instructor per six candidates is permitted. A class can be conducted with a minimum of six candidates and a maximum of 12.

(4) Candidate pre-work activity

All candidates will receive locally developed and tailored pdCPR material at least seven days before commencement of the course. They will also need to log-on to a learning management platform and watch a locally developed video of ideal CPR performance. Once this is complete they are required to complete pre-course

assignment, and study for a pre-course test. The pre-course material includes all possible information one would need for successful completion of the course. The document has the learner objectives, as well as the assessment tools that would be used to determine candidate proficiency. The need for clear objectives at the outset is important for individuals with theorists learning styles as they think problems through in a vertical, step-by-step logical way. They also tend to be perfectionists who don't necessarily rest easy until things are tidy and fit into a rational scheme. For these types of individuals a clear set of measurable objectives are suited especially when provided early enough. Reflectors on the other hand learn much from books, articles and case studies, therefore providing them with additional reading, case studies, and examples of real cases are likely to optimise their learning experiences even before they enter the classroom.

(5) Overview of course

Once candidates have been registered, and their pre-course assignments are collected, they will need to undergo the first of three tests. On completion of the test, candidates will receive a multi-media audio-visual presentation that will repeat, clarify, and enforce key messages already covered in the pre-course assignment. In addition, a focused presentation to cover ideal pdCPR performance in an actual real life cardiac arrest allows reflectors who normally prefer to stand back to ponder experiences and observe them from many different perspectives the opportunity to witness the quality standard of pdCPR that will be expected from them at the end of training and when working out on the road.

Immediately after the presentation, candidates are handed back their tests and requested to grade themselves based on answers provided and discussed through by the instructor. The goal of this exercise is to use assessment as a learning tool as well as a tool that allows candidates to identify and accept their knowledge gaps. Allowing reflectors to self-grade themselves takes away the added pressure of colleagues asking them to disclose grades, understand how questions should be answered, and most of all, also allows them to acknowledge areas and opportunities for improvement.

Once tests are completed, graded and returned candidates are shown a locally developed pdCPR video that demonstrates the quality standard of how pdCPR

should be performed and will be assessed. To reflectors the thorough collection and analysis of data about experiences and events is what counts so they tend to postpone reaching definitive conclusions for as long as possible. As discussed earlier, their philosophy is to be cautious, and while this is appropriate for some instances it may not be ideal for an emergency and time sensitive situations such as a cardiac arrest. Showing reflectors the exact behaviours that is expected of them and what they will be assessed against will preclude behaviour they are known for, i.e. being overtly thoughtful people who like to consider all possible angles and implications before making a move. A clear picture removes ambiguity and decreases the likelihood that different learners may interpret verbal instructions differently.

The next step in the process is to provide candidates with multiple rounds of peer review and structured feedback in performing single key skills that form part of the initial process of recognition of cardiac arrest; starting and performing high quality CPR, rhythm identification, shock delivery, and application of a mechanical chest compression device. Theorists like to analyse and synthesize information into bite sized chunks. They are keen on understanding parts of the puzzle and then deciphering how each part fits together. Their philosophy prizes rationality and logic. These learners however often rely too much on information they already know to infer logic instead of being innovative and adapting to new theories or situations. As a result, facts to support or negate new teachings should be provided as early as possible even before new theories are proposed. Reflectors on the other prefer to take a back seat in meetings and discussions however they also enjoy observing other people in action. They listen to others and get the message of the discussion before expressing their own views. They tend to adopt a low profile and have a slightly distant, tolerant composed air about them. When they act it is part of a wide picture which includes the past as well as the present and others' observations as well as their own. Reflectors therefore thrive on feedback until proficient or skill mastery is gained.

Cardiac arrest in special circumstances often needs a tailored or different resuscitation approach. For these rare eventualities participants are placed in teams, and required to work out, write down, and present preferred or ideal management for different and less frequent OHCA scenarios. Since reflectors prefer to collect data, both first hand and from others, and prefer to think about it thoroughly before coming to a

conclusion, providing them with paper scenarios of different OHCA situations to think and discuss through in small groups is an example of how this can be achieved given the time constraints. Theorists on the other hand adapt and integrate observations into complex but logically sound theories. They typically embrace past experiences but assimilate stories and facts into coherent theories. As a result strict facilitation is required here to avoid time-wasting on anecdotal events and instructor feedback should focus on the provision of facts over stories of past experiences, particularly when time is an essential consideration.

Once the paper scenarios of special situations cardiac arrests are presented, learners are placed in teams of two; the team dynamic that they would work if responding to a real life OHCA, and perform practice rounds of simulated cardiac arrests with different first monitored rhythms; i.e. shockable or non-shockable. This process allows learners to assimilate singular skills conducted in the peer review and structured feedback cycles into a compound fully drawn out cardiac arrest simulation.

The training intervention ends with participants doing a post-course test and a final simulated cardiac arrest assessment.

Table 4.18 PdCPR training intervention

Admission to training intervention	New recruits to HMCAS Refresher training for APs
Duration of programme	One full day programme (6-8 hours)
Required instructor to candidate ratio	<ul style="list-style-type: none"> One instructor per 6 candidates (Minimum of 6 and maximum of 12 per class)

Candidate pre-course work or activity	<ul style="list-style-type: none"> • Read prescribed pre-course document • Watch prescribed pre-course demonstration of pdCPR • Complete pre-course assignment • Study for pre-course test
CPR training intervention overview	<ul style="list-style-type: none"> • <i>Course registration</i> • <i>Collection of pre-course assignment</i> • <i>Pre-course test</i> • <i>Theory component</i> • <i>Mark pre-course test – discussion</i> • <i>Simulated OHCA demonstration (Video)</i> • <i>Skills with peer feedback cycles</i> • <i>Manage and present paper scenarios</i> • <i>Simulated OHCA performance</i> • <i>Post-course test</i> • <i>Mental practice and modelling sessions</i> • <i>Simulated OHCA competency assessment</i>
Theory component	<ul style="list-style-type: none"> • Reinforce elements from pre-course reading and video • Role and impact of CPR • Physiological consequences of CPR • Non-technical skills
Individual skills component	<ul style="list-style-type: none"> • Recognition of cardiac arrest • Hand positioning for chest compressions • Compression rate • Compression depth • Compression release ratio • LUCAS application • Airway management • Provision of synchronised ventilations
Practice component	<ul style="list-style-type: none"> • Skill component – Individual practice with feedback until mastery achieved. • Candidates placed in teams of two to complete and demonstrate outcome of paper scenario • Mental practice and modelling prior to simulated OHCA assessment
CPR training competency assessments	<ul style="list-style-type: none"> • Continuous assessment • Pre-course assignment: 10% • Pre-course test: 20% • Post-course test: 20% • Simulated OHCA assessment: 50%

4.4. OBJECTIVE 4

Implement the new tailored training intervention and then describe the pdCPR performance of APs post-training and at specified time intervals.

4.4.1. PdCPR performance post training

The CPR performances of **Sample 2** participants were evaluated after they had received the CPR training provided by the traditional CPR training intervention (**TraditionalCPRInt**). Using a RET, a rating of "competent" was calculated for the four categories of process measures. The test protocol was then repeated on a second group of participants (n = 156) who had received the CPR training provided by the tailored programme developed in this study (**TailoredCPRInt**).

The total proportion of participants rated as competent, as reflected by the RET, was higher in the group that had undergone the TailoredCPRInt 144/156 (92.3%) versus 13/100 (13%) ($p=0.196$) for the group that had undergone the TraditionalCPRInt (Table 4.19). The TailoredCPRInt group performed significantly better ($p < 0.01$) in all four of the categories of process measures, namely, (1) basic life support skills; (2) condition specific skills; (3) specific overall skills and (4) non-technical skills, compared to the TraditionalCPRInt group. Specific improvements in the TailoredCPRInt as compared to the TraditionalCPRInt group were seen in cardiac arrest detection time (75% vs. 100% respectively), chest compression position (63% vs. 96.15%), ratio (14.3% vs. 96.15%), depth (61% vs. 94.87%); and rhythm identification (65% vs. 98.07%) as well as in processes B1,B2,B4-B6,C1-C7,D1-D3 as depicted in Table 4.19.

Table 4.19 Observed proportions of process measures achieved at baseline

Process measures	Process measures achieved		P value post Bonferroni correction
	Traditional Programme (n = 100) Yes/No	Tailored Programme (n = 156) Yes/No	
A1. Loud shout and shaking used to determine unconscious state in < 5s	100/0	156/0	1.00
A2. No or agonal breathing detected on visual inspection of chest in < 10s	91/9	151/5	0.053
A3. Compressions started < 15s from patient contact	75/25	156/0	P<0.01
A4. Chest compressions : 100 in total =< 1 minute	100/0	156/0	1.00
A5. Chest compressions : Correct position at lower half of the sternum	63/37	150/6	P<0.01
A6. Chest compressions : Correct ratio at 50 : 50 with no chest leaning	75/25	150/6	P<0.01
A7. Chest compressions : Correct depth at one third of chest depth	61/39	148/8	P<0.01
A8. Rhythm analysis < 1, 20s from patient contact	96/4	152/4	0.715
Aggregated basic life support skills(Sum of A1 through A8)	661/139	1219/29	P<0.01
B1. Rhythm identification correct	65/35	153/3	P<0.01
B2. Composite process measures B2	94/6	156/0	P<0.01

B3. Composite process measures B3	100/0	156/0	1.00
B4. Composite process measures B4	82/18	154/2	P<0.01
B5. Composite process measures B5	96/4	156/0	P<0.01
B6. Composite process measures B6	98/2	156/0	0.151
B7. Composite process measures B7	99/1	156/0	0.390
B8. Composite process measures B8	47/53	151/5	P<0.549
Aggregated condition specific skills (Sum of B1 through B8)	681/119	1238/10	P<0.01
C1. Correct sequence of events	78/22	149/7	P<0.01
C2. Interruptions in chest compressions < 10s	17/83	148/8	P<0.01
C3. LUCAS position correct throughout cardiac arrest event	75/25	154/2	P<0.01
C4. Ventilations < 10 per minute	48/52	148/8	P<0.01
C5. Medications correct: time/dose/interval	82/18	154/2	P<0.01
C6. Rhythm treatment correct	35/65	152/4	P<0.01
C7. Defibrillation correct: time /safe/ joule	65/35	153/3	P<0.01
Aggregated condition specific skills (Sum of B1 through B8)	400/300	1058/34	P<0.01
D1. Good leadership and scene control non-technical skills	70/30	153/3	P<0.01
D2. Good situational awareness non-technical skills	52/48	150/6	P<0.01
D3. Good communication non-technical skills	66/34	149/7	P<0.01
Aggregated Non-technical skills (Sum of D1 through D8)	188/112	452/16	P<0.01
Observed proportions achieved: Rated as overall competent	13/87	144/12	0.196

4.4.2. PdCPR performance at various time intervals

Repeat tests which were conducted at 1, 3 and 6 months after the initial training showed a decrease in the pass rates from 93.75% post initial training to 33.33% at the final testing, six months after the initial testing (Figure 4.7). Table 4.20 presents the scores achieved by participants across all four categories over the 6 month period.

Figure 4.7 Percentage of participants rated as competent over time

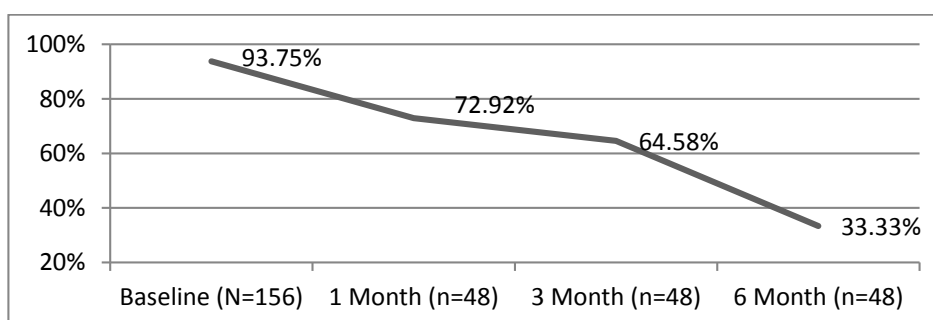


Table 4.20. Proportions of categories achieved over 6 month period

Categories of process measures	Baseline	1 Month	3 Month	6 Month
BLS Skills	97.68%	96.35%	92.71%	87.24%

Condition specific skills	99.20%	96.61%	97.40%	91.93%
Specific overall skills	96.89%	97.92%	95.83%	92.26%
Non-technical skills	96.58%	93.75%	89.58%	84.72%
Rated as competent	93.75%	72.92%	64.58%	33.33%

4.4.3. PdCPR performance at 1 month post training.

The total proportion of participants rated as competent, as reflected by the RET, was lower ($p = 0.011$) after 1 month (93.75% (45/48) as compared to. 72.92% (35/48) respectively) at baseline. As illustrated in Table 4.21 there was no evidence of significant degeneration ($p > 0.01$) in the individual process measures from baseline to 1 month although there was significant degeneration in the aggregated BLS skills (sum of process measures A1 through A8) and the condition specific skills (B1 through to B8).

Table 4.21 Observed proportions of the process measures achieved at 1 month

Process measures	Process measures achieved		P value post Bonferroni correction
	Baseline (n = 48) Yes/No	1 month (n = 48) Yes/No	
A1. Loud shout and shaking used to determine unconscious state in < 5s	48/0	48/0	1.00
A2. No or agonal breathing detected on visual inspection of chest in < 10s	47/1	46/2	1.00
A3. Compressions started < 15s from patient contact	48/0	48/0	1.00
A4. Chest compressions : 100 in total =< 1 minute	48/0	48/0	1.00
A5. Chest compressions : Correct position at lower half of the sternum	48/0	47/1	1.00
A6. Chest compressions : Correct ratio at 50 : 50 with no chest leaning	47/1	46/2	1.00
A7. Chest compressions : Correct depth at one third of chest depth	48/0	44/4	0.117
A8. Rhythm analysis < 1, 20s from patient contact	47/1	43/5	0.203
Aggregated basic life support skills(Sum of A1 through A8)	381/3	370/14	P<0.01
B1. Rhythm identification correct	48/0	48/0	1.00
B2. Composite process measures B2	48/0	47/1	1.00
B3. Composite process measures B3	48/0	48/0	1.00
B4. Composite process measures B4	46/2	43/5	0.435
B5. Composite process measures B5	48/0	48/0	1.00
B6. Composite process measures B6	48/0	48/0	1.00
B7. Composite process measures B7	48/0	46/2	0.494
B8. Composite process measures B8	46/2	43/5	0.435
Aggregated condition specific skills (Sum of B1 through B8)	380/4	371/12	P<0.01
C1. Correct sequence of events	45/3	48/0	0.242
C2. Interruptions in chest compressions < 10s	46/2	42/6	0.163

C3. LUCAS position correct throughout cardiac arrest event	48/0	48/0	1.00
C4. Ventilations < 10 per minute	45/3	48/0	0.242
C5. Medications correct: time/dose/interval	46/2	48/0	0.247
C6. Rhythm treatment correct	48/0	47/1	1.00
C7. Defibrillation correct: time /safe/ joule	48/0	48/0	1.00
Aggregated condition specific skills (Sum of B1 through B8)	326/10	329/7	0.475
D1. Good leadership and scene control non-technical skills	48/0	48/0	1.00
D2. Good situational awareness non-technical skills	46/2	41/7	0.094
D3. Good communication non-technical skills	47/1	46/2	1.00
Aggregated Non-technical skills (Sum of D1 through D8)	141/3	135/9	0.086
Observed proportions achieved: Rated as overall competent	45/3	35/13	0.011

4.4.4. PdCPR performance at 3 months post training

The total proportion of participants rated as competent, as reflected by the RET, was significantly lower ($p < 0.01$) after three months (97.91% (47/48) as compared to the 64.58% at baseline (31/17) respectively). As illustrated in Table 4.22 there was evidence of significant degradation ($p < 0.01$) in the individual process measures A4, A6, A7, B7 and D2 as well as aggregated the BLS skills (sum of process measures A1 through A8), the aggregated condition specific skills (B1 through to B8), the aggregated specific overall skills (C1 through C7) and the aggregated non-technical skills (D1-D3).

Table 4.22 Observed proportions of process measures achieved at 3 months

Process measures	Process measures achieved		P value post Bonferroni correction
	Baseline (n = 48) Yes/No	3 month (n = 48) Yes/No	
A1. Loud shout and shaking used to determine unconscious state in < 5s	48/0	48/0	1.00
A2. No or agonal breathing detected on visual inspection of chest in < 10s	47/1	44/4	0.361
A3. Compressions started < 15s from patient contact	48/0	42/6	0.013
A4. Chest compressions : 100 in total =< 1 minute	48/0	48/0	1.00
A5. Chest compressions : Correct position at lower half of the sternum	48/0	47/1	1.00
A6. Chest compressions : Correct ratio at 50 : 50 with no chest leaning	48/0	40/8	$p < 0.01$
A7. Chest compressions : Correct depth at one third of chest depth	47/1	39/9	$p < 0.01$
A8. Rhythm analysis < 1, 20s from patient contact	47/1	48/0	1.00
Aggregated basic life support skills(Sum of A1 through A8)	381/3	356/28	$p < 0.01$
B1. Rhythm identification correct	48/0	48/0	1.00
B2. Composite process measures B2	48/0	47/1	1.00
B3. Composite process measures B3	48/0	48/0	1.00

B4. Composite process measures B4	48/0	48/0	1.00
B5. Composite process measures B5	48/0	48/0	1.00
B6. Composite process measures B6	48/0	48/0	1.00
B7. Composite process measures B7	48/0	39/9	p < 0.01
B8. Composite process measures B8	48/0	48/0	1.00
Aggregated condition specific skills (Sum of B1 through B8)	384/0	374/10	p < 0.01
C1. Correct sequence of events	47/1	40/8	0.030
C2. Interruptions in chest compressions < 10s	48/0	42/6	0.013
C3. LUCAS position correct throughout cardiac arrest event	48/0	48/0	1.00
C4. Ventilations < 10 per minute	47/1	48/0	1.00
C5. Medications correct: time/dose/interval	48/0	48/0	1.00
C6. Rhythm treatment correct	48/0	48/0	1.00
C7. Defibrillation correct: time /safe/ joule	48/0	48/0	1.00
Aggregated condition specific skills (Sum of B1 through B8)	334/2	332/14	p < 0.01
D1. Good leadership and scene control non-technical skills	48/0	47/1	1.00
D2. Good situational awareness non-technical skills	48/0	37/11	p < 0.01
D3. Good communication non-technical skills	47/1	45/3	0.367
Aggregated Non-technical skills (Sum of D1 through D8)	143/1	129/15	p < 0.01
Observed proportions achieved: Rated as overall competent	47/1	31/17	p < 0.01

4.4.5. PdCPR performance at 6 months post training.

The total proportion of participants rated as competent, as reflected by the RET, was significantly lower ($p < 0.01$) after six months (97.91% (41/48)) compared to the 33.33% (16/48) respectively at baseline. There was evidence of significant degradation ($p < 0.01$) in the individual process measures A3 and B4 as well as the aggregated BLS skills (sum of process measures A1 through A8) and aggregated condition specific skills (B1 through to B8) - see Table 23.

Table 4.23 Observed proportions of the process measures achieved at 6 months

Process measures	Process measures achieved		P value post Bonferroni correction
	Baseline (n = 48) Yes/No	3 month (n = 48) Yes/No	
A1. Loud shout and shaking used to determine unconscious state in < 5s	48/0	46/2	0.494
A2. No or agonal breathing detected on visual inspection of chest in < 10s	46/2	40/8	0.090
A3. Compressions started < 15s from patient contact	48/0	38/10	p < 0.01
A4. Chest compressions : 100 in total =< 1 minute	48/0	46/2	0.494
A5. Chest compressions : Correct position at lower half of the sternum	43/5	45/3	0.491
A6. Chest compressions : Correct ratio at 50 : 50 with no chest leaning	43/5	38/10	0.260
A7. Chest compressions : Correct depth at one third of chest depth	42/6	37/11	0.195

A8. Rhythm analysis < 1, 20s from patient contact	47/1	40/8	0.030
Aggregated basic life support skills(Sum of A1 through A8)	365/19	335/49	p < 0.01
B1. Rhythm identification correct	45/3	48/0	0.242
B2. Composite process measures B2	48/0	43/5	0.056
B3. Composite process measures B3	48/0	45/3	0.121
B4. Composite process measures B4	48/0	40/8	p < 0.01
B5. Composite process measures B5	48/0	46/2	0.494
B6. Composite process measures B6	48/0	46/2	0.494
B7. Composite process measures B7	48/0	46/2	0.494
B8. Composite process measures B8	45/3	39/9	0.073
Aggregated condition specific skills (Sum of B1 through B8)	378/6	353/31	p < 0.01
C1. Correct sequence of events	46/2	38/10	0.027
C2. Interruptions in chest compressions < 10s	42/6	38/10	0.412
C3. LUCAS position correct throughout cardiac arrest event	46/2	45/3	0.680
C4. Ventilations < 10 per minute	45/3	47/1	0.616
C5. Medications correct: time/dose/interval	48/0	46/2	0.494
C6. Rhythm treatment correct	44/4	48/0	0.058
C7. Defibrillation correct: time /safe/ joule	45/3	48/0	0.242
Aggregated condition specific skills (Sum of B1 through B8)	316/20	310/26	0.445
D1. Good leadership and scene control non-technical skills	45/3	43/5	0.714
D2. Good situational awareness non-technical skills	44/4	36/12	0.052
D3. Good communication non-technical skills	44/4	43/5	1.00
Aggregated Non-technical skills (Sum of D1 through D8)	133/11	122/22	0.063
Observed proportions achieved: Rated as overall competent	41/7	16/32	p < 0.01

4.5. CONCLUSIONS

The data collected in the study revealed an improvement in the pdCPR performance after the participants had undergone the training provided by the tailored pdCPR intervention developed in the study. However, there appeared to have been notable degeneration in the pdCPR performance as early as 1 month after the initial training. Repeat testing at one, three, and six months after the initial training revealed that there was already degeneration in the aggregated process measures at 1 month while degeneration in the individual process measures was evident three months after the initial training. Nevertheless, the significant degenerations in the individual process measures at three months were found to be not as significant at 6 months with the exception of the individual process measure A3 (i.e. compressions started < 15s from

patient contact) which showed a significant degeneration at both three and six months after initial training.

CHAPTER FIVE

DISCUSSION

This study developed and tested a training intervention designed to improve the acquisition and retention of CPR knowledge and skills of APs. In order to develop this intervention, systematic consensus methods and mixed method research techniques were used to identify an operational definition of competent pdCPR performance as well as an assessment tool which was capable of evaluating all treatment actions, activities and procedures which reflected that performance standard in a valid and reliable way.

In order to test the training intervention, the pdCPR performance was evaluated in two groups of APs with comparable background education and experience. Group 1 (Control Group) had received CPR training via a conventional training intervention which was traditionally used to train paramedics (referred as the TraditionalCPRInt Group) while Group 2 (Experimental Group) had received CPR training via the tailored CPR training intervention (referred as the TailoredCPRInt Group) developed for the purposes of this study. The TailoredCPRInt Group underwent repeat evaluations at one, three and six month intervals after the initial training.

5.1. FINDINGS

The results of the study were presented in Chapter Four according to a linear investigative path which was aligned to the four interconnected research objectives. The purpose of this chapter is to synthesise the main findings of the study, discuss the investigator's interpretations of the findings, contextualise these findings and explain the implications and limitations of the findings.

5.1.1. Establishing an operational definition of pdCPR competence

Walter Shewhart, the father of statistical quality control, wrote: *"Being free from grease is not rigorously definite; to some people it means clean enough to eat on; to the experimental physicist it may, in some instances, mean baked out at high temperature under vacuum"* [391]. Shewhart claims that, in the absence of a general consensus regarding how or by which means data is collected, data would be collected differently by different people,

or differently each time data is collected and, as a result, it would be difficult to ascertain whether changes in the data were the result of either changes which had been tested or inconsistencies in the data collection [392].

In this study it was deemed essential to have agreement on the way in which the data which reflected pdCPR performance was to be collected. Such agreement would not only ensure that the entire data collection process would be consistent but also that the study would probably reveal whether changes in the pdCPR performance were the result of changes in the training as opposed to inconsistencies in the assessment. However, the general lack of specific and detailed measurements of CPR quality for all CPR providers including paramedics meant that there is no consensus on the way in which pdCPR performance data is collected. Accordingly, the study developed an operational definition (the term used for such an agreement) through systematic consensus in order to establish a communicable meaning of the term pdCPR competence. The study used this operational definition to specify how the concept would be applied in the context of and throughout the study. An important component of an operational definition is the statement of the measurement process to be used [393] and it is essential that this statement explains the method of measurement to be used and indicates set of criteria for evaluation [393,394]. The study formulated an operational definition of pdCPR competence (Table 4.1), as well as a set of criteria for evaluation of competence (Table 4.2) and a method of measurement (**Appendix C and D**) in order to ensure that the data collection process was consistent so as to achieve the aim of the study, namely, to show the true impact of the tailored CPR training intervention on pdCPR performance.

5.1.2. PdCPR performance and traditional training interventions

The study revealed that the pdCPR performance in a simulated OHCA scenario was poor when the training had been delivered via traditional training interventions. This was clearly evident in the significantly low proportion of participants who were rated as competent during a simulated OHCA evaluation when their training had been via a TraditionalCPRInt (Table 4.6). The fact that performance was poor for all categories of aggregated skills (i.e. (1) basic life support skills; (2) condition specific skills; (3) specific overall skills; and (4) non-technical skills) implied that a TraditionalCPRInt is unable to equip paramedics adequately with the knowledge and skills required to

perform effective CPR. While studies specific to pdCPR performance subsequent to training are largely non-existent, the underlying premise of the finding cited above is corroborated by similar context studies [68,77,137]. For example, Brennan et al. unambiguously demonstrated that half of their participants (50%) only had managed to assess breathing and pulse correctly during the initial steps involved in recognising cardiac arrest, 50% only were able to perform both compressions and ventilations correctly while only 35% managed to achieve a compression rate of between 80 to 100 per minute immediately after undergoing a traditional CPR training course [137]. This study of Brennan et al. is not unique and, in many ways, its findings are consistent with previously published data as well as studies subsequent to their study [68,77]. Overall the study discussed in this dissertation validated findings from previously published, similar context studies which reported that, in the main, CPR performance was found to be poor after training. The study also provided sufficient evidence to support previous arguments that inadequate teaching, lack of proper instruction and limited hands-on practice were the likely causes of such poor performance rather than the learners experiencing difficulties in remembering and performing CPR.

In addition to evaluating the impact of training on training outcomes, this study yielded data which reflected pdCPR performance in real life OHCAs. Consistent with the findings reported by Krarup et al. [39], Wang et al. [210], Wik et al. [38] and many other similar context studies (**Appendix A**) the study revealed that the degeneration that occurs between the skills acquisition and actual performance extends beyond classroom activities. The findings from the qualitative data analysis of the information contained in actual patient report forms, a cardiac registry, death in care reviews and root cause analyses revealed that the CPR delivered by APs was rarely in line with established resuscitation guidelines. The data identified ten broad categories of factors which reflected of poor pdCPR performance. Although all ten categories are not regularly cited in existing literature, the three sub-themes into which the ten broad categories may be grouped (i.e. poor *technical skills*, poor *non-technical skills*, and *non-compliance with established guidelines and processes*) are frequently cited in the literature on factors related to poor CPR performance [38,39,168].

5.1.3. PdCPR training and pdCPR performance

Mancini et al. [68], Kaye et al. [77] Chamberlain [79] Perkins et al. [367] and many other known experts in resuscitation have, over the years, made the claim that CPR training inevitably impacts on training outcomes and performance. This study also provides convincing evidence in support of this claim. This was clear in the significantly higher proportion of participants who were rated as competent after the training had changed as compared to those who had undergone the traditional training. This, in turn, implies that the training individuals receive directly impacts on the manner in which they perform CPR in a simulated OHCA. Using data source triangulation, the study identified 14 categories of factors related to poor pdCPR training. These factors were grouped into three sub-themes relating to the *design*, the *instructor*, and the *content and content delivery methods* of training interventions. *Environmental factors* have also been found to contribute to poor pdCPR performance. While studies in the past have reported on environment factors and discussed their impact on CPR performance, it would appear that very little has been done to address these environmental factors [396,397]. Mechanical chest compression devices may be a possible solution in settings in which it is difficult to perform manual CPR as a result of environmental factors. However, it would seem that the introduction of these devices is precluded by the overarching argument that they are of no superior benefit to patient outcomes as compared to manual CPR. While this may be true based on current evidence, in settings in which manual CPR is difficult to perform as a result of environmental factors (e.g. poorENVIR1, poorENVIR2, and poorENVIR3 as illustrated in Table 4.13), mechanical chest compressions may be the only source of consistent, continuous compressions.

5.1.4. A systems approach to improving pdCPR performance

While the focus of the study was on developing and testing a tailored pdCPR training intervention, the data collected provided an appreciation of the benefit of systems that ensure governance and supervision, particularly at the local and organisational level. These findings are consistent with the claims of Travers et al. [24] and Neumar et al. [29] that improvements to training are merely the starting point to improving pdCPR. Overall, consistent and long-term improvement systems require iterations of

the real-time assessment of performance to ensure timely and effective interventions to improve care continually. However, such proactive, real-time and focused actions which address the challenges and deficiencies identified in CPR are only likely to happen when governance and supervision are provided at the grass roots level (i.e. by the ambulance service itself) rather than a national or international statutory body as is traditionally the case.

5.1.5. Tailored training

As discussed in Chapter Two, the gap that exists between the body of scientific evidence on resuscitation guidelines and their optimal implementation is probably the result of training that has not been tailored to the operational role of CPR-providers in the context of a health care system response to an OHCA. In addition to training that is not tailored, there is training that may not be clinically relevant or which does not reflect the operational case-mix of the learners. In tandem these hurdles attenuate assimilation and the seamless transition from classroom simulated scenario activities to real-life performances [69].

Existing data continues to indicate that, despite the global movement aimed at augmenting and improving CPR training for all providers, the acquisition and long-term retention of CPR knowledge and skills remain a challenge. As a result there is an ongoing inquiry into the factors that influence both the acquisition and the retention of such knowledge and skills. It is anticipated that the findings from this study will contribute to the growing support for tailored training as a means of improving training outcomes. However, tailored training extends beyond health care workers. Mancini et al. [67] reported that the traditional, classroom-based instruction of CPR has failed to achieve the desired rates of bystander CPR. In their study Mancini and colleagues showed that tailoring CPR training to include video self-instruction (VSI) provided a more accessible alternative to traditional classroom instruction. Tailoring the training to the needs of the learners (i.e. taking training to the bystander learner as opposed to having the learner come to a central place to learn) resulted not only in the production of more providers of CPR but the VSI resulted in an improved overall CPR skill performance. This study demonstrated that CPR performance is improved when the training is tailored to meet the needs and

learning styles of the learners and it is designed specifically for the scope of practice, educational background, learner preferences and operational role of APs. This is clearly evident in Chapter Four, which illustrates that the proportion of TailoredCPRInt AP performances rated as competent was significantly higher as compared to the proportion of competent TraditionalCPRInt AP performances.

5.1.6. The tailored CPR training intervention (TailoredCPRInt)

The study identified several locally relevant principles for the contextualised effective pdCPR teaching and learning. These principles then informed the framework within which a TailoredCPRInt was created. It is important to note that the TailoredCPRInt is the product of a major redesign and not merely a reorganisation or repackaging of existing training interventions or programmes. The core goal of the TailoredCPRInt is to train APs to effectively manage the first 10 minutes of OHCA from the time they arrive on scene. Based on available evidence this would appear to be the time frame during which pdCPR is the most likely to have any positive effect on patient outcomes [5,42,68]. It is also believed, that although important, adding additional information and material outside of this ten minute window detracts from the core goal of the acquisition of CPR knowledge and skill [68,70].

The subject matter of the TailoredCPRInt and the TraditionalCPRInt is the same. However, the overarching difference is to be found in the way in which the content is delivered in both training interventions and the requirements to ensure the acquisition and long term retention of CPR knowledge and skills by the learners. For example, the TailoredCPRInt requires learners to memorise the first steps of pdCPR only (i.e. early recognition, early compressions, early rhythm analysis and early and correct defibrillation). The requirement then extends to the learners using an aide-memoir to inform and direct the next steps, during both during training and real-life OHCAs. On the other hand, the TraditionalCPRInt directs learners to memorise all the steps and sequences of pdCPR.

As reported by McEvoy et al [41], the impact of even slight omissions and deviations from the established guidelines on patient outcomes is both too significant and too pronounced for them to be left entirely up to the memory and recall of CPR-providers. There is also growing support for the claim that APs are less likely to deviate from

established CPR protocols, the required chest compression fractions and compression to ventilation ratios if an aide- memoire is used than may otherwise be the case. The study also claimed that the integration of the aide memoir into the choreographed AP response to OHCA inevitably diminishes the embarrassment that usually arises from the use of aide-memoirs.

While previously published studies report that pre-training reading does not impact positively on the acquisition and retention of knowledge and skills [395], this study claims that a degree of acquired or pre-established knowledge is necessary for successful completion of the TailoredCPRInt. In order to ensure that the pre-established knowledge on the part of learners reflected the same subject content the TailoredCPRInt recognised the need for a prescribed, pre-training, reading document (**Appendix K**). However, the data resulting from the pilot test of the TailoredCPRInt provided sufficient evidence that learners are unlikely to read the prescribed reading in the absence of a compulsory, pre-training assignment and pre-training test which compelled the learners to read and understand the content contained in the pre-training document.

The TailoredCPRInt also identified the benefit of assessment in order to evaluate competency as well as to supplement learning. Using the same RET to evaluate performance during practice OHCA simulations provided learners with the opportunity to receive immediate and targeted corrective feedback. In the same vein, the use of multiple, peer audit, feedback iterations enabled learners to receive prompt and corrective feedback from multiple peers in multiple practice cycles up to the point at which skill mastery was achieved. The influence of real-time feedback on CPR quality is consistent with the findings of previous studies and extends further than simulated based scenarios. Bobrow et al. [398] demonstrated that the implementation of resuscitation training, combined with real-time audiovisual feedback, were independently associated with improved CPR quality, an increase in survival and favourable functional outcomes after out-of-hospital cardiac arrest.

Furthermore, the use of a contextualised, locally relevant and customised CPR video which demonstrated the ideal or expected pdCPR performance proved to be of

tremendous value in narrowing the gap that often exists between expected performance and actual performance (*The TailoredCPRInt 10 minute video made specifically for the purposes of this study is available on request*). The hallmark of the video is its practise-what-you see approach and which has been seen in similar studies that made use of videos and which have seen notable successes in improved skill performances [66,93,399].

In view of the fact that the focus of the TailoredCPRInt was to steer learners towards the mastery of core skills and the treatment of the condition of cardiac arrest and not particularly on the underlying aetiology (which appears to be somewhat counterintuitive), the learners were deliberately given four types of OHCA only as simulated practice scenarios. These included OHCA with either a shockable VT or VF or a non-shockable Asystole or PEA as the first contact, initial, monitored rhythm. In order to expose the learners to the wide range of different OHCA scenarios where OHCA management may require a slight alteration (e.g. a pregnant patient, geriatric, entrapped patient, overdose, hypothermic, etc.), the learners were given paper scenarios and asked to discuss and explain how they would manage these less frequent and largely exceptional cases. While these activities were intended to cover the “what if” scenarios, the underlying aim of this activity was to steer the discussion towards and promote understanding as regards the learners’ intuitive perceptions of their actions and the resultant consequences. As discussed in Chapter Two, the aim of such an educational activity – termed mental modelling – is to shape the learners’ thinking and behaviour and, ultimately, to establish an approach to solving problems, particularly those problems involving the less frequent, but countless, exceptional cases which may arise.

5.1.7. Evaluating pdCPR performance

While the judgment of instructors on its own is not sufficient to determine learner competence, it is still not feasible for the currently available technical equipment and high fidelity manikins to replace experienced instructors. The main reason for this is because CPR requires both wide medical knowledge and technical skills [400]. Although technical skills may be more reliably evaluated by technical equipment, the evaluation of overall performance requires instructors, and involves the use of

checklists [354]. It must be noted, however, that a combination of feedback from CPR reports generated by technical equipment such as the high fidelity manikin such as a SimMan3g or the Physio-Control Code-stat® CPR software application, and debriefing reports provided by instructors evaluating overall performance, has been shown to provide the most comprehensive reports [354].

5.1.8. PdCPR performance during repeat tests

The study revealed that, while the TailoredCPRInt is capable of adequately equipping learners with the knowledge and skills required to perform competent pdCPR in a simulated OHCA scenario, such competency may deteriorates in as short a time as one month after initial training. The time intervals for CPR skill deterioration are known to vary from between 1 month and 12 months after initial training although general consensus regarding an established timeframe is, however, still lacking [245]. The deterioration of skills over time has been associated with the type of training interventions employed, variations in course structure and design, and the time interval between training and reassessment [400-403]. Although this study did not prescribe a time frame within which retraining should take place, it was clear that significant deterioration in individual skills had occurred as early as three months after initial training [403-405]. On the basis of this finding it is reasonable to conclude that initial training should always include specific plans for refresher sessions because even tailored CPR training interventions are unlikely to impart permanent, optimum skills and knowledge.

5.2. IMPLICATIONS OF THE STUDY FINDINGS

There is consensus that paramedic-delivered CPR quality is often suboptimal and that changes are required in order to improve OHCA outcomes. The tailoring of CPR training with the aim of improving the acquisition and retention of CPR knowledge and skills has long been recommended as one strategy for improving performance. The result of this study contributes, in part, to validating this recommendation, demonstrating that tailoring CPR training to the operational role of a healthcare practitioner within a healthcare systems response to OHCA, the practitioners' clinical

scope of practice, educational background, learner characteristics, learning styles, and learning needs would likely ensure improved acquisition and retention of CPR knowledge and skills, with subsequent improvement in CPR performance during a simulated OHCA assessment.

This study also showed that while new resuscitation guidelines appear to have improved the process of CPR, overall performance following traditional pdCPR training, as evaluated in a simulated OHCA assessment, remains poor, as seen in the low proportion (13%) of participants that were rated as competent following the traditional CPR training programme. This finding is consistent with previous reports. The tailored programme's approach in preparing learners before the course by using precourse reading and a precourse assignment appears to have reduced the need for long formal lectures during actual course time. Although reports indicate that precourse reading or work is unlikely to improve overall performance, the absence of long formal theoretical components during the tailored programme allowed participants more time for structured cycles of actual hands-on practice which, as previous reports indicate, is correlated to enhanced skill retention. In addition, the use of continuous assessments comprising written and practical evaluations, and the provision of cycles of structured feedback from peers and the instructor in a consistent and measured fashion appear to have allowed the tailored CPR training programme group to rectify identified knowledge and skill gaps promptly in the apportioned time. This finding is also consistent with earlier reports supporting the use of constant feedback to improve CPR performance. Furthermore, the inclusion in the tailored CPR training programme of a short locally developed and custom-made video of HMCAS staff demonstrating CPR in a simulated OHCA appears to have been successful in reinforcing the sequence of steps and the quality standard of CPR that the experimental group was expected to perform at. The traditional CPR training programme did not include a video, and an understanding how to perform in an OHCA appears to have been left to participants' own interpretation. While videos that instruct and/or demonstrate CPR during training may not be essential, reports have often indicated superior overall CPR performance when videos are used. As opposed to a live demonstration which may include elements that distract the audience, the images presented on a screen can be selected to focus the attention of the audience on specific aspects. The tailored CPR training programme also required

participants to work in pairs, to discuss and then to present their ideal management of different OHCA theoretical scenarios to the entire group. It also required them to undergo brief sessions of mental modelling before the final simulated assessment. The three interdependent pedagogical interventions (think through, talk through and act out) appear to have created a holistic learning experience tailored to challenge OHCA preconceptions while, more importantly, also improving the acquisition and retention of knowledge and skills. The resultant impact of these novel and tailored pedagogical approaches was demonstrated when, compared to the Traditional CPRInt group, the TailoredCPRInt group performed significantly better ($p < 0.01$) in all four of the categories of process measures, namely, (1) basic life support skills; (2) condition specific skills; (3) specific overall skills and (4) non-technical skills while specific improvements were also seen in cardiac arrest detection time (75% vs. 100% respectively), chest compression position (63% vs. 96.15%), ratio (14.3% vs. 96.15%), depth (61% vs. 94.87%); and rhythm identification (65% vs. 98.07%) – all fundamental components of high quality CPR.

The findings from the repeat tests which were conducted at specified time intervals revealed that a significant degeneration in individual skills may occur as early as 3 months post initial training. In common with previously published studies [94,96], the repeat tests in this study also specifically identified individual skills as those skills in terms of which skill decay was the most prevalent. This, in turn, implies that refresher training could be structured, designed and tailored both to target specific skills and to intervene before skill attrition may be expected, particularly when time and training resources are limited.

5.3. LIMITATIONS OF THE STUDY

The limitations of this study include the following:

Findings pertaining to TraditionalCPRInt are specific to one country

An obvious limitation of the study is the fact that baseline pdCPR performance, as depicted in Table 4.5, reflected only one country's practice in training paramedics in pdCPR. While previously published studies have revealed that pdCPR performance is, in general, poor (**Appendix A**), assessing the pdCPR performance of multiple paramedic cohorts from several different ambulance services and using different training interventions against the pdCPR standard developed in this study would

probably have provided greater corroboration regarding the findings on the impact on global TraditionalCPRInt. However, in the absence of any globally accepted and published pdCPR specific training intervention, there was no compelling argument to assess the TraditionalCPRInt used in any countries other than Qatar.

The definitions provided in this study may not be representative of opinion outside of the Delphi group

The Delphi technique used in the study was deemed to be the most suitable and feasible way in which different nationalities could aggregate the opinions of experts in order to formulate a single definition of pdCPR competence. While the Delphi technique is frequently used because of its reliability as regards establishing consensus, it is not without its limitations. The most significant limitation of Delphi is that the judgements used are those of a select group of people and may not be representative of opinion outside of the Delphi group. While the study made every attempt to select the most appropriate subjects to be part of the group as this process relates directly to the quality of the results generated, true consensus requires sufficient time and participant commitment, and also skill in both articulation and written communication. In view of the fact that the study used Delphi subjects of different nationalities from around the world and with different levels of skill in written communication, the study investigators were required to explain the aims and preconceptions of the research problem to the subjects on a regular basis. However, this often results in the problem being over specified and may also attenuate the contributions of other perspectives related to the problem. While there is no evidence that this had occurred, the investigator felt that it is necessary to cite this as a limitation as it is essential that future research in this area take this potential threat into account.

Questionnaires did not allow for unknown problem related perspectives to emerge.

Both the fact that English was not the first language of a large proportion of the participants and also that there was sufficient evidence to indicate that long open-ended questions would be less likely to be answered, it was necessary to tailor the questionnaires used in Phase 2, part A to ensure higher response rates than may otherwise have been the case. Accordingly, the tailored questionnaires comprised

closed-ended questions that were sufficient to elicit the required information but were sufficiently general to avoid the likelihood of revealing the identities of the participants. However, the main limitation with closed ended questions is that such questions preclude the expression of other perspectives related to the problem in question. While the use of interviews and focus group discussions compensated to some extent for this limitation there is always the possibility, however small, that the study may have omitted an important source of data that could have contributed to the development of a TailoredCPRInt.

Instructors were not blinded during evaluations

Despite the measures that were taken to address all anticipated sources of bias, the nature, size and novelty of the TailoredCPRInt made it difficult to blind the instructors to the type of training the participants had received. In addition, the training intervention instructors for the TraditionalCPRInt had been notified of the study at the same time as the participants had been informed (i.e. at the end of the training intervention, just before participants were to undergo their final competency evaluation). However, this was not the case for the instructors of the TailoredCPRInt as they had had to undergo the TailoredCPRInt instructor course and had probably also been told about the study by the participants and the instructors from the TraditionalCPRInt group. Although there was no evidence to suggest that this had, in fact, happened, it is possible that, as compared to the TraditionalCPRInt instructors, the TailoredCPRInt instructors were more motivated and had more invested in training as regards a better training output result.

The majority of the study participants were male

A large body of literature has suggested that men and women learn in different ways and also that specific educational approaches impact differently on men and women. It is therefore important to note that the study results may not apply equally to EMS systems with a more balanced gender composition than that of this study.

Simple manikins without the use of CPR analytics

In view of the fact that training in actual resuscitations exposes patients to risks and may also traumatise inexperienced learners, the use of simulated manikin based

scenarios is particularly appropriate for resuscitation training. However, it is also clear that the use of a manikin with limited interactive features and the CPR analysis which it provides does not adequately reflect clinical reality and may also limit the generalisability of the findings. While the study made it clear that the focus of the study was on evaluating performance in a simulated environment, it was also likely that the use of computerised methods of measuring compression depth, ratio, rate and ventilation ratios would provide more exact quantitative information about the quality of the CPR performed.

Small sample used during repeat tests.

The number of participants ($n = 48$) used in the repeat tests at 1, 3 and 6 months was small. Although the sample was sufficiently large to allow and generate acceptable statistical analysis, a larger cohort of paramedics would obviously have provided a more representative sample.

5.4. SUMMARY

This chapter presented the main findings of the study, discussed the investigator's interpretations of the findings, contextualised the study and explained the implications and limitations of the study findings. The implications of the study discussed in this chapter led into the concluding chapter of the thesis. This final chapter makes recommendations for future research and briefly discusses these areas of future research.

CHAPTER SIX

6.1. CONCLUSION

During the last four decades training interventions for CPR have been implemented worldwide and have followed the guidelines established by bodies such as the ERC and the AHA. These training interventions specify both the course content and guidelines for CPR practice and testing. However, while many of these training interventions have proved to be successful in transferring CPR knowledge and skills to learners, a closer look at the existing data indicates that the teaching and learning of CPR skills remain a challenge for the majority of training institutions. Over the years some studies have claimed that inadequate skill acquisition, which may be associated with the quality and pedagogical techniques of the teaching of such skills, may be the main cause of poor skill retention. Nevertheless, convincing corroboration of this claim is still required.

In the absence of overwhelming and confirmatory evidence specifying the causes of poor CPR training outcomes, there is ongoing investigative inquiry into the factors that influence both the acquisition and retention of CPR skills. While several innovative training interventions have already been introduced in an attempt to improve acquisition retention over the years, the gap between expected CPR performance and actual CPR continues to prevail. In addition, in view of the fact that there is no compelling argument to indicate that this gap is not also associated with the low and relatively unchanged OHCA survival rates, there is a significant opportunity to improve paramedic training and, subsequently, pdCPR performance and, thus, improved OHCA survival rates.

One of the factors associated with the low OHCA survival rate is the deficient quality of CPR provided by paramedics during an OHCA. Despite revised training standards, structured CPR training programmes, and industry-regulated CPR refresher training schedules, the paramedic delivered CPR (pdCPR) during OHCA is reportedly inadequate and rarely in line with established resuscitation guidelines. International resuscitation bodies such as the International Liaison Committee on Resuscitation (ILCOR) postulate the need for tailored CPR training interventions in order to improve CPR performance. In addition, it is essential that these tailored,

population specific (e.g. lay rescuers, healthcare providers) training interventions are evaluated to ensure that they achieve the desired learning outcomes – not just at the end of training but also during actual resuscitation events. The aim of this study was to investigate the impact of a tailored pdCPR training intervention on pdCPR performance.

The study was conducted in four phases and used a mixed-methods multi-phase design to develop, implement and evaluate the impact of a pdCPR training intervention designed and tailored to improve the acquisition and retention of knowledge and skills of ambulance paramedics (AP). The primary outcome measure was the achievement of a competent rating which reflected the ability of ambulance paramedics to perform high quality, effective CPR as determined and evaluated by a 26 measure CPR Rapid Evaluation Tool (based on variables derived from the globally accepted Cardiff list). Each of the 26 measures represented a treatment element in a pdCPR care bundle which had been shown to contribute to successful resuscitation.

Both the training programmes lasted 8 hours. Both covered the same subject matter, paramedic scope of practice, resuscitative equipment and sequence of CPR steps, they were designed to teach the same pdCPR protocol and they used the same assessment tool to evaluate proficiency. The overarching difference, however, was in the way in which the subject matter was delivered and also the pedagogical activities undertaken in each programme to ensure the acquisition and long-term retention of CPR knowledge and skills by participants. For example, in contrast to the traditional programme, the tailored programme included mandatory pre-course work, which required the learners to read a locally developed and tailored pre-course information booklet, watch a video demonstration of the expected paramedic-delivered CPR performance at HMCAS and then demonstrate the assimilation of the pre-course work through a pre-course assignment which was collected from the learners at the commencement of the course. The learners received the pre-course work no less than 7 days before the commencement of the programme while those who were unable to collect the material were not recruited for the study. The tailored programme also included a pre, midway and post course evaluation, followed by discussions and feedback after each of the three assessments. This was not the case with the traditional programme which included only one summative evaluation which was conducted at

the end of the course. In addition, the tailored programme predicated CPR proficiency on multiple practice cycles of eight individual and core skills, as opposed to the traditional programme which required learners to participate in multiple practice rounds of different, full-length, high fidelity OHCA scenarios. In order to expose learners to a wide range of OHCA scenarios in which the OHCA management may require a slight modification (e.g., a pregnant, geriatric or trapped patient, overdose, hypothermia, etc.), the participants in the tailored programme were given theoretical scenarios and asked to discuss and explain how they would manage these less frequent and mainly exceptional cases. In addition, in contrast to the traditional programme the tailored programme ensured strict adherence to the allocated time intervals for pedagogical activities, required increased attention to the use of nontechnical skills such as communication, leadership and situational awareness and included mental modelling sessions. These novel pedagogical activities (i.e., mental modelling) were exclusive to the tailored programme while the aim of such activities was to shape the learners' thinking and behaviour and, ultimately, attempt to establish an approach to solving problems, particularly problems involving the less frequent, but countless, exceptional OHCA cases that may arise. An overview of both training programmes is presented in Table 3.7 and 4.18 respectively. The tailored programme was designed to reinforce the knowledge acquired through the pre-course work as opposed to the introduction of knowledge during the traditional programme. The smaller candidate-to-instructor ratio in the tailored programme, compared to the traditional programme, and the absence of multiple practice cycles of full-length high fidelity OHCA simulations in the tailored programme made it possible for the activities outlined in Table 4.18 to be completed in the same 8-hour day that was allocated to the traditional programme

The overall study results revealed that, as reflected by the evaluation tool, the total percentage of participants rated as competent was 92.3% (144/156) for the paramedics who had attended the tailored pdCPR training intervention and 13% (13/100) for those who had attended the traditional pdCPR training intervention ($p < 0.01$). Repeat tests which were conducted at one, three and six-month intervals after the initial training revealed a degeneration in the percentage of APs rated as competent from 92.3% after initial training to 33.3% after final testing six months later. There was significant degeneration ($p < 0.05$) in the individual process measures at

three months, while significant degeneration in the aggregated process measures emerged as early as 1 month after the initial training.

While the proportion of pdCPR performances rated as competent in a simulated OHCA assessment was significantly higher when the training involved a tailored pdCPR training intervention, the significant degeneration in individual skills as early as three months after initial training suggested that the traditional two-year period before retraining is too long. The importance of this study lies specifically in the suggestions regarding what should be done to improve pdCPR performance in APs. The following chapter discusses several recommendations based on the results of the study. The recommendations are followed by a brief discussion of possible areas of future research.

CHAPTER SEVEN

7.1. RECOMMENDATIONS

Recommendation 1

CPR training interventions for paramedics must be developed and integrated into an understanding of their occupational roles and educational background.

There is consensus that paramedic-delivered CPR quality is often suboptimal and that changes are required in order to improve OHCA outcomes. Tailoring CPR training with the aim of improving the acquisition and retention of CPR knowledge and skills has long been recommended as one strategy for improving CPR performance. It is believed that the results of this study contribute, in part, to validating this recommendation, demonstrating that the tailoring of CPR training both to the operational role of a healthcare practitioner within a healthcare system's response to OHCA and to the practitioners' clinical scope of practice, educational background, and learner characteristics should ensure the improved acquisition and retention of CPR knowledge and skills with the resultant improvement in CPR performance during a simulated OHCA assessment.

While the pdCPR training intervention developed in this study may not be a "one-size fits all" as different ambulance services may follow different guidelines, use different equipment, and employ different staff with different educational backgrounds; the framework against which this tailored training intervention was aligned should be replicated. Accordingly, the framework proposes a structured series of learning activities designed and sequenced to specifically improve the acquisition and retention of CPR knowledge and skills of paramedics, represent an articulation of what paramedics should know and be able to do, and also support CPR instructors in knowing how to achieve these goals.

Recommendation 2

Training outcomes should be continuously monitored to measure the effectiveness of training and the gap between what should be known and what is actually done.

This study also showed that, while the new resuscitation guidelines appear to have improved the process of CPR, the overall performance following traditional CPR training, as evaluated in a simulated OHCA assessment, remains poor. Accordingly, while appropriate pedagogic activities remain a condition for ensuring learner outcomes are reliably achieved to ensure sustained and consistent educational effectiveness essential consideration must also be given to certain components of an overarching educational framework. These components discussed within the thesis range from an established governance structure to quality standards for instructors.

Recommendation 3

Pre-course work supports effective learning and allows more time for actual hands on practice.

The tailored programme's approach in preparing learners prior to commencement of the course in using pre-course reading and a pre-course assignment appears to have reduced the need for lengthy formal lectures during actual course time. Although reports indicate that pre-course reading or pre-course work are unlikely to improve overall performance, the absence of lengthy, formal, theoretical components during the tailored programme allowed participants more time for the structured cycles of the actual hands-on practice which, as previous reports indicate, correlates with enhanced skill retention.

The pedagogic activity used to deliver content is an important determinant of the success or failure of the training intervention. Deciding on the type of pedagogic activity is largely a result of the content to be delivered and the preferred learning styles that are found to exist amongst learners who will receive the training. In this study, within the context of the Qatar ambulance service and its largely migrant workforce, pedagogic activities were premised on the finding that a majority of

participants had reflector and theorists learner style preferences. Learning styles differ amongst people and even groups of people within the same profession or educational background, therefore paramedics in a different country; different ambulance service may likely have different communal learning preferences than those identified in this study. However, undertaking an assessment of the needs of learners before choosing pedagogic activities is essential as it provides insights into the way in which outside factors and specific learner characteristics and styles of learning may affect the training intervention.

Recommendation 4

Peer review and feedback are effective pedagogic methods during skills practice

The use of continuous assessments comprising written and practical evaluations as well as the provision of cycles of structured feedback from both peers and the instructor in a consistent and measured fashion appear to have enabled the tailored CPR training programme group to rectify the knowledge and skill gaps which had been identified promptly and in the apportioned time. This finding is also consistent with earlier reports supporting the use of constant feedback in order to improve CPR performance.

Recommendation 5

Demonstration of ideal or expected CPR performance closes the gap between what is taught and what is interpreted.

The inclusion in the tailored CPR training programme of a short locally developed and custom-made video of HMCAS staff demonstrating CPR in a simulated OHCA appears to have been successful in reinforcing the sequence of steps and the quality standard of CPR at which the experimental group was expected to perform. The traditional CPR training programme did not include a video while an understanding of how to perform in an OHCA appears to have been left to the participants' own interpretation. While videos that instruct and/or demonstrate CPR during training

may not be essential, reports have often indicated superior overall CPR performance when videos are used. As opposed to a live demonstration which may include elements that distract the audience, the images presented on a screen may be selected specifically to focus the attention of the audience on specific aspects.

Recommendation 6

Training should be contextually and clinically relevant and use a combination of pedagogic activities to ensure learning is reliably achieved.

The tailored CPR training programme required the participants to work in pairs in order to discuss and then to present their ideal management of various OHCA theoretical scenarios to the entire group. In addition, it also required them to undergo brief sessions of mental modelling before the final simulated assessment. The three interdependent pedagogical interventions (think through, talk through and act out) appear to have created a holistic learning experience tailored to challenge OHCA preconceptions while, more importantly, also improving the acquisition and retention of the requisite knowledge and skills. This accordingly seems to have offset the limitation of using one isolated pedagogical intervention and, as a result, ensured that the set, team-based, paramedic-delivered, CPR learning objectives were reliably achieved.

7.2. FUTURE RESEARCH

The importance of this study is as much in what it does not show as in what it suggests should be done to improve training outcomes and, ultimately, pdCPR performance. However, there is still much to further investigate in areas that either did not form part of this study or were not entirely or adequately addressed. Areas of future research related to this study and to pdCPR training in general should be geared to answering the following research questions:

- What impact does a TailoredCPRInt have on actual patient outcomes?
- What training interventions may be used as refresher training to maintain knowledge and skills?

- What is an optimal method of assessment during pdCPR training?
- What is an optimal method of assessment of pdCPR performance in simulated and real-life OHCA's?

SCA represents one of the greatest challenges facing modern medicine [16]. While it would appear that the science of CPR is evolving rapidly OHCA survival to discharge rates remain at < 10%. It is not in the best interest of patients to wait to find answers to the questions. The sooner these questions are answered; the sooner healthcare professionals will be informed about pedagogic advances in the field of resuscitation. The sooner this happens, the sooner more lives may be saved than is currently the case.

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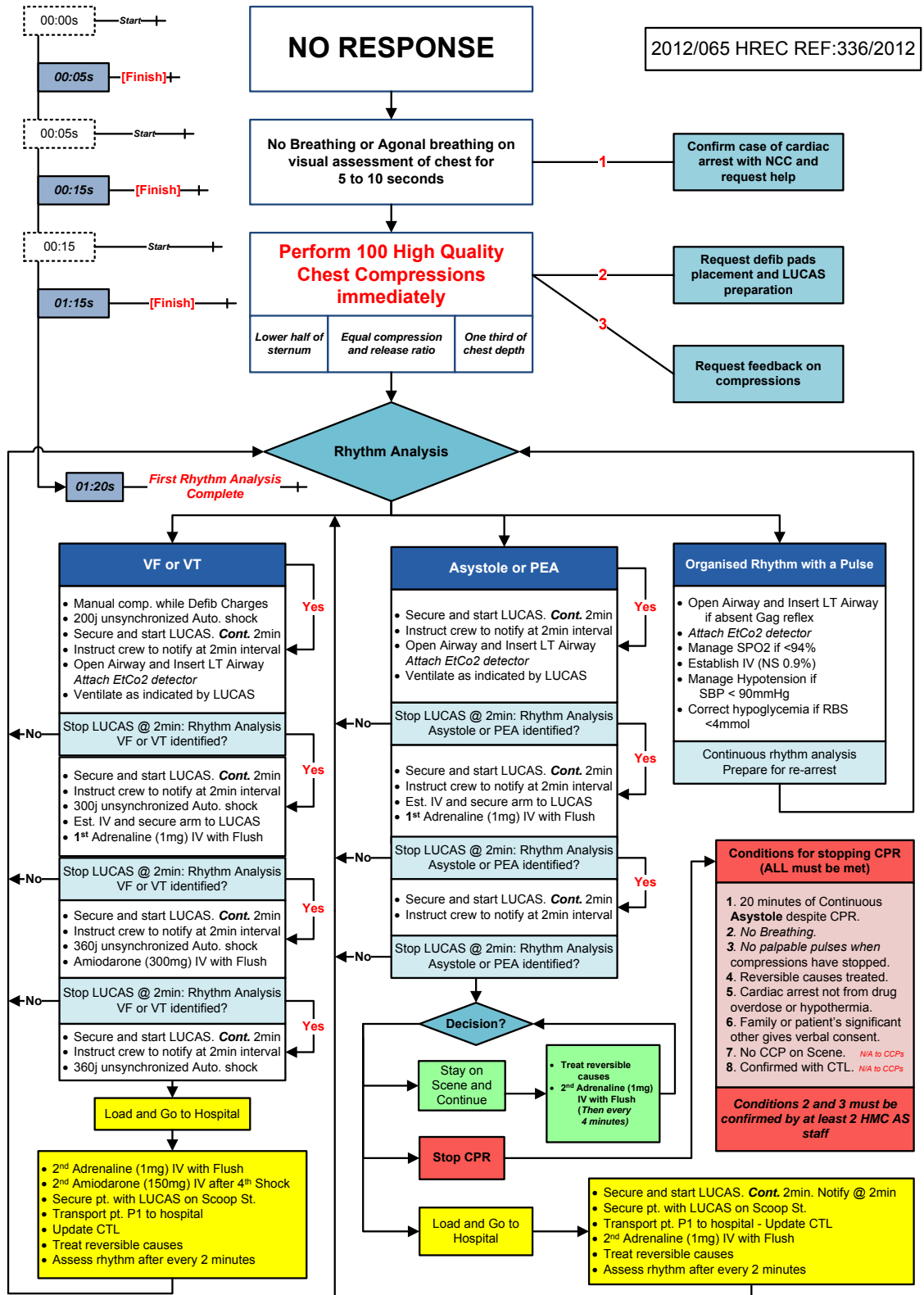
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APPENDIX A: SUMMARY OVERVIEW OF PDCPR PERFORMANCE

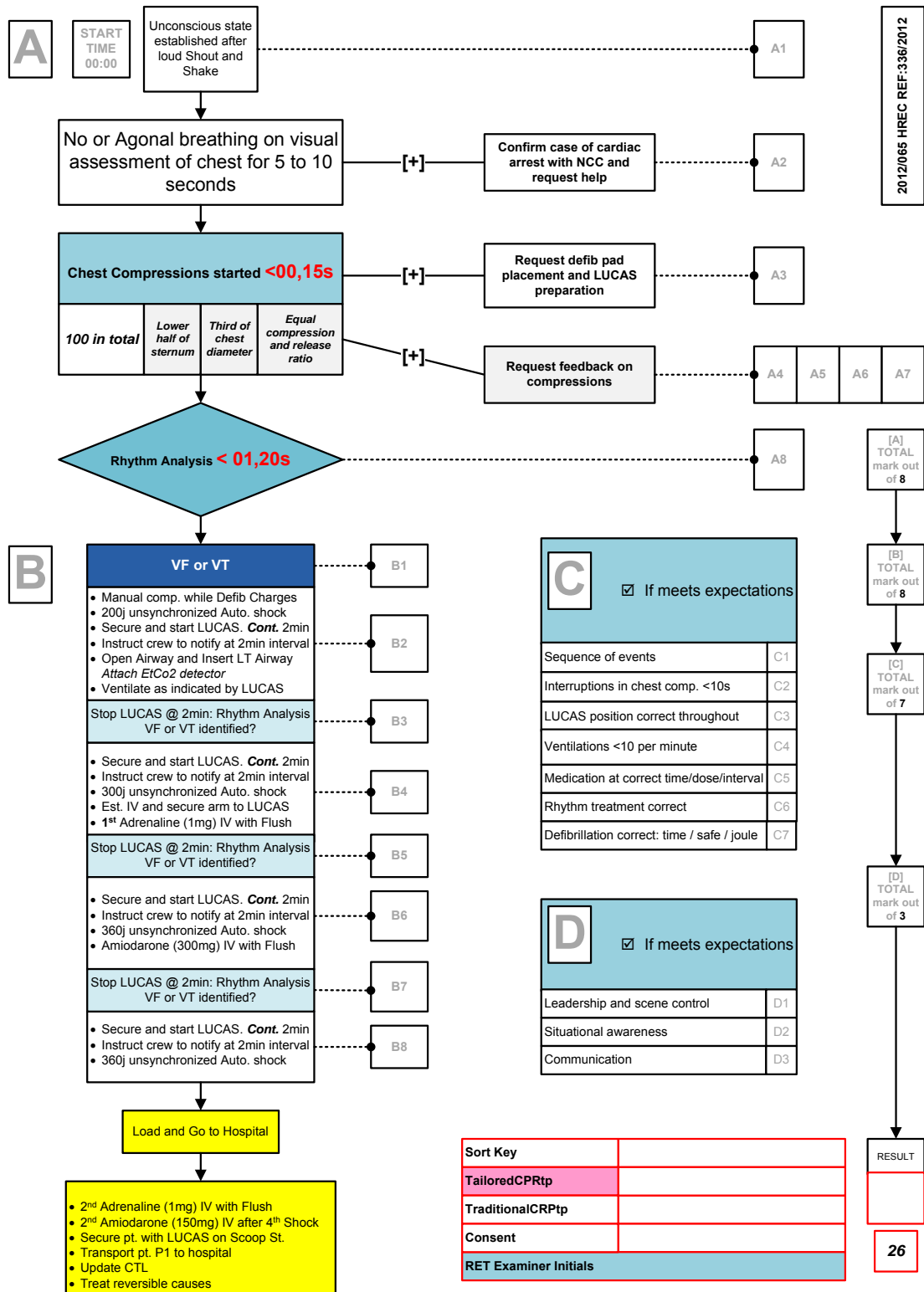
Study	Objective	Main Finding
Krarup et al, 2011 [39] Quality of cardiopulmonary resuscitation in out-of-hospital cardiac arrest is hampered by interruptions in chest compressions - a nationwide prospective feasibility study	To evaluate the quality of CPR provided by emergency medical service providers	CPR is hampered by extended interruptions, particularly during loading of the patient into the emergency medical service vehicle, rhythm analysis and defibrillation.
Wang et al, 2009 [210] Interruptions in CPR from paramedic endotracheal intubation.	To quantify the frequency and duration of CPR chest compression interruptions associated with paramedic endotracheal intubation efforts during OHCA	Paramedic out-of-hospital endotracheal intubation efforts were associated with multiple and prolonged CPR interruptions.
Ødegaard et al, 2009 [168]	To analyse the quality of CPR before vs during transport with ongoing CPR	CPR quality was sub-standard both before and during transport. Early decision to transport might have negatively affected

The effect of transport on quality of cardiopulmonary resuscitation in out-of-hospital cardiac arrest		CPR quality from the early stages of resuscitation.
Olasveengen et al, 2008 [383] Quality of cardiopulmonary resuscitation before and during transport in OHCA	To evaluate quality of CPR performed during Ambulance transport after OHCA	Time without chest compressions increased during transport of OHCA patients.
Wik et al, 2005 [38] Quality of cardiopulmonary resuscitation during OHCA	To measure the quality of CPR performed during an OHCA by ambulance personnel, as measured by adherence to CPR guidelines	Chest compressions were not delivered for half of the time, and most compressions were too shallow.
Aufderheide et al, 2005 [36] Incomplete chest wall decompression: a clinical evaluation of CPR performance by EMS personnel...	To evaluate the quality of chest wall recoil during CPR performed by emergency medical services (EMS) personnel on patients with an OHCA	All forms of manual CPR tested (including the Standard Hand Position) in professional EMS rescuers using a recording manikin produced an inadequate depth of compression more than half the time.
Lieberman et al, 1999 [384] Cardiopulmonary resuscitation: errors made by pre-hospital emergency medical personnel	To evaluate the CPR techniques of emergency healthcare professionals	The results of this study showed a high rate of errors occurring in the CPR provided by emergency healthcare professionals.
Hodgetts et al, 1995 [385] Pre-hospital cardiac arrest: room for improvement	To audit the outcome of pre-hospital cardiac arrest managed by ambulance personnel.	The drug dose in cardiac arrest care did not comply with guideline recommendations and was inadequate in over a third of the cases. Stricter compliance with established CPR guidelines, facilitated by extended refresher training, are required if the outcome is to be improved.

APPENDIX B: ADULT CARDIAC ARREST PROTOCOL



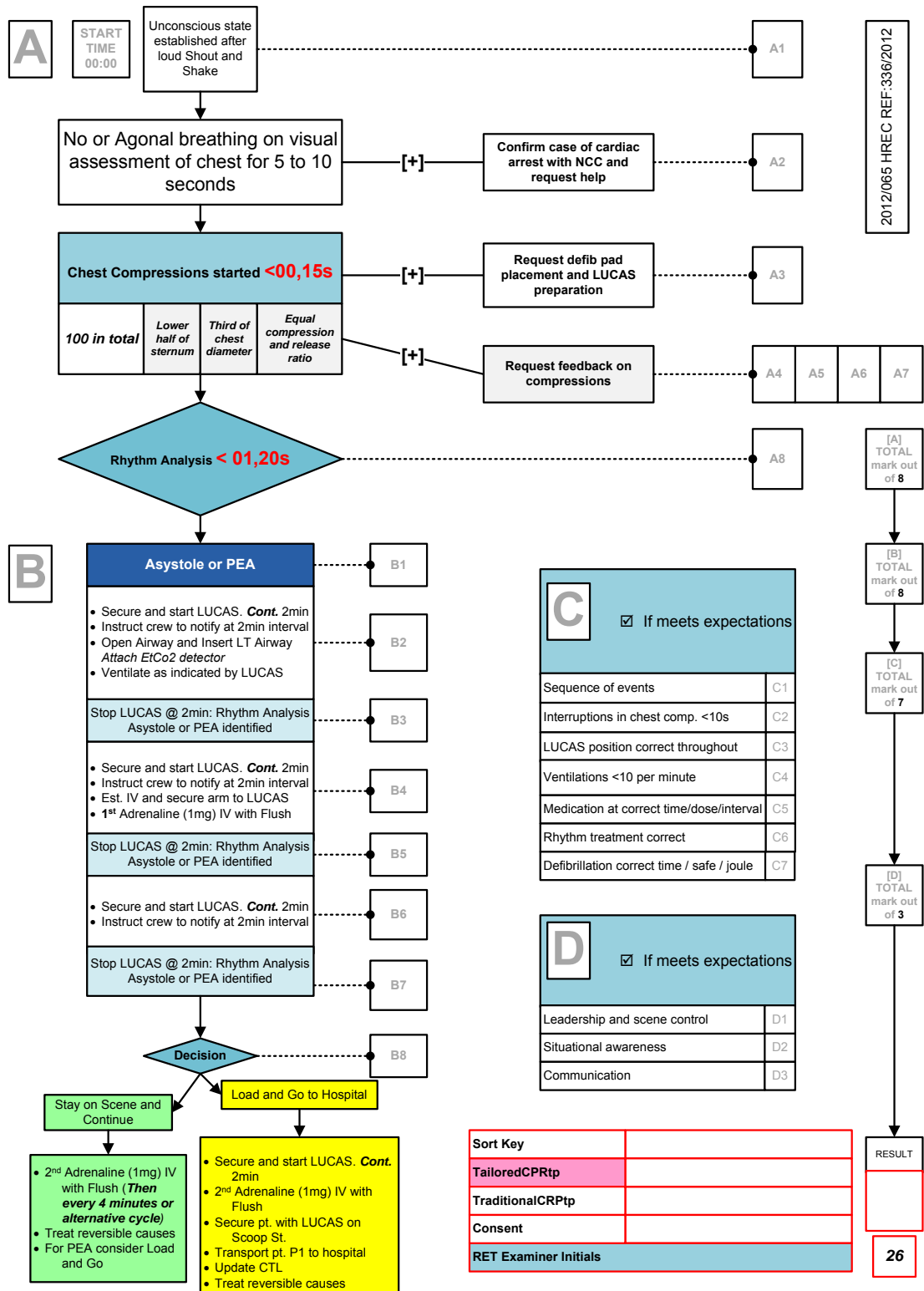
APPENDIX C: RET [SHOCKABLE VERSION] AND RUBRIC [PAGE 1]



APPENDIX C: RET [SHOCKABLE VERSION] AND RUBRIC [Page 2]

Basic and Advanced Care – Technical Skills		Overall Care – Technical Skills	
A1	Tick if victim's unconscious state has been detected by loud shout and shake.	C1	Tick if steps A1 through to B8 were followed in sequence
A2	Tick if NO breathing and/or NO normal breathing has been detected in >5<10s and request for help/report given to NCC.	C2	Tick if all interruptions were <10 seconds
A3	Tick if chest compressions are commenced in <15 seconds from patient contact and instructions for Switching LF15 on, application of Defib pads and preparation of the LUCAS are given to second rescuer.	C3	Tick if the LUCAS was positioned correctly and remained at the lower half of the sternum throughout the simulation.
A4	Tick if Primary RESCUER provides 100 compressions	C4	Tick if ventilations given throughout the cardiac arrest event was under 10 a minute.
A5	Tick if chest compressions are at the lower half of the sternum and SECOND RESCUER provides real time feedback	C5	Tick if overall dose/interval and administration of medications during the entire cardiac arrest event was correct.
A6	Tick if chest compressions are third of chest diameter and SECOND RESCUER provides real time feedback	C6	Tick if all identified rhythm were correctly treated.
A7	Tick if equal chest compression and release ratio and SECOND RESCUER provides real time feedback	C7	Tick if all defibrillations were safe and given at the correct time/ interval and joule dose.
A8	Tick if rhythm analysis done < 1.20s from patient contact		
B1	Tick if VF or pulse less VT is detected.	Non-Technical Skills	
B2	Tick if all 6 bulleted steps are completed	D1	<p>Leadership and Scene control. Tick if overall leadership and scene control skills were effective. The following situations are to be evaluated when rating leadership and control skills.</p> <p>Family or bystanders: Identifies and controls family and bystanders that appear anxious and agitated and whose actions could likely hinder resuscitative attempts.</p> <p>Second Rescuer: Clear instructions, continuous supervision and feedback from crew-mate.</p> <p>Other EMS on scene: Takes lead and instructs all involved on what to do and supervises those lacking experience and familiarity with tasks.</p>
B3	Tick if LUCAS stopped at 2 minutes and if VF or VT is detected	D3	<p>Situational Awareness. Tick if overall Situational Awareness was effective. The following situations are to be evaluated when rating overall Situational Awareness skills.</p> <p>Family or bystanders: Advises on prognosis and course of action.</p> <p>Second Rescuer: Ensures crew-mate's wellbeing, endurance, state of mind, etc.</p> <p>Other EMS on scene: Checks on overall team's condition, endurance, state of mind, etc.</p>
B4	Tick if all 5 bulleted steps are completed	D4	<p>Communication Skills. Tick if overall Communication Skills were effective. The following situations are to be evaluated when rating overall Communication Skills</p> <p>Family or bystanders: History taking and reassurance.</p> <p>Family or bystanders: Responds to questions and concerns.</p> <p>Second Rescuer: Clear instructions on what to do.</p> <p>Second Rescuer: Clearly answers questions put forward by crew-mate.</p> <p>Other EMS on scene: Advises on how to be of assistance.</p> <p>Other EMS on scene: Responds to questions and provides assistance.</p>
B5	Tick if LUCAS stopped at 2 minutes and if VF or VT is detected		
B6	Tick if all 5 bulleted steps are completed		
B7	Tick if LUCAS stopped at 2 minutes and if VF or VT is detected		
B8	Tick if the three bulleted steps were completed and a decision is taken and all bulleted steps for that decision is completed/explained		

APPENDIX D: RET [NON-SHOCKABLE VERSION] AND RUBRIC [PAGE 1]



APPENDIX D: RET [NON-SHOCKABLE VERSION] AND RUBRIC [Page 2]

Basic and Advanced Care – Technical Skills		Overall Care – Technical Skills	
A1	Tick if victim's unconscious state has been detected by loud shout and shake.	C1	Tick if steps A1 through to B8 were followed in sequence
A2	Tick if NO breathing and/or NO normal breathing has been detected in >5<10s and request for help/report given to NCC.	C2	Tick if all interruptions were <10 seconds
A3	Tick if chest compressions are commenced in <15 seconds from patient contact and instructions for Switching LF15 on, application of Defib pads and preparation of the LUCAS are given to second rescuer.	C3	Tick if the LUCAS was positioned correctly and remained at the lower half of the sternum throughout the simulation.
A4	Tick if Primary RESCUER provides 100 compressions	C4	Tick if ventilations given throughout the cardiac arrest event was under 10 a minute.
A5	Tick if chest compressions are at the lower half of the sternum and SECOND RESCUER provides real time feedback	C5	Tick if overall dose/interval and administration of medications during the entire cardiac arrest event was correct.
A6	Tick if chest compressions are third of chest diameter and SECOND RESCUER provides real time feedback	C6	Tick If all identified rhythm were correctly treated.
A7	Tick if equal chest compression and release ratio and SECOND RESCUER provides real time feedback	C7	Tick if all defibrillations were safe and given at the correct time/interval and joule dose.
A8	Tick if rhythm analysis done < 1.20s from patient contact		
B1	Tick if Asystole or PEA is detected.	Non-Technical Skills	
B2	Tick if all 4 bulleted steps are completed	D1	<p>Leadership and Scene control. Tick if overall leadership and scene control skills were effective. The following situations are to be evaluated when rating leadership and control skills.</p> <p>Family or bystanders: Identifies and controls family and bystanders that appear anxious and agitated and whose actions could likely hinder resuscitative attempts.</p> <p>Second Rescuer: Clear instructions, continuous supervision and feedback from crew-mate.</p> <p>Other EMS on scene: Takes lead and instructs all involved on what to do and supervises those lacking experience and familiarity with tasks.</p>
B3	Tick if LUCAS stopped at 2 minutes and Asystole or PEA is detected.	D3	<p>Situational Awareness. Tick if overall Situational Awareness was effective. The following situations are to be evaluated when rating overall Situational Awareness skills.</p> <p>Family or bystanders: Advises on prognosis and course of action.</p> <p>Second Rescuer: Ensures crew-mate's wellbeing, endurance, state of mind, etc.</p> <p>Other EMS on scene: Checks on overall team's condition, endurance, state of mind, etc.</p>
B4	Tick if all 4 bulleted steps are completed	D4	<p>Communication Skills. Tick if overall Communication Skills were effective. The following situations are to be evaluated when rating overall Communication Skills</p> <p>Family or bystanders: History taking and reassurance.</p> <p>Family or bystanders: Responds to questions and concerns.</p> <p>Second Rescuer: Clear instructions on what to do.</p> <p>Second Rescuer: Clearly answers questions put forward by crew-mate.</p> <p>Other EMS on scene: Advises on how to be of assistance.</p> <p>Other EMS on scene: Responds to questions and provides assistance.</p>
B5	Tick if LUCAS stopped at 2 minutes and Asystole or PEA is detected.		
B6	Tick if all 2 bulleted steps are completed		
B7	Tick if LUCAS stopped at 2 minutes and Asystole or PEA is detected.		
B8	Tick if a decision is taken and all bulleted steps for that decision is completed/explained		

APPENDIX E: INFORMED CONSENT [GENERIC]



**University of Cape Town
South Africa**

Letter of information and Informed consent form

Dear Potential Participant

I am conducting a research study in order to complete the degree of Doctor of Philosophy: Emergency Medicine through the University of Cape Town, South Africa.

Title of research:

The development and testing of a training intervention designed to improve the acquisition and retention of CPR knowledge and skills in Ambulance Paramedics

Aim of the study:

The aim of this study is to investigate the impact of a tailored CPR training intervention on paramedic-delivered CPR performance.

PhD Research Reference No: (UCT 2012/065-Ethics 336/2012)

Participants needed:

The study aims to establish through consensus agreement a set of specific operational definitions that will be used to standardise the way in which CPR performance in Ambulance Paramedics (AP) is measured and evaluated. Using these definitions, the study will evaluate performance in APs after they had received CPR training from conventional training methods and then after they receive CPR training from a new

tailored training intervention. In the group that receives tailored CPR training, evaluation will occur immediately after training and repeated at 1, 3, and 6 months. In order to reliably achieve these objectives the study needs to recruit four different samples of participants. A summary description of each Sample is provided.

Sample 1 – This sample will include purposively chosen individuals who will become subjects in a Delphi process to establish consensus on key operational definitions needed for this study.

Sample 2 – This sample will include randomly selected APs who will receive CPR training conventionally used by the HMCAS.

Sample 3 – This sample will include purposively chosen participants who will become informants to the study via one-on-one interviews and a focus group discussion.

Sample 4 – This sample will include randomly selected APs who will receive tailored CPR training developed in this study to improve the acquisition and retention of CPR knowledge and skills.

The study procedure:

The study will consist of four phases; Phase 1 will include the establishment of specific operational definitions. **Sample 1** participants will be contacted by the study investigator and invited to contribute in developing certain operational definitions through systematic consensus agreement in the form of a two Delphi studies.

Also in Phase 1, **Sample 2** participants will be invited to participate in a mannequin based simulation of an out-of-hospital cardiac arrest (OHCA). In Phase 2, questionnaires will be sent out to **Sample 2** participants hoping to identify learning style preferences and also the components of a CPR training intervention that could improve acquisition and retention of CPR knowledge and skills. Phase 2 also includes focus

group discussions and interviews with key informants. These purposively chosen individuals will make up **Sample 3** of the study.

Following multiple stages of data analysis an attempt will be made to understand the requirements of a CPR training intervention designed to improve the acquisition and retention of CPR knowledge and skills in Ambulance Paramedics.

Phase 3 involves implementing the new curriculum while Phase 4 involves determining and describing CPR competency after the new CPR intervention has been implemented. **Sample 4** will be used at this stage.

Your role - If you agree to participate:

All that is required from you if you decide to participate in any part of the four phases of the study is to read and complete this document, sign and return it to the study investigator. By this action you have provided permission and informed consent to be part of this study.

You are free to withdraw from the study at any stage.

Risks: There are no risks to study participants. Strict confidentiality of the participants and their responses will be maintained. Study findings will be reported in a manner which will prevent the identification of individuals. The data will be used for research purposes only.

Benefits: There are no financial benefits to individuals participating in this study. However, it is hoped that the results of the study will identify a training intervention that will improve the acquisition and retention of CPR knowledge and skills in Ambulance Paramedics and enable them to act correctly in actual cardiac arrests and ultimately improve patient outcomes.

The study results

The results of the study will be available to you. This will be done in the form of a report which will be copied into a locked PDF on completion of the project and forwarded to you on your request.

If you are unable to be a part of this study because you are not satisfied with certain areas or require more information about the study please feel free to forward any concerns to me or the study supervisors. Contact details are provided at the end of this document.

Confidentiality

The Research Team will:

- 1) Make sure that all information collected on you and your performance during the assessment is kept confidential, and that no-one will be able to identify you from the information that is published.
- 2) The records and recordings of interviews will all be stored in a secure place with limited access by the research team only.
- 3) The research materials, including the recordings, will only be seen by members of the research team.
- 4) Results of the study that may be reported in scientific journals will not include any information which identifies you as a participant in the study.

ADDITIONAL INFORMATION

If you require any information on the study, you may contact either Professor. Karen Sliwa – Hahnle: Sliwa-hahnlek@mdh-africa.org or Professor. Lee Wallis @ [+2721 948 9908](tel:+27219489908). If you have any queries about your rights as a research subject you may contact Professor. M. Blockman, Chairperson of the UCT Research Ethics Committee in the Faculty of Health Sciences @ [+2721-406-6411](tel:+27214066411).

INFORMED CONSENT

Statement of agreement to take part in study

I hereby confirm that I have read this document in its entirety and understand its contents. I am fully aware of the nature, conduct, benefits and risks of the study. Where I have had any queries or questions, these have been explained to me by _____ (full name in block letters) to my satisfaction.

I am aware that the results of the study, including personal details will be anonymously processed into the study report and that this anonymous data will be used in on-going research leading from the current study. Furthermore I fully understand that I may withdraw from this study at any stage without any adverse consequences. I, therefore voluntarily agree to participate in this study.

I may, at any stage, without prejudice withdraw my consent and participation in the study. I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study

Participant's name _____ Participant's signature _____
Date _____

Witness name _____ Witness signature _____
Date _____

Researcher's name _____ Researchers signature _____
Date _____

Supervisor's name _____ Supervisors signature _____
Date _____

Thank You for your time and effort

Primary Investigator

Mr. Pregalathan (Kevin) Govender

Cell Number: 3383 7728

kevin.govender@yahoo.com

Study Supervisor

Professor Karen Sliwa – Hahnle

MD, PhD, FESC, FACC

Director: Hatter Institute for Cardiovascular Research in Africa

Sliwa-hahnlek@mdh-africa.org

Study Co – Supervisor

Professor Lee Wallis MD

Head of Emergency Medicine, Provincial Government Western Cape

leewallis@bvr.co.za

End of letter of information and informed consent form

APPENDIX F: QUESTIONNAIRE [PHASE 2 PART A] - ENGLISH



**University of Cape Town
South Africa**

Phase 1 - Questionnaire

Thank you for agreeing to participate in this study. Please remember that your responses in this questionnaire will be kept strictly confidential. Nobody else, apart from the researcher, will be able to identify who completed this document.

Instructions

1. Please do not show this questionnaire to anyone, or obtain input from others or discuss your responses.
2. Please answer all the questions, unless you are uncomfortable about providing such information.

Thank you for your time again

People learn in many different ways. For example, some people learn primarily with their eyes or with the ears; some people prefer to learn by experience and or by "hands-on" tasks; some people learn better when they work alone while others prefer to learn in groups. Knowing and understanding our learning style helps us to learn more effectively and improves acquisition and retention of knowledge and skills.

For us to gain a better understanding of you as a learner of CPR, we need to evaluate the way you prefer to learn or process information.

Section One: Determining your learning style

There is no time limit to the completion of this section; however, it will probably take you no longer than 10 minutes.

There are no right or wrong answers. If you agree more than you disagree with a statement write down the word **YES** in the box. If you disagree more than you agree with a statement write down the word **NO** in the box. Be sure to mark each item with either a **YES** or a **NO**.

Box for either YES or NO answer

- | | | |
|---|--------------------------|---|
| 1 | <input type="checkbox"/> | I quite like taking tasks. |
| 2 | <input type="checkbox"/> | Before taking part in a discussion or meeting, I like to read the appropriate papers and prepare carefully. |
| 3 | <input type="checkbox"/> | I like to be absolutely correct about things. |
| 4 | <input type="checkbox"/> | I like practical, tried, and tested techniques. |
| 5 | <input type="checkbox"/> | I often do things just because I feel like it, rather than thinking about them first. |
| 6 | <input type="checkbox"/> | I make decisions only after weighing up the pros and cons of different possibilities. |
| 7 | <input type="checkbox"/> | I prefer to solve problems using a systematic approach that reduces guesswork and uncertainty. |
| 8 | <input type="checkbox"/> | What matters most is whether something works in practice. |
| 9 | <input type="checkbox"/> | I actively look for new things to do. |

- | | | |
|----|--------------------------|--|
| 10 | <input type="checkbox"/> | I prefer to establish the facts and think things through before reaching a conclusion. |
| 11 | <input type="checkbox"/> | I like to check things out for myself rather than take them for granted. |
| 12 | <input type="checkbox"/> | When I hear about a new idea or technique, I immediately start working out how to apply it to my situation or problem. |
| 13 | <input type="checkbox"/> | I like the challenge of trying out different ways of doing things. |
| 14 | <input type="checkbox"/> | I prefer to have as many bits of information about a subject as possible. The more I have to sift through the better. |
| 15 | <input type="checkbox"/> | I am quite keen on sticking to fixed routines, following procedures and keeping to timetables. |
| 16 | <input type="checkbox"/> | In discussions, I get straight to the point. |
| 17 | <input type="checkbox"/> | I prefer to jump in and do things as they come along rather than plan things out beforehand. |
| 18 | <input type="checkbox"/> | I prefer to base decisions on hard evidence and not to trust a hunch or intuition. |
| 19 | <input type="checkbox"/> | I like to fit things into some sort of pattern, framework or model. |
| 20 | <input type="checkbox"/> | I tend to judge people's ideas on their practical merits. |
| 21 | <input type="checkbox"/> | In discussions, I usually come up with lots of spontaneous ideas. |
| 22 | <input type="checkbox"/> | I prefer to look at a problem from as many different angles as I can before starting to solve it. |
| 23 | <input type="checkbox"/> | I prefer to evaluate the soundness of my ideas before sharing them. |

- | | | |
|----|--------------------------|---|
| 24 | <input type="checkbox"/> | In meetings and discussions, I put forward ideas that I know are down to earth and realistic. |
| 25 | <input type="checkbox"/> | Usually I talk more than I listen. |
| 26 | <input type="checkbox"/> | If I write a report or a formal letter, I prefer to have several rough drafts before settling on the final version. |
| 27 | <input type="checkbox"/> | I am rather fussy about how I do things – a bit of a perfectionist. |
| 28 | <input type="checkbox"/> | I find that I can often work out more practical ways of doing things. |
| 29 | <input type="checkbox"/> | I find rules and procedures take the fun out of things. |
| 30 | <input type="checkbox"/> | I like to consider many options before I make up my mind. |
| 31 | <input type="checkbox"/> | I believe that careful, logical thinking is the key to success. |
| 32 | <input type="checkbox"/> | I prefer ideas with an obvious relevance to my life and work. |
| 33 | <input type="checkbox"/> | I'm usually the "life and soul" of a party. |
| 34 | <input type="checkbox"/> | I like to think through the consequences before taking action. |
| 35 | <input type="checkbox"/> | I like to understand the assumptions, principles and rationale upon which things are based. |
| 36 | <input type="checkbox"/> | In my opinion, it doesn't matter how you do something, as long as it works. |
| 37 | <input type="checkbox"/> | I enjoy the excitement of a crises situation. |

- 38 I usually do more listening than talking.
- 39 I like meetings and discussions to be structured and orderly.
- 40 I do whatever I need to, to get the job done.

End of Section One

Section Two: Determining the components for a curriculum

Below is a list of 8 key components to which particular attention will be given to when developing a CPR training curriculum in this study. Each component includes a brief explanation of what it is likely to entail.

All you need to do is decide to what degree you agree or disagree with each component being considered when developing a CPR training curriculum that could improve acquisition and retention of knowledge and skills in this study. Mark your answer on the Likert scale provided for each key component.

1) Curriculum governance

The curriculum should include established criteria for who should be responsible for overseeing and managing CPR courses and programs for paramedics. This should include the recruitment of specialist committees within the EMS that will be responsible for registering, regulating and ensuring attendance and adherence to requirements that define CPR competency.

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

2) Identifying criteria and instructor requirements

The curriculum should include established requirements for course instructors. This should include attributes around experience, formal qualifications and proficiency in the language of instruction.

Strongly Agree Agree Neutral Disagree Strongly Disagree

3) Pre-course requirements and selection of course candidates

The curriculum should include an established formal application process for potential course candidates; this should include assessing candidate prior knowledge.

Strongly Agree Agree Neutral Disagree Strongly Disagree

4) Course duration and format

The curriculum should include an established duration for how long courses should be and the format they should be presented in.

Strongly Agree Agree Neutral Disagree Strongly Disagree

5) Venue and Instructor to candidate ratio

The curriculum should include established requirements for training venues and instructor to candidate ratios.

Strongly Agree Agree Neutral Disagree Strongly Disagree

6) Course content and format

The curriculum should include established course content that cover knowledge and skills that are most likely to result in successful resuscitation during an OHCA.

Strongly Agree Agree Neutral Disagree Strongly Disagree

7) Assessment

The curriculum should include established non-discriminatory methods that reliably measure candidate competency.

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

8) Establishing time frames that ensure competence

The curriculum should include established time frames for how often candidates should attend updates and refresher courses.

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

End of Questionnaire - Thank YOU for your time

Primary Investigator

Mr. Kevin P Govender

Cell Number: 3383 7728

kevin.govender@yahoo.com

Study Supervisor

Professor Karen Sliwa – Hahnle

MD, PhD, FESC, FACC

Director: Hatter Institute for Cardiovascular Research in Africa

Sliwa-hahnlek@mdh-africa.org

Study Co – Supervisor

Professor Lee Wallis MD

Head of Emergency Medicine, Provincial Government Western Cape

leewallis@bvr.co.za

APPENDIX G: QUESTIONNAIRE - ARABIC



مركز آسيا للترجمة والخدمات

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جامعة كلب تون
جنوب أفريقيا
المرحلة الأولى
استبيان

نشكركم بمشارككم في هذه الدراسة، ويرجى شكر أن ردودكم على هذا الاستبيان سوف يحاط بالسرية، وسوف لن يمكن أي شخص غير الباحث من تحديد شخصية الذي قام بتعبئة هذه الممنندات.

مقدمة:

- 1- يرجى عدم إظهار الاستبيان لأي شخص، أو العصفون على أجراء من آخرين، أو التشاور بشأن ردودكم.
- 2- يرجى وضع علامة في المربع أمام الإجابة الأكثر ملاءمة لك.
- 3- يرجى الإجابة على كافة الأسئلة، ما لم تكون راغباً في تقديم المعلومات.

نشكركم مرة أخرى على وقتكم

يتعلم الإنسان بطرق عديدة ومختلفة، فعلى سبيل المثال، بعض الناس يتعلمون بشكل أساسي بالنظر مع السمع، وبعض الناس يفضلون التعلم عن طريق الخبرة أو عن طريق المهام اليدوية، وبعض الناس يتعلمون بشكل أفضل عندما يعملون بمفردهم بينما يفضل الآخرون أن يتعلموا في مجموعات. ومعرفة وفهم طريقتنا في التعلم تساعدنا في التعلم بشكل أكثر فاعلية وتصين مستوى الاستيعاب والحفظ للمعرفة والمهارات.

وبالنسبة لنا، فمن أجل أن نفهمك كطالب سي بي آء، فإننا نحتاج إلى تقييم الطريقة التي تفضلها في التعلم أو اكتساب المعلومات.

Signed

من ت: ١٠٤٧٨ - تيلفون: ٤٤٣٦١٥٥٥ / ٤٤٤٠٩٤٣ +٩٧٤ - فاكس: ٤٤٣٦٣٢٧ / ٤٤٣٦٤٥٥ - ص.ب: ٢٩٥٧ - لوجهة - قطر
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مركز آسيا للترجمة والخدمات

التسجيل: 02-09-524-02، صفحة رقم: ٢، التاريخ: 9/27/2012

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سنة ١٩٨٧

القسم الأول: تحديد أسلوب تعلمك

لا توجد حدود زمنية لإكمال هذا القسم، ومع ذلك فإنه سوف يكون من الملائم أن لا يستغرق أكثر من ١٠ دقائق.

لا توجد إجابات صحيحة وإجابات خاطئة، فإذا كنت تتفق أكثر مما تختلف مع الجملة ضع علامة [X] في المربع، علامة [] في المربع، وإذا كنت تختلف أكثر مما تتفق مع الجملة ضع علامة [] في المربع، وأحرص على أن تضع على كل مربع أي من العلامتين [X] أو [].

- | | | |
|-----|--|--|
| ١. | أحب تماماً أن أحصل على مهام | |
| ٢. | قبل المشاركة في المناقشة أو الاجتماع، أود قراءة الأوراق المتعلقة والاستعداد جيداً. | |
| ٣. | أود بشكل مطلق أن أصحح الأخطاء | |
| ٤. | أحب ممارسة، وسماولة وتجربة التقنيات | |
| ٥. | غالباً أقوم بالأمور فقط لأنني أشعر أنني أحبها، قبل التفكير في ماهيتها أو لا. | |
| ٦. | أأخذ القرارات فقط بعد | |
| ٧. | أفضل حل المشاكل باستخدام الأسلوب العلمي الذي يحد التخمين وعدم الثقة. | |
| ٨. | الأمر الأكثر أهمية هو أن يكون الشيء ممكن تطبيقه عملياً | |
| ٩. | أبحث بنشاط عن الأمور الجديدة لتجربتها. | |
| ١٠. | أفضل وضع الحقائق والتفكير في الأشياء قبل الوصول إلى قرار | |
| ١١. | أحب أن أتخصص الأشياء بنفسى بدلاً من أخذها على محمل ثقة | |
| ١٢. | عندما أسمع عن فكرة أو تقنية جديدة، أبدأ فوراً في العمل على كيفية تطبيقها في مشكلتي أو وضعي. | |
| ١٣. | أحب التحدي في محاولة طرق مختلفة للقيام بالأشياء | |
| ١٤. | أفضل أن يكون لدي العديد من المعبومات القليلة حول موضوع قدر الإمكان، كلما كان علي التحقيق في الأمر كلما كان أفضل. | |
| ١٥. | أنا أحرص تمام على التمسك بالروتين الثابت، وإتباع الإجراءات والمحافظة على الجدول الزمني. | |
| ١٦. | في المناقشة، أتوجه مباشرة إلى صلب الموضوع. | |

Signed

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مركز آسيا للترجمة والخدمات

تصنيف: 12-09-524-02 - حيازة رقم: ٢٠٠٢ - التاريخ: 9/27/2012

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Since 1987

سنة: ١٩٨٧

- | | |
|-----|--|
| ١٧. | أفضل لقفز إلى القيام بالأشياء التي تأتي بدلا من أخطط للأمور قبل تناولها. |
| ١٨. | أفضل أن تكون المناقشات على أرض صلبة ولا أتق بالأمور الندية أو التحسس. |
| ١٩. | أحب أن تتناسب الأشياء مع نموذج أو إطار عمل أو عينة. |
| ٢٠. | أميل للحكم على أفكار الناس حول جدارتها العملية. |
| ٢١. | في المناقشة، عادة ما أصل إلى العديد من الأفكار المتولدة بشكل تلقائي. |
| ٢٢. | أفضل أن أنظر إلى مشكلة من زوايا مختلفة عديد وذلك يمكنني حلها. |
| ٢٣. | أفضل تقييم مدى سلامة أفكاري قبل مشاركتها مع الآخرين. |
| ٢٤. | في الاجتماعات و المناقشات، أطرح الأفكار على أعرقها على أرض الواقع. |
| ٢٥. | عادة ما تكلم أكثر من أن أسمع. |
| ٢٦. | إذا قمت بكتابة تقرير أو رسالة رسمية، أفضل أن أقوم بعمل مسودات عديدة قبل كتابة نسخة نهائية. |
| ٢٧. | أحتاج إلى معرفة كيفية القيام بالأشياء على نحو أقرب إلى الكمال. |
| ٢٨. | أجد أنني يمكنني دائما العمل بطرق عملية أكثر عندما أقوم بفعل شيئا ما. |
| ٢٩. | أجد أن القوانين والإجراءات تقضي على متعة الأشياء. |
| ٣٠. | أحب أن أنظر إلى الكثير من الخيارات قبل أن أقرر. |
| ٣١. | أعتقد أن الحرص والتفكير المنطقي هو مفتاح النجاح. |
| ٣٢. | أفضل الأفكار المرتبطة ارتباطا وثيقا بحبائي وعقلي. |
| ٣٣. | عادة ما أمس "المرح والروح" للمفلات. |
| ٣٤. | أفضل التفكير في لتبعات قبل اتخاذ أي إجراء. |
| ٣٥. | أحب أن أفهم الفرضيات والأسس والعلاقات على تبنى عليها الأشياء. |
| ٣٦. | في رأيي، لا يهم كيفية عمل الأشياء مادامت تعمل. |
| ٣٧. | استمتع بالإثارة في مواقف الأزمات. |
| ٣٨. | عادة أسمع أكثر مما أتحدث. |
| ٣٩. | أحب الاجتماعات والمناقشات أن تكون منظمة ومرتبطة. |
| ٤٠. | أعمل كل ما يتطلبه الأمر لتفدية المهمة. |



Signed

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مركز آسيا للترجمة والخدمات

الرجوع إلى: 12-09-524-02، صلحة رقم: 9/27/70/2 التاريخ

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القسم الثاني: تحديد مكونات المنهج

عندما تقوم بتطوير المنهج تؤدي يمكن أن تضمن من عملية اكتساب المعرفة والمهارات يجب أن تضع في الحسبان مكونات أساسية محددة.

قرر إلى أي درجة أنت تتفق مع أو تختلف مع، كل من المكونات التالية وضع علامة على الإجابة التي تفضلها فيما يلي:

١) البرنامج الدراسي الرئيسي

لتحديد الشخص الذي ينبغي أن يكون مسئولاً عن الإشراف على ومراقبة دورات (الإعاش القلبي الرئوي) للمسعفين، فإن هذا الأمر قد يتطلب تكاليف اداخ مختصة في خدمات الطوارئ الطبية والتي سوف تكون مسئولة عن تسجيل، تنظيم و ضمان حضور والالتزام بالمتطلبات التي تحدد كفاءة الإعاش القلبي الرئوي.

أوافق تماماً أوافق سياتر لا أوافق أرفض تماماً

٢) تحديد معايير متطلبات المحاضر

لتحديد ووضع متطلبات محاضري المنهج، فإن هذا يتضمن أيضا جوانب حول لغة المحاضرة والمادة المقدمة للمشاركين.

أوافق تماماً أوافق سياتر لا أوافق أرفض تماماً

٣) المتطلبات المحدد مسبقاً للمنهج واختيار المرشحين للمنهج

إن تصميم عملية التقديم الرسمي للمنهج لطلاب المحتملين، قد يتضمن تقييم معلومات الطلاب المحتملين المسبق.

Signed

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 رقم: 12-09-524-02، صفحة رقم: = التاريخ: 9/27/2012
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 مترجمون قانونيون متميزون
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 Since 1937
 منذ: ١٩٣٧

أوافق تماما أوافق سيان لا أوافق أرفض تماما

٤) مدة وهيئة المنهج

تحديد م هي التي ينبغي أن يستغرقها المنهج الدراسي والهيئة التي ينبغي أن يكون عليها، مثل: المنهج المنبني المقابل لتطور التنشيطية، فإن ذلك يتضمن أيضا تحديد الأماكن المثالية والمحاضر المثالي وفق لمؤثرات الطلاب

أوافق تماما أوافق سيان لا أوافق أرفض تماما

٥) محتوى المنهج

محتوى المنهج سوف يغطي المهارات التي هي الأكثر احتمالا أن تنتج في الإنعاش الناجح أثناء برنامج (السكنة اقلية خرج المستفى)، وهذا قد يتضمن فحص المعنات قبل إرسالها إلى رعاية القلب للوقوف على مدى فعالية أدائها الوظيفي في بيئة المستشفيات المتعددة الوكالات لاستخدام مهارات غير شفهية للتواصل عند وجود حاجز اللغة.

أوافق تماما أوافق سيان لا أوافق أرفض تماما

٦) التقييم

ويتضمن هذا الأمر وضع طرق غير تمييزية التي تقيس بفعالية كفاءة الطالب.

أوافق تماما أوافق سيان لا أوافق أرفض تماما

Signed

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مركز آسيا للترجمة والخدمات

الرجوع إلى: 12-09-524-02، صفحة رقم 1، تاريخ: 9/27/2012

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Since 1987 منذ ١٩٨٧

(٧) وضع الأطر الزمنية التي تضمن الكفاءة
لتحديد كيفية حضور الطلاب لبرامج التحديث والتثقيف

أرفض تماماً

لا أوافق

متساو

أوافق

أوافق تماماً

نهاية الاستبيان - شكراً لكم على الوقت.

الباحث الرئيسي

كيفين، جي جوفيندر

Kevin.govender@yahoo.com

٣٣٨٣٧٧٢٨



من ب: ١٠٤٧٨ - تليفون: ٤٤٣٦٤٥٥٥ / ٤٤٤٠٩٤٣ +٩٧٤ - فاكس: ٤٤٣٢٨٣٢٧ +٩٧٤ ص.ب: ٢٩٥٧ - الدوحة - قطر
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APPENDIX H: INTERVIEW GUIDE



University of Cape Town
South Africa

Semi-Structured Interview questionnaire

Question 1

What are your thoughts regarding CPR when performed by Ambulance Paramedics (AP)?

Question 2

Why do you think this is so? (Referring to answer given in Q1) Could be positive and or negative.

Question 3

What could be done to improve overall CPR performance in APs?

Question 4

Is the training APs receive in CPR one; appropriate AND two; adequate?

Question 5

What training would be appropriate and adequate to improve and maintain overall CPR performance in APs?

Question 6

Feedback forms were collected from APs who had attended CPR classes or training that had a CPR component in it. Following a process of grouping and coding common themes; the following factors were found to negatively affect learning and retention of knowledge and skills.

I will list these components one at a time. What I would like from you; is to please discuss your thoughts on each factor and what you may understand by it.

- Insufficient hands on practice
- Inconsistent teaching methods
- Unrelated course content
- Trustworthiness of information and content
- Complex instruction
- Delays between instruction and skills practice
- Lack of supervision
- Low instructor feedback
- Instructor incompetence
- No motivation or accountability

Question 7

A specific or ideal curriculum to teach and train APs CPR knowledge and skills does not exist. Curriculums that have shown to improve acquisition and retention of knowledge and skills have paid particular attention to eight key components.

I will list these components one at a time and include a brief description of each one. What I would like from you; is to please discuss your thoughts on each component with regards to including it into a curriculum designed specifically at teaching CPR to APs.

1) Curriculum governance

The curriculum should include established criteria for who should be responsible for overseeing and managing CPR courses and programs for paramedics. This should include the recruitment of specialist committees within the EMS that will be responsible for registering, regulating and ensuring attendance and adherence to requirements that define CPR competency.

2) Identifying criteria and instructor requirements

The curriculum should include established requirements for course instructors. This should include attributes around experience, formal qualifications and proficiency in the language of instruction.

3) Pre-course requirements and selection of course candidates

The curriculum should include an established formal application process for potential course candidates; this should include assessing candidate prior knowledge.

4) Course duration and format

The curriculum should include an established duration for how long courses should be and the format they should be presented in.

5) Venue and Instructor to candidate ratio

The curriculum should include established requirements for training venues and instructor to candidate ratios.

6) Course content and format

The curriculum should include established course content that cover knowledge and skills that are most likely to result in successful resuscitation during an OHCA.

7) Assessment

The curriculum should include established non-discriminatory methods that reliably measure candidate competency.

8) Establishing time frames that ensure competence

The curriculum should include established time frames for how often candidates should attend updates and refresher courses.

The End – Thank You!

APPENDIX I: FOCUS GROUP INTERVIEW GUIDE



**University of Cape Town
South Africa**

Focus Group and Interview questionnaire

For Chair/Interviewer

1. Welcome participants and obtain process consent.
2. Explain briefly the study, indicate how far the study has come, and how this Phase ties into the study.
3. Answer any questions.
4. Discuss ground rules:

For Participate/Interviewee

1. The objective of the focus group is to draw upon your' attitudes, feelings, beliefs, experiences and reactions to a specific question or topic.
2. As a result it is expected for YOU to do the talking.
3. To allow everyone to participate, questions will be directed to you.
4. Please refrain from talking over each other.
5. There is no right or wrong answer.
6. The discussion, interview will be recoded and transcribed for analysis.
7. No names or identifying data will be included.

Question 1

What are your thoughts regarding CPR when performed by Ambulance Paramedics (AP)?

Question 2

Why do you think this is so? (Referring to answer given in Q1) Could be positive and or negative.

Question 3

What could be done to improve overall CPR performance in APs?

Question 4

Is the training APs receive in CPR one; appropriate AND two; adequate?

Question 5

What training would be appropriate and adequate to improve and maintain overall CPR performance in APs?

Question 6

Feedback forms were collected from APs who had attended CPR classes or training that had a CPR component in it. Following a process of grouping and coding common themes; the following factors were found to negatively affect learning and retention of knowledge and skills.

I will list these components one at a time. What I would like from you; is to please discuss your thoughts on each factor and what you may understand by it.

- Insufficient hands on practice
- Inconsistent teaching methods
- Unrelated course content
- Trustworthiness of information and content
- Complex instruction
- Delays between instruction and skills practice
- Lack of supervision
- Low instructor feedback
- Instructor incompetence
- No motivation or accountability

Question 7

A specific or ideal curriculum to teach and train APs CPR knowledge and skills does not exist. Curriculums that have shown to improve acquisition and retention of knowledge and skills have paid particular attention to eight key components.

I will list these components one at a time and include a brief description of each one. What I would like from you; is to please discuss your thoughts on each component with regards to including it into a curriculum designed specifically at teaching CPR to APs.

1) Curriculum governance

The curriculum should include established criteria for who should be responsible for overseeing and managing CPR courses and programs for paramedics. This should include the recruitment of specialist committees

within the EMS that will be responsible for registering, regulating and ensuring attendance and adherence to requirements that define CPR competency.

2) Identifying criteria and instructor requirements

The curriculum should include established requirements for course instructors. This should include attributes around experience, formal qualifications and proficiency in the language of instruction.

3) Pre-course requirements and selection of course candidates

The curriculum should include an established formal application process for potential course candidates; this should include assessing candidate prior knowledge.

4) Course duration and format

The curriculum should include an established duration for how long courses should be and the format they should be presented in.

5) Venue and Instructor to candidate ratio

The curriculum should include established requirements for training venues and instructor to candidate ratios.

6) Course content and format

The curriculum should include established course content that cover knowledge and skills that are most likely to result in successful resuscitation during an OHCA.

7) Assessment

The curriculum should include established non-discriminatory methods that reliably measure candidate competency.

8) Establishing time frames that ensure competence

The curriculum should include established time frames for how often candidates should attend updates and refresher courses.

The End – Thank You!

**CPR Training Module
APs and CCPs**

**INSTRUCTOR
GUIDE**

Instructor Name	
Education : Head	

Confidential

Introduction

This document is the instructor guide for the CPR Training Module offered by HMCAS. It was developed with the specific aim of providing YOU, the HMCAS CPR instructor, with clear, step by step guidelines on how CPR training of HMCAS staff should be conducted. It explains the intended objective of each learning event and guides the process in which the learning event should be conducted.

Aim of CPR training

The primary aim of the CPR training module is to equip HMCAS staff with up to date technical and non-technical resuscitative skills allowing them to become proficient in performing high quality pre-hospital CPR in adults in medical cardiac arrest, in a manner and at a level that is likely to restore oxygen delivery and maintain circulation and perfusion of vital organs, to allow for return of spontaneous circulation (ROSC) and/or successful defibrillation.

The HMCAS CPR training module

The HMCAS CPR training module is a product of a collaborative effort between the HMCAS Consultant Paramedic Program and the HMCAS training section. Following extensive consultation, research, and analysis of HMCAS staff and learner needs and preferences; the module content, structure and teaching methods employed by the HMCAS CPR training module, was developed specifically to ensure improved acquisition and retention of CPR knowledge and skills. This has with it the intended aim of improving HMCAS staff CPR performance, and ultimately, out-of-hospital cardiac arrest (OHCA) hospital to discharge rates in the state of Qatar.

STEP 1: Identifying HMCAS Staff that require training

All HMCAS Operational staff that will be expected to provide CPR to patients with medical cardiac arrest will undertake CPR training as outlined in this CPR Adult Medical training module. In accordance to HMC AMBULANCE SERVICE STAFF TRAINING AS 9019; Staff employed at HMCAS will be scheduled to attend CPR training during their orientation programme as well as at identified training intervals to ensure clinical competence.

STEP 2: Module preparation (2 weeks in advance)

1. Select candidates.

HMCAS new recruits who will be required to perform Cardiopulmonary Resuscitation (CPR) in Adult patients with medical cardiac arrest must attend and successfully complete this module. This module is also used as the CPR re-certification training module that candidates will undertake on an annual basis to remain clinical current and proficient in CPR.

Please note the following:

A maximum of 6 candidates per instructor is permitted.

A maximum of 12 candidates per classroom is permitted.

2. Prepare pre-module reading and assignment.

Review and update if necessary – provide references for updates and changes to module content. **Changes must be approved by an HMCAS Education Department Manager.**

3. Prepare training equipment.

Locate, clean, and test equipment. Equipment should be suitable, sufficient, and available for all candidates for the training day. Two full-body manikins with ECG simulators, two complete sets of AP primary response kits and two LUCAS devices are needed for each group of 6 candidates.

4. Prepare rooms.

Two rooms will be utilised; one for theory and practical activities, and the other for mental modelling sessions and the simulated OHCA assessment. The theory and practical teaching room should include a matted floor, chairs with writing tables, and multimedia equipment for PowerPoint presentations and video playbacks. Label desks 1-6.

5. Identify and prepare the instructor and facilitators.

There should be one instructor per six candidates. An instructor equal in training to the instructor is preferred during the simulated OHCA assessments at the end of the module. The instructor must complete the **HMCAS CPR instructor module** and be proficient in written and spoken English, and have the ability to communicate effectively.

STEP 3: Pre-module reading and assignment

The pre-module package must be made available to candidates at least 7 days before commencement of the module (1 full week).

Please note: Our research has shown us that when HMCAS staff know what to expect from training; anxiety, apprehension and resistance to training is dramatically reduced.

The objective of the pre-module package is to:

- Provide HMCAS candidates with a clear outline of the proposed training.
- Shift focus from learning new information on the day of the module to reinforcing information that has already been acquired.
- Provide a clear standard and expectation on what must be known.
- Allow candidates to identify and become familiar with new updates and changes in resuscitation content prior to commencement of module.
- Allow learners to become familiar with module assessments.
- Allow learners to identify specifically the CPR content that should be known when employed by HMCAS.

The focus of training should be towards ensuring that HMCAS staff perform high quality effective CPR every time they are required to do it.

STEP 4: Day of Module (1 day [07:45-16:00])

The *HMCAS CPR Training Module Guide and Checklist* should be filled in at every module.

See Appendix 1 at the end of this instructor guide for a print version.

The next few pages of this instructor guide lists and explain each step of CPR training module as they appear in Appendix 1.

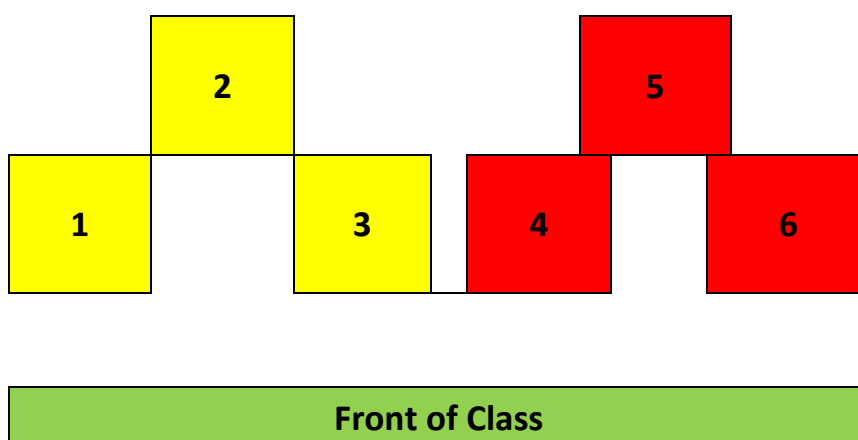
Please review Appendix 1 NOW.

Step	<i>What should be done</i>	Attached as:	Tick when done <input checked="" type="checkbox"/>
1	Welcome candidates. Max 6 per instructor. Sign Register.	App. 2	
2	Collect pre-module assignment	App. 2	
3	Inform candidates of seat allocation – Provide individual pins	App 3 and Fig.1	

Guide for Steps 1 to 3:

- Call one candidate at a time to the instructor’s desk.
- Collect pre-module assignment.
- Candidate signs register – **Appendix 2.**
- Provide module number tags to each candidate.
- **See Appendix 3 for a print version of the name tags.**
- Inform candidate of seat allocations for pre-module test. **See Figure 1.**

Figure 1: Example of seat allocation



4	Administer pre-module test (Max time 30 Minutes)	TBA - CP	
---	---	----------	--

Overview of Step 4:

- Test to be stopped 30 minutes after commencement – No extra time and no early submission is allowed.
- The pre-module test will be provided to you on the day of the module by the Education Department.
- The test is collected after 30 minutes.
- **NOTE:** After Step 5 of the module is done the tests are handed back to candidates for self-marking

The objective of Step 4:

- Promotes importance of pre-module reading.
- Self-marking allows candidate to recognize knowledge gaps before commencement of the module.
- Using a fixed time frame to complete test removes competition and anxiety that may be experienced by candidates when prompted to finish quickly.

Guide for adjusting or amending test:

- The test must comprise of open and closed ended questions.
- The primary aim of the test should be to reinforce learning.
- Questions are repeated and necessary to promote learning and retention.

- All suggested changes to tests must be approved by the Education Department Manager

Guide for processing test on completion:

- Check for completeness in front of candidate.
- Do not mark test – but mark a line through blank spaces where answers were not provided so answer scripts can no longer be altered by candidates during self-marking.

5	Provide Power Point presentation	PP1-USB	
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Overview of Step 5:

The presentation should consist of 10-12 slides only. It should take no longer than 30 minutes to present. Inform candidates that they should note any questions that they may have and ask them at the end of the presentation.

The objective of Step 5:

- Re-enforce information provided by the pre-module reading.
- Slides should be presented in a sequence with the aim of answering the following questions:
 - Why perform CPR?
 - How does CPR work?
 - How to diagnose cardiac arrest?
 - What are the components of good quality CPR?
 - How to achieve adequate coronary perfusion pressure?
 - Airway management in cardiac arrest
 - Use of medications in cardiac arrest
 - The LUCAS chest compression device
 - Interruptions in compressions
 - Rhythm analysis and defibrillation
 - Sequence of events
 - Post cardiac arrest care
- Overall focus of the presentation should be:
 - *Where are we now?*
 - *Where do we want to be?*
 - *How are we going to get there?*

Guide for adjusting PowerPoint presentation:

- Clear, font size >30, Simple English – Maximum 2 points per slide.
- Less writing. The instructor provides the explanation not the PowerPoint.
- Tailor the message and use examples HMCAS staff could relate to within the context of Qatar.

Guide for Step 5:

- Make it known early that questions will be answered at the end.
- Entire presentation should not exceed 30 minutes.
- Your preparation for the presentation should include a complete understanding of the content within the pre-module package.
- All the information you need to know to equip you with the content knowledge for the presentation is within the pre-module package.
- If you encounter candidates that digress from the content and introduce examples of practice that works for them - politely inform them that although that example may work for them – it is not the standard that HMCAS will use to measure CPR performance.
- Do not allow loud individuals to take control of the class – It may become necessary to call these individuals aside and inform them that their actions and behavior is affecting or at worst confusing other candidates.
- If these individuals continue undeterred – Please inform the Training Manager immediately.

6	Have candidates mark their own test	TBA -CP	
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Overview of Step 6:

- Assessments should be returned to candidates after the PowerPoint presentation.
- Candidates are requested to mark their own answer scripts.
- Marked answer scripts are returned to module instructor for administrative purposes.

The objective of Step 6:

- Promote further learning and retention of knowledge.
- Promote instructor/candidate trust relationship.
- Prevent anxiety and embarrassment that may come with candidates marking other colleagues/candidate's answer scripts.

Guide for Step 6:

- Discuss each question.
- Explain answers and provide rationale if necessary.
- The reference to all answers is the pre-module package (PCP).

7	Play OHCA Cardiac Arrest Video	Video-USB	
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Overview of Step 7:

The simulation should be conducted by individuals who work for HMCAS. The recorded simulation presents OHCA practice that candidates should aspire to achieve.

The objective of Step 7:

- Provide an example of current theory demonstrated into everyday practice.
- Provide example of actions as well as procedures that should occur in an OHCA.
- Provide example of language and tone of instruction to be used in an OHCA.
- Provide example of non-technical skills that should be used in an OHCA.
- Demonstrate overall example of ideal practice.
- Provide candidates clarity on sequence of events.
- Demonstrate assessment expectations.

Guide for adjusting video in Step 7:

- Full-scale simulation at expected candidate learning outcome level, i.e. Ambulance Paramedic (AP) and Critical Care Paramedics (CCPs).
- All procedures done and medications given in real time to the manikin.
- Emphasis placed on high quality compressions.
- Emphasis placed on limiting interruptions during compressions.
[Effective compression fraction]
- Include events to show use of non-technical skills.
Communication, leadership, teamwork etc.

Guide for Step 7:

- The video is self-explanatory – it was developed to play without facilitation and instructions.
- Do not stop the video at any time to explain the demonstrated practice.

- Clarity or explanations of certain aspects of the video can be given after the full playback.

8	Evaluate Key performance measures	App. 4	
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Overview of Step 8:

Early recognition of cardiac arrest, performing high quality chest compressions with feedback and application of the LUCAS are activities that contribute significantly to the overall outcome of OHCA resuscitative attempts. As a result emphasis must be placed on these activities to ensure skill mastery.

The objective of Step 8:

- Observe and examine candidates' understanding of revised sequence of steps.
- Examine candidates' interpretation of the revised compression rates.
- Promote participation in simple active learning exercise.
- Redirect emphasis towards early recognition and high quality CPR.
- Allow candidates to identify their own current proficiency.
- Allow candidates to watch peer performances.
- Guide proficiency using real time feedback on performance.
- Using evaluation/assessment as a teaching aid.

Guide for Step 8 is:

- Before commencement emphasize the revised sequence for detection of cardiac arrest:
 - (1) Unconscious –
 - (2) No breathing or no normal breathing –
 - (3) **START COMPRESSIONS.**
- Before commencement emphasize the following:
 - (4) Sequence of events (CAB), position (Lower half of sternum), depth (5cm), ratio (equal rise and fall), rate 100 (to the tune of staying alive),
 - (5) Updating NCC, Instruction for attaching Defibrillation /Monitor and LUCAS and requesting Feedback(UIF)
 - (6) LUCAS application should be in less than 10 seconds.

- Each candidate should be given a Key Performance Measure evaluation tool
See Annexure 4 for a print version at the end of this instructor guide.
- Instructors should measure whether 100 compressions are given at the desired rhythm.
- Appoint remaining candidates to each examine 1 feature of performed CPR.
- After the first cycle, receive feedback from all candidates, encourage correction and ways to improve performance.
- Next candidate should be asked to participate.
- Before 2nd attempt each candidate should be asked to verbally review key points regarding sequence of events, position, depth, and recoil, rate, and LUCAS application.

9 Split Class into 2 groups of 3 people	
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Overview of Step 9:

Based on content, candidate needs, and goals of promoting acquisition and retention of CPR knowledge and skills, a maximum of six candidates per module instructor is recommended. To further ensure that all candidates get adequate instructor attention classes should be split into smaller groups. This may require additional instructors or one instructor dedicating portioned time to each group. While groups of two candidates are ideal, a group of three is recommended as it is more practical.

The objective of Step 9:

- Allow and encourage input from all candidates.
- Ensure all content is covered and not rushed due to time constraints.
- Promote greater sense of personal accountability.

Guide for Step 9:

- Candidates with similar personalities should be grouped.
- Candidates with different skill levels should be grouped.
- Talkative candidates should be grouped together.
- Candidates who appear as withdrawn or nervous should be grouped together.
- Ensure English is the medium of communication during all group activities

10	Provide 1 of 2 paper scenarios to each team
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App. 5	
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Overview of Step 10:

Two OHCA scenarios printed out on paper should be presented to each group. Each group should identify and write down ideal management for a specific paper scenario. Groups will then present their findings of ideal management and have their ideal management appraised by the remaining group and facilitated by the instructor.

The objective of Step 10:

- Promote active learning, teamwork, and conflict resolution.
- Provide stress-free platform for knowledge and skill application.
- Allow and encourage consensus thinking and application.
- Allow filling in of knowledge gaps and achieving overall clarity.

Guide for Step 10:

- Provide 2 scenarios (Asystole/ PEA or VF or pulseless VT).
- Each scenario should consist of a situation specific to Qatar. This may be a conflict situation, a VVIP, or an angry disruptive crew member etc.

Appendix 5 provides examples of these scenarios.

- Have each group determine ideal management for each specific scenario.
- Have groups present their ideal management as a flow diagram on paper provided.
- Have groups include non-technical skills (phrases or statements to be used).
- Encourage talking softly to prevent disturbing other groups.
- Avoid becoming part of group, encourage active learning.

11	Have class appraise scenarios – Reach consensus
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App. 5	
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Overview of Step 11:

A designate from each group will stand up and present their management of the paper scenario. The rest of the group will appraise the management, provide comments, and feedback.

The objective of Step 11:

- By having all candidates appraise and provide feedback – conclusions regarding ideal management become more real, appreciated, and valid.

Guide for Step 11:

- During presentations, treat all mistakes as a valuable resource from which learning can occur.
- Take notes while listening, to point out mistakes areas of concerns.
- Let learners complete the entire presentation, and then facilitate a brief discussion to review and analyse the decisions made.
- Discussion should be around the presentation with a focus on bringing presented management towards ideal management.
- Provide candidates with valid, factual information to substantiate claims.
- Every attempt must be made to facilitate a discussion to help candidates reflect and notice by themselves their mistakes. This will lead to a deeper level of learning from experience and discussion.
- Facilitate – don't lecture. The aim is for candidates to appreciate management conclusions as their own and not ones that are imposed onto them by the instructor.
- Facilitate. DO NOT LECTURE.

12	Group 1 to assess Group 2s performance using RET	App. 6/7	
13	Group 2 to assess Group 1s performance using RET	App. 6/7	

Overview of Step 12 and 13:

Group 1 will demonstrate consensus management on simulated OHCA for any one of the paper scenarios. Group 2 will assess group 1s performance using the official Rapid Evaluation Tool (RET). **See Appendix 6 and Appendix 7**

The objective of Step 12/13:

- Promote active learning, teamwork, and conflict resolution.
- Provide platform for knowledge and skill application.
- Get candidates accustomed to simulation exercises.
- Familiarize candidates with what is expected from assessments.
- Allow candidates to concentrate on quality.
- Allow all candidates to see ideal management of two possible scenarios.

- Allow candidates to experience assessment standard and environment prior to final assessment.

Guide for Step 12/13:

- Provide one scenario from paper scenarios given to group in step 11.
- Have groups assessing scenarios use standard official RET. **Annexure 6/7**
- Instructor should conduct simulation as they would in the actual assessment.
- Candidates should be asked to perform all actions, procedures, and skills.
- Candidates conducting the assessment should be briefed on how an assessment should be conducted.
- Candidates conducting the assessment should make notes on RETs.
- A short debrief should happen immediately after the simulation, encouraging reflection through enquiry and discussion, providing feedback and outcome of simulation.
- Candidates should be encouraged to justify their decisions and actions.
- Consensus should be reached.

14	Administer post module test	TBA - CP	
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Overview of Step 14:

- Test to be stopped 30 minutes after commencement – No extra time and no early submission within this timeframe is allowed.
- The post-module test will be provided to you on the day of the module by the training section.
- Please Note: 15 minutes of quiet time must be given to candidates before post-module test.

The objective of Step 14:

- Allow culmination of thoughts, knowledge, and skills.
- Allow candidates to gauge what is now known and what still remains unknown.
- Allow learner to solidify and retain information.

Guide for Step 14:

- Ensure that students are given at least 15 minutes of quiet time to go over the flow diagrams detailing the sequence of actions before post-module test.

- Post-module test is similar to pre-module test, however, structure and wording can change.

15	Divide class into pairs of 2 – Mental Practice and Model	App. 8	
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Overview of Step 15:

- This allows candidates to prepare for the team dynamic within which they are most likely to work while operational.
- Mental practice is the cognitive rehearsal of a task before performance. When we add the model aspect into it, we now rehearsing a task but also modelling our thinking around certain actions prior to the performance of that action.
- The term HMCAS uses is ***verbally enhanced mental simulation***.

Guide for Step 15:

- Choose a two person team advising them that each will be the team leader for one of two simulations.
- Each team will be presented with 3 possible scenarios.
- They will need to work through and discuss each scenario through a ***verbally enhanced mental simulation*** session.
- Each candidate in the team will be given a RET (Appendix 6/7) and a blank page to write down the outcome of the ***verbally enhanced mental practice and modelling*** session for each scenario.
- This document together with the pre-module package will be handed to the instructor when the candidate enters the simulation assessment.
- Candidate will sign after session of register at this time.

The objective of Step 15:

- Promote active learning, teamwork, and conflict resolution outside the practical simulation environment.
- Candidates can talk through, establish roles, tasks, and describe ideal management of different OHCA scenarios.
- Sessions provide a stress-free platform for knowledge and skill application.
- It allows and encourages consensus thinking and application.
- It eliminates knowledge gaps and provides clarity before the practical simulation.

Guide for Step 15:

- Provide any 3 scenarios used in step 11.
- Have each individual within each pair present ideal sequenced management for each specific scenario after verbally enhanced mental simulation.
- Have each individual within each pair present their ideal management as a flow diagram on the paper provided.
- When ready – call one team into the simulation room at a time.
- Each individual within the pair should bring with them their individual pre-module package and the document the outcomes of their verbally enhanced mental practice and modelling sessions were written on.

16 OHCA simulation assessment.	App. 6/7
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Overview of Step 16:

Directly after the verbally enhanced mental practice and modelling session – each pair should be taken into the simulation assessment room. A VT scenario is given first, followed by an Asystole scenario. Each candidate will be the team leader in one scenario.

The objective of Step 16:

- Promotes active learning, teamwork, and conflict resolution.
- Provides assessment platform for knowledge and skill application.
- Allows candidates to gauge proficiency.
- Allow instructors to gauge knowledge and skill transfer and overall CPR proficiency.

Guide for Step 16:

- When candidates enter the rooms collect the document the outcomes of their verbally enhanced mental practice and modelling sessions were written on.
- Inform candidates who will go first. [This is random – flip a coin]
- The first person becomes the team leader and the second becomes his/her crew mate.
- Make it CLEAR – the crewmate will only act on instruction from the team leader.
- Provide the VT scenario first then the Asystole scenario.
- All candidates will therefore undertake two scenarios.
[Six scenarios in total for six candidates]
- Instructors should use the same official RET.

- Once simulation is complete – allow crewmate and second instructor to tidy up and prepare room for next practical simulation.
- Candidate that has performed the simulation as the team leader should provide the instructor feedback about the simulation.
- Instructor should ask for explanations and clarity around candidate actions or performances deviant from current training.
- Instructor should determine outcome of simulation but NOT inform candidate at that time. Results should only be given after both candidate have performed both simulations
- Two attempts at the final practical simulation are allowed. [Same scenario is given]
- If both simulations are failed – Please escalate to training manager.
- Simulation accounts for 50% of module mark. [Pass 90% min].

17 Feedback	Train.	
	Dept.	

- Candidates should be asked to provide feedback by filling in an anonymous feedback form to aid improvements to the module and training at HMCAS in general.

Appendix 1: CPR Training Module Guide and Checklist

Please complete the following checklist for each module

Step	What should be done	Attached as:	Tick when done <input checked="" type="checkbox"/>
1	Welcome candidates. Max 6 per instructor. Sign Register.	App. 2	
2	Collect pre-module assignment	App. 2	
3	Inform candidates of seat allocation – Provide Individ. Pins	App 3 and Fig.1	
4	Administer pre-module test (Max time 30 Minutes)	TBA - CP	
5	Provide Power Point presentation	PP1-USB	
6	Have candidates mark their own test	TBA -CP	
7	Play OHCA Cardiac Arrest Video	Video-USB	
	TEA BREAK – 15 Minutes.		
8	Skill mastery of Key Performance Measures	App. 2	
9	Split Class into groups of 3 people		
10	Provide 1 of 2 paper scenarios to each group	App. 5	
11	Have class appraise scenarios – Reach consensus	App. 5	
	LUNCH BREAK – 30 Minutes.		
12	Group 1 to assess Group 2s performance using RET	App. 6/7	
13	Group 2 to assess Group 1s performance using RET	App. 6/7	
14	Administer post module test	TBA - CP	
15	Divide class into pairs – Conduct Mental Practice Models	App. 8	
16	OHCA final simulation assessment. Collect MP Models	App. 6/7	
17	Feedback	Train. Dept	

Appendix 2: CPR Training Module Register

Please complete the following register for each module

NO	Full Name	Corp No:	PMA	Candidate Signature	Instructor Signature
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Appendix 3: CPR Training Module Number Tags

Please cut out neatly and insert into plastic name tags – Change Colour

1-CPR	2-CPR
3-CPR	4-CPR
5-CPR	6-CPR

Appendix 4: CPR Training Module KPM forms

NO	Key Performance Measure	Candidate. No	Tick/ Cross	Feedback if cross given
1	Unconscious state detected < 5 seconds from contact			
2	Breathing state detected < 10 seconds from contact			
3	Compressions started < 15 seconds from detection			
4	NCC informed during 100 compressions			
5	Requested for Defib Pads and LUCAS preparation			
6	Requested feedback on position, depth, comp and release ratio			
7	Rhythm treatment correct			
8	LUCAS correctly placed and started in < 10 seconds			

Appendix 5: CPR Training Module – Paper scenarios

Please indicate ideal management for each of the four patient scenarios. Write your answers on the blank pages attached.

NOTE:

- Indicate how you would approach the scene, treat the patient and deal with possible conflict situations. Please indicate non-technical skills including phrases or statements that you would likely use when dealing with family, crew or bystanders.

Scenario 1

1. 86yr old VVIP – Patient with rigor mortis – family insists on resuscitation. Family is hostile and aggressive.

Scenario 2

2. Undeniable death and Police insistent on resuscitation.

Scenario 3

3. You are 7 minutes from hospital – your crewmate is driving P1 and you are attending to the patient. Patient complained of severe Asthma and suddenly goes into cardiac arrest.

Scenario 4

4. You are out on a call near Abu Samra border . Resuscitation has now gone on for 23 minutes. Initial rhythm was VF. After one shock patient went into Asystole and remained in Asystole for 17 minutes.

Scenario 5

5. Asystole

Scenario 6

6. VF

Appendix 6: Verbally enhanced mental practice and modelling session

Please indicate ideal management for each of the three patient scenarios. Write your answers on this document. Please refer to the assessment tool given to you earlier today.

Use the assessment tool to ensure that your management is in line with each assessment metric your performance will be measured against.

Scenario 1

1. 86yr old VVIP – Patient unconscious, no breathing – Found in Refractory Asystole.

Scenario 2

2. 23yr old male in refractory VT

Scenario 3

3. 16yr old female with initial rhythm Asystole – after two minutes LUCAS CPR goes to VF – after another two minutes goes into PEA

Please close your eyes – visualise each management step and indicate verbally in point form how you would treat each of these situations.

Your partner will write down your management steps as you talk them out.

Please note: This document will be collected from you and evaluated – So please write legibly.

Appendix 7: OHCA equipment needed for 6 candidates

Equipment needed	
Life pack 15 monitor	Response bag
LUCAS 2	Oxygen cylinder
Mannequin ACLS	Medication bag
Simulator	Sharps container
Gloves	Suction Unit



APPENDIX K: PRE-COURSE READING DOCUMENT

CPR Pre-Module document

Candidate Name	
HMC Corp Number	

NOTE: This Pre-Module document must be made available to you at least 7 days before you attend the module.

Date module package made available to student	
Module start date	

Contents of this Pre-Module Package

1. Module overview
2. Module outline
3. Module learning objectives
4. Module assessments
5. Outline of test conducted at commencement of module
6. Essential pre-module reading
7. References
8. Module support and contact details
9. Essential pre-module assignment collected at commencement of module
10. Appendices

1. Module overview

This CPR training module was developed with the specific aim of equipping and or re-enforcing HMCAS staff with up-to-date, evidence-based CPR knowledge and skills. The training intervention was developed after recognising the needs of adult victims in cardiac arrest and the role of HMCAS in catering to those needs, through evidence-based best treatment that has been shown to improve survival to discharge rates.

The module also recognised that survival from OHCA (Out of Hospital Cardiac Arrest) is not determined solely by the quantity and quality of the scientific evidence supporting care and treatment guidelines, but more so by the level of adherence to the guidelines when they are applied in clinical practice.^{1,2} In other words, the module content, activities and structure has been designed to promote better acquisition (taking in) as well as better retention (keeping in) of information.

This document is the pre-module document that YOU must read at least seven days prior to commencement of the module. It provides specific information that prepares you for successful completion of the module.

Included in this package is the essential pre-module reading. It outlines and explains the sequences of actions, skills, and procedures recommended by HMCAS for the care and treatment of adult victims in cardiac arrest.

The information presented here is the result of an extensive review of valid and reliable scientific studies based on large global OHCA populations and the most recent resuscitation guidelines published by the American Heart Association (AHA), the European Resuscitation Council (ERC) as well as the International Liaison Committee on Resuscitation (ILCOR).

This document and the information it contains has recognised the needs of a global workforce, where no universal foundational CPR certification or qualification, no common language of instruction, and no universal scope of practice may exist.

Although academic in its context, the information is presented in concise, clear English that is easy to read and understand.

2. Module outline

07:45 – 08:00	<ol style="list-style-type: none"> Welcome and module registration Collection of pre-module assignment
08:00 – 08:30 30 minutes	<ol style="list-style-type: none"> Pre-module test <p>Candidates will undertake a pre-module test to determine knowledge acquired from pre-module reading. See <i>point 6. Essential pre-module reading</i>. An outline of the test is provided in <i>point 5. Outline of test conducted at commencement of module</i>.</p>
08:30 – 09:00 30 minutes	<ol style="list-style-type: none"> Theory component <p>Knowledge and skills that learners are expected to know is re-enforced through simple explanations, as well as through a question and answer session. The session is guided by a slide show presentation. The content of this presentation is covered in detail in this document.</p>
09:00 – 09:30 30 minutes	<ol style="list-style-type: none"> Simulated OHCA demonstration <p>Candidates will be provided with a simulated OHCA video demonstration of recommended CPR performance.</p>
<i>Break for TEA – 15 Minutes</i>	
09:45 – 10:30 45 minutes	<ol style="list-style-type: none"> Skill practice with peer feedback cycles <p>Candidate performance in <i>recognising</i> Sudden Cardiac Arrest, <i>provision</i> of compressions, rhythm <i>identification and application</i> of the LUCAS will be practiced through enforced and evaluated.</p>
10:30 – 11:15 45 minutes	<ol style="list-style-type: none"> Manage and present paper scenarios <p>Placed in teams, candidates will be required to work out, write down, and present preferred or ideal management for different OHCA scenarios specific to Qatar.</p>
11:15 – 12:15 60 minutes	<ol style="list-style-type: none"> Simulated OHCA demonstration <p>Each team will be required to manage two simulated OHCAs. Remaining teams will be required to evaluate performance using the official assessment rubric. The OHCA RET (Rapid Evaluation Tool)</p>
<i>Break for LUNCH – 45 minutes</i>	
13:00 – 13:30 30 minutes	<ol style="list-style-type: none"> Post-module test <p>Candidates will undertake a Post-module test. The test will be based on knowledge acquired from this document and through the module.</p>
13:30 – 14:15 45 minutes	<ol style="list-style-type: none"> Conduct mental practice and modelling session <p>Candidates will be required to talk through and establish roles and tasks, and describe ideal management of different OHCA scenarios.</p>
14:15 – 15:45 90 minutes	<ol style="list-style-type: none"> Conduct simulated OHCA assessment <p>Candidates will undertake a final simulation assessment of a randomly selected OHCA simulation.</p>
15:45 -16:00 15 minutes	<ol style="list-style-type: none"> Feedback

3. Module learning objectives

The learner will be able to:	determined by RET Measure
Recognise cardiac arrest in less than 15 seconds.	A2
Perform prescribed CPR steps in a standardised sequence.	C1
Confirm the case of cardiac arrest with the NCC and request for help.	A2
Perform compressions for more than 80% of the total cardiac arrest time.	A4,B3,B5,B7,C2
Utilise leadership and scene control non-technical skills, situational awareness and communication skills.	D1,D2,D3
Achieve an effective chest compression rate during manual compressions.	A4
Achieve an effective chest compression depth with correct hand position during manual compressions.	A6, A7
Achieve an effective chest compression ratio with no leaning.	A5
Ensure consistent high quality compressions through real-time feedback.	A4,A5,A6,A7
Undertake correct rhythm recognition.	B1
Promptly and correctly manage identified rhythms.	B2
Defibrillate safely during compressions and in escalating joules.	C7
Manage a patient's airway with the blind insertion of supraglottic airway device during compressions.	B2
Provide minimal ventilations provided slowly and during release of chest.	C4
Establish intra-venous/osseous access during compressions.	B4
Administer the correct drug at the dose and administration interval.	C5
Treat reversible causes.	B8
Routine sugar testing and hyperglycaemia avoided.	ROSC Protocol
Early ROSC management (Preventing hypoxia, hypotension and hypoglycaemia)	<i>ROSC Protocol</i>
Patients taken to the right hospital to ensure definitive care is provided	<i>ROSC Protocol</i>

4. Module assessments

Overall competency during the module will be established using four individual assessments.

Assessment	
1	Pre-module assignment
2	Pre-module theory test
3	Post-module theory test
4	Post-module simulation

4.1. The OHCA RET

The Out of Hospital Cardiac Arrest (OHCA) Rapid Evaluation Tool (RET) that will be used to determine and describe your demonstrated performances, during classroom activities and simulations is attached at the end of this document. The designs of the OHCA RETs are specific to determining and describing OHCA **CPR Competence** of HMCAS Ambulance Paramedics (AP)

CPR Competence is defined as the ability to perform up to date technical and non-technical resuscitative skills in a manner and at a standard that is likely to restore oxygen delivery and maintain circulation and perfusion of vital organs, to allow for return of spontaneous circulation (ROSC) and/or successful defibrillation.

As an HMCAS AP or CCP, this standard of competence recognises technical skills such as high quality chest compressions, appropriate and safe defibrillation, use of a laryngeal tube, and safe and appropriate administration of medications. It also recognises non-technical skills like situational awareness, effective communication, and good leadership abilities facilitating co-operation and teamwork.

In essence, CPR competency identifies skills that complement and offset the limitations of each other while working towards achieving and maintaining ROSC.

When used in classroom activities the OHCA RET will allow you to quickly recognise your CPR strengths and weaknesses, and through specific and immediate constructive feedback, promote corrective practice and improve overall performance.

5. Outline of pre-module test

Following the welcome and registration, you will undertake a pre-module test. The test will be 30 minutes in duration and include questions similar to those in the pre-module assignment. It is therefore in your best interest to complete the pre-module assignment.

You will also need to familiarise yourself with the following:

- 5.1. The LifePak 15 monitor/defibrillator.
- 5.2. The LUCAS 2 chest compression device.
- 5.3. You need to be able to identify the following underlying rhythms:
(Asystole, PEA, VF, and VT)
- 5.4. You would need to know how to measure up and insert a Laryngeal Tube Airway.
- 5.5. You would need to know the dosages, when, and how epinephrine and Amiodarone are administered in patients in cardiac arrest.

6. Essential pre-module reading

6.1. Why perform CPR?

Cardiac arrest, also known as cardiopulmonary arrest or circulatory arrest, is the cessation of normal circulation of blood due to failure of the heart to contract effectively.³ When the heart is unable to pump blood throughout the body, delivery of oxygen and nutrients to the body stops. This sudden lack of oxygen to the brain causes **loss of consciousness**, which then results in **abnormal or absent breathing**. Brain injury is likely to occur if cardiac arrest goes untreated for more than five minutes.^{4,5}

The treatment for cardiac arrest is immediate defibrillation if a "shockable" rhythm is present, while cardiopulmonary resuscitation (CPR) is used to provide circulatory support and/or to induce a "shockable" rhythm.^{6,7}

In other words, CPR is performed to keep blood circulating to the brain, heart and lungs when the heart itself is unable to do so. The objective of CPR is to preserve or try to return the heart to its pre-arrest state which is the state of the myocardium just before cardiac standstill. This pre-arrest state is usually fibrillation.⁸ By preserving fibrillation or promoting its return — the heart can be defibrillated back into a normal perfusing rhythm.^{9,10}

Fibrillation uses up myocardial energy stores extremely quickly (about 10% every minute).¹¹ CPR not only keeps the myocardium perfused, in an attempt to induce a shockable rhythm, it also allows myocardial energy stores to be available for use if the heart spontaneously reverts, or is defibrillated back into a normal perfusing rhythm.^{6,11}

6.2. How does CPR work?

Forward blood flow during compressions is achieved by a direct compression and relaxation of the heart between the sternum and the spine.¹² This is referred to as the *Cardiac Pump Theory*.¹³ A second mechanism, characteristically referred to as the *Thoracic Pump Theory*, also contributes to forward blood flow.¹⁴

The thoracic pump theory was presented when forward blood flow was witnessed in cardiac arrest when direct compression of the heart was not possible.⁶ In patients in cardiac arrest following severe asthmatic attacks with air trapping, or patients with pneumothoracies, the air trapped between the heart and the wall of the chest prevented direct compression of the heart between the spine and the sternum. According to this theory, chest compressions cause abrupt changes in intrathoracic pressures, which directly affect compression and relaxation of the heart causing blood to move forward.^{13,}

14

The combination of both the cardiac and thoracic pump theory only generates about 30% of normal cardiac output. This amount is sufficient to support circulation to vital organs, and preserve or return the heart to its pre-arrest state for up to ten minutes after circulatory arrest.^{11, 15} From minute seven onwards, even in the presence of CPR, the heart valves and valves inside vessels leaving the heart become increasingly sensitive to hypoxia and begin to fail.^{16, 17} This causes a decrease in forward blood flow until it

eventually stops. After 10 minutes of CPR, forward blood flow becomes insufficient to preserve vital organs and chances of survival drops to less than 1%.¹⁸

6.3. When to commence CPR?

When a patient is in cardiac arrest, blood circulation stops. Soon afterwards the body starts to die. Chest compressions is the only known activity that can get the heart pumping again and keep blood moving to the now dying brain and ischemic vital organs.¹¹ During cardiac arrest, the now stagnant circulatory arterial blood still contains unused oxygen reserves and will continue to do so for a short period of time.¹⁹ Circulating this stagnant blood with some oxygen to the vital organs offer greater benefit than delaying compressions to first re-oxygenate blood.²⁰ This is partly the rationale behind the change from ABC to CAB, with the focus being placed on compressions first.²¹

Feeling for a pulse, opening the airway, clearing the airway, and providing ventilations are important and lifesaving, however when it results in delaying the start of compressions, the benefit of these activities is questionable, even when performed by health care providers.^{6, 7, 21}

6.3.1. No more pulse checks to detect cardiac arrest.

Studies have shown that the presence of agonal chest wall movements, agonal breaths, and clinical inexperience in determining the presence or absence of a pulse often delays the start of compressions and, as a result, decreases the chances of ROSC.^{17, 22-26}

Although a clear feature of cardiac arrest is the absence of a palpable pulse, there is no evidence that checking for a pulse is superior to a determined state of unconsciousness with no breathing or no normal breathing during the detection of cardiac arrest.^{6, 7}

There is often the fear of starting CPR in someone later found not to be in cardiac arrest and the possibility of causing injuries to that patient; there however is no evidence to justify this fear. Data shows that the benefit of unwarranted compressions rarely caused any injuries. The overall benefit of early CPR far outweighs any injuries that may have been caused.^{19, 27, 28}

KEY POINT 1	CPR includes chest compressions and artificial ventilations. It is performed to provide circulatory support to the body until defibrillation can occur. CPR must be started as early as possible after collapse with minimal interruptions until a shock can be given or until ROSC is achieved.
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KEY POINT 2	During CPR, forward blood flow is achieved by direct and indirect compression of the heart. This activity supports circulation for up to ten minutes in cardiac arrest. In essence - CPR increases the time that a shockable rhythm lasts before becoming Asystole. This increased time interval increases the window for which a shock can be given.
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KEY POINT 3	Pulse checks are often unreliable and take too long. This delays the start of compressions. The benefit of chest compressions outweighs the potential risk of possible injuries it may cause. In line with current expert consensus and guidelines on resuscitation, checking for the presence of a pulse to determine cardiac arrest is no longer recommended by HMCAS.
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6.3.2. HMCAS Recommendation – When to Commence CPR?

STEP 1 - Determine if the victim is unconscious.

A person is considered unconscious if they are not moving and give no response to a “shout and shake”. In other words, if a HMCAS staff member arrives to a patient that is not awake and not moving, they should immediately tap or shake them on their shoulders and ask loudly, “ARE YOU OK?” If the person is NOT unconscious they are likely to answer, move, or moan. If the patient remains unresponsive that person is considered to be UNCONSCIOUS.

STEP 2 – Expose the patient’s chest.

As soon as a state of unconscious is determined – expose the patient’s chest so you can correctly determine if there is normal equal rise and fall of the chest. (Care should be taken to maintain patient privacy – particularly in females).

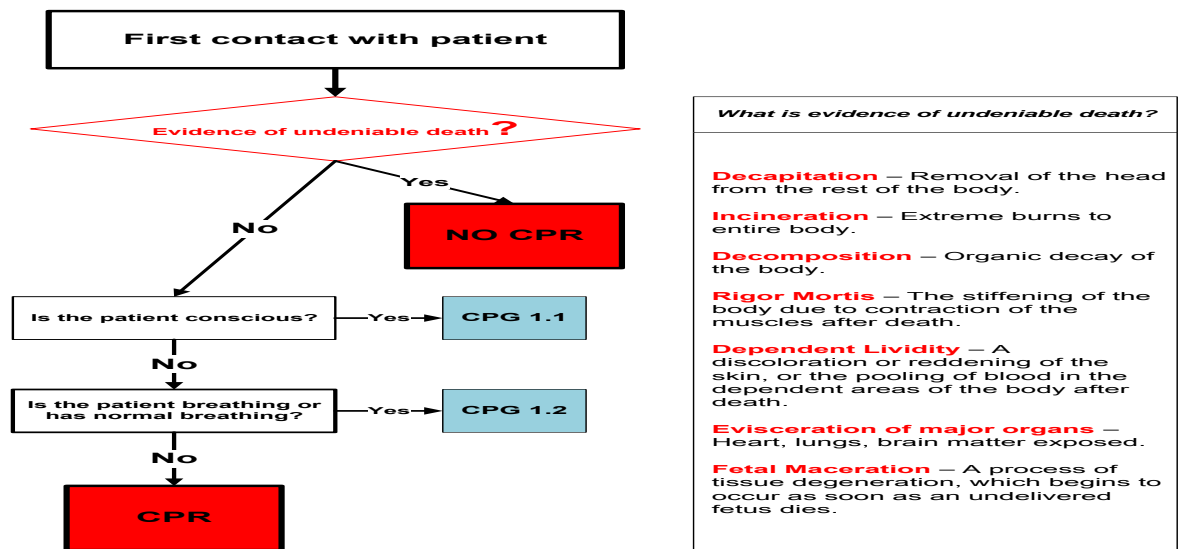
STEP 3 - Assess for normal breathing.

The “look, listen, and feel for breathing” is no longer recommended. To assess breathing, kneel at the patient’s side and look at their exposed chest for at least 5 seconds but not more than 10 seconds. Normal breathing is equal rise and fall of the chest. Do not try and determine the rate at this stage. If there is no rise and fall of the chest, or short, sudden intakes or gasps of air usually associated with a snore or grunting noise – this patient is considered to have no normal breathing.

STEP 4 – Begin with compressions only. (Figure 1)

If at any time during MANUAL compressions, the victim speaks out, moves, or moans, compressions should be stopped immediately.

Figure 1: When to Commence CPR?



6.3.3. Undeniable Death

Sometimes a victim presents with evidence suggestive of undeniable death, where any attempts at resuscitation is considered futile. HMCAS staff are not obligated to initiate

CPR in situations when death is undeniable. If in doubt however, staff shall initiate resuscitation while seeking consultation and advice from the CTL (Clinical Team Leader) over the radio. Sometimes staff may be faced with hostile family members that insist the CPR must be done even though death is undeniable. In these scenarios staffs are advised to seek the help of HMCAS Deltas or Scene supervisors. While staff waits for scene supervisors they should begin to package and transport these patients to hospital.

6.4. How are compressions performed?

Successful defibrillation and ROSC depends on how early chest compressions are performed after collapse, and the duration and quality in which it is performed during cardiac arrest.^{22,29} The objective of compressions is to generate forward blood flow and a Coronary Perfusion Pressure (CPP) sufficient enough to perfuse the myocardium.³⁰ CPP is the result of pressure in the aorta during relaxation of the heart (diastole) that drives blood into the coronary blood vessel, minus the pressure restricting its flow.³¹ So, for CPP to be effective, the pressure driving its flow has to always be greater than the pressure impeding or restricting its flow.

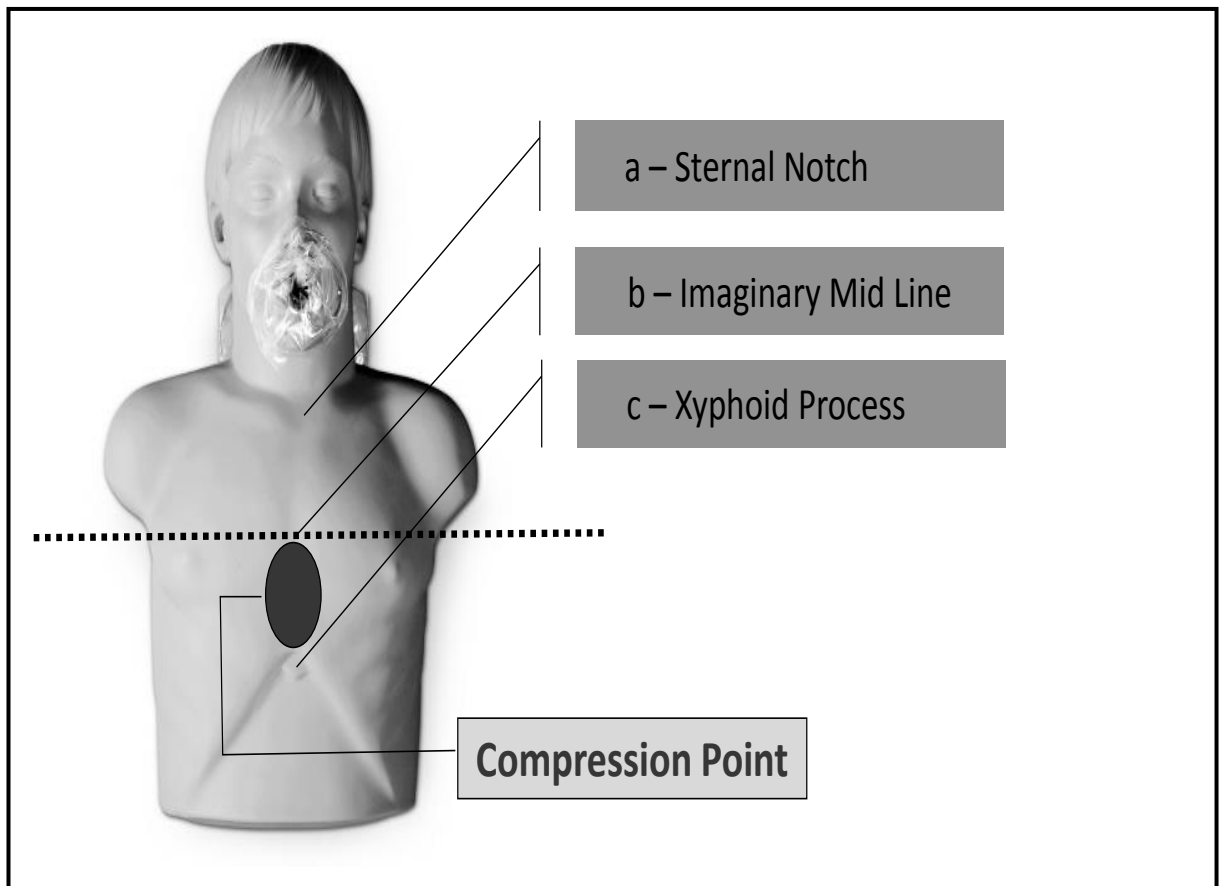
The pressure impeding CPP is found in the right atrium. The right atrium is the heart chamber into which the myocardium's venous blood drains. During cardiac arrest, the heart is not pumping; as a result there is a backlog of blood in the right atrium.¹⁵ This backlog prevents continued drainage through myocardial blood flow, which in turn decreases myocardial perfusion. Decreased myocardial perfusion decreases the chances of successful defibrillation and ROSC.³²

6.4.1. Where should you compress? - Hand position

The mid-chest or nipple line is recognised globally as the point for compression in CPR. This point however has been associated with an increased level of confusion, and as a result delayed the start of compressions.³³ There is insufficient evidence to support any one technique for identifying a specific hand position for chest compressions. Manikin studies shows that consistent quality compressions are only possible when the dominant hand is in contact with the lower half of the sternum. Doing compressions over the left chest or any other location on the chest is less effective.^{20, 33}

Compressions over the lower half of the sternum in adults is associated with producing the compression depth most likely to generate adequate CPP. The position of the heart and the decreased compliance of higher positioned ribs make compression at the top or middle of the sternum less effective.^{6, 33} Compressions performed at a level lower than the lower half of the sternum are also less effective and have an increased risk of intra-abdominal injuries³³ (Figure 2)

Figure 2: Hand Position in CPR



6.4.2. Depth of compression

A compression depth of 5 cm was found to improve the success of defibrillation and ROSC.³¹ Compression depths less than 4 cm are associated with poor outcomes.³² The Resuscitation Outcomes Consortium (ROC), a database of standardised out-of-hospital cardiac arrest information collected from 260 Emergency Medical Services (EMS) agencies in the United States and Canada, showed that patients with compression depths of more than (>) 3,8 cm had better chances of achieving ROSC, better 1-day survival, and better chances of surviving to discharge.³³

6.4.3. Rate of compressions*

Studies comparing high and low frequency compressions showed improved blood flow with compressions between 100 and 120 per minute with no increase in trauma, when compared with 60 compressions per minute. When compressions increased from 120 to 140 compressions per minute (as observed in machine-performed CPR on humans), no overall benefit in haemodynamics was seen.^{6, 7, 36}

Overall agreement is that a rate of at least 100 and not more than 120 in a minute generates a CPP sufficient to sustain myocardial blood flow and as a result increase the chance for successful defibrillation and ROSC; especially when compared to short cycle compressions with interruptions for ventilations, i.e. Compression: ventilation ratio of 30:2.^{20, 34}

Interruptions in compressions cause a fall in aortic diastolic pressures, causing a reduction in CPP. During interruptions, blood accumulates in the right ventricle, causing it to enlarge and flatten out the inter-ventricular septum. It also causes a reduction in left ventricular volume; this phenomenon is called ventricular interaction.

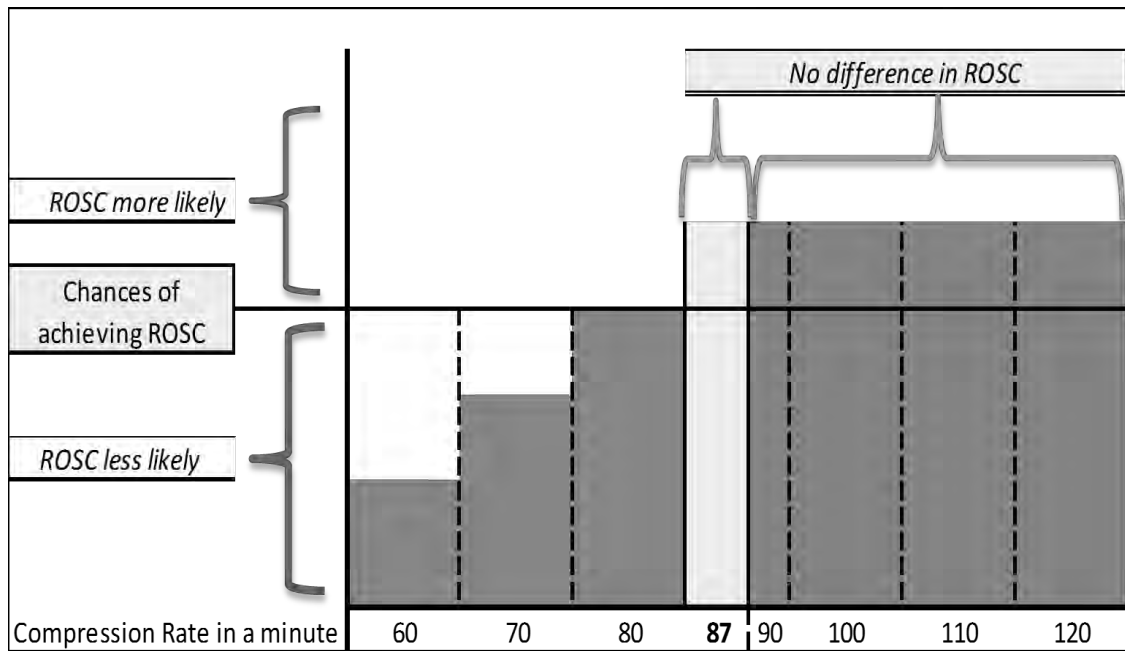
This is particularly harmful especially at the time immediately before delivering a shock. Since ventricular interaction can reduce left ventricular muscle cell stretch, the heart is less likely to recover and generate an effective contraction after defibrillation.^{20, 34-37}

120 compressions over a minute equates to two compressions per second. (120/60 seconds) This fast rate often prevents full chest recoil. Full chest recoil is necessary to allow for artificial diastole – it is during artificial diastole that the myocardium is perfused.^{6, 7}

Recent human studies showed that compression rates less than 87 per minute were associated with less ROSC when compared to rates >87 per minute, and rates above 120 per minute offered no greater benefit when compared to rates between 100 and 120^{20, 22} (Figure 3).

* {Addition Information – Don't worry you won't be tested on this – Just try to understand it}

Figure 3: Comparison of compression rates



6.4.4. Allowing for complete chest recoil*

There is insufficient evidence to determine an optimal method to achieve complete chest recoil without compromising other aspects of CPR. For example, one technique proposed as a way to ensure complete chest recoil was to remove the heel of the hand slightly but not completely of the chest wall after each compression. The intended effect of this was to cause the chest to recoil completely as there was now no downward pressure on it. It was later discovered that this technique has the potential to reduce compression depth as a result of rescuers hands inadvertently moving from the compression point.^{36, 38}

6.4.5. Achieving a 50/50 duty cycle*

The period between the start of one compression and the start of the next is referred to as the duty cycle. Coronary blood flow is determined partly by the time spent to compress and release the chest.^{3,7} For example, if a duty cycle takes 1 second, and in that 1 second 0,2 seconds is spent compressing the chest and 0.8 seconds releasing the chest, that's a 20/80 duty cycle or 20% of the time pushing the chest downwards towards the spine and 80% of the time releasing the chest as it comes towards the sternum.^{6, 12}

100 compressions over 1 full minute equals to 1 duty cycle lasting 0.6 second (100/60 seconds). Data show us that duty cycles between 20% and 50% are associated with improved coronary and cerebral perfusion while duty cycles >50% showed reductions in coronary and cerebral perfusion.^{6, 7, 20}

See key points 4 to 9 that summarise how compressions should be performed.

KEY POINT 4	<p>Chest compressions should be provided at a specific position on the chest, at a specific rate, depth, and duty ratio to increase the pressure driving Coronary Perfusion Pressure (CPP) and decrease the right diastolic arterial pressure which impedes CPP.</p>
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KEY POINT 5	<p>The compression point or hand position during chest compressions during CPR in adults is the lower half of the sternum (Figure 2).</p> <p>The technique to find this compression point is as follows:</p> <ol style="list-style-type: none"> 1. To find the lower half of the sternum you would need to first find the top and the bottom of the sternum. The easiest way to find the top of the sternum is to locate the suprasternal notch. 2. To find the bottom of the sternum, locate the Xyphoid 3. Then imagine a line drawn across the sternum, separating it into top and bottom halves. 4. Place the palm of your dominant hand just below this imaginary line on the bottom half. <p>This is the compression point for both manual and LUCAS performed compressions</p>
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* {Addition Information – Don't worry you won't be tested on this – Just try to understand it}

KEY POINT 6	<p>An initial sequence of 100 continuous manual compressions without ventilations is now recommended. A rate of 100 compressions is easier to perform and easier to remember. Try to achieve at least two compressions a second or be guided by the song “Staying Alive”. DON’T measure time. Just perform 100 compressions.</p>
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KEY POINT 7	<p>There is insufficient evidence to recommend a specific upper limit of chest compression depth. In line with current expert consensus and guidelines on resuscitation, HMCAS staff will compress the chest at a depth of at least 5 cm during manual compressions. This will be confirmed by real time feedback given by a crewmate</p>
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KEY POINT 8	<p>Allowing the chest to recoil produces artificial diastole, the period when blood flow into the coronary arteries occurs. There is insufficient evidence to support a specific technique to ensure complete chest recoil without affecting other aspects of quality CPR. HMCAS staff are required to pay more attention to achieving a 50/50 duty cycle. A 50/50 duty cycle is equal time spent to compress the chest downwards towards the spine and release the chest upwards towards the rescuer. Hands should remain on the chest at all times.</p>
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KEY POINT 9	<p>Since a duty cycle of 50/50 is mechanically easier to achieve and memorise than duty cycles between 20-50%, HMCAS staff will perform a duty cycle of 50%, i.e. equal time spent in compression and release of the chest.</p>
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6.5. The LUCAS 2 chest compression device

Although manual chest compressions are often performed very poorly, no adjunct has consistently been shown to be superior to conventional manual CPR.^{6, 7, 22} The Lund University Cardiac Arrest System (LUCAS) is a gas-driven sternal compression device that incorporates a suction cup for active decompression or release of the chest.⁵⁴

HMCAS has the LUCAS 2. This device runs on batteries, has a long shelf life, and requires no test-cycle maintenance. It is easy to use and is designed to deliver uninterrupted compressions at a consistent rate and depth to facilitate ROSC.

KEY POINT 10	It is HMCAS organisational consensus that the LUCAS 2 chest compression device be used on all adult victims of medical OHCA. The LUCAS is not to be used in traumatic OHCA or if too big or small for a patient.
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6.6. Airway management in *MEDICAL* cardiac arrest

An unconscious patient lying on their back has an obstructed airway. The tongue, which is attached to the back of the jaw, falls against the back of the throat, blocking air from entering the lungs. Opening and securing the airway takes priority over possibility of neck injuries in an unconscious **medical** patient with no breathing or no normal breathing.²²

KEY POINT 11	As a result, in line with expert consensus and international guidelines, HMCAS staff will perform a head tilt/chin lift to open the airway of a MEDICAL patient in cardiac arrest.
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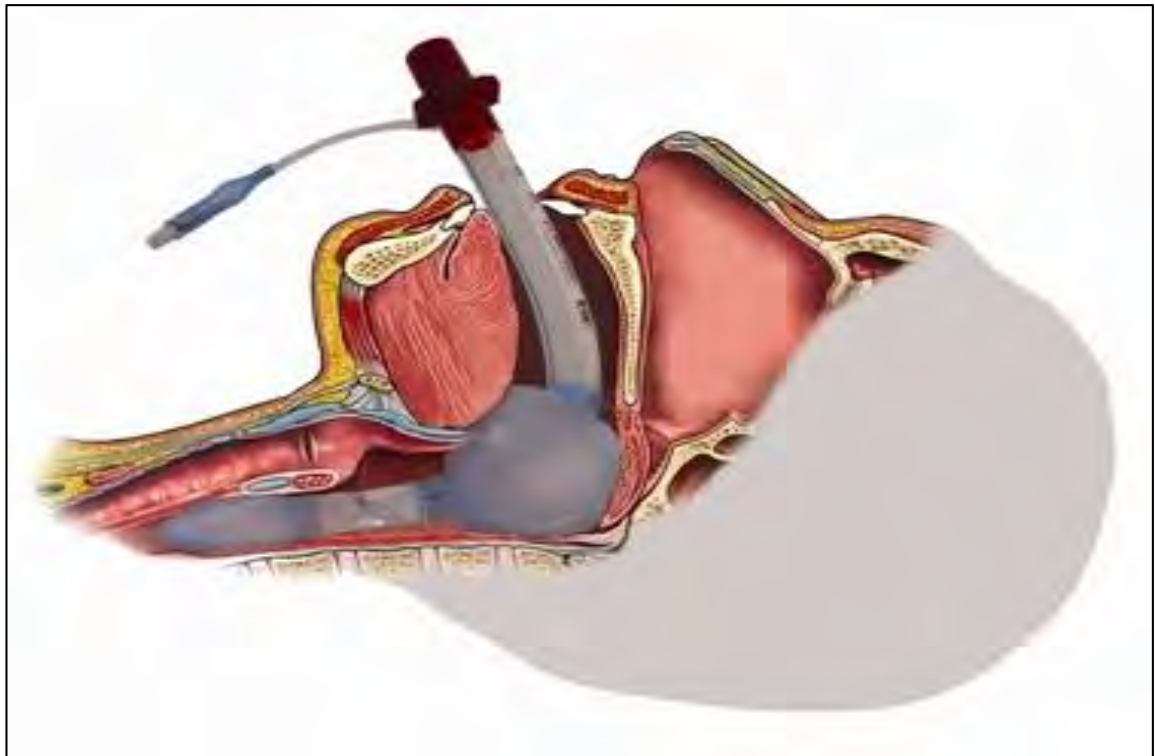
The technique is as follows:

1. One hand is placed on the forehead or top of the head.
2. The chin lift should be done by hooking your index finger under the angle of the jaw and then doing an upwards pull. The head will come back automatically.

PLEASE NOTE: The head (NOT the NECK) is tilted backwards. It is important to avoid excessive force, especially where neck injury may be suspected, **even** in medical patients.

The Laryngeal Tube Airway (LTA) is a supraglottic airway device that is placed in the oesophagus through blind insertion and serves as a mechanical airway when ventilation is needed in patients that are unconscious and cannot maintain and protect their own airways. **See Figure 4.**

Figure 4: Placement of LTA



The LTA takes less time and skill to insert and has been shown to provide ventilation that is as effective as that provided by an endotracheal tube during cardiac arrest. It consists of a cuffed tube with ventilation apertures located between two inflatable bulbs. The lower bulb is designed to seal off the oesophagus while the upper bulb is designed to seal off the oropharynx.

The technique to insert the LTA is as follows:

1	Choose the correct size LTA using the guide below.
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LTA Size	3	4	5
Patient Height	1,2 - 1,5 meters	1,5 – 1,8 meters	>1,8 meters
Cuff Volume	50ml	70ml	80ml
Connector Colour	Yellow	Red	Purple

2	Test the cuff inflation system by injecting the maximum recommended volume of air into the cuff, using the syringe included in the pre-packed HMCAS kit.
3	Remove all air from the cuff using the syringe provided, prior to insertion.
4	Apply water-based lubricant to the bevelled distal tip and posterior aspect of the tube. Take care to avoid the introduction of lubricant in or near the ventilatory openings.
5	Hold the LTA at the connector end with the dominant hand.
6	With the non-dominant hand, continue applying the chin lift.
7	With the LTA rotated laterally 90 degrees such that the blue orientation line is touching the corner of the mouth.
8	Introduce the tip of the tube into the mouth and advance behind base of the tongue.
9	<i>Never force the tube into position.</i>
10	As the tube tip passes under the tongue, rotate the tube back to midline until the blue orientation line faces the chin.
11	Without exerting excessive force, advance the LTA until the base of the connector aligns with the teeth or gums.
12	Fully inflate the cuff using the maximum volume of the syringe provided.
13	Attach a side stream EtCO ₂ capnometric device to the LTA.
14	Immediately attach BVM to LTA.
15	Secure the LTA to the patient using a tube holder.

6.6.1. Providing ventilations in cardiac arrest

Although evidence exists to suggest that ventilations at a rate above 12 breaths per minute may be excessive, there is insufficient evidence that any specific number of ventilations is associated with improved outcome in patients with cardiac arrest.³⁹⁻⁴⁰

What is known though, is that providing ventilations and compressions at the same time is associated with decreased survival.²⁰ The objective of ventilation is to oxygenate blood rather than removing carbon dioxide during low flow states. With excessive ventilation, a significant rise in intrathoracic pressures is seen, negatively affecting preload and ultimately CPP. Therefore, the delivery breaths should be controlled, not forceful, and during the relaxation phase of compressions.^{7, 20-22}

KEY POINT 12	<p>Bag-valve-mask ventilation (BVM) with oropharyngeal airways (OPA) can produce gastric inflation with complications; including regurgitation, aspiration, and pneumonia. In addition, gastric inflation can elevate the diaphragm, restrict lung movement, and decrease respiratory system compliance. As a result, the LTA has become the primary airway device for protecting and maintaining an airway in a Cardiac Arrest Victim. CCPs may consider endotracheal intubation in an attempt to treat reversible causes however; compressions should not be interrupted during intubation attempts.</p>
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KEY POINT 13	<p>Opening the airway, inserting a LTA, and providing ventilations will only take place once LUCAS CPR is performed. No airway management is required during the first 100 compressions and therefore chest compressions take precedent. If more skilled hands are available and airway management does not cause compressions to stop, a third person can assist with insertion of the airway. This must be coordinated by a TEAM LEADER. Under no circumstances should compressions be stopped to insert and LTA.</p> <p>When ventilation is provided during LUCAS CPR, it will be provided at 8 ventilations per minute. The green LED signal on the LUCAS will blink 8 times per minute to alert for ventilation when the LUCAS is in continuous ACTIVE mode.</p> <p>HMCAS staff delivering ventilations should give ONE slow controlled breath over 1 full second.</p>
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6.7. Monitoring the adequacy of CPR

The maximum benefit of CPR depends on how early it is performed after cardiac arrest and the quality and consistency to which it is performed.⁶⁻⁹ Even slight deviations from correct and prescribed hand positioning, compression depth, rate, recoil, duty cycle, and allowing for chest recoil has the potential to affect the adequacy of CPP and cardiac output generated, myocardial blood supply, and ultimately the chances for success of defibrillation and ROSC.^{22, 34}

Determining cardiac output and CPP levels during CPR in victims of cardiac arrest outside an intensive care facility is difficult and impractical.²⁰

Wave amplitudes on the ECG and carotid pulsations do not indicate the efficacy of myocardial or cerebral perfusion during compressions.⁷ Palpation of a femoral pulse is unreliable as it may indicate venous return rather than arterial blood flow.⁴¹ Pulse oximetry does not provide a reliable signal because a pulsatile blood flow is inadequate in peripheral tissue beds during cardiac arrest.⁷

KEY POINT 14	HMCAS staff will not use ECG waveforms, pulse checks, or EtCO₂ values to determine the adequacy of CPR. To ensure that CPR is performed correctly, continually assess that the compression point on the chest is at the lower half of the sternum, for both manual and LUCAS performed compressions, at the correct depth of 5 cm, and that a 50% duty cycle is maintained, allowing for chest recoil, with the avoidance of interruptions. This should be achieved through real time feedback from a second rescuer helping with the resuscitation.
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While evidence does suggest that end tidal carbon dioxide levels (EtCO₂) less than 10mmHg are associated with a low probability of survival, and a sudden and significant increase in EtCO₂ levels during CPR may indicate a return of pulmonary blood flow (a product of sustained cardiac output), there is insufficient evidence to support or refute a specific EtCO₂ value that may provide a rescuer with an indicator of CPR adequacy.^{20, 42-}

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6.8. Intravenous lines and medications in cardiac arrest

Although evidence is insufficient to support or refute the insertion of intravenous lines and routine use of any particular drug or sequence of drugs in cardiac arrest, Adrenaline and Amiodarone have been included as standard care medications in the treatment of OHCA.^{6, 20}

6.8.1. Adrenaline

Despite widespread use of adrenaline during resuscitation, there are no studies that show that the routine use of adrenaline at any stage during human cardiac arrest increases neurologically intact survival to hospital discharge. Through its mechanism of action, adrenaline attempts to reverse cardiac arrest by increasing arterial blood pressure and CPP through vasoconstriction via its alpha-adrenoceptor agonist effects.⁴⁶⁻⁴⁸

The increased CPP increases the frequency and amplitude of the shockable rhythm waveforms and thus improves the chance of restoring circulation when defibrillation is prompted and attempted.^{7, 20}

Unfortunately this alpha-adrenoceptor agonist effects also decreases microvascular blood flow causing post cardiac arrest myocardial dysfunction; which typically offsets any earlier benefit. In addition, due to its beta-adrenoceptor agonist effects, it causes pulmonary vasoconstriction, significantly reducing arterial oxygen saturation during cardiac arrest.²²

Epinephrine use in OHCA has been shown to increase the incidence of return of pulses, but not significantly alter longer-term neurologically intact survival. In fact many studies have shown epinephrine to reduce long-term survival and functional recovery after CPR.²² Evidence is also lacking to support the optimal dose of adrenaline, the use of repeated doses, and the optimal duration of CPR and number of shocks that should be given before epinephrine should be given.^{22, 48-51}

6.8.2. Amiodarone

As with adrenaline, the evidence that Amiodarone provides any benefit in cardiac arrest is limited. Although Amiodarone has been shown to increase survival to hospital admission after shock-refractory VF/pulseless VT, there is no evidence to suggest its benefit in increasing survival to hospital discharge.^{7, 18}

Amiodarone stabilises the myocardium and slows down overall conduction and as a result cause hypotension. It remains the first—line antiarrhythmic agent given during cardiac arrest because it has been shown to improve the rate of ROSC and hospital admission in adults with refractory VF/ pulseless VT.^{52, 53}

KEY POINT 15	Based on organisation consensus, the HMCAS AP will continue to give epinephrine in cardiac arrest. For Asystole, PEA, VF, and VT, epinephrine will be only given during the second round of LUCAS performed CPR, and then every 4 minutes or alternate cycle. At no time should compressions be stopped or delayed for or during the administration of epinephrine.
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KEY POINT 16	If VF or VT persists after 3 shocks, give 300 mg of Amiodarone by bolus via IV flushed with 20 ml of 0.9% sodium chloride or 5% dextrose. A further dose of 150 mg may be given for recurrent or refractory VF/ VT after the fourth shock. At no time should compressions be stopped or delayed for or during the administration of Amiodarone.
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6.9. Interruptions in compressions

The compression fraction is the portion of total CPR time during which compressions are performed. Compression fraction was shown to be the most influential factor affecting myocardial blood supply, ROSC and/or successful defibrillation. Even relatively short interruptions in chest compression were found to be associated with reduced survival. Interruptions in chest compression also reduce the chances of converting VF to another rhythm.³ Once deemed unconscious with no breathing or no normal breathing, chest compressions should be done immediately.⁶ Inaction or delay due to uncertainty of a

cardiac arrest diagnosis, could result in death when compared to compressions performed on someone later found not to be in cardiac arrest.^{26-28, 55-56}

KEY POINT 17	Compressions should only be interrupted for rhythm analysis. With LUCAS-CPR; defibrillation, placement of LTA and or ETT, and IV access, can all occur during on-going compressions. If interruption in compressions must occur, it should be NOT longer than 10 seconds.
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6.10. Non-Technical Skills

An effective compression fraction can be achieved by performing continuous, high quality, closed chest compressions; however, this may not always be possible in stressful situations. Family members, police, civil defence, and angry bystanders may often put added pressure on HMCAS staff to transport victims in cardiac arrest to hospital.

Non-technical skills like monitoring and situational awareness, effective communication, prompt and appropriate decision-making, and good leadership abilities, are increasingly important to facilitating co-operation and teamwork to ensure an effective compression fraction.⁵⁷

HMCAS staff are likely to encounter three common groups of people where good non-technical skills are essential. These groups include the victim's family and bystanders, other emergency services on scene, and second rescuers (these could be HMCAS staff or staff from other emergency response agencies). To be able to effectively manage these three groups of people HMCAS staff need to be aware of certain characteristics that may affect the outcome of difficult or possible conflict situations

6.10.1. Family/bystander Characteristics

Families can be difficult during a cardiac arrest situation. They can be incredibly dependent, clingy, and have a sense of entitlement; they may also be manipulative, self-destructive, noncompliant to your instructions, litigious (wanted to sue, or engage in legal disputes), and sometimes even hostile.

6.10.2. HMCAS Staff Characteristics

HMCAS staffs own attitudes and behaviours may often also contribute to difficult encounters with family members during a cardiac arrest situation. Staff who are overworked, burned out, sleep deprived, stressed and generally frustrated over work situations are more likely to react negatively during conflict.

Staff may also have strong personal beliefs and values about medical care and the role of the HMCAS in offering that medical care. These strong beliefs can lead staff to overemphasize their own beliefs and emotions disregarding the patient's views and requests.

6.10.3. Situational characteristics

Sometimes conflict and difficult encounters with family/bystanders/crew and or other rescuers have more to do with the circumstances surrounding the situation than with the people involved. These include different languages, cultural differences, and religious differences. In addition, certain environmental issues may increase the likelihood of a conflict situation. A noisy, chaotic cardiac arrest situation especially one that does not afford a patient appropriate privacy is more likely to make family unhappy.

6.10.4. How to deal with these issues.

6.10.4.1. HMCAS staff should begin by asking themselves whether they are doing everything that they can to understand and address the patient's underlying needs.

- If the answer is no, attempts should be made to meet those needs.

This may include ensuring that an interpreter translates everything that is said rather than "editing" the conversation. HMCAS staff should direct their eyes and speech toward the patient's family rather than the interpreter.

6.10.4.2. Often the needs or expectations of families on HMCAS staff may be impractical, illegal or unrealistic and are deviant from HMCAS standard operating procedures (SOPs) and policies.

- In these instances HMCAS staff should reiterate HMCAS policies and SOPs to families. If families persist in their requests – escalate immediately to NCC.

During any interactions, HMCAS staff should speak in a caring voice, slowly and confidently using simple terms as if one is speaking to a person with no medical background or experience.

Remember!

To you it's just another call. To them it's the worst day of their life.

6.10.4.3. HMCAS staff must also recognise their own trigger issues and know what personal baggage they are likely to bring to the cardiac arrest situation.

- Often your own baggage may prevent you from assessing information presented to you by family members. Identifying your trigger issues and avoiding situations in which your beliefs may inappropriately close off adequate exchange of information is critical to prevent difficult situations or conflict situations.

A standardized approach can help lessen the emotions involved in dealing with difficult family members in a cardiac arrest situation. You may not be able to be “culturally competent” for all people, but as an HMCAS staff, your goal should be to remain “culturally sensitive” in all situations.

6.10.5. Breaking bad news.

When it is necessary to give family members information that will be difficult for them to hear, preparation is critical. The highest qualified HMCAS clinical staff involved in the cardiac arrest should address family. Having a translator is crucial if families don't speak the same language as the person bearing the news.

RESUSCITATION ATTEMPTS MUST CONTINUE DURING THIS TIME.

CPR should only stop after family or patient's significant other acknowledges and gives verbal consent to stopping.

Know who will be present for the discussion, allow adequate time and privacy, and review the clinical situation to the family. Disclose the news directly, allowing adequate time for family and others in the room to experience their emotions and process the

information. After giving the news, discuss the implications, offer additional resources, agree on next steps, and summarize the discussion.

At HMCAS – Three groups of non-technical skills are of particular importance. These include: Leadership and scene group, Situational Awareness and Communication. Tables 1 to 5 present tasks or situations where these non-technical skills apply:

Table 1: Communication skills

Group of people	Situation or tasks
Family or bystanders:	History taking and reassurance.
Second Rescuer:	Offers clear instructions on what to do.
Other EMS on scene:	Advises on how to be of assistance.

Table 2: Leadership and scene control: Co-operative skills

Group of people	Situation or tasks
Family or bystanders:	Responds to questions and concerns.
Second Rescuer:	Clearly answers questions put forward by crewmate.
Other EMS on scene:	Responds to questions and provides assistance.

Table 3: Situational awareness: Forward planning skills

Group of people	Situation or tasks
Family or bystanders:	Requests advice on aggress routes to move patient.
Second Rescuer:	Utilises help, second rescuer, or crewmate to facilitate calling for additional backup.
Other EMS on scene:	Anticipates and facilitates further requirements for resuscitation.

Table 4: Leadership and scene control: Overall

Group of people	Situation or tasks
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Family or bystanders:	Identifies and controls family and bystanders who appear anxious and agitated and whose actions could likely hinder resuscitative attempts.
Second Rescuer:	Clearly instructs, and offers continuous supervision and feedback from crew-mate.
Other EMS on scene:	Takes lead and instructs all involved on what to do and supervises those lacking experience and familiarity with tasks.

Table 5: Situational Awareness: Continuous monitoring skills

Group of people	Situation or tasks
Family or bystanders:	Advises on prognosis and module of action.
Second Rescuer:	Ensures crew-mate's wellbeing, endurance, state of mind, etc.
Other EMS on scene:	Checks on overall's team's condition, endurance, state of mind, etc.

KEY POINT 18	<p>To ensure that compressions are not interrupted, the first senior HMCAS staff on the first responding unit (Alpha or Charlie or Delta) who makes the diagnoses of cardiac arrest will take on the role of team leader and direct the resuscitation.</p> <p>Good leadership and other non-technical skills will ensure an effective compression fraction.</p> <p>This role as the team leader will continue until a HMCAS CCP arrives on scene and directs further care.</p>
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6.11. Pulse checks, Rhythm analysis and defibrillation

Pulse checks during CPR should only be done provided:

- 1) The rhythm identified is a narrow complex organised rhythm
- 2) In addition, **NOTE:** A pulse check should take no longer than 10 seconds. If there is any doubt about the presence of a pulse, chest compressions should be resumed immediately.

If a cardiac monitor is attached to the patient at the time of arrest, the rhythm **can** be diagnosed before Compressions are initiated.⁵⁸ If a shock is indicated, one shock should be given. While the defibrillator charges, chest compressions should be performed.

Cardiac arrest can be associated with four underlying rhythms:

- (1) ventricular fibrillation (VF),
- (2) pulseless ventricular tachycardia (VT),
- (3) pulseless electric activity (PEA), and
- (4) Asystole.

VF represents disorganized electric activity (Figure 4) whereas pulseless VT represents organized electric activity of the ventricular myocardium (Figure 5). Neither of these rhythms generates significant forward blood flow. A unconscious patient that is not breathing or has no normal breathing and presents with a VT is now considered to be a VT without a pulse. **Do not feel for a pulse if you see a VT at any stage.**

In other words, HMCAS staff will not spend time to determine if a VT is a VT with a pulse or a VT without a pulse. Remember, this patient is already symptomatic – *unconscious and not breathing*. This is a pre-arrest rhythm. It needs to be shocked as soon as possible.

Pulseless electrical activity (PEA) is associated with either absence of mechanical ventricular activity or mechanical ventricular activity that is insufficient to generate a palpable pulse (Figure 6). Asystole (perhaps better described as ventricular asystole) represents the absence of detectable ventricular electric activity or “straight” line (Figure 7).

Figure 4: Ventricular Fibrillation

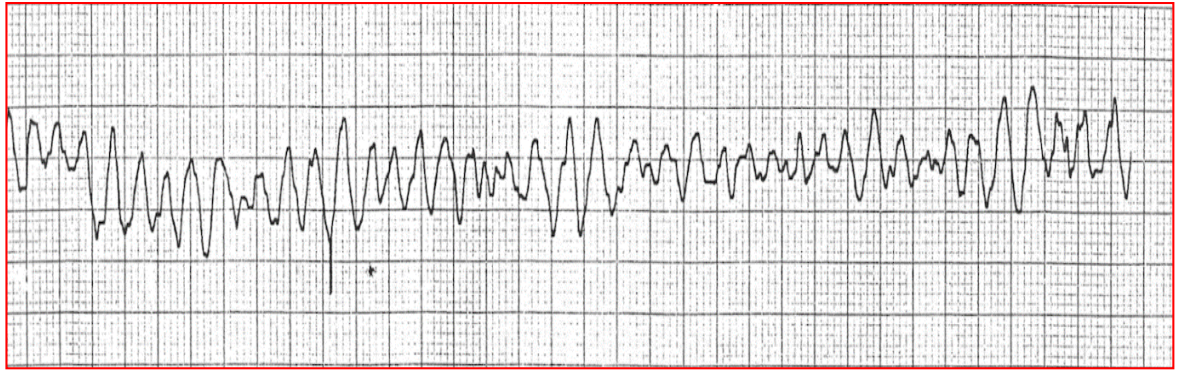


Figure 5: Ventricular Tachycardia (may have a pulse or be pulseless). If the patient is unconscious and not breathing treat as NO pulse

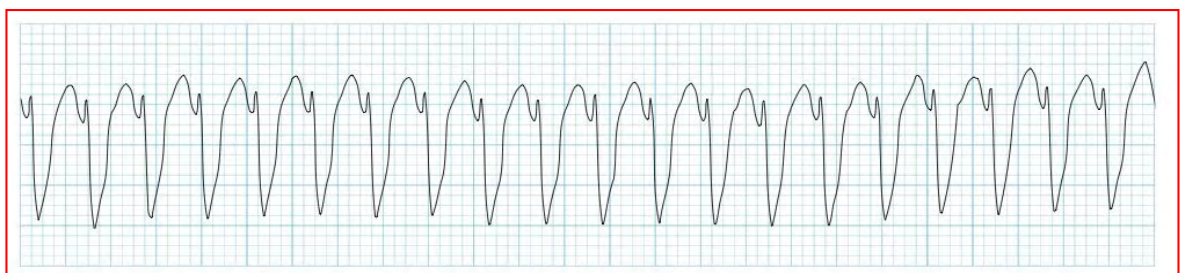
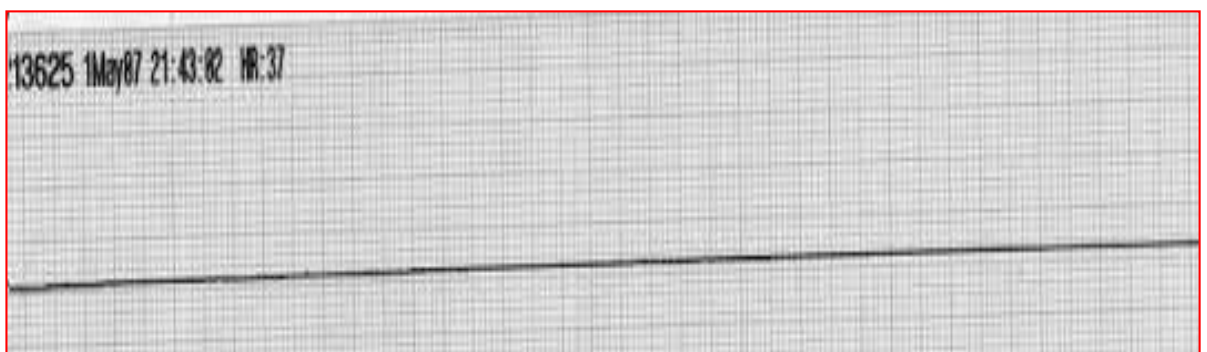


Figure 6: Pulseless Electrical Activity



NO PULSE

Figure 7: Asystole



For OHCA a combined three-stacked shock protocol is no longer recommended.^{20,22} The interruptions in compressions to conduct three rhythm analyses and three subsequent shocks, decreased CPP and was found to reduce the chances of

converting VF to another rhythm. The improved first shock efficacy for terminating VF/VT from biphasic defibrillators prompted the recommendation of a single shock.

Regardless of the energy level, any electrical shock administered to a patient will result in some degree of myocardial injury. The greater the energy level the more substantial the injury is likely to be.²² Escalating the energy level with each shock reduces the number of shocks required to convert VF/ VT to another rhythm, however, rates of ROSC or survival to discharge are not increased.²²

A fixed energy level protocol has demonstrated high success with a repeated fixed energy dose protocol. Based on current evidence both fixed dose and escalating dose strategies are acceptable, it is the Lifepak manufacturer's recommendations and thus the HMCAS organisation consensus that escalating doses of 200J, 300J, and 360J biphasic shocks be administered in the presence of a VF/ VT through self-adhesive pads.

If a rhythm is difficult to distinguish — do not defibrillate it. Rather continue high quality CPR, which is likely to improve the amplitude and frequency of the rhythm, making it more visible. The additional CPR will also improve the chance of successful defibrillation. Defibrillating undistinguishable rhythms is no longer recommended.

6.12. Sequence of events

6.12.1. Non-shockable rhythms (Asystole and PEA)

Pulseless electrical activity (PEA) is defined as the absence of any palpable pulse in the presence of cardiac electrical activity that would be expected to produce a cardiac output. These patients often have some mechanical myocardial contractions but they are too weak to produce a detectable pulse or blood pressure.

PEA may be caused by reversible conditions that can be treated if they are identified and corrected. Survival following cardiac arrest with Asystole or PEA is unlikely to occur unless reversible causes can be found and treated effectively. Tables 3 and 4 describe the recommended sequences of actions for the treatment of a refractory Asystole and a refractory PEA.

KEY POINT 19	<p>When a manual rhythm check on the ECG reveals VF or pulseless VT, compressions are continued while the defibrillator charges. The HMCAS staff performing the compressions will administer the shock. This is to ensure safe shock delivery.</p> <p>CPR is started immediately after shock delivery. Compressions are commenced without a rhythm or pulse check. CPR must continue for 2 minutes, after which the sequence is repeated, beginning with a rhythm check. If an organised rhythm is seen, only then is a pulse check is done.</p>
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6.12.2. Conditions for considering termination of resuscitation

Prolonged pre-hospital CPR that is clearly without any benefit may be terminated if certain conditions are met (Table 2).

Table 2: Asystole - Conditions for considering termination of CPR

Conditions for considering termination of resuscitation (ALL must be met)
1. 20 minutes of continuous Asystole despite ACLS CPR
2. Reversible causes treated
3. Cardiac arrest not from drug overdose and/or hypothermia
4. Family or patients significant other gives verbal consent
5. <i>No breathing</i>
6. <i>No palpable pulses</i>
7. No CCP on scene (in the case of APs)
8. Confirmed with CTL
<i>Points 5 -6 must be confirmed by at least 2 HMCAS attendants</i>

6.12.3. Shockable rhythms (Witness and unwitnessed)

CPR must be provided before a shock in unwitnessed cardiac arrest. If the cardiac arrest is witnessed, CPR should be performed while the cardiac monitor is attached. If cardiac arrest is witnessed and an AED is attached, a DC shock can be given immediately (See

Table 3). CPR should be resumed immediately. If the patient regains consciousness or moans, stop compressions immediately and reassess.^{58, 59}

6.13. Few important points

1. CPR must be performed using a HMCAS OHCA pocket guide.
2. Random blood glucose tests should not be performed during OHCA.
3. At 8 minutes into the cardiac arrest – you should decide whether you plan to package and transport or stay on scene and continue.
4. The approach to a witnessed OHCA and an unwitnessed OHCA is different.

See Table 3

Table 3: Witnessed versus unwitnessed arrest

Arrest not witnessed by HMCAS staff with or without bystander CPR	Arrest witnessed by HMCAS staff with defibrillator attached [#]
Unconscious	Unconscious
No or no normal breathing	No or no normal breathing
Give 100 chest compressions	Rhythm Analysis
Rhythm Analysis	Shock given to VF/VT
200j Shock given to VF/VT	Two minutes CPR
Two minutes CPR	Rhythm Analysis
Rhythm Analysis	CHECK PULSE if narrow complex organised rhythm
CHECK PULSE if narrow complex organised rhythm	[#] If defibrillator not attached – perform manual compressions until attached

6.14. Sequence of events in OHCA management

- 1) Sequence of Actions – Asystole. Table 4
- 2) Sequence of Actions – PEA. Table 5

3) Sequence of Actions – VF or VT. Table 6

Table 4: Sequence of Actions – Asystole

Step	ACTION
1	Confirm unconsciousness.
2	Expose chest — Confirm no breathing or no normal breathing.
3	Perform 100 HIGH QUALITY chest compressions(<i>Update, Instruct, Feedback</i>)
4	Rhythm Analysis*
5	Asystole identified.
6	Immediately apply LUCAS on patient. Ensure correct placement.
7	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
8	Airway — Neutral Position for LTA – Prepare and lubricate.
9	Insert and secure LTA.
10	Attach ETCO2 side stream.
11	Instruct ventilation when LUCAS LED blinks.
12	Stop LUCAS after two minutes of compressions - Rhythm analysis *
13	Asystole identified.
14	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
15	Establish IV line (NS 0.9%) ACF and secure arm to LUCAS.
16	Administer 1mg Epinephrine (1:10000) PFS.
17	Stop LUCAS after two minutes of compressions - Rhythm analysis *
18	Asystole identified.
19	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
20	Make decision for further care - Correct reversible causes.
21	Administer epinephrine 1mg every 4 minutes.
22	If no CCP in attendance, contact CTL.

* If Rhythm changes to Shockable Rhythm Go to VF/VT sequence of events.

* If Rhythm changes to Organised Rhythm with pulse go to Post Cardiac Arrest Care.

Table 5: Sequence of Actions – PEA

Step	ACTION
1	Confirm unconsciousness

2	Expose chest — Confirm no breathing or no normal breathing
3	Perform 100 HIGH QUALITY chest compressions(<i>Update, Instruct, Feedback</i>)
4	Rhythm Analysis*
5	Organised narrow complex rhythm identified
6	Pulse Check (5 seconds, maximum 10 seconds) – NO Pulse Found
7	Immediately apply LUCAS on patient. Ensure correct placement.
8	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
9	Airway — Neutral Position for LTA – Prepare and lubricate
10	Insert and Secure LTA
11	Attach ETCO2 side stream
12	Instruct ventilation when LUCAS LED blinks
13	Stop LUCAS after two minutes of compressions - Rhythm Analysis *
14	Organised narrow complex rhythm identified
15	Pulse Check (5 seconds, maximum 10 seconds) – NO Pulse Found
16	Activate LUCAS — Continuous 2 minutes.
17	Establish IV line (NS 0.9%) ACF and secure arm to LUCAS.
18	Administer 1mg Epinephrine.
19	Stop LUCAS after two minutes of compressions - Rhythm Analysis *
20	Organised narrow complex rhythm identified.
21	Pulse Check (5 seconds, maximum 10 seconds) – NO Pulse Found
22	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
23	Secure patient to scoop stretcher with LUCAS CPR on-going.
24	Transport patient P1 to HGH – Treat reversible causes **
25	Administer Epinephrine 1mg every 4 minutes.
26	Update CTL.

*If Rhythm changes to Shockable Rhythm go to VF/ VT sequence of events

**If Rhythm changes to Organised Rhythm with pulse go to Post Cardiac Arrest Care

Table 6: Sequence of Actions – VF/VT

Step	ACTION
1	Confirm unconsciousness

2	Expose chest — Confirmed no breathing or No Normal Breathing
3	Perform 100 HIGH QUALITY chest compressions(<i>Update, Instruct, Feedback</i>)
4	Rhythm Analysis*
5	VF or VT identified. (If VT – Do not check for pulse) <i>Manual chest compressions while defibrillator charges</i>
6	Administer 200 J automated shock
7	Immediately apply LUCAS on patient. Ensure correct placement.
8	Activate LUCAS — Cont. 2 minutes. Inform Crew to notify on 2min
9	Airway — Neutral Position for LTA – Prepare and lubricate
10	Insert and Secure LTA.
11	Attach ETCO2 side stream.
12	Instruct ventilation when LUCAS LED blinks
13	Stop LUCAS after two minutes of compressions - Rhythm analysis *
14	VF or VT identified. (If VT – Do not check for pulse) <i>Start LUCAS chest compressions while defibrillator charges</i>
15	Administer 300 J shock while LUCAS continues compressions
16	Establish IV line (NS 0.9%) ACF and secure arm to LUCAS
17	Administer 1mg Epinephrine (1:10000) PFS
18	Stop LUCAS after two minutes of compressions - Rhythm Analysis *
19	VF or VT identified. (If VT – Do not check for pulse) <i>Start LUCAS chest compressions while defibrillator charges</i>
20	Administer 360 J shock while LUCAS continues compressions
21	Administer 300mg Amiodarone IV with 20 ml flush
22	Secure patient to scoop stretcher with LUCAS CPR on-going
23	Transport patient P1 to HGH
24	Administer Epinephrine 1mg every 4 minutes
25	Update CTL
26	Correct reversible causes enroute to hospital

*If Rhythm changes to Shockable Rhythm go to VF/ VT sequence of events

*If Rhythm changes to Organised Rhythm with pulse go to Post Cardiac Arrest Care

6.14. Post cardiac arrest care

Successful ROSC is just the first step toward the goal of complete recovery from cardiac arrest. Although post cardiac arrest treatment includes a variety of treatment goals, not

many can be achieved in the prehospital setting. In line with expert consensus and guidelines on resuscitation, HMCAS staff will pay particular attention to the following regarding post cardiac arrest care:

- **Airway and breathing**

Low levels of oxygen and high levels of carbon dioxide both increase the likelihood of a further cardiac arrest and may contribute to secondary brain injury. Maintaining a patient's SpO₂ above 94% and an EtCO₂ between 35 and 45 mmHg is the targeted post cardiac arrest care plan. Do **NOT** hyperventilate patients.

- **Circulation**

Attempts must be made to maintain a systolic blood pressure (SBP) above 90 mmHg. This can be achieved using up to 2 litres of Normal Saline (NS), administered in 250ml boluses.

- **Glucose control**

There is a strong association between high blood glucose after resuscitation from cardiac arrest and poor neurological outcome. Routine checking of RBS (Random Blood Sugar) during cardiac arrest is no longer recommended unless there is a high likelihood that the cause of arrest may be glucose related, e.g. insulin overdose. Even then – RBS should only be done after the first dose of 1mg epinephrine is given to a patient. Post cardiac arrest care includes correcting hypoglycaemia (<4.0mmol/L) to within normal ranges (4-6mmol/L). If RBS is <4mmol/L, small boluses of 50ml of 10% Dextrose should be given, with repeated RBS measurements until RBS returns to a level between 4mmol/L and 6mmol/L. All attempts must be made to PREVENT hyperglycaemia (>10mmol/L)

- **Agitated patient**

There is little evidence to support Rapid Sequence Induction (RSI) after ROSC even when patient agitation is considered to be life-threatening. With the increased prevalence of pneumonia, and the resultant poor outcomes to hospital discharge in intubated patients following cardiac arrest, routine RSI of patients after ROSC is not recommended. However, if the therapeutic benefit of sedation outweighs the possibility of potential complications later on, sedation NOT RSI should be considered. Ketamine should be used at 1mg/kg as a bolus dose.

**KEY
POINT 20**

There is little evidence to support Rapid Sequence Induction (RSI) after ROSC even when patient agitation is considered to be life-threatening. With the increased prevalence of pneumonia, and the resultant poor outcomes to hospital discharge in intubated patients following cardiac arrest, routine RSI of patients after ROSC is not recommended.

However, if the therapeutic benefit of sedation outweighs the possibility of potential complications later on, sedation NOT RSI should be considered. Ketamine should be used at 1mg/kg as a bolus dose.

- Post cardiac arrest care includes correcting hypoglycaemia (<4.0mmol/L) to within normal ranges (4-6mmol/L). All attempts must be made to PREVENT hyperglycaemia (>10mmol/L).
- If RBS is <4mmol/L, boluses of 150ml of 10% Dextrose should be given, with repeated RBS measurements until RBS returns to a level between 4mmol/L and 6mmol/L.

6.14.1. Temperature control

Several studies document an association between post-cardiac-arrest pyrexia (>37.6 °C) and poor outcomes. In addition, mild hypothermia was found to decrease the cerebral metabolic rate for oxygen by about 6% for each 1 degree Celsius reduction, bringing about a level of neuroprotection by suppressing and delaying brain cell death.

International guidelines recommend that adult patients with pre-hospital ROSC who **remain unconscious** be cooled to 32°C to 34°C using 30 ml per kg of cold (4°C) 0.9% NS. As true core temperature readings are difficult to determine in the pre-hospital setting, and because HMCAS cannot ensure that hospitals receiving post cardiac arrest cases continue with post ROSC cooling, **HMCAS staff will not practice post cardiac arrest cooling.**

KEY POINT 21	<ol style="list-style-type: none"> 1. Maintain oxygen saturation above 94% and EtCO₂ between 35-45 mmHg. Do not hyperventilate. 2. Treat hypotension, (SBP < 90 mmHg). A maximum of 2 litres of 0.9% NS at room temperature can be given in 250ml boluses to raise SBP to 90 mmHg. 3. Treat hypoglycaemia (<4.0mmol) but AVOID hyperglycaemia (>10.0mmol). 4. Treat severe patient agitation or gagging against an instituted tube with Ketamine 1mg/kg as a bolus dose. <p style="text-align: center;">Call CTL to arrange destination most appropriate for patient admission, e.g. Heart Hospital for PCI.</p>
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7. Module support and contact details

If YOU are unsure of content, CPR sequence of actions or any part of this pre-module package, please contact the training department before commencement of the training module.

Education department contact details:

emsinstructor@hmc.org.ga

For urgent matters you can contact The HMCAS Consultant Paramedic with a speciality focus on Adult Cardiac arrest, **Mr. Kevin Govender** on 3383 7728

8. Pre-module assignment

Please complete the pre-module assignment that came with this document. The pre-module assignment will be collected from you by the module instructor at the commencement of the module.

9. Appendices

Appendix 1 .HMCAS Cardiac Arrest Detailed Supplement to CPG 4.1

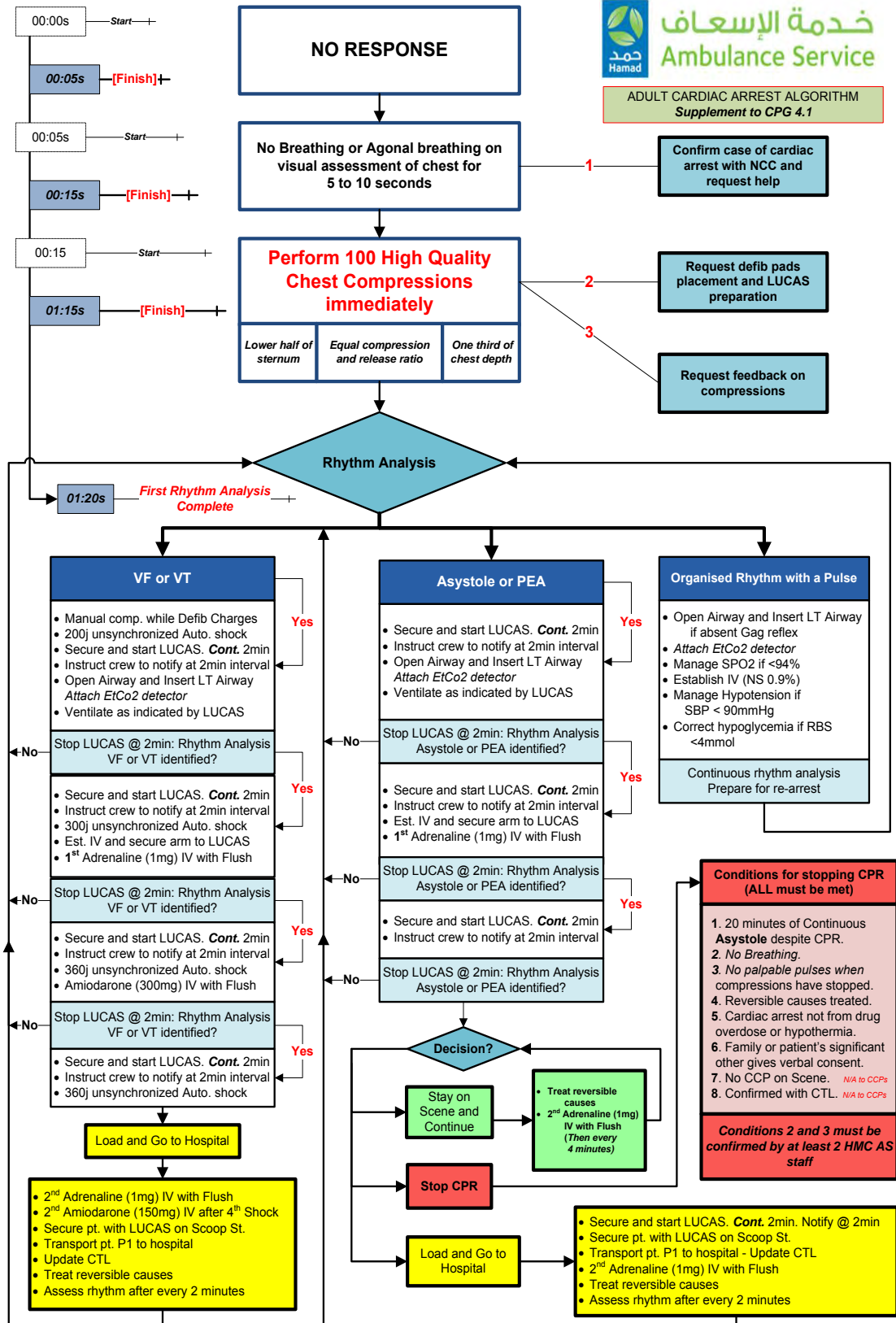
Appendix 2 .OHCA - RET VF/ VT and Assessment Rubric

Appendix 3 .OHCA – RET Asystole/PEA and Assessment Rubric

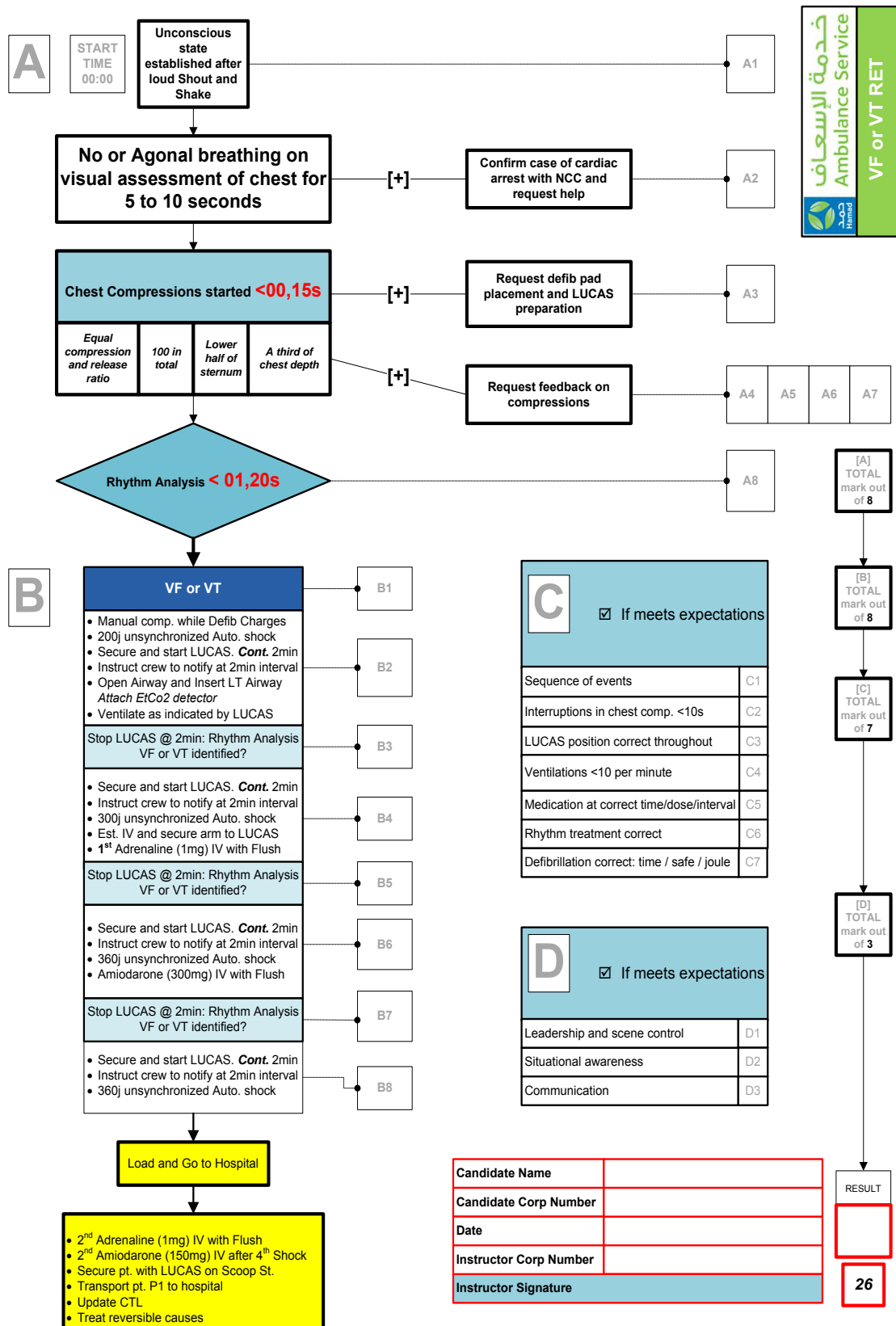
Appendix 4 .HMC AS Primary Response Equipment staff directive

Appendix 1: HMCAS Cardiac Arrest Detailed Supplement to CPG 4.1

ADULT CARDIAC ARREST ALGORITHM
Supplement to CPG 4.1



Appendix 2: OHCA Rapid Evaluation Tool - VF/ VT



Basic and Advanced Care – Technical Skills

A1	Tick if victim's unconscious state has been detected by loud shout and shake within 5 seconds
A2	Tick if No breathing/agonal breathing has been detected in >5<10s and request for help/report given to NCC.
A3	Tick if chest compressions are commenced In <15 seconds from patient contact and instructions for application of Defib pads and preparation of the LUCAS are given to second rescuer.
A4	Tick if SECOND RESCUER provides real time feedback on correct position during compressions
A5	Tick if SECOND RESCUER provides real time feedback on correct compression release ratio during compressions
A6	Tick if SECOND RESCUER provides real time feedback on correct depth during compressions
A7	Tick if 100 continuous chest compressions given
A8	Tick if rhythm analysis done < 1.20s from patient contact
B1	Tick if VF or VT is detected.
B2	Tick if all 6 bulleted steps are completed
B3	Tick if LUCAS stopped at 2 minutes and VF or VT is Identified.
B4	Tick if all 5 bulleted steps are completed
B5	Tick if LUCAS stopped at 2 minutes and VF or VT is Identified.
B6	Tick if all 4 bulleted steps are completed
B7	Tick if LUCAS stopped at 2 minutes and VF or VT is Identified.
B8	Tick if all 3 bulleted steps are completed, a decision is taken and all bulleted steps for that decision is completed

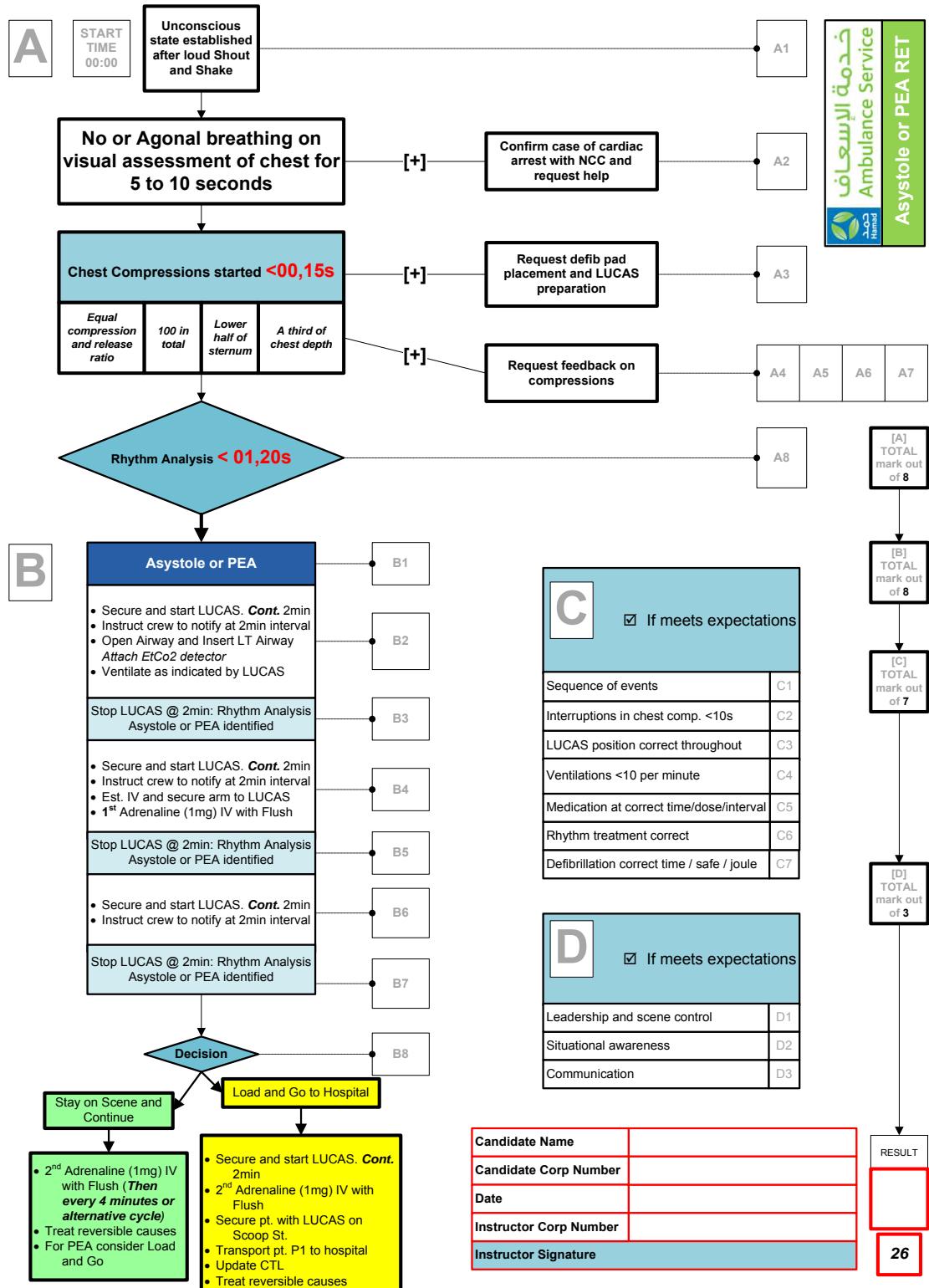
Overall Care – Technical Skills

C1	Tick if a CAB sequence of treatment events were done.
C2	Tick if any interruptions in compression that was seen during the entire cardiac arrest event was less than or equal to 10 seconds. LUCAS Application is allowed at 15 seconds
C3	Tick if the LUCAS was positioned correctly and remained at the lower half of the sternum throughout the simulation.
C4	Tick If ventilations given throughout the cardiac arrest event was under 10 per minute.
C5	Tick if overall administration of medications during the entire cardiac arrest event was at the correct time/dose and cycle interval.
C6	Tick if any identified rhythm was treated correctly.
C7	Tick if defibrillation was safe, given at the right time/interval and joule dose.

Non-Technical Skills

D1	<p>Leadership and Scene control. Tick if leadership and scene control non-technical skills are evident and did not compromise Chest Compression Fraction. Examples include:</p> <p>Family or bystanders: <i>Identifies and controls family and bystanders that appear anxious and agitated and whose actions could likely hinder resuscitative attempts.</i></p> <p>Second Rescuer: <i>Clear instructions, continuous supervision and feedback from crew-mate.</i></p> <p>Other EMS on scene: <i>Takes lead and instructs all involved on what to do and supervises those lacking experience and familiarity with tasks.</i></p>
D2	<p>Situational Awareness. Tick if student continuously monitors the scene and pre-empt potential problems. Examples include..</p> <p>Family or bystanders: <i>Advises on prognosis and course of action.</i></p> <p>Second Rescuer: <i>Ensures crew-mate's wellbeing, endurance, state of mind, etc.</i></p> <p>Other EMS on scene: <i>Checks on overall team's condition, endurance, state of mind, etc.</i></p>
D3	<p>Communication Skills. Tick if student utilizes good overall communication skills. The following situations are to be evaluated when rating communication skills.</p> <p>Family or bystanders: History taking and reassurance.</p> <p>Family or bystanders: Responds to questions and concerns.</p> <p>Second Rescuer: Clear instructions on what to do.</p> <p>Second Rescuer Clearly answers questions put forward by crew-mate</p> <p>Other EMS on scene Advises on how to be of assistance.</p> <p>Other EMS on scene: Responds to questions and provides assistance</p>

Appendix 3: OHCA Rapid Evaluation Tool Asystole/PEA



Basic and Advanced Care – Technical Skills

A1	Tick if victim's unconscious state has been detected by loud shout and shake within 5 seconds
A2	Tick if No breathing/agonal breathing has been detected in >5<10s and request for help/report given to NCC.
A3	Tick if chest compressions are commenced In <15 seconds from patient contact and instructions for application of Defib pads and preparation of the LUCAS are given to second rescuer.
A4	Tick if SECOND RESCUER provides real time feedback on correct position during compressions
A5	Tick if SECOND RESCUER provides real time feedback on correct compression release ratio during compressions
A6	Tick if SECOND RESCUER provides real time feedback on correct depth during compressions
A7	Tick if 100 continuous chest compressions given
A8	Tick if rhythm analysis done < 1.20s from patient contact
B1	Tick if Asystole or PEA is detected.
B2	Tick if all 4 bulleted steps are completed
B3	Tick if LUCAS stopped at 2 minutes and Asystole or PEA is Identified.
B4	Tick if all 4 bulleted steps are completed
B5	Tick if LUCAS stopped at 2 minutes and if Asystole or PEA is detected
B6	Tick if all 2 bulleted steps are completed
B7	Tick if LUCAS stopped at 2 minutes and Asystole or PEA is detected
B8	A decision is taken and all bulleted steps for that decision is completed

Overall Care – Technical Skills

C1	Tick if a CAB sequence of treatment events were done.
C2	Tick if any interruptions in compression that was seen during the entire cardiac arrest event was less than or equal to 10 seconds. LUCAS Application is allowed at 15 seconds
C3	Tick if the LUCAS was positioned correctly and remained at the lower half of the sternum throughout the simulation.
C4	Tick If ventilations given throughout the cardiac arrest event was under 10 per minute.
C5	Tick if overall administration of medications during the entire cardiac arrest event was at the correct time/dose and cycle interval.
C6	Tick if any identified rhythm was treated correctly.
C7	Tick if defibrillation was safe, given at the right time/interval and joule dose.

Non-Technical Skills

D1	<p>Leadership and Scene control. Tick if leadership and scene control non-technical skills are evident and did not compromise Chest Compression Fraction. Examples include:</p> <p>Family or bystanders: <i>Identifies and controls family and bystanders that appear anxious and agitated and whose actions could likely hinder resuscitative attempts.</i></p> <p>Second Rescuer: <i>Clear instructions, continuous supervision and feedback from crew-mate.</i></p> <p>Other EMS on scene: <i>Takes lead and instructs all involved on what to do and supervises those lacking experience and familiarity with tasks.</i></p>
D2	<p>Situational Awareness. Tick if student continuously monitors the scene and pre-empt potential problems. Examples include..</p> <p>Family or bystanders: <i>Advises on prognosis and course of action.</i></p> <p>Second Rescuer: <i>Ensures crew-mate's wellbeing, endurance, state of mind, etc.</i></p> <p>Other EMS on scene: <i>Checks on overall team's condition, endurance, state of mind, etc.</i></p>
D3	<p>Communication Skills. Tick if student utilizes good overall communication skills. The following situations are to be evaluated when rating communication skills.</p> <p>Family or bystanders: <i>History taking and reassurance.</i></p> <p>Family or bystanders: <i>Responds to questions and concerns.</i></p> <p>Second Rescuer: <i>Clear instructions on what to do.</i></p> <p>Second Rescuer: <i>Clearly answers questions put forward by crew-mate</i></p> <p>Other EMS on scene: <i>Advises on how to be of assistance.</i></p> <p>Other EMS on scene: <i>Responds to questions and provides assistance</i></p>

APPENDIX L: PUBLISHED ARTICLE IN EMJ

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Comparison of two training programmes on paramedic-delivered CPR performance

Kevin Govender, Karen Sliwa, Lee Wallis and Yugan Pillay

Emerg Med J published online December 23, 2015

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Comparison of two training programmes on paramedic-delivered CPR performance

Kevin Govender,^{1,2} Karen Sliwa,³ Lee Wallis,⁴ Yugan Pillay⁵

► Additional material is published online only. To view these images please visit the journal online (<http://dx.doi.org/10.1136/emmermed-2014-204404>)

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ABSTRACT

Objective To compare CPR performance in two groups of paramedics who received CPR training from two different CPR training programmes.

Methods Conducted in June 2014 at the Hamad Medical Corporation Ambulance Service, the national ambulance service of the State of Qatar, the CPR performances of 149 new paramedic recruits were evaluated after they had received training from either a traditional CPR programme or a tailored CPR programme. Both programmes taught the same content but differed in the way in which this content was delivered to learners. Exclusive to the tailored programme was mandatory precourse work, continuous assessments, a locally developed CPR instructional video and pedagogical activities tailored to the background education and learner style preferences of paramedics. At the end of each respective training programme, a single examiner who was blinded to the type of training paramedics had received, rated them as competent or non-competent on basic life support skills, condition specific skills, specific overall skills and non-technical skills during a simulated out-of-hospital cardiac arrest (OHCA) assessment.

Results Paramedics who received CPR training with the tailored programme were rated competent 70.9% of the time, compared with paramedics who attended the traditional programme and who achieved this rating 7.9% of the time ($p<0.001$). Specific improvements were seen in the time required to detect cardiac arrest, chest compression quality, and time to first monitored rhythm and delivered shock.

Conclusions In an OHCA scenario, CPR performance rated as competent was significantly higher when training was received using a tailored CPR programme.

INTRODUCTION

Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, paramedic-delivered CPR during out-of-hospital cardiac arrests (OHCA) remains inadequate and is rarely in line with established resuscitation guidelines.^{1–4}

International resuscitation bodies such as the International Liaison Committee on Resuscitation postulate the need for tailored CPR training programmes in order to improve CPR performance.⁵ The aim of this study was to investigate the impact of a tailored CPR training programme designed specifically for the scope of practice, educational background, learner preferences and operational role of paramedics in Qatar, as well as within the country's healthcare system's response to OHCA.

Key messages

What is already known on this subject? Despite revised training standards, structured CPR training programmes and industry-regulated CPR refresher training schedules, paramedic-delivered CPR during out-of-hospital cardiac arrests (OHCA) remains inadequate and is rarely in line with established resuscitation guidelines. International resuscitation bodies such as the International Liaison Committee on Resuscitation postulate the need for tailored CPR training programmes in order to improve CPR performance.

What might this study add? The results of this study indicate that paramedic-delivered CPR performance in an OHCA simulation, at the Hamad Medical Corporation Ambulance service in the state of Qatar, was improved following tailored CPR training. The process of tailoring CPR training to promote improved acquisition and retention of knowledge and skills took into account the operational role, clinical remit and scope of practice, educational background and learner characteristics of paramedics in Qatar.

METHODS

This prospective cohort study was approved by the Institutional Review Board at the University of Cape Town, South Africa, and conducted with permission at the Hamad Medical Corporation Ambulance Service (HMCAS), the national Ambulance Service for the State of Qatar.

Participants and recruitment for the study

The first of two groups of new paramedic recruits ($n=63$) was enlisted into the study to represent the participant cohort that had been assigned to receive traditional CPR training (control group). At the time, this training programme was used by HMCAS to train new paramedic recruits in CPR and existing paramedics who required CPR recertification every 2 years. The second group of paramedics ($n=86$) had background training and experience comparable to the first group and were recruited into the study after the first group had completed its training and had been signed off for active operational duty. This second group of new paramedic recruits was assigned to receive CPR training from an alternative tailored CPR training programme (experimental group). It should be noted that, apart from the different CPR training



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programmes, all 149 new paramedic recruits underwent exactly the same HMCAS administrative and clinical skill orientation programme.

Similarities and differences between the two CPR training programmes

Both training programmes were 8 h in duration and covered the same subject matter, paramedic scope of practice, resuscitative equipment and sequence of CPR steps, as prescribed by the HMCAS clinical practice guideline for adult cardiac arrest (see online supplementary appendix 1). The overarching difference, however, was in the way in which this subject matter was delivered and the pedagogical activities undertaken by each programme to ensure the acquisition and long-term retention of CPR knowledge and skills by learners. For example, in contrast to the traditional programme, the tailored programme included mandatory precourse work, which required learners to read a locally developed and tailored precourse information booklet, view a video demonstration of expected paramedic-delivered CPR performance at HMCAS and then demonstrate the assimilation of the precourse work through a precourse assignment, which was collected from learners at the commencement of the course. Learners received the precourse work no less than 7 days before commencement of the programme and those who were unable to collect this material were not recruited into the study. The tailored programme also included a pre, midway and postcourse evaluation followed by discussions and feedback at each of the three assessment junctures. This was not the case with the traditional programme, however, which contained only one summative evaluation conducted at the end of the course. In addition, the tailored programme predicated CPR proficiency on multiple practice cycles of eight individual and core skills, as opposed to the traditional programme which required learners to participate in multiple practice rounds of different full-length high fidelity OHCA scenarios.

In order to expose learners to a wide range of OHCA scenarios, where OHCA management might require a slight modification (eg, a pregnant, geriatric or trapped patient, overdose, hypothermic, etc), participants in the tailored programme were given theoretical scenarios and asked to discuss and explain how they would manage these less frequent and largely exceptional cases. In contrast to the traditional programme the tailored programme ensured strict adherence to allocated time intervals for pedagogical activities, increased attention to the use of non-technical skills like communication, leadership and situational awareness, and the inclusion of mental modelling sessions. These novel pedagogical activities (ie, mental modelling) were exclusive to the tailored programme and had the aim of shaping learners' thinking and behaviour and, ultimately, attempting to establish an approach to solving problems, particularly those problems involving the less frequent, but countless, exceptional OHCA cases that may arise. An overview of both training programmes is presented in table 1. Because the tailored programme was designed to reinforce knowledge acquired through the precourse work as opposed to introducing knowledge during the traditional programme, and due to the smaller candidate-to-instructor ratio, and the absence of multiple practice cycles of full-length high fidelity OHCA simulations, it was possible for the activities outlined in table 1 to be completed in the same 8-h day as was allocated to the traditional programme.

Overview of instructors

Six instructors were recruited to the study, all of whom were at the time working in the training department at HMCAS teaching the traditional CPR training programme. All instructors had

the same foundational clinical qualification and had between 3 years' and 5 years' experience as CPR instructors at HMCAS. Three of the six instructors were then randomly chosen to attend the 1-day instructor course for the tailored training programme. This course included in-depth and step-by-step guidance on how the tailored programme should be conducted. This guidance ranged from how and what to prepare for each tailored programme, to employable methods to ensure that all learning objectives were reliably achieved, to the tone and approach to take when providing corrective real-time and post-event feedback. It also emphasised the role of facilitation as opposed to instruction when conducting mental modelling sessions as well as specific techniques to ensure that simulated assessments were conducted in a standardised fashion.

Outcome measures

The primary outcome measure was the rating of competent. This outcome measure reflects the learners' ability to perform high-quality effective paramedic-delivered CPR as defined and presented in box 1.

This ability was evaluated by a paramedic-delivered CPR Rapid Evaluation Tool (RET) (see online supplementary appendices 2 and 3). The tool was based on variables derived from the globally accepted Cardiff list and updated to the European Resuscitation Guidelines 2010 for adult cardiac arrest and consisted of 26 process measures.³⁻⁷ Each measure represents a single or a group of treatment elements within a CPR care bundle, which has been proven by scientific evidence or expert consensus to be most likely to contribute to successful resuscitation.⁸ In a separate study, in which the RET was developed and tested, Cohen and Fleiss κ coefficients ranging 0.92–1.00 and 0.75–0.96, respectively, were demonstrated, indicating acceptable intrarater reliability and inter-rater agreement.⁶

Examiners and application of the RET

The same examiner was used to evaluate CPR performance across both training programmes. This examiner also worked at HMCAS as an instructor; however, he had not participated in CPR training at any time in the past nor had he been involved in the development of the tailored programme. He therefore was blinded to the type of CPR training participants had attended and received. Prior to evaluation, the examiner attended a training session in which he received detailed instructions in how to evaluate CPR performance using the RET. To further aid the examiner in applying the RET, he was given a RET assessment rubric which he had on hand during every evaluation. In completing the RET, the examiner was simply required to mark dichotomous ratings by placing either a tick if a process measure was achieved or a cross if it was not. Using the same examiner to score the RET for the traditional and the tailored programme test protocols was decided on as a way of attenuating possible measurement bias, although the use of different raters would have been acceptable based on the tool's demonstrated inter-rater agreement scores.

Statistical analysis

Data were subjected to statistical analysis using SPSS (V17.0, Chicago, Illinois, USA). Categorical data (dichotomous variables—tick for 'achieved' and cross for 'did not achieve') are reported as proportions. Comparisons of means of process (singular) and composite (grouped) measures between the control and the experimental groups are reported using independent samples *t* tests, with a *p* value <0.05 being considered as statistically significant.

Table 1 Overview and comparison of the two CPR training programmes

	Conventional CPR training programme	Tailored CPR training programme
Admission to training programme	New recruit to HMCAS Last CPR training >2 years while employed at HMCAS (Refresher)	New recruits to HMCAS Refresher training for APs
Duration of programme	1 full-day programme (6–8 h)	1 full-day programme (6–8 h)
Required instructor to candidate ratio	No prescribed instructor-to-candidate ratio (Minimum of 6 candidates for programme quorum)	One instructor per 6 candidates (Minimum of 6 candidates and maximum of 12 per class)
Candidate precourse work or reading	None	Read prescribed precourse document Watch prescribed pre-course demonstration of pdCPR Complete precourse assignment Study for precourse test
Programme overview	Course registration Presentation of theory component Skills practice component Practice sessions with different full-length simulated OHCA scenarios Competency assessment includes a full-length OHCA simulation	Course registration Collection of precourse assignment Precourse test Theory component Mark precourse test—discussion Simulated OHCA demonstration (Video) Skills with peer feedback cycles Manage and present paper scenarios Simulated OHCA performance Postcourse test Mental practice and modelling sessions Simulated OHCA competency assessment
Theory component	Key changes in CPR from 2005 to 2010. Evidence supporting changes. Related pharmacology (OHCA and IHCA) Non-technical skills	Reinforce elements from precourse reading and video Role and impact of CPR Physiological consequences of CPR Non-technical skills
Skills component	Supraglottic airway device insertion Intravenous line insertion LUCAS application	Recognition of cardiac arrest Hand positioning for chest compressions Compression rate Compression depth Compression release ratio LUCAS application Airway management Provision of synchronised ventilations
Practice component	Candidates placed in groups of 4 Candidates undertake full length simulated OHCA scenarios Each candidate to perform as team leader in at least 1 full OHCA scenario Postpractice feedback and support provided by instructor	Skill component—individual practice with feedback until mastery achieved Candidates placed in teams of two to complete and demonstrate outcome of paper scenario Mental practice and modelling prior to simulated OHCA assessment
Programme competency assessments	Final assessment Simulated OHCA assessment using a programme-specific assessment tool 100% of total mark	Continuous assessment Precourse assignment: 10% Precourse test: 20% Postcourse test: 20% Simulated OHCA assessment: 50%

AP, Ambulance Paramedic; CPR, cardio-pulmonary arrest; HMCAS, Hamad Medical Corporation Ambulance Service; IHCA, in-hospital cardiac arrest; OHCA, out-of-hospital cardiac arrest; pdCPR, paramedic-delivered CPR.

Study protocol

Study participants were informed about the study and their permission was requested on the day of the training programme at the beginning of their competency assessment for the respective programmes. Each individual participant was told to enter a

Box 1 Definition of paramedic-delivered CPR

In the context of this study, paramedic-delivered CPR is defined as a cardiac arrest treatment bundle that includes manual and/or mechanical chest compressions, defibrillation, airway and ventilator support, as well as advanced cardiac life support drug management that is provided by paramedics who respond to an out-of-hospital cardiac arrest in the official capacity as part of an ambulance service response team in Qatar.

skills assessment room with only their primary response equipment on hand. This included a primary response bag, an oxygen cylinder and regulator, a Lifepak 15 monitor/defibrillator and a Lund University Cardiopulmonary Assist System (LUCAS) mechanical chest compression device. Participants were also told that when they entered the assessment room, they would see three examiners, two of whom were their training programme instructors and one of whom was there to carry out the function of this study. Participants were also told that the programme instructors would answer any questions about the patient's condition that could not be obtained from this particular type of manikin, for example 'Yes' or 'No' to the possible question 'Is the patient breathing?' They were asked not to direct any questions to the study examiner, and were in fact told to imagine that the study examiner was not even present.

On entering the room the participants encountered a simple resuscitation manikin (Resusci Anne, Laerdal Medical, Stavanger, Norway) connected to an ECG rhythm generator.

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They were asked to imagine the resuscitation manikin to be a 50-year-old male patient lying supine on the floor. They were informed that there were no signs of trauma, no bystanders, and no other history was available or obtainable.

Each participant was accompanied by a basic life support (BLS) partner. The partner was to act only on instruction and was not allowed to perform any skills outside their clinical scope of practice. Participants were told to perform all skills and activities as if this were a real patient. This included everything from insertion of airways to delivery of shocks, establishment of intravenous lines, and loading patients for active transportation onto the long back board and stretcher provided. The simulation briefing was essential as it helped participants be clear on what they should simulate or actually do.^{9 10}

To really test participants' understanding of the application of the CPR protocol, none of the participants in either test group (traditional and tailored CPR training programme group) had prior knowledge of the type of cardiac arrest simulation they would encounter, other than that it would be an adult medical cardiac arrest.¹⁰

RESULTS

The demographics, background training and experience of participants across the two groups were comparable (table 2).

The total proportion of participants rated as competent, as reflected by the RETs, was significantly higher in the experimental group: 61/86 (70.9%) vs 5/63 (7.9%) for the control group (traditional CPR). The experimental group performed significantly better in (1) BLS skills; (2) condition-specific skills; (3) specific overall skills and (4) non-technical skills. These four categories of process measures reflected a CPR care bundle that has been proven by scientific evidence or expert consensus to be most likely to contribute to successful resuscitation (table 3). Aggregated BLS skills (sum of A1 through B1) were performed

significantly better ($p<0.001$) by the experimental group ($n=86$; $\bar{x}=8.78$) in comparison to the control group ($n=63$; $\bar{x}=3.89$). Aggregated condition specific skills (sum of B2 through B8) were also performed significantly better by the experimental group ($n=86$; $\bar{x}=6.92$) than the control group ($n=63$; $\bar{x}=2.22$) ($p<0.001$). Specific improvements across the control and experimental groups were seen in cardiac arrest detection time (17.5% vs 98.8%, respectively), and the components of chest compression quality, that is, rate (20.6% vs 98.8%), position (60.3% vs 100%), ratio (14.3% vs 100%), depth (25.4% vs 89.5%); and time to first monitored rhythm (20.6% to 100%) (table 3).

DISCUSSION

There is agreement that paramedic-delivered CPR quality is often suboptimal and changes are needed to improve OHCA outcomes.¹⁻⁴ Tailoring CPR training with the aim of improving the acquisition and retention of knowledge and skills has long been recommended as one strategy for improving performance.^{6 11 12} The result of this study contributes, in part, to validating this recommendation, demonstrating that tailoring CPR training to the operational role of a healthcare practitioner within a healthcare systems response to OHCA, the practitioners' clinical scope of practice, educational background, and learner characteristics, would likely ensure improved acquisition and retention of CPR knowledge and skills, with subsequent improvement in CPR performance during a simulated OHCA assessment.

This study also showed that while new resuscitation guidelines appear to have improved the process of CPR, overall performance following traditional CPR training, as evaluated in a simulated OHCA assessment, remains poor, as seen in the low proportion (7.9%) of participants that were rated as competent following the traditional CPR training programme. This finding is consistent with previous reports.¹²

The tailored programme's approach in preparing learners before the course by using precourse reading and a precourse assignment appears to have reduced the need for long formal lectures during actual course time. Although reports indicate that precourse reading or work is unlikely to improve overall performance,^{13 14} the absence of long formal theoretical components during the tailored programme allowed participants more time for structured cycles of actual hands-on practice which, as previous reports indicate, is correlated to enhanced skill retention.^{15 16}

In addition, the use of continuous assessments comprising written and practical evaluations, and the provision of cycles of structured feedback from peers and the instructor in a consistent and measured fashion appear to have allowed the tailored CPR training programme group to rectify identified knowledge and skill gaps promptly in the apportioned time. This finding is also consistent with earlier reports supporting the use of constant feedback to improve CPR performance.^{17 18}

Furthermore, the inclusion in the tailored CPR training programme of a short locally developed and custom-made video of HMCAS staff demonstrating CPR in a simulated OHCA appears to have been successful in reinforcing the sequence of steps and the quality standard of CPR that the experimental group was expected to perform at. The traditional CPR training programme did not include a video, and an understanding how to perform in an OHCA appears to have been left to participants' own interpretation. While videos that instruct and/or demonstrate CPR during training may not be essential, reports have often indicated superior overall CPR performance when videos are used.¹⁹ As opposed to a live demonstration which

Table 2 Demographics, training and previous work experience for participants across the two groups

	Control group (n=63)	Experimental group (n=86)
Percentage male	89% (56/63)	94% (81/86)
Percentage female	11% (7/63)	6% (5/86)
Age*	29 (3.87) (23-39)	26 (2.51) (24-36)
Percentage with 4 years healthcare-related degree.	100 (63/63)	100 (86/86)
Years of experience in healthcare*	7.14 (3.84) (2-17)	4.66 (2.56) (2-14)
Percentage with previous work as EMT or paramedic.	6.3% (4/63)	10.5% (9/86)
Percentage with previous work as a nurse.	93.7% (59/63)	89.5 (77/86)
Percentage with valid BLS certification.	100 (63/63)	100 (86/86)
Percentage with valid ACLS certification.	87 (55/63)	81 (70/86)
Number of times CPR delivered (During simulation)*	6.32 (1.32) (4-10)	6.55 (0.85) (6-10)
Number of times CPR delivered (in real patients)*	8.17 (5.43) (1-33)	5.99 (3.59) (1-21)

*Expressed as a mean (SD) (range).
ACLS, advanced cardiac life support; BLS, basic life support; EMT, Emergency Medical Technician.

Table 3 Observed proportions of participants achieving process measures after training

Process measures	Control group		Experimental group		p-Value
	Per cent	n/63	Per cent	n/86	
A1 Loud shout and shake used to determine unconscious state in <5s	74.6	47	95.3	82	0.000
A2 No or agonal breathing detected on visual inspection of chest in <10 s	79.4	50	95.3	82	0.002
A3 Compressions started <15 s from patient contact	17.5	11	98.8	85	0.000
A4 Chest compressions given: 100 in total ≤1 min	20.6	13	98.8	85	0.000
A5 Chest compressions given: Correct position—lower half of the sternum	60.3	38	100.0	86	0.000
A6 Chest compressions given: Correct ratio—50: 50 and no leaning	14.3	9	100.0	86	0.000
A7 Chest compressions given: Correct depth—third of chest depth	25.4	16	89.5	77	0.000
A8 Rhythm analysis <1, 20 s from patient contact	20.6	13	100	86	0.000
B1 Rhythm identification correct	76.2	48	100	86	0.000
B2 Composite measure B2	28.6	18	100.0	86	0.000
B3 Composite measure B3	23.8	15	91.9	79	0.000
B4 Composite measure B4	42.9	27	100.0	86	0.000
B5 Composite measure B5	30.2	19	100.0	86	0.000
B6 Composite measure B6	28.6	18	100.0	86	0.000
B7 Composite measure B7	34.9	22	100.0	86	0.000
B8 Composite measure B8	33.3	21	100.0	86	0.000
C1 Correct sequence of events	74.6	47	100.0	86	0.000
C2 Interruptions in chest compressions <10 s	57.7	36	91.9	79	0.000
C3 LUCAS position correct throughout cardiac arrest event	25.4	16	98.8	85	0.000
C4 Ventilations <10/min	20.6	13	100.0	86	0.000
C5 Medications correct: time/dose/interval	46.0	29	98.3	82	0.000
C6 Rhythm treatment correct	95.2	60	91.9	79	0.419
C7 Defibrillation correct: time/safe/joule	82.5	52	91.9	79	0.086
D1 Non-technical skills—Good leadership and scene control	56.6	35	89.5	77	0.000
D2 Non-technical skills—Good situational awareness	22.2	14	93.0	80	0.000
D3 Non-technical skills—Good communication	54.0	34	89.5	77	0.000
Observed proportions rated as overall competent	7.9	5	70.9	61	0.000

may include elements that distract the audience, the images presented on a screen can be selected to focus the attention of the audience on specific aspects.

The tailored CPR training programme also required participants to work in pairs, to discuss and then to present their ideal management of different OHCA theoretical scenarios to the entire group. It also required them to undergo brief sessions of mental modelling before the final simulated assessment. The three interdependent pedagogical interventions (think through, talk through and act out) appear to have created a holistic learning experience tailored to challenge OHCA preconceptions while, more importantly, also improving the acquisition and retention of knowledge and skills. This appears to have offset the limitation of one isolated pedagogical intervention and as a result ensured that the set team-based paramedic-delivered CPR learning objectives were reliably achieved.

Addressing potential sources of bias

By enrolling the entire population of paramedics from each of the two new recruitment groups, the potential for selection bias was minimised. In addition, none of the study investigators themselves played any part in actual facilitation or teaching in either of the two training programmes (other than the initial instructor course and examiner training), nor were they permitted to examine participants during the actual data collection phases.

Study limitations

Despite measures taken to address all anticipated sources of bias, the nature, size and novelty of the tailored CPR training

programme made it difficult to blind instructors to the type of training provided to participants. The instructors for the traditional CPR training programme were notified and asked to enrol in this study at the same time as the participants were informed (ie, at the end of the programme, just before participants had to undertake the final competency evaluation). This was not the case for the instructors of the tailored programme group who underwent a tailored CPR training programme instructor course and probably became aware of the study from other participants and instructors. Although there was no evidence to suggest that this happened, it is possible that the tailored CPR training programme instructors were not just better trained because of the trainer course, but also more motivated and more interested in training so a better training output result could be achieved. While in this study the examiner was blinded, a consideration and opportunity for further study is blinding instructors and examiners.

The use of a manikin with limited interactive features together with RET, and the CPR analysis it provides, does not adequately reflect clinical reality but was judged sufficient for the learning objectives being tested.^{5 20} Although computerised methods of measuring compression depth are available, they also have limitations owing to the dependency of the underlying surface,⁴ so the use of skill-reporting software is likely to provide more exact quantitative information about the quality of compressions performed. This presents an opportunity and consideration for further research. Another opportunity for further study is to examine the sustainability of the tailored CPR training programme from an economical and patient

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outcome perspective as it is notably far more resource-intensive and requires more work on the part of the instructors, when compared with traditional CPR programmes.

And lastly, while not a specific objective of this study, the lack of follow-up on retention, or competence in the field post training is a notable limitation and should also be included as a goal for further study.

Conclusions

The results of this study indicate that paramedic-delivered CPR performance in an OHCA simulation, at the HMCAS in the state of Qatar, was improved following tailored CPR training. The process of tailoring CPR training to promote improved acquisition and retention of knowledge and skills took into account the operational role, clinical remit and scope of practice, educational background and learner characteristics of paramedics in Qatar. Further research is required to determine the testing methods that relate classroom performance post tailored training to actual performance in the field, and to assess whether CPR performance rated as competent persists over time.

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Contributors All authors (KG, KS-H, LW and YP) have participated sufficiently in the work to take responsibility for the content. KG, KS-H and LW were involved in the study design, study protocol and writing of the manuscript. KG and YP were involved in the study implementation, data collection and analysis. All authors have reviewed, edited and approved the final submission.

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