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Preparing providers for advanced life support in the prehospital environment

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Preparing Providers for Advanced Life Support in the Prehospital Environment

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EDITH COWAN UNIVERSITY

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Declaration

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Abstract

Out-of-hospital cardiac arrest is a leading cause of death and Ambulance Victoria estimated over 30,000 cardiac arrests occur outside of hospital each year in Australia (1, 2). When an out-of-hospital cardiac arrest occurs, first responders, paramedics or other clinicians attached to ambulance, industrial or aeromedical services are often the first providers on scene with the skills and equipment to implement advanced life support (ALS). Despite the essential role of prehospital advanced emergency care in the treatment of out-of-hospital cardiac arrest, at the time this research was commenced, ALS training courses had been designed for those responding to cardiac arrests in controlled environments such as in hospitals. These courses emphasised methodology, processes and teamwork suitable for the controlled hospital environment. In contrast, prehospital clinicians typically face an uncontrolled and unpredictable environment, often working with lay responders, and with the added challenge of extricating and transporting the patient to hospital care. As a result, prehospital ALS providers were not trained in an environment that aligned with their workplace or the teams they regularly worked with. Ultimately, there is evidence that out-of-hospital cardiac arrest has a less than optimal patient survival rate when compared to in-hospital cardiac arrests (3, 4).

The aim of this research was to review the characteristics of prehospital cardiac arrest ALS and identify gaps in the current ALS training courses in relation to preparation for the prehospital environment and then use this knowledge to develop and evaluate a pilot, standardised, prehospital ALS course. In terms of the potential broader benefits to society, a standardised prehospital ALS course could enhance healthcare professional preparedness to deliver prehospital resuscitation and have positive impacts on out-of-hospital survival rates within the community.

A mixed method research design was implemented whereby both qualitative and quantitative data were collected. Using an iterative approach, a prehospital cardiac arrest ALS course congruent with the Australian Resuscitation Council (ARC) guidelines was developed, piloted, and evaluated. Finally, the course was validated by an expert advisory panel.

The implementation of a standardised, validated prehospital cardiac arrest ALS training course may assist in improving patient survival rates from out-of-hospital cardiac arrest. The prehospital course designed from this research has tailored elements of leadership, teamwork, and resource management relevant to the prehospital clinicians working environment. However, whilst this research designed and validated a prehospital resuscitation course, further work is needed to determine whether such a course has an impact on prehospital cardiac arrest outcomes.

Australian Higher Education Graduation Statement

When an out-of-hospital cardiac arrest occurs first responders, paramedics or other clinicians attached to ambulance, community nursing, industrial or aeromedical services are typically the first providers on scene with the skills and equipment to implement advanced life support (ALS). At the time this research was commenced, cardiac arrest ALS training courses had been designed and validated for controlled environments such as hospitals. In contrast to hospital-based resuscitation, prehospital clinicians face an uncontrolled and unpredictable environment, often working with lay responders, and with the added challenge of extricating and transporting the patient via road or air. This research reviewed the characteristics of prehospital ALS and identified gaps in current ALS training courses in relation to the prehospital environment, then used this knowledge to develop and evaluate a pilot standardised prehospital ALS course. A specific prehospital ALS course could enhance healthcare professional preparedness to deliver prehospital resuscitation and have positive impacts on out-of-hospital survival rates within the community.

Publication List

Appendix A: Publication Links (in order presented in thesis)

1. Reid, D., Jones, R., & Sim, M. Prehospital advanced life support education - Core components for prehospital professionals. https://doi.org/10.33151/ajp.15.1.565, *Australasian Journal of Paramedicine*. 2018;15(1).
2. Reid., D., Sim, M., Beatty, S., Grantham, H., & Gale, M. Prehospital advanced life support resuscitation – a curriculum for prehospital education. https://doi.org/10.33151/ajp.17.757, *Australasian Journal of Paramedicine.* 2020;17.
3. Reid, D., Beatty, S., Sim, M., Grantham, H., & Gale, M. Prehospital advanced life support resuscitation training: A pilot of an evidence-based curriculum. https://doi.org/10.33151/ajp.17.846, *Australasian Journal of Paramedicine.* 2020; 17.

Presentation List

1. Appendix C.1: Council of Ambulance Authorities 2016, Melbourne Australia
2. Appendix C.2: Spark of Life Conference 2017, Adelaide, Australia
3. Appendix C.3: Spark of Life conference 2019, Sydney, Australia

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Glossary of Terms

Advanced Life Support: Advanced life support is the provision of effective airway management, ventilation of the lungs and production of a circulation by means of techniques additional to those of basic life support. These techniques may include, but not be limited to, advanced airway management, vascular access, drug therapy and defibrillation (5, 6). In this thesis advanced life support focuses on the activities undertaken to restore life in a patient with no breathing and no heartbeat, i.e. in cardio-pulmonary arrest.

Healthcare Professional: Healthcare professionals maintain health in humans through the application of the principles and procedures of evidence-based medicine and caring (7). In the context of this research a 'healthcare professional' was one who is registered by the Australian Health Practitioner Regulation Agency (AHPRA) and trained to deliver advanced life support in the prehospital setting. The professions most commonly delivering prehospital ALS on a regular basis include medical, nursing and paramedic staff.

Paramedics: In the context of this research 'paramedics' refers to all clinical staff who are registered as paramedics with the Australian Health Practitioner Regulation Agency (8).

Prehospital: 'Prehospital' in the context of this research on cardiac arrest refers to any care which occurs before or during transport to a hospital (9). The term ''prehospital' can also be used interchangeably with out-of-hospital.

Out-of-hospital: 'Out-of-hospital' refers to any care provided in the community and is used interchangeably with 'prehospital' in this research (10).

Resuscitation: 'Resuscitation' is the act of attempting to maintain or restore life by establishing or maintaining airway (or both), breathing, and circulation through cardiopulmonary resuscitation, defibrillation, and other related emergency care techniques (11).

Training: 'Training' refers to the process of learning the skills needed to do a particular job or activity (12). In the context of this research 'training' refers to resuscitation education provided to paramedics including university study, courses internally delivered by organisations for employees or volunteers, and any external education provided for healthcare professionals by organisations such as the Australian Resuscitation Council.

List of Abbreviations

Abbreviation	Expansion
AHA	American Heart Association
AHPRA	Australian Health Practitioner Regulatory Agency
ALS	Advanced life support
ANZCOR	Australian and New Zealand Committee on Resuscitation
ARC	Australian Resuscitation Council
Aus-ROC	Australia and New Zealand Out-of-Hospital Cardiac Arrest Epistry
CHERRIES	Checklist for Reporting Results of Internet E-Surveys
COREQ	Consolidated Criteria for Reporting Qualitative Research
CPR	Cardiopulmonary resuscitation
DCI	Data collection instrument
ECU	Edith Cowan University
ERC	European Resuscitation Council
GRA	Global Resuscitation Alliance
HCP	Healthcare professional
ILCOR	International Liaison Committee on Resuscitation
NHMRC	National Health and Medical Research Council
OHCA	Out-of-hospital cardiac arrest
WS	Weighted Score

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Chapter 1: Introduction

1.1 Introduction

This chapter of the thesis presents an overview of the research and structure of this thesis. The research question and aims of the research will be presented. The significance of the research will be identified, and the underpinning conceptual framework outlined. The structure of the thesis, including the publications is presented.

1.2 The Question

The problem this research sought to address was:

> *How can cardiac arrest advanced life support (ALS) training be tailored for the out-of-hospital environment to reflect evidence-based educational practice and improve healthcare professionals' preparedness to deliver resuscitation in the prehospital setting?*

1.3 Research Aims

Key questions addressed by this research were:

- RQ1: What, according to the published literature, are the key components of effective ALS training?
- RQ2: To what extent did current ALS training courses reflect the actual resuscitation experiences of prehospital clinicians?
- RQ3: How should a prehospital ALS course be designed to meet the needs of prehospital clinicians?
- RQ4: To what extent did a pilot prehospital ALS training course meet participants' educational needs to deliver resuscitation in the prehospital environment?

1.4 Research Significance

The Australian Resuscitation Council has published guidelines for in-hospital resuscitation including principles for training, however none could be identified specifically for pre-hospital resuscitation (13, 14). In their review of cardiac arrest practices and challenges, Jentzer et al. identified that a standardised approach to training was an important component in improving cardiac arrest outcomes (36). Research, discussed further in this thesis, has focussed on general ALS training rather than out-of-hospital specific aspects of training.

The American Heart Association (AHA) scientific statement on resuscitation training has identified that standardised resuscitation courses do not meet the needs of prehospital learners (15), and there have been calls for national standards in prehospital resuscitation training to ensure the

resuscitation standards of prehospital clinicians are maintained at the consistent and high level required (16). This research on prehospital Advanced Life Support (ALS) training is important because at the time it commenced there did not appear to have been a specific, researched, advanced life support training course targeted at professionals working in the Australian prehospital environment. Whilst courses from the Australian Resuscitation Council (ARC) and AHA existed and were well validated, the simulations largely focussed on a facility-based environment with multiple resources, such as a hospital. Ambulance services also provide training for prehospital resuscitation however, to date, such training has varied between providers.

The importance of prehospital resuscitation is highlighted by the poor patient outcomes in this setting. Ball et al. identified that delays to high-quality ALS in Victoria may have contributed to a 50% reduction in survival-to-discharge rates for out-of-hospital cardiac arrest, although this result occurred during a public health (specifically a pandemic) emergency (17). Other studies reported that survival to discharge rates for out-of-hospital cardiac arrest patients were around half or less than half of patients suffering a cardiac arrest in-hospital (3, 4). Factors affecting survival of patients are many and multi-factorial. Factors such as patient age, functional status, presenting rhythm, co-morbid disease have all been identified as influencing factors on the outcomes from cardiac arrest (18, 19). In the prehospital environment, early bystander cardiopulmonary resuscitation has been identified as an influencing factor on patient outcomes (20). Studies show that survival to discharge from out of hospital cardiac arrest vary widely (21). The chain of survival in cardiac arrest demonstrates the links which are required in a system to achieve positive patient outcomes. Maximising the efficiency of these links has been shown to improve patient survival (22, 23). As a key component of the chain of survival it is critical that prehospital clinicians are well prepared to perform resuscitation in the environment in which they are required to work in order to maximise the opportunity for positive patient outcomes. At the time of writing this research was unable to find comprehensive published standardised content guidance for pre-hospital cardiac arrest ALS courses. This research sought to address that gap and develop a standardised pre-hospital cardiac arrest ALS course which could be taught across pre-hospital providers. The focus of this research was on the core components of prehospital ALS training in the out-of-hospital setting Out of scope in this research was the review and analysis of what skills should or should not be undertaken by paramedics as part of ALS training, for example, endotracheal intubation. The skills included in ALS has been the subject of conjecture and is ongoing as new equipment and techniques are introduced to the prehospital setting (24). For the purposes of this research ALS included all those skills which were additional to the basic life support skills of chest compressions, automated defibrillation (AED) and ventilation using non-invasive techniques such as a bag-valve-mask..

1.5 Conceptual Framework

The design of this research was based on an interpretivist paradigm in which reality is constructed based on an individual's perception of the world (25). People interpret events differently and have multiple perspectives based on their own experiences. In the context of prehospital resuscitation training, participants in this research had varying opinions on the need, content, and timing for a prehospital ALS training course. These opinions were based on participants' own experiences of training and implementation of that training in real resuscitations. It was therefore important to ensure that a range of participant groups were included in the research to capture a variety of views to have an evidence base for the importance, design, and implementation of a prehospital ALS training course.

1.6 Thesis Outline

This thesis is presented as a series of published papers outlining the development and evaluation of a prehospital ALS training course. The first article analysed current ALS training for prehospital clinicians from two perspectives: the literature, and the views of prehospital clinicians. It collated data on the lived experiences of prehospital clinicians and whether ALS courses reflected their requirements of resuscitation in the prehospital environment. This article outlined the core components of prehospital resuscitation based on the literature review and a survey of prehospital clinicians.

The second article produced an evidence-based curriculum to bridge the gap between current ALS courses and the lived experiences of respondents, based on a follow-up clinician survey, interviews, and advice from an Expert Panel. It described the recommended design of a prehospital ALS resuscitation course, including high-quality resuscitation techniques through a 'pit crew' approach and the Global Resuscitation Alliance's 'Ten Programs' for improving survival from cardiac arrest (26). The third article evaluated a pilot prehospital ALS resuscitation course based on evidence from the first two papers. A flow diagram detailing the questions addressed in each paper is presented in Figure 1.1.

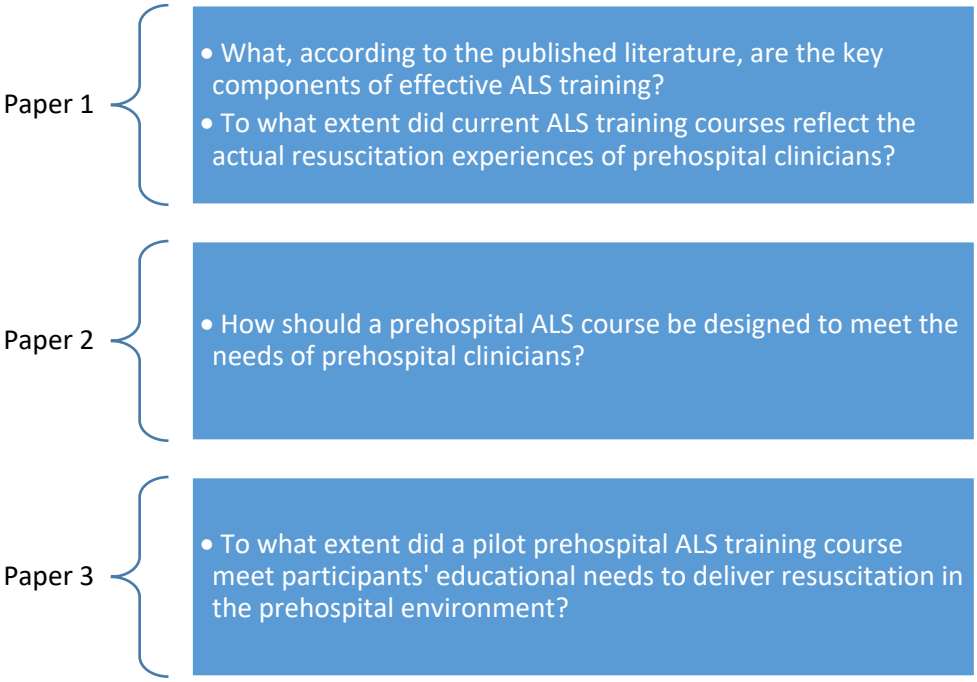


Figure 1.1: Relationship between published papers and key questions

1.6.1: Chapter 2 Literature Review

The literature review builds the context of the thesis through a comprehensive background review of issues related to resuscitation and training identified in published research. The literature review identified that the prehospital environment is different to the facility or in-hospital based environment and that training should reflect, as much as possible, the environment in which participants work.

1.6.2 Chapter 3 Research Design

The approach to the research utilised a mixed method research design within an interpretivist paradigm. The research took place across three stages and involved consultation with prehospital clinicians, academics, and an Expert Panel of clinicians with experience in the prehospital ALS environment. Phase one involved a literature review and clinician survey. Phase two included a follow-up survey and interviews with prehospital clinicians. The final phase of the research involved piloting a prehospital ALS course which was designed based on the findings from the first two research phases.

1.6.3: Chapter 4 Publication One

Prehospital advanced life support education – core components for prehospital professionals

This paper explored the literature on ALS training and reported the results of an international survey undertaken to identify the lived experiences of resuscitation by prehospital clinicians. The training elements which differ in the prehospital setting compared to the healthcare facility setting were

identified by survey respondents. The online survey on ALS training was developed to examine the lived experiences of prehospital clinicians in resuscitation training; comparisons of training scenarios, equipment, and human factors to respondent's actual resuscitation experience; and workplace implementation of the providers' resuscitation skill set.

1.6.4: Chapter 5 Publication Two

Prehospital advanced life support resuscitation – a curriculum for prehospital education

This paper described the development of a curriculum for ALS resuscitation training for providers working in the prehospital or resource-limited settings. The focus on prehospital ALS training was important because actions taken by prehospital clinicians have a critical impact on the likelihood of patient survival. The prehospital ALS curriculum development described in this paper was derived from data collected utilising a follow-up survey and semi-structured interviews with prehospital clinicians, and guidance from an Expert Panel of resuscitation, medical and education experts.

1.6.5: Chapter 6 Publication Three

Prehospital advanced life support resuscitation training - a pilot of an evidence-based curriculum

The third paper outlines the results of a pilot ALS resuscitation training course for prehospital clinicians. Prehospital ALS course design was completed as part of the previous paper, and the third paper presented the results of the pilot prehospital ALS course design. This third paper focussed on analysing participants' feedback in relation to the applicability of the pilot course to their working environment, and whether it bridged the gaps identified in Paper One of this research.

1.6.6: Chapter 7 Discussion

Chapter seven provides an overall synthesis of the results presented in the literature review and of the three published papers, integrating the major findings from each paper and suggesting further research opportunities. Limitations of the research are also discussed in this Chapter.

1.6.7: Further Research and Conclusion

The final Chapter addresses opportunities for further research and provides recommendations for prehospital ALS training.

1.7 Thesis as a Series of Papers

Edith Cowan University (ECU) supports a Thesis with Publication as a combination of publishable work based on original research and a substantive written, integrating component (27). ECU's Postgraduate Training Policy (28) outlines that the submitted thesis can consist of publications that have already been published, are in the process of being published, or a combination. The policy also

states that the candidate should be the first author with a contribution of at least 50% to each publication. This research meets the ECU policy.

The structure of submission with publication structure has been adopted by the candidate in the submission of this thesis. As such, while the theoretical linking between the studies/papers should be clear for the examiner, each study must be stand-alone in content. Consequently, theses adopting a series of papers approach sometimes result in repetition of literature and methodology from study to study.

1.8 Conclusion

This chapter has provided an overview of the thesis structure and outlined how a thesis by publication is presented. This chapter has outlined the research question, and the aims of the research. The conceptual framework for the research and the research design has been presented. A summary of each of the published papers has been provided. In the next chapter the literature review will be discussed.

Chapter 2: Literature Review

2.1 Introduction

The previous chapter outlined the research question and aims of the research. The conceptual framework and a summary of each of the articles was also provided. This literature review outlines the good practice elements of resuscitation education as identified from the published literature. This chapter outlines the methodology used for this review and the search strategy. This chapter identifies what the literature has found in relation to cardiac arrest outcomes, and how the prehospital environment differs from that of the in-hospital environment. The identified core components of good practice resuscitation education are then examined, including course delivery, simulation, human factors, and competency assessment, ready for implementation back in the workplace. Publication One then consolidates the literature review, evaluating the gaps between the literature and actual prehospital practice, then proposing core education components to improve prehospital ALS training.

There are a number of types of reviews (29) when examining the literature, and these include a critical review, literature review, systematic maps and meta-analysis (29). Sub-set within literature reviews include narrative, scoping, systematic and umbrella reviews (30-32). Based on Pare's work the literature review for this study is best described as a descriptive review, as shown in Table 2.1.

Literature Review Component	This Review
Overarching goal	Summary of prior knowledge.
Scope of review	Broad review across the literature.
Search strategy	Representative of the literature on resuscitation including in-hospital and out-of-hospital resuscitation.
Nature of primary sources	Empirical outlining observations, experiments, and verifiable evidence.
Explicitness of study selection	Yes, based on resuscitation themes.
Quality of studies	Non-empirical research was excluded from the study. Research quality was based on the credibility of the journal, dependability, reliability, and transferability of the research conducted.

Literature Review Component	This Review
Methods of analysis	Content analysis based on findings within and between studies reviewed.

Table 2.1: Literature Review Components

Source: Pare (30)

The descriptive literature review was appropriate for this research because it sought to identify any patterns and trends in pre-hospital resuscitation training. The descriptive literature review was also appropriate because it sought to form a representative sample of findings from the larger group of published works and identify specific areas of interest for investigation. In this case the areas of interest specifically related back to the core research questions:

- RQ1: What did the literature identify as the core components of resuscitation education?
- RQ2: Was there any literature that explored pre-hospital clinicians' experiences of training vs actual resuscitations?
- RQ3: What did the literature identify as the components of a pre-hospital ALS course?
- RQ4: Was there any literature which explored candidates' experiences of prehospital resuscitation courses?

This research searched for qualitative, quantitative and mixed-methods studies on prehospital and general resuscitation training. The literature reviewed as part of this research was limited to published literature including peer-reviewed publications, conferences proceedings and guidelines. The inclusion criteria included peer-reviewed studies concerning cardiac arrest resuscitation, including prehospital resuscitation and training. Excluded were case studies, editorials unless directly referenced to a peer-reviewed article, and purely technical papers.

The literature was sourced from electronic sources. To facilitate the literature review conducted in late 2016, The ECU World Search database, containing 291 academic databases including ProQuest, MEDLINE, PubMed and Embase, was used as the primary search engine. Initially article titles were reviewed for relevance, and those that did not resonate with the research question were discarded. The abstracts of the remaining articles were read and those that did not reflect the research question were rejected. Finally, the full content of the remaining articles was reviewed, and only those that would likely enable the research question to be answered were retained for quality appraisal.

The logic grid classified search terms or synonyms used for the literature search. These search terms were identified from and related to the research question, and examples are provided in Table 2.2 following.

Populations	Phenomenons of Interest	Context
Resuscitation Education	Advanced life support Prehospital Out-of-hospital Paramedic Ambulance Resuscitation training Human factors Resuscitation simulation	ALS (Advanced Life Support) CPR (Cardio-pulmonary resuscitation)

Table 2.2: Logic grid and search words

Boolean operators were applied between keywords and categories for each search completed. A series of MeSH terms were identified and used in the literature search. The search strategy is summarised in Table 2.3 below.

Category	Search Words
Resuscitation Search #1	**MeSH** Cardiopulmonary resuscitation OR Resuscitation OR Out-of-hospital Cardiac Arrest OR Cardiac arrest. **Other Terms Used** Out-of-hospital cardiorespiratory arrest OR Sudden death OR OHCAOR resuscitation OR CPROR cardiopulmonary resuscitation.
Prehospital Search #2	**MeSH** Emergency Medical Services OR Emergency medical technicians OR Ambulance. **Other Terms Used** Paramedic OR Prehospital OR pre-hospital OR out-of-hospital OR out of hospital OR EMS OR paramedic OR emergency medical technician OR EMT OR prehospital care.

Category	Search Words
Education Search #3	**MeSH** Education OR Competency-based education OR Patient simulation OR Problem-based learning OR Computer-Assisted instruction OR Professional competence OR Clinical competence. **Other Terms Used** Training OR Simulation OR Clinical education.
Search Strategy Resuscitation + Out-of-Hospital	#1 AND #2
Search Strategy Resuscitation + Education	#1 AND #3
Search Strategy Out-of-Hospital + Education	#2 AND #3

Table 2.3: Search Strategy

The searches were limited to articles published in the English language between 1987 and 2016, with further articles reviewed and incorporated into the research during the publication phases of the research from 2017-2021. The search inclusion and exclusion criteria are defined more explicitly in Table 2.4.

Inclusion Criteria	Exclusion Criteria
Peer reviewed journal articles	Non-reputable or non-peer reviewed articles Case studies Commentary Purely technical papers (for example scientific debate on drug doses)
Articles written in English	Articles not written in English
Literature with concise titles and abstracts relevant to the research	Literature with ambiguous or vague titles and/or abstracts

Inclusion Criteria	Exclusion Criteria
Method considered rigorous and well defined with sufficient participant numbers	Method poorly described with few participants
Discussion and conclusion well defined and argued	Discussion and conclusion considered to be written to fit the initial objective/hypothesis and not the results as found
Articles able to generally clarify research thesis topic; found via search keywords	Articles considered too general after reading abstract and articles where necessary
Specific to literature review chapter: Articles able to help identify and clarify research questions	Articles with some relevance to resuscitation but not sufficiently specific to clarify research questions
Where the article included review and/or analysis of resuscitation factors including training and/or performance	Articles which specifically focussed on the technical aspects of resuscitation such as medication dosages or timing of medications
Literature which related directly to the search question	Literature which was considered minimally relevant to the search questions

Table 2.4: Inclusion and exclusion criteria for the initial literature search

The research literature retained for quality appraisal as a result of the steps reported above could be categorised as primarily qualitative in nature, and as such was assessed using the Standards for Reporting Qualitative Research (SRQR) (33). The COREQ checklist and the Mixed Methods Appraisal Tool (MMAT) were also used to identify papers of quality (34, 35).

The risk of bias is inherent in all literature reviews, and in this research study bias was reduced through a peer review process for each published article. Further, the candidate assessed the literature proposed for inclusion in the research: first by title relevance and then by abstract significance to the search question and, by extension, the candidate's research. Lastly the full articles were read by the candidate and then appraised for quality using the SRQR and/or COREQ checklist. Following assessment, an initial early supervisor for this research then reviewed the literature reviewed and either concurred with the researcher's assessment or provided an alternative view.

At the end of this research, from an initial search strategy yielding over 74,000 articles, 212 relevant articles had abstracts were reviewed for inclusion in the research. Figure 2.1 shows the breakdown

of articles reviewed for this research based on the primary nature of the article and key aims from the article. Whilst there was crossover between categories within articles, articles have been classified based on the main aims of the research questions in the article to avoid double-counting. Articles excluded from the research, not reflected in the figure below, were those which focussed exclusively on technical aspects of ALS such as the relative merits of various pharmacologies of ALS medications, or the specific processes used to perform skills such as intubation.

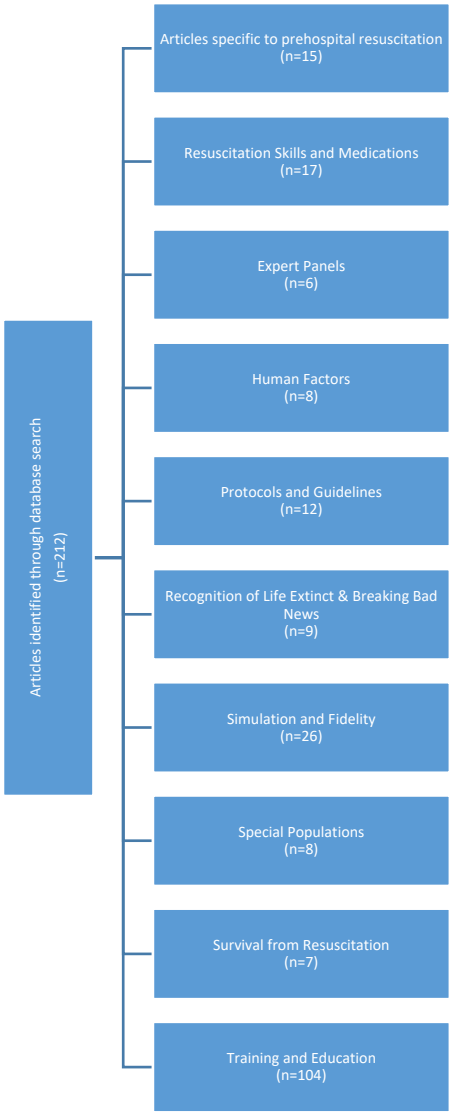


Figure 2.1: Review Articles

Articles were analysed in a systemic manner (36) using the Standards for Reporting Qualitative Research (SRQR) (33), the COREQ checklist to identify papers of quality (34) or Mixed Methods Appraisal Tool (MMAT) (35) . Each article was reviewed for its relevance to resuscitation, the quality of the study and any limitations, analysis conducted, and conclusions reached by the authors. Articles were then examined for common themes to identify trends across the resuscitation

literature. Following the review, implications for prehospital clinicians were identified for inclusion in this research.

2.2 Resuscitation Outcomes

The poor outcomes associated with out-of-hospital versus in-hospital cardiac arrest was the first major theme to emerge from the literature (37). Outcomes from out-of-hospital cardiac arrest are important to understand because they provide direct evidence of the need for research in the prehospital environment to address an inequality that exists. The Australia and New Zealand out-of-hospital cardiac arrest epistry (Aus-ROC) estimates that across Australia and New Zealand there was a crude incidence rate of 102.5 out-of-hospital cardiac arrests per 100,000 head of population (38). In retrospective data analysis studies undertaken by Andersen et al., focusing on over 290,000 cardiac arrests in the USA, and Cavallotto et al. in a conference report, on over 1,860 cardiac arrests in Belgium, the survival-to-discharge rates for out-of-hospital cardiac arrest patients were around half or less than half of patients suffering a cardiac arrest in-hospital, with in-hospital cardiac arrest survivability being 23%-25% and out-of-hospital cardiac arrest being between four per cent and 12% (3, 4). In a retrospective review of paramedic response outcomes over six years using data recorded in the Utstein style, Handel et al. reported that only 14% of patients were discharged from hospital alive (39, 40). Furthermore, no patients survived beyond the emergency department unless they had a return of circulation prior to hospital arrival. While there are different measures and circumstances across countries it is clear that out-of-hospital arrests are consistently associated with worse outcomes than in-hospital arrests. The ARC recommends that all clinical staff should attend a multidisciplinary resuscitation program, and that those staff working in speciality areas should be trained in the specific aspects of resuscitation relevant to their working environment (14).

2.3 Out-of-Hospital Environment

The second theme to emerge from the literature review undertaken for this research was that the out-of-hospital resuscitation environment was significantly different to that of in-hospital resuscitation. A key differentiator of the out-of-hospital environment in comparison with the hospital environment is the usual absence of trained healthcare professionals at the time that a cardiac arrest occurs (41, 42). This means that usually, lay responders often deal with cardiac arrests initially in the out-of-hospital setting, followed by teams of professional ambulance staff who attend later, each of whom may implement a different approach to managing the out-of-hospital cardiac arrest (43-45). By contrast, in-hospital cardiac arrests have rapid access to teams of medical and nursing professionals to resuscitate the patient following established protocols, backed up by allied health providers such as social workers to assist the family.

In addition to differences in environment between in-hospital and out-of-hospital there is also a difference in the type of cardiac arrests experienced in hospital compared to that experienced out-of-hospital. In-hospital cardiac arrest generally occur in people with known risk factors and medical conditions. By contrast, out-of-hospital cardiac arrest is often sudden in nature, and can be as a result of a variety of unknown causes (46). Out-of-hospital responders are typically generalists at resuscitation, and able to deal with a variety of causes, both medical and traumatic across the lifespan. In-hospital providers can specialise depending on the area in which they work, for example paediatrics, trauma units, or cardiology.

Other differences identified from the literature in terms of the environment in which out-of-hospital and in-hospital cardiac arrests occur have included that out-of-hospital cardiac arrests typically involve challenges in team composition, lighting, as well as access to and extrication of the patient, including movement on a stretcher (16, 47). Thus, prehospital resuscitation was reported to be more challenging than that which occurs in hospitals which have known teams, good lighting, specialised patient beds, suitable access, and only require movement inside buildings (16, 47). To address the challenge of the out-of-hospital environment it is necessary to identify the core components of resuscitation training that are most important and will maximise the potential for a positive patient outcome. These studies were based on descriptive reports and data collected from Australia, UK, and the USA, which although operating slightly different prehospital emergency medical systems, all provide a tiered approach including first responders, ambulance officers and paramedics.

2.4 Core Components of Resuscitation Training

There are core components of resuscitation training which have been shown in the literature to be important, no matter the environment in which the resuscitation is taking place. In their review of cardiac arrest practices and challenges, Jentzer et al. identified that the entire chain of survival, including prehospital skills and therapies, post-resuscitation treatment and a standardised approach to training were all important components to improving cardiac arrest outcomes (48). Other research has identified that ALS training is an important aspect of improving the outcomes from cardiac arrest, although a large focus in the literature was on general ALS training rather than out-of-hospital specific aspects of training. Perkins et al., in their randomised control trial of 572 participants, concluded that training interventions were one of the key attributes in improving outcomes from cardiac arrest (49). According to Williams' literature review of ALS training and assessment, the European Resuscitation Council (ERC) identified the aim of training interventions in resuscitation as being to "ensure that learners acquire and retain the skills and knowledge that will enable them to act correctly in actual cardiac arrests and improve patient outcomes" (50 p.243).

Across the literature there was a consistent suite of themes identified in relation to the core components of any resuscitation training. These themes, discussed in the following sections, were that training could consider the use of e-learning however should involve a face-to-face component (49, 51-54); training should be realistic and relevant (55-57); training should involve the use of simulation (58-64); human factors are an important consideration (65-69); and competency assessment is required to ensure participants are ready to implementation the training when back in their workplace (50, 66, 70-82).

2.4.1 Delivery Methods

The literature identified that resuscitation education can be delivered in several ways, including face-to-face or online, over a range of timeframes, including multiple short sessions through to one or two-day courses. The ARC delivers one and two-day ALS courses in an interdisciplinary face-to-face modality, with pre-reading provided to students prior to courses (83). In an accelerated learning approach for nurses, implemented by Keys et al., the authors identified that, for many nurses, a cardiac arrest on a ward was a rare event (80). the authors concluded that formalised training may not be associated with the best learning outcomes and retention of knowledge for all nursing staff. The authors implemented an approach incorporating the principles of accelerated learning in the ward environment, rather than a training room, over an extended period. Following scenario-based training, the educators followed up on the wards providing random cardiac arrest drills to embed the learning already carried out. Keys et al. concluded that their approach improved performance, enhanced readiness and increased nurses' confidence when dealing with a cardiac arrest.

A similar study was carried out by Kurosawa et al., who implemented a randomised control trial of paediatric ALS which compared a traditional intensive paediatric ALS training course with learning modules spaced over time, provided on the nurses' ward over six sessions, held over six months (81). The authors found students performed better in their simulation examination after modular training compared to a standard course. However, behaviour, confidence and satisfaction did not show any significant difference between the two approaches.

Another study by Ko et al., involving third-year medical students, compared a two-day course (21 students) to a two-week (29 students) longer simulation course (73). The authors found the longer course approach to teaching advanced cardiac life support was as effective as a traditional shorter course approach. Student satisfaction was higher in the longer course and the authors concluded that longer training was particularly useful because it allowed an opportunity for students to practise in between formal sessions, thus embedding their learning.

A modular approach to learning advanced cardiac life support has also been trialled by the AHA. In a small study by Darr, which examined a self-directed, scenario-based course, it was suggested that a modular approach, which included short face-to-face or recorded lectures, nine case-study based modules, a 90-minute practical simulation session and interactive computer-based assessment resulted in fewer hours per student and higher pass rates when compared to a traditional two-day lecture and simulation course (82).

The ARC delivers ALS courses in a face-to-face modality, with pre-reading provided to students prior to courses (83). However, various factors, including time-poor clinicians, disparate locations, and an increased desire for self-directed learning have led to the introduction of computer-aided learning or augmented reality as either an adjunct to, or replacement for, face-to-face training in some courses (49, 51-54, 65, 84). In a review of a newborn life support training course, Lumsden identified that a mix of theory lectures and simulation worked best when educating midwifery students about newborn resuscitation compared to theory lectures only (84).

Lau et al., in their systematic review and meta-analysis of 20 randomised control trials across 13 countries of digital resuscitation courses, concluded that although more long-term follow-up was required, online resuscitation courses may be suitable for basic life support and suitable as one component of ALS courses which blend both online and face-to-face learning (51). Perkins et al., in their randomised study of 572 candidates examining the relationship between the use of e-learning simulation prior to attendance at an ALS course and subsequent candidate performance, identified that blended learning, which included computer-based simulation, resulted in improved theoretical knowledge, but did not improve cognitive or psychomotor skills. From the research reviewed (49, 53, 54), the preference was that computer-aided learning be an adjunct to, rather than a replacement for, hands-on, instructor led training (49, 53, 54).

The evidence for e-learning improving psycho-motor competency outcomes at the end of ALS courses appeared to be variable. The literature indicated variously that e-learning could reduce the pass rate of students, result in no difference, or improve their competency at the assessment stage (49, 53, 54, 65, 85). In a randomised control trial of doctors over four years, Low et al. compared the competency of junior doctors using a phone-based resuscitation app during a mock cardiac arrest against those who did not use the app (65). Use of an app during the scenario improved overall performance. They concluded that, combined with feedback devices, the use of cognitive aids may improve patient outcomes in real cardiac arrest situations. Although the literature is variable on the benefits of computer-based training in relation to competency outcomes, computer-based training may improve resuscitation training effectiveness. A randomised study with medical students

conducted by Bonnetain et al., identified that computer-based learning, when compared to traditional learning, was as effective in assisting medical students in their preparation for simulation training (54). The authors concluded that the reason computer training was useful was because it assisted learners to memorise procedures prior to hands-on training sessions. However, Perkins et al., in a multi-centre randomised control trial of 572 participants, concluded that distributing an e-learning package prior to attending a course did not improve either cognitive or psychomotor skills during the actual course itself, recommending that e-learning was a potential inclusion as part of a blended learning approach but would be unsuitable as a replacement for face-to-face learning (49).

In a randomised control trial of blended learning across 3,732 participants, Perkins et al. examined the efficiency of cardiac arrest training, comparing a one-day blended e-learning/face-to-face course and a two-day 'traditional' face-to-face only course (85). Although both groups performed equally well on the theory tests, students who studied via the e-learning route and then went into one day of practical scenarios, performed worse than those who did a two-day face-to-face lecture/simulation course. When the data from the students were analysed, it demonstrated that the e-learning approach meant one additional person failing the course for every 39 participants. These authors concluded that e-learning did not allow for the same level of teamwork to be practised compared to the traditional face-to-face course. Although they identified the e-learning approach was cost effective, the cost effectiveness needed to be considered against the value placed on hands-on training.

Contrasting Perkins' et al. conclusion that e-learning resulted in poorer psycho-motor outcomes when compared to traditional face-to-face learning, was a study of final year medical students completed by Christenson et al. (53). In their study, the authors compared students randomly allocated to a multimedia ALS learning system against those who completed a traditional face-to-face course. Christenson et al. found there was no statistical difference in the final evaluation in the management of a patient between those who had completed the computer-aided training against those who had completed a standard face-to-face lecture approach. However, a greater proportion of students who undertook the computer-aided learning required retesting to pass the psycho-motor element of the course, which suggested that face-to-face teaching may result in improved 'first pass' results. Christenson et al. concluded the need for retesting was because students required additional familiarisation and training time on the manikins, which face-to-face learners had already experienced as part of their course.

The factors influencing the introduction of e-learning, including time-poor clinicians, disparate locations, and an increased desire for self-directed learning, need to be balanced against the psycho-motor competency outcomes required from an ALS course. Whilst the literature appears to support e-learning as a suitable alternative for theory learning, the research tends to suggest that face-to-face training is superior in relation to psycho-motor skills and ensuring maximal first-pass rates for students. As part of the face-to-face component, simulation was identified in the literature as an important component of ALS training.

2.4.2 Simulation

It is not possible to ethically train students when a real cardiac arrest is occurring because the outcome if mistakes are made can result in a patient death. The literature on resuscitation training identified that training should be realistic and conducted in environments that the student was likely to encounter, using simulation to ensure patient safety (55-57, 86). Simulation is one way of increasing the authenticity of training, allowing mistakes to be made in a safe, but realistic, environment.

Gokhale et al. in their study of fifth year medical students' resuscitation training, identified that simulation is an important teaching methodology in healthcare because it allows for a realistic yet safe environment in which to practice both technical and non-technical skills (87). Ko et al., in their comparison of two-week workplace-based simulation training to a two-day classroom-based course, concluded that, for both timeframes, simulation allowed for interactive learning without the risks associated with learning on 'real' patients (73).

In a literature review examining the effectiveness of ALS training using learner-centric techniques, Kidd and Kendall concluded that competency-based training, combining theory and practical skills, was needed in resuscitation training (88). Kidd and Kendall also identified that realism in training was vital, and that instructors should create scenarios which reflected the learners' own environment. In their review of in-situ simulation training programs and their results, Kurup et al. identified that the workplace environment was going to be different for students on the same resuscitation course, in particular where courses were multidisciplinary in nature (56). Engstrom et al. identified in their randomised control trial of prehospital healthcare simulation, that immersion needed to be contextualised to the student's workplace environment (86).

Lumsden found as part of a literature review on newborn life support courses, that students welcomed simulation and rehearsal of skills in a realistic simulation environment prior to consolidation in a clinical area (84). The conclusion drawn was that simulation in an environment like that in which the students performed the skills, enhanced learning without endangering the life of

real patients. In a longitudinal survey study of cancer care nursing staff in an outpatient setting, Scaramuzzo et al. recommended that simulated cardiac arrests should be conducted in the workplace as a means of improving practitioner skills (89).

The simulation environment can be either high or low-fidelity and the literature appeared to present mixed evidence for the benefits of each in the healthcare environment There is a difference between physical fidelity, or 'look' of a simulator, and functional fidelity, or what the simulator does (90). The literature identifies that low-fidelity refers to the basic look of simulators, where high-fidelity refers to the functionality of the simulator (90). An example is resuscitation mannikins. A low fidelity mannikin may look like a person but have no internal electronics to simulate patient sounds, cardiac rhythms, or vital signs. A high-fidelity mannikin may look like a real person and additionally, is able to make sound, generate cardiac rhythms and provide vital signs such as pulse or breathing.

Although learners prefer it, there is mixed evidence as to whether high-fidelity is needed as a component of simulation. Williams et al., in their literature review of ALS training and assessment, concluded that there was no difference in post-course psycho-motor competency between students who had training using low or high-fidelity simulation (50). Davis et al., in their randomised control trial of pharmacy students attending classroom lectures and high-fidelity simulation for advanced cardiac life support training, concluded that theoretical knowledge and psycho-motor skills were enhanced when simulation followed lectures, and student satisfaction was higher when using high-fidelity simulation (63). These authors also identified that high-fidelity simulation resulted in higher levels of confidence in skills. Langdorf et al., in their review of a new ALS delivery method to postgraduate medical students involving 12 hours of didactic time and eight hours of experiential time, concluded that in an intensive, advanced cardiac life support training course, the use of a high-fidelity manikin improved performance and was preferred by students (91). An experiential study by Hoadley that randomised healthcare workers to either high- or low-fidelity simulation, identified no statistical difference in terms of knowledge between the groups in terms of skills learned, written satisfaction, or self-confidence (92). The authors concluded that high-fidelity training did not produce higher gains than the low-fidelity training. After conducting a series of simulations of trauma-team training, focusing on non-technical skills, Gjerra, Moller and Ostergaard identified that amongst paramedics, nurses and physicians, the use of high-fidelity manikins increased realism and increased student confidence and communication skills (66). However, the authors could not conclude whether high-fidelity simulation improved patient outcomes when compared to low-fidelity simulation.

It has been recommended that the use of simulation for training purposes should align with the reality of resuscitation. Krogh et al., in their randomised control trial of simulation using realistic ALS timing using fourth year medical students, identified that in simulation-based training, timing was often shortened to increase the number of scenarios (93). Students who were made to conform to the actual recommended two-minute cycle during training performed better, at a statistically significant level, than those who had the cycle shortened, measured using the ERC Cardiac Arrest Simulation Test. Krogh et al. concluded that realism in training, including timing, was important so that students, when faced with real resuscitations, did not have a skewed perception of time.

It is important that once students complete an ALS course, they need to retain the knowledge for implementation back in the workplace. A randomised control trial of nursing students using either high- or low-fidelity equipment, by Aqel et al., examined students' knowledge and skill retention (94). Across 90 nursing students, both groups had similar levels of knowledge at the end of their course, and both groups demonstrated a loss of knowledge by three months after the training. However, at three months post training, the high-fidelity group had relatively greater retention of knowledge and skills than the low-fidelity group. Aqel et al. concluded that there was value in high-fidelity training in relation to knowledge retention.

The financial cost of high-fidelity simulation is significant and Williams, in a literature review of ALS training and assessment, concluded that the small learner improvements demonstrated from the use of high-fidelity simulation may not outweigh the financial investment needed (50). Bredmose et al., in their explanation of outdoors simulation training over two years in a helicopter emergency service, concluded that low-fidelity simulation equipment was generally acceptable in the prehospital environment, as the cost of high-fidelity was prohibitive (55).

Although there did not appear to be research that has directly demonstrated improved patient outcomes from simulation, in a workplace setting, the benefits from simulation training can include increased confidence, improved psycho-motor skills as well as human factors and scene control skills, which are all important during an ALS resuscitation situation (66). Weersink et al. in their study of ALS training for emergency residents in a hospital, identified that simulation in the workplace setting statistically improved the participants' competence for implementation in a clinical setting (95),. Ko et al., in their comparison of a two-week workplace-based simulation-based training with a two-day classroom-based course, concluded that, based on self-reporting from participants, the students trained in the workplace environment were better prepared and more confident to run an ALS resuscitation (73).

Bredmose et al., described their use of outdoor simulation for medical and paramedical helicopter medical crew in Scandinavia and London Helicopter Emergency Medical Services over a two-year period, and identified that the use of workplace-based scenarios enabled crews to develop crew resource management skills, extrication, experience handling unsafe scenes, and administering clinical care in uncontrolled environments (55). Whilst not directly reviewing ALS, these results reinforce the findings of Engstrom et al. who, in their randomised control trial of prehospital healthcare simulation, identified the entire prehospital emergency call involved a myriad of factors, including clinical decision making, extrication, care and leadership (86). These elements form components of human factors also identified as important in the literature.

2.4.3 Human Factors

The role of human factors previously identified in aviation research has become increasingly recognised in medical care and, in particular, in those situations that are high-stress or high-risk for the providers and/or patient, for example, anaesthesia (96-99). Human factors are also referred to as 'non-technical skills'. According to Gjerra, Moller and Ostergaard, in their study on trauma-based simulation, human factors are the cognitive, social and personal skills that completement technical skills. These authors identified that human factors could include elements of situational awareness, decision-making, communication, teamwork, leadership, and management (66).

In a randomised controlled trial examining intubation, Low et al. found a disparity between resuscitation theory and its practical application and concluded that the reason for disparity was largely based on human factors including leadership and poor delegation as examples (65). Likewise, in their commentary on out-of-hospital cardiac arrest, Dagnell et al. identified that non-technical skills such as leadership, teamwork and communication are core elements of resuscitation training (100). In a study by von Wyl et al., 30 paramedics were rated for non-technical skills during a simulated emergency training scenario. Six non-technical skills including leadership, delegation, team leader and member communication, responsibility and teamwork were evaluated (101). The results of the study showed there was a positive correlation between technical and behavioural performance, thus underlying the importance of human factors as part of resuscitation training.

A study by Husebo et al. that examined nursing students' coordination during 28 simulated cardiac arrests, concluded that communication was critical during resuscitation (67). These authors identified that communication failures were a core failure of coordination and were responsible for up to 70% of all errors made during resuscitation. They also identified that in a resuscitation situation, which is a critical event, coordination within teams needed to be explicit, and a positive patient outcome was supported by multiple modes of communication. In another study reviewing

the implementation of resuscitation guidelines in a tertiary paediatric hospital using high-fidelity simulation across a multi-disciplinary team, Birkhoff and Donner identified that communication errors occurred 100% of the time in mock paediatric cardiac arrests (76). Verbalisation of plans in out-of-hospital cardiac arrest was found by Marzuki et al. to be particularly important in the first five minutes (102).

The importance of effective communication has been highlighted as an important human factor in the research relating to resuscitation. In a study of resuscitation training using simulation with 222 nursing and medical students, completed by Dagnone et al., inter-professional training, focusing on teamwork and communication improved the confidence of the students, and participants reported a positive attitude to inter-professional working (68). In an experimental crisis simulation study examining student acquisition and retention of teamwork and communication skills, by Garbee et al., communication was improved amongst a group of interdisciplinary students using crisis management principles and simulation (69). Over the course of a year these authors found training and professional structures were broken down, and, using a communication and teamwork skills assessment instrument, observed behaviours improved, which translated to improved resuscitation processes.

2.4.4 Competency Assessment and Skills Decay

Training decay, or candidate ability to retain the knowledge and skills learned, was also identified as an issue in the literature, and reducing the likelihood of decay competency assessment was identified as a core component of ALS resuscitation training (62)(103). The ARC recommends that competency assessment be included in all resuscitation courses (104). Gjerra, Moller and Ostergaard identified, in their systematic review of trauma resuscitation training, that Kirkpatrick's Four-level Model could be used to evaluate learning (66, 105, 106). This may be a suitable model to include in prehospital resuscitation courses because it included reaction (participant satisfaction), learning (knowledge, skills, and attitudes), behaviour (translation of learning to clinical setting) and patient outcomes.

Based on the recommendations of international and Australian resuscitation bodies (104), most resuscitation courses involve both a theory and practical (i.e. generally competency-based) examination. Williams, in a literature review of resuscitation training and assessment, identified that even with specific practical tools there was variability in pass/fail results, as examiners implemented such tools in a variable manner (50). Additionally, the authors noted that a good result on a theoretical assessment did not consistently translate into the same level of competency in a practical scenario. The authors' findings reinforce the need for both theory and practical

assessments in resuscitation training courses. Further, practical assessments should be designed so that there is minimal variation in how candidates are assessed and marked in terms of their competency. That is, practical assessments should seek to maximise reliability (42).

In a systematic review on retention of adult ALS knowledge, Yang et al. identified that maximising outcomes from cardiac arrest required those performing resuscitation to retain the knowledge from that training (77). Regular assessment should also address the issue of skills decay, which occurs when practitioners are not regularly using the skills taught on an ALS course. The literature reviewed indicated that practical skills decay begins immediately after a course is completed and continues at a rapid rate, with noticeable impairment present at three months post training (75). A literature review by Williams examining ALS certification and course content, found evidence that only 31% of those resitting an examination and skills test after three months post-training passed the examination (50).

The ARC recommended "regularly" (50 p.244) updating resuscitation skills. Other authors have identified a need for updates every six months although Yang et al., in their systematic review of retention of ALS knowledge and skills, found some guidelines that recommend retraining every two years or more (16, 77). Yang et al. further identified healthcare staff regularly involved in real resuscitation retained their skills and theoretical knowledge for longer, and thus had a higher pass rate than those who did not regularly participate in resuscitations.

E-learning may be one way to maintain theoretical knowledge, however, the literature did not appear to fully support its use. In a review of resuscitation literature, Williams found the ongoing use of e-learning did not maintain resuscitation skills or knowledge (50). In another paper by Howell and Greenwald examining new ways to teach paediatric ALS, it was suggested that spaced learning modules had the potential to address skill decay (79). Skills were maintained for longer because the learning modules could be delivered on-site, over a longer timeframe at times, which better suited learners, and presented in a format that encouraged in-situ training in the environment in which the practitioner worked.

2.4.5 Implementation in the Workplace

The literature identified that lessons and skills learned on a resuscitation course are not consistently implemented back in the workplace. Rasmussen et al. and Currey et al. in their review of the long-term experiences of simulation-based ALS training based on interviews with nurses and physicians, identified three key issues when implementing ALS training back in the workplace (70-72). The first was 'contextual adaptation', that is, bringing their new skills back into their workplace which already had its own culture and practices. The second was 'communities of practice', that is, ensuring that

the newly qualified staff were integrated into their own workplace's ALS community and being given the opportunity to 'prove' they were skilled at resuscitation. The third and final issue was 'transfer', or ensuring that, during actual resuscitation events, the newly qualified staff member was able to transfer their leadership and knowledge to others who had not undergone the course. Currey et al. expanded on the contextual adaptation theme, with interviewees identifying that there were differences between the scenarios taught on the course and those experienced in actual resuscitations, highlighting the need for scenarios to reflect the student's working environment.

In a survey of 526 ALS course participants in Denmark, Rasmussen et al. respondents identified their ability to implement ALS skills back in the workplace was most influenced by the level of teamwork and their co-workers' skills (72). Other factors identified by respondents included role distribution, communication, a positive team atmosphere, and, to a less extent, the clinical setting in which the emergency took place. These results highlight the need for resuscitation training to address human factors and be provided to students in the setting in which they work, alongside the multidisciplinary teams or co-workers they work with during an actual resuscitation.

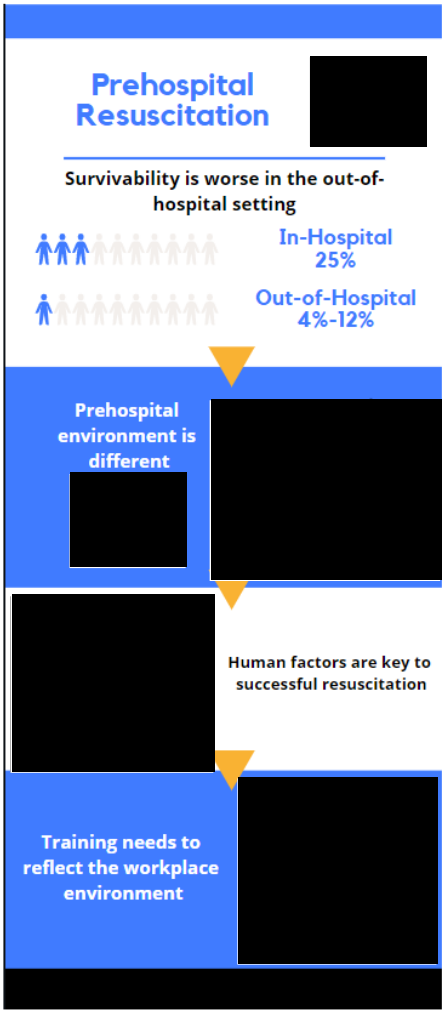


Figure 2.2: Out-of-Hospital Resuscitation

2.5 Conclusion

The literature on ALS resuscitation identified several core themes in relation to effective ALS training. Firstly, out-of-hospital cardiac arrest has worse outcomes than cardiac arrests experienced in-hospital. Successful resuscitation of out-of-hospital cardiac arrests were found to be less than half as successful as those cardiac arrests experienced in-hospital (3, 4). The literature identified that the out-of-hospital environment is different. Cardiac arrests in the out-of-hospital environment are not usually attended rapidly by trained healthcare professionals (41-43). Out-of-hospital cardiac arrests also follow a different aetiology to in-hospital cardiac arrests, being more often related to coronary artery heart diseases (46), and in the prehospital environment clinicians are less likely to be fully aware of the patient's underlying medical comorbidities. The out-of-hospital environment also differs in terms of patient access, team composition, lighting and extrication of the patient, including movement on a stretcher (16).

To address the challenges of the out-of-hospital environment, the literature identified that, although the entire chain of survival was important, training formed one important element in preparing healthcare professionals to conduct ALS resuscitation (50, 62). The literature identified several best-practice training components which should be incorporated into any ALS curriculum, which comprised the second phase of this research. To maximise candidate outcomes and learnings, either modular courses delivered over several weeks or short intensive courses over several days could achieve acceptable outcomes for students (73, 80-82). Although education has increasingly moved to incorporate e-learning, the literature identified that ALS training should involve a face-to-face component to ensure that the appropriate level of psycho-motor skills was achieved (49, 51-54).

One way of achieving psycho-motor competency was through simulation. Although there were different views on the need for high and low-fidelity simulation, based on the look and functionality of the simulator, the literature identified that use of simulation was needed to ensure patient safety and so that training could be realistic and relevant, mimicking as far as possible the student's own working environment (55-64, 90, 93). Human factors are an important consideration (65-69) and should include elements of situational awareness, decision-making, communication, teamwork, leadership, and management. Ensuring that the required competencies have been met was identified as a core component of ALS training, and the literature recommended formal competency assessment, using Kirkpatrick's model, including reaction, learning, behaviour and patient outcomes, is required prior to implementation of training back in the workplace (50, 66, 70-82, 105, 106).

The core components of effective ALS resuscitation training identified in the literature review applied to both in-hospital and out-of-hospital ALS resuscitation training. However, much of the research to date appeared to focus on the training of medical and nursing personnel in hospitals. The literature identified that the environment in which cardiac arrests occur (i.e., out-of-hospital versus in-hospital) has a critical impact on patient survival rates, however the research to date did not appear to adequately identify the specific needs of out-of-hospital providers. On this basis it was deemed warranted to investigate the lived experience of those whose role it is to respond to out-of-hospital cardiac arrests. The first publication in this study therefore identified the core components of resuscitation in the out-of-hospital environment, based on a survey of respondents, to investigate their lived experiences of ALS resuscitation.

Chapter 3: Research Design and Methodology

3.1 Introduction

The previous chapter outlined the findings of a descriptive literature review and the key themes that emerged in relation to resuscitation outcomes, the out-of-hospital environment and training in ALS. This chapter outlines the research design used for this mixed-methods study, informed as a result of the findings of the literature review. A mixed-methods approach (107) allowed the research to evolve from the literature, presented in the previous chapter, to respondents' opinions regarding the uniqueness of the prehospital environment, to their opinions on ALS training gaps. Presented in this chapter are the:

- Research questions
- Research phases
- Research design
    - Action research
    - Adult learning
- Data collection instruments (DCI)
    - DCI 1 and DCI 2: Clinician surveys
    - DCI 3: Interviews
    - Field research and DCI 4: Course feedback
- Expert Panel, and
- Ethical considerations

Subsequent chapters contain each of the published papers that emerged from this research.

3.2 Research Questions

This research sought to answer the following research questions (RQ):

- RQ1: What, according to the published literature, are the key components of effective ALS training?
- RQ2: To what extent did current ALS training courses reflect the actual resuscitation experiences of prehospital clinicians?
- RQ3: How should a prehospital ALS course be designed to meet the needs of prehospital clinicians?
- RQ4: To what extent did a pilot prehospital ALS training course meet participants' educational needs to deliver resuscitation in the prehospital environment?

3.3 Research Phases

The research was conducted over three phases, shown in Figure 3.1, with each component of the research and data collection instruments being discussed in the following sections.

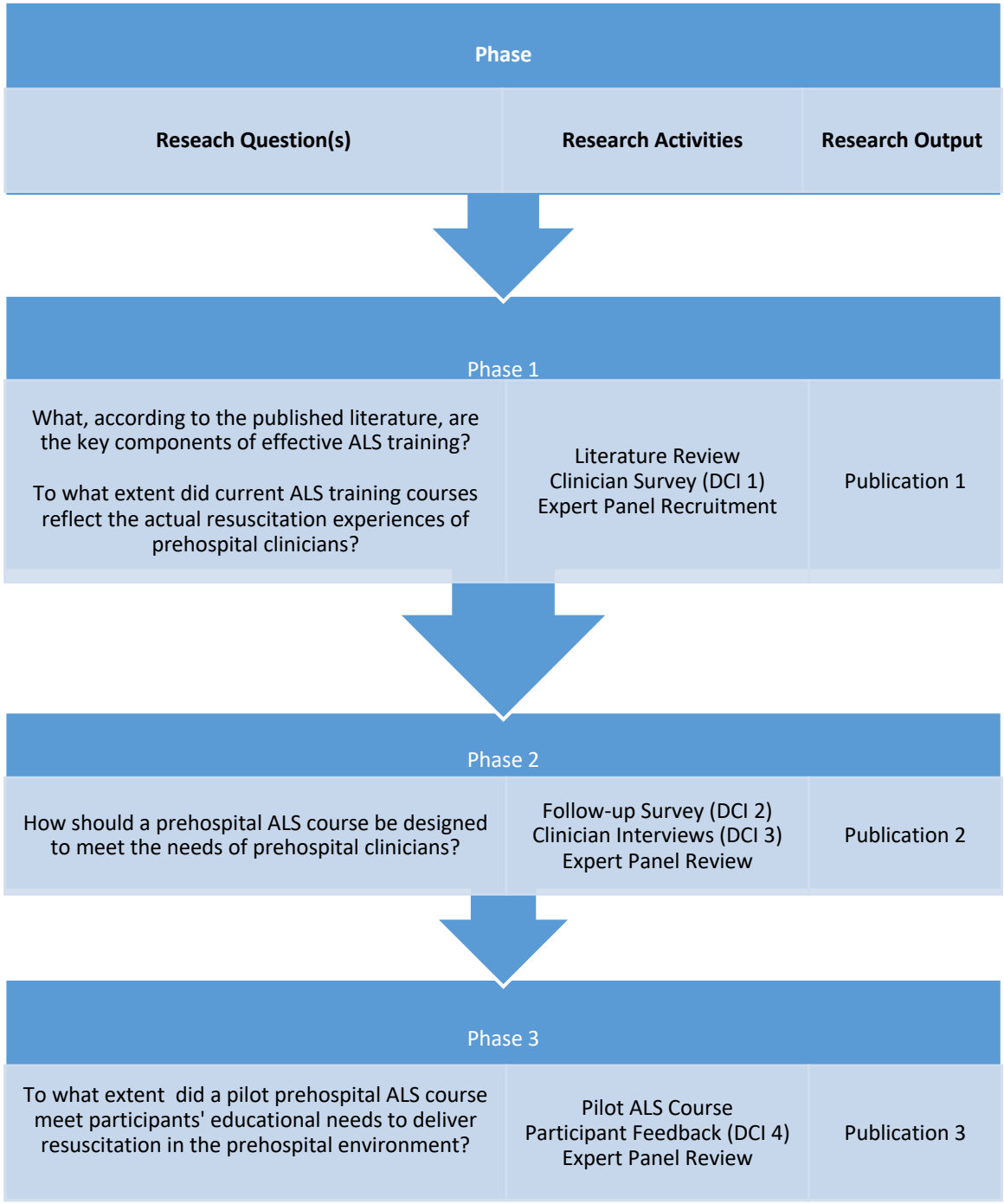


Figure 3.1: Research Approach

3.4 Research Design

This research used a scientific approach, performing systematic and linear investigations to collect and interpret facts (108, 109). It is recommended that the choice of research design should be driven by the nature of the research questions (108). The mixed-methods approach selected for this research was appropriate because qualitative and quantitative information was required to address the research questions (110).

A qualitative study is appropriate when the goal of the research is to explain a phenomenon based on individuals' experience in a given situation and where dynamics of social relations cannot be explained by quantitative methods alone (108, 111). The collection of qualitative data for this research was appropriate because the research sought to investigate the participants' ALS training preferences based on their professional experience. This research did not lend itself to purely quantitative methods because the data could not be collected in a systematic manner, then analysed using statistical methods, so a mixed methods approached was used (112, 113). The ability to anonymously present participants' own words was important in this study because it provided an insight into individuals' views and perceptions regarding ALS training, considering the interpretivist paradigm being used. According to Javadi and Zarea a range of thematic analysis have become common across qualitative research (114). The authors identify that thematic analysis is an approach that seeks to extract meanings and concepts from data. Types of thematic analysis include pinpointing, examining, and recording patterns or themes. The method chosen is subject to a range of variables including depth of the data set, complexity as well as whether the research is broad-based or seeks to pinpoint or examine specific aspects of the data collected. Explanatory thematic analysis coming out of qualitative information was used in this research because the research was broad-based and data-sets were based on respondents' opinions. Further, the survey instruments promoted discussion at interviews, which was then compared, contrasted, and clustered into similar themes. Quantitative research is reported to be appropriate when the researcher seeks to understand the relationship between variables (115). Quantitative data were appropriate for this study because data from Likert scales in the surveys administered provided valuable information about ALS course content, delivery methods and scenarios (116, 117). Likert scales meant that respondent opinions could be analysed using a systematic approach. The quantitative data were analysed and used to support the qualitative information gathered from open text boxes in the surveys and participant interviews.

This research used an interpretivist paradigm. An interpretivist paradigm allows for the in-depth exploration of individuals' experience, on the assumption that such experiences cannot be explored in the same way as physical phenomena (109, 118). An interpretivist paradigm seeks to provide rich

insights based on individual experiences within a social context, rather than attempting to provide universal and definite laws which can be applied to everyone (109, 118). In this study, emphasis was placed on the reflective nature of the research as the key themes evolved (119). Reflecting on the emerging themes throughout the first two phases of the research study was important in guiding the development of a prehospital ALS training course. The aim of the interpretivist paradigm in this research was to enable research participants to tell their own stories of resuscitation training and then provide information on whether that training prepared them for the reality of prehospital resuscitation. In this study, emphasis was placed on the lived experiences of research participants in the prehospital environment, and thus their ability to provide feedback on the benefits or otherwise of a prehospital ALS course.

3.4.1 Action Research

Underpinning the interpretivist paradigm were the foundation principles of action research. Action research was used as a foundation in this research as the justification for continual improvement, based on subsequent iterations of qualitative and quantitative data.

With regard to action research, Helskog made the observation that professions should strive for continued improvements, and that practice improvement should be based on innovative research (120). Action research seeks to improve practice, rather than theory (121). This research implemented an action research process because the research questions sought to improve the practice of ALS, rather than the underpinning theory which applies to, for example, medication administration timing, or effects on the body of rate and depth of compression, which are more related to traditional scientific observation. Action research was a valid pedagogy for this study because it brings together a socio-technical line of enquiry, aimed at practical change. The research is also pragmatic and participatory, with an aim of acting wisely and prudently in the resuscitation situation. To be useful, action research needs to satisfy a number of conditions as outlined by Argyris et al. (122), and shown in Table 3.1.

Action research component	Action research applied in this research
Empirically non-conformable propositions organised into a theory in real-life contexts.	This study took the proposition that prehospital ALS should be taught differently to in-hospital ALS training and proposed methods to do so in a real-life context.
Knowledge of what is useful in action so that it can be implemented in an action context.	This research took the underpinning knowledge of ALS processes and evidence-based educational methods and combined them to propose an innovative curriculum for prehospital ALS resuscitation training.

Action research component	Action research applied in this research
Provides alternatives to the status quo that illuminates what exists and informs change.	This research revised current ALS teaching modalities, which are focused on in-hospital processes, and challenged the status quo to suggest how training could be improved for the prehospital environment.

Table 3.1: Action Research Conditions

Source: Argyris et al. (122)

3.4.2 Adult Learning

The Theory of Adult Learning was core to the development and delivery of the ALS training course that emerged from the action research process summarised earlier. Two premises of Adult Learning Theory are that adults bring life experience and a variety of learning styles. The principles of adult learning were therefore embedded in the ALS curriculum that was developed as an outcome of this research. Knowles identified the following five characteristics of an adult learner (123):

1. Self-concept: As a person matures his/her self-concept moves from one of being a dependent personality toward one of being a self-directed human being.
2. Adult Learner Experience: As a person matures, he/she accumulates a growing reservoir of experience that becomes an increasing resource for learning.
3. Readiness to Learn: As a person matures, his/her readiness to learn becomes oriented increasingly to the developmental tasks of his/her social roles.
4. Orientation to Learning: As a person matures, his/her time perspective changes from one of postponed application of knowledge to immediacy of application. As a result, his/her orientation toward learning shifts, from one of subject-centeredness to one of problem centeredness.
5. Motivation to Learn: As a person matures, the motivation to learn is internalised.

Knowles identified four principles when providing effective learning experiences for adults (123). Outlined in Table 3.2, the principles identified by Knowles were applied to the ALS curriculum developed as part of this research.

Adult Learning Principles (ALPs)	Application of ALPs in This Research
Adults need to be involved in planning and evaluation.	The research involved pilot programs and seeking feedback from participants. The final curriculum involved feedback to ensure continuous improvement.

Adult Learning Principles (ALPs)	Application of ALPs in This Research
Experience provides the basis for learning activities.	The scenarios developed as part of the curriculum were purposefully based on the authentic real-world prehospital ALS environment.
Adults are interested in subjects that have immediate relevance and impact to their job.	The ALS curriculum was aimed at healthcare staff working in the prehospital environment and therefore had immediate relevance to their working environment.
Adult learning is problem-centered rather than content-oriented.	The ALS curriculum sought to address the problems of the uncontrolled prehospital environment as well as varying teams and equipment use in the prehospital setting, thus empowering participants to solve authentic problems.

Table 3.2: Principles of Adult Learning

Source: Knowles (123)

3.5 Data Collection Instruments

In addition to the literature review (outlined in the previous chapter) and regular engagement with the Expert Panel (outlined in the following section), four data collection instruments were used in this research to collect verifiable and evidence-based information to inform the findings and conclusions. There were four data collection instruments, summarised in Table 3.3.

Data Collection Instrument (DCI)	Research Question Addressed				Research Phase	Participants
	1	2	3	4		
DCI 1: Clinician Survey		✓			1	Prehospital clinicians
DCI 2: Follow-up Survey			✓		2	Prehospital clinicians who had responded to DCI 1.
DCI 3: Clinician Interviews		✓	✓		2	Prehospital clinicians who had responded to DCI 1.
DCI 4: Pilot ALS Course Feedback				✓	3	Prehospital clinicians from emergency and

Data Collection Instrument (DCI)	Research Question Addressed				Research Phase	Participants
						non-emergency services

Table 3.3: Data Collection Instruments

3.5.1 Data Collection Instrument 1 and Data Collection Instrument 2: Clinician Surveys

The two online clinician surveys aligned with The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) recommendations for improving the quality of web surveys and collected information on respondents' views of ALS training and their actual resuscitation experiences (DCI 1) (124). In a follow-up survey (DCI 2), the content that prehospital clinicians considered should be incorporated in a prehospital ALS training course was identified.

The strength of qualitative research depends on what the researcher sees and hears. Nowell et al noted that in a thematic analysis, credibility, transferability, dependability and confirmability were important in establishing the trustworthiness of the information gathered (125). One way to ensure trustworthiness is to ensure that the data are drawn from research participants with the experience to discuss the core research questions. In this research, clinicians who had undertaken an ALS training course and who were currently or had worked previously in the prehospital environment were eligible to participate in the first clinician survey (DCI 1). All participants had to be fluent in the English language, but English did not have to be their native tongue. Examples of participants included paramedics, nurses, emergency medical technicians, medical practitioners and first responders. All respondents had to have experience in the prehospital environment. The recruitment of research participants for the first survey followed a snowball approach (126, 127). Participants were drawn from, initially, personal clinical contacts of the researcher, social media recruitment through Paramedics Australasia, and emails to other undergraduate Paramedicine lecturers. The sample of research participants for the follow-up survey (DCI 2) was drawn from respondents to the first survey (DCI 1).

The clinician surveys (DCI 1 and DCI 2), as approved by the Edith Cowan University Research Ethics Committee, are shown in Appendix E.1: Data Collection Instrument 1 and Appendix E.2: Data Collection Instrument 2. An information letter and consent form were electronically signed by participants prior to survey completion. Robust research should ensure that, as far as possible, the data gathered and their analysis, are relatively free from bias and error. Assessing the validity and reliability of items contained in data collection instruments are recognised ways to ensure the rigour and trustworthiness of research results (128, 129). Prior to release of each survey, validity, and

reliability were both tested through pre-testing (128, 130, 131). Validity was assessed by administering the questions to a small cohort of six experienced prehospital healthcare providers who were also university lecturers. A briefing on the aims of the survey in the context of the overall research was provided, prior to the survey being administered for completion and comment, to check validity. Face validity and content validity of the survey items were tested in the form of written feedback and discussions with the lecturers (132). Feedback from the prehospital clinicians was obtained on survey content, question scales and whether the questions allowed them to accurately capture their views on ALS training. Comment was also made on the survey format. Reliability, or testing the stability of the data collection instrument when administered to the same individuals at different times, was assessed by administering the survey to the same cohort of university lecturers at least three days apart (133).

Data collection and analysis, an overview of which is shown in Figure 3.2, was conducted in a systematic and structured manner. The use of a structured approach ensured that data collection directly addressed each of the research questions, as outlined in the following sections.

Figure 3.2: Data Analysis Process

Data collection for the survey was carried out anonymously online using SurveyMonkey® (DCI 1) and Qualtrics® (DCI 2) software. While the surveys were anonymous, respondents could elect to provide contact information if they wished to participate further in the research. Analysis of the data were undertaken using reporting capability within each software system, including relevant cross tabulations, for example, respondent profession, years of service and prehospital experience. Questions analysed from the surveys were directly linked back to the data collection objectives (see following sections) which were in turn linked to each of the research questions.

Data Collection Instrument 1: Clinician Survey

The first survey, shown in Appendix E.1: Data Collection Instrument 1, distributed between 27th April and 16th July 2016, attracted 177 responses from a range of healthcare professionals nationally and internationally, including medical practitioners, nurses, paramedics and first responders, all with prehospital care experience. It was not possible to estimate the total number of paramedics and prehospital care nursing staff, so it was not feasible to determine a response rate in relation to the prehospital emergency responder population. Eighty-three respondents completed the survey in full. The survey, the objectives of which are outlined in Table 3.4, consisted of questions relating to ALS resuscitation education, and then the actual experiences of the respondents in relation to performing prehospital resuscitation.

Data Collection Objective	Survey Section	Survey Questions	Link to Research Question
Ensure representation across prehospital clinicians	Section 1: Demographic Information	Q1.1 - Q1.6	RQ 2
Identify experience in resuscitation education	Section 2: Resuscitation Education	Q2.1 - Q2.4	RQ 2
Opinions on resuscitation courses		Q2.5 - Q2.6	RQ 2
Experience in real prehospital resuscitations		Q2.7 - Q2.8	RQ 2
How real resuscitations differed from training	Section 3: Training vs Real Resuscitations	Q3.1	RQ 2
Specific components needed in prehospital resuscitation training		Q3.2	RQ2 / RQ3

Table 3.4: DCI 1 Data Collection Objectives

Data Collection Instrument 2: Follow-Up Survey

The follow-up survey (DCI 2), shown in Appendix E.2: Data Collection Instrument 2, was administered between 1st March and 20th May 2018 with a convenience sample of 140 healthcare professionals who indicated, from the first survey, that they were interested in further participating in the research. A convenience sample was appropriate because it was not feasible, given the resources available in this research, to establish a process or procedure that assured that all prehospital clinicians would have equal probability of being chosen as would be found in a probability sampling method (134). The follow-up survey resulted in 38 fully completed responses (27% response rate). The survey was presented in four sections, including survey introduction and informed consent,

respondent demographics, course content, and final comments and an open-ended response. The content of the follow-up survey was focussed on answering Research Question 3 and are summarised in Table 3.5.

Data Collection Objective	Survey Section	Survey Questions	Link to Research Question
Ensure representation across prehospital clinicians	Section 1: Demographic Information	Q1.1-Q1.6	RQ 3
What course preparation was required for a prehospital ALS course?	Section 2: Course Preparation	Q2.1-Q2.5	RQ 3
How should a prehospital ALS course be delivered?	Section 3: Course length	Q3.1	RQ 3
	Section 4: Course delivery	Q4.1-Q4.2	
What theoretical elements should be included in a prehospital ALS course?	Section 5: Theoretical course elements	Q5.1-Q5.3	RQ 3
	Section 6: Human Factors	Q6.1-Q6.2	RQ 3
What clinical skills should be taught in a prehospital ALS course?	Section 7: Resuscitation Skills	Q7.1-Q7.2	RQ 3
What resuscitation scenarios should be taught in a prehospital ALS course?	Section 8: Resuscitation Scenarios	Q8.1-Q8.4	RQ 3
How should prehospital ALS course teams be organised?	Section 9: Teamwork	Q9.2-Q9.2	RQ 3
	Section 10: Roles & Responsibilities	Q10.1-Q10.4	RQ 3
How should a prehospital ALS course be assessed?	Section 11: Assessment	Q11.1-Q11.2	RQ 3
How should a prehospital ALS course be governed?	Section 12: Standards and Governance	Q12.1-Q12.3	RQ 3

Table 3.5: DCI 2 Data Collection Objectives

3.5.2 Data Collection Instrument 3: Clinician Interviews

All participants who had participated in the follow-up (DCI 2) clinician survey were eligible to participate in an interview to explore, in-depth, their experiences and suggestions for prehospital ALS training. All those approached participated, with 36 telephone or face-to-face semi-structured interviews being held. The interviews, which were held between June 2016 and October 2018, were guided by their qualitative nature and aligned to the Consolidated Criteria for Reporting Qualitative Research (COREQ) (34). Interview participants were all over 18 years of age. Each interview participant had, in the follow-up survey (DCI 2), provided their contact details and permission for the researcher to contact them for interview. Data collection objectives for the interviews are outlined in Table 3.6 and the full interview protocol and letters are shown in Appendix E.3: Data Collection Instrument 3, Appendix E.3a: Interview Participant Information and Appendix E.3b: Interview Running Sheet.

Face-to-face or telephone interviews, depending on the respondent's location and preference, were held with paramedic educators and operational paramedics (17 interviews), registered nurses (2 interviews), medical (2 interviews), military (1) and first responders (14 interviews, including volunteer ambulance officers). Interviews were held with respondents from Western Australia (21 interviews), the Northern Territory (9 interviews), New South Wales (2 interviews), Northern Ireland (3 interviews) and Victoria (1 interview). Interviews were held either face-to-face (33 interviews) or via the telephone (3 interviews).

Interviews with research participants were conducted in a single session using a semi-structured approach. Validity was assessed by trialling the questions and the interview protocol with six academics and two of the Expert Panel. Feedback on the interview protocol and questions was received either verbally or via email. Each interviewee read an information letter and signed an informed consent form. The interviews had contemporaneous notes taken by the researcher. At the start of each interview the interviewer confirmed the interviewees' experience in prehospital ALS to ensure they could provide sufficient information about the prehospital environment in the following interview sections:

Data Collection Objective	Interview Section	Link to Research Question
Provide an overview of the research, its objectives and importance	Section 1: Research Introduction	RQ 1
Provide an outline of the findings to date including the literature review and	Section 2: ALS Courses	RQ 2

Data Collection Objective	Interview Section	Link to Research Question
prehospital professional surveys (DCI 1 & DCI 2)		
Gather participant opinions on how a prehospital ALS course should be designed	Section 3: ALS course design focussing on: • Pre-course preparation and reading • Course length and delivery method • ALS skills (technical skills and human factors) • ALS scenarios • Assessment • Quality control, and • Their experience of previous courses and what was missing	RQ 3

Table 3.6: DCI 3 Data Collection Objectives

The interviews used an interpretivist paradigm and did not seek to reach a consensus on prehospital cardiac arrest training. The interpretivist paradigm assumes that reality cannot be separated from knowledge, and that the views of all involved in the research was equally 'truthful' and based on the individuals' personal experiences of prehospital resuscitation (135). Standardised interview questions were developed from the literature review, but the semi-structured nature of the interviews allowed interviewees to delve in-depth into their specific requirements of ALS training. The interview opened by seeking the background of the interviewee, then asked a series of questions on the resuscitation environment, skills used, scenarios, education approach and the aspects of prehospital ALS education which were missing from the courses they had attended. The Interview questions were piloted with six paramedic academics prior to data collection. The standard question guide was used by the researcher in each interview, and the interview participants were provided with a consent letter, which outlined the key questions which were to be discussed in the interview. The interview process is shown in Figure 3.3: Interview Process.

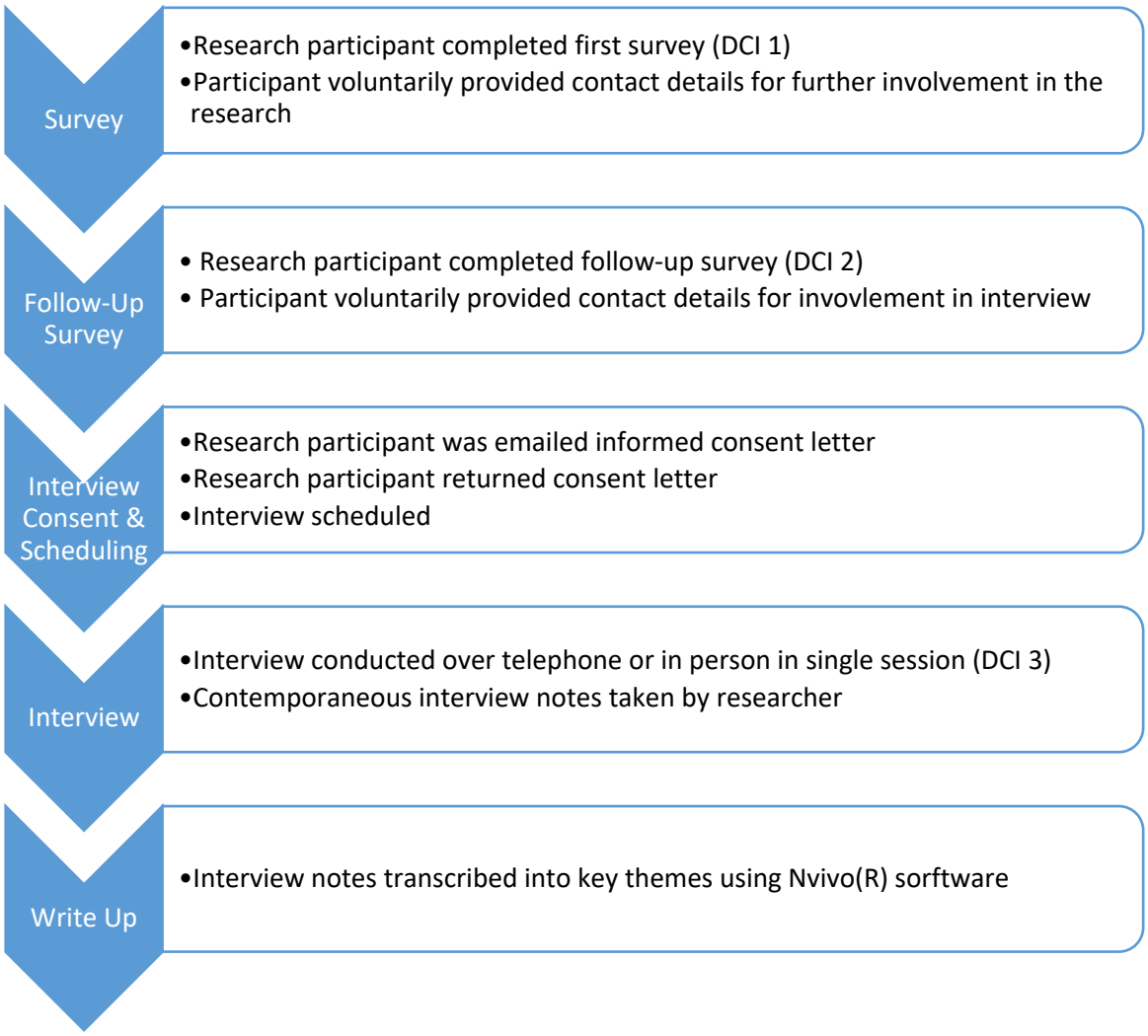


Figure 3.3: Interview Process

The interpretivist paradigm and use of semi-structured interviews meant that because the themes emerged from the data, based on the research participant's experiences, some interview questions were added or modified during each interview (119, 136). This was done to ensure that the researcher appropriately responded to the respondents' experiences. Clarifying questions were used during interviews to explore topics or gaps which emerged. Each interview lasted at least one hour, with the longest interview being of one and one-half hours duration. While no interviews were recorded, each had contemporaneous written notes taken which were then transcribed into NVivo® for analysis. Interview data were coded, using a bracketing technique as suggested by Gearing (137), into themes based on words used by the interviewee (138). In conducting the interviews there was a risk of bias on the part of the researcher, through both conscious and unconscious assumptions about the topic or the answers given by the interviewee. The bracketing approach used in analysis was appropriate because it assisted the researcher to mitigate the potential effects of unacknowledged preconceptions related to the research and facilitated a deeper analysis of the

themes identified by interview participants (139, 140). Although a small sample was used in this research, the themes identified were common across the interviewees, indicating that thematic saturation (141) was reached.

The interview data were coded after each interview into key themes using Nvivo® software. Codes were developed by the researcher, not by the software. Coding occurred over the course of the interviews, with regular analysis helping to minimise bias because note taking and then coding was reflective, which aided objectivity. Coding in a timely manner from contemporaneous notes helped to remind the researcher of their thoughts and helped to separate thoughts the researcher might impose from the literature review, from themes emerging from research participants' own views (136).

The process of analysing, reanalysing, and comparing new information is known as constant comparison. As each interview was coded it was important to review previous coding and themes so that connections were being made, until no new themes were emerging. Coding used in this research was adapted from Urquhart (142) who identified three phases of coding as open, selective, and theoretical as shown in Figure 3.4.

Figure 3.4 is not available in this version of the thesis

Figure 3.4: Coding Approach

Source: Urquhart (142)

Coding was completed in the order in which interviews were conducted, allowing the researcher to reflect and edit the codes as themes emerged from subsequent interviews. Coding was used to aid the researcher to identify key themes from the perspective of research participants and in analysing their combined experiences, then matching them to the literature to identify gaps in prehospital ALS training. Themes were created during the coding process, based on the data provided by

interviewees, for the purposes of identifying the participants' perceived gaps in prehospital ALS training.

Identifying themes from the surveys and interviews, then matching them to the literature was a key component of the research. Coding was instrumental in identifying the key themes and the gaps in ALS training in a structured way. Coding helped to prevent the researcher overemphasising the importance of one aspect of ALS training, and helped ensure a thorough analysis of all elements of the research, prior to development of a pilot prehospital ALS training course (111, 119). The use of constant coding ensured that systematic data analysis was made and that links between the theory and participants' experiences were robust (119).

In their work Glaser and Strauss discussed, amongst other methods, the concept of saturation, where the researcher realises that for a given subject, no new categories or themes emerge from the thematic coding (141). In this research, thematic saturation was reached at the conclusion of 36 interviews, and the key themes were then presented to an Expert Panel for review and confirmation. Demonstrating thematic saturation is one way of minimising the risk of bias, and was a factor in ensuring that sufficient data had been collected to provide credibility to the themes identified (141).

3.5.3: Field Research and DCI 4: Pilot ALS Course Feedback

The field research phase of the study (i.e., Phase 3) was completed by piloting the prehospital ALS curriculum with prehospital clinicians in Perth, Western Australia and Darwin, Northern Territory in 2018 and 2019. The ALS curriculum that was piloted was developed from best practice identified in the literature review, data collected from the online survey (DCI 2) and interviews (DCI 3) with prehospital clinicians, as well as input from the Expert Panel of ALS, medical and education experts, all with an expertise in and exposure to prehospital resuscitation (143).

The pilot prehospital ALS resuscitation training course comprised of a one-day course. Non-mandatory pre-reading targeted ARC guidelines. A research ethics approved research letter of participation, and a set of joining instructions was sent to participants at least two weeks in advance of the course commencement. At the start of the course the ethics-approved research participation letter was provided for signature by all participants. By the end of the course, participants were expected to be able to:

- Manage the patient in cardiac arrest in the prehospital setting using the Australian Resuscitation Council cardiac arrest algorithm
- Identify and treat the prehospital reversible causes of cardiac arrest using a structured team-based approach

- Recognise non-life sustaining cardiac rhythms, delivering appropriate safe defibrillation therapy when indicated
- Lead and be a constructive member of a prehospital resuscitation team
- Plan the management and safe extrication and transfer/care of the post resuscitation patient, and
- Recognise life extinct and conduct hot debriefing on scene

The content in the ALS training curriculum sought to actively engage participants in the principles of prehospital resuscitation, reflect the principles of adult learning (123), and contain a blend of theoretical knowledge, teamwork and human factors skills. The detailed content of the ALS curriculum can be found online in the link provided in Appendix B: List of Training Material, and is summarised in Figure 3.5.

Pre-Course Reading
- Pre-course reading on ARC guidelines

Course Introduction
- Pre-course multiple choice quiz
- Course introduction

Lectures
- Prehospital cardiac arrest in perspective
- Causes of cardiac arrest in the prehospital environment
- Team based ALS resuscitation
- Human factors in resuscitation
- Post Resuscitation Care and transport

Skills Stations
- A-E patient assessment
- ALS algorithm reminder
- Team based approach to prehospital resuscitation

Group Discussions / Case Studies
- Decisions relating to resuscitation
- Hot debriefing

Prehospital Scenarios
- Scenarios involving varying number of responders, variety of roles and different prehospital locations

Post-Course Quiz
- Post-course multiple choice quiz

Figure 3.5: Prehospital ALS Course Curriculum Overview

Several strategies were employed to increase the likelihood that the prehospital ALS curriculum covered the theoretical domains of good practice (content validity) and that they conveyed the intended messages to course participants (face validity). The ALS course content was based on that used by the ARC and, where appropriate, amended for the prehospital context. To ensure that the key requirements of effective ALS training practice (content validity) were included in the course, a content audit was conducted to check all concepts were covered. A matrix, shown in Table 3.7, outlines the key principles and content of the ALS training course and the published support for the approach taken in the research.

Identified Good Practice	Published Support
Overview of resuscitation outcomes	(3, 4)
Uniqueness the out-of-hospital environment	(16, 41-43, 46, 47)
Importance of prehospital resuscitation	(48, 49)
Face-to-face delivery of training	(49, 51-54, 65, 83, 84)
Course delivery in modular blocks	(73, 79-83, 85)
Realism and relevance to participants; **Contextual adaptation of content**	(55-57, 70-72)
Use of simulation activities	(50, 55-64, 66, 73, 84, 86-93)
Inclusion of human factors in resuscitation	(65-69, 76, 95-102)
Competency assessment	(16, 50, 66, 70-82, 104-106)

Table 3.7: Good Practice Audit

The ALS course content was provided to the Expert Panel for review as well as to an experienced group of academics who were also paramedics. The Expert Panel and academics were provided with the course material and asked to comment either directly on the material, or via email, their suggestions as to the appropriateness of the course content. They were specifically asked to ensure that the content aligned with ARC guidelines, the coverage of the concepts in the prehospital environment, and the suitability of the simulations for a prehospital audience. Overall, with minor modifications to course timing and some assessment questions, the feedback was that the course content was suitable for piloting with a prehospital audience.

Piloting of the ALS training course followed the principles of adult learning, outlined previously in this chapter. The pilot of the prehospital ALS training course involved delivering it 13 times between September 2018 and December 2019. There were 67 participants of whom 66 provided informed consent to provide feedback on their perceptions of the training course. Participants were recruited through the delivery partners, an ambulance service and an industrial healthcare provider who was

providing continuing professional education to its own and client staff. All those who provided emergency medical care and held at least a Certificate IV in Healthcare were eligible to participate. The course was delivered by the primary researcher on 11 occasions, and two registered paramedics on the other two occasions. Both paramedics had assisted in earlier deliveries of the course.

The one-day course consisted of theory lectures, case studies, video exemplars and practical simulated resuscitation scenarios. Participants in the course completed a 50 stem-question (total 200 questions), closed-book quiz at the start and then again at the end of the course, to determine the impact of the course on their theoretical knowledge of prehospital resuscitation. The ALS quiz was based on a currently used ARC ALS2 quiz, and then contextualised for the prehospital environment. In this research, the multiple-choice ALS written paper may have sought to evaluate ALS knowledge, but it may have evaluated overall clinical knowledge rather than resuscitation knowledge (133, 144). The ARC has completed internal validation of the ALS2 quiz, however this has not been published. In light of this finding, prior to release of the quiz, validity, and reliability were additionally assessed with the amended questions for the prehospital environment as follows (128, 130, 131).

Face validity of the quiz was confirmed prior to its administration by six prehospital clinicians, all of whom were paramedic educators, as well as input from the Expert Panel as well as, where appropriate, reference to previous research instruments such as surveys and the ARC ALS quiz. Construct validity was tested by reference to the literature review and taking the accumulation of evidence from a range of studies, as well as basing the quiz on the current ARC ALS1 quiz. Content validity was addressed through seeking input from the Expert Panel and academics. Particularly in relation to the ALS quiz, the basis of the quiz was drawn from the currently used ARC ALS2 quiz, with individual questions modified for the prehospital setting. In this way the quiz achieved content validity because it examined resuscitation, with a specific emphasis on prehospital elements which was the focus of this research.

Reliability of the quiz was tested with a convenience sample of seven undergraduate paramedic students who had each undertaken a university-level ALS course in a prior semester. To test reliability, the seven students completed the quiz two-days apart, without having completed the ALS training course. The students demonstrated no improvement between their first and second quiz attempts, with scores remaining at 72% for both quiz attempts (M=144, SD=8.1). Four of the students indicated that they talked about resuscitation between their two attempts, and three indicated they read information about resuscitation.

Each stem question in the quiz had four sub-questions. The prehospital resuscitation quiz, which was based on the ARC ALS2 course quiz, amended for a prehospital environment, included questions on:

- Airway management (2 questions)
- ALS algorithm (9 questions)
- ALS medications (6 questions)
- Cardiac arrest in perspective (2 questions)
- Causes of cardiac arrest (1 question)
- Decisions relating to resuscitation (2 questions)
- Defibrillation (1 question)
- Hot debriefing (4 questions)
- Human factors (3 questions)
- Infection control (1 question)
- Legal aspects of resuscitation (1 question)
- Rhythm recognition (13 questions), and
- Return of spontaneous circulation (ROSC) (2 questions)

The theory lectures and case studies included in the ALS training course, were delivered over approximately two hours, and covered the following topics:

- Prehospital cardiac arrest in perspective
- Causes of cardiac arrest in the prehospital environment
- Team based ALS resuscitation
- Human factors in resuscitation
- Post resuscitation care and transport
- Decisions relating to resuscitation, and
- Hot debriefing including supporting bystanders

There was a minimum of six standardised prehospital scenarios, from a pool of 12, delivered across the day, and these included:

- Two-person resuscitation
- Three-person resuscitation (with/without bystanders)
- Four-person resuscitation, and
- Five-person interprofessional team resuscitation

Shockable and non-shockable rhythms were practised in scenarios, in a range of prehospital locations including a mock medical centre, outdoor and indoor areas at ground level, and ambulance

vehicle, including moving the post-arrest patient and performing cardio-pulmonary resuscitation in the back of an ambulance. The team mix was, dependent upon the participants present, altered to include clinicians and first responders. During the course some participants also took on the role of non-trained lay-people to give participants experience at leading in a resource-limited environment.

Participants on each pilot of the ALS training course completed an evaluation form which sought to answer Research Question 4: To what extent did a pilot prehospital ALS course meet participants' educational needs to deliver resuscitation in the prehospital environment? The evaluation form, shown in Appendix E.4b: Course Evaluation Form, sought each participant's opinions on each aspect of the prehospital ALS curriculum including:

- Theory lectures: 8 questions, 4-point Likert scale
- Practical sessions: 6 questions, 4-point Likert scale
- Support and mentoring: 3 questions, 5-point Likert scale
- Venue and logistics: 2 questions, 5-point Likert scale
- Achievement of the course objectives: 7 questions, 3-point Likert scale
- Comparison to a standard ARC course if participants had previously completed such a course: 2 questions, 3-point Likert scale if 'yes'
- Pre-course preparation, 3 questions, Yes/No responses
- Course logistics, length and equipment used on the course: 10 questions, 4-point Likert scale
- Net Promoter Score for the course, and
- Demographic information on their role, length of service, and highest clinical qualification level, 10 questions

3.6 Expert Panel Selection and Consultation

Successful mixed methods research includes teams of researchers with a range of experience (145). In this research the candidate and supervisors identified the need for expert advice in relation to resuscitation, education, and prehospital care. It was not necessary for advisors to be experts in research, however they did require a robust understanding of the research process and had to be able to provide robust advice on the findings from each of the data collection instruments. The expert panel also had to understand the principles of action research, in that their feedback had to acknowledge that innovation, continual improvement and new ways of working were possible and even desirable to improve patient outcomes through evidence-based research. To build the expert panel, Kotter's eight-steps to change management were followed (146-149). That is, a guiding team was built, based on individual and collective expertise; a sense of urgency for change as a means to

overcome resistance was presented based on evidence from the literature review and clinician survey (DCI 1); the vision of improved patient outcomes was clearly communicated to align with the Australian Commission on Safety and Quality in Health Care patient-centred care approach; and communication with the panel via email, telephone and surveys was conducted through the research, which enabled buy-in and two-way communication. Short-term wins in the form of the pilot courses were communicated back to the panel and where required, follow-up with individual members was initiated.

Expert panels have been identified as an effective means of validating and confirming research findings which are qualitative in nature (150, 151). Coulter et al. identified that expert panels can be useful for reviewing evidence and providing insight into its clinical application, but also cautioned that, if not properly managed, their insights may be erroneous (152). Previous research identified that an expert panel, when examining evidence, should have members from both clinical and research backgrounds, including those who have academic publications and are recognised as knowledgeable in the topic being examined (152-154). This research benefitted from an Expert Panel made up of clinical and academic experts, including a consumer member. The membership and qualifications of each of the Expert Panel Members is outlined in the Expert Panel section earlier in this Thesis. Coulter et al. identified two types of panels, that is, a consensus panel, and an appropriateness panel (152). This research did not seek to obtain consensus from survey respondents, interviewees or participants in the pilot course, the interpretivist paradigm took all views as being valid. This research used an appropriateness panel where full consensus was not required, and where extreme disagreements were discarded to ensure that the research moved forward and that the majority view was incorporated into the research.

The Expert Panel of 10 healthcare professionals were consulted face-to-face, via email or on the telephone, in Phases 2 and 3 of the research. Consultation with the panel mirrored the surveys and interviews conducted for each of the articles in this research. Additionally, the panel were consulted after each research instrument for their interpretation and whether they had further comments on the results obtained. Recruited during Phase 1, from personal contacts of the researcher and supervisors, the Expert Panel was made up of four medical staff (all with experience in the prehospital field), two registered nurses (both with education and prehospital experience), three paramedics (one a researcher and two in senior operational management), and one patient advocate. The Expert Panel members were recruited through face-to-face conversations and email following telephone calls. The Expert Panel members were chosen based on their knowledge of prehospital care, resuscitation, and education. In Phase 2 of the research, each member of the Expert Panel was interviewed at least once, with two medical members interviewed twice, one nurse

consulted four times, and the patient advocate twice. Informal conversations with the panel also occurred as the research progressed. Following completion of the ALS training courses (Phase 3), nine members of the Expert Panel were consulted at least once, and four twice on the results of the course. Six members provided written feedback, five held telephone interviews and two held face-to-face discussions with the researcher to provide their views on the ALS training course and the implications for prehospital ALS resuscitation education into the future.

3.7 Ethical Considerations

According to Edith Cowan University researchers are required to ensure the health and welfare of any research involving human respondents, and ensure free and informed consent is obtained prior to participation (155). Furthermore, the University identifies projects should consider local social, cultural, and social attitudes.

The National Health and Medical Research Council (NHMRC) Statement on Ethical Conduct in Human Research identifies four key principles that underlie ethical research practices (156). These principles are important because they provide a solid framework against which researchers can critically examine their proposed topics to ensure they are meeting a minimum ethical standard within their specific context of their research. Table 3.8 outlines the primary ethical principles and how they related to this research.

Ethical Principle	Relation to This Research
Research Merit and Integrity	This research had the potential to improve prehospital resuscitation by producing an ALS training course which took into consideration the environment, human resources, and equipment available to successfully resuscitate patients in the prehospital setting. The research problem considered the available literature, and the research approach was designed so that individual participants in the research were not compromised. The research was appropriately supervised through academic supervisors and the University Ethics Committee.
Justice	The selection of participants was based upon the accessible population and the research approach ensured their time spent in responding to the research instruments would not place them under an unfair burden or exploit them in any way.

Ethical Principle	Relation to This Research
Beneficence	The likely benefit to the wider public through improved training of paramedics was considered to outweigh any potential detriment to any individual respondent who participated in the research.
Respect	The research problem and instruments (interviews and surveys) contained inherent respect for all respondents with all results being anonymous, and participants were provided with avenues to decline participation.

Table 3.8: Ethical Principles

Source: National Health and Medical Research Council (156)

There are five basic practices which must be followed to conduct research ethically and these are identified in the Principles of Research Ethics (157). Table 3.9 outlines the approach this research undertook to minimise risk and meet the principles of research ethics.

Research Ethics Principle	Approach Taken by this Research
Minimising the Risk of Harm	In this research participants may have been exposed to inconvenience by completing a survey, participating in an interview, or attending a training course. The first two elements were considered to pose minimal ethical risk, with participants able to choose not to complete or participate in either surveys or in interviews. Of greater concern was manual handling risk associated with participating in the ALS training course as participants were performing cardiopulmonary resuscitation. Additionally, participants were exposed to technical hazards such as needle stick injuries when using resuscitation equipment. Assessing and mitigating these risks was therefore important to ensure individual participants were no worse off by participating in the research. Risk assessments were undertaken in line with Edith Cowan University risk assessment and treatment guidelines, for example removing needles and using alternative simulation methods to draw up medications. All participants signed informed consent forms which outlined the risks to them.
Obtain Informed Consent	All participants received written information on the study and signed an informed consent form. The form was based on the risk

Research Ethics Principle	Approach Taken by this Research
	assessment and identified safe practice. Underpinning the informed consent was ethics approval from the University. Gaining ethics approval was important because it provided confidence to participants, and to the greater research community, that an independent third-party had reviewed and approved the research topic and approach and that safeguards were in place.
Protect anonymity and confidentiality	Confidentiality and anonymity were assured through the use of anonymous online surveys. Interviewees did not have their names published. Names of participants were not published, and end-of-course questionnaires were anonymous. In interviews, survey and pilot course reports, only aggregated data were reported.
Avoiding deceptive conduct	Full disclosure on the study was provided to all participants via information letters, including what the study was about, their role and how their information would be used.
Providing the right to withdraw	At any stage of the research processes participants were able to withdraw, not complete or submit their survey and/or leave an interview. No one was forced to participate in an interview or the ALS training course, and this was particularly important for university students who may have felt obliged. At the end of the ALS training courses participants voluntarily completed the end-of-course questionnaire.

Table 3.9: Research Ethics Principles

3.8 Conclusion

This chapter has outlined the research design and methodology used to investigate the research questions. This chapter also outlined the four research questions which this research sought to address. Each research phase, with its approach and data collection instruments, were described. A discussion of the methodology, the research approach and how each data collection instrument was developed and implemented was detailed. The principles of action research and the application of adult learning principles were documented to highlight how each was used in the research and, in particular, in the development of the prehospital ALS curriculum and the piloting of the curriculum. Recruitment and consultation processes with the Expert Panel were summarised and finally, ethical considerations and the processes by which this research sought to minimise ethical risks were noted. The following chapter provides the results of the first phase of the research.

Chapter 4: Publication One

4.1 Linking Statement

The previous chapter outlined the research methodology and design, including the four research questions this research sought to address. The research approach and each of the data collection instruments were described and linked back to the research questions. This chapter (Publication One) presents the findings of an initial literature review on resuscitation training and prehospital resuscitation, and the results of an initial online survey of prehospital clinicians. Publication One sought to address Research Questions 1 and 2:

- RQ1: What, according to the published literature, are the key components of effective ALS training?
- RQ2: To what extent did current ALS training courses reflect the actual resuscitation experiences of prehospital clinicians?

The literature review conducted at this stage of the research was conducted to the year 2016. After this paper the resuscitation literature continued to be reviewed, hence the final number of articles in this first paper is fewer than the total number reviewed as part of the Literature Review Chapter. The literature review, previously outlined in an earlier chapter, identified that although there was a substantial evidence-base for resuscitation education in hospital and healthcare settings, there was less specific information on their application in the out-of-hospital environment. An initial online survey aligned with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) recommendations for improving the quality of web surveys (124) sought to determine whether current ALS training courses reflected prehospital clinicians' actual experiences and sought feedback on prehospital-specific ALS education including:

- The experiences of prehospital clinicians in resuscitation education
- Comparisons of education scenarios, equipment, and human factors to respondents' actual resuscitation experiences
- Workplace implementation of providers' resuscitation skill set

The survey was administered to volunteer and paid healthcare professionals such as medical practitioners, nurses, paramedics and first responders who worked in the prehospital setting and attracted a total of 177 responses, of which the number of responses per question varied from 150 to 177. Demographic information was collected at the conclusion of the survey and was not well recorded by respondents which is a limitation on the results if reviewing by type of provider. The survey consisted of both quantitative and qualitative elements. The survey was administered online

via SurveyMonkey® software and recruitment employed a snowball technique (127) through prehospital contacts of university academics, personnel in clinical settings, social media including LinkedIn, and the professional representative body Paramedics Australasia.

The survey collated the experiences of prehospital clinicians in relation to ALS resuscitation training and confirmed that the prehospital environment is different to resuscitations carried out in healthcare facilities. The first publication built upon the increased interest in prehospital ALS resuscitation and commenced collating data on what prehospital clinicians wanted in ALS training and where the gaps were in the ALS training courses being delivered at the time. This first article was important because the literature showed that prehospital resuscitation was associated with high morbidity, yet the literature suggested that the prehospital perspective and context was not consistently incorporated into the design of ALS resuscitation training courses.

Following completion of the first article, the next phase of the research developed a pilot prehospital cardiac arrest ALS course, using the evidence gathered from the literature review, initial clinician survey and discussion with the expert panel. Chapter 5 outlines the development of the pilot course.

Chapter 4 has been published in the Australasian Journal of Paramedicine, and is not available in this version of the Thesis. The published article is available at:

Reid, D., Jones, R., & Sim, M. (2018). Pre-hospital advanced life support education – core components for pre-hospital professionals. *Australiasian Journal of Paramedicine, 15*(1), article 4. https://doi.org/10.33151/ajp.15.1.565

Chapter 5: Publication Two

5.1 Linking Statement

The previous chapter identified the core components of ALS resuscitation education, based on a comprehensive literature review, and then identified whether current ALS courses reflected the actual experiences of prehospital clinicians, based on a survey of prehospital clinicians' experience of ALS resuscitation training. The previous chapter also outlined the initial literature review undertaken early in this research, which highlighted the core components of cardiac arrest ALS training and also that the prehospital environment is different to the facility-based or in-hospital environment.

This chapter (Publication Two) documents the development of an evidence-based ALS training curriculum, based on a robust process of development, based on a survey of practitioners, interviews with prehospital clinicians and advice from an Expert Panel. The ALS training curriculum was also developed so as to be consistent with current ARC resuscitation guidelines and based on a 'pit crew' approach and the Global Resuscitation Alliance's 'Ten Programs' for improving survival from cardiac arrest (26).

The first publication identified that prehospital perspectives and the out-of-hospital context may not be well incorporated into the design of existing resuscitation training courses and this second publication produced a systematic, evidence-based ALS training curriculum to bridge this gap. This publication provides information on how a prehospital ALS training course could be designed to meet the expressed needs of prehospital clinicians and presents a proposed curriculum for a specific prehospital ALS resuscitation course as means to address the gaps identified in Publication One.

The proposed curriculum was designed in a systematic manner based on a second online survey which built upon the first survey's information, interviews with prehospital clinicians and discussions with an Expert Panel. The first publication demonstrated that there were core components of resuscitation training including technical skills and human factors which are common across all resuscitation environments. The first publication also confirmed that prehospital resuscitation is different to facility-based resuscitation, and that the views of professionals working in the prehospital environment was that ALS training course content did not sufficiently teach the skills specifically needed in the uncontrolled prehospital setting. A follow-up online survey, the methodology of which was outlined in Research Design with results presented in Chapter 4, collected information on the content prehospital clinicians perceived should be incorporated in a prehospital ALS training course.

In this second paper, semi-structured interviews were then conducted either face-to-face or on the telephone with 36 prehospital clinicians. The interviews focussed on identifying the gaps in current ALS training courses and what respondents perceived was needed in a prehospital setting to answer the third research question, that is, how should a prehospital ALS course be designed to reflect prehospital clinicians' actual experiences?

Globally there are three recognised groups which heavily influence ALS training in Australia. The International Liaison Committee on Resuscitation (ILCOR) brings together Resuscitation Councils globally and develops overarching guidelines and recommendations. The ILCOR includes members from Australia, the United States, South Africa, Asia and Europe (158). The ARC is the peak body in Australia, developing, based on ILCOR recommendations, resuscitation guidance for the Australian environment. The ARC includes members as diverse as Australian ambulance services, Australian Red Cross, Surf Life Saving Australia, Australasian College of Paramedicine, critical care nursing and St John Ambulance (159). More recently the Global Resuscitation Alliance (GRA) has emerged as a body seeking to advance the implementation of ALS training guidelines through a Resuscitation Academy model, specifically outlining a 10-step approach to improving resuscitation outcomes (160, 161). It was important that as part of this research the views of these organisations were considered and factored into the research questions. An Expert Panel was formed to assist in that regard.

The Expert Panel were approached and selected for their academic, clinical, and research knowledge. Each of the panel members has been involved in developing prehospital resuscitation processes and protocols making them experts in their field, and open to new ways of working. Following completion of the interviews the Expert Panel of 10 educational, clinical and resuscitation experts was consulted face-to-face, via email or telephone on suggested prehospital ALS training content, and their input and suggestions incorporated into the prehospital ALS curriculum. Expert panels are reported to be an effective means of validating and confirming research (150-152). The Expert Panel recruited for this study consisted of clinical and academic experts, many with both credentials, from a range of specialties and all with prehospital experience. Two members of the Panel were members of the Australia and New Zealand Resuscitation Council, and the panel included international experts in prehospital resuscitation. Given the expert nature of the Panel, discussions allowed for individual panel members to provide detailed information in relation to prehospital ALS training content and the areas which they considered were critical in prehospital ALS training. The breadth and influence of the Expert Panel was important for the research to drive innovation in prehospital resuscitation. Members of the Expert Panel are key innovators in resuscitation and will diffuse and drive change to improve standards in education for prehospital clinicians (162).

Development of the pilot course concluded that it should closely follow the ARC ALS course, with some key differences in relation to equipment, team composition and scenarios Additionally, this phase of the research found that team and bystander debriefing was important as part of a prehospital cardiac arrest ALS course. Following completion of pilot course development, it was piloted with a group of prehospital care providers. Chapter 6outlines the pilot process and the results of the pilot.

Chapter 5 has been published in the Australasian Journal of Paramedicine, and is not available in this version of the Thesis. The published article is available at:

Reid, D., Sim, M., Beatty, S., Grantham, H., & Gale, M. (2020). Pre-hospital advanced life support resuscitation – a curriculum for pre-hospital education. *Australasian Journal of Paramedicine, 17,* 1-7. https://doi.org/10.33151/ajp.17.757

Chapter 6 : Publication Three

6.1 Linking Statement

The previous chapter identified the curriculum for a pilot ALS resuscitation training course based on a survey and interviews with prehospital clinicians, and the input of an Expert Panel. The previous phase of the research concluded that it should closely follow the ARC ALS course, with some key differences in relation to equipment, team composition and scenarios Additionally, this phase of the research found that team and bystander debriefing was important as part of a prehospital cardiac arrest ALS course. This chapter (Publication Three) describes a pilot of the prehospital ALS resuscitation training course curriculum, based on evidence from previously published papers on the need for a specific prehospital ALS resuscitation course (Publication One), and the development of a curriculum (Publication Two). Publication Three seeks to address the third Research Question, that is, to what extent did a pilot prehospital ALS training course meet participants' education needs to deliver resuscitation in the prehospital environment?

To support delivery of the pilot ALS training course, based on the ALS2 course as developed by the Australian Resuscitation Council and Resuscitation Council (UK) in a joint initiative, a substantial suite of training documentation and material was developed as outlined in Table 6.1. Documentation included a facilitator guide, candidate joining instructions, feedback paper, MCQ paper, lectures, scenarios, and flowcharts. This material is available on CloudStor and a link is provided in Appendix B: List of Training Material.

File Code	Name	Content
Admin-01	Facilitator Guide	Course facilitator guide
Admin-02	Candidate Guide	Candidate joining instructions
Admin-03	Course Evaluation	Candidate feedback on course
Exam-01	Pre-Course MCQ Paper	Pre course multiple choice quiz
Exam-01a	Pre-Course ECGs	Pre course ECGs to support multi-choice paper
Exam-02	Blank Answer Grid	Blank MCQ paper answer grid
Exam-03	MCQ Answers	MCQ answer grid (not for candidate release)
Lect-01	Prehospital ALS Lectures	PowerPoint lectures for the prehospital ALS course
CastTeach-01	CasTeach Scenarios	Scenarios to support the CasTeach program
CasPrac-01	CasPrac Scenarios	Scenarios to support the CasPrac program

File Code	Name	Content
App-01	Team Resuscitation Flowcharts	Visio flowcharts of team-based resuscitation processes

Paragraph removed for Copyright reasons

ARC Course Component	Sub-Component	Pilot Course Additions	Key Difference(s)
Pre-Course Quiz	Pre-Course Quiz		The pilot course quiz included questions from the ALS1 quiz, however focussed on care in the prehospital environment.
Theory Lectures	ALS in perspective		Cardiac arrest In the prehospital environment was presented including aetiology, influences on survival and dealing with the prehospital environment,
	Causes and prevention of cardiac arrest		
	Acute coronary syndromes		This section was reduced for pilot course.
	ALS treatment algorithm		The treatment algorithm in the prehospital context was presented including varying team roles (eg including bystanders) as well as varying the number of team members present from 2 to 5.
		Team based care	An additional topic on team-based care and working with rescuers with differing skill level was included.

ARC Course Component	Sub-Component	Pilot Course Additions	Key Difference(s)
		Human factors in resuscitation	An additional topic on human factors and leadership was included in the pilot course.
	Post resuscitation care		The importance of cardiac stabilisation was included in the prehospital pilot course, including post ROSC medications and selection of the most appropriate transport destination. Transport care and considerations were included in the pilot course.
Skills Stations	Airway management Rhythm recognition Defibrillation		Skills were not specifically included in the pilot course, with the pre-requisite that candidates had the defined skills already. A series of
	12-lead ECG Tachycardia and cardioversion Bradycardia and pacing Arterial blood gases		Not included in the pilot course
		A-E patient assessment ALS algorithm Team based resuscitation	Skills relating to the named topics were included in the pilot course as they applied to the prehospital environment.
Special Circumstances	Anaphylaxis Asthma Hypovolaemia Immersion and submersion Poisoing		These were included in the pilot course as discussions rather than scenarios due to limited time.

ARC Course Component	Sub-Component	Pilot Course Additions	Key Difference(s)
	Pregnancy		
Cas Demo 1-4			A series of 12 prehospital scenarios was developed which included between 2-5 team members (rather than standardised team composition as on an ARC course), a range of presenting rhythms and locations which reflected the prehospital, rather than in-hospital, environment.
Cas Teach 5-6			
Discussions	Ethics / DNAR		Included in the pilot course.
		Decisions relating to resuscitation Hot debriefing	Decisions relating to commencing / ceasing resuscitation in the prehospital environment was included. A discussion and approach to hot debriefing of resuscitation teams and bystanders was included in the pilot course.

Table 6.2: Pilot Training Material

In addition to a quiz and theory lectures delivered during the course, 12 scenarios were developed - three standardised teaching scenarios were developed to teach core ALS resuscitation skills in a stepwise approach. An additional nine standardised interprofessional role-based hands-on prehospital scenarios, using mannikins, were then also delivered to embed the prehospital resuscitation skills. The teaching and practical scenarios included varying locations and reversible causes of the cardiac arrest. Table 6.3 outlines a summary of the prehospital scenarios developed for the pilot ALS course.

To reflect a realistic prehospital environment, the number of persons in the resuscitation 'team' was varied from two to five, included a range of rhythm sequences in line with ARC algorithms, and the scenario location was varied as would typically be found in a prehospital environment. During the course some participants also took on the role of non-trained lay-people to give participants experience at responding in a resource-limited environment.

CasTeach/Prac	Rotation	Team	Focus	Location	Rhythm	Reversible Cause
CasTeach 1	CT1	2 HCP + Team	A – E Assessment	Emerg. Dept	VF	AMI
	CT2.1	3 HCP	ALS Algorithm	Small Emerg. Dept	Asystole	AMI
	CT2.2	4 HCP	ALS Algorithm	Small Emerg. Dept	PEA	Pulmonary Embolism
CasPrac 1	CP1.1	2 HCP	Rhythm & Defib	Small Emerg. Dept	Asystole	Asthma
	CP1.2	2 HCP & 1 Non-HCP	Rhythm & Defib	Doctor Surgery	STach ➔ pVT	Anaphylaxis (Hypovolaemia)
	CP1.3	3 HCP & 1 Non-HCP	Rhythm & Defib	Nursing Home	VF ➔ PEA	Hypoxia (Choking)
CasPrac 2	CP2.1	2 HCP	Teamwork	External Environment	Asystole	AMI
	CP2.2	3 HCP & 1 Non-HCP	Teamwork	External Environment	VF ➔ Asystole	Hypokalaemia (D&V)
	CP2.3	2 HCP + 2 HCP (back up)	Teamwork	External Environment	PEA	Hypoxia (Drowning)
CasPrac 3	CP3.1	2 HCP + 2 HCP (back up)	Environment	External Environment	Asystole	AMI
	CP3.2	2 HCP & 1 Non-HCP + 1 HCP (back up)	Environment	External Environment	PEA ➔ Deceased	Cardiac Tamponade
	CP3.3	2 HCP + 2 HCP (back up)	Environment	External Environment	VF	Overdose

Table 6.3: Summary of Pilot Scenarios

This publication is significant, because whilst there has been a range of literature published on the results from facility-based resuscitation courses, there is limited peer-reviewed research on feedback on the content and delivery of specifically tailored and standardised prehospital ALS training courses. This third publication brings together the recommended curriculum from Publication Two and participant feedback (Publication Three) to bridge that knowledge gap.

Following completion of the research, as agreed during the planning for the research, the ALS curriculum, scenarios, and all training material were provided to the National Education Manager for the ARC for use with prehospital clinicians as appropriate. It is noted that the education manager was also a co-author for the second and third papers of this thesis with publication. The education manager was brought on as part of the expert panel after the first phase of the research, and only when it was proven that the prehospital environment was different to the in-facility or in-hospital environment. The other most immediate outcome from the research is a draft amendment to the 2014 Clinical Standards for Resuscitation to specifically identify and recommend those educational components required in prehospital ALS training being submitted to the ARC National Course Coordinator for consideration and review by the member organisations (14).

Following on from this phase of the research, the results from each of the data collection instruments was reviewed and examined in relation to each of the research questions. Presented in the following chapter, the research questions are reviewed, significant of the research highlighted, limitations identified, and recommendations are made.

Chapter 6 has been published in the Australasian Journal of Paramedicine, and is not available in this version of the Thesis. The published article is available at:

Reid, D., Sim, M., Beatty, S., Grantham, H., & Gale, M. (2020). Pre-hospital advanced life support resuscitation training: A pilot of an evidence-based curriculum. *Australasian Journal of Paramedicine, 17,* 1-8. https://doi.org/10.33151/ajp.17.846

Chapter 7 : Discussion

7.1 Introduction

The previous chapters outlined findings from a literature review into the teaching of prehospital cardiac arrest ALS training and the core components which have been identified as good practice. An initial clinician survey provided an overview of their experiences of ALS education and, where appropriate, whether such training reflected their real-world experiences. The structured development of a pilot prehospital cardiac arrest ALS training course was then explored, and this included theory, practical and scenario elements. The involvement of clinicians and input from an expert panel was highlighted. Finally, in the previous chapter the pilot of the prehospital cardiac arrest ALS course was presented. The pilot course included theory and practical elements, including importantly various elements of different team numbers, roles and locations for scenarios. In this chapter the research problem is revisited and discussed in relation to the research conducted. Each research question is reviewed, and recommendations made. The limitations of the research and its significance are presented.

7.2 The Research Problem Revisited

Out-of-hospital cardiac arrest is a leading cause of death in Australia (1, 164) and there is evidence suggesting that out-of-hospital cardiac arrests may have less than half the patient survival rate when compared to in-hospital cardiac arrests (3, 4, 17). Survivability from cardiac arrest has been shown to be multi-factorial and ALS training for the professionals who respond to out-of-hospital cardiac arrests is an important aspect of improving patient outcomes (49). It has been reported that a one-size fits all approach to resuscitation training courses did not fully meet the needs of clinicians working in the prehospital environment because of the environmental factors which may complicate out-of-hospital cardiac arrests and their management (15, 16).

When an out-of-hospital cardiac arrest occurs, first responders, paramedics or other clinicians attached to ambulance, industrial or aeromedical services are often the first providers on scene with the skills and equipment to implement advanced life support. At the time this research commenced, evidence-based ALS training courses had been created for, and the literature reported on, ALS courses designed for healthcare providers responding to cardiac arrests in controlled environments such as hospitals and health care facilities.

The prehospital cardiac arrest resuscitation environment is different to the in-hospital resuscitation environment. There are often no trained healthcare professionals immediately available when a cardiac arrest occurs in the out-of-hospital environment and small teams of lay responders typically

deal with cardiac arrests initially in the out-of-hospital setting, followed by teams of professional ambulance staff (41-43). Out-of-hospital cardiac arrests, when compared to those that occur in an in-hospital environment are more complex in relation to the physical environment, bystander behaviour and the requirement to transport patients in a moving vehicle to definitive care (16).

There has been a significant volume of research into resuscitation education, however the majority found was focussed on preparing professionals to administer ALS in the hospital setting. At the time this research commenced the literature on prehospital resuscitation appeared to focus on reporting patient outcomes and comparing the outcomes to in-hospital outcomes. There did not appear to be any standardised ALS training courses or curriculum specifically tailored to performing resuscitation in the prehospital environment, or any discussion about how such bespoke training could improve patient outcomes.

Between 2015 and 2020 the ILCOR conducted 39 systematic reviews, one of which focussed on prehospital resuscitation issues and specifically the control of life-threatening external bleeding in the out-of-hospital setting (165). A search of the ARC website found that Guideline 11.1 focuses on an introduction to and principles of in-hospital resuscitation (13). There was, however, no specific guidance on prehospital resuscitation.

This research sought to determine which educational elements of an ALS training course are required to address the gaps between the current training developed in hospital environments and the actual experience of delivering resuscitation in the prehospital setting. In this research, a training course tailored for the out-of-hospital environment was developed. The self-reported preparedness of healthcare professionals, who participated in this training course, to perform resuscitation in the prehospital setting was subsequently assessed.

The Global Resuscitation Academy (part of the GRA) outlines 10-steps to improve resuscitation outcomes with a focus on systems (160). Step 3 of the Academy's process indicates that high performance resuscitation in the prehospital setting is a critical step in the process of improving outcomes from resuscitation. This research adds to the Academy's recommendations, which are largely technical in nature (that is, hand position, compression depth and roles of rescuers), by suggesting a curriculum to train prehospital clinicians in effective out-of-hospital ALS should also include specific scenarios, define roles and responsibilities, and include education on a suite of human factors that impact the outcome of resuscitation efforts.

The involvement of and consultation with prehospital clinicians, the use of an Expert Panel to validate participant feedback, reporting at conferences, and the publication of three manuscripts

builds momentum to acknowledge the uniqueness of out-of-hospital resuscitation and the importance of developing specific ALS educational interventions which may lead to improved patient outcomes. The research investigated four research questions, each addressed in one of three studies discussed in the following sections of this chapter.

7.2.1 Research Question One: What, according to the published literature, are the key components of effective ALS training? and Research Question Two: To what extent did current ALS training courses reflect the actual resuscitation experiences of prehospital clinicians?

The aim of resuscitation training courses is to "ensure that learners acquire and retain the skills and knowledge that will enable them to act correctly in actual cardiac arrests and improve patient outcomes" (50 p.243) and it is therefore essential to understand what, according to the published literature, were the key components of effective cardiac arrest ALS training. After the core components of ALS resuscitation were identified, it was then important to determine whether they were included in prehospital ALS training courses to determine whether best practice was being followed, and to identify the gaps in prehospital ALS training. Current training in resuscitation focuses on in-hospital or in- health facility settings, and therefore doesn't address the environmental factors that may complicate out- of-hospital resuscitation. Hence, the need to research resuscitation training that better suits the out-of- hospital environment

Several parallel themes emerged from the literature and the survey of prehospital clinicians and their experiences of ALS resuscitation courses. Providing pre-reading for participant may be a component required as part of ALS training courses in order to ensure candidates have the required level of prerequisite theoretical knowledge (83), and 74% of survey respondents in this research indicated that their course included pre-reading, with 80% indicating that the pre-reading improved their understanding of the theoretical aspects of resuscitation. Likewise, course length should be tailored to the needs of the participants, with longer courses allowing participants to practise their skills between sessions. However, the literature identified that overall, candidates did not show any discernible difference in their level of knowledge, based on course length (73, 80, 81).

Increasing time constraints on already time-poor clinicians has seen the introduction of computer-aided learning and augmented reality as an alternative or adjunct to face-to-face ALS training courses. The evidence from the literature was that ALS training courses require an element of face-to-face teaching, with computer-based learning improving theoretical knowledge, but not practical skills (49, 51-54, 65, 84, 85). The literature concluded that ALS training courses required pre-reading prior to the course, with practical skills taught face-to-face (88).The best practice approach identified

in the literature was confirmed in this research, with all survey respondents indicating that their ALS training course had an element of face-to-face training.

The literature indicated that best practice cardiac arrest ALS training courses include a face-to-face element. As such, it is important that training be realistic and conducted in environments that the participant is likely to encounter in the workplace, using simulation (55-57, 86). Simulation allows for technical and non-technical skills to be practiced in a safe environment (58-64, 73, 84, 87). Over 95% of survey respondents in this research indicated that their ALS training courses included simulation. Realism in training is vital, and instructors should create scenarios which reflect the learners' own working environment (56, 86, 89). Scenarios should be run on a realistic time-frame to reflect the real world environment (93). Half of the survey respondents in this research indicated that they had previously completed courses which did not reflect their working environment. Almost a third of survey respondents indicated that their ALS training scenarios were situated in an emergency department (29%) or hospital ward (28%). A quarter indicated scenarios included a home environment such as kitchen or lounge, with 68% of respondents indicating at least one scenario in a prehospital environment. Although this appeared to be a positive result, only 35% of respondents indicated that their real resuscitation experience was 'almost identical' or 'very similar' to their training environment. Almost a quarter of survey respondents indicated that the equipment used in their ALS training was 'somewhat' or 'very' different to the equipment they used in real resuscitations in the prehospital environment.

The literature indicated that simulation fidelity, although improving candidate feedback, did not have a direct influence on candidate ALS competency. The literature concluded that the environment in which the simulation was taking place was more important than the fidelity of the resuscitation mannikins themselves (50, 63, 66, 90-92, 94).

Human factors, originating from aviation, have become an increasing important aspect of healthcare delivery, and ALS resuscitation requires effective teamwork, clinical decision making, care and leadership (65-69, 76, 86, 96-101). Thirty-seven per cent of survey respondents in this research indicated that leadership during their actual resuscitations was different to that encountered on their ALS training course and they commented on the need to improve teamwork during resuscitation education.

Competency assessment was identified in the literature as being a core component of ALS training (50, 66, 73-82). There was mixed evidence for the type of assessment, being either continuous or end-of-course assessment. A key recommendation from the literature was that assessment should utilise Kirkpatrick's four-level model to evaluate learning (105, 106). This model may be a suitable

model to include in prehospital resuscitation training courses because it included reaction (participant satisfaction), learning (knowledge, skills, and attitudes), behaviour (translation of learning to clinical setting), and patient outcomes.

The recognition that the prehospital environment presents unique challenges which are not fully reflected in all current training programs provided a compelling motivation to develop a specific evidence-based prehospital ALS training program. The first publication had identified the core components of ALS education and provided information on prehospital clinicians' experience in relation to their ALS training and their actual resuscitations. In the second phase of the research this information was scaffolded to identify the components of an effective prehospital ALS training course.

7.2.2 Research Question Three: How should a prehospital ALS course be designed to meet the needs of prehospital clinicians?

Following on from the first two research questions which provided a framework for good practice in ALS education, a follow-up survey and semi-structured interviews with review by an Expert Panel were used to collect data to determine how a prehospital ALS training course should be designed to meet the needs of prehospital clinicians and reduce the gaps in best practice identified from the literature review and first survey. The development of a prehospital ALS training curriculum followed the principles of adult learning as outlined in the Methodology Chapter. The survey, using weightings from a Likert scale (116, 117), of strongly agree (WS 5) to strongly disagree (WS 1), asked respondents for their views on the content of a prehospital ALS training course, based on the recommended core components as identified in the literature review. Further exploration of course content, delivery and simulation were then undertaken via semi-structured interviews with 36 prehospital clinicians.

Respondents strongly agreed that a prehospital ALS course should follow ARC guidelines, contextualised for the prehospital environment (WS 4.4). The provision of pre-reading was supported by respondents (WS 3.8) as was as pre-course quiz. There was variation in terms of the preferred length of the quiz. Interviewees and the Expert Panel also identified that pre-reading and a quiz were important components of a prehospital ALS training course. In response to this finding the ALS course developed in this research provided pre-reading to participants. The ALS training course developed in this research followed ARC guidelines.

Utilising equipment available in the prehospital setting was strongly supported by respondents (WS 4.5), as was attention to the team composition typically found in the prehospital setting (WS 4.3). Delivery methods in terms of the ALS training course being delivered either fully face-to-face or via a

mix of online and face-to-face attracted variable support. While survey respondents agreed that the ALS training course should be taught in a mixed mode (WS 4.0), half the Expert Panel indicated the course should be fully face-to-face. At interview, the disparity was explained in relation to the Expert Panel indicating that the pre-reading could be considered an online component, thus freeing up time on the face-to-face element for scenario training. The ALS training course developed in this research was therefore designed to be taught face-to-face with the only online component being the pre-reading sent to participants in advance.

Theory components of a prehospital ALS training course were identified in this research as being recognition of the deteriorating patient (WS 4.6), ALS treatment algorithm (WS 4.6) shockable and non-shockable rhythms, (WS 4.6), as well as decisions relating to starting or stopping resuscitation (WS 4.5) and post resuscitation care (WS 4.5). The inclusion of human factors in an ALS training course were supported by both survey respondents and interviewees. The elements of human factors most strongly supported were team communication (WS4.3), critical thinking (WS 4.2), and leadership skills (WS 4.1). In response, the ALS training course developed in this research implemented three theoretical components, being lectures, skills stations, and discussions (Table 7.1).

Lectures	Skills Stations	Discussions
• Prehospital cardiac arrest in perspective • Causes of cardiac arrest in the prehospital environment • Team based ALS resuscitation • Human factors in resuscitation • Post resuscitation care and transport	• A-E patient assessment • ALS algorithm reminder • Team-based approach to prehospital resuscitation	• Decisions relating to resuscitation • Hot debriefing

Table 7.1: ALS Course Theory Components

Survey respondents, interviewees and the Expert Panel agreed that technical skills such as drug administration should be assumed knowledge. The ALS training course developed in this research assumed that causes of cardiac arrest; the ALS treatment algorithm; and patient assessment were all known by the participants. Skills including airway management, ventilation, drug administration, and

defibrillation were also considered to be assumed knowledge. The pre-reading provided did however, provide an opportunity for participants to review these elements of prehospital resuscitation.

The literature review identified that scenarios, tailored for the environment in which course participants would be working, were a core component of a prehospital ALS training course. Respondents to a survey conducted as part of this research supported scenarios in outdoor areas (85% of respondents), homes or offices (79%) and ambulance vehicles (76%). Other scenario locations identified as suitable included small emergency departments, GP surgeries, and nursing homes, because each of these areas were resource limited. There was strong agreement that scenarios should use varying numbers of responders, including lay responders, as would be found in the prehospital environment. In response to the findings, the ALS training course developed in this research included a series of practical scenarios (Table 7.2).

CasTeach/Prac	Rotation	Team	Focus	Location	Rhythm	Reversible Cause
CasTeach 1	CT1	2 HCP + Team	A – E Assessment	Emerg. Dept	VF	AMI
	CT2.1	3 HCP	ALS Algorithm	Small Emerg. Dept	Asystole	AMI
	CT2.2	4 HCP	ALS Algorithm	Small Emerg. Dept	PEA	Pulmonary Embolism
CasPrac 1	CP1.1	2 HCP	Rhythm & Defib	Small Emerg. Dept	Asystole	Asthma
	CP1.2	2 HCP & 1 Non-HCP	Rhythm & Defib	Doctor Surgery	STach ➔ pVT	Anaphylaxis (Hypovolaemia)
	CP1.3	3 HCP & 1 Non-HCP	Rhythm & Defib	Nursing Home	VF ➔ PEA	Hypoxia (Choking)
CasPrac 2	CP2.1	2 HCP	Teamwork	External Environment	Asystole	AMI
	CP2.2	3 HCP & 1 Non-HCP	Teamwork	External Environment	VF ➔ Asystole	Hypokalaemia (D&V)
	CP2.3	2 HCP + 2 HCP (back up)	Teamwork	External Environment	PEA	Hypoxia (Drowning)
CasPrac 3	CP3.1	2 HCP	Environment	External Environment	Asystole	AMI

CasTeach/Prac	Rotation	Team	Focus	Location	Rhythm	Reversible Cause
		+ 2 HCP (back up)				
	CP3.2	2 HCP & 1 Non-HCP + 1 HCP (back up)	Environment	External Environment	PEA ➔ Deceased	Cardiac Tamponade
	CP3.3	2 HCP + 2 HCP (back up)	Environment	External Environment	VF	Overdose

Table 7.2: Course Prehospital ALS Scenarios

There was variation in terms of the preferred length of the course, with respondents to a survey conducted as part of this research identifying either a one or two-day course based on the finalised content. Respondents to the research survey agreed that theory elements (WS 3.9) and case studies were important (WS 4.), and there was a strong preference for practical skills (WS 4.7) and scenarios (WS 4.7). This finding was confirmed by the interviews. In response, the ALS training course was run over one day in a face-to-face mode.

There was support from respondents for continuous assessment throughout the ALS training course (WS 4.4), including both theoretical knowledge and the implementation of skills in a scenario setting. Survey respondents indicated a preference for a Statement of Attainment to be provided at the end of the course (WS 4.4) and recertification occurring every two to three years (83% of respondents). The Expert Panel indicated a preference for strong governance over the ALS training course, with instructors being approved by the ARC. In response to the findings, the ALS training course implemented a quiz, testing theoretical knowledge. A Certificate of Participation was issued to each participant.

At the end of the second phase of the research a robust, evidence based prehospital ALS resuscitation training course had been developed and validated through a survey, semi-structured interviews, and review by an Expert Panel. In the final phase of the research the course was piloted, to address the fourth research question, whether the curriculum developed in this research met the educational needs of prehospital clinicians.

7.2.3 Research Question Four: To what extent did a pilot prehospital ALS training course meet participants' educational needs to deliver resuscitation in the prehospital environment?

The final component of this research involved piloting the tailored prehospital ALS training course to assess the extent to which the course met participants' educational needs to deliver resuscitation in the prehospital environment. The course was run 13 times, and 66 participants provided feedback on whether the prehospital ALS training course met their needs.

The theory quiz was based on the ARC ALS2 quiz. The quiz was delivered at the start and end of the course, was validated using the Cronbach Alpha (166, 167) score (α=0.9), and showed an acceptable level of consistency prior to administration with the ALS training course participants. Course participants showed a statistically significant (t=-6.5, DF=65, p<0.01) improvement in their theoretical knowledge of resuscitation after completing the course. Whilst both degree-qualified and non-degree-qualified participants showed an improvement in theoretical knowledge, it was the degree-qualified participants who scored highest on the quiz after the training course. There was no statistical difference between participants who reported completing course pre-reading and those who reported they did not complete course pre-reading (t=0.25, DF=50, p=0.80). There was mixed feedback from participants in relation to the quiz, with around two-thirds indicating that the quiz was too challenging to be completed during the course.

The ALS training course included a range of theory topics and over 90% of course participants indicated the lectures, case studies and discussions met their needs in relation to:

- Cardiac arrest in perspective
- Causes of prehospital cardiac arrest
- Team-based ALS resuscitation
- Human factors in resuscitation
- Post resuscitation care and transport
- A-E patient assessment
- ALS algorithm
- Decisions relating to resuscitation, and
- Hot debriefing

A series of 12 prehospital scenarios were contained within the ALS training course. Each scenario included different numbers of team members, different roles (including lay responders) and varying prehospital locations, including small medical centres, outdoor locations, indoor locations, and ambulance vehicle, to simulate typical prehospital environments. Ninety-eight per cent of

participants reported in the course feedback survey that the skills and scenarios taught met their needs for implementation in real resuscitations. Over 90% of participants agreed that:

- The course was the right length
- Equipment was relevant to the prehospital environment
- Team mix (mix of roles) was relevant to the prehospital environment
- Team numbers were relevant to the prehospital environment, and
- Scenario locations were relevant to the prehospital environment

There were six identified learning outcomes for the prehospital ALS training course, and all course participants reported that the learning outcomes were either fully or partially met, with the results summarised in Table 7.3. This result compared favourably to findings from ARC ALS1 courses, where respondents indicated that ALS1 course outcomes were fully or partially met 96%-99% of the time (168). All but three of the ALS training course participants indicated that the course was entirely relevant to their practice, with the other three indicating it was partially relevant. Of the participants who indicated the course was partially relevant, one was a medical practitioner, one a registered nurse and one a non-degree-qualified participant. The Expert Panel indicated that the course learning outcomes were relevant and appropriate for a prehospital ALS training course.

Learning Outcomes	Fully Met	Partially Met	Not Met	Total
Management of the patient in cardiac arrest in the prehospital setting using the Australian Resuscitation Council cardiac arrest algorithm	92%	8%	0%	100%
Identify and treat the prehospital reversible causes of cardiac arrest using a structured team-based approach	88%	12%	0%	100%
Recognise non-life sustaining cardiac rhythms, delivering appropriate safe defibrillation therapy when indicated	85%	15%	0%	100%
Lead and be a constructive member of a prehospital resuscitation team	92%	8%	0%	100%
Plan the management and safe extrication and transfer/care of the post resuscitation patient	88%	12%	0%	100%

Learning Outcomes	Fully Met	Partially Met	Not Met	Total
Recognise life extinct and conduct hot debriefing on scene	87%	13%	0%	100%
Overall learning needs	85%	15%	0%	100%

Table 7.3: ALS Course Learning Outcomes

Ten participants had previously undertaken an ARC ALS training course. Seven indicated that the prehospital ALS training course developed in this research was more relevant than the ARC course they previously attended, with three (one a medical practitioner, one a registered nurse and one a paramedic) indicating it had the same relevance. None of the participants indicated that the ALS training course was less relevant than the ARC course they had previously attended.

Recommendations from the ALS training course developed in this research included making the course quiz a pre-requisite and spending additional time on patient assessment and information on cardiac catheterisation after cardiac arrest. Whilst there was some variance of opinion amongst the Expert Panel in relation to the inclusion of debriefing bystanders and breaking bad news to families, ALS training course participants and the consumer representative were strongly supportive of including these elements.

The results from the ALS training course developed in this research indicated that a tailored prehospital ALS course met participants' needs and improved their self-reported ability to implement high-quality ALS resuscitation in the prehospital environment.

7.3 Recommendations from the Research as a Whole

Taken together, the primary recommendations from this research project are as follows:

1. The core components of ALS resuscitation training are the same for the in-hospital and out-of-hospital environment. These include theory lectures, case studies and technical skills. Course delivery and timing can be adjusted to suit the audience and final agreed level of content. The prehospital ALS training course, however, requires a modified curriculum.
2. Prehospital ALS courses should include a pre-course quiz focussing on the application of ARC resuscitation guidelines to the prehospital resuscitation environment.
3. Prehospital ALS courses should include scenarios reflecting the prehospital environment. Specifically:
    a. Using equipment commonly found in the prehospital environment. For instance, response bags and oxygen bags rather than equipment trolleys and piped oxygen.

b. Scenarios that vary the mix of roles. For instance, paramedic/nurse/doctor or paramedic team plus lay responder/s.
c. Varying the number of responders in scenarios to reflect the prehospital environment where human resources may be limited.
d. Conducting scenarios in the prehospital environment. For instance, small (human resource limited) emergency department or GP surgery, indoor and outdoor locations (for instance, sidewalk, lounge room, bathroom, etc.).

4. Training on hot debriefing and breaking bad news should be included in a prehospital ALS training curriculum.

7.4 Research Strengths and Limitations

The findings from this research need to be considered in the context of several limitations. This section outlines the strengths of the research methodology as well as the limitations which need to be contemplated when considering the results. While strengths and limitations of each individual published paper are discussed in their respective chapters, the overarching strength of this research is the use of the mixed methods approach, including quantitative and qualitative data, to address the research questions (169, 170), linked to the published literature and confirmed by an Expert Panel.

7.4.1 Research Significance

The Australian Resuscitation Council has published guidelines for in-hospital resuscitation including principles for training, however none could be identified specifically for pre-hospital resuscitation (13, 14). At the time this research commenced a literature review was unable to identify specific standards for prehospital ALS cardiac arrest training or identify a systematically researched curriculum. The importance of having a specific prehospital curriculum is highlighted by the poor patient outcomes in this setting as identified in previous research (3, 4, 17).

However, there is a risk that, as with all research, there is no need to answer the question posed. The fact that the topic is of interest to the researcher does not make it worthy of investigation alone (171). Information from the literature review, confirmed by data collected in the first clinician survey, demonstrated that out-of-hospital cardiac arrests have worse outcomes than those that occur in hospitals, and that current ALS education may not prepare providers adequately for the prehospital environment. It was therefore concluded that the topic was worthy of further investigation to potentially improve survival from out-of-hospital cardiac arrest. Mitigating the risk that the research is insignificant is the involvement of the Expert Panel, as well as key representatives from the ARC. As agreed during the planning for this research, the ALS curriculum,

scenarios, and all training material were provided to the National Education Manager for the ARC for use with prehospital clinicians as appropriate. The other immediate outcome from the research is a draft amendment to the 2014 Clinical Standards for Resuscitation (14) to specifically identify and recommend those educational components required in prehospital ALS training has been submitted to the ARC National Course Coordinator for review by the member organisations.

7.4.2 Mixed Methods Approach

Mixed methods research involves the combination of two or more research methods, however there may be a tension within a mixed methods approach between diverse philosophical positions (145, 172). Although some authors have indicated that, within mixed methods research the qualitative and quantitative approaches exist in their own right and should have separate paradigms, others have called for more flexibility in mixed methods research (172). The mixed methods approach to research, combining qualitative and quantitative data, should be treated with caution, given the inherent limitations of each approach in themselves, which may be magnified when both methods are combined (173). In this research, this limitation was addressed by reviewing the literature, conducting multiple surveys, conducting interviews, as well as the review of findings by an Expert Panel. The constant checking and rechecking of findings, triangulated between each data collection method and merging of data and information reduced the likelihood that the findings and conclusions were misleading (145, 171). Additionally, Creswell has indicated that a mixed methods approach provides an opportunity to develop new knowledge based on ‘what works’, valuing both subjective qualitative information and the objective quantitative information (145).

7.4.3 Interpretivist Paradigm

A paradigm is an epistemological stand that determines the type of questions which are asked during research (172). The interpretivist paradigm is socially-constructed and the goal of research taken from this perspective is to understand experiences from the point of view of the research participants (172). Drawing conclusions from a small pool of individuals therefore relies on their experiences being representative of the greater population. If the research participants’ experiences do not reflect the greater experience, then conclusions from the research may be misleading. This research sought to minimise errors drawn from an interpretivist paradigm by reviewing the literature, conducting multiple surveys and interviews, and having findings reviewed by an Expert Panel. Connecting the data creates confidence that the conclusions can be audited back to multiple sources, and are therefore valid (145).

7.4.4 Research Methodology

Online Surveys

Whilst surveys are a cheap, and easily accessible means of collecting data they have several potential limitations (174, 175). The researcher was required to develop a survey as no validated prehospital resuscitation surveys could be found. This meant that the length, question types, comprehensibility and display of the survey needed careful consideration. The validity of the survey was confirmed by pre-testing and review as described in Chapter 3: Research Design and Methodology.

The survey on prehospital resuscitation training was limited by self-respondents. It was only available online and as such respondents had to have to have access to the internet. The snowball recruitment approach to the first survey was limited in that recruitment relied on advertising through social media, email and word of mouth (126, 127). As such, this approach is likely to attract those with a particular interest in prehospital resuscitation, that is self-selection bias. When answering the questions on their experiences respondents may have been influenced by recall bias. Attracting respondents who may already have an interest in prehospital resuscitation may have resulted in findings that are skewed towards the positive because the participants already had a positive opinion on the need for a specific prehospital ALS training course. Snowball approaches are also self-limiting in that they rely on personal contacts to source the initial cohort of research participants. It was not possible to estimate the total pool of potential respondents as the survey was conducted across Australia and included a range of healthcare professionals and first responders. The total population could not be estimated.

Surveys do not allow for an interviewer to be present to probe participant responses, although interviews were conducted in a latter phase of the research. Response rates for surveys may also be low. In this research not every respondent completed the survey in full, and this may have reflected their prehospital experience or the length of the survey. Surveys, such as the first one in this study, which are anonymous, do not allow for authentication. This limitation was partially addressed by allowing respondents to provide their contact details if they wished to discuss prehospital resuscitation further, including participating further in the research.

Interviews

Interviews provide a rich source of data for qualitative research, however are subject to limitations such a time pressure and intrusiveness (176). Interviewee characteristics, such as age, gender and experience may have influenced their knowledge and perspective on the research questions (177). The interview participants in this research were drawn from a wide cohort of prehospital clinicians with a range of experience, across Australia and the United Kingdom. An interview needs to

engender trust between the interviewee and respondent, and runs the risk of leading a respondent if they are not answering how the interviewer wants, or not providing sufficient information for the research (176). The use of the interview guide in this research ensured that all interviewees were asked the same questions, whilst also, within the semi-structured approach, allowing for in-depth exploration of themes identified by interviewees. Another limitation is the self-selection of interviewees. In this research each interviewee had an interest in prehospital resuscitation and therefore may have been biased towards the need for a prehospital resuscitation course (176). Interview information is taken at face value and the researcher therefore had to be cautious in drawing too extensive inferences from single interviews (178). In this research, triangulation with surveys, the literature review and Expert Panel consultation provided confidence that interview findings were robust (171). Additionally, thematic saturation was reached as evidenced by key themes being consistent through the interviews (141).

Pilot Courses

Pilot training programs have potential limitations in that by their nature they are 'experiments' and as time continues the approach typically evolves. As such initial results may not hold if the pilot course delivery, duration, or content changes significantly. Depending on the types of participants, their views may be either poorly informed due to their limited experience (in the case of university students) or biased towards the need for a course (in the case of qualified paramedics who agreed to participate). This research delivered a standardised ALS training course, with the same curriculum delivered to all participants, thus making the findings of each comparable between each course and in their totality.

While the self-reported impact of the ALS training course on participants' knowledge and skills were assessed in this research, the outcomes in terms of the impact of the training on out-of-hospital cardiac arrests was not able to be measured. This means that, whilst the ALS course participants' views on improved ability to perform prehospital resuscitation were captured, actual implementation and patient outcomes were not as they were beyond the scope of this research. This study was undertaken at a point in time. Taken at a point in time does not allow for long-term cause and effect relationships to be examined, or for the effects of changes in variables, (for example, implementation of the prehospital ALS training course impact on patient outcomes) to be reported upon (179).

There is also a possibility that individuals' self-reported improvements in terms of their confidence and resuscitation skills was not as accurate as an objective external assessment of these outcomes (180). Whilst the participant feedback was supplemented by an objective theoretical knowledge

quiz, delivered at the start and end of the course, further research would benefit from objective researcher observations being taken during future iterations of the ALS training course, as well as longitudinal outcome measures being implemented after the course completion and participants are back in the workplace.

7.4.5 Sampling Error

There is a risk that the sample selected does not represent the prehospital workforce and their experience or needs in prehospital resuscitation, thus resulting in sampling error (108, 177). The sample utilised for the surveys, based on a snowball approach, the ALS training courses, being primarily from an industrial emergency medical service, and the Expert Panel, all with an interest in prehospital resuscitation each have inherent limitations (171). Whilst self-selection of survey participants and Expert Panel interest in resuscitation may lead to bias in terms of their views on the need or not for a prehospital ALS course, an inherent interest means that the research participants are generally well informed and understand resuscitation and the prehospital environment, thus making them informed participants.

It is important when considering the research to determine whether the appropriate level of investigation depth has been reached (171). The purpose of the research was to determine whether a prehospital ALS training course could improve prehospital clinicians' confidence and ability to perform ALS resuscitation. To accurately answer this overarching question, it was appropriate to consider, in depth, underpinning theory in the literature, participants' actual experiences of resuscitation and their feedback from the ALS training course developed in this research.

7.4.6 Data Analysis

Analysis of data from the publish research requires caution. For example, Andersen has identified the likelihood of variability between countries in both incidence of and survival after in-hospital cardiac arrest (3). Differences occur because of varying definitions used to identify in- hospital cardiac arrest, the use of registries, patient characteristics and demographics, and country-specific culture including incidence of bystander cardiopulmonary resuscitation, do-not-resuscitate orders, and withdrawal of care.

Data analysis through the use of NVivo® and the use of a bracketing technique can lead to bias, as thematic codes were determined by the researcher (171). Bias was, however, minimised by regular coding, reviewing codes against interview themes, and matching the coding to the findings in the literature review (171). Findings from each of the surveys and interviews had peer review conducted by the Expert Panel, thus providing a further layer of review to ensure findings were as free from bias as possible (171). Systematic error, which occurs when consistent but inaccurate

analysis occurs, is a potential limitation of the study (177). Systematic error was avoided in this research through triangulation of findings between multiple data points. However, this potentially resulted in correlation error, which incorrectly identifies relationships between variables which in reality do not exist (177). The likelihood of correlation error was reduced by not over-emphasising any single finding and ensuing that each research conclusion could be audited back to multiple points of origin (177).

7.4.7 Level of Evidence

This research has used an approach which is at a low level of evidence as defined by the NHMRC (181). For example, the literature review was a descriptive review, rather than a systematic review. The literature review approach raises a risk of bias, inherent in all interpretations of literature, and this was minimised through the peer-review process as well as standardised checklists to confirm the quality of research reviewed. To confirm the conclusion of this research would require a randomised control trial of prehospital clinicians, with and without specific prehospital ALS training, then comparing the training to patient outcomes following prehospital resuscitation. Such a study was beyond the scope of this PhD research and would require considerable ethical justification and a robust research methodology to account for all the variables present in the prehospital environment.

7.4.8 Generalisability of Findings

Another limitation of this research that should be acknowledged when interpreting the results is the lack of generalisable findings. Each study utilised information from a small selection of prehospital clinicians, whether that be survey, interview, or participation in the ALS training course. Replication of this research with a broader, larger, and randomised sample of prehospital clinicians, particularly ambulance service employed providers, would be necessary before findings could be generalised.

7.4.9 Workplace Implementation

Adoption of new ways of working can be challenging in a workplace environment and the ALS course curriculum resulting from this research has not been widely adopted and evaluated in prehospital workplaces. Diffusion of Innovation Theory seeks to explain why barriers may exist and influence the rate of adoption. According to Diffusion of Innovation Theory, considering a new way of working helps to identify which aspects of change management require focus to improve update in the workplace environment (182, 183).

Whilst it was beyond the scope of this research to examine the adoption of the prehospital ALS resuscitation training course developed in this research, diffusion of innovation elements has been considered in course design to make it feasible for the recommendations to be adopted. Five (182, 184) elements have been considered as outlined in Table 7.4: Diffusion of Innovation in Action.

Diffusion of Innovation in Action	This Research
Desirable versus undesirable change	The change is desirable as one means to potentially improve patient survivability from prehospital cardiac arrest.
Direct versus indirect change	Direct change is possible as the new ALS training course curriculum does not require significant new equipment or changes to underpinning ALS processes.
Anticipated versus unanticipated change	The change can be anticipated, planned in advance, and implemented over time.
Public versus private	The curriculum is suitable for the private and public sectors.
Benefits versus costs of change	The curriculum can be implemented at low cost as there is no requirement for significant new capital investment.

Table 7.4: Diffusion of Innovation in Action

Chapter 8 : Further Research and Conclusion

8.1 Further research

A strength of a mixed methods approach is the focus on the research questions in the context of research participant experiences (145). This research, whilst useful for developing a framework for prehospital ALS training, requires further research in the prehospital workplace and more specifically additional research to examine patient outcomes.

The cardiac arrest ALS resuscitation training course developed in this research could be replicated with a larger, randomly selected cohort of participants, specifically from State Ambulance Services, to improve the breadth of feedback in relation to whether the course meets their educational needs for delivering high-quality ALS resuscitation training in the prehospital environment. As a component of widening the research participant pool, elements of researcher observation could be incorporated, to provide further evidence in relation to participants' self-reported preparedness to conduct prehospital resuscitation, which has been suggested as being a limitation of this research (180). This research focussed on ALS training in a prehospital setting in an uncontrolled environment. Further research could also be conducted as to the curriculum's applicability in semi-controlled environment (such as a small rural hospital) or environments where resources are limited, such as general practice, nursing posts or aero-medical retrieval services.

It would appear to be premature to suggest that a specific prehospital cardiac arrest ALS resuscitation training course will result in improved patient outcomes. To determine the impact on patient outcomes would require a randomised control trial tracking those professionals specifically trained in prehospital ALS through to the implementation of skills and ultimately patient survival rates, in particular neurological outcomes. State Ambulance Services would be ideally placed to conduct such research, however there are ethical limitations to such studies if it can be shown early on that specific prehospital ALS training has advantages over those who have generic training.

8.2 Conclusion

Successful prehospital cardiac arrest ALS resuscitation is a core component of the chain of survival and plays a critical element in improving survivability from out-of-hospital cardiac arrest. This research has demonstrated that a specific ALS resuscitation training course may improve the confidence and skills of prehospital clinicians to deliver high-quality cardiac arrest ALS resuscitation in what can be an austere and challenging environment. It is the author's hope that this research helps to shape the cardiac arrest ALS resuscitation training curriculum for prehospital clinicians and will ultimately benefit patients who suffer a cardiac arrest in the prehospital environment.

Appendices

Appendix A: Publication Links

Paper 1: Prehospital advanced life support education – core components for prehospital professionals, https://doi.org/10.33151/ajp.15.1.565

Paper 2: Prehospital advanced life support resuscitation – a curriculum for prehospital education, https://doi.org/10.33151/ajp.17.757

Paper 3: Prehospital advanced life support resuscitation training: A pilot of an evidence-based curriculum, https://doi.org/10.33151/ajp.17.846

Appendix B: List of Training Material

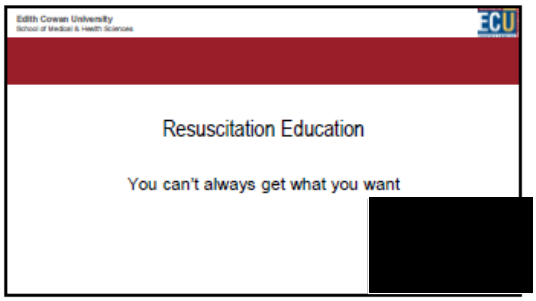
Training material is stored on ECU's CloudStor and can be accessed via the following public link:

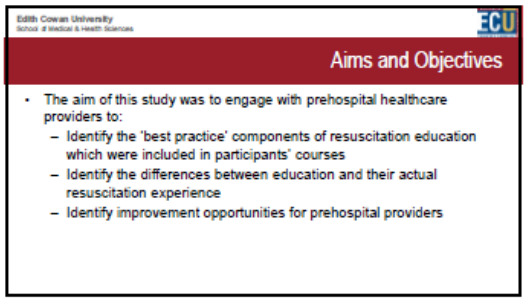
https://cloudstor.aarnet.edu.au/plus/s/rAls2yL29jWcn7L

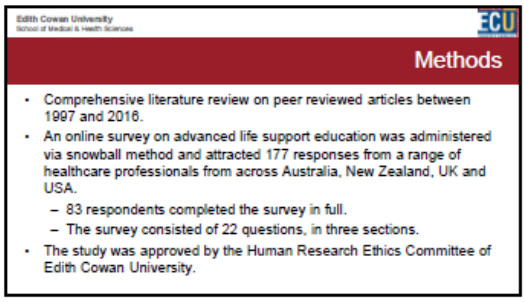
File Code	Name	Content
Admin-01	Facilitator Guide	Facilitator guide
Admin-02	Candidate Guide	Candidate joining instructions
Admin-03	Course Evaluation	Candidate feedback on course
Exam-01	Course MCQ Paper	Course multiple choice paper
Exam-01a	ECGs	ECGs to support multi-choice paper
Exam-02	Blank Answer Grid	Blank MCQ paper answer grid
Exam-03	MCQ Answers	MCQ answer grid (not for candidate release)
Lect-01	Prehospital ALS Lectures	PowerPoint lectures for the prehospital ALS course
CastTeach-01	CasTeach Scenarios	Scenarios to support the CasTeach program
CasPrac-01	CasPrac Scenarios	Scenarios to support the CasPrac program
App-01	Team Resuscitation Flowcharts	Visio flowcharts of team-based resuscitation processes

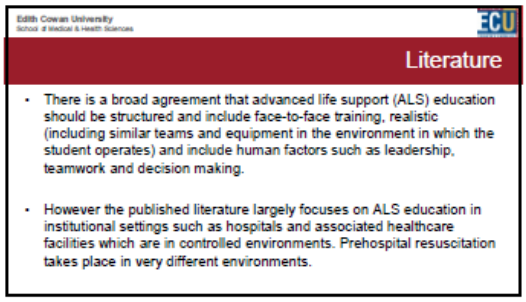
Appendix C: Conference Presentations and Posters

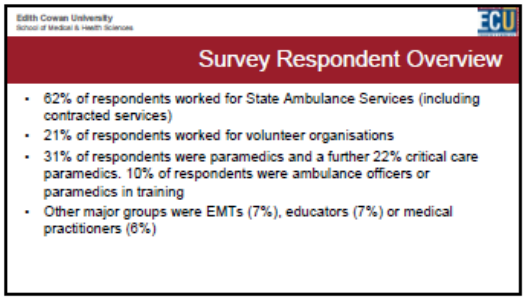
Appendix C.1: Council of Ambulance Authorities 2016

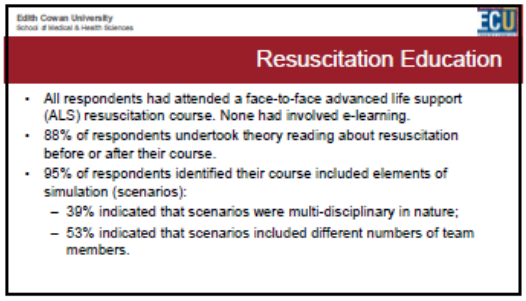












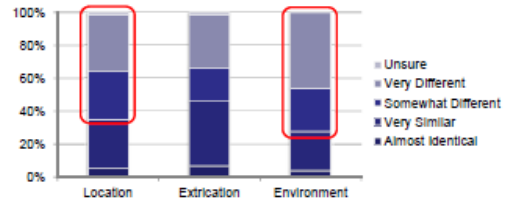
Human Factors

- Communication failures are responsible for up to 70% of all errors made during resuscitation (Husebø, et al., 2011).
- Leadership and role definition are two key elements of high quality resuscitation:
  - 27% of respondents to the survey identified that leadership during an actual resuscitation was different to that in their training.
  - 51% of respondents to the survey identified that team member roles during actual resuscitations were different to those on their course.

Competency Assessment

- All respondents to the survey indicated their course involved simulation and competency assessment in line with good practice.
- A number of respondents identified additional areas they would like a prehospital course to include:
  - Prehospital scene control;
  - Patient assessment;
  - Working as multi-disciplinary team with physicians as team leaders/members;
  - Extraction; and
  - Family counselling post resuscitation.

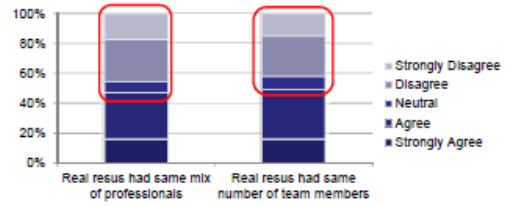
Training vs Real Resuscitation



Equipment and Drugs

- 76% of respondents to the survey identified the equipment used in their training was 'almost identical' or 'very similar' to that used in their real resuscitations.
- 79% of respondents identified that the medications used were 'almost identical' or 'very similar'

Team Members



Respondent Comments

I believe training has got better from when I started in the ambulance service but there is still a long way to go. The best courses I have attended have been in my own time and not provided by my employer.

Resuscitation scenarios should closely reflect actual practice. Patients do not go into cardiac arrest on tables in well-lit rooms. Scenarios that contain loud noise, lots of bystanders, low lighting etc.

Having taught and been taught both in and prehospital as both a paramedic and now a doctor it is my opinion that the pre-hospital teaching provides a more flexible approach to resuscitation which can be adapted to hospital, the converse is not as true.

Edith Cowan University
School of Medical & Health Sciences

Recommendations

- Resuscitation education should incorporate best practice principles identified in the literature. Areas for particular improvement in pre-hospital resuscitation include:
  - Multi-disciplinary team scenarios
  - Scenarios held in common pre-hospital settings
  - Teams should consist of those commonly encountered in the prehospital setting (eg. Bystander, first responder and paramedics)
  - The number of team members should be varied to reflect first responders, paramedics and then back up
  - Leadership should be a focus to promote high quality resuscitation

Edith Cowan University
School of Medical & Health Sciences

Acknowledgement

- Professors Moira Sim (Dean) and Professor Russell Jones – PhD supervisors
- Mike Gale – National Education Director Australian Resuscitation Council
- All images sourced through open google images and labelled for re-use.

Edith Cowan University
School of Medical & Health Sciences

Contact

David Reid
Director Paramedicine
Edith Cowan University
[redacted]

Appendix C.2: Spark of Life Conference 2017

Resuscitation Education For Pre-hospital Healthcare Professionals
Results of an Online International Pre-hospital Provider Survey

David Reid, Prof. Moira Sim, Prof. Russell Jones
Edith Cowan University, Perth, Australia

Introduction and Objectives

When an out-of-hospital cardiac arrest occurs, ambulance paramedics or pre-hospital healthcare professionals are often the first providers on scene with the skills and equipment to implement advanced life support (ALS).

The aim of this study was to review the literature and engage with pre-hospital healthcare providers to:

- Identify the 'best practice' components of resuscitation education;
- Identify the differences between the education and training received by ALS course participants and their real resuscitation experience; and
- Identify improvement opportunities for pre-hospital ALS providers.

Methods

A comprehensive literature review was carried out using Medline and CINAHL (reviewing articles from 2006-2017), followed by an international online survey attracting 177 responses.

Literature Review

There was broad agreement that ALS education should be structured and include face-to-face training, realistic environments (such as similar teams and equipment) and include human factors such as leadership, teamwork and decision making.

However, the published literature largely focused on ALS education within controlled institutional settings such as hospitals and associated healthcare facilities. There were few specific reviews or recommendations for pre-hospital education.

Pre-hospital Provider Survey

An online, international survey of pre-hospital providers was administered and attracted 177 responses. 62% of respondents worked for State Ambulance Services (including contracted services). 31% of respondents were paramedics and a further 22% critical care paramedics. 10% of respondents were ambulance officers or paramedics in training. The remainder were medical personnel, nurses or first responders.

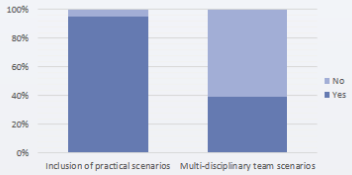
Assessment

All respondents to the survey indicated their course involved competency based assessment, in line with good practice.

"Resuscitation scenarios should closely reflect actual practice. Patients do not go into cardiac arrest on tables in well-lit rooms. Scenarios that contain loud noise, lots of bystanders, low lighting etc." (Survey Respondent Comment)

Simulation

95% of respondents identified their most recent ALS course included elements of simulation. However, only 39% indicated their scenarios were multi-disciplinary in nature, a core focus of contemporary healthcare education .

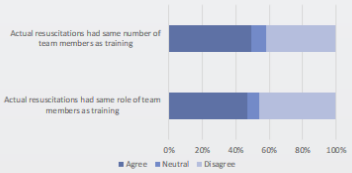


Only 35% of respondents indicated their real resuscitations were similar to that of their most recent ALS course. Only 28% of respondents indicated environmental factors at their real resuscitations were similar to those within their most recent ALS course. These results indicate many providers of ALS in the pre-hospital environment are not being trained using the locations and environmental factors that are most relevant to their ALS practice.

Human Factors

27% of respondents to the survey identified leadership during their actual resuscitations was different to that in their training.

51% of respondents to the survey identified team member roles during their actual resuscitations were different to those on their course.



Improvement Opportunities

Respondents to the survey identified a number of improvement opportunities for pre-hospital ALS courses:

- Pre-hospital scene control and situational awareness;
- Patient assessment;
- Working as multi-disciplinary teams with physicians as team leaders/members;
- Movement from the scene and transport to hospital; and
- Family counselling post resuscitation.

Conclusions

Results indicated healthcare professionals working in the pre-hospital setting faced an uncontrolled and unpredictable environment compared to their in-hospital colleagues. Pre-hospital professionals worked with various numbers of responders of differing experience, often had lay-persons involved in a resuscitation, and dealt with the challenges of removing patients from the scene and transporting patients to hospital via ambulance (air or road).

Improvement areas identified by the literature and survey respondents for pre-hospital resuscitation education included realism and relevance, number of providers, simulation locations, roles and responsibilities, human factors and competency-based assessment.

[redacted]

Next Steps

Next steps in this project are to:

- Convene an expert panel;
- Consider development of a specific pre-hospital ALS course that includes the elements identified from the literature review and survey.

"I am yet to find a paramedic specific ALS course, which incorporates 2 provider ALS with a time delay before 2-3 more responders arrive, such as in a real pre-hospital resuscitation. Paramedic ALS courses should include patient treatment and movement in awkward areas/rooms/lighting to simulate real cases; a time delay before more responders arrive to help, and scenarios where paramedics have to decide to stop resuscitation efforts." (Survey Respondent Comment)

References

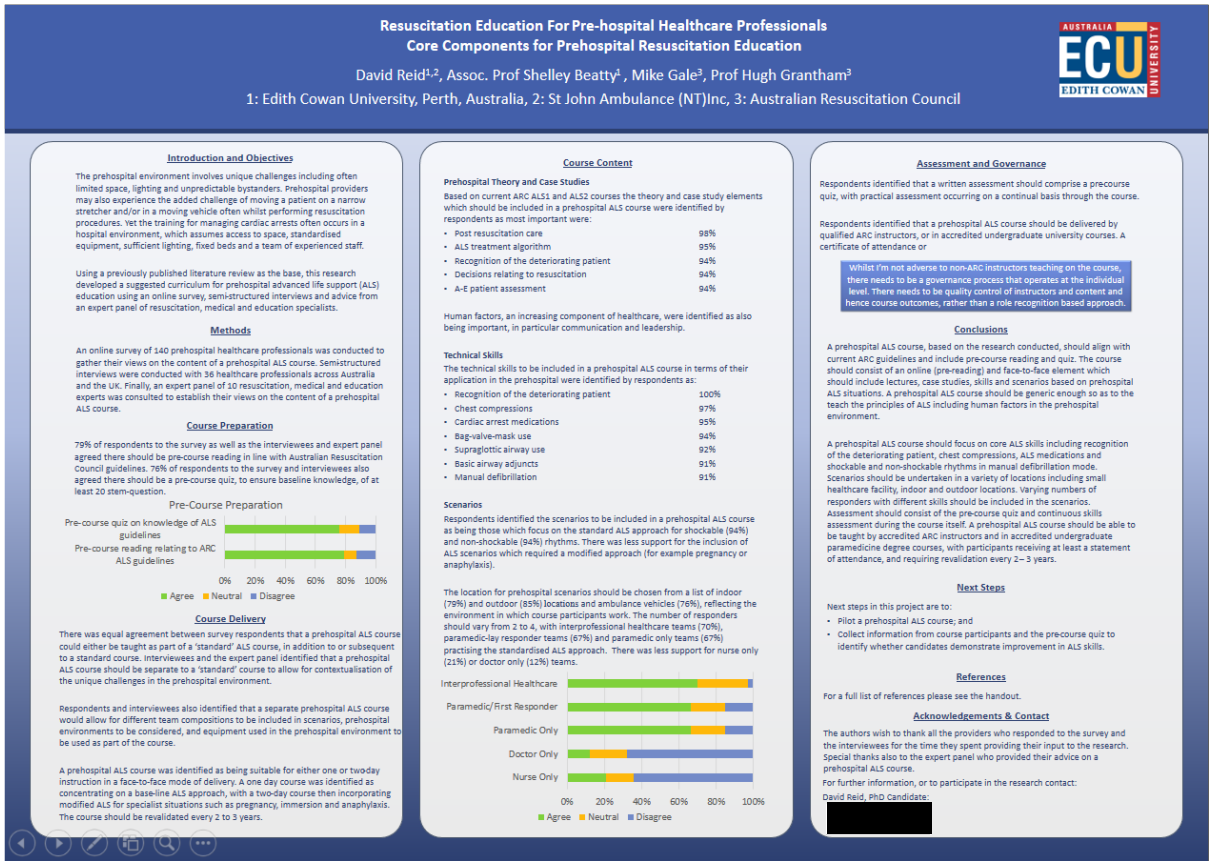
For a full list of references please see the handout.

Acknowledgements & Contact

The authors wish to thank all the providers who responded to the survey and Mr Mike Gale from the Australian Resuscitation Council who provided advice to the literature review.

For further information, or to participate in the research contact:
David Reid, PhD Candidate:
[redacted]

Appendix C.3: Spark of Life conference 2019



Resuscitation Education For Pre-hospital Healthcare Professionals
Core Components for Prehospital Resuscitation Education

David Reid[1,2], Assoc. Prof Shelley Beatty[1], Mike Gale[3], Prof Hugh Grantham[3]
1: Edith Cowan University, Perth, Australia, 2: St John Ambulance (NT)Inc, 3: Australian Resuscitation Council

Introduction and Objectives

The prehospital environment involves unique challenges including often limited space, lighting and unpredictable bystanders. Prehospital providers may also experience the added challenge of moving a patient on a narrow stretcher and/or in a moving vehicle often whilst performing resuscitation procedures. Yet the training for managing cardiac arrests often occurs in a hospital environment, which assumes access to space, standardised equipment, sufficient lighting, fixed beds and a team of experienced staff.

Using a previously published literature review as the base, this research developed a suggested curriculum for prehospital advanced life support (ALS) education using an online survey, semi-structured interviews and advice from an expert panel of resuscitation, medical and education specialists.

Methods

An online survey of 140 prehospital healthcare professionals was conducted to gather their views on the content of a prehospital ALS course. Semi-structured interviews were conducted with 36 healthcare professionals across Australia and the UK. Finally, an expert panel of 10 resuscitation, medical and education experts was consulted to establish their views on the content of a prehospital ALS course.

Course Preparation

79% of respondents to the survey as well as the interviewees and expert panel agreed there should be pre-course reading in line with Australian Resuscitation Council guidelines. 76% of respondents to the survey and interviewees also agreed there should be a pre-course quiz, to ensure baseline knowledge, of at least 20 stem-question.

Course Delivery

There was equal agreement between survey respondents that a prehospital ALS course could either be taught as part of a 'standard' ALS course, in addition to or subsequent to a standard course. Interviewees and the expert panel identified that a prehospital ALS course should be separate to a 'standard' course to allow for contextualisation of the unique challenges in the prehospital environment.

Respondents and interviewees also identified that a separate prehospital ALS course would allow for different team compositions to be included in scenarios, prehospital environments to be considered, and equipment used in the prehospital environment to be used as part of the course.

A prehospital ALS course was identified as being suitable for either one or two-day instruction in a face-to-face mode of delivery. A one day course was identified as concentrating on a base-line ALS approach, with a two-day course then incorporating modified ALS for specialist situations such as pregnancy, immersion and anaphylaxis. The course should be revalidated every 2 to 3 years.

Course Content

Prehospital Theory and Case Studies

Based on current ARC ALS1 and ALS2 courses the theory and case study elements which should be included in a prehospital ALS course were identified by respondents as most important were:

- Post resuscitation care 98%
- ALS treatment algorithm 95%
- Recognition of the deteriorating patient 94%
- Decisions relating to resuscitation 94%
- A-E patient assessment 94%

Human factors, an increasing component of healthcare, were identified as also being important, in particular communication and leadership.

Technical Skills

The technical skills to be included in a prehospital ALS course in terms of their application in the prehospital were identified by respondents as:

- Recognition of the deteriorating patient 100%
- Chest compressions 97%
- Cardiac arrest medications 95%
- Bag-valve-mask use 94%
- Supraglottic airway use 92%
- Basic airway adjuncts 91%
- Manual defibrillation 91%

Scenarios

Respondents identified the scenarios to be included in a prehospital ALS course as being those which focus on the standard ALS approach for shockable (94%) and non-shockable (94%) rhythms. There was less support for the inclusion of ALS scenarios which required a modified approach (for example pregnancy or anaphylaxis).

The location for prehospital scenarios should be chosen from a list of indoor (79%) and outdoor (85%) locations and ambulance vehicles (76%), reflecting the environment in which course participants work. The number of responders should vary from 2 to 4, with interprofessional healthcare teams (70%), paramedic-lay responder teams (67%) and paramedic only teams (67%) practising the standardised ALS approach. There was less support for nurse only (21%) or doctor only (12%) teams.

Assessment and Governance

Respondents identified that a written assessment should comprise a pre-course quiz, with practical assessment occurring on a continual basis through the course.

Respondents identified that a prehospital ALS course should be delivered by qualified ARC instructors, or in accredited undergraduate university courses. A certificate of attendance or

> Whilst I'm not adverse to non-ARC instructors teaching on the course, there needs to be a governance process that operates at the individual level. There needs to be quality control of instructors and content and hence course outcomes, rather than a role recognition based approach.

Conclusions

A prehospital ALS course, based on the research conducted, should align with current ARC guidelines and include pre-course reading and quiz. The course should consist of an online (pre-reading) and face-to-face element which should include lectures, case studies, skills and scenarios based on prehospital ALS situations. A prehospital ALS course should be generic enough so as to the teach the principles of ALS including human factors in the prehospital environment.

A prehospital ALS course should focus on core ALS skills including recognition of the deteriorating patient, chest compressions, ALS medications and shockable and non-shockable rhythms in manual defibrillation mode. Scenarios should be undertaken in a variety of locations including small healthcare facility, indoor and outdoor locations. Varying numbers of responders with different skills should be included in the scenarios. Assessment should consist of the pre-course quiz and continuous skills assessment during the course itself. A prehospital ALS course should be able to be taught by accredited ARC instructors and in accredited undergraduate paramedicine degree courses, with participants receiving at least a statement of attendance, and requiring revalidation every 2– 3 years.

Next Steps

Next steps in this project are to:

- Pilot a prehospital ALS course; and
- Collect information from course participants and the pre-course quiz to identify whether candidates demonstrate improvement in ALS skills.

References

For a full list of references please see the handout.

Acknowledgements & Contact

The authors wish to thank all the providers who responded to the survey and the interviewees for the time they spent providing their input to the research. Special thanks also to the expert panel who provided their advice on a prehospital ALS course.

For further information, or to participate in the research contact:

David Reid, PhD Candidate:
[redacted]

Appendix D: Ethics Approval

HUMAN RESEARCH ETHICS COMMITTEE
For all queries, please contact:
Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: [redacted]
Fax:
E-mail: research.ethics@ecu.edu.au

AUSTRALIA ECU UNIVERSITY
EDITH COWAN

OFFICE OF RESEARCH AND INNOVATION
270 Joondalup Drive,
Joondalup
Western Australia 6027
Telephone [redacted]
Facsimile
CRICOS 00279B
ABN 54 361 485 361

10 April 2015

Mr David Reid
Faculty of Health, Engineering and Science
JOONDALUP CAMPUS

Dear David

ETHICS APPROVAL

Project Code:	12730	
Project Title:	Study on Resuscitation Education	
Chief Investigator:	Mr David Reid	
Approval Dates:	From: 10 April 2015	To: 30 November 2015

Funding Source: Unfunded

Thank you for your recent application for ethics approval. This application has been reviewed by members of the Human Research Ethics Committee (HREC).

I am pleased to advise that the proposal complies with the provisions contained in the University's policy for the conduct of ethical human research and ethics approval has been granted. In granting approval, the HREC has determined that the research project meets the requirements of the National Statement on Ethical Conduct in Human Research.

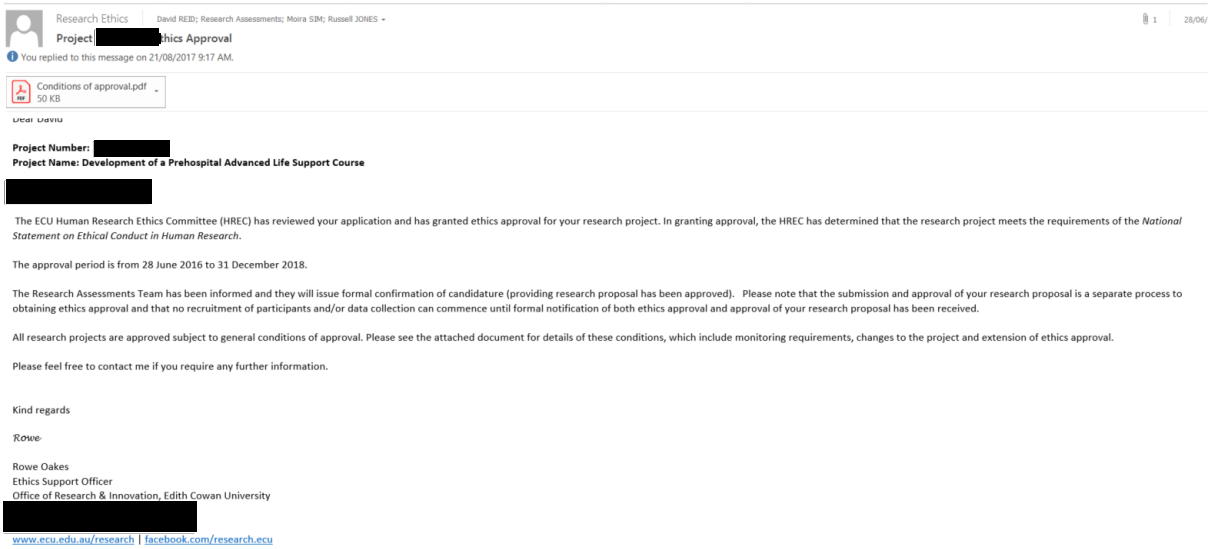
All research projects are approved subject to general conditions of approval. Please see the attached document for details of these conditions, which include monitoring requirements, changes to the project and extension of ethics approval.

We wish you success with your research project.

Yours sincerely

[redacted]

RESEARCH ETHICS OFFICER



Research Ethics David REID; Research Assessments; Moira SIM; Russell JONES 1 28/06/

Project [redacted]thics Approval

You replied to this message on 21/08/2017 9:17 AM.

Conditions of approval.pdf 50 KB

Dear David

Project Number: [redacted]

Project Name: Development of a Prehospital Advanced Life Support Course

[redacted]

The ECU Human Research Ethics Committee (HREC) has reviewed your application and has granted ethics approval for your research project. In granting approval, the HREC has determined that the research project meets the requirements of the *National Statement on Ethical Conduct in Human Research*.

The approval period is from 28 June 2016 to 31 December 2018.

The Research Assessments Team has been informed and they will issue formal confirmation of candidature (providing research proposal has been approved). Please note that the submission and approval of your research proposal is a separate process to obtaining ethics approval and that no recruitment of participants and/or data collection can commence until formal notification of both ethics approval and approval of your research proposal has been received.

All research projects are approved subject to general conditions of approval. Please see the attached document for details of these conditions, which include monitoring requirements, changes to the project and extension of ethics approval.

Please feel free to contact me if you require any further information.

Kind regards

Rowe

Rowe Oakes
Ethics Support Officer
Office of Research & Innovation, Edith Cowan University
[redacted]
www.ecu.edu.au/research | facebook.com/research.ecu

Note that extensions were granted in line with annual reports submitted on research progress. Between approval of the first phase of the project and the remaining phases, approvals moved from a formal letter to an email as shown above.

Appendix E: Participant Information Sheets and Data Tools

Appendix E.1: Data Collection Instrument 1

Appendix E.1a: Clinician Survey

Study on Resuscitation Education

Dear respondent

This anonymous survey is for nurses, paramedics, medical practitioners, and allied health professionals who have completed a Basic Life Support (BLS), Immediate Life Support (ILS) or Advanced Life Support (ALS) course. We seek your opinions on the resuscitation training you have undertaken and its applicability to your clinical practice areas.

This project is being undertaken as part of academic research at Edith Cowan University (ECU). The aim is to gather information on the transferability of BLS/ILS/ALS education to the clinical environment.

The survey will take approximately 10 minutes. You may complete the questionnaire online. The survey is in four-parts. Should you wish to withdraw from the survey you are free to do so at any time prior to submitting it. Once you have submitted it, we cannot withdraw it since your identity is anonymous.

All individual responses will remain anonymous and only aggregated information will be reported. The individual responses will be held by the researchers in a locked file or pass worded computer for a period of 5-years after which they will be destroyed.

Your response will add to the body of knowledge about resuscitation education and assist with future planning of training. The results of the project may be published by the researchers in appropriate peer-reviewed journals, and should individual respondents wish a copy of the findings you are welcome to contact the researchers in September of this year.

The research is being undertaken by David Reid. If you have any questions about the research the researchers can be contacted at [redacted] If you have any concerns or complaints about the research project and wish to talk to an independent individual, you may contact:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: [redacted]
Email: research.ethics@ecu.edu.au

Section 1: Demographic Information (Australian Bureau of Statistics, 2011)

This section of the survey collects demographic information to undertake anonymous analysis about whether there are differences in opinion between the various respondent groups.

1.1 What is your gender?

❑ Male ❑ Female

1.2 What is your age?

❑ 18 – 19
❑ 20 – 24
❑ 25 – 29
❑ 30 – 34
❑ 35 – 39
❑ 40 – 44
❑ 45 – 49
❑ 50 – 54
❑ 55 – 59
❑ 60 – 64
❑ 65 and over

1.3 What is the post-code of your primary (main) employment location? _____

1.4 Where do you work? (Select all which apply)

❑ Public Hospital
❑ GP Clinic
❑ Prehospital – State Ambulance Service
❑ Aeromedical / Retrieval Service
❑ Private Hospital
❑ Other Healthcare Clinic
❑ Prehospital- Private/NFP Ambulance Service
❑ Industrial Paramedical Service
❑ Other (Please specify): _____

1.5 What is your primary role?

❑ Enrolled Nurse
❑ Registered Nurse
❑ Physiotherapist
❑ EMT / Medic / First Responder
❑ Medical Practitioner
❑ Occupational Therapist
❑ Social Worker
❑ Paramedic (incl. ICP, Crit Care)
❑ Other (Please specify): _____

1.6 How long have you been working in your current role? (This is the total time in the primary role identified in the previous question, not necessarily the time spent with your current employer.)

❑ < 1 year
❑ 1-3 years
❑ 4 – 6 years
❑ 7 – 9 years
❑ 10 or more years

Section 2: Resuscitation Education

2.1 Have you ever undertaken a Basic Life Support (BLS), Immediate Life Support (ILS) and/or Advanced Life Support (ALS) course(s)?

❑ No – Thank you for your time. Please do not complete any further questions.

❑ Yes

2.1.1 If yes what was the last course you attended:

❑ Basic Life Support (BLS) ❑ Immediate Life Support (ILS)

❑ Advanced Life Support (ALS) ❑ Unsure

2.2 Was the last course you attended?

❑ Your first course ❑ A requalification course

2.3 Who was the provider of the last course you attended?

❑ Hospital ❑ Ambulance Service

❑ Private Company ❑ Australian Resuscitation Council

❑ Medical College ❑ Nursing College

❑ Other:_____ ❑ Unsure

2.4 How long ago did you undertake your last resuscitation course?

❑ < 6 months ❑ 6 months – 1 year

❑ 1-2 years ❑ 2-3 years

❑ More than 3 years

2.5 Thinking about the last resuscitation course you attended. Please indicate the extent to which you agree with the following statements.

		Yes	No	Unsure
A	I received theory reading prior to the course			
B	I completed the reading prior to the course			
C	I completed the reading after the course			

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
D	The theory reading provided assisted my understanding of the process of resuscitation						
E	The theory reading provided was applicable to my area of clinical practice (Area of practice applies to <u>where</u> you work such as a hospital or prehospital, <u>not</u> to your role as a medical practitioner, nurse, paramedic etc)						

2.6 This question collects information on practical scenarios contained within your last resuscitation course.

	Practical Scenarios	Yes	No	Unsure
A	The resuscitation course I attended included practical resuscitation scenarios			
B	The resuscitation course I attended incorporated multi-disciplinary teams during the scenarios (e.g., doctors, nurses, paramedics, allied health)			
C	Varying numbers of team members were included in the scenarios (e.g., one scenario having 3 team members and another having 6)			

		Emergency Dept.	Hospital Ward	Operating Theatre / Recovery	Health Clinic	Prehospital Setting	Other (Please Specify)
D	Practical scenarios were undertaken in the following simulated settings (Select all that apply)						

2.7 This question collects information on your actual resuscitation experience post course completion.

Have you been involved in at least one resuscitation since you attended your resuscitation course?

❑ No – Thank you for your time. Do not complete further questions and return your survey

❑ Yes – Please complete the following questions

2.7(i) Please indicate the level to which you agree or disagree with the following statements.

	Resuscitation Experience Post-Course	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	The resuscitation(s) I have been involved in:					
A	Were held primarily in the same clinical environments in which the course was conducted (e.g., training on mock ward and resus held on actual ward)					
B	Involved the same or very similar team members by role as were involved on the course (e.g., team of doctors and nurses on course and same during actual resuscitation *or* nurses/paramedics on course and same during the real resuscitation)					
C	Involved the same or similar numbers of team members in the resuscitation (e.g., 6 team members in course and 6 during real resuscitation)					

2.8 This question collects information on how well you perceive the resuscitation course you attended prepared you for real resuscitation(s).

	Preparation for Real Resuscitations	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
A	The resuscitation course prepared me for the clinical setting in which I carry out resuscitations (e.g., ward, ED, operating theatre, prehospital)					
B	The resuscitation course involved similar team members to what I experience in real resuscitations (e.g., doctors, nurses, paramedics, lay persons)					
C	The resuscitation course prepared me for similar numbers of team members involved in the resuscitations I experience in real life (e.g., 4 persons present, 6 persons present)					

Section 3: Differences in Training and Real Resuscitation

3.1 To what extent was your real resuscitation experience the same as or different to that taught on your course?

	Differences in Training and Actual Resuscitation	Identical	Similar	Different	Unsure
A	Leadership during the resuscitation				
B	Team composition during resuscitation				
C	Number of team members during resuscitation				
D	Equipment available and used during resuscitation				
E	Patient movement/extrication during resuscitation				
F	Location in which the resuscitation occurred				
G	Medications used during the resuscitation				
H	Availability of additional help during the resuscitation				

	Differences in Training and Actual Resuscitation	Identical	Similar	Different	Unsure
I	Environment in which the resuscitation occurred (e.g., lighting, heating, indoor vs outdoor etc)				
J	Other (Specify):				

3.2 In the real resuscitation, what skills did you need that you had not been taught on the resuscitation course? *For example: patient assessment, medication use, resuscitation teams differs, resuscitation setting differs.*

1	
2	
3	

Section 4: Final Comments

4.1 Do you have any final comments you would like to make regarding resuscitation education, and in particular training provided for those delivering out-of-hospital resuscitation?

Thank you for your assistance. Please return this survey to the box provided

Appendix E.2: Data Collection Instrument 2

Appendix E.2a: Follow-Up Survey

Study on Resuscitation Education – Follow-Up Survey

Dear respondent

This anonymous follow-up survey is for nurses, paramedics, medical practitioners, and allied health professionals who completed the first survey on ALS education. We seek your opinions on the content of an ALS course, specific to the prehospital environment.

This project is being undertaken as part of academic research at Edith Cowan University (ECU). The aim is to gather information on what components of ALS education are needed in a prehospital ALS course.

The survey will take approximately 15 minutes. You may complete the questionnaire online. Should you wish to withdraw from the survey you are free to do so at any time prior to submitting it. Once you have submitted it, we cannot withdraw it since your identity is anonymous.

All individual responses will remain anonymous and only aggregated information will be reported. The individual responses will be held by the researchers in a locked file or pass worded computer for a period of 5-years after which they will be destroyed.

Your response will add to the body of knowledge about resuscitation education and assist with future planning of training. The results of the project may be published by the researchers in appropriate peer-reviewed journals, and should individual respondents wish a copy of the findings you are welcome to contact the researchers in September of this year.

The research is being undertaken by David Reid. If you have any questions about the research the researchers can be contacted at [redacted] or on [redacted] If you have any concerns or complaints about the research project and wish to talk to an independent individual, you may contact:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: [redacted]
Email: research.ethics@ecu.edu.au

Section 1: Demographic Information

This section of the survey collects demographic information to undertake anonymous analysis about whether there are differences in opinion between the various respondent groups.

1.1 Where do you work? (Select all which apply)

- ❑ Public Hospital
- ❑ Private Hospital
- ❑ GP Clinic
- ❑ Other Healthcare Clinic
- ❑ Prehospital – State Ambulance Service
- ❑ Prehospital - Private/NFP Ambulance Service
- ❑ Aeromedical / Retrieval Service
- ❑ Industrial Paramedical Service
- ❑ Other (Please specify): _____

1.2 What is your primary role in resuscitation?

- ❑ Enrolled Nurse
- ❑ Medical Practitioner
- ❑ Registered Nurse
- ❑ Occupational Therapist
- ❑ Physiotherapist
- ❑ Social Worker
- ❑ EMT / Medic / First Responder
- ❑ Paramedic (incl. ICP, Crit Care)
- ❑ Other (Please specify): _____

Section 2: Course Preparation

2.1 Course Preparation. Please indicate the extent to which you agree with the following: A course that incorporates specific elements for prehospital ALS providers should:

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Have no pre-reading mandated					
2	Consist of pre-reading relating to the ARC advanced life support guidelines					
3	Include a pre-course quiz on student knowledge of advanced life support guidelines					

2.2 A pre-course quiz of a course that incorporates specific elements for prehospital ALS providers should consist of approximately ____ stem questions

#	Question	10	20	30	40	50	None - no quiz
1	New practitioners (e.g., new graduates, students, novice practitioners)						
2	Experienced practitioners						

2.3 Do you have any comments on pre-course reading and assessment?

2.4 The pre-reading of a course that incorporates specific elements for prehospital ALS providers should take approximately:

#	Question	2 hours	4 hours	6 hours	8 hours	None - No pre-reading
1	New practitioners (e.g., new graduates, students, novice practitioners)					
2	Experienced practitioners					

2.5 A course that incorporates specific elements for prehospital ALS providers should be (select one option only):

1	Separate to an ALS1 and ALS2 course, but have the same learning outcomes contextualised for the prehospital environment	Tick
2	An addition to an ALS1 and ALS2 course, covering those elements unique to the prehospital environment	
3	Incorporated into an ALS1 and ALS2 course, with specific prehospital elements covered as required	

Section 3: Course Length

3.1 Please indicate the extent to which you agree with the following: The face-to-face component of a course that incorporates specific elements for prehospital ALS providers should be held over ___ days for:

#	Question	Half day	1 Day	2 Days	> 2 Days
1	New practitioners (eg. new graduates, students, novice practitioners)				
2	Experienced practitioners				

3.2 Do you have any comments on course length?

Section 4: Delivery Method

4.1 Please indicate the extent to which you agree with the following: A course for prehospital ALS providers should:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Include face-to-face theory lectures					
4	Include case study discussions					
2	Include practical skills teaching					
3	Include practical scenario simulations					

4.2 The amount of time spent on the ____ element of a course for prehospital ALS should be (as a proportion of total course time)

#	Component	%
1	Theory Lectures	
2	Case Studies	
3	Practical Skills	
4	Practical Scenarios	

4.2 Are there any other components of a prehospital ALS course which should be included?

4.3 Please indicate the extent to which you agree with the following in relation to theory elements of a prehospital ALS course. The theory and case study elements of a course that incorporates specific elements for prehospital ALS providers should be conducted:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Entirely online					
2	Entirely face-to-face					
3	Mix of online and face-to-face					

4.4 Do you have any comments on the delivery approach?

Section 5: Theoretical Course Elements

5.1 Pease indicate the extent to which you agree with the following: A course that incorporates specific elements for prehospital ALS providers should:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Follow ARC resuscitation guidelines, contextulised for the prehospital environment					
2	Include the equipment commonly used in the providers' environment (e.g., response bags for prehospital providers and emergency trolleys for small facilities)					
3	Use 'teams' commonly encountered in the prehospital environment (e.g., paramedics, nursing, first (lay) responder, medical practitioner, and mixed teams)					

5.2 Please indicate the extent to which you agree with the following: A prehospital ALS course should include theory / case studies of:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Post resuscitation care					
2	ALS treatment algorithm - non-shockable rhythms					
3	Recognition of the deteriorating patient					
4	ALS treatment algorithm - shockable rhythms					
5	Decisions relating to starting and/or stopping resuscitation					
6	A to E approach to patient assessment					
7	Resuscitation in special circumstances (asthma, anaphylaxis, pregnancy)					
8	Chain of survival					
9	Recognition of acute coronary syndromes					
10	ALS treatment algorithm - traumatic arrest					
11	Handover and reporting					
12	Pit crew approach to resuscitation (teamwork approach to resuscitation)					
13	Overview of incidence of out of hospital cardiac arrest					
14	Causes and prevention of cardiac arrest in the prehospital					
15	Cardiac arrest systems (research through equipment through prehospital response, hospital options, to rehabilitation					
16	Bradyarrhythmias					
17	Tachyarrhythmias					
18	Extrication and transport considerations					
19	Breaking bad news to relatives					
20	Prehospital diagnostic equipment					
21	Legal considerations (unexplained deaths and the police / coroner)					
22	Debriefing lay responders					

5.3 Do you have any comments on the theory/case study content to be included in a prehospital ALS?

Section 6: Human Factors

6.1 Please indicate the extent to which you agree with the following: A prehospital ALS course should:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Include elements of team communication					
2	Include elements of critical thinking					
3	Include team leadership as a specific component					

6.2 Do you have any comments on human factors?

Section 7: Resuscitation Skills

7.1 Please indicate the extent to which you agree with the following: A prehospital ALS course should include practical elements of:

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Recognising the deteriorating patient					
2	Chest Compressions - Manual					
3	Cardiac Arrest Medications					
4	Bag-Valve-Mask (BVM)					
5	Supraglottic airway (iGel or LMA)					
6	Basic Airway Adjuncts (OPA, NPA)					
7	Defibrillation - Manual Mode					
8	A-E patient assessment					
9	Introduction to the pit crew (teamwork) approach to resuscitation					
10	Patient Extrication					
11	Capnography					
12	Defibrillation - AED Mode					
13	Chest compressions (device assisted - e.g., LUCAS)					
14	Endotracheal Intubation					

7.2 Do you have any comments on the skills that should be included in a prehospital ALS course?

Section 8: Resuscitation Scenarios (Simulations)

8.1 Please indicate the extent to which you agree with the following: A prehospital ALS course should include scenarios/simulations involving:

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Non-shockable rhythms (General Reversible Causes of Cardiac Arrest - H's & T's)					
2	Shockable rhythms (General Reversible Causes of Cardiac Arrest - H's & T's)					
3	Immersion (drowning)					
4	Anaphylaxis					
5	Hypovolaemia					
6	Traumatic arrest					
7	Asthma					
8	Pregnant patient					
9	Bariatric patients					
10	Poisoning & electrolytes					
11	Bradycardia (pacing)					
12	Envenomation					
13	Tachycardia (cardioversion)					

8.2 Do you have any comments on the scenarios that should be included in a prehospital ALS course?

8.3 Please indicate the extent to which you agree with the following: A prehospital ALS course should have scenarios/simulations in _____ locations.

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Outdoor (e.g., sidewalk, park etc)					
2	Private area (e.g., home, office)					
9	Ambulance vehicle					
4	General practitioner surgery					
6	Nursing home					
3	Small emergency department (e.g., small rural ED or nursing post)					
7	Aircraft (retrieval)					
5	Rehabilitation facility					
8	Aircraft (commercial)					
10	Boat					

8.4 Do you have any comments on the scenario locations that should be included in a prehospital ALS course?

Section 9: Teamwork

9.1 Please indicate the extent to which you agree with the following: A prehospital ALS course should include scenarios/simulations involving.

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2 Responders					
2	3 Responders					
3	4 Responders					
4	5 Responders					
5	More than 5 Responders					

Section 10: Roles and Responsibilities

10.1 Please indicate the extent to which you agree with the following: A prehospital ALS course should include scenarios/simulations that involve.

#	Question	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Paramedic only teams					
2	Paramedic - First Responder teams (lay responders)					
3	Nurse only teams					
4	Doctor only teams					
5	Interprofessional healthcare teams					

10.2 Do you have any comments on the teamwork which should be undertaken as part of scenarios?

10.3 The candidates on a course that incorporates specific elements for prehospital ALS providers should, as part of the scenarios:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Work within their own role (e.g., doctors stay as doctors, nurses stay as nurses etc)					
2	Take on the 'role' of others (e.g., nurse act as a doctor, paramedic act as lay responder etc)					

10.4 Do you have any comments on the roles that candidates should 'play' on a course for prehospital providers?

Section 11: Assessment

11.1 As part of a course that incorporates specific elements for prehospital ALS, assessment should occur.

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Skills assessed on a continual basis through the course					
2	Skills assessed as a single scenario at the end of the course					
3	Overall competence assessed on a continual basis through the course					
4	Overall competence assessed in a single scenario at the end of the course					
5	A written assessment on the theoretical knowledge of ALS prior to the course					
6	A written assessment on the theoretical knowledge of ALS at the end of the course					

11.2 Do you have any comments on assessment?

Section 12: Standards and Course Governance

12.1 Please indicate the extent to which you agree with the following: A course that incorporates specific elements for prehospital ALS providers should:

#	Question	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	Be taught only by accredited ARC instructors					
2	Be able to be taught by State Ambulance Service educators					
3	Be able to be taught by prehospital providers (e.g., RFDS, home nursing etc)					
4	Be able to be taught in Accredited Council of Ambulance Authority University courses					
5	Result in an ARC Certificate of Attendance					
6	Result in an ARC Statement of Attainment					

12.2 When should a course that incorporates specific elements for prehospital ALS providers require 'recertification'?

#	When should a course that incorporates specific elements for prehospital ALS providers require 'recertification'?	Tick
1	6 months	
2	12 months	
3	2 years	
4	3 years	

12.3 Do you have any comments on quality control and course governance?

Section 13: Final comments

13.1 Do you have any final thoughts on a draft prehospital ALS course?

13.2 Would you like to discuss your responses with the researcher?

❑ Yes ❑ No

13.3 If yes, please provide a contact phone number or email.

Thank you for participating in this survey, your response will now be submitted.

Appendix E.3: Data Collection Instrument 3

Appendix E.3a: Interview Participant Information

July 2016

Development of a Prehospital Advanced Resuscitation Course

Dear Research participant

You are invited to participate in an interview developing a Prehospital Advanced Life Support (ALS) training course, part of PhD academic research, School of Health and Allied Health at Edith Cowan University, 270 Joondalup Drive, Joondalup, Perth, WA 6027. This research project is being undertaken as part of the requirements of a PhD at Edith Cowan University.

The aim of the research is to develop a tailored prehospital ALS training course which will enable prehospital practitioners to deliver a higher quality of resuscitation. It anticipated that the implementation of this research will improve outcomes for persons in cardiac arrest.

The research is being conducted in phases including a literature review, development of course material and piloting of a course. The purpose of this phase of the study is to explore participants' views on the content of a specific prehospital ALS course; In particular, the teaching content and scenarios used in teaching and examination. This focus group will take approximately sixty minutes to complete and the only risk to you is inconvenience from attendance.

The information collected in the interview will be used to develop a robust prehospital ALS training course. Only the researcher will have access to notes of the interview, however summary information of all participants' views may be published. Notes of the interview will be kept by the researcher for 5 years on a password protected computer. After this time period all information will be deleted.

You have been selected to be part of this interview as you are a prehospital care practitioner. Your participation in this research is very much appreciated and completely voluntary. You may decline to answer any question. You should also be aware that you have every right to withdraw from this research process at any time.

The results of this research will be published in peer review journals, and if you would like to discuss the outcomes you are welcome to contact the researcher.

The ECU Human Research Ethics Committee has approved this research. Ensuring confidentiality and anonymity is part of the researcher's responsibility. All information gathered will be used only in the aggregate without identifying any person or organisation at any time and any place. Other than my supervisors, no one will have any access to data collected during this research.

If you require any further information concerning this research, please contact either:

David Reid (Chief Investigator) School of Medical and Health Sciences Edith Cowan University 270 Joondalup Drive, Joondalup Western Australia, 6027 Email: [redacted] Tel: [redacted]	Professor Russell Jones School of Medical and Health Sciences Edith Cowan University 270 Joondalup Drive, Joondalup Western Australia, 6027 Email: [redacted] Tel: [redacted]

The researchers are full-time academics at ECU in the School of Medical and Health Sciences. David is Director of Paramedical Programs and a paramedic with over 20 years' experience. He has interests in prehospital resuscitation, helicopter retrieval and beach injuries. Prof. Russell Jones is Director of Clinical Education with specialist interests in aeromedical retrieval and education through simulation.

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact the:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive, Joondalup
Western Australia, 6027
Phone: [redacted]
Email: research.ethics@ecu.edu.au

To participate in this research, please sign the following page and return it to the researcher.

Informed Consent Document – Development a Prehospital Advanced Life Support training course

By signing below, I, the participant, have read the information above and clearly understand the contents provided. I have been informed that I have a full right to withdraw from this study at any time.

I willingly agree to participate in this study.

_____ _____

Signature Date

Appendix E.3b: Interview Running Sheet

Overview of Interview – Running Sheet (Course Design)

Time	Section	Core Focus
30:00	Prior to Focus Group	Arrive and Registration Coffee as appropriate
00:00	Introduction	Introduction of researcher Overview of research Importance of research Conduct of interview
00:05	ALS Courses	General outline of an ALS course and why the research indicates the need for a prehospital specific ALS course
10:00	Course Teaching	Outline the key prehospital teaching elements of a prehospital ALS course Seek participant feedback on the prehospital teaching elements What amendments are missing?
25:00	Practical Elements	Outline the key prehospital scenarios to be included in a prehospital course Seek participant feedback on the prehospital teaching elements Do they reflect their experience of real resuscitations? What amendments are needed?
40:00	What's missing?	What aspects of a prehospital ALS course are still missing?
50:00	Summary of information	Summarise overall info gathered for each key category above
55:00	Close	Thank participants Provide follow up contact details Close

Appendix E.4: Data Collection Instrument 4

Appendix E4a: Course Participant Information and Consent Form

January 2019

Dear Research Participant

Development of a Prehospital Advanced Life Support training course (Pilot Course)

As part of PhD research, I am conducting research into the need for a specific prehospital Advanced Life Support (ALS) course for prehospital providers in Australia.

The overall aim of the research is to determine whether a specific ALS course would improve the preparedness of prehospital practitioners to deliver resuscitation in the prehospital setting. This research has been approved by the Human Research Ethics Committee at Edith Cowan University (Approval No. 14928).

You are invited to participate in a free one-day pilot prehospital resuscitation course. The course will cover skills including patient assessment, airway management, CPR and defibrillation, and medication administration.

You have been selected to be part of this research as you offer valuable skills in prehospital resuscitation. Your participation in this research would be very much appreciated and completely voluntary. You may decline to participate in any element of the course. You should also be aware that you have every right to withdraw from this research at any time, up to the end of the course.

There are minimal risks to your participation, and the main one is discomfort doing CPR. You may also suffer inconvenience, as this is voluntary research participation. You have been selected to participate because you already know how to perform CPR and have demonstrated competency in it, so the risk of injury is unlikely and injury, if it occurs, is most likely to be minor. However, if you have an injury, you should decline participation in this research. We have mitigated the risk by selecting you from a pool of participants who have already demonstrated competence in CPR, are using equipment you are familiar with, in facilities which are regularly used for teaching, and have been risk assessed as part of that teaching.

This research will improve prehospital education in resuscitation, improving care of patients in the prehospital setting across Australia. The de-identified results of this research will be published in peer review journals and at conferences, and if you would like to discuss the outcomes you are welcome to contact the researchers.

If you require any further information concerning this research, please contact either: David Reid [redacted] Associate Professor Shelley Beatty [redacted] or Professor Moira Sim [redacted]

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact the:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive, Joondalup
Western Australia, 6027
Phone: [redacted]
Email: research.ethics@ecu.edu.au

Thank you for assisting with this research project.

Yours sincerely

Shelley Beatty
Research Supervisor
Associate Professor
ECU

David Reid
Researcher
Senior Lecturer
ECU

Moira Sim
Research Supervisor
Professor
ECU

Informed Consent – Development of a prehospital ALS course (Pilot Course)

By signing below, I, the participant, acknowledge that I:

- have been provided with a copy of the Information Letter, explaining the research study;
- have read and understood the information provided;
- have been given the opportunity to ask questions and have had any questions answered to my satisfaction;
- am aware that if I have any additional questions, I can contact the research team;
- understand that participation in the research project will involve participation in simulated resuscitations;
- understand that I can decline participation in any particular element of the course, and can withdraw from the research at any time;
- understand that the course pilot will be used for the purposes of this research project, which is a PhD, but results may also be disclosed to the Australian Resuscitation Council (ARC) to support prehospital resuscitation development;
- acknowledge the risks involved in performing CPR and confirm that I am injury free;
- understand that I am free to withdraw from further participation at any time, without explanation or penalty; and
- freely agree to participate in the project.

_____
Name

_____ _____
Signature Date

Appendix E.4b: Course Evaluation Form

Prehospital Advanced Life Support training course Evaluation Form

Course Centre:		Dates:	

Please indicate your rating/assessment of each session according to the **content** of the material and the **presentation** of the information, (N/A – not attended/session not conducted). All answers are confidential, and no individual's answers can be distinguished.

The scores from these forms are used to provide feedback to the ARC and aid towards development of future courses. Your evaluations contribute towards identifying areas of excellence and any improvement needed. Instructors also receive a summary of the whole course evaluations for their professional development.

Course Content	Poor	Adequate	Good	Excellent
Welcome and Introduction	☐	☐	☐	☐
Prehospital cardiac arrest in perspective	☐	☐	☐	☐
Causes of cardiac arrest in the prehospital environment	☐	☐	☐	☐
Team based ALS resuscitation	☐	☐	☐	☐
Human factors in resuscitation	☐	☐	☐	☐
Post resuscitation care and transport	☐	☐	☐	☐
A-E patient assessment	☐	☐	☐	☐
ALS algorithm	☐	☐	☐	☐
Team based ALS (skills stations)	☐	☐	☐	☐
Decisions relating to resuscitation	☐	☐	☐	☐
Hot debriefing	☐	☐	☐	☐
Prehospital scenarios (Rhythms & Skills)	☐	☐	☐	☐
Prehospital scenarios (Team Mix & Number)	☐	☐	☐	☐
Prehospital scenarios (Environment)	☐	☐	☐	☐

	N/A	**Poor**	**Adequate**	**Good**	**Excellent**
Theory Presentations	☐	☐	☐	☐	☐
Supervised Practice Session(s)	☐	☐	☐	☐	☐
Support from mentors and instructors	☐	☐	☐	☐	☐
Catering	☐	☐	☐	☐	☐
Venue	☐	☐	☐	☐	☐

	N/A	Poor	Adequate	Good	Excellent
Measurement of learning objectives. Please rate the following:			**Not met**	**Partially met**	**Fully met**
Management of a patient in cardiac arrest in the prehospital setting using the Australian Resuscitation Council cardiac arrest algorithm			☐	☐	☐
Identify and treat the prehospital reversible causes of cardiac arrest using a structured team-based approach			☐	☐	☐
Recognise non-life sustaining cardiac rhythms, delivering appropriate safe defibrillation therapy when indicated.			☐	☐	☐
Lead and be a constructive member of a prehospital resuscitation team.			☐	☐	☐
Plan the management and safe extrication and transfer/care of the post resuscitation patient.			☐	☐	☐
Recognise life extinct and conduct hot debriefing on scene.			☐	☐	☐
Please rate to what degree your overall learning needs were met			☐	☐	☐

Please rate to what degree this course is relevant to your practice	Not Relevant	Partially Relevant	Entirely Relevant
	☐	☐	☐

	Yes	No
Pre-course reading	☐	☐
Did you read any ARC guidelines prior to the course?	☐	☐
Did you feel well prepared for the course?	☐	☐
Did you receive sufficient information about the course prior to it?	☐	☐

Relationship to an ARC ALS Course	**Yes**	**No**
Have you ever undertaken an Australian Resuscitation Council ALS Course?	☐	☐

	Less	Same	More
If yes, was this course, less, as relevant, or more relevant to your practice when compared to the ARC course?	☐	☐	☐

Course Logistics	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
The instructors were supportive	☐	☐	☐	☐
The course met my needs	☐	☐	☐	☐
The course was the right length	☐	☐	☐	☐
The content was appropriate for the prehospital environment	☐	☐	☐	☐
The pre-course quiz was pitched at the 'right' level	☐	☐	☐	☐
The pre-course quiz was too easy	☐	☐	☐	☐
The equipment used was relevant to the prehospital environment	☐	☐	☐	☐
The team mix was relevant to the prehospital environment	☐	☐	☐	☐
Team member numbers were relevant to the prehospital environment	☐	☐	☐	☐
Scenario locations were relevant to the prehospital environment	☐	☐	☐	☐

On a scale from 0 (definitely not recommend) to 10 (definitely recommend), how likely would you be to recommend this course to a colleague? _____

Additional Comments: (what you found valuable or could improve/add and why etc.)

About You

What is your profession?

☐ Medical ☐ Nursing ☐ Paramedic ☐ First Responder/ESO

What is your primary role? ☐ Clinical (patient facing)

☐ Administrative/Management

☐ Education

Which type of organisation do you primarily work for? ☐ Hospital

- ☐ Retrieval Service (aeromedical/road)
- ☐ State ambulance service (including St John NT and/or WA)
- ☐ Private / Not for profit ambulance service
- ☐ General practice (including general medical centres)
- ☐ Home visiting service (e.g., Silver Chain)
- ☐ Industrial health care service (incl. mining and occupational health)
- ☐ Voluntary first response (e.g., Volunteers in SJA, SLSA, SES, Fire, Red Cross etc.)
- ☐ Paid first response (e.g., Lifeguard, paid staff in SLSA, Fire, SES etc.)
- ☐ Education provider (VET or university)

Please tick if you are currently a student

☐ Med Student ☐ Nursing Student ☐ Paramedic Student

How long have you been in your profession? ☐ 0-4 years ☐ 5-9 years ☐ 10 or more years

Do you primarily work in the: ☐ Prehospital sector (incl. retrieval) ☐ Facility based / hospital sector

How many years have you worked prehospital? ☐ 0-4 years ☐ 5-9 years ☐ 10 or more years

What is your age?	☐ 15-19	☐ 20-24	☐ 25-29	☐ 30-34
	☐35-39	☐40-44	☐ 45-49	☐ 50-54
	☐ 55-59	☐60-64	☐ 65-69	☐ 70 or over
What is your gender?	Male	Female	Other	
Would you like to discuss the course further?	Yes	No		
If yes, please provide: Name:	_____			
Telephone:	_____			

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