Advanced airway management training for paramedics: Are we providing sufficient levels of clinical experience and knowledge?

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Declaration

Having completed my course of study and research towards the degree of Master of Health Professions Education (90670) by coursework and thesis, I hereby submit my thesis for examination in accordance with the regulations and declare that the thesis is my own work. This thesis has been completed during the course of enrolment in this degree at the University of Western Australia and has not been previously submitted to this or any other institution.

Gary Wilson
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Abstract

**Title:** Advanced airway management training for paramedics: Are we providing sufficient levels of clinical experience and knowledge?

**Background:** Poor judgement, education and training in airway management are leading causes of patient morbidity and mortality. There has been a decline in opportunities for paramedics to consolidate their airway management education within hospital operating theatres, especially with an increase in the use of supraglottic airways and increased competition between clinicians, which can impact on individual paramedic competency to undertake these infrequently, performed critical skills.

**Aim:** To identify if Western Australian paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be competent and effective in their practice and identify possible improvements to current training practice.

**Method:** Data gathered through a questionnaire and focus groups identified education curriculum, clinical practice opportunities, self-confidence in undertaking various airway techniques and individual perceptions on the suitability and effectiveness of their training programmes.

**Results:** Advanced airway management techniques are infrequently utilised and while the original training received by interstate and overseas paramedics provided greater opportunities for learning, the infrequency of skill performance and formal continued professional development, has affected the confidence of
all West Australian paramedics to perform the techniques. Education programmes also concentrate on the physical technique with little emphasis on the importance of human factors and risk identification and minimisation.

**Conclusion:** The traditional model of airway management education does not provide the range of knowledge, understanding and performance opportunities to ensure all paramedics are competent. Development of a competency-based education programme and pre-hospital airway algorithms, with regular assessment of clinical skills, needs to be introduced to improve success rates and ensure competency. While it is possible to have an ambulance service that undertakes intubation safely, competently and effectively, it does, however, require a firm clinical governance and educational structure.
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Chapter 1: Introduction

1.1 Background

Pre-hospital airway management is an essential paramedic skill which can mean the difference between patient survival and death. Paramedics and other emergency medical service practitioners have to deliver critically ill and injured patients to hospital with a protected airway and adequate ventilation. Endotracheal intubation (ETI), frequently considered the gold standard for airway management and the definitive definition of a protected airway – a cuffed endotracheal tube in the trachea - and surgical cricothyroidotomy are two advanced airway management skills used by paramedics to secure the airway(1).

It has been identified that moderately injured trauma patients who are delivered to the emergency department without an endotracheal tube have a higher mortality (11.8 %), compared with those intubated earlier (1.8 %) (2). These skills are considered to be relatively complex procedures associated with potential life-threatening risks and therefore require a comprehensive training programme to ensure paramedics are competent. The curriculum and education standards for the teaching of these skills vary greatly around the world. Measuring intubation success rates is commonly used to describe the quality of airway management in pre-hospital environments, with United States (US) studies reflecting success rates of 69 to 98.4 per cent (3). Examining studies with weak airway management outcomes Jacobs and Grabinsky identified that poor training and low skill level of
the providers are often the causes of unsuccessful prehospital-attempted endotracheal intubation while Deakin et al went as far to state that “the current format of paramedic training is inadequate for training prehospital intubation” and that it is not feasible to improve the training for UK paramedics to ensure they are competent to perform this skill (2-5).

While research suggests a relationship between the number of intubation experiences and ETI success, difficulties have been identified providing sufficient learning experiences (3). This, and the wide variations seen in pre-hospital intubation success rates, has seen a removal of intubation as a paramedic skill set in some ambulance services and initiated numerous discussions on whether paramedics should intubate or not due to the difficulty in ensuring competence among paramedics (3, 5-7) In addition, differing models of Emergency Medical Services (EMS) exist around the world, all with varying practitioner and education systems, for example physician EMS providers perform advanced airway procedures in several European countries while experienced paramedics, with additional post-graduate education and training, operate as intensive care paramedics in all Australian States and Territories apart from Western Australia (WA) (3, 8).

Following several airway management adverse events in WA, paramedics were stopped from performing intubation until waveform capnography – technology which clearly demonstrates the success of the intubation process – was introduced across the ambulance service (9). While the introduction of waveform capnography reduces the number of undetected oesophageal intubations, it cannot increase the ambulance service’s poor intubation success rates. High
Intubation success rates have been linked to good education, high quality of training and efficient recertification standards – all designed to ensure that paramedics are equipped with the skills necessary to avoid life-threatening complications from loss of airway or respiratory problems (7, 10). While ETI is considered the gold standard for airway management, there have been several suggestions that paramedics should not be undertaking intubation and using supraglottic airway devices, such as the Laryngeal Mask Airway (LMA) instead, due to their ease of insertion, increased skill retention and comparable ventilation adequacy (11). Despite this there is still a degree of uncertainty as to which airway management device provides the most favourable outcomes in the pre-hospital setting (12).

1.2 Research purpose

The aim of undertaking this research is to identify whether Western Australian (WA) paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be competent and effective in their practice and suggest improvements to current training practice.

The research questions were:

• How confident are paramedics in performing advanced airway skills?

• Do WA paramedics perceive that the current training regime provides adequate knowledge, technical and non-technical skills to undertake advanced airway procedures?

• Are there sufficient opportunities in clinical placements to practice endotracheal intubation and laryngeal mask insertion?
• What do paramedics suggest be included in initial airway management training programmes?

The outcomes of the study were also used to develop an education curriculum on paramedic advanced airway management.

1.3 Organisation of the thesis

Chapter two discusses the literature reviewed in the undertaking of this study which includes articles concerning paramedics, airway management, education and learning theories, competency and confidence.

The adequacy of initial advanced airway skills training, the level of experience achievable during hospital placements and prevention of skill erosion once qualified has questioned as to whether the continued teaching of endotracheal intubation to paramedics is appropriate. While advocates for paramedic intubation suggest that with comprehensive education and training, the procedure is safe and may be associated with improved patient outcomes, critics suggest that ETI in relatively unskilled hands, combined with infrequent exposure and limited experience, may result in prolonged attempts, unrecognised complications and compromised patient care (11, 13-15).

The review of the literature revealed that for Australia, there are no recommendations or requirements for a minimum number of successful intubations before the student can perform intubation within a pre-hospital environment and as with any clinical skill, regular practice and training is required to prevent skill erosion. While there is no objective scientific data which suggests a minimum number of intubations each year to maintain competency, without
regular exposure and experience, the paramedics’ ability and competency is reduced (16-18).

Chapter three discusses the methods used in the study and the advantages of the mixed methodological approach used. The mixed methodology allowed different approaches, using both qualitative and quantitative data, to be used to answer the research questions. The study consisted of a survey designed to collect information on the training approaches used in paramedic training as well as their perceptions of confidence and competency of practice. The focus groups were conducted to gain a greater understanding of paramedics’ educational experiences and their opinions on ensuring competency.

The results of the study are presented in Chapter four. The descriptive data obtained from the survey questions were analysed using Statistics Package for Social Sciences (SPSS) software with the results divided into tables and figures. Transcripts from the digitally recorded focus groups and the non-structured questions in the survey were analysed using content analysis to code and identify keywords before arranging into themes and categories.

Chapter five contains a discussion on the results of the study and implications to paramedic education; while chapter six proposes an educational curriculum and programme for adult advanced airway management.

Chapter seven describes the conclusions and recommendations of the study, sharing insights into ways to improve paramedic education and airway management competency.
As an objective of this project was to identify the effectiveness of existing paramedic education in delivering advanced airway management competency and suggest possible improvements, the conclusion and suggested curriculum in Appendix nine have focussed on education content, theories of learning and ensuring competency.
Chapter 2: Literature review

2.1 Introduction

Western Australia (WA) is the only state in Australia where each paramedic is routinely provided with training in and allowed to practice endotracheal intubation (ETI). In all other states and territories of Australia, only a small select group of experienced paramedics are taught and authorised to perform this skill.

Following an investigation of four clinical incidents where undetected oesophageal intubation were reported, St John Ambulance (SJA), who holds the contract to supply an emergency ambulance service for WA, stopped all paramedics from performing intubation unless waveform capnography was available (9). While capnography (quantitative and qualitative measurement of expired carbon dioxide) is a gold standard that the tube is correctly located in the trachea, it does not address the competence of the paramedics to correctly perform intubation. All WA paramedic ambulances have now been equipped with waveform capnography monitors and paramedics are once again permitted to perform intubation but the debate continues whether paramedics should perform the skill, arguing that the airway can often be maintained by other means and suggesting that LMA is an advanced airway which may be more appropriate (19, 20).
2.2 Airway management

Successful airway management requires the practitioner to not just have good procedural skills but also be competent in clinical decision making – choosing the most appropriate airway management technique appropriate for the patient, their illness or injury and environment (21). Paramedics have several different airway management techniques available to them.

2.2.1 Basic airway management techniques

Basic skills are the foundation of airway management and are the initial techniques used for all patients requiring airway and breathing support. They include both positional and manual manoeuvres and airway adjuncts.

Positional and manual manoeuvres include the recovery position – where the patient with an altered level of consciousness is placed on their side, opening the upper airway and allows fluid to drain from the mouth – and methods to open the airway without equipment. The head tilt-chin lift, head tilt-chin lift-jaw thrust and jaw thrust manoeuvre describe techniques to open the patients upper airway but they do not protect against aspiration and require additional personnel if additional treatment, for example ventilation, is required (22).

Oropharyngeal and nasopharyngeal airways are used as an airway adjunct to improve oxygenation and ventilation, but are often used as a temporary device, until they can be replaced with a more definitive airway device (3).

2.2.2 Supraglottic airways

Dr Brain invested the first supraglottic device in 1981 and was introduced into clinical practice in 1988. Since then supraglottic airway devices, especially
Laryngeal Mask Airways (LMAs) have seen increased use around the world as an alternative to endotracheal intubation, particularly due to their ease of use; simplicity of training; predictability; and speed of insertion. One complication of the LMA is that it does not function as a definitive airway as it only masks the glottis rather than protecting the trachea from aspiration (19, 23).

2.2.3 Endotracheal intubation

Considered as the 'gold standard' for definitive airway management, endotracheal intubation (ETI) involves inserting a cuffed endotracheal tube into the trachea. This allows positive-pressure ventilation, positive end-expiratory pressure and protection from aspiration; however, it requires rigorous training and experience. As the skill level, and risks, for rapid sequence intubation (RSI) – intubation with the aid of pharmacologic muscle relaxants – is even higher than simple direct intubation without drugs, due to the elimination of the patient’s spontaneous respirations, some paramedics are only authorised to intubate patients without a gag reflex (3).

While ETI is considered the cornerstone to definitive airway management, there is controversy over whether paramedics should be allowed to perform the skill for a variety of reasons, including poor reported success rates, extensive training requirements and whether it is a clinical benefit to the patient, often with supraglottic devices suggested as being more appropriate for paramedics (3, 14). There has been some research that has shown pre-hospital ETI is associated with improved patient outcomes over supraglottic airway insertion, especially in cardiac arrest patients (15, 24, 25).
2.2.4 Surgical airways

When conventional methods fail to secure the airway, paramedics are required to manage the airway with a more invasive approach, either an open surgical cricothyroidotomy (cutting a hole in the cricothyroid membrane and inserting an endotracheal tube directly into the trachea) or needle cricothyroidotomy (a 14 gauge cannula is inserted through the membrane into the trachea and oxygenation achieved with a high pressure jet ventilator). While easier to perform, a needle cricothyroidotomy is considered a temporary measure, due to the build-up of carbon dioxide, until an open cricothyroidotomy can be performed (22).

2.3 Paramedicine and WA paramedic education

A paramedic is a health professional who provides rapid response, emergency medical assessment, treatment and care in the out-of-hospital environment (8).

To qualify as a paramedic in WA, students need to pass an undergraduate degree in paramedic science. Unlike the rest of Australia (where students undertake a full-time, three-year degree university programme before applying for a job with the ambulance service) students have to apply both to the university and SJA. The first year at university is full-time on campus, while the remaining three years are spent working full-time on road with a paramedic while they undertake their university units online and short courses at SJA’s ambulance training college (26, 27). The method of training Western Australian paramedics to intubate has changed little over the decade since its introduction; a short classroom course instructing the students how to use the equipment to insert a tube into the trachea of a manikin followed by five days supervised practice in the operating theatre where they consolidate the skills of endotracheal intubation and
laryngeal mask airway insertion. Training in surgical cricothyroidotomy is taught
with the use of skills-practice trainers only (28).

Despite numerous research studies investigating the competency of paramedics
to undertake endotracheal intubation, typically through quantitative research into
intubation success rates, there has been minimal research undertaken on the
training received by Western Australian paramedics. With regard to the worldwide
research that does exist, it has been suggested that studies investigating pre-
hospital intubation in adults lack the core data required for useful interpretation of
results and rarely present high-quality scientific evidence, for example in a
complex intervention such as intubation, with its many separate but interacting
components, it is difficult to prove a true association between a single cause
(intubation) and an effect (survival), which creates challenges when attempting to
compare research (29).

After completing the classroom course and clinical placement, students
undertake a further one year of clinical placement working on an ambulance.
These clinical placements are suggested to be critical to the education of
paramedics who will be required to autonomously make clinical decisions under
challenging circumstances which do not always lend themselves to simulation
scenarios. It has also been argued that sole reliance on mannequin-based
simulation activities and anatomical models is insufficient to prepare paramedic
students for the range of human external and internal anatomy required to be
competent in some invasive procedures, including airway management (26, 30).

Considering the increased difficulty in performing endotracheal intubation in a
pre-hospital environment when compared with the operating theatre, it has been
suggested that paramedics should receive comprehensive theoretical education and extensive clinical experiences, including performing endotracheal intubation, ideally on a level similar to physicians (3, 14). Emergency room physicians are expected to perform between 35 and 200 endotracheal intubations before graduating from their respective training programmes. While several reports predict that 15 to 20 endotracheal intubation encounters are required to attain baseline proficiency (defined as predicted endotracheal intubation success threshold of 90 per cent), others predict a 90 per cent success rate cannot be achieved until over 27 to 57 attempts (3, 31-36). Konrad et al identified that a specifying a minimum number of successful intubations was not sufficient to ensure competency, that even after 80 intubations 18 per cent of residents still required assistance, individual learning styles and different educational opportunities may have significance (37).

Both locally and internationally, the adequacy of initial advanced airway skills training, the level of experience available during hospital placements and prevention of skill erosion once qualified has raised the question as to whether the continued teaching of endotracheal intubation is appropriate, especially considering intubation is an infrequent event for most paramedics. In the United Kingdom (UK) paramedics perform intubation between one and four times a year. There are several ambulance services that have already started phasing out intubation training for new paramedics because of the difficulties gaining sufficient experience during the hospital placement and challenges to maintain competency (6, 13, 14, 38-40). In the state of Victoria in 2011, there were 543 mobile intensive care (MICA) paramedics and 714 RSIs were performed. Fisk identified that 45 per cent of the MICA paramedics did not perform a single RSI
during the 12 month study period and of those who performed at least one RSI, the majority only performed between one and five intubations (41). Similarity can be seen among non-anaesthesiologist physicians who infrequently perform ETI, occasional performance of intubation does not ensure skill maintenance (42).

Similar low rates for intubation can also be seen within the population of WA paramedics, with less than one intubation per paramedic a year. The 2012, 2013 and 2014 success rates for WA paramedic intubation were 57.1 per cent, 66.0 per cent and 55.0 per cent (n=723) respectively. A failure to successfully intubate the patient would require a LMA to be successfully inserted. If this was also unsuccessful, utilisation of using basic airway management techniques, or a surgical airway in the ‘unable to ventilate, unable to oxygenate’ situation, is required. The successful paramedic LMA insertion rates for 2012 and 2014 were 80.7 per cent and 76.0 per cent (n=340) respectively. (10, 43-45).

The intubation success rate is often used as a measure of both provider and ambulance service success and a marker for public safety. In a study of 58 ambulance services, comparing physician and paramedic ETI, Lossius et al identified that the median ETI success rates for physicians was 99.1 per cent compared with 84.9 per cent for paramedics (46). For comparison, in a review of 83 institutions’ Emergency Departments, in 10 different countries, Park et al identified that the first-pass ETI rate was 84.1 per cent (47), and 81.8 per cent when only trauma patients were considered. The experience of individual physicians and paramedics is a factor for ETI success rate, Bernard et al identified that first-pass ETI success rates for first year anaesthesiology residents steadily increased from 67 per cent after their first 25 intubations to 83 per cent.
when they had performed 200 intubations. Until the residents had achieved an adequate level of success, it was recommended that they should be supervised by a more experienced member of staff (48).

First-pass success – successful intubation by the first attempt – is promoted as a goal of emergency ETI as each repeated attempt has been shown to be associated with an increase of adverse attempts, such as aspiration, oxygen desaturation, hypotension and cardiac dysrhythmias (49). Given that the rates of WA paramedics are overall success rates, it may be presumed that the first-pass success rates would be even less.

Je et al utilised a learning-cumulative summation test to evaluate ETI in emergency medicine, identifying that nearly 75 intubations were required to reach an adequate performance limit. As part of the study, they defined that a 90 per cent success rate was an adequate performance and that 80 per cent was considered inadequate (34). Failure rates of 10 to 25 per cent in an infrequently performed skill should be seen as a considerable concern, especially when compared with the considerably higher intubation success rates seen within hospital emergency departments (50-52).

Studies, undertaken predominately in the UK and USA during the last ten years, have highlighted adverse events and errors associated with intubation including poor outcomes; unrecognised tube displacement; oxygen desaturation; and bradycardia. The risks of intubation include a range of factors relating to the clinician, including skill, experience and confidence, and the patient, for example anatomy, co-morbidity and pathophysiology (6, 7). Pre-hospital ETI success rates range from 69 to 98.4 per cent (39, 53). While the routine use of qualitative end-
Tidal carbon dioxide capnography will reduce the rate of uncorrected misplaced tracheal tubes from 25 per cent to zero per cent, questions on the adequacy of paramedic training still remains, especially when errors, adverse events and poor outcomes has been proven to be associated with the volume of procedural experience. In addition, a 2013 study identified that requiring a second attempt to correctly place the endotracheal tube increases the percentage of adverse effects (including aspiration, desaturation, hypotension and dysrhythmias) from 14.2 per cent to 47.2 per cent (38). With the largest increase in adverse events occurring after the first unsuccessful first attempt and the second intubation attempt, it was again suggested that paramedics should ideally be intubating on the first attempt, which requires a certain level of expertise (13, 38, 49, 54, 55).

It has also been suggested that the skill of the paramedic to perform advanced airway skills is not the only concern within the paramedic’s education, the ability of the paramedic to correctly identify patients who require intubation emergently, in comparison to those who can be managed less invasively and wait until arriving at the emergency department, is a factor which contributes to poor patient outcomes. Including paramedic decision-making and patient risks and selection in the curriculum, regular continuing education and an awareness of one’s own skill level have been suggested as essential to improve patient care requiring emergent airway management (38, 56-58).

For paramedics in the United States of America (USA) undertaking recognised training programmes there is a national curriculum recommendation for a minimum of five intubations within the operating room, with each paramedic attempting a mean of seven intubation attempts. In the United Kingdom, the
number of intubations mandated was even higher with the Institute of Healthcare Development (IHCD) requiring paramedics to achieve a minimum of 25 intubations, of which five must be unassisted. However, this requirement has recently been withdrawn with the move to higher education training providers and the termination of endotracheal intubation as a required skill for some new paramedics, with LMA insertion and needle cricothyroidotomy (inserting a cannula through the cricothyroid membrane into the trachea) the only advanced airway techniques taught. The decision for 25 intubations was not based on scientific assessment of learning curves but was a number of intubations that could be expected to be achieved within a two week clinical placement.

Wang identified that intubation success was associated with accumulated intubation experience with Operating theatres or Emergency Departments the locations that provided the most beneficial experiences (32). It was also identified that while intubation skill improves with cumulative experience, the established minimum thresholds did not denote intubation proficiency and even suggested that there is little benefit if fewer than 13 experiences are achieved during placement (59). Other studies identified that a significant correlation exists between the total number of intubation attempts on patients and intubation success rates but no similar relationship exists between months of experience and success rates. This, combined with a lack of objective evidence about individual competency, has seen a move towards individual assessment of competence and defined the learning curve for airway skills (34, 60).

One US study attempted to prove that there was no statistical relationship between the number of hospital-based intubation attempts and the likelihood of
pre-hospital intubation success, negating the requirement for paramedics to undertake a hospital placement and achieve the required five intubations. These paramedics only achieved a pre-hospital success rate of 52 per cent after an average of 6.5 clinical attempts during the hospital placement (61).

In Australia, there are no recommendations or requirements for a minimum number of successful intubations before the student can perform intubation within a pre-hospital environment. When intubation and LMA insertion was first introduced into WA in 2001, paramedics only received instruction and practice using manikins, with no hospital placements or consolidation of learning (13, 16, 28, 62).

As with any clinical skill, regular practice and training is required to prevent skill erosion. While there is no objective scientific data which suggests a minimum number of intubations each year to maintain competency, without regular exposure and experience, the paramedics’ ability is reduced, especially when the yearly median frequency of less than one intubation per paramedic in some areas. Recently some ambulance services in the USA require their paramedics to achieve a minimum of 12 successful intubations a year to maintain competence, while Scandinavian guidelines recommend ten, perhaps reflecting a greater understanding of competency (17, 18). In 2005, one study suggested that having four Emergency Medical Technicians (EMTs), not even paramedics, undertake 32 intubations over four years with a 94 per cent success rate was proof of an effective training programme (63). While resuscitation guidelines qualified the amount of sufficient experience with 6-12 intubations per year, this recommendation has not been introduced to the Australian resuscitation
guidelines. Paramedics in WA may only be required to undertake two or three intubations each year, some even fewer (44). While some organisations require a minimum number of intubations a year, other services require airway management continued education to be undertaken after a specific time period, for example 90 days, especially when the number of intubations performed is likely to be low (64, 65). Consideration of Ebbinghaus’ ‘forgetting curves’ could provide direction for airway management education, specifically that every repetition in learning increases the ideal interval before it needs to be repeated; reviewing material should occur within 24 hours and that overlearning skills (practiced more than required to memorise it) increases the likelihood of information being impervious to being forgotten. In addition, stress and sleep, both factors associated with paramedicine, were shown by Ebbinghaus to increase memory loss (66, 67).

Initially paramedic training in WA was provided by the ambulance service training centre. Since 2004 this training has been developed in association with the higher education sector and has resulted in the offering of a Bachelor of Science in Paramedic Science at Edith Cowan University and, more recently, Bachelor of Science in Paramedicine at Curtin University. The student undertakes the first year full-time at the university, before commencing work for SJA, on a full-time paid basis, while undertaking the rest of their degree by distance learning. As part of this degree programme, student paramedics receive two short face-to-face courses at the SJA training centre and a short hospital clinical placement to consolidate their advanced airway management training (68-71). In all other states and territories of Australia, students attend universities for the full duration of their degree before applying to ambulance services for an internship as a
graduate paramedic. In addition, endotracheal intubation is an extended paramedic skill, requiring post-graduate education and continued professional development (8).

Simulation, as with other health disciplines, has been suggested as an answer to this reduced lack of opportunities of skill practice and development but few practitioners agree that simulation, regardless of the level of fidelity, is a satisfactory replacement for in-field practice (72). While simulation can supplement the learning process, it is suggested that sole-reliance on manikin activities and anatomical models is insufficient to prepare for the variance of human internal and external anatomy (30, 73, 74). Dehmer et al, although describing the views of medical students, suggests that simulation without actual patient encounters will almost certainly fail to deliver competent clinicians but should be used to verify competence prior to becoming a clinician (75).

Traditionally, initial training in intubation has been undertaken in the classroom: including skill practice on mannequins and park-task trainers, before consolidation in the operating theatre. While allowing paramedics to practise and learn the psychomotor complexities of advanced airway management within the controlled clinical conditions of the operating theatre, under the guidance of anaesthetists, is an accepted method for novices to acquire the fundamentals of intubation, it has been found that student paramedics access to the operating theatre for training has decreased over the last decade (13, 16). Moreover, with the increased use of the Laryngeal Mask Airway (LMA) in operating theatres has reduced the number of endotracheal tubes used by anaesthetists. This reduction in opportunities for student practice has even led to some paramedic students not
undertaking a theatre clinical placement. Despite the documented benefit of the development of student’s confidence, organisation skills, clinical decision making and preparedness for practice, learning opportunities are restricted to practicing on task-trainers and manikins. It has also been identified that patients in cardiac arrest and medical non-arrest had an increased survival risk when intubated by providers with a high procedural experience (39, 73, 74, 76, 77).

Another benefit of the clinical placement, in addition to the consolidation of skill performance, is the opportunity to develop clinical-decision making skills and problem-solving processes. Removal of the clinical placement, due to a perceived lack of performance opportunities, can be argued as also reducing the opportunities for students to experience good clinical-decision making skills while in a safe, supervised learning environment (39). In Australia there are no mandatory requirements in relation to duration, content or measurement of quality in student paramedic clinical placements (78).

Using cadaveric training has been suggested as an adjunct to clinical placement, as it provides exposure to human anatomy, including variations in normal tissue planes and textures and minor anatomical variations not available with manikins but essential to the development of paramedics’ competence and confidence. Despite this, integration of human cadaveric training into paramedic education is rare although when introduced into a paramedic programme at the Queensland University of Technology it was found that in addition to complementing simulation training and clinical placements, it delivered significant improvements in knowledge, interventional skill and student attitude (30).
2.4 Adult learning

A large proportion of paramedic education is experiential in design, with student paramedics spending one year full time at university learning health sciences, before a spending majority of the following two years undertaking fieldwork experience, where they learn from continued exposure to patients, while working on an ambulance with a qualified paramedic (79).

One learning model where students acquire the knowledge, skills and feelings in an immediate and relevant environment is Kolb’s model of experiential learning, where learning is achieved through reflection on everyday experiences (80).

Kolb’s theory describes a learning process where students build and refine their knowledge through personal and environmental interactions, specifically four stages that exist in a cyclical learning process. Kolb’s theory involved two different methods of gaining experience – concrete experience (feeling) and abstract conceptualisation (thinking) combined with reflective experience (watching) and active experimentation (doing) to transform the experience (80, 81).
Kolb’s theory suggests that students learn more effectively if the education process is directed towards that student’s individual learning preference and that providing learning experiences, across the range of learning styles and in a variety of environments, are essential when designing the paramedic curriculum. Systems developed using experiential learning theories can be used to measure skill abilities throughout the educational programme (81, 82).

Advanced airway management is usually taught during a clinical laboratory at the end of the second year of study. Intubation is effectively a practical skill, the paramedic inserts a tube into the trachea allowing ventilation of the patient and, as such, it could also be considered that the theories of motor learning can be applied to teaching intubation.

Fitts and Posner proposed a three stage sequential model of motor learning to provide a framework for developing education strategies for teaching physical
skills (83). Consisting of the cognitive stage, the associative stage and the autonomous stage, the student is first taught an overall understanding of the skill before they are expected to be able to demonstrate consistent performance with fewer errors until they reach the third stage where they are able to perform the skill rapidly and accurately without thinking about how to undertake the skill. On reaching the third stage, paramedics should be able to undertake intubation in a range of circumstances autonomously. To achieve this though, the student has to be allowed to practice in a variety of conditions, for example different environments, positions, distractions and varying anatomically differences, insufficient practice can lead to paramedics not reaching the autonomous stage and being unable to problem solve or successfully intubate in difficult environments (83-85).

While the theory of motor learning provides guidance on developing instructional strategies to teach good techniques, which according to Mulcaster, if used correctly (i.e. inserts and lifts the laryngoscope successfully and asks for appropriate help) the student will have a 90 per cent probability of performing a good intubation (36).

Dreyfus and Dreyfus introduced a model where the progression from novice to master is the result of the successive transformation of four mental functions – recollection, recognition, decision and awareness (86). In 2004, Stuart Dreyfus wrote a second article, on the same five stage model of skill acquisition, but changed the five stages from novice, competent, proficient, expert and master to novice, advanced beginner, competent, proficient and expert, suggesting that it takes longer to become competent (87). Dreyfus' five stage model of adult skill
acquisition (table 1) describes students moving from novice to expert, but unlike the earlier article, the 2004 paper utilises recollection, perspective, decision and commitment to differentiate the levels. This model also describes a situation where only an expert shows intuitive decision, compared with the 1980 article where both expert and master showed intuitive decision making (86-88). The Dreyfus model has been widely adopted within the medical profession, for example, assessing medical students, nurses and paramedics, as they progress through their studies and develop specific skills and competencies (89-91).

*Table 1: Dreyfus’ five stages of skill acquisition (87)*

<table>
<thead>
<tr>
<th>Skill level</th>
<th>Components</th>
<th>Perspective</th>
<th>Decision</th>
<th>Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novice</td>
<td>Context free</td>
<td>None</td>
<td>Analytic</td>
<td>Detached</td>
</tr>
<tr>
<td>Advanced beginner</td>
<td>Context free and situational</td>
<td>None</td>
<td>Analytic</td>
<td>Detached</td>
</tr>
<tr>
<td>Competent</td>
<td>Context free and situational</td>
<td>Chosen</td>
<td>Analytic</td>
<td>Detached, understanding and deciding, involved outcome</td>
</tr>
<tr>
<td>Proficient</td>
<td>Context free and situational</td>
<td>Experienced</td>
<td>Analytic</td>
<td>Involved outcome, detached deciding</td>
</tr>
<tr>
<td>Expert</td>
<td>Context free and situational</td>
<td>Experienced</td>
<td>Intuitive</td>
<td>Involved</td>
</tr>
</tbody>
</table>
One of the criticisms of Dreyfus, is that it does not take into account variations in student abilities or variations in clinical experience available on during placement, assuming that all students develop in accordance to a timetable. Basing her theoretical model on the work of Dreyfus, Benner’s suggestion is more student orientated, where the student moves to the next stage depending on individual competence. Like Dreyfus’s model, Benner’s framework was developed for nursing but can be applied to all health professionals, including paramedics. By the time the student qualifies as a paramedic, they should be considered at least competent. To reach the expert level, it has been suggested that at least 2,500 to 5,000 intubations are required and that clinicians who are unable to become proficient performers, undertaking 10 – 50 intubations a year, should be restricted to use of supraglottic devices (65, 89, 92).

Developments in cognitive learning theories have resulted in an improved understanding of how students acquire clinical expertise, including education that is systematically organised and coherently sequenced with well-defined objectives; at an appropriate intellectual development stage and that skills acquisition occurs in a relevant context. Learning is also improved if students can build on their knowledge and skills through combining their existing experiences with new ones and there are opportunities to consolidate their knowledge and skills through practice in a variety of clinical environments (73, 93, 94).

It has been identified that students learn more from successful intubation attempts compared with failed challenges, consistent with the theory that intubation is a motor skill best learned by practice of the correct technique –
Plummer et al identified that a trainee learns as much from one successful ETI as from 12 failed trials (95). This theory proposes that continued repetition of intubation, often considered as a difficult skill when first taught, will eventually become automatic and intuitive with positive practice. Repetition or incorrect performance can be considered as offering little benefit and introduction of difficult airway situations should only be introduced when the student has a good prospect of successfully performing the skill (95). Watts et al also identified that performing a procedure badly a large number of times has little educational value and puts patients at risk (96).

While intubation can be considered a psychomotor skill, it forms part of the airway management process, which should not be considered simply as a collection of physical skills inserting adjuncts into the airway. Clinical decision making and the use of difficult airway algorithms should also be considered as essential part of paramedic education from the outset (73).

2.5 Competence

Competency is defined by the Council of Ambulance Authorities as the skills, attitudes and other characteristics attained by an individual through knowledge and experience, which together are considered adequate to enable the individual to work as a paramedic (97). Similarly proficiency is defined by the Paramedic Association of Canada as the demonstration of skills, knowledge and abilities in accordance with consistency, independence, timeliness, accuracy and appropriateness (98). However, recognising that the paramedic profession is developing into a patient-centred approach, Tavares et al documented that Canadian paramedics now also need to demonstrate capabilities of six roles –
clinician; team member; health and social advocate; educator; reflective practitioner and professional – in order to be proficient (99).

Competence is dependent on a good foundation of basic clinical skills, scientific knowledge and moral development and is a combination of communication, knowledge, technical skills, clinical reasoning, emotions, values and reflective practice (100).

From these definitions it can be seen that competency in intubation is more than simply performing the physical skill of inserting a tube into the trachea, it represents the combination of knowledge, attitudes and skills required to be a safe and effective clinician who can adapt to new situations and environments (101).

There is limited information on an agreed extent of training required for competence in ETI for paramedic providers and what actually signifies true competence, with region or institution specific recommendations developed along with numerous non-standardised airway training programmes existing, of varying duration and abilities (36, 102, 103).

Considering Benner’s framework, a student paramedic has to pass through the novice and advanced beginner stages before being considered as competent, defined by Benner as requiring two or three years’ experience of undertaking the same role or similar situation (104). However, the assessment of competence is subjective; for example, the student’s approach to learning and motivation might influence the assessors’ confidence in declaring the student as competent rather than a summative review or snapshot of one activity (105).
**Table 2:** Benner’s stages of clinical competence (104)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Novice</strong></td>
<td>Has no experience in the situations they are expected to perform. They lack confidence to demonstrate safe practice, require continual verbal and physical direction and are unable to use discretionary judgement.</td>
</tr>
<tr>
<td><strong>Advanced beginner</strong></td>
<td>Able to demonstrate marginally acceptable performance as a result of some prior experience in actual situations. While they are efficient and skilful in segments of their practice area, they still require occasional supportive cues.</td>
</tr>
<tr>
<td><strong>Competent</strong></td>
<td>Normally demonstrated after working within the same or similar environments for two or three years. They can demonstrate efficiency, is coordinated and confident in their actions. Able to operate within a suitable time frame without supporting cues, decisions are based on conscious, abstract, analytic contemplation of the problem.</td>
</tr>
<tr>
<td><strong>Proficient</strong></td>
<td>The individual perceives situations in their entirety rather than segments or individual aspects and this holistic understanding improves the individual’s decision making.</td>
</tr>
<tr>
<td><strong>Expert</strong></td>
<td>The individual has an intuitive grasp of each situation and can concentrate on the specific problem without wasteful consideration of a range of unfruitful alternative diagnoses and solutions. Their performance is fluid, flexible and highly proficient while their highly skilled analytic ability allows management of situations not previously experienced.</td>
</tr>
</tbody>
</table>

Medical education has recently seen a move from traditional time-based programmes to competency-based systems to reflect the understanding that adult students learn at different rates and the rate of achieving competency is individualised, defined by outcomes rather than number of encounters.

Experience has also been shown to be necessary to develop competence, with competency not achievable by theoretical teaching alone due to the complexities of clinical practice. Within some medical skills there has also been a change from traditional subjective evaluations of student skill performance to objective
measures due to suggestions that educators were not preparing all students to be able to perform skills independently (75, 104).

For student paramedics to be competent in intubation – simply measuring exposure to the skill in the operating theatre or performing the skill on a manikin, under observation in a well-lit training room, is not sufficient to declare competence. Repeated practice under increasingly difficult and realistic conditions is an essential requirement of their education and assessment process (100, 101).

Competency based education has evolved from three learning domains described by Bloom, namely cognitive domain; affective domain and psychomotor domain and is concerned with application and synthesis of knowledge rather than simply the acquisition of knowledge. Bloom’s taxonomy has been used as the basis for curriculum development, instructional design, framework development and setting assessment levels for decades. Bloom’s cognitive domain described six different levels (knowledge, comprehension, application, analysis, synthesis and evaluation) associated with increasing levels of difficulty and ability (106-108).

Applying a competency-based system to airway management replaces the subjective nature of assessment with discreet, transparent, achievable, measurable objectives, which allow the attainment of increasing levels of knowledge and skill. It has been shown to be particularly effective for the assessment of discrete procedural skills, including intubation, due to its focus on individual and attainable skills but is not as effective in the assessment of non-technical skills such as clinical decision-making. The consequence of this is that
while it is possible to assess whether the paramedic can perform the specific skill, it cannot identify if they can use it correctly and appropriately (108).

Konrad et al defined success as adequate technical performance without the assistance of a staff person and to achieve success they defined a learning curve, which reached a 90 per cent success rate after an average of 57 attempts. It was, however, found that 18 per cent of these residents still required assistance after 80 intubations, raising the question that basing competence on a specific number of intubations does not ensure the paramedic is competent. Je et al and Grissom et al also identified that the number of ETI attempts to achieve a predetermined level of competency are variable and suggested a learning curve cumulative summation analysis could be used to monitor a learning process for training of airway management and assessing clinical competency at the end of training (34, 35, 37).

Due to the complexities of predicting competency in a medical skill, complex techniques have been used in an attempt to provide a thoughtful assessment. DeMeo used Bayesian analysis to evaluate the intubation attempts of over 100 doctors working in a neonatal intensive care unit. Bayesian analysis is a methodological technique that relies on the initial conditions set in a mathematical analysis to predict an outcome. In this study, competency was defined as four cumulative successful intubations with approximately one quarter of residents achieving competency in the 8-year study period, which according to the authors, illustrates how challenging it can be to define and achieve competence in intubation regardless of the setting (2).
The Alberta College of Paramedics recently attempted to define the minimum education requirements for paramedics undertaking intubation as a minimum of ten intubations in a simulated setting and 15 intubations on a live patient in a clinical practicum in order to complete their programme requirements. They also recognised that their educational programme has to provide appropriate resources, learning facilities and learning opportunities that allow the student to achieve proficiency (defined as consistently, independently, timely, accurately and appropriately demonstrating intubation) in the required competencies (102).

2.6 Competence vs confidence

Increasing student self-confidence has been claimed to be an essential goal of the education system, with some suggestions that a more confident paramedic will perform better than a less confident one. Both manikin and clinical experience has been shown to increase self-confidence in performing intubation with more experience resulting in high self-confidence levels until a plateau is reached (i.e. after 30 manikin intubations). Once this plateau is reached continued performance results in minimal increases in confidence until a different learning experience is introduced, for example supervised to unsupervised practice or a move from manikins to live tissue, however, students with low confidence often visualise defeat before it occurs. Kruger and Dunning also found that all but the highest performers tended to overestimate their abilities and performance, with the worst performers being the ones most likely to overestimate their abilities (109-111).

When questioning novice paramedics on their self-reported competence in intubation as part into a study to define the learning curve, the investigators found
that group who had only performed five intubations, in comparison to the groups who had performed ten or 20, were the only ones who perceived themselves as most competent in the skill. It was suggested that their limited exposure had not provided them with the opportunity to experience difficulty (21).

Self-efficacy is an important consideration in the education of paramedics as Miabach identified that clinicians are hesitant to use skills for which they lack confidence. Self-efficacy does not decrease at the same rate as skill retention and competence, resulting in a paramedic feeling capable of performing a critical skill but actually being unable to perform the skill (112). Youngquist identified that skill degradation is more pronounced for intubation, specifically paediatric intubation, that ventilation; that skill retention for intubation is poor and that a large majority of paramedics were unable to pass skill testing at six months after training (64).

Apart from paramedics, intubation is normally only performed by doctors. Hanson described the existence of a fine line in medicine between competence and self-confidence and over-confidence and arrogance. Andrews also identified a dichotomy between low levels of experience and high levels of confidence and self-assessed competence in doctors undertaking emergency airway management. Either the doctors are truly competent, as a result of the quality of their education, or are overconfident, but their inexperience means they do not recognise their lack of competence (113, 114).

WA student paramedics receive a very short introductory teaching course prior to undertaking a clinical placement, often only a few days in duration and a focussed on obtaining specific skills. Esterl et al found that the lack of confidence
at this stage can usually be attributed to insufficient practical training or contact hours addressing the specific skills (115).

The relationship between confidence and competence may not just be associated with levels of experience and education, with influences regarding age and gender. A large proportion of student paramedics belong to Generation Y (born between 1980 and 1994) and while this generation has been associated with being empowered, well-educated and talented other, less desirable traits have been identified, including over confidence with skill levels and disproval when receiving negative feedback (116). Pliskea and Mutter identified that older adults have greater insight into the limitations of their knowledge but other studies have found that there is a tendency for greater over-confidence in older adults (117). It has also been identified that men can have equal or higher self-confidence than women when performing medical skills, Wolf et al even identified an inverse relationship between confidence and competence, with the overestimation of skill ability worsening as confidence is increased (109, 110, 118).

2.7 Summary

Western Australia paramedics are the only ambulance service within Australia where every paramedic is taught, and authorised, to perform intubation. As a result of changing airway management practices, there has been a reduction in the number of opportunities for paramedics to practice intubation in a supervised environment, raising the question of how competent are these paramedics to practice. It may be that reduced opportunities to perform intubation on real patients, leaving paramedics relying on their training with simple manikins and
skills trainers, which, due to their inexperience, can result in over-confidence in their abilities.

The literature shows that the accepted education and assessment techniques for paramedic intubation, specifically time on placement or number of exposures to the skill, are no longer recognised as adequate to decide competence. Competence is achieved through a combination of communication, knowledge, technical skills, clinical reasoning, emotions, values and reflective practice, which should be delivered by the education programme. The paramedic education programme should take into account the individualistic nature and rate of learning and competency-based assessment tools will need to be utilised is adequate success rates are to be achieved. The next chapter describes the research methods used in the study.
Chapter 3: Methodology

3.1 Introduction

This chapter describes the methodology used in this study, specifically the adopted research design; participant sampling; questionnaire development and administration; design and management of the focus groups; the approach to data collection and analysis; along with the ethical considerations of the research. This study contributes to existing literature on paramedic education by identifying whether Western Australian paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be effective and competent in their practice, especially in comparison with paramedics trained interstate or overseas.

3.1.1 Research aim and questions

The aim of this study was to identify whether Western Australian paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be competent and effective in their practice and identify possible improvements to current training practice. Specifically, four research questions were identified:

• How confident are paramedics in performing advanced airway skills?
• Do WA paramedics perceive that the current training regime provides adequate knowledge, technical and non-technical skills to undertake advanced airway procedures?

• Are there sufficient opportunities in clinical placements to practice endotracheal intubation and laryngeal mask insertion?

• What do paramedics suggest be included in initial airway management training programmes?

3.2 Study design and rationale for the methods used

Three possible research methods were considered for the study:

• Qualitative research which explores the implications which individuals or groups attribute to a problem:

• Quantitative research which tests theories by examining the relationships between variables: and

• Mixed methods which involves collecting both qualitative and qualitative data and integrating the data using philosophical assumptions and theoretical frameworks (119).

In order to develop a comprehensive understanding of airway management training within St John Ambulance (SJA), a mixed methods descriptive study was designed to collection information on training programme content, teaching methods used and individual paramedic perceptions on their confidence and competence. The mixed methods design was chosen, rather than a traditional homogeneous research design, because it would
provide a greater depth of understanding and corroboration compared with a simple quantitative or qualitative design and provides strengths that offset the weakness of qualitative and quantitative research. It is clear from the literature study that paramedic competence in airway management techniques cannot be solely assessed by quantitative (i.e. number of intubations performed on placement) or qualitative (i.e. what topics the paramedics think they should be taught) methods and a combination of both techniques will provide a clearer picture (29, 120-122).

3.2.1 Mixed methods research

Mixed methods research answers the research questions by systematically collecting, analysing and synthesising both quantitative and qualitative data in a single research project. Use of mixed methods research creates evidence which is more meaningful, complete and purposeful than using only a quantitative or qualitative approach. Another advantage is that the design should allow the validation of the quantitative statistical findings by data collected using qualitative methods (120, 123, 124).

The use of mixed methods research in pre-hospital care is relatively new, but due to its ability to tackle healthcare questions in complex, diverse environments, its use appears to be increasing (125).

Rather than considering the qualitative and quantitative data separately, in mixed methods research the two forms of data are combined, often building one form of data on the other, into a single study yielding a more complete analysis with data that complements each other (121, 126).
Suggestions of when mixed methods research is appropriate include when one data source may be inadequate, it is required to explain the results, exploratory results need to be generalised and when the overall research project is best tackled with multiple projects or parts (121).

Descriptive studies provide an accurate description of the variables associated with a particular circumstance rather than determining a cause and effect relationship (127). A descriptive design is often utilised when there is little known about a subject and while there have been some studies which have questioned paramedic confidence levels, research on adult airway management has been limited to the use of a particular type of adjunct or effectiveness of a new programme.(38, 127).

As part of the development of the mixed methods design, four questions have to be addressed (119, 120):

1. What is the sequence in which data should be collected, should it be concurrent or sequential?

The choice was made to choose to conduct a quantitative study first in order to examine the results and use this information to generate new research questions to be part of the follow up qualitative study. Undertaking the quantitative study first also allows contradictory results between the quantitative and qualitative studies to be explored (124).

2. Should equal status be given to the qualitative and quantitative data collection and analysis or should one be dominant?
It is the intention to provide, at least in the initial planning phase, equal priority to the quantitative and qualitative research as, while producing different types of evidence, both will influence the question of paramedic competency.

3. Should the research be integrated at data collection, data analysis, data interpretation or with some combination?

Research will be integrated both during data interpretation and data analysis. While the results of the questionnaire will be evaluated during the initial data analysis and used to formulate questions for the qualitative research phase it does not involve integrating the results. Following the data analysis of the qualitative research, during the data interpretation phase the results will be integrated in an attempt to answer the research questions.

4. Will a theoretical perspective be used to guide the research?

No one theoretical perspective will be used as the guiding framework for the study.

After consideration of these four questions, it is possible to identify six different primary mixed methods design strategies which are illustrated in Table 3 (128).
Table 3: Designs for mixed methods research from Creswell (101)

<table>
<thead>
<tr>
<th>Design type</th>
<th>Implementation</th>
<th>Priority</th>
<th>Stage of integration</th>
<th>Theoretical perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential explanatory</td>
<td>Quantitative followed by qualitative</td>
<td>Usually quantitative but can be qualitative or equal</td>
<td>Interpretation phase</td>
<td>May be present</td>
</tr>
<tr>
<td>Sequential exploratory</td>
<td>Qualitative followed by quantitative</td>
<td>Usually qualitative but can be quantitative or equal</td>
<td>Interpretation phase</td>
<td>May be present</td>
</tr>
<tr>
<td>Sequential transformative</td>
<td>Either qualitative followed by quantitative or quantitative followed by qualitative</td>
<td>Quantitative, qualitative or equal</td>
<td>Interpretation phase</td>
<td>Definitely present</td>
</tr>
<tr>
<td>Concurrent triangulation</td>
<td>Concurrent collection of quantitative and qualitative</td>
<td>Preferably equal but can be quantitative or qualitative</td>
<td>Interpretation or analysis phase</td>
<td>May be present</td>
</tr>
<tr>
<td>Concurrent nested</td>
<td>Concurrent collection of quantitative and qualitative</td>
<td>Quantitative or qualitative</td>
<td>Analysis phase</td>
<td>May be present</td>
</tr>
<tr>
<td>Concurrent transformative</td>
<td>Concurrent collection of quantitative and qualitative</td>
<td>Quantitative, qualitative or equal</td>
<td>Usually analysis phase but can be interpretative</td>
<td>Definitely present</td>
</tr>
</tbody>
</table>

A sequential explanatory design was chosen as it would provide an accurate description of the various training methods utilised for paramedic
airway management and identify any differences in paramedics’ confidence and experience. While the quantitative survey questionnaire addresses the all research questions, analysis of the qualitative focus groups and interviews is necessary to satisfactorily answer the first and fourth question fully.

3.2.2 Validity and reliability

Validation is an essential foundation of quantitative, qualitative and mixed methods research and is a representation of the quality and rigor of the research (129). As mixed methods research involves both quantitative and qualitative approaches, both types of research validity should be considered during the both the design and undertaking (127). However, as mixed methods research involves combining the complementary strengths and non-overlapping weaknesses of the two research types, assessing the validity of findings can be particularly complex resulting in a problem of integration (130).

Onwuegbuzie and Johnson suggested the following nine types of validity for mixed methods research (130):

Sample integration is “the extent to which the relationship between the quantitative and qualitative sampling designs yields quality meta-inferences” (130). In an attempt to minimise sample integration, individuals for the qualitative research are drawn from the quantitative group and because the focus and interview group was so small, in comparison to the number who responded to the questionnaire, no generalisations were made regarding the population from the qualitative component;
Inside-outside refers to how faithfully the researcher represents the insider’s and observer’s viewpoint (131). The researcher has remained objective and impartial during collecting, analysing and interpreting the research.

Weakness minimisation occurs when the weakness of one approach is compensated by the strengths of another (131). The study was planned, designed and undertaken in a way that weaknesses associated with qualitative design was compensated by the strengths of quantitative research, for example the use of focus groups allowed the identification of the emotions of the participants, information which cannot be obtained from a questionnaire.

Sequential validity refers to the extent to address any effects resulting from reversing the qualitative and quantitative phases (127). Sequential validity is minimised by using the research phases to identify different data, the quantitative phase predominately identifies the participants’ memories of education while the qualitative phase examines their opinions and viewpoints.

Conversion refers to the extent to which the quantitating or qualitising produces quality meta-inferences (130). During the data analysis and interpretation phase attempts were made to minimise decreases in quality resulting from counting inaccuracies, including verbal counting, misleading counting and over counting.

Paradigmatic mixing is the “extent to which the researcher’s epistemological, ontological, axiological, methodological and rhetorical beliefs that underlie the qualitative and quantitative approaches are
successfully combined into a usable package” (131). To minimise paradigms, the quantitative and qualitative approaches were treated as separate phases with consideration of each of the results during the interpretation phase of the study.

Commensurability legitimation refers to the extent to which the meta-inferences made reflect a mixed worldview based on the cognitive process of Gesalt switching and integration (130). It is the intention of the interpretation phase of the study to provide a combined position of the data collected during the qualitative and quantitative phases.

Multiple validities refers to the “extent to which addressing legitimation of the quantitative and qualitative components result from the use of qualitative, quantitative and mixed validity types yielding high quality meta-inferences” (127). Consideration, and attempted minimisation, of the individual validity issues associated with both qualitative and quantitative research along with those associated with mixed methods will result in high quality research.

Political validity refers to the extent to which the researcher has addressed the interest, values and viewpoints of the various stakeholders (127). To increase political legitimation the study does not only involve generating statistical results and report opinions, but also proposes paramedic education curriculum strategy and objectives, in an attempt to provide a workable solution to the issue of ensuing competence.

Study reliability has been enhanced by conducting the research by the transparency of methods used, for example, clearly documenting the
methods for selection and data analysis, and defensible in terms of
documenting evidence, substantiative results and validating conclusions
(132).

3.3 Population and sampling

The population of interest were paramedics, especially those working within
Western Australia, who have performed endotracheal intubation or LMA
insertion within the last 12 months. Apart from WA and the Northern
Territory, where St John Ambulance hold the contract to provide an
ambulance service, all other states and territories have government run
ambulance services. In addition, WA is the only ambulance service where
all its paramedics are taught and authorised to perform intubation, other
states and territories train a select few intensive care paramedics to perform
this skill.

3.3.1 Ethics

Ethics approval for this low risk study was sought from the Human Ethics
Committees of the University of Western Australia (approval granted on 16
October 2013, reference number RA/4/1/6404) and St John Ambulance
(approval granted on 6 January 2014). Copies of the approvals can be
found in Appendix 1.

To allow a short test to be included prior to the commencement of the focus
groups an amendment was sought to the original University of Western
Australia ethics approval on 21 August 2014 and granted on 26 August
2014.
3.3.2 Inclusion criteria

Participants should ideally be randomly selected from the population to minimise systematic bias but also be representative of the population (127). If the sampling technique is appropriate then a reasonable accurate understanding of the experiences in the target population will be possible (123).

The target population were paramedics who had attempted intubation or LMA insertion within the previous 12 months. The sample selection was volunteer sampling with Australian paramedics, regardless of where they received their initial paramedic instruction, invited to participate.

Student paramedics could participate in the study as long as they had completed their initial training and operating theatre clinical placement, be authorised to practice advanced airway skills under the direction of qualified paramedics and have attempted intubation or LMA insertion within the previous 12 months.

The reason for the one year limit is that these paramedics were more likely to be able to recall their feelings and concerns, paramedics who have not attempted an intubation or LMA insertion within 12 months may have high levels of confidence in their abilities as their advanced airway management skills have not been recently challenged.
3.3.3 Pilot study

A pilot study was undertaken to check validity and reliability of the questionnaire. Pilot tests can be used to assess whether the questionnaire is realistic, workable and identify any logistical problems (133).

Six Clinical Support Paramedics (CSPs) were involved in the project; one had originally trained in the UK, two in South Africa and the remaining three received their original airway management training in Western Australia. The aim was to choose subjects with similar training experiences to the participants in the study, but who would not be involved in the research.

CSPs are experienced paramedics who, due to their extended care role, have received additional advanced airway management education and operating room hospital placements, compared with the average paramedic. As a result of this post-qualification education, it would be likely, their confidence scores would be higher, and, if allowed to participate in the research, would influence average confidence scores.

The CSPs were requested to make text comments throughout the questionnaire and specifically feedback any ambiguities or difficult questions; record the length of time taken to complete the questionnaire and gauge whether there are an appropriate number of responses to the questions.

The CSPs responded that the questions were clear and easy to answer. A couple of typographic errors were corrected and it was found the questionnaire took an average of 20 minutes to complete. While the pilot
participants believed that the questionnaire would collect the required results, several thought that limiting the collect method to a paper questionnaire, even if emailed, might limit the number of potential responses. To maximise the potential number of responses, it was decided that the participants would be able to select whether they wanted to complete the questionnaire online or complete a paper version.

3.3.4 Number of participants

There are currently approximately 700 paramedics employed by the WA ambulance service with approximately 150 overseas and interstate trained paramedics being employed since 2009 (68, 134-137). As interstate and overseas trained paramedics only constituted approximately 20 per cent of the paramedics employed by SJA, interstate intensive care paramedics were invited to participate to increase the population size.

In 2012 WA paramedics intubated 436 patients and for 55 cases multiple attempts were required to successful place an advanced airway. These intubations were undertaken by 270 paramedics who represented 46 per cent of the workforce. This is a similar to the data contained in Tan’s report into intubation statistics between 1 July 2012 and 1 September 2013 where he identified 311 paramedics who had attempted intubation over the previous 14 months, averaging 267 over 12 months. From this information it was presumed that the population would be approximately 270 paramedics (9, 43, 138).

For a sample to be representative of the population, the response rate should be as large as possible, with response rates of 70 per cent or higher
quoted as acceptable (127). Bias also appears to be minimised when response rates of over 70 per cent are achieved (139). In this study this would result in an ideal sample size of 189 paramedics.

3.3.5 Recruitment

The initial research plan and ethics application involved convenience sampling of SJA paramedics by emailing all SJA paramedics who had documented either intubation or LMA insertion within the previous 12 months a copy of the questionnaire. This was not achievable as SJA ethics approval did not support the provision of individually contacting paramedics but as they would publicise details of the research within their workforce a change of plan was required.

All SJA paramedics and ambulance officers were emailed details of the study inviting participation, including:

Participation information leaflets (Appendix 2)

The information leaflet described the purpose of the research, including the proposed outcome, the data collection methods utilised and the organisation involved in the research.

Consent form (Appendix 3)

The consent form provided confirmation that the participant agrees to participate in the research. Participants who failed to complete the online questionnaire were also considered to have withdrawn from the study.

The questionnaire (Appendix 4)
The questionnaire was available in several versions: a printed paper version which could be handed to potential participants; an electronic pdf which could be emailed and an online questionnaire hosted by SurveyMonkey®. The link to an online version of the questionnaire hosted on the SurveyMonkey® website was included in direct response to feedback from the CSP pilot group. The questions and responses were identical regardless of the format of the questionnaire. One of the answers allowed identification of the state or country where the participant originally trained to allow comparison between the results.

A press release, describing the study and detailing online links to the study paperwork and questionnaire, was sent to Paramedics Australasia, a professional association for pre-hospital providers, for inclusion in their member publications and website. The study was also described on the Pre-hospital Research Forum (an online discussion site on pre-hospital research), published in the SJA’s Clinical Director’s Clinical Information Notice and online links to the study publicised on Facebook. Additionally, as a visual reminder of the study, a postcard (see Appendix 5), which described the research, was printed and distributed to the SJA training centre and ambulance depots throughout the Perth Metropolitan region. In addition, some Clinical Support Paramedics encouraged participation in the study while undertaking their regular duties conversing with ambulance crews.

Two weeks prior to the close of the data collection period, all SJA paramedics were emailed again to notify them of the closing date and notify
them that the end of the opportunity to participate in the study was approaching.

Paramedics and student paramedics had ten months to complete the questionnaire. Respondents who expressed an interest in participating in a focus group, by supplying a valid email address, were invited to one of several focus groups.

The advantages of this type of convenience sampling, where participants volunteer to participate in the study, are that the sample is easy to access, readily available and cost of obtaining the data relatively low. The disadvantage of this non-probability type of sampling is that it a low participation rate may limit generalisation (140).

3.4 Data collection

A questionnaire, focus groups and interviews were all used to gather information required by the researcher from study participants. Combining these different survey methods can provide a good way to conduct high-quality research (127).

3.4.1 Questionnaire

Questionnaires can be used to measure a range of different types of characteristics, including thoughts, attitudes, beliefs, perceptions and feelings (127) While recognising that questionnaires are a common type of study methods for descriptive research, it is being used in this study as the initial method of data collection due to its ability for targeting a population
spread across Australia, relative inexpense and its known effectiveness for measuring attitudes (141).

When compared with interviews as a source of data collection, questionnaires eliminate interviewer bias as no researcher is present and as a larger sample is often involved, resulting in increased generalisation of results, but one disadvantage is that the response rate from postal questionnaires can be as low as 20 per cent (123, 142).

According to Howie, research questions should be important, interesting and answerable, ideally in a timely manner. This required consideration during the questionnaire planning phase into the language, vocabulary and type of questions to be used (139, 143).

3.4.1.1 Questionnaire development

Questions cover four content areas: attributes, behaviours, attitudes and beliefs and the way the questions are posed is important to minimise inaccuracies due to social expectations, bias or misunderstanding the question (139).

The initial research tool was a self-administered questionnaire (see Appendix 4) which conformed to the 15 principles of questionnaire construction and included the use of open-ended and closed questions, and numerical rating scales. Other considerations when planning the questions included using familiar language, avoiding double negatives or double-
barrelled questions, possible responses for closed question questions and ensuring the questions are logically organised (127).

The quantitative data included the number of days in theatre, number of LMA, endotracheal intubation, successful and unsuccessful, attempts and confidence scores. The qualitative, consisting of free text responses, provided a picture of the paramedics’ opinions on the effectiveness and usefulness of the different methods of teaching airway management.

Paramedics’ self-efficacy to undertaking various advanced airway management techniques was measured through the use of an evidence-based practice confidence scale. The optimum number of response categories, for example 5, 7, 9, 10, 11, 15 or 21 points, in a Likert Scale has been discussed for numerous years, with Foddy suggesting that a minimum of seven points is required to ensure scale validity and reliability (144, 145).

Individuals completing the scale were asked to rate their level of confidence in performing each step using an 11-point rating scale that ranged from 0 to 100 percentage points. An 11-point scale allowed the identification of smaller variations in confidence levels than a four to six point score (127, 146).

The evidence-based confidence scale was developed by Salbach and Jaglal to evaluate health care professionals’ (HCPs’) self-efficacy when undertaking specific clinical skills. The scale involved HCPs rating their confidence on an 11-point scale ranging from 0% (no confidence) to 100% (completely confident) in their ability to perform each specific activity (147).
Paramedics were also given the option to provide an email address if they were interested in participating in a focus group.

3.4.2 Focus groups

In a focus group, a facilitator directs a discussion between a small group of individuals in an attempt to collect qualitative data, usually the participants’ thoughts and opinions on a subject which are recorded using the words utilised by the group participants (127).

Focus groups have the ability to rapidly generate complex information and are generally more economical to conduct than interviews, they may, however, not explore the subject as deeply as possible during interviews or identify sensitive or embarrassing information (123, 148).

Focus groups generally follow either a structured approach often seen in market-research, or a less formal, more semi-structured approach where participants are encouraged to discuss the questions amongst themselves rather answering the moderator’s questions. By adopting the semi-structured approach, the moderator facilitates the discussion rather than directing it, providing a greater understanding of attitudes, behaviour, opinions and perceptions (148, 149).

The primary aim of the focus group was to identify and effectiveness of the differing teaching methods utilised to teach advanced airway management, including clinical placements, high and low fidelity scenarios, individual skill-based simulators, case study discussion and practice on animal and human
tissue. The discussion questions for the focus groups (Appendix 6) were identified from the open-ended responses in the questionnaire. These semi-structured focus groups were intended to be the main form of qualitative data collection. Open-ended questions not only investigated the participants' airway management training and experiences but allowed discussion of the effectiveness of individual education techniques to provide the cognitive, psychomotor and effective skills required to competently manage the adult airway.

While it is recognised that focus groups do not explore issues as deeply as one-on-one interviews, they are an effective means of stimulating new ideas and concepts, so were used to generate impressions of varying training programmes and as a means of verification and consensus between a range of participants (123, 127).

Before the focus groups, undertaken in SJA's Ambulance Training College, commenced, participants were invited to participate in a short quiz, designed to assess their recall of the correct order of procedures to undertake intubation, in accordance with the SJA skills manual. The SJA skills manual contains a description of how to perform the skills authorised and all training and assessments follow these descriptions. A copy of the quiz can be found in Appendix 7 (150).

The focus groups were audio recorded and then transcribed to ensure an accurate record of the events is maintained. Transcribed data was imported into management software NVivo (QSR International Pty Ltd: NVivo 69.
qualitative data analysis software. Version 10, ed 2014). This data was coded and analysed to identify how effective the participants believed their airway management training regime was, whether they thought any possible improvements could be made and what measures should be adopted to ensure skills maintenance.

Two focus groups were undertaken, each with two participants attending. Additional focus groups were attempted to be organised, but the required number of participants could not be guaranteed. As a result of poor attendance at the focus groups, a decision was made to conduct one-to one interviews utilising the focus group questions.

3.4.3 Interviews

Qualitative interviews allow information regarding a participant’s knowledge, understanding reasoning, motivation and feelings of a subject to be identified. Structured interviews, utilising the open-ended questions developed for the focus groups, were used to provide qualitative data which would support the data obtained in the focus groups (151).

While often associated with qualitative research, interviews can be a useful tool in mixed methods research. While interviews allow the clarification of participant responses, they can be time consuming, especially considering the fact that they contain a single participant. There is also a potential for interviewer bias when compared with other methods (120).
Two interviews were commenced but the interviews could not be completed because both paramedics received an emergency call during the interview, requiring them to terminate the interview.

3.5 Data analysis

While qualitative and quantitative data can be analysed separately, to achieve a richer, deeper analysis of the data the results from the two methods have to be integrated. In addition, merging the results, from different data collection methods, increases validation. After the quantitative and qualitative data were individually analysed data comparison and integration was performed to achieve the full benefits of undertaking a mixed methods study (120).

3.5.1 Quantitative results

The study intended to not only present the results as efficiently as possible, but in a format which could be easily interpreted and understood. Responses from the questionnaire were entered into a data spreadsheet within Statistics Package for Social Sciences (SPSS) software (152).

The data entry was checked for errors and levels of measurement identified prior to the data analysis using SPSS. The levels of measurement have to be identified first as they influence the type of analysis that can be used. These four levels can be either considered as discrete variables (nominal and ordinal levels) or continuous variables (interval and ratio levels) and can be analysed through the use of statistics. (123, 153).
The nominal and ordinal data, such as the sex of participants, place of original training and ranked data, such as the importance of specific skills or teaching methods, were summarised using counts and percentages and, if it increased the understanding and interpretation of data, was presented as a visual display. Pie charts, bar charts and tables are the most appropriate methods for summarising nominal and ordinal data (154, 155).

The first step in the summarising interval and ratio data was to determine if the distribution is normal. If the distribution curve is normal (bell-shaped), then measures of central tendency, such as the mean and standard deviation, were used to summarise the data. If the distribution was not normal, then non-parametric statistics were used, often the median and the mode. Non-parametric statistics are less likely to identify a significant effect, if one exists, as they do not rely on assumptions about the distribution and increase the likelihood of error (154, 155).

In addition to analysing the data to identify possible differences between WA trained paramedics and those trained overseas or interstate, it was also decided to if there were real differences dependent on paramedic age and experience.

Nominal data, such as the sex of participants, were analysed using the Chi-square test of independence. Otherwise, the Mann-Whitney U test was used to test for differences in the results between the independent groups of respondents. These non-parametric tests are used when data have been measured on a nominal or ordinal scale and do not involve stringent
assumptions about the distribution of variables. The Mann-Whitney U test ranks the data for each condition before identifying the difference between the two rank totals. When comparing the different groups with the Mann-Whitney U test, if the distributions had different shapes the mean ranks were compared instead of the medians. The statistical significant alpha value was chosen to be 0.05, a commonly used value, to reduce the possibility of type one error. When multiple comparisons were undertaken, Bonferroni corrections were also made to the alpha value of $p < 0.05$ (154-156).

3.5.2 Qualitative results

The data analysis phase for the qualitative data consists of preparing and organising the data for analysis, then reducing the data into themes through a process of coding and condensing the codes, before representing the data in figures, tables, or a discussion. Five different approaches can be used to inquire and highlight specific differences in analysis and representing data: narrative; phenomenology; grounded theory; ethnography; and case study (157).

Grounded theory was chosen as the methodology for the analysis of the quantitative data because of the indicative nature of the analysis, i.e. the resulting theories materialises from the data through a process of thorough and structured analysis. During the grounded theory analysis phase, the concepts, themes and categories emerging are compared with each other
and relationships between them identified to form the basis of the emerging theory. (158).

Transcripts from the digitally recorded focus groups and interviews were analysed using the constant comparative method and data was analysed as it was collected through the process of coding. Through the matrixes and coding, common thoughts and experiences of paramedic advanced airway education were identified and examined (159).

3.5.3 Concept map

Qualitative research often involves taking large amounts of text-based data and condensing that data into an understandable and practicable form without losing the entrenched meaning. Concept maps are a useful strategy in the data analysis of qualitative research, especially with regard to clearly illustrating concept meanings, themes and patterns, while allowing the meaningful reduction of data, for example, displaying a 20 page interview transcript as a single page. A concept map, due to its visual representation of the participant’s experience, may also assist researchers into increasing the in-depth analysis of the qualitative data through the use of participant-generated themes (160, 161).

Following review of the qualitative data, from both the questionnaire and focus groups, education and reasons for successes and failures in advanced airway management were identified and then these concepts grouped together to organise and illustrate the various relationships in a retrospective concept map. This is termed retrospective as the concept
mapping was undertaken after the qualitative data was collected, rather than as part of the data collection procedure (162).

3.6 Summary

Descriptive research was utilised to undertake this study through the use of a questionnaire, focus groups and interviews. Information from the questionnaire was used to establish any variation in the education and confidence between WA and interstate or internationally trained paramedics. Quantitative data from the questionnaire was also used to develop the focus group questions.

Qualitative evidence from the questionnaire and focus groups was used to identify beneficial and unhelpful methods of education and curriculum content. Due to operational requirements, the interviews could not be completed and therefore the results not utilised.

The use of various data collection methods for paramedics’ experiences and opinions – method triangulation – was to establish a broader understanding regarding the challenges facing paramedics when managing a patient’s airway. While the quantitative data identified challenges, the focus groups allowed the challenges to be discussed in detail, with participants sharing their own perspectives and experiences. The results of the analysis of this data are presented in the following chapter.
Chapter 4: Results

4.1 Introduction

This chapter describes the results of the questionnaire along with presenting the findings from the focus groups. Details of the demographics and characteristics of the paramedics and student paramedics who participated in the survey are presented first, then the participant's perceptions on their and self-assessment of confidence in relation to airway management skills are described. Finally, reports on paramedics’ opinions on airway management competency and practice are described.

4.2 Demographics

4.2.1 Response fraction

A total of 696 WA paramedics were emailed a copy of the questionnaire with a total of 164 questionnaires returned but 120 had complete data sets. Confirmation was received from a few paramedics that they were interrupted during the online completion of the questionnaire to respond to an emergency call and completed another questionnaire at a later time. To prevent duplication of information, questionnaires where the final question was unanswered were disregarded for the study. Only four of the 120 completed questionnaires were from paramedics from outside Western Australia (WA). The total response fraction from WA paramedics was 17%
However, not every paramedic in WA would have performed an intubation in the previous year, reducing the possible number of research participants. Based on SJA statistics, approximately 270 paramedics would be eligible to participate in the research, therefore resulting in an estimated response fraction of 43.0% (n = 116) (9, 43, 138).

4.2.2 Paramedic characteristics

The characteristics of the paramedics are described in relation to their age, gender, state where currently working, number of years since initial training and location where they received their initial training.

4.2.2.1. Sex

70 per cent of the respondents were male (n = 84) and 30 per cent (n=36) were female, which is representative of the male dominated paramedic workforce. The proportion of female paramedics in the workforce has been gradually increasing over the last few years as all new paramedics have come from a graduate pool where the gender balance is increasingly female (163).

4.2.2.2. Age

The ages of the participants ranged from 22 to 53 years with the overall with the overall mean age being 35.8 ± 7.47 years. The mean age of WA trained paramedics was 34.3 years compared with 40.3 years for interstate and overseas trained paramedics. For the WA respondents, majority (92 per cent) were between the ages of 20 – 29 years compared with 70 per cent of
the interstate/ overseas trained paramedics being between 30 – 44 years old.

Figure 2 displays a comparison of the participants’ age and sex.

While it was not possible to obtain detailed age and sex demographics for the SJA paramedic workforce, the average age is reflective of an organisation where 336 student paramedics have been recruited in the last three years. An average age of undergraduate student paramedics is 26 years old (134-136, 164). According to the 2016 Commonwealth Report on Government Services, approximately 50 per cent of Australian paramedics
are under the age of 40 years, with 75.2 per cent aged less than 50 years old (165).

4.2.2.3. State of employment

Almost all of the respondents worked in WA with the remaining 3 per cent (n=4) working in Queensland. As WA is the only state where all paramedics can intubate, with all other states have a very small cohort of intensive care paramedics who can perform the skill, it was not expected that large numbers of interstate paramedics would participate in the study.

4.2.2.4. Years since initial training

Figure 3 illustrates the number of years since their initial airway management training, ranging from less than a year to 24 years since their initial training. The mean number of years since initial training was 6.16 ± 5.61 years for the entire population (n=120). When comparing WA trained paramedics to those trained interstate or overseas, those trained in WA had nearly a third less time since initial training – 4.27 ± 3.88 years compared with 11.83 ± 6.22 years (P < 0.05).

Eighty three percent (n=25) of interstate and overseas trained paramedics reported over five years since their initial airway management training course compared with thirty percent (n=27) of paramedics trained in WA.
Figure 3 displays a comparison of the years since training.

4.2.2.5. Location of initial airway management training

A quarter of the respondents (n = 90) received their initial advanced airway management training in WA, with the remaining 30 per cent interstate or overseas, specifically 16.7 per cent in the United Kingdom (n = 20), 5.8 per cent in South Africa (n = 7) and 0.8 per cent in Queensland (n = 1), South Australia (n = 1) and Victoria (n = 1).
4.2.2.6. Authorised advanced airway techniques

Figure 4 illustrates the range of advanced airway techniques the respondents are authorised to practice. Paramedics in WA (97 per cent of participants) are authorised (once qualified) to perform supraglottic airway insertion, endotracheal intubation and surgical cricothyroidotomy.

![Bar chart showing percentages of participants for various airway techniques.](image)

**Figure 4: Authorised advanced airway techniques**

4.2.2.7. Successful LMA insertions in the last year

Table 4 illustrate the number of self-reported successful LMA insertions. The total average number of LMA insertions during the last year was 2.47 (SD 3.61). The mean average for WA trained paramedics was 2.17 (SD 2.7)
compared with 3.37 (SD 5.48) for interstate and overseas trained
paramedics demonstrating no statistical difference between the two groups
(p = 0.115). For comparison, the median average for WA trained
paramedics was 1.0 compared with 2.0 for interstate and overseas trained
paramedics.

Table 4: Successful LMA insertions in the last year

<table>
<thead>
<tr>
<th>LMAs</th>
<th>WA paramedics</th>
<th>Interstate/ overseas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>1 – 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 – 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 – 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 – 14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 – 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>100</td>
<td>30</td>
</tr>
</tbody>
</table>

4.2.2.8. Successful intubations in the last year

The number of successful intubations during the last year is illustrated in
Table 5. While the mean number of intubations for both samples was 3.13
(SD 4), there was a significant difference between the two groups: 2.53 (SD
3) for WA trained paramedics compared with 5.03 (SD 6) for those trained
overseas and interstate (p = 0.047). For comparison, the median average
for WA trained paramedics was 2.0 compared with 3.0 for interstate and
overseas trained paramedics.
Table 5: Successful intubations in the last year

<table>
<thead>
<tr>
<th>ETIs</th>
<th>WA paramedics</th>
<th>Interstate/ overseas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>&lt; 1</td>
<td>23</td>
<td>25.6</td>
<td>3</td>
</tr>
<tr>
<td>1 – 2</td>
<td>43</td>
<td>32.2</td>
<td>10</td>
</tr>
<tr>
<td>3 – 5</td>
<td>15</td>
<td>16.7</td>
<td>8</td>
</tr>
<tr>
<td>6 – 9</td>
<td>2</td>
<td>2.2</td>
<td>4</td>
</tr>
<tr>
<td>10 – 14</td>
<td>4</td>
<td>4.4</td>
<td>3</td>
</tr>
<tr>
<td>15 – 30</td>
<td>2</td>
<td>2.2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>100</td>
<td>30</td>
</tr>
</tbody>
</table>

4.2.2.9.  Perceived intubation success rate in the last year

Table 6 and Figure 5 illustrates the participants perceived intubation success rate in the last year showing a significant difference between WA (4.54, SD 1.92) and interstate/ overseas (5.46, SD 1.1) trained paramedics, corresponding to 71 – 80 per cent and 81 – 90 per cent respectively (p = 0.02).
Table 6: Perceived intubation success rate in the last year

<table>
<thead>
<tr>
<th>% of success</th>
<th>WA paramedics</th>
<th>Interstate/ overseas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>11</td>
<td>12.2</td>
<td>1</td>
</tr>
<tr>
<td>51 – 60</td>
<td>10</td>
<td>11.1</td>
<td>0</td>
</tr>
<tr>
<td>61 – 70</td>
<td>3</td>
<td>3.3</td>
<td>0</td>
</tr>
<tr>
<td>71 – 80</td>
<td>5</td>
<td>5.6</td>
<td>3</td>
</tr>
<tr>
<td>81 – 90</td>
<td>10</td>
<td>11.1</td>
<td>4</td>
</tr>
<tr>
<td>91 – 100</td>
<td>46</td>
<td>51.1</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>100</td>
<td>28</td>
</tr>
</tbody>
</table>

Figure 5: Perceived intubation success rates
4.2.3. Characteristics of initial advanced airway programme

Variations in the initial airway management training programmes was sought with respondents questioned on the length of the course, whether it included a clinical placement, and the opportunities the placement offered, the teaching methods, topics and equipment taught. The respondents also had the opportunity to describe their perceived value of various teaching methods and topics and their opinions on competency maintenance.

4.2.3.1 Length of course

Figure 6 illustrates the reported duration of the initial advanced airway training programme, which varied from 1 day to 35 days with a mean length of 6.54 (SD 5.77) days. There was a significant difference in course length between the WA trained and the overseas/ interstate groups: 5.48 ± 4.03 for WA trained paramedics compared with 9.96 ± 8.65 for those trained overseas and interstate P < 0.05).

As advanced airway management training normally only forms a small part of paramedic education, participants had to estimate the total length of time spent on advanced airway management training.
Figure 6: Comparison of duration of airway management course

4.2.3.2 Hospital placements

Only two participants did not undertake a hospital placement as part of their advanced airway training, these paramedics trained in WA over 23 and 14 years ago. This correlates with the introduction of advanced airway management training (ETI and LMA insertion) in 2001. Introduction of intubation was included as part of the paramedics’ two day annual refresher training programme and only utilised task-based trainers and manikins (28).
Paramedics who indicated that they attended a hospital placement documented varying lengths of clinical practice, ranging from 2 days to 30, with half of WA trained paramedics (n = 45) receiving 5 days in operating theatres and majority of interstate and overseas trained paramedics (n = 25) having longer hospital placements.

There was a significant difference in hospital placements between the WA trained and the overseas/ interstate groups: 5.65 ± 2.95 for WA trained paramedics compared with 15.07 ± 7.58 for those trained overseas and interstate P < 0.05).

Figure 7: Comparison of duration of hospital placement
4.2.3.3 LMA insertions during placement

The number of successful LMA insertions during the hospital placement varied from 0 to 40 and is displayed in Figure 9.

Figure 8: Comparison of reported LMA success insertions

For the WA trained paramedics, the average number of self-reported LMA insertions was 7.42 (SD 5.41) compared with a significance difference of 15.69 (SD 12.71) trained elsewhere (P = 0.02). There was no statistical difference when variations of age are examined. Use of the LMA was introduced into UK practice in approximately 2003, UK paramedics trained prior to this date were not required to perform this skill during their hospital placement (166).
4.2.3.4 Intubations during placement

The number of self-reported intubations during the hospital placement varied from 0 to 50. For the WA trained paramedics, the average number of successful intubations was 4.78 (SD 4.33) compared with 22.67 (SD 11.87) for those trained overseas or interstate (P < 0.05).

![Figure 9: Comparison of number of intubations on hospital placement](image)

Only four per cent (n = 4) of WA trained paramedics recorded over 15 successful intubations compared with seventy seven per cent (n = 23) of interstate and overseas trained paramedics.
4.2.3.5 Other advanced airway management skills during placement

Very few participants reported performing various other advanced airway techniques during their placement, with the most commonly being use of the bougie as an airway adjunct and video laryngoscope.

4.2.4 Use of simulation-based assessments

Majority of participants reported the use of simulation-based assessments during their initial advanced airway management education programme, 93.3 per cent (n = 84) of WA trained paramedics and 96.7 per cent (n = 29) of interstate/ overseas trained paramedics.

4.2.5 Equipment included in programme

A range of endotracheal tube sizes (n = 106), stylet (n = 109), stethoscope (n = 116), gauze/ tape to secure the tube ( n = 106) and LMA (n = 111) were the most frequently taught equipment both within WA and interstate/ overseas.

Table 7 details the equipment included in the initial airway management training programme, including detailing the statistical significance – considering Bonferroni corrections, the significance is when p < 0.0024 (italics).
<table>
<thead>
<tr>
<th>Skill</th>
<th>WA trained</th>
<th>Interstate/ overseas</th>
<th>Total</th>
<th>Total %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of Macintosh laryngoscope blades</td>
<td>33</td>
<td>26</td>
<td>58</td>
<td>49.57</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Range of Miller laryngoscope blades</td>
<td>10</td>
<td>21</td>
<td>29</td>
<td>24.79</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Range of endotracheal tube sizes</td>
<td>79</td>
<td>29</td>
<td>105</td>
<td>89.74</td>
<td>0.1606</td>
</tr>
<tr>
<td>Stylet</td>
<td>82</td>
<td>27</td>
<td>107</td>
<td>91.45</td>
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</tr>
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<td>Lighted stylet</td>
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<td>4</td>
<td>5</td>
<td>4.27</td>
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</tr>
<tr>
<td>Gum elastic bougie</td>
<td>3</td>
<td>19</td>
<td>22</td>
<td>18.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Oesophageal detection device</td>
<td>9</td>
<td>9</td>
<td>15</td>
<td>12.82</td>
<td>0.0082</td>
</tr>
<tr>
<td>Stethoscope</td>
<td>86</td>
<td>30</td>
<td>113</td>
<td>96.58</td>
<td>0.2446</td>
</tr>
<tr>
<td>Gauze/ tape to secure tube/ LMA</td>
<td>77</td>
<td>29</td>
<td>103</td>
<td>88.03</td>
<td>0.1019</td>
</tr>
<tr>
<td>Commercial ET holder</td>
<td>4</td>
<td>15</td>
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<tr>
<td>Optical laryngoscope</td>
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<td>7</td>
<td>17</td>
<td>14.53</td>
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<td>Video laryngoscope</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>5.13</td>
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<td>Laryngeal mask airway (LMA)</td>
<td>86</td>
<td>25</td>
<td>108</td>
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<td>0.0272</td>
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<tr>
<td>I-gel supraglottic airway</td>
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<td>7</td>
<td>11</td>
<td>9.4</td>
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<td>King LT supraglottic device</td>
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<td>1</td>
<td>0.85</td>
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<tr>
<td>Combitube supraglottic device</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>6.84</td>
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</tr>
<tr>
<td>Colormetric carbon dioxide detector</td>
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<td>8</td>
<td>38</td>
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<tr>
<td>Waveform capnography</td>
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<td>54</td>
<td>46.15</td>
<td>0.8271</td>
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<tr>
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<td>72</td>
<td>13</td>
<td>82</td>
<td>70.09</td>
<td>0.0001</td>
</tr>
<tr>
<td>Commercial cricothyroidotomy kit</td>
<td>5</td>
<td>9</td>
<td>14</td>
<td>11.97</td>
<td>0.0003</td>
</tr>
<tr>
<td>Nasogastric tube</td>
<td>6</td>
<td>9</td>
<td>15</td>
<td>12.82</td>
<td>0.0009</td>
</tr>
</tbody>
</table>

Training in more than one type of supraglottic devices occurred more often in the interstate/ overseas group while more WA trained paramedics received instruction in the use of scalpel/ forceps for cricothyroidotomy (80 per cent compared with 43 percent).
4.2.6 Subjects and teaching methods

Airway anatomy (n = 117) and physiology (n = 104) featured highly in the educational programme, along with patient positioning (n = 117), indications for airway management (n = 117) and management of a failed airway (n = 112).

Both participant groups reported a high use of clinical skills trainers but while the interstate/overseas group report more frequent use of low fidelity (70 per cent (n = 21) compared with 48 per cent (n = 43)) and high fidelity simulations (50 per cent (n = 15) compared with 39 per cent (n = 26)) to teach airway management this question was poorly answered.

Interstate and overseas trained paramedics received more instruction in alternative intubation techniques than WA trained paramedics and the results clearly illustrate the different technique chosen to perform a cricothyroidotomy (surgical predominately in Australia compared with needle in the UK).

Table 8 details the subjects included and teaching methods utilised in the initial airway management training programme, including detailing the statistical significance – considering Bonferroni corrections, the significance is when $p < 0.0019$ (italics).
### Table 8: Subjects and teaching methods for training programme

<table>
<thead>
<tr>
<th>Subjects included in training</th>
<th>WA trained</th>
<th>Interstate/ overseas</th>
<th>Total</th>
<th>Total %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway anatomy</td>
<td>87</td>
<td>96.7</td>
<td>30</td>
<td>100</td>
<td>114</td>
</tr>
<tr>
<td>Airway physiology</td>
<td>67</td>
<td>74.4</td>
<td>27</td>
<td>90</td>
<td>92</td>
</tr>
<tr>
<td>Positioning of the patient</td>
<td>88</td>
<td>97.8</td>
<td>29</td>
<td>96.7</td>
<td>114</td>
</tr>
<tr>
<td>Indications for airway management</td>
<td>87</td>
<td>96.7</td>
<td>30</td>
<td>100</td>
<td>114</td>
</tr>
<tr>
<td>Selecting the most appropriate airway</td>
<td>74</td>
<td>82.2</td>
<td>27</td>
<td>90</td>
<td>98</td>
</tr>
<tr>
<td>Cricoid pressure</td>
<td>82</td>
<td>91.1</td>
<td>30</td>
<td>100</td>
<td>109</td>
</tr>
<tr>
<td>BURP</td>
<td>80</td>
<td>88.9</td>
<td>22</td>
<td>73.3</td>
<td>100</td>
</tr>
<tr>
<td>Practical skills on clinical task trainers</td>
<td>84</td>
<td>93.3</td>
<td>29</td>
<td>96.7</td>
<td>110</td>
</tr>
<tr>
<td>Low fidelity simulations</td>
<td>43</td>
<td>47.8</td>
<td>21</td>
<td>70</td>
<td>64</td>
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<tr>
<td>High fidelity simulations</td>
<td>26</td>
<td>28.9</td>
<td>15</td>
<td>50</td>
<td>41</td>
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<tr>
<td>Identifying airway management problems</td>
<td>71</td>
<td>78.9</td>
<td>29</td>
<td>96.7</td>
<td>98</td>
</tr>
<tr>
<td>Case study discussion</td>
<td>18</td>
<td>20</td>
<td>14</td>
<td>46.7</td>
<td>31</td>
</tr>
<tr>
<td>Identifying ventilation difficulties</td>
<td>59</td>
<td>65.6</td>
<td>29</td>
<td>96.7</td>
<td>85</td>
</tr>
<tr>
<td>Management of a failed airway</td>
<td>84</td>
<td>93.3</td>
<td>28</td>
<td>93.3</td>
<td>109</td>
</tr>
<tr>
<td>Direct intubation</td>
<td>46</td>
<td>51.1</td>
<td>22</td>
<td>73.3</td>
<td>66</td>
</tr>
<tr>
<td>Nasopharyngeal intubation</td>
<td>10</td>
<td>11.1</td>
<td>16</td>
<td>53.3</td>
<td>26</td>
</tr>
<tr>
<td>Retrograde intubation</td>
<td>7</td>
<td>7.8</td>
<td>9</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Video laryngoscopy</td>
<td>2</td>
<td>2.2</td>
<td>3</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Optical laryngoscopy</td>
<td>5</td>
<td>5.6</td>
<td>7</td>
<td>23.3</td>
<td>12</td>
</tr>
<tr>
<td>Digital intubation</td>
<td>3</td>
<td>3.3</td>
<td>8</td>
<td>26.7</td>
<td>11</td>
</tr>
<tr>
<td>Rapid sequence intubation</td>
<td>2</td>
<td>2.2</td>
<td>11</td>
<td>36.7</td>
<td>13</td>
</tr>
<tr>
<td>Nasogastric tube</td>
<td>5</td>
<td>5.6</td>
<td>11</td>
<td>36.7</td>
<td>15</td>
</tr>
<tr>
<td>Needle cricothyroidotomy</td>
<td>4</td>
<td>4.4</td>
<td>22</td>
<td>73.3</td>
<td>26</td>
</tr>
<tr>
<td>Surgical cricothyroidotomy</td>
<td>75</td>
<td>83.3</td>
<td>14</td>
<td>46.7</td>
<td>86</td>
</tr>
<tr>
<td>Percutaneous transtrachal jet ventilation</td>
<td>1</td>
<td>1.1</td>
<td>9</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Clinical placements</td>
<td>66</td>
<td>73.3</td>
<td>26</td>
<td>86.7</td>
<td>90</td>
</tr>
</tbody>
</table>
4.2.7 Most important perceived topics

The participants were invited to select the most important ten topics or learning methods for airway management and rank these in order, figure 10 illustrates the results. Airway anatomy, indications for airway management and positioning of the patient were the three highest subjects.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway anatomy</td>
<td>40</td>
</tr>
<tr>
<td>Indications for airway management</td>
<td>35</td>
</tr>
<tr>
<td>Positioning of the patient</td>
<td>34</td>
</tr>
<tr>
<td>Airway physiology</td>
<td>33</td>
</tr>
<tr>
<td>Selecting the most appropriate airway</td>
<td>30</td>
</tr>
<tr>
<td>Practical skills on clinical task trainers</td>
<td>29</td>
</tr>
<tr>
<td>Identifying airway management problems</td>
<td>28</td>
</tr>
<tr>
<td>Cricoid pressure</td>
<td>27</td>
</tr>
<tr>
<td>BURP</td>
<td>26</td>
</tr>
<tr>
<td>Management of a failed airway</td>
<td>23</td>
</tr>
<tr>
<td>Clinical placements</td>
<td>22</td>
</tr>
<tr>
<td>Identifying ventilation difficulties</td>
<td>21</td>
</tr>
<tr>
<td>High fidelity simulations</td>
<td>20</td>
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<tr>
<td>Low fidelity simulations</td>
<td>16</td>
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<tr>
<td>Case study discussion</td>
<td>15</td>
</tr>
<tr>
<td>Direct intubation</td>
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<tr>
<td>Nasopharyngeal intubation</td>
<td>13</td>
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<tr>
<td>Retrograde intubation</td>
<td>12</td>
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<tr>
<td>Video laryngoscopy</td>
<td>10</td>
</tr>
<tr>
<td>Optical laryngoscopy</td>
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<tr>
<td>Surgical cricothyroidotomy</td>
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<td>Digital intubation</td>
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<td>5</td>
</tr>
<tr>
<td>Needle cricothyroidotomy</td>
<td>4</td>
</tr>
<tr>
<td>Percutaneous transtracheal jet ventilation</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 10: Most important perceived topics and teaching methods
4.2.8 Beneficial to initial training programme

When discussing subjects or teaching methods that the participants believed, reflecting on their experiences since training, would have been beneficial to be included on their initial advanced airway management course the responses centred on hospital placements and education.

4.2.8.1 Hospital placements

Requests for a longer hospital placement (n = 18) which was better organised and structured was a common desire, with detailed comments focussing on the limited opportunity to perform intubation, for example:

- “I didn't get the chance to insert any ETT, I organised my own hospital placement in my own time to get experience inserting ETT”;
- “more opportunity on clinical placements to intubate”;
- “paramedic specifically is indicated to insert the advanced airways”;
- “clinical placement at appropriate facilities where a variety of advanced airways are utilised”;
- “simply: more consistent exposure to REAL airway management, i.e. via the surgical setting”;
- “placements can be very hit and miss. I did not have a good experience in my placements as far as ETT go. Placements need to have a minimum number of successful intubations to pass”; and
- “more hospital placements as practising on real people is better than manikins”.
Ensuring that the hospital placement staff supervising the student paramedics understood and support the need for paramedics to perform advanced airways was another potential improvement:

- “Clinical placement provided minimal opportunities to exercise advanced airway management due to the nature of the surgery at the facility, willingness of the anaesthetist to allow advanced airway attempts, or medical student exposure taking priority over ambulance personnel”;
- “Doctors must understand the importance of educating paramedics to a high standard”;
- “more proactive doctors in theatres”; and
- “anaesthetists who are selected for and fully briefed about the purpose of our placements”.

One participant also suggested that there should be a review with the student after the hospital placement examining the success and benefits of the learning experience.

4.2.8.2 Education

Ensuring sufficient theoretical knowledge and skills practice before undertaking a hospital placement was a frequently mentioned topic and more opportunity to practice skills:

- “I feel that a better basis of anatomy would have been beneficial BEFORE undertaking a clinical placement”;
- “intubation training before hospital placements”;
- “Clinical placement provided minimal opportunities to exercise advanced airway management due to the nature of the surgery at the facility, willingness of the anaesthetist to allow advanced airway attempts, or medical student exposure taking priority over ambulance personnel”;
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- “anaesthetists who are selected for and fully briefed about the purpose of our placements”.

One participant also suggested that there should be a review with the student after the hospital placement examining the success and benefits of the learning experience.
“practise, practise, practise” (requested by two participants);
“more hands on opportunities”;
“I feel the airway training is wholly inadequate. To be safe and competent in an invasive skill such as ETT, there should be a minimum of ETT inserted at placement”;
“more practise on positioning patients to optimise technique”; and
“further discussion/ revision of airway anatomy and physiology”.

Use of videos and video laryngoscopes to demonstrate the airway anatomy and various views was suggested by several participants:
“ETT videos for anatomy and landmark purposes would have been beneficial”;
“more videos of actual anatomy, which looks very different to manikin anatomy”; and
“using digital camera equipment might assist in identifying landmarks with some early manikin intubations”.

Another potential discussion was the qualifications and experience of the educators, with some participants believing that recently qualified paramedics should not be teaching intubation:
“having anaesthetists take some lectures and practical classes”;
“a proper course run by a person who has real experience on road and many years of experience. Not a newly qualified secondment”;
• “different grip and viewing positions getting instructions from paramedics / CCP that have done it, not being taught by people who just practised on manikins or junior staff that have never done it”;
• “would have been good to have some guest speakers i.e. Anaesthetists, critical care paramedics, then just a greater intensity of course both the science and the practical”; and
• “exposure and discussions with subject matter experts”.

Education programmes often teach airway management as a series of individual physical skills rather than a combination of cognitive, psychomotor and affective skills but some of the respondents have identified that a holistic approach to airway management is better (21):

• “more emphasis on preparation especially patient positioning and the theory of intubation e.g. why we pre-oxygenate”;  
• “discuss not just ETT but the importance of airway altogether especially the use of capnography”;  
• “emphasising BLS airway management and simple techniques to ensure successful intubation. Also a better understanding on ventilation/ oxygenation physiology”; 

There were a few respondents who believed additional airway adjuncts would have been beneficial, including:

• “bougie introduction to assist with difficult intubations” (requested by two participants);
“waveform capnography which is now being utilised on road”
(requested by five participants);
“bougie, videoscope, portable paediatric airway management”;
“more training, different styles of equipment, techniques, Cadaver
training”; and
“introduction to various intubation tools like bougie, video
laryngoscope etc”.

A larger proportion believed that improved use of manikins and realistic
training simulations, that reflected pre-hospital environments, would have
been beneficial:
“more time needed on training and assessment, also the use of
different graded airway view dummies may have also been of benefit
to learn different techniques for difficult intubations as this can be
seen as an issue when responding to obese patients and patients
with difficult airways out in the field”;
“training in classroom environment did not reflect on road
environment e.g. soiled airways, patient positioning etc”; and
“cadaver plus ETT or LMA would have been very useful”; and
“perhaps having more realistic dummies with different grades of
airway difficulty”.

More education on the management of difficult airways was also an area in
which more time would have been beneficial:
• “intubation is really difficult on larger patients and the lack of training with larger patients reflects in the amount of LMAs used in my experience”;

• “can't ventilate and can't intubation, More use of Sellicks and BURP” (requested by two participants);

• “different techniques and tips with difficult airways, management of the difficult airway (n = 2)”;

• “better management of failed intubations” (requested by two participants);

• “dealing with, and overcoming difficult airways”;

• “improve selection of most appropriate airway”;

• “wider range of intubation options for greater ability to manage difficult or failed intubation”;

A lack of opportunities to continue to develop their skills and knowledge once trained was also identified:

• “monthly mandatory hospital placements or training days specifically for keeping advanced airway skills up to date”;

• “better Clinical Support Paramedic support – debriefing & training”;

• “more hands on experience, clinical exposure” (requested by three participants);

• “more pre-hospital practice”;

• “yearly hospital placements with x number of tubes guaranteed” (requested by two participants); and

• “access to professional development for continued practice”.
There were also two respondents who believed that the entire focus of the education was incorrect:

- “I think at present I am facing problems maintaining the skills after training due to low advanced airway call volume. Second I think a lot of money is spent to tell us we intubated wrong (MRx with C02), little or no money spent to aid us in the actual intubation (different blade sizes, flat blades, video laryngoscopes and so on)”; and

- “I don't feel ETT is an appropriate skill for the holder of an undergraduate degree only, rather that further training be undertaken following several years on road as a qualified officer. Specifically I refer to either a graduate diploma or masters in intensive care paramedicine or the development of a tiered system”.

4.2.9 Methods of instruction

Majority of WA, interstate and overseas trained paramedics believe that initial advanced airway training should be a mix of practical and theoretical learning.
4.3 Maintenance of skills

Skill maintenance is a concern among clinicians who do not regularly perform skills such as intubation. The participants were asked for their opinions on how frequently refresher training should occur and how to ensure and maintain competence.
4.3.1 Frequency of refresher training

Figure 12 illustrates that majority of participants believe that airway management refresher training programmes should be undertaken once \((n = 66)\) or twice a year \((n = 46)\).

![Comparison of frequency of refresher training](image)

Figure 12: Comparison of frequency of refresher training

4.3.2 Minimum number of skills

Figure 13 illustrates the participants' beliefs on the minimum number of successful intubations/ LMA insertions a year necessary to remain competency. Ten was the most common number for all participants \((n = 20)\), followed by 2 \((n = 17)\). The mean average for the WA trained group
was six (SD 5) compared with 12 (SD 18) for the interstate/ overseas group – a significant difference between the two groups (p = 0.0049). One interstate/ internationally trained participant documented a minimum number of 100 intubations a year, a figure totally unachievable in the WA prehospital environment.

Figure 13: Comparison of the believed number of successful intubations needed to maintain competency per year

Two respondents believed that the minimum should reflect the individual’s success rate rather than a minimum number, one ratio was 50 per cent and the other was 95 per cent. Other comments to the question included a belief that not performing the skill in 12 months does not make the individual
incompetent, and others thought that the specific number would depend on exposure and experience.

Between 1 July 2012 to 1 September 2013, according to patient care records, over 98 per cent of SJA paramedics attempted five or less intubations (138).

4.3.3 Maintaining competency

Hospital-based clinical placements (n = 66) and practical workshops with task trainers (n = 32) were the preferred educational tools to ensure competence if the minimum number of intubations or LMA insertions was achieved, illustrated in Figure 14.

Figure 14: Comparison of teaching methods used to maintain competency
Participants also had to opportunity to suggest other education methods they will believe should be used to ensure competence. Their responses included:

- Combination of skill assessment with manikins, theory and hospital placements (placements every 2/3yrs);
- Wet lab;
- Retraining each year regardless of how many advanced airways are performed;
- Skills assessment is satisfactory, although a yearly Monday to Friday week with an anaesthetist or specialist would be great;
- 5 day course. First day theory refresher in the morning. Practice in the afternoon and four day theatre placement; and
- This skill should be dedicated to a group of advanced skill paramedics only.

4.4 Confidence

Participants were requested to gauge their confidence levels (on a scale of 0 to 100) in performing specific airway management techniques. The initial comparison was between the location of the initial advanced airway management course – WA or interstate/ overseas.

4.4.1. Perceived confidence dependent on training location

A statistically significant difference, identified utilising the Chi Square Test, in perceived confidence when undertaking 10 of the 16 skills was found between paramedics who had been initially trained within WA and interstate/ overseas. Both groups reported perceived high mean confidence
levels (> 95 per cent) for preparing equipment for intubation but for WA trained paramedics this was the only skill. Low confidence levels (< 50 per cent) were reported for RSI and perform needle cricothyroidotomy as this was not a skill routinely taught in WA. The results of paramedics perceived confidence in advanced airway skills are illustrated in Table 9.

**Table 9: Comparison of training location on perceived mean confidence score**

<table>
<thead>
<tr>
<th>Skill</th>
<th>WA trained</th>
<th>Interstate/overseas</th>
<th>U</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare required equipment for SGA insertion</td>
<td>86 83 %</td>
<td>27 91 %</td>
<td>1028</td>
<td>0.312</td>
</tr>
<tr>
<td>Prepare equipment for intubation</td>
<td>89 95 %</td>
<td>30 98 %</td>
<td>1098.5</td>
<td>0.06</td>
</tr>
<tr>
<td>Select appropriate sized intubation equipment</td>
<td>89 88 %</td>
<td>30 95 %</td>
<td>872</td>
<td>0.003 *</td>
</tr>
<tr>
<td>Prepare failed airway equipment</td>
<td>89 89 %</td>
<td>30 96 %</td>
<td>988</td>
<td>0.022</td>
</tr>
<tr>
<td>Identify potential airway difficulties</td>
<td>89 78 %</td>
<td>30 89 %</td>
<td>762</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Select most appropriate airway technique</td>
<td>89 84 %</td>
<td>30 94 %</td>
<td>734.5</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Identify appropriate SGA and insert correctly</td>
<td>87 77 %</td>
<td>27 86 %</td>
<td>1025</td>
<td>0.306</td>
</tr>
<tr>
<td>Visualise cords with your technique</td>
<td>89 80 %</td>
<td>30 94 %</td>
<td>682</td>
<td>0.000 *</td>
</tr>
<tr>
<td>Pass tube through cords within 20 seconds</td>
<td>89 79 %</td>
<td>30 91 %</td>
<td>843</td>
<td>0.002 *</td>
</tr>
<tr>
<td>Secure endotracheal tube</td>
<td>89 93 %</td>
<td>30 96 %</td>
<td>1132</td>
<td>0.146</td>
</tr>
<tr>
<td>Prepare and perform RSI</td>
<td>83 8 %</td>
<td>25 46 %</td>
<td>542.5</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Monitor tube placement/ detect displacement</td>
<td>89 79 %</td>
<td>30 97 %</td>
<td>891</td>
<td>0.003 *</td>
</tr>
<tr>
<td>Extubate the patient</td>
<td>89 87 %</td>
<td>30 97 %</td>
<td>883.5</td>
<td>0.003 *</td>
</tr>
<tr>
<td>Locate cricothyroidotomy landmarks</td>
<td>88 76 %</td>
<td>30 90 %</td>
<td>805</td>
<td>0.001 *</td>
</tr>
<tr>
<td>Perform needle cricothyroidotomy</td>
<td>83 21 %</td>
<td>29 85 %</td>
<td>264</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Perform surgical cricothyroidotomy</td>
<td>89 64 %</td>
<td>29 78 %</td>
<td>877</td>
<td>0.009</td>
</tr>
</tbody>
</table>

* Statistically significant adjusted p values < 0.0031
4.4.2. Perceived confidence dependent on age

When considering only WA trained paramedics, those aged 30 years and over consistently had higher mean perceived confidence scores for all 16 skills. Paramedics perceived confidence in visualising cords with their technique; passing the tube through the cords within 20 seconds; extubating the patient and locating circothyroidotomy landmarks revealed statistically significant difference for the comparison group. The results for WA paramedics perceived confidence in advanced airway skills are illustrated in Table 10.

Table 10: Comparison of age on perceived mean confidence score of WA trained paramedics

<table>
<thead>
<tr>
<th>Skill</th>
<th>Age &lt; 30 years</th>
<th>Age ≥ 30 years</th>
<th>U</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>n Confidence</td>
<td>n Confidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare required equipment for SGA insertion</td>
<td>28 80</td>
<td>58 85</td>
<td>1118.5</td>
<td>0.460</td>
</tr>
<tr>
<td>Prepare equipment for intubation</td>
<td>29 94</td>
<td>60 95</td>
<td>1198.5</td>
<td>0.277</td>
</tr>
<tr>
<td>Select appropriate sized intubation equipment</td>
<td>29 86</td>
<td>60 90</td>
<td>1028</td>
<td>0.045</td>
</tr>
<tr>
<td>Prepare failed airway equipment</td>
<td>29 88</td>
<td>60 90</td>
<td>1078.5</td>
<td>0.089</td>
</tr>
<tr>
<td>Identify potential airway difficulties</td>
<td>29 74</td>
<td>60 80</td>
<td>906</td>
<td>0.007</td>
</tr>
<tr>
<td>Select most appropriate airway technique</td>
<td>29 82</td>
<td>60 86</td>
<td>1031.5</td>
<td>0.052</td>
</tr>
<tr>
<td>Identify appropriate SGA and insert correctly</td>
<td>29 74</td>
<td>58 79</td>
<td>124.7</td>
<td>0.93</td>
</tr>
<tr>
<td>Visualise cords with your technique</td>
<td>29 76</td>
<td>60 82</td>
<td>869.5</td>
<td>0.003 *</td>
</tr>
<tr>
<td>Pass tube through cords within 20 seconds</td>
<td>29 81</td>
<td>60 93</td>
<td>802</td>
<td>0.001 *</td>
</tr>
<tr>
<td>Secure endotracheal tube</td>
<td>29 90</td>
<td>60 90</td>
<td>1048.5</td>
<td>0.04</td>
</tr>
<tr>
<td>Prepare and perform RSI</td>
<td>27 7</td>
<td>56 9</td>
<td>963.5</td>
<td>0.159</td>
</tr>
<tr>
<td>Monitor tube placement/ detect displacement</td>
<td>29 85</td>
<td>60 91</td>
<td>1105.5</td>
<td>0.125</td>
</tr>
</tbody>
</table>
4.4.3. Perceived confidence dependent on time since training

When considering only WA trained paramedics, those who received their initial training five years and over ago consistently had higher mean perceived confidence scores for all 16 skills. Paramedics perceived confidence in performing RSI and performing needle cricothyroidotomy revealed statistically significant difference for the comparison group, despite the two skills not being routinely taught to WA paramedics. The results for WA paramedics perceived confidence in advanced airway skills are illustrated in Table 11.

Table 11: Comparison of time since training on perceived mean confidence score

<table>
<thead>
<tr>
<th>Skill</th>
<th>&lt; 5 years since training</th>
<th>≥ 5 years since training</th>
<th>U</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Confidence</td>
<td>n</td>
<td>Confidence</td>
</tr>
<tr>
<td>Prepare required equipment for SGA insertion</td>
<td>56</td>
<td>93</td>
<td>30</td>
<td>94</td>
</tr>
<tr>
<td>Prepare equipment for intubation</td>
<td>57</td>
<td>93</td>
<td>32</td>
<td>97</td>
</tr>
<tr>
<td>Select appropriate sized intubation equipment</td>
<td>57</td>
<td>85</td>
<td>32</td>
<td>93</td>
</tr>
<tr>
<td>Prepare failed airway equipment</td>
<td>57</td>
<td>88</td>
<td>32</td>
<td>91</td>
</tr>
<tr>
<td>Identify potential airway difficulties</td>
<td>57</td>
<td>76</td>
<td>32</td>
<td>80</td>
</tr>
<tr>
<td>Select most appropriate airway</td>
<td>57</td>
<td>83</td>
<td>32</td>
<td>86</td>
</tr>
</tbody>
</table>
### Table 12: Comparison of recall of the correct order of intubation skills

<table>
<thead>
<tr>
<th>Technique</th>
<th>Mean Rank</th>
<th>1st Position</th>
<th>2nd Position</th>
<th>3rd Position</th>
<th>4th Position</th>
<th>Adjusted p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify appropriate SGA and insert correctly</td>
<td>57</td>
<td>77</td>
<td>30</td>
<td>78</td>
<td>821</td>
<td>0.755</td>
</tr>
<tr>
<td>Visualise cords with your technique</td>
<td>57</td>
<td>79</td>
<td>32</td>
<td>83</td>
<td>761.5</td>
<td>0.188</td>
</tr>
<tr>
<td>Pass tube through cords within 20 seconds</td>
<td>57</td>
<td>76</td>
<td>32</td>
<td>83</td>
<td>757.5</td>
<td>0.177</td>
</tr>
<tr>
<td>Secure endotracheal tube</td>
<td>57</td>
<td>93</td>
<td>32</td>
<td>94</td>
<td>905.5</td>
<td>0.949</td>
</tr>
<tr>
<td>Prepare and perform RSI</td>
<td>53</td>
<td>2</td>
<td>30</td>
<td>19</td>
<td>544.5</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Monitor tube placement/ detect displacement</td>
<td>57</td>
<td>88</td>
<td>32</td>
<td>90</td>
<td>874.5</td>
<td>0.732</td>
</tr>
<tr>
<td>Extubate the patient</td>
<td>57</td>
<td>85</td>
<td>32</td>
<td>90</td>
<td>808</td>
<td>0.346</td>
</tr>
<tr>
<td>Locate cricothyroidotomy landmarks</td>
<td>57</td>
<td>73</td>
<td>31</td>
<td>82</td>
<td>724.5</td>
<td>0.158</td>
</tr>
<tr>
<td>Perform needle cricothyroidotomy</td>
<td>53</td>
<td>7</td>
<td>30</td>
<td>46</td>
<td>403</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>Perform surgical cricothyroidotomy</td>
<td>57</td>
<td>60</td>
<td>32</td>
<td>70</td>
<td>735</td>
<td>0.127</td>
</tr>
</tbody>
</table>

* Statistically significant adjusted p values < 0.0031

### 4.5 Intubation order quiz

Prior to the commencement of the focus groups and interviews, the six participants were invited to complete a short quiz requiring the participant to document the correct order of the steps for intubation, in accordance with SJA’s skills manual (150). Table 12 compares the different order of intubation skills by the participants.
<table>
<thead>
<tr>
<th>Skill</th>
<th>Respondents order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1  2  3  4  5  6</td>
</tr>
<tr>
<td>Place patient’s head in a neutral position</td>
<td>1  2  2  2  2  2</td>
</tr>
<tr>
<td>Ensure airway is clear</td>
<td>2  1  1  1  1  1</td>
</tr>
<tr>
<td>Pre-oxygenate the patient</td>
<td>3  3  3  3  4  3</td>
</tr>
<tr>
<td>Hold the laryngoscope with the left hand</td>
<td>5  5  4  5  5  4</td>
</tr>
<tr>
<td>Insert the blade into the patient’s mouth, sweeping the tongue to the left</td>
<td>6  7  6  6  6  5</td>
</tr>
<tr>
<td>Advance the blade by placing the tip into the vallecula, identify epiglottis</td>
<td>7  8  7  8  7  6</td>
</tr>
<tr>
<td>Lift the laryngoscope in the direction of the handle</td>
<td>8  9  8  7  8  7</td>
</tr>
<tr>
<td>Identify the arytenoid cartilage and vocal cords</td>
<td>9 10  9  8  8  8</td>
</tr>
<tr>
<td>Insert the ETT from the right of the patient’s mouth</td>
<td>10 11 10 10  9  9</td>
</tr>
<tr>
<td>Slowly insert the ETT between the vocal cords under direct vision</td>
<td>11 12 11 11 10 10</td>
</tr>
<tr>
<td>Note and record the distance of the tube at the teeth</td>
<td>14 13 12 18 18 14</td>
</tr>
<tr>
<td>Remove the laryngoscope</td>
<td>12 12 12 17 11 12</td>
</tr>
<tr>
<td>Attach a 10mL syringe and inflate the cuff</td>
<td>13 14 13 15 17 11</td>
</tr>
<tr>
<td>Remove the stylet</td>
<td>15 14 12 12 13</td>
</tr>
<tr>
<td>Ventilate and visualise chest rise and fall equally</td>
<td>17 18 15 14 15 17</td>
</tr>
<tr>
<td>Auscultate stomach and lungs to confirm equal air entry</td>
<td>18 15 14 16 16 16</td>
</tr>
<tr>
<td>Connect End-tidal CO2 detector &amp; observe for a waveform on monitor</td>
<td>16 17 17 13 14 15</td>
</tr>
<tr>
<td>Using either linen or adhesive tape secure the ETT in position</td>
<td>19 18 16 20 20 19</td>
</tr>
<tr>
<td>Place a bite block in situ</td>
<td>20 16 16 19 19 18</td>
</tr>
<tr>
<td>Stabilise the head and neck</td>
<td>4  6  5  4  3  20</td>
</tr>
</tbody>
</table>

Considering all instruction and assessment for SJA paramedics (and students) follows the format detailed in the skills manual, none of the six respondents could recall the correct order of the individual skills.

Discussions, following the quiz, included opinions that it would be more appropriate for several of the skills to appear more than once during the list.
and that while the list could be considered suitable for a classroom situation, during difficult and real life challenges variation was needed to rapidly secure the airway.

4.6 Focus groups

The facilitator conducted the two focus group using semi-structured interview questions (Appendix 6) and an observer took notes of responses. A digital audio recording was made of the sessions, which was then transcribed and coded into themes. For reasons of confidentiality, pseudo initials have been utilised and the comments made by the focus group participants transcribed verbatim. Results are described within each of the chosen coding themes.

4.6.1 Skills

Both groups believed that the paramedic advanced airway skill set of LMA, intubation and surgical cricothyroidotomy was appropriate, with strong beliefs that intubation should remain as a paramedic skill.

AS commented:

“I think our skill set is important to hold on to something like intubation, because there are times when it's absolutely necessary. Especially things like your asthmatics and things where you need the pressure. You can't effectively ventilate someone with an LMA, when the pressure inside the thoracic cavity is too high.”
Despite all participants believing that intubation is an essential skill for paramedics, one suggested that RSI should also be included, there was a consensus of opinion that tiering the service, to create a small group of paramedics who are the only ones authorised to intubation, should be considered.

KL commented:

“I think that the tiered system would be a possibility . . . maybe not everyone needs the whole skill set.”

And this was agreed by RP:

“I agree with the tiered systems. Some people can do with advanced skills and should receive more training in regards to those advanced skills. If you aren't competent or not willing to participate in advanced skills, then you shouldn't have to - you shouldn't be forced”

And when discussing the introduction of RSI, DS commented:

“You need to have another tier of people. If you're going to introduce that, it needs to have another tier of people that you can call for back-up, who have extra knowledge, skills and training.”

4.6.2 Training

A logical and consistent stepwise approach to teaching advanced airway was suggested by all participants, with theory and individual skill instruction
taught before gradually introducing challenges, difficult airways, troubleshooting and clinical decision making. RP commented:

“You could have a whole week just for basic through to advanced airway management. So, you start off with all your theory and your anatomy and physiology of a patient and the airway . . . Move on from theory and start doing basic - a whole day on basic stuff, including ventilation, get people ventilating for half an hour at a time, so they understand that airway is essential. And then throughout your week, you progress through. Next day, you're doing a little bit more advanced, Next day, you're doing intubations. Next day, or that arvo, you're doing difficult, next day you're doing failed. So, you're going through from the very basics, everything that's in our skills, but you're actually taking a lot of time to do it. Doing it absolutely step by step, once I've learned the technique, once I was comfortable with my own technique, and I'd adapted myself, based on what I'd been taught, what I'd learned from others, and what I'd worked out for myself, that then becomes my absolute technique.”

Linking the theory with practice was also important according to DS:

“Teaching the theory is one thing . . . the anatomy and physiology and everything is absolutely necessary and needs to be done, way before you start playing with the actual kit. And then teaching the theory behind everything, and why you do what you do . . . I think having the reinforcement of why you do, what you do, at the time that
you're doing it, helps to tie it all together. Because, there can
sometimes be a little bit of a disconnect between theory and practice.
And, you can sit there until you're blue in the face, and tell people
why you're what you're doing, because you read it. But unless you've
actually reinforced that with practical reasons why, or had a patient
scenario come up, and then added that in to the practical stuff that
you're doing and, why would you be doing that and why would you
might do this instead.”

This was reinforced also by KL:

“I mean, if you look at theory, you're not really developing your
technique. You don't know if you're putting that head back enough.
You don't know if you're getting that position correct. And I find I'm
still trying to work on my technique, trying to get it right. The
technique is a big thing for me, and I think theory doesn't teach

4.6.3 Simulations

Simulations were identified by the respondents an effective method of
training, but, according to the participants, should not replace hospital
placements and be representative of the situations faced by paramedics.

KL commented:

“I'm not convinced that you could do everything on a mannequin,
without ever having touched a human.”

DS commented:
“In terms of loss of memory, it helps you create it, but there's no substitute, the first time I saw the cords, I sort of thought I knew what I was looking for, but the first time you see one, That's what I'm looking for. And that wasn't achieved on the mannequin, because it just looks all-- a bit of plastic put together . . . They help, but it's never the same . . . as good as the manikins are, you're not going to get the real-life anxiety and the experience that you get from doing it on someone.”

Simulations with the manikin in the centre of a room, flat on their back, were another criticism. DS commented:

“Mine was always flat on the floor. I think in ALS, one of the instructors suggested moving it around and trying it in different positions. That was just a suggestion if you were bored. And again, it's always the resuscitation scenario. It's not another scenario.”

RP commented:

“I think practising in different. Given the fact that as paramedics you work in all sorts of different environments . . . they're not all laid down, preferably, on their backs waiting for you to go and see them, with perfect access. They're behind the toilet system, upside down in a ditch, in the dark, so having lots of practice in different scenarios and settings is quite important.”

This was agreed by DS:
“All of the scenarios that they give you are straight forward stuff about that certain skill, or it's can't intubate, can't ventilate . . . but there's never anything about how can we teach you to manage a difficult airway. Even if they can't give you a real person, give you something where there's a problem with the airway, so get you to critically think about it at the time, so that you have tools in your toolkit, so that when you do get a difficult airway, it's second nature to deal with it."

4.6.4 Placements

All participants believed that placements were an essential part of paramedic airway management education, teaching not only the physical skills of LMA insertion and intubation, but also clinical decision making and ventilation.

KL commented:

“I trained in the UK, and the anaesthetist would make us, actually before we could pick anything up, they'd sedate the patient, and we had to prove that we could ventilate with a BVM for 30 minutes without dropping the saturations, because they put so much emphasis on the basics of core skill . . . In the three years of ventilating patients, and thought I was pretty good, until I went into theatres and you're given that patient, and then the anaesthetist is like, No, you're not doing that right.”
One issue identified was that it was possible to undertake the hospital placement and still have little opportunity to practice the airway management skills.

AS commented:

“I think it was only two days . . . all we were doing were LMAs.”

And RP commented:

“You can go to a hospital placement with no tubes at all . . . and then be expected to be a senior officer on-road, taking a lead of a call. Often there are mishaps with people's hospital placements and they don't get the required learning that they should have had.”

4.6.5 Competency

While all participants agreed of the importance of paramedics to maintain competency in airway management skills, what would actually define competency was not agreed on.

AS commented:

“I do think that two intubations on road, a year . . . would be great, but that’s if you get access to them, maybe one LMA and one intubation, or two of one.”

KL commented:

“You need to have a minimum of practice, educated practice on a decent manikin, at least annually. Same with CPR, it's a skill that will
be subject to skill erosion. In an ideal world, we’d all practice at least one every six months."

RP commented:

“I definitely think a minimum number each year that you have to do a refresher on, you should have to go back in and maybe secure five more tubes and five LMAs. I think it's only through practice and repetition can you be proficient at a skill, any skill. I think advanced airway management is no different.”

4.6.6 Confidence

All of the participants agreed that more exposure to airway management situations increased their confidence, but it was just as easy for confidence to be reduced following a bad exposure.

RP explained:

“When I first came out, I was extremely confident. It was all fresh in your head, and yeah, I'd say my confidence was high. I went through probably a six month period with no resuscitations, felt my confidence dropping, got a Clinical Support Paramedic to come around, did some airway training and it would come back up.”

DS commented:

“I would have said my confidence was quite high and I had a good success rate, but then the success rates declined, and then had the lack doing it. I can't remember the last time I put a tube in. So, with
training, it lifts the confidence, but not doing it again, you're like, well, it's been a while, let's see how I go.”

AS commented:

“I can feel myself getting a lot more confident in doing this, but it's taken a lot of airways to get me to the stage. Some people are lucky enough when they finish their grade two school and do it on manikins to come out and maybe get a tube opportunity, but not a lot. Even when they do get that opportunity, the paramedic will normally step in any way to take that. And if they miss it, which a lot of them do, maybe 60-70 per cent will probably miss it on their first tube, then a paramedic comes in and it hits their confidence level down.”

4.6.7 Proposals

Improving education experiences and opportunities for skill practice for student paramedics were the main considerations when attempting to ensure paramedic competency, but one beneficial individual experience resulted in new proposal.

KL suggested:

“Going into a pre-admission clinic. The patients all come to you and the anaesthetist - you sit in the room with the anaesthetist - and you literally discuss the history, and then you discuss with the anaesthetist why all of these things are problematic from an airway point of view. And then maybe they have a look in the mouth and
they say, "Open up. Poke your tongue out." They have a look. You look at what they look at, so that you can see when you're sitting there, looking at a conscious breathing, happy little patient, what they see and what they anticipate from looking at that patient and that physicality of that patient could be a problem.”

All of the participants believed that simply providing an intubation manikin on ambulance depots throughout the Metropolitan area, would allow regular practice and maintenance of skills and confidence. Angela commented:

“Having an airway mannequin on each of the main depots near to a hospital, for example, Fremantle; Rockingham; Joondalup. Post-job, you're going to go clean your truck . . . you could actually take another five to ten minutes as well, to do some airway management and sign it off in your clinical development logbook.”

4.6.8 Concept map

The focus groups and open-ended questions within the questionnaire provided a wide range of opinions and theories regarding paramedic intubation, in an attempt to describe the range of variables which could affect intubation success rates and paramedic competence a concept map, displayed below and in Appendix 8) was developed as a graphical representation of the information.

As it has been recognised that successful intubations are dependent on a range of circumstances, the qualitative results, from both the questionnaire and focus groups, were examined for such topics and themes.
Questionnaire answers and focus group transcripts were searched for occasions where respondents or participants described a variable which may affect intubation success, including methods of education or clinical practice. These variables were then grouped as either human factors; education and training; environment or patient, with further sub-groups if appropriate. As a retrospective concept map, the participants were not involved in either the coding or the creation of the concept map.

The importance, or relevance, of these themes can also be identified when compared with the three most frequent causes of airway management errors, namely: patient factors; poor judgement; and education/training (49, 167).
Figure 15: Concept map illustrating variables affecting intubation success
Chapter 5: Discussion

5.1 Introduction

With an increasing number of paramedics qualifying and fewer opportunities to perform advanced airway techniques within the operating theatre, it can be a challenge to ensure all student paramedics gain sufficient experience in the use of essential airway management techniques (73).

The aim of this study was to identify whether Western Australian paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be competent and effective in their practice and identify possible improvements to current training practice. Specifically, four research questions were identified:

• How confident are paramedics in performing advanced airway skills?

• Do WA paramedics perceive that the current training regime provides adequate knowledge, technical and non-technical skills to undertake advanced airway procedures?

• Are there sufficient opportunities in clinical placements to practice endotracheal intubation and laryngeal mask insertion?

• What do paramedics suggest be included in initial airway management training programmes?

Through the questionnaire and focus groups, it has been possible to gain an understanding of what paramedics perceive to be challenges to their
learning and practice and how confident they feel when performing advanced airway management techniques. It was also possible to identify areas to be included into the education framework and the development of an education package. This chapter discusses the answers to the research questions, the results of the study in relation to the issues identified during developing the intubation concept map, especially as intubation success can require a combination of variations that involve equipment, personnel, and medication often in a simultaneously and proposes an educational package and framework. (168).

5.2 Demographics

While a response rate of 43 per cent can be considered low, it is similar to other research involving paramedics completing questionnaires, with a response of less than 50 per cent common. The previous research undertaken within SJA involving paramedics completing a questionnaire received a response rate of 41.6 per cent (169-171).

While SJA did not respond to a request regarding the demographics of their paramedic workforce, namely average age, sex and length of service, some relevant statistics can be found in Paramedics Australasia’s response to the Australian Health Ministers’ consultation paper regarding paramedic registration and the Australian Government’s Productivity Commission report on Government services (163, 165).

Thirty per cent of the questionnaire responses were from female paramedics which can be considered as fairly reflective of the paramedic
workforce. According to the PA research, women comprised 32 per cent of the paramedic workforce in 2011 (163).

The average age of the paramedic workforce has gradually decreased, for example 20 per cent of paramedics (in 2011) were within the 20-29 age range, compared with 15.6 per cent in 2006. The last several years have seen an increase in the number of student ambulance officers commencing their studies with SJA and this has resulted in a decrease in the age of paramedics (134, 135, 163).

Majority of the WA questionnaire respondents were within the 20 – 29 year old age range, all these paramedics would have undertaken a degree in paramedical science, with St John Ambulance establishing the undergraduate degree route to paramedic practice in 2004 (69).

As part of this degree programme student paramedics completed a module on research in paramedic practice and would understand the importance of research in developing clinical practice. It has been argued that paramedics who qualified before the introduction of a degree programme may not understand the importance of research and less likely to participate in research (172).

With 97 per cent of the respondents employed within WA, the results can be considered as reflective of the education and clinical practices of SJA, the primary employer of paramedics within WA.
5.3 Research questions

Following analysis of the results, it has been possible to answer the four research questions.

5.3.1 Question 1: Paramedic confidence

1. How confident are paramedics to perform advanced airway skills?

The paramedics are moderately to highly confident in providing simple advanced airway management skills but not confident in undertaking techniques that are infrequently utilised or practices, such as surgical cricothyroidotomy. There is concern that the limited opportunities to perform advanced airway management skills, both within clinical placements and during normal patient-contact experiences, may provide an element of overconfidence due to not previously experiencing a difficult airway or challenging situation.

The survey identified that interstate and overseas trained paramedics were consistently more confident in performing airway management skills when compared to their WA trained colleagues, which is likely to be a result of their initial airway management training programme, including an extended period of time performing their skills during hospital theatre placements. This was also identified by Brandling and her colleagues when investigating the differences between Higher Education Institute (HEI) and non-HEI trained paramedics, suggesting that the non-HEI trained paramedics, who were required to complete 25 intubations in a hospital environment under the tutelage of an anaesthetist before being certificated competent had a
superior training mechanism compared with HEI trained paramedics, who
did not have a similar process (173).

The repetitive rehearsal in IHCD training was seen as providing skill
confidence. For some this was a motor skill; once learned, never forgotten.

Both groups however, were not confident in rarely used skills, such as
identifying cricothyroidotomy landmarks and performing surgical
cricothyroidotomy, despite both being part of the SJA failed airway algorithm
(150). Comparison of the confidence levels for WA paramedics with regard
to age and experience suggested the small increases in confidence seen
could be due to maturity and exposure to patients requiring airway
management interventions.

Examining the confidence scores in relation to SJA success rates could
identity a different view. Half of the paramedics questioned had a self-
perceived success rate of over 90 per cent and a confidence score of
between 80 and 100 but according to patient care records, the total
intubation success rate was only 55 per cent. This could reflect
overconfidence in an infrequently used skill.

5.3.2 Question 2: Training regime

2. Do WA paramedics perceive that the current training regime provides
adequate knowledge, technical and non-technical skills to undertake
advanced airway procedures?

Paramedics believe that the current training regime provides basic
instruction on how to undertake individual airway management skills but
further education on non-technical skills, such as clinical decision making, airway assessment and human factors could positively increase individual’s knowledge and competence.

The research also identifies additional improvements to the training regime, including further education on managing difficult airways; realistic training scenarios; appropriately qualified and experienced educators; and further continuing professional development opportunities.

Paramedic education is a combination of learning both theoretical knowledge and clinical procedures with airway management compromising a small segment of the programme. According to the respondents, the airway management portion of their programmes lasted from one day to 35 days, with an average of six to ten days.

Comprehensive paramedic training programs, with rigorous and universally accepted training standards, have reported significantly higher success rates with prehospital intubation (174).

As there is evidence to support the teaching of specialised skills, including airway management, in a ‘block rotation’, combined with the recognition that little evidence supports the traditional stepwise training approach, airway management education should adopt evidence-based, proven educational strategies (73).

5.3.3 Question 3: Clinical opportunities

3. Are there sufficient opportunities in clinical placements to practice endotracheal intubation and laryngeal mask insertion?
There has been a reduction in the opportunities to perform endotracheal intubation within a controlled clinical environment, with some qualified paramedics experiencing minimal, or even no, opportunities to perform intubation but are still declared as competent and authorised to perform intubation.

While almost all of the participants undertook a clinical placement in a hospital operating theatre, the length and educational opportunities varied greatly, with interstate and overseas paramedics’ placements lasting nearly three times longer than WA paramedics and a large difference in the number of airway procedures achieved. As the time taken for student paramedics to become competent is not only dependent on experience but also influenced on personal abilities and learning styles, perhaps there should be greater emphasis on individual competencies to decide the length of hospital placements and programmes (75, 101).

It is possible for WA trained paramedics to be declared competent by SJA and authorised to perform intubation despite not undertaking a single intubation during their hospital placement, in fact, 18 per cent of the WA respondents reported no successful intubations during their placement. As part of the Curtin University paramedicine degree programme, intubation is taught in the clinical laboratories, which is delivered by SJA WA College of Pre-hospital Care (27). Paramedics who have never performed a critical skill on a human patient cannot be declared competent, especially as inadequate skill and poor judgement in airway management has been proven to lead to avoidable brain damage and death. These students who
do not receive opportunities for safe and deliberate practice of airway
techniques in patients with varying anatomy, physiology and pathology
during their hospital placement should receive this education by other
methods, but did they? While simulation, using low to medium-fidelity
manikins in the classroom, was also utilised during their education, it may
still not provide sufficient opportunities to declare the student as competent,
especially as it has been previously argued that poorly implemented and
managed simulation-based education is no better than other teaching
methods, such as problem-based discussions, and can cause students to
overrate their clinical abilities and knowledge (167, 175, 176).

5.3.4 Question 4: Programme content

4. What do paramedics suggest be included in initial airway
management training programmes?

In addition to learning and practicing individual airway management
techniques, paramedics believe that they should receive education in, and
opportunities to develop, assessing the airway and management strategies
to overcome identified difficulties; receive a hospital placement which
consolidates their education and training and regular opportunities to
maintain confidence and competency through practice and feedback.

Intubation success is dependent on a complex relationships between
education and training, procedural experience (both recent and total) and
available equipment and medication. Research has identified the type of
out-of-hospital provider, such as doctor, paramedic or nurse, is not as
important as experience and training with well-trained, experienced
paramedics achieving intubation success and clinical outcomes similar to
their doctor counterparts. The challenge is ensuring that these paramedics
obtain the required level of experience and education, with current hospital
arrangements making it difficult for paramedics to accumulate enough
clinical experience with certain procedures, including ETI, to maintain
competency. As procedural experience – particularly recent experience – is
associated with both performance as well as clinical outcomes it is
important that these paramedics are regularly utilising their skills (168, 177).

Paramedic education and scope of practice, including intubation, should be
directly related to individual competency, with improved education and
training algorithms required to identify and correct individual deficiencies to
assure optimal performance (58, 178)

While opportunities to alter individual clinical circumstances and patient
pathology are limited, paramedics often do have an opportunity to manage
other external factors, including decision-making with respect to an
anticipated difficult airway; communication; stress; availability of appropriate
equipment; currency in the use of that equipment and access to assistance
(179).

The survey identified that the majority of paramedics believed that the most
beneficial initial airway management training should be a mixture of
practical and theoretical learning. Current practice focuses on the teaching
of the three main techniques of advanced airway management: LMA
insertion; intubation; and surgical cricothyroidotomy, in a stepwise fashion.
5.4 Proposing an education package

Paramedics are required to manage patients’ airways in difficult and challenging circumstances. For paramedics to achieve this safely and effectively, the education system needs to ensure that providers are competent practitioners. Following analysis of the results, it can be seen that the existing education system does not provide the required clinical knowledge and experiences. The concept map identifies critical topics that are relevant to an airway education programme and obtaining intubation success. The rest of this chapter describes strategies to manage the themes identified in the concept map before suggesting how to not only restructure the education programme but also the education system to improve the situation for the future.

5.4.1 Education and training
The traditional model of medical learning, predominantly experimental
learning in a clinical environment, has been suggested to be inconsistent
and inadequate, with education and training believed to be a leading cause
of patient morbidity and mortality. To prevent inadequate skill and poor
judgement in airway management, curriculum change is already underway
in many medical organisations to improve airway management competency
and paramedic training organisations should also follow (167, 180). Within
the UK anaesthetics educational system it has been identified that core
training must include airway assessment, ability to establish an airway using
a facemask, supraglottic airway and tracheal tube, basic extubation
techniques and emergency airway management. Inclusion of non-technical
skills such as decision-making and communication has also been identified
as essential, and the routine use of checklists and training in cognitive aids
such as the Vortex approach or DAS algorithms. It is logical and beneficial if
paramedic airway management education follows a similar process (181).

The survey identified that a range of learning methods should be utilised,
including regular hospital-based placements, education by industry experts
and practical workshops. Opportunities for paramedics to perform advanced
airway skills within the hospital operating room are limited so education
establishments should attempt to identify other opportunities to develop
skills, for example through simulation in clinical skills laboratories.
Simulation can provide a method for teaching and evaluating both technical
and cognitive skills outside of the hospital placements and without risk to
patients. As the transfer of psychomotor skills from simulator to human is
hindered by issues of tissue fidelity, the skills still need to be reinforced in real patients. However, maximising the learning opportunities, including skills performance and minimisation of errors associated with human factors, before undertaking a hospital placement will increase the learning experience within the hospital environment and act as a consolidation of previous learning. Initial teaching has to be more than just teaching the psychomotor skills required. It needs to include the cognition decision making process, for example how to decide the most appropriate airway management technique and when to apply it, and how to minimise the occurrence of process-related adverse events, such as hypotension, hypoxia and aspiration, all of which influence the patient outcome. While simulation can provide a suitable method of instruction to achieve this, the objectives of individual simulations have to be appropriate and not just about getting the tube in the correct hole (21).

WA is the only state where all paramedics are routinely taught to intubate, all of the other Australian states have intensive care paramedics where a smaller cohort of experienced paramedics, competent using basic and intermediate airway management techniques, receive advanced airway management skills. Some of the paramedics in the study believe that a similar arrangement, where a smaller group of paramedics undertake all intubations would create a more thorough advanced airway management education programme and improve skill maintenance (8).

This view was reflected in the 2009 Government review into SJA, where it was identified that for paramedics the option of a tiered training pathway including a base level and critical care level was favoured and identified for
further review. It was argued that a tiered service raises organisational issues around the additional requirements and responsibilities of a more highly trained elite group, especially when the critical mass of paramedics is not large compared with their interstate counterparts. While the report described this as a process which can be further assessed during the implementation phase SJA has not started implementation(182).

Another alternative would be to develop paramedics’ airway management skills in stages, over a longer period of time. Instead of teaching student paramedics all of their advanced airway techniques at the same time, having one course introduce the anatomy, physiology, pathophysiology, clinical decision making and human factors required to manage a patient’s airway along with inserting supra-glottic airway devices and a hospital placement to consolidate learning. Then some time after qualifying (perhaps after three years as this interval is associated with a pay rise for the paramedic to reflect their experience) have a second course which builds on their previous education and experience which teaches intubation and surgical cricothyroidotomy and another hospital placement, however, this should instead of just performing intubation, have the paramedic assigned to a specific anaesthetist who is responsible to developing a broader knowledge of advanced airway management. The theoretical knowledge and clinical experience gained throughout this process needs to be clearly documented to allow monitoring of the student’s progress, assist on the decision to declare each individual as competent and also provide proof of sufficient education and training (73).
Post-qualification airway management education is essential to maintain skills and competence, but continuing education is frequently a discussion on the subject and one or two demonstrations or assessments on a skill-based trainer. Successful airway management continuing education should not be just defined as reminding paramedics how to achieve correct placement of the endotracheal tube or LMA, but also measured by positive patient outcomes. These outcomes can be improved by continually working to enhance paramedics’ airway management and ventilation knowledge and skills. Considering continuing professional development programmes for Australian anaesthetists includes courses such as the Effective Management of Anaesthetic Crises – a two and a half day course simulation-based course which includes a strong theme of human factors, decision-making, reflective learning and teamwork training and a mandatory requirement for advanced airway management to be refreshed every three years – should WA paramedics receive regular mandatory and specialist airway management continued professional development programmes, especially when nearly half may not intubate during the previous 12 months (9, 21, 167, 183).

5.4.1.1 Educator

The study identified that the paramedics who teach intubation are not necessarily the most experienced in airway management skills, with newly qualified paramedics with limited on-road clinical experience teaching students. A WA trained paramedic with three years post-qualification experience who, considering an average of one to four intubations a year and successfully inserted five endotracheal tubes during their hospital
placement, could have an experience of between eight to 17 intubations, which is less than the suggested learning curve of up to 60 procedures to be competent, even before the significant skill fade from performing the skill less than five times a year is considered (50).

If sufficiently experienced and competent paramedic clinical educators are not available to facilitate the airway management portion of the student paramedic programme, then paramedics with extensive experience in airway management or anaesthetists should be used as guest speakers to provide opportunities to learn from experienced clinicians. Ideally clinical teaching and development should only be delivered by healthcare professionals who are experienced and specialised in the subjects they are teaching and hold relevant professional teaching qualifications. Anaesthesiologists, given that they manage thousands of airway encounters throughout their careers, should also be ideally consulted as subject experts during the development of an educational curriculum for airway management (2, 184).

The educator can increase the student’s self-efficacy, and hence learning, by directing attention to the successful aspects of a performance, especially through emphasising their existing skills to increase the student's awareness and use of these skills, however a poor educator can destroy confidence just as easily. For learning to be effective, the educator has to understand the principles of education and also have credibility as an educator. The mentor's credibility is also important, the more credible the mentor, the greater the potential to affect student's perceptions of self-efficacy and learning. It has also been found that professionals with strong
mentors are more productive and have more confidence in their abilities than their peers (185, 186).

The survey identified there was a belief among paramedics that some of the instructors were not sufficiently experienced to teach advanced airway management, with some not even having undertaken the skill themselves. If there are insufficiently competent and experienced paramedic educators who can teach the entire airway management procedure then perhaps airway management experts, for example anaesthetists and other doctors, ideally with pre-hospital airway management practice, accompanied with educational experience, should be utilised to teach segments of the educational programme (187).

In addition, the educators may not hold any qualifications of experience in education and certainly not an understanding on instructional design and applying educational psychology to paramedic education curriculum materials. Similar to some medical teaching, paramedic presentations often consist of PowerPoint slides with redundant text with numerous bullet points that does not necessarily influence learning. The paramedic educator has to not only know something about the topic, the audience and understand how people learn to be able to design and deliver and effective learning experience (188).

During the hospital placement, as a result of the reduced frequency of patients being intubated, due to an increased use of LMAs and an increased competition between health professionals for these intubations, student paramedics do not have a specific educator/ supervising
anaesthetists because they move from one operating theatre to another trying to maximise airway management opportunities. This lack of coordinated clinical practice may result in a poor learning environment, especially if the anaesthetist being unaware of, or on occasions uninterested in, the student paramedic’s abilities or requirements, as they may have unwillingness for the student to attempt advanced, or high risk, procedures. It has been recognised that initial clinical training is best organised with one consultant acting as their tutor throughout the initial week of training and working with differing consultants at this stage can be confusing rather than helpful (73).

Paramedics’ hospital placements should be an integral part of their education programme towards the end of their programme to allow consolidation of learning, under the guidance of suitable qualified, experienced and motivated clinicians, enabling the amalgamation of theory into clinical practice and continuing the development of clinical skills. There is no requirement under the existing Australian paramedic undergraduate system for a mandatory hospital placement. For this change, the Council of Ambulance Authorities has to make changes to their course accreditation programme and would require a well research and supported proposal to be submitted for initial discussion on the subject (189). The hospital placement area staff should also be informed as to what is expected of the student, including their learning requirements, and then debriefed as to what was achieved during the placement (184).
5.4.1.2 Knowledge

WA SJA paramedics, including students, operate within clinical practice guidelines and in accordance with a skills manual. The skills manual is the primary document which addresses airway management skills and details the steps required to correctly perform each skill, including oropharyngeal airway and LMA insertion, intubation and surgical cricothyroidotomy. The only algorithm is a failed airway algorithm, which documents the procedure required for when a paramedic fails to secure the airway with an endotracheal tube and there is a clear distinction between basic and advanced airway management skills (150, 190).

The survey identified that some paramedic students believed that they should receive a greater theoretical knowledge and practical skills instruction and practice as part of their airway management training programme, and definitely before undertaking their hospital placement. Use of more visual learning methods, such as videos and video laryngoscopes, were believed may increase the effectiveness of learning and the differences between manikin and human anatomy. This was also identified by Levitan who found that an instructional videotape made with a direct laryngoscopy video system significantly improved the initial success rates of novice intubators and training with video imaging improves the initial intubation success rates of paramedic trainees in an operating room setting (191). An improved rate of successful intubation and the decreased rate of oesophageal intubation have also been seen with the use of video laryngoscopy for tracheal intubation training (192), but if video laryngoscopy is only used within the training environment, students would have to be
taught two different intubation techniques – video and direct laryngoscopy (193).

Airway management should be a combination of attempted basic and advanced techniques, with the least invasive method which eliminates the risks utilised, with a focus on the decision making skills required to select the most appropriate management technique for an individual patient at that particular time of the treatment process. In an attempt to reduce poor outcomes with airway management, various algorithms have been developed by organisations. The use of algorithms, which combines both basic and advanced airway management techniques, should be promoted to assist in critical clinical decision making and reduce the likelihood of poor clinical care by eliminating the idea that the paramedic is there only to perform advanced airway skills (194).

The Vortex airway management approach is a relatively new tool, launched in 2016, which paramedics can also consider as an alternative or adjunct to difficult airway algorithms. The Vortex is designed as a simple and predominantly visually based cognitive aid, used in real time during airway emergencies to support team function and target recognised failings in airway crisis management. This tool, unlike the major algorithms, which are context specific and not always representative of the pre-hospital environment, is claimed to be flexible enough to be applied to any circumstance in which airway management takes place, independent of context, patient type, or the intended airway device. For this reason, the Vortex approach should be included in paramedic airway management
education programme when discussing algorithms and educational resources (195).

5.4.1.3 Experience

Obtaining intubation education and experience in the operating theatre is considered the gold standard of airway training, but an increased number of hospital staff seeking intubation experience and a reducing number of intubations performed due to increased use of supraglottic airways, has reduced the opportunities to learning in a safe clinical environment (196).

The survey found that only four per cent of WA educated paramedics achieved more than 15 intubations while on their hospital placement, compared with over 77 per cent of international and inter-state trained paramedic. Considering authors such as Baker et al believe that trainees need at least 50 intubation attempts to be able to achieve an intubation success rate of greater than 90 per cent, a self-reported average intubation success rate of five during a hospital placement does not necessarily provide student paramedics with an acceptable level of experience to safely perform intubation on critically injured or ill patients (167).

It was also identified that the supervising anaesthetists selected the patients who could be intubated by paramedics, possibly choosing the patients who had easy airways and who they believed intubation was achievable by the inexperienced paramedics. This selection bias by the supervisors, while probably safer for the patient, further limits the intubation experiences and could affect their confidence levels (196).
Paramedics educated overseas and interstate received a wider range of experience during their hospital placements in differing airway equipment and techniques, a range of adjuncts and types of airway devices when compared with WA trained paramedics. The experience gained by using different equipment and techniques may enable paramedics to be able to recognise and modify their technique when faced with challenging or difficult airways, but after working several years within the WA environment with minimal utilisation of these skills, some of this experience may have been lost.

London Ambulance Service (LAS) stopped teaching intubation to student paramedics in 2010 because it believed that it was going to be impossible to maintain its current programme of hospital placements for 25 successful intubations for each student. Students, however, still undertake a hospital placement to gain clinical exposure to airway management, but the focus is on the use of supraglottic airway devices and good basic airway management skills (197).

While intubation can be life-saving, particularly in cases of severe trauma with circulatory arrest, it may also be detrimental in certain ambulance systems. Pepe et al described a successful system was one which provides:

1. ‘street-wise’ training that is provided by experts in out-of-hospital patient care who themselves are well-experienced in on-scene emergency ETI;
2. tiered EMS deployment systems that spare a small cadre of highly-skilled paramedics from the majority of EMS incidents (focusing them on the more critical cases, thus resulting in a very high frequency of ETI performance by each individual in the system); and


Pepe et al summarised that ambulance systems unable to adopt the appropriate configurations, protocols, training, monitoring, and all other characteristics that optimise ETI may, therefore, need to be discouraged from performing ETI or they need to develop alternative mechanisms to better ensure routine success with placement of the tube and its appropriate use. This should be the same for SJA – it is possible to have an ambulance service that undertakes intubation safely, competently and effectively – however it does require a firm clinical governance and educational structure (187).

Gaining the 50 intubations and LMA insertions suggested as necessary to provide sufficient experience for the majority of individuals to become competent within the WA system, especially with only several days hospital placement, is not achievable.

Introducing an education programme which provides graduated development and relevant experience throughout the curriculum may assist in providing learning that is currently not obtained during existing hospital placements and allow the final placement become simply a consolidation of learning. Developing the educational programme with recognised curriculum design principles, such as needs assessment; goals and objectives;
educational strategies and implementation and evaluation, and a rigorous competency assessment process should deliver improved patient care and increased paramedic confidence and competence (167, 198).

Utilisation of a range of task-trainers, simulation and multi-media, for example the recording of real intubations, can all be utilised to provide relevant experience. Refocussing the emphasis to ventilating patients, rather than performing individual airway management skills, could also reinforce the importance of the entire airway management experience rather than just performing an initial advanced airway technique.

5.4.1.4 Skills

Specific airway skills utilised by SJA paramedics are LMA insertion, intubation and surgical cricothyroidotomy and it appears that the education programme focusses on teaching technical skills, with limited emphasis on clinical decision making. The variances in patient anatomy and physiology require paramedics to be skilled in a variety of techniques to be able to successfully manage the range of clinical presentations, however, due to education time limitations, there may be a tendency in WA to limit skills to a few core techniques (73, 167).

The survey identified that inter-state and internationally trained paramedics, whose average clinical placement duration was three times longer, received training in a wider range techniques and different equipment compared with WA trained paramedics. The paramedics identified that there should be more emphasis on the theory of airway management, including anatomy variations and pathophysiology, rather than just the physical skill of inserting
a LMA or endotracheal tube into the correct hole. Utilisation of medium to high-fidelity manikins and realistic simulations would not only allow the mastering of the technical skills but also the non-technical skills, such as interpretation of difficult airway algorithms and clinical decision making, essential to ensuring paramedic competency (73).

Skill maintenance is applicable to all paramedic techniques but is essential for the highly technical skill of intubation where it is already recognised that lack of regular exposure will result in skills fade (14). The survey identified that paramedics are aware of the risk and believe that the current SJA continuing education programme of two days a year is insufficient in providing opportunities to develop their knowledge and skills, with more clinical placements, cadaver and manikin simulations and training days essential. It was even suggested that the focus of airway management education was incorrect, with suggestions that intubation is taught either as a post-qualification skill after several years after qualifying or the formation of a tiered ambulance service. Some ambulance services, both Australian and international, already have adopted the tiered system, which increases exposure to advanced airway management skills by limiting the skills to a smaller group of paramedics who are selectively tasked to critically ill or injured patients (50).

When requested to arrange the individual procedures required to intubate a patient, in accordance with their skills manual and instruction, none of the paramedics could correctly arrange the 20 steps in the correct order. Research shows that humans can only manage to retrieve seven +/- two pieces of information from our memory with relative accuracy, and this
decreases in a stressful situation. That the paramedics could not recall the correct order in a non-stressful environment, rather than when faced with a critically sick patient, would indicate that the procedure is not followed when dealing with real patients. Breaking the skill procedure into different phases, such as equipment preparation, patient preparation, insertion of the tube, post-intubation and failed insertion, each containing no more than four or five steps, could improve recall and procedure performance. Unlike hospital-based airway management algorithms, algorithms for pre-hospital environments need to involve clinician factors, clinical decision makings, such as differences of acuity (high versus low or transport duration) and patient assessment as paramedics do not always have the same cognition, experience and equipment as their in-hospital colleagues (21, 73, 199, 200).

The use of checklists and cognitive aids for airway management procedures has increased in recent years, especially as the result of research into human-factors and championed by the likes of Martin Bromiley, following the death of his wife due to medical error. Instead of expecting perfection from paramedics, would it be more appropriate to acknowledge that error is inevitable in any system, and ensure there are effective systems in place. When examining critical procedures within other industries, such as aviation and the nuclear industry, the requirement for high degrees of safety despite the technically complex nature of tasks the use of checklists is fundamental to practice. One of the key recommendations from the UK’s NAP4 study was for use of an intubation checklist to be used alongside capnography in all remote site emergency airway management situations involving critically
ill patients, as they have been shown to significantly reduce complication rates. A paramedic airway management curriculum should include the use of checklists for airway management, especially intubation and RSI. An example of an intubation checklist has been developed as part of the curriculum development and is located in Appendix 11 (201-203).

5.4.1.5 Competence

Competency in intubation is difficult to assess, especially as due to its complex nature and the range of variables affecting success, including varied patient anatomy; patient physiology; provider experience; clinical environment; and time of the day (2).

To achieve a 90 per cent success rate with the first intubation attempt, research has identified a minimum of 57 intubation attempts required during training, which is higher than the UK’s original requirement for paramedics to achieve 25 successful intubations. Even under ideal intubation conditions, Deakin et al estimated that the average paramedic is likely to achieve an intubation success rate of 70 – 75 per cent at best, with little scope for further improvement in skills performance after initial training (16). In 2010, LAS paramedics undertook, on average, three or four intubations a year and this was declared by their medical director as insufficient to maintain an adequate skill level.

While the survey identified that paramedics should achieve a between six and 12 LMA and intubations a year to maintain competency, some paramedics believed that the competency should be associated with individual success rates rather than a minimum number. Considering that in
a 13 month period, 98 per cent of SJA paramedics attempted five or less intubations, both intubation and LMA insertion are infrequently used skills and opportunities for paramedics to maintain competency through skill performance is limited. The most successful pre-hospital airway management programmes are those who require paramedics to perform a minimum of 12 intubations a year and also have access to operating theatres for the provision of supplemental training (196, 197).

Clinical competence varies greatly between individuals, but the health care system does not necessarily recognise that individual clinical experience and skill differs greatly among practitioners (204). Simply implementing a minimum number of intubations performed in a year as a requirement to remain competent or observing paramedics perform advanced airway skills on a manikin, does not address this variance between clinicians. While all paramedics may be able to intubate a single manikin in the centre of a well lit room during an annual education programme, some may struggle when faced with a challenging cardiac arrest or trauma patient. Some paramedics recognise their limitations and correctly alter their airway management strategy accordingly, for example choosing to insert an LMA as the primary management strategy, this avoidance of intubation contributes to a reduction in competence and confidence which may result in poor outcomes in those patients where intubation is essential. In addition, Cook and his colleagues identified that while the commonest factor associated with serious airway complications was difficulty with tracheal intubation, the commonest cause of death and brain injury was pulmonary aspiration of gastric contents, with a supraglottic airway was the planned technique in
more than 50 per cent of death or brain damage cases. In a pre-hospital environment, where the patient was always non-fasted, selecting a LMA before attempting intubation could contribute to patient morbidity and mortality (4, 10, 205, 206).

There is no minimum competency standard for WA trained paramedics to practice intubation. It is possible to attend a five day hospital operating theatre placement, not attempt an endotracheal intubation and as long as the student can intubate a manikin or task-trainer they are still declared competent to practice. This could mean that the first time they attempt an intubation is on a critically ill or injured patient and there is no guarantee that they will be working with a qualified paramedic who has performed the skill themselves, so is unable to provide guidance and feedback. This is in comparison to overseas trained paramedics who were required to undertake a minimum number of intubations and LMA insertions, often at least 30 independently performed skills, during their hospital placement and be signed off as competent by their supervising anaesthetist, before being authorised to perform the skill. While requiring a minimum of 30 intubations will not guarantee competence, especially when Baker et al identified that a success rate of 90 per cent cannot be expected until 50 attempts and even after 80 attempts 18 per cent of students still require assistance, the experience and familiarity gained will allow the student to continue to gain further experience through self-directed teaching. In addition, the inclusion of simulation-based instruction to the educational programme results in improved learner outcomes in adult airway management (73, 167, 207).
The requirement for a minimum number of skills performances doesn’t just increase experience. This deliberate practice, especially when accompanied with direct feedback, allows students to problem-solve varying anatomy and airway challenges and modify their technique accordingly, which will increase their performance and expertise in managing the airway (167).

The introduction of a competence-based approach to paramedic education, especially in regard to airway management skill being considered a clinically fundamental skill, should see more rigorous assessments to ensure initial and maintained competency (167).

5.4.1 Patient

Patients' variations in anatomy and the physiological response to the airway management techniques can influence the success of the airway management attempt. Airway management techniques can induce a range of negative physiological responses, including hypotension, desaturation, aspiration, dysrhythmias, increased cardiac demand, increased intracranial pressure and intraocular pressure and paramedics need to be taught management strategies to overcome them.
5.4.1.1 Difficult airway

While a failure to effectively assess and identify any potential airway management difficulties, and a failure to incorporate these findings into a management strategy, can contribute to a poor outcome the SJA training programme does not emphasise the importance of this key element. While a difficult airway can be defined as a clinical situation where the clinician experiences difficulty with face mask ventilation and/or difficulty with intubation, it should also include difficulty with supraglottic devices, direct tracheal access and potential extubation issues. Research has identified that when one airway technique is difficult or fails, the risk of other rescue techniques being difficult or failing is increased considerably, paramedics need to be taught that the patient is not just at risk of having a difficult intubation, but an all-round difficult airway (4, 208).

While including the use of predictive tests for identifying difficult mask ventilation, supraglottic airway insertion, intubation and cricothyroidotomy into the SJA educational programme may be beneficial, it should also be emphasised that there is no perfect airway assessment tool and identifying the potential difficulty is meaningless unless the implemented airway strategy plan incorporates variations in equipment, technique and drugs necessary to overcome the potential difficulty (208).

5.4.1.2 Positioning

 Majority of the airway management training received by those surveyed involved a skills trainer positioned on a table or a manikin positioned in the middle of a classroom floor and students taught the ‘sniffing position’ as the
only method to align the three axis (oral, pharyngeal and laryngeal) to expose the glottis to facilitate intubation. While this may be beneficial during the initial learning of the skill itself, it is not the only method of positioning a patient for intubation and has been suggested as unsuitable for groups of patients, such as the obese, traumatic or even 'normal-sized' patients and definitely does not reflect the range of environments which paramedics face, especially as no single technique is always effective (158, 159).

5.4.3 Environment

Considering paramedics are expected to manage patient airways and achieve effective ventilation in a range of situations and environments, majority of which would fall into an anaesthetist's definition of a 'difficult airway' we should be teaching paramedics who to manage airways in a variety of positions and situations, especially when the choice of a particular
position may be critical for successful intubation and maintaining adequate oxygenation, such as ‘head-elevated’ position for obese patients. Education, especially simulations, should provide realistic situations as close as possible to those faced by paramedics, such as confined spaces, seated patients, darken rooms with no natural, or any, light (73, 157, (209)158).

5.4.3.1 Fatigue

It has already been identified that fatigue significantly affects paramedics’ alertness, vigilance, concentration, judgement, mood and performance are all significantly affected by fatigue, with decreases in work productivity and performance from impaired memory, problem-solving and decision-making skills. Both these physical and mental stressors can increase clinical risks, resulting in clinical incidents, errors and injuries to patients or others. WA paramedics are aware that the risks of long hours, including 14 hour night shifts, disturbed sleep pattern and an ever increasing workload can affect their ability to undertake critical skills, for example intubation (67).

Managing fatigue is an issue of concern for many ambulance services and it is recognised that further research is needed on sleep deprivation, fatigue and patient safety, especially in the Australian paramedic discipline, but from an education point of view, educating paramedics to how to minimise the risk of fatigue and how to identify the signs, especially with regard to making time-critical, high-level clinical judgement and decision-making decisions, may be the only achievable option. From a clinical governance and human factors viewpoint, recognising that humans make mistakes,
especially when tired, and that paramedics should not function as individuals, with increased emphasis on team work, with clinical decisions discussed prior to undertaking critical procedures, could reduce the likelihood of a poor decision made by an individual, fatigued, paramedic (67, 201).

5.4.3.2 Equipment

Laryngoscope blades are either curved (Macintosh) or straight (Miller) and are available in sizes 1 – 4 and 0 – 4 respectively. An average adult requires a size 3.8 Macintosh blade but SJA paramedics are only issued with a size 2 and 4 blade. Blade size is often decided by the size of the patient’s tongue, length of neck, or position of posterior, alternatively a size 3 blade is recommended for majority of adults and size 4 for large males. Limiting SJA paramedics to the largest sized blade may be considered as contributing to high failure rates (21, 210, 211).

It was not just the available of different sized laryngoscope blades that was an equipment concern. Spending money on waveform capnography, implemented to inform paramedics whether they were successful or not intubating, but not on providing airway adjuncts, such as bougies and efficient suction, or new technology, including optical and video laryngoscopes, designed to increase the intubation success rate, was seen by some WA paramedics as an inaccurate focus, despite waveform capnography be recommended for all ventilated patients dependent on an artificial airway. Paramedics in the UK are routinely required to have access to a bougie for all pre-hospital intubation attempts. The bougie is
inexpensive, readily available and the technique combines simplicity of operation with a high success rate with evidence that the bougie is more effective than the stylet, especially as stylets have also been associated with pharyngeal or laryngeal trauma and for one ambulance service simply introducing video laryngoscopy increased the intubation success rate from 64.9 per cent to 91.5 per cent. Video laryngoscopes also allow educators and supervisors to observe and provide real-time feedback to the operator, both within the educational and clinical environment (4, 16, 210, 212-214). Due to the time since original training for the older paramedics, particularly the overseas/ interstate group, it is unlikely they had experienced video laryngoscopy, and other new technologies, for managing the airway.

Within the Australian hospital system, there are recommendations and minimum standards for essential equipment, including a variety of blade sizes and shapes, stylets and bougies, which are required to manage a patient’s airway by anaesthetists. It is believed that standardisation across the health systems ensures that all anaesthetists have access to the equipment required to assist managing airway emergencies as financial restrictions may prevent clinicians working in certain environments, for example private practice, may limit the availability of expensive equipment. Perhaps establishing a similar system within Australian ambulance services will ensure that paramedics have access to a range of adjuncts to effectively manage an airway (179) For this to be achievable, it is likely that all States would have to agree on national clinical practice guidelines and an Australian-wide ambulance accreditation system.
5.4.3.3 Scene/ circumstances

A large proportion of the skills training and simulations experienced by paramedics who participated in the study involved the manikin laid supine in the middle of a well illuminated classroom; however, this situation is not often experienced within the clinical environment. Paramedics may experience critically ill or injured patients, requiring emergency airway management techniques, in confined spaces, trapped in or under vehicles, at night or in poorly illuminated environments, in adverse weather conditions, such as rain or >40 degree Celsius heat, and distracting environments, such as noisy concerts or hostile situations. To ensure that the paramedics are suitable experienced for these challenges, the education should reflect these environments, would placing the manikin in a noisy, dark room or under a vehicle increase the learning opportunities?

Good quality simulation will allow paramedics to practise their techniques and develop their management and leadership skills within challenging clinical situations, and to receive feedback regarding their performance and, while does not eliminate the requirement from consolidation of learning from manikins to human tissue, does allow development of not only physical skills but management of human factors influencing airway management success. Education systems which utilise simulation and competency-based models in teaching procedures have been identified as successful in improving patient care practices and patient/ public health outcomes (101, 215, 216).
Human factors have been defined as ‘the environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety’. Human factors and human error have been implicated in up to 80 per cent of critical incidents within hospital anaesthetic departments, with one study identifying human factors, including omitting checks, judgement errors, incorrect technique, inattention, inexperience, equipment and communication problems, were documented in 83 per cent of incident reports (4, 217).

Patient safety has historically been considered as dependent on technical skills and competence and while technical excellence in healthcare is important, stress can adversely influence even the most technically qualified and expert clinicians. Paramedics education should put equal value on non-technical (cognitive and social) skills and clinical techniques. All humans, especially when under pressure, have the capacity to become fixated on technical problems, without appreciation of the ‘bigger picture’, resulting in
poor decision making, for example focussing on the passing of the endotracheal tube into the trachea rather than the increasing hypoxia resulting from the extended duration on the intubation attempt (218).

Within WA, airway management education focusses on the procedural skills and the knowledge required to secure the airway rather than fully engage the three principle regions of human performance: psychomotor, cognitive and affective (21). The study identified several areas where paramedics believed human factors influenced their learning and intubation success rate. Rather than blaming clinicians as the primary sources of error, it should be the aim of an organisation’s governance strategy to ensure that clinicians are empowered to adopt an increased role in preventing the failure of badly designed systems (219).

5.4.4.1 Confidence

Paramedics' self-efficacy is likely to influence the care received by patients, with individuals less likely to initiate treatment regimens for which they lack confidence, despite them having the knowledge and skills necessary to perform the skill, for example choosing to place a LMA rather than intubating the patient. It is essential that airway management education, both initial and continuing, provides paramedics with an adequately strong belief in their capabilities as research into self-efficacy has indicated that it is likely to influence the development to other cognitive, affective, psychomotor, and social aspects of skills proficiency. (185).

Perceived self-efficacy can be changed through positive personal performance experiences, observational learning, verbal persuasion, and
inferences made from the individual’s physiologic and/or affective state.

Learning strategies to achieve this include:

- Frequent practice of individual skills and utilisation of techniques within in realistic environments and situations (including manikins, computer simulation and simulations) as self-efficacy is enhanced through frequent repetitions of a behaviour. Students should also be encouraged to engage in frequent mental rehearsals of each skill, because mental rehearsal can contribute markedly to increased self-efficacy and motor performance gains;

- When performing demonstrations the educators should strive to make the unobservable aspects of the skill, including the mental processes involved, observable to the students and also provide both good and poor practices to the students;

- Education of airway management techniques should be a graduated process, with simple examples and exercises being mastered before proceeding to more difficult ones, with learning linked to individual student abilities. This approach provides educators a range of opportunities to provide students with positive feedback regarding their performance and corrective feedback when identified. Any students who appear to have low self-efficacy should be identified early and provided with extra assistance from educators and other more capable students; and

- Teaching paramedics to control dysfunctional physiologic and affective states, such as anxiety, fear, panic and shame, should also be part of their education. The tendency to experience these feelings
should be acknowledged and methods for controlling those states should be taught and practiced (21, 185).

5.4.4.2 Communication

Effective patient care is dependent on good teamwork, which is dependent on excellent communication between team members. In the aviation industry, professionals are taught how to voice their opinions, and to listen and respond to any concerns expressed by team members, regardless of their rank or role, because their priority is ensuring that everyone does the right thing. Perception of clinicians by their colleagues can also influence patient care, if paramedics regard a colleague as unapproachable or aggressive, it is likely that they will not feel as if they can raise their concerns under stress or when they believe something has gone wrong. Essential communication, including the importance of informing the team of management strategies, including measures to take when difficulty occurs, before undertaking airway management procedures and the significance of speaking up should be taught to all paramedics and their training should provide opportunities to develop these essential skills (4, 218).

5.4.4.3 Judgement

It has been suggested that limited exposure to intubation can create paramedics who are over confident in their skills, with paramedics with the least experience perceiving themselves as the most competent. It was argued that their limited exposure had not provided them with opportunities to experience challenging situations, or failure, in the three principle domains of human performance – psychomotor, cognitive and affective.
While it would be unethical to have paramedics intentionally experience failure during their hospital placements, the use of appropriate simulations can be used to not only increase paramedics’ confidence but to realise their limitations, including appreciating how normal cognitive biases can impair the approach to risk, decision-making and performance in critical situations. (21, 220).

5.4.4.3 Experience

While paramedics in the respondent group who originally trained overseas have more clinical experience than those educated within WA, this increased experience does not necessarily reflect in improved intubation success rates. Recent tracheal intubation training and skill performance has been proven to be associated with improved success rates with the number of years’ experience as a paramedic has no significant correlation with intubation success rate (60, 221).

According to SJA patient care records, between 1 July 2012 and 1 September 2013 there were 315 paramedics who were documented to have attempted intubation. Figure 5 displays the number of attempts by individual paramedics recorded for the period, with over 98 per cent of paramedics attempting five or fewer intubations (138).
With the study findings identifying that 98 per cent of paramedics attempted less than five intubations a year, the number of years’ experience as the paramedic has becomes irrelevant, considering all international or interstate paramedics have been working for SJA in WA for at least three years and that performing a procedure less than five times annually has already been suggested to be subject to significant skill fade (50, 135).

5.4.4.4 Ego

Majority of the paramedics perceived their intubation success rate between 70 and 90 per cent, with over half believing their success rate was over 90 per cent. When compared directly with intubation success rates from patient care records, the average intubation success rate for WA paramedics in 2014 was just 55 per cent (10).
It has been previously identified that paramedics may under-report the number of intubation attempts, especially if unsuccessful, in an attempt to not ‘look bad’ or appear incompetent. Paramedics in the Denver Metro Airway Study Group only reported 70% of attempted intubations, which could suggest that self-reported rates of intubation may actually underestimate the number of intubation attempts and therefore overestimate success rates. This thought process needs to be changed, to create a culture where paramedics believe that a sign of an effective clinician is one who can recognise their own limitations and request help when they need it (21, 222).

5.5 Further research

During undertaking this study, it has also become apparent that a prehospital airway management algorithm should be developed for WA paramedics to assist in clinical decision making and risk mitigation. While a draft clinical decision making algorithm has been developed (Appendix 10), future research could assess the suitability and feasibility of such an algorithm, while an evaluation on implementing the suggested airway management programme and curriculum described in Appendix 9 is another suggestion for future research. Another area of research could be a comparison of the different paramedic education programmes, specifically comparing the eastern states’ full-time university approach and WA’s more vocational system.
5.6 Limitations

The study had a number of strengths and weaknesses. The questionnaire was piloted to ensure understanding and designed using the principles of good questionnaire design. The main limitation was the poor response rate, which means that the sample may not be representative of WA paramedics. Poor participation in pre-hospital research has been noted in previous studies, with low response rates possibly reflecting limited engagement in research amongst paramedics, including a perceived threat of research to professional autonomy and practice. There is little paramedic clinical research published, especially when compared with medicine and nursing, and it has been identified that paramedics may be reluctant to participate in clinical research due to suspicions that the outcomes may be used for industrial or political leverage (172, 223, 224).

Another limitation was that questionnaires and focus groups can only measure reported behaviour rather than actual behaviour. As this was an observational study utilising self-reported data, the results should be interpreted with caution. The inclusion of intubation and LMA insertion success rates, collated from SJA patient care records by its Clinical Governance department, was included to compare participants’ reported behaviour but these results are also dependent on that skill performance is documented correctly on the patent care records.

5.7 Summary

It has been proven that the creation and implementation of an airway management educational programme, utilising simulation training,
protocols, team leadership, crew resource management and checklist utilisation can improve success rates, reduce complications and improve patient-related outcomes (214). With an appropriate and effective educational system implemented it is possible for paramedics to be competent in intubation, but will require a lot of effort by the organisation.
The study demonstrated that the current education programme focussed on the teaching of individual airway management skills with limited teaching on identifying and managing potential airway difficulties, minimising human factors and errors and ensuring individual competence. The exclusion of essential subject areas, including problem solving; critical and creative thinking and decision making; and evidence-based practice, can have a huge influence on intubation success and patient safety. This skills are essential to the evolving healthcare system but practitioners, including paramedics, will only develop these skills if are effectively integrated into the curriculum.

A description of a curriculum was provided by Keating as “the formal plan of study that provides the philosophical underpinning, goals and guidelines for delivery of a specific educational program.” An airway management curriculum would describe the learning outcomes required to be met by student paramedics and providing a basis of which learning opportunities and assessments would be focussed (225, 226).

Kern described a six-step approach to developing a curriculum for medical education. The system commences with problem identification and a general needs assessment before describing a needs assessment for targeted learners. These findings can then be used to develop the goals and objectives of the programme, from which the educational strategies to
be utilised can be identified. Following the implementation of the programme, a review process of evaluation and feedback should be undertaken to gauge the effectiveness of the programme (198).

Considering Kern’s six stages in relation to developing a paramedic curriculum for airway management, it is possible to visualise the start of a new programme.

6.1 Problem identification and general needs assessment

The study has identified that the existing paramedic education system does not ensure, or prove, competency in advanced airway management. The ideal system is an evidence-based education programme, which minimises risk of patients while allowing paramedics to develop their skills in a range of circumstances and conditions.

6.2 Needs assessment of targeted learners

Student paramedics will have different educational requirements compared with qualified paramedics. Student paramedics will require an educational system that describes anatomy and physiology, provides opportunities to learn and develop basic skills before consolidating learning through simulations in realistic environments. The focus of an education programme for qualified paramedics should be to develop critical thinking and team work while managing difficult airways in challenging situations. Recent reports have also emphasised the importance of clinicians having an awareness of how human factors influence clinical performance in the workplace (227).
6.3 Goals and objectives

Appendix 9 describes goals and cognitive, psychomotor and affective objectives of an education curriculum, utilising the principles of competency-based training, designed to provide paramedics with sufficient knowledge, skills and development opportunities to achieve competence in airway management techniques. The curriculum framework should allow paramedics to be able to perform advanced airway management skills and practices to a level sufficient for unsupervised practice – a description of competency for healthcare professionals (228).

The Council of Ambulance Authorities (CAA) manage an accreditation scheme for Australian undergraduate paramedic programmes, which stimulates requirements for the course – which the proposed curriculum framework will have to comply with. The CAA accreditation of entry-level paramedic education programmes requires students to receive sufficient clinical experiences as part of the curriculum. While a hospital theatre placement is not a mandatory requirement under the accreditation scheme, the CAA guidance does stipulate that where it is not possible to offer clinical placements, appropriate strategies, such as high fidelity clinical simulation, are needed to match the training needs (189).

6.4 Educational strategies

The curriculum content chosen and educational methods selected should be those most likely to achieve the educational objectives for each targeted learners’ needs assessment. With regard to student paramedics, the curriculum content will need to focus on airway anatomy and physiology,
airway skills and their appropriate use. Qualified paramedics should have a curriculum content which develops existing skills and increases both confidence and competency. Educational strategies utilised will depend on the learning styles and requirements of the learners. Case-based, problem solving exercises and simulations are more likely to improve clinical reasoning skills and team work than attendance at lectures for qualified paramedics. Lectures and demonstrations, however, are likely to be beneficial to introduce theoretical knowledge and individual skills to student paramedics. Easy access to evidence-based information and high-quality multimedia presentations for teaching and learning should also increase learning opportunities. Regardless of the strategies used, all programmes will need to use validated workplace evaluation tools to assess, and re-certify, paramedic competency in managing airways (2, 167, 198, 229).

As simulation has been suggested as a solution to the lack of clinical placements, and is associated with an increase in patient safety and improved transfer of theoretical knowledge to the clinical context, it is likely that simulations, both low and high fidelity will play a key role in the educational strategy. To take advantage of the positive relationship between simulation-based learning and learning outcomes it is important that simulations are well planned and practiced, with goals aligned with the needs of individual learners, to meet clearly defined learning objectives (230, 231)
6.5 Implementation

For the curriculum programme to be implicated and effective, it will need to support of SJA and its training college. Before the programme can be implemented, the resources required will need to be identified and, if necessary, procured. Possible barriers to successful implementation will need to be identified and managed before piloting the programme to a targeted audience before widespread, graduated, implementation. Administrations systems will also need to be developed along with and opportunities to refine the curriculum (198).

6.6 Evaluation and feedback

In addition to being summative (providing competency-based assessment systems for evaluation of individuals) and formative (providing feedback allowing the improvement of both learners and curriculum) this section should also be used to develop curriculum resources; gauge effectiveness of specific curriculum and different educational approaches,
Chapter 7: Conclusion & recommendations

7.1 Recommendations

Paramedics undertaking intubation should receive an education and training programme which covers a wide range of airway management techniques and not focus on individual skills. While the BestBets recommendation suggest ensuring competence through underpinning and supporting information, manikin and simulator practice, a minimum of 25-30 in-hospital and pre-hospital intubations along with supervision by competent clinicians, it has to be recognised that this may be insufficient for some students – competency has to be assessed on an individual basis (204).

The training and education process for student paramedics needs to reflect the importance of linking curriculum with appropriate educational evidence, including recognising that students use a diverse range of learning styles to obtain the required knowledge, skills and attributes. The balanced curriculum, not just for airway management, needs to utilise a variety of teaching and learning strategies to encourage and enable critical clinical decision making, promote lifelong learning along with providing the required clinical knowledge and skills (184).

This study suggests that although the current training programme contributes to the acquisition and maintenance of knowledge and skills, it is inadequate for achieving and maintaining procedural proficiency, especially considering the frequency the skills are demonstrated. Methods of
instruction need to support the acquisition of technical competency; along with demonstrating valid assessment of individual knowledge, skill, and attitudes; and incorporate sufficient learning opportunities with enough fidelity to facilitate the consolidation from the training environment to clinical care of patients while the introduction of competency-based education and a quality assurance system will ensure the process is fully transparent for ongoing quality and safety improvement, along with monitoring successes achieved by the quality improvement and educational programme (167, 207, 232).

Chapter 6 and Appendix 9 details an airway management training programme and curriculum which is designed to not just teach the physical airway management procedures but the cognitive, psychomotor and affective skills required to competently manage simple and complex airway management challenges (21, 220).

The curriculum focuses on providing the required knowledge and experience required for paramedics to perform skills and maintain their confidence and competence in airway management, through identification of a potentially difficult airway – not just a difficult intubation, but difficulty performing ventilation, laryngoscopy, placement of supraglottic devices and surgical airway techniques; creation of pre-procedural optimisation strategies for ensuring oxygenation and haemodynamics through efficient teamwork and appropriate equipment utilisation; selection of appropriate techniques to optimise first attempt success with established back-up plans; and navigation of critical clinical decision making algorithms to avoid airway and ventilation related complications (38, 214).
The proposed programme does not contain any specific performance goals, such as 12 successful intubations, as it is recognised that all students learn at different rates and through various methods of instruction, the programme and its educators have to be flexible enough to ensure that all students can become proficient in their skills, knowledge and abilities (184, 214).

7.2 Conclusion

The study has provided an overview of the experiences of WA paramedics with regard to advanced airway management education and practices. The research has

1. demonstrated there are challenges in maintaining competency;
2. identified and suggested the need for an airway management algorithm and checklist (Appendix 10 and 11); and
3. suggested a curriculum for introductory and continuing training for paramedics.

Increasing both the quality and quantity of airway management training programmes, including changing the focus to oxygenation and ventilation rather than skill-based, should see an increase in higher success rates, as identified in other studies around the world, but the required level of education to maintain competency for over 700 paramedics is likely to be difficult to achieve. There will either have to be a commitment to ensure the required education to maintain intubation competency for all staff is provided or a reassessment of airway management techniques and paramedic skill level, perhaps utilising second generation supraglottic
airways and reducing the number of practitioners authorised to perform advanced airway techniques. While introducing a blanket decision to remove airway interventions from paramedics in response to negative data has been suggested as inappropriate, the organisation needs to identify and eliminate (or reduce) the factors which contribute to the negative links between out-of-hospital airway management and poor patient outcomes, for example: paramedics’ ability to correctly identify patients who require ETI emergently compared with those that can be managed less invasively and wait until arriving at the emergency department for ETI; and the skill and competence of the paramedic to perform ETI. An increased focus on quality introductory and continuing education with emphasis on paramedic clinical decision-making and awareness of one’s own skill level, may improve care of patients requiring emergent airway management. Combining efficient education principles required to ensure practitioner competence, for example an increased emphasis on simulation to develop the psychomotor and human factor qualities and improved practitioner evaluation and monitoring, along with introducing modern equipment and techniques, such as video laryngoscopy may increase patient care further (3, 38, 176, 213, 220, 233).
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## Glossary

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<tr>
<th>Acronym</th>
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<td>ALS</td>
<td>Advanced life support</td>
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<td>BETS</td>
<td>Best evidence topics</td>
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<td>Basic life support</td>
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<td>BVM</td>
<td>Bag valve mask resuscitator</td>
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<td>CAA</td>
<td>Council of Ambulance Authorities</td>
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<td>Cricothyroidotomy</td>
<td>Insertion of a needle or tube into the trachea through the cricothyroid membrane</td>
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<td>CSP</td>
<td>Clinical Support Paramedic</td>
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<td>EMS</td>
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<td>EPIC</td>
<td>Evidence-based practice confidence</td>
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<td>Endotracheal intubation</td>
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<td>IHCD</td>
<td>Institute of Health Care and Development</td>
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<tr>
<td>Intubation</td>
<td>Insertion of a tube into the trachea</td>
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<td>London Ambulance Service</td>
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<td>LMA</td>
<td>Laryngeal mask airway</td>
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<td>NVivo qualitative data analysis software</td>
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<td>RSI</td>
<td>Rapid sequence intubation</td>
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<td>Abbreviation</td>
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<td>SJA</td>
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Appendices
Appendix 1: Ethics approvals
6 January 2014

Professor Sandra Carr
Associate Dean (Teaching and Learning)
University of Western Australia
Faculty of Medicine, Dentistry and Health Sciences
(M515) 35 Stirling Highway
CRAWLEY WA 6009

Dear Professor Carr,

RE: Application to Conduct Research within St John Ambulance WA

Further to your application regarding research project "Advanced Airway Management Training for Paramedics: Does current practice ensure sufficient levels of clinical experience and knowledge?" this has been reviewed by our Research Advisory Group and I am pleased to advise your application has been approved subject to clarification of the following points:

- Please advise if the study will focus on all attempted intubations or only "successful" procedures;
- Please clarify whether the study will examine the use of ETT only or whether you will also be exploring advanced airway management procedures;
- Please note that St John Ambulance WA does not support the provision of individual contact details of paramedics who have undertaken intubations and / or advanced airway management procedures. However we are happy to support internet promotion of the research project and publicize contact details of the involved research contacts for paramedics to voluntarily contact and participate in the study. Please contact Clinical Governance Executive Manager Dean Drink to assist facilitate this process.

Once again, don’t hesitate to contact us should any details of the project change or further assistance be required.

Yours sincerely,

PROF. IAN JACOBS
DIRECTOR CLINICAL SERVICES

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Our Ref: RA/4/1/6403  
26 August 2014

Professor Sandra Carr  
Faculty of Medicine, Dentistry and Health Sciences  
MBDP: M501

Dear Professor Carr

HUMAN RESEARCH ETHICS OFFICE – AMENDMENT REQUEST APPROVED

*Advanced airway management training for paramedics: Does current practice ensure sufficient levels of clinical experience and knowledge?*

**Student(s): Gary Wilson**

I confirm receipt of your correspondence requesting an amendment to the protocol for the above project. Approval has been granted for the amendment as outlined in your correspondence and attachments (if any) subject to any conditions listed below.

The following is a brief description of the amendment and any conditions that apply:

1. Updated Participant Information Form.
2. Imbution Questionnaire.

If you have any queries, please contact the HEO at humanethics@uwa.edu.au

Please ensure that you quote the file reference RA/4/1/6403 and the associated project title in all future correspondence.

Yours sincerely

Dr Caixia Li  
Manager, Human Ethics
Appendix 2: Information sheet

Participant information form

You are invited to take part in this research project. This is because it has been identified that you have performed an intubation or laryngeal mask airway insertion within the last 12 months. The research project aims research is to identify whether Western Australian paramedics are receiving sufficient theoretical, practical and clinical training in advanced airway management skills to be competent and effective in their practice and identify possible improvements to current training practice. It will also provide information in relation to whether the current clinical placements provide sufficient experience for the paramedic to be competent in advanced airway management and the perspectives of these paramedics regarding effectiveness of the training received.

Participation in this research is entirely voluntary. If you decide you want to take part, you will be asked to sign the participant consent form. You are free to withdraw from the research at any time, without providing any reason or justification, without prejudice in any way. In such cases, your records will be destroyed, unless you agree that the researcher may retain and use the information obtained prior to your withdrawal. The results of this research will be used by the researcher Gary Wilson to obtain a Master’s degree in Health Professional Education.

Despite numerous research studies investigating the competency of paramedics to undertake endotracheal intubation, typically through quantitative research into intubation success rates, there has been minimal research undertaken on the training received by Western Australian paramedics. In addition, it was found after a detailed review of literature, research comparing WA with other states and countries, and including the perspective of the paramedics and their confidence in performing their skills based upon their training have not been investigated.

This study aims to identify what training opportunities are available to Western Australian paramedics during their education and clinical placements, how this compares with paramedics elsewhere in Australia and seeks to identify the paramedics’ perspectives of their experiences in preparation for efficient clinical practice. The researcher believes that this approach has the potential to make a useful contribution to identifying an appropriate paramedic training programme for advanced airway management.

The initial research tool will be a questionnaire which will include the use of open-ended and closed questions, along with numerical rating scales. Quantitative data, such as the number of days in theatre, number of LMA and endotracheal intubation attempts (successful and unsuccessful) and confidence score will be combined with qualitative group interview data to provide a more extensive picture of the effectiveness and usefulness of the different methods of teaching airway management. If you agree to participate, you will be required to complete a questionnaire designed to investigate your training experiences, knowledge and confidence levels while undertaking airway management skills. You will also be asked to describe an optimum airway management education programme along with voluntary participation in a focus group discussion and to complete a pre and post workshop questionnaire.

After completing the questionnaire you will be invited to participate in a focus group. If selected you will be notified of the subjects of discussion prior to the focus group – these will be identified following analysis of the information provided from the questionnaire and will include paramedics’ feelings and confidence in performing advanced airway skills and suggestions for improving advanced airway management training will be sought. All participants in the focus group will be invited to a short workshop on adult advanced airway techniques.

All discussions in the focus groups will be audio recorded for the use of this study only. All study records, including audio recordings and transcripts, will be stored in a secure location and will be destroyed three years after the close of the study. All electronic files containing identifiable information will be password protected with only the researcher having access to the passwords.

At the conclusion of this study, participants will not be identified in any thesis, publications or presentations.

For further information please contact the researcher Gary Wilson on Mob: 0424 588880 or via email: gary.wilson@research.uwa.edu.au

By signing the participant consent form you are notifying the researcher that you:

• understand what you have read;
• consent to take part in the research project;
• consent to be involved in the procedures described;
• consent to the use of your personal and health information as described.

Approval to conduct this research has been provided by The University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time.

In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Research Ethics Office at The University of Western Australia on (08) 6488 3703 or by emailing to: hreo-research@uwa.edu.au
Appendix 3: Consent form

Participant consent form

I (the participant) have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time without reason and without prejudice.

I understand that all identifiable (attributable) information that I provide is treated as strictly confidential and will not be released by the investigator in any form that may identify me. The only exception to this principle of confidentiality is if documents are required by law.

I have been advised as to what data is being collected, the purpose for collecting the data, and what will be done with the data upon completion of the research.

I agree that research data gathered for the study may be published provided my name or other identifying information is not used.

___________________________  __________________________
Participant                          Date

Approval to conduct this research has been provided by The University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time.

In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Research Ethics Office at The University of Western Australia on (08) 6488 3703 or by emailing to: hreo-research@uwa.edu.au
Appendix 4: Questionnaire

1. Over seas (please specify country):
   - WA
   - VIC
   - TAS
   - SA
   - NT
   - NSW
   - ACT

2. What is your age at 1st August 2013?
   - Male
   - Female

3. What is the state you are currently working in (if applied):
   - ACT

4. How many years since you undertook your initial advanced aviation management (AAM) training?
   - WA
   - VIC
   - TAS
   - SA
   - NT
   - NSW

5. What was the state or country where you received your initial AAM training:
   - ACT
6. What advanced airway techniques are you authorised to perform?  
   - Supraglottic □
   - Endotracheal intubation (ETI) □
   - Rapid sequence induction (RSI) □
   - Needle cricothyroidotomy □
   - Surgical cricothyroidotomy □

7. How many Laryngeal mask airways (LMAs) did you successfully insert in the last 12 months?

8. How many intubations did you successfully perform in the last 12 months?

9. What is your perceived success rate of intubation during the last 12 months:
   - < 50% □
   - 51 – 60% □
   - 61 – 70% □
   - 71 – 80% □
   - 81 – 90% □
   - 91 – 100% □

Initial advanced airway management programme

10. What was the length of initial advanced airway management course (in days)?

11. Did you undertake a hospital clinical placement?  
    - Yes □
    - No □ (go to question 15)

12. If yes, how many days was the placement?

13. What was the number of successful LMA insertions on placement?

14. What was the number of successful intubations on placement?
### Table: Equipment Used

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Miller laryngoscope blades</td>
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<tr>
<td>Gum Elastic Boagie</td>
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<tr>
<td>Stethoscope</td>
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<tr>
<td>Commercial ET holder</td>
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<tr>
<td>Video laryngoscope</td>
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<tr>
<td>I-gel supraglottic airway</td>
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<tr>
<td>Combitube supraglottic device</td>
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<tr>
<td>Weed medical cricotomy</td>
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<tr>
<td>Commercial cricothyroidotomy kit</td>
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</tbody>
</table>

*Please list any equipment not detailed in the table.*
18. Did your initial advanced airway management programme involving the following topics or teaching methods?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway anatomy</td>
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<tr>
<td>Positioning of the patient</td>
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<tr>
<td>Selecting the most appropriate advanced airway</td>
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<tr>
<td>BURP</td>
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<tr>
<td>Airway management simulations: Low fidelity</td>
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<tr>
<td>Identifying airway management problems</td>
<td></td>
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<tr>
<td>Identifying ventilation management difficulties</td>
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<tr>
<td>Direct intubation</td>
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<td></td>
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<tr>
<td>Retrograde intubation</td>
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<tr>
<td>Optical laryngoscopy</td>
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<tr>
<td>Rapid sequence induction (RSI)</td>
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<tr>
<td>Needle cricothyroidotomy</td>
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<tr>
<td>Percutaneous transtracheal jet ventilation</td>
<td></td>
<td></td>
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<tr>
<td>Airway physiology</td>
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<td></td>
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<tr>
<td>Indications for advanced airway management</td>
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<tr>
<td>Cricoid pressure</td>
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<tr>
<td>Practical skills on clinical task trainers/manikins</td>
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<tr>
<td>Airway management simulations: High fidelity*</td>
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<tr>
<td>Case study discussion</td>
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<tr>
<td>Management of a failed airway procedure</td>
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<tr>
<td>Nasopharyngeal intubation</td>
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<tr>
<td>Video laryngoscopy</td>
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<tr>
<td>Digital intubation</td>
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<tr>
<td>Nasogastric tube</td>
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<tr>
<td>Surgical cricothyroidotomy</td>
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<tr>
<td>Clinical placements in hospital operating rooms</td>
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</tbody>
</table>

*Definition: High fidelity manikins are extremely realistic manikins that respond to treatment and have recording properties.
19. What do you believe are the ten most important topics or learning methods (please number 1 to 10) which should be included in an airway management programme?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway anatomy</td>
<td>Airway physiology</td>
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<tr>
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<td>Indications for advanced airway management</td>
</tr>
<tr>
<td>Selecting the most appropriate advanced airway</td>
<td>Cricoid pressure</td>
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<tr>
<td>BURP</td>
<td>Practical skills on clinical task trainers/manikins</td>
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<tr>
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<td>Airway management simulations: High fidelity*</td>
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<td>Identifying airway management problems</td>
<td>Case study discussion</td>
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<td>Identifying ventilation management difficulties</td>
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<td>Retrograde intubation</td>
<td>Video laryngoscopy</td>
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<tr>
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<td>Nasogastric tube</td>
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<tr>
<td>Needle cricothyroidotomy</td>
<td>Surgical cricothyroidotomy</td>
</tr>
<tr>
<td>Percutaneous transtracheal jet ventilation</td>
<td>Clinical placements in hospital operating rooms</td>
</tr>
</tbody>
</table>
20. Reflecting on your advanced airway experiences since qualifying, are there any subjects/methods you feel would have been beneficial on your initial advanced airway management course?

21. What do you believe is the most beneficial method of initial instruction for airway management competency (not consolidation of learning)?
   - Lectures only
   - Mix of practical and lecture
   - Pre-reading and practical
   - Practical only
   - Other (please describe)

22. How frequently do you believe an airway management refresher course should be undertaken to remain competent?
   - Twice a year
   - Once per year
   - Every two years
   - Every three years

23. What do you believe is the minimum number of successful intubations/LMA insertions a year is necessary to maintain competency?

24. If this minimum number of successful intubations is not achieved, what learning methods do you believe should be used to ensure competence?
   - Practical workshop with task trainer
   - Case study simulations
   - Skills assessment with manikins
   - Hospital-based clinical placement
   - Other (please describe)
Confidence

For each of the following activities, please indicate how confident you are in your current level of ability by choosing the corresponding number on the following rating scale:

<table>
<thead>
<tr>
<th>Activity</th>
<th>0 %</th>
<th>10 %</th>
<th>20 %</th>
<th>30 %</th>
<th>40 %</th>
<th>50 %</th>
<th>60 %</th>
<th>70 %</th>
<th>80 %</th>
<th>90 %</th>
<th>100 %</th>
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</thead>
<tbody>
<tr>
<td>25. Prepare the required equipment for supraglottic airway device insertion</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
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<tr>
<td>26. Prepare the required equipment for intubation</td>
<td>☐</td>
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<tr>
<td>27. Select the appropriately sized intubation equipment, including endotracheal tube</td>
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<td>28. Prepare the equipment for a failed airway procedure</td>
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<tr>
<td>29. Identify potential airway difficulties before undertaking advanced airway procedures</td>
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<tr>
<td>30. Select the most appropriate advanced airway technique for the patient and situation</td>
<td>☐</td>
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<tr>
<td>31. Correctly identify the correct size supraglottic airway device and correctly insert</td>
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<tr>
<td>32. Visualise the cords with your intubation technique</td>
<td>☐</td>
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### How confident are you in your ability to:

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<tbody>
<tr>
<td>33. Pass the endotracheal tube through the cords within 20 seconds</td>
<td>0%</td>
<td>10%</td>
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<tr>
<td>34. Secure the endotracheal tube</td>
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<td>90%</td>
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<tr>
<td>35. Prepare and perform RSI (Rapid sequence induction)</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
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<tr>
<td>36. Monitor tube placement, ventilate and detect possible displacement</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
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<tr>
<td>37. Exsuscitate the patient</td>
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<tr>
<td>38. Locate the landmarks for cricothyroidotomy</td>
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<td>39. Perform and manage a needle cricothyroidotomy</td>
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<tr>
<td>40. Perform and manage a surgical cricothyroidotomy</td>
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</table>

41. Would you be willing to participate in a focus group on airway management training?   Yes / No

If yes, please provide your e-mail address:
Appendix 5: Postcard

Performed an advanced airway technique in the last year?

If yes, you can now participate in a research project investigating paramedic training in advanced airway management and help to develop a new training programme.

Australian pre-hospital care providers who have undertaken intubation or LMA insertion in the last 12 months are invited to complete a questionnaire investigating training content, experience and confidence levels when undertaking airway management techniques for the research study.

The study, undertaken by Gary Wilson for his Masters in Health Professional Education degree, will suggest possible improvements to current advanced airway management training programmes to ensure they meet the need of paramedics.

The questionnaire can be completed online (via the below address) or by a traditional paper version. To receive a copy of the paper questionnaire email Gary via aamI@prehospitalresearchforum.net.au

www.prehospitalresearchforum.net.au/paramedicairway.html
Appendix 6: Focus group questions

- Tell me your thoughts and experiences on airway management?
- What airway management techniques do you believe should be part of the paramedic skill set? And why?
- What are your views on training programmes which require a minimum requirements, for example number of intubations in theatres, before student paramedics are authorised to practice under supervision?
- Do you think that simulations can provide an effective alternative to a clinical placement? If so, how? What do you believe will increase the effectiveness of simulations?
- What are your views on clinical placements?
- How have your feelings and confidence changed, when performing endotracheal intubation on a patient in the pre-hospital environment, since you completed your initial airway management training?
- What teaching methods do you believe are the most and least effective in providing the knowledge and experience to be competent in intubation? Tell me about your experiences with:
  - Lectures on anatomy and physiology;
  - Discussions on airway management case studies;
  - Video/ multimedia of actual airway techniques;
  - Skill stations/ manikin practice in a classroom environment; and
  - Simulations in realistic environments resembling situations commonly encountered by paramedics.
- What are your thoughts on skills maintenance with regard to ensuring paramedic competent in advanced airway management techniques?
- If you had to create a training programme to teach intubation what would be included?
Appendix 7: Order of intubation quiz

Number the list in order of procedure

_____ Auscultate stomach and lungs to confirm equal air entry.
_____ Advance the blade by placing the tip into the vallecula, identify epiglottis.
_____ Note and record the distance of the tube at the teeth.
_____ Ventilate and visualise chest rise and fall equally.
_____ Insert the blade into the patient’s mouth, sweeping the tongue to the left.
_____ Lift the laryngoscope in the direction of the handle.
_____ Attach a 10mL syringe and inflate the cuff.
_____ Slowly insert the ETT between the vocal cords under direct vision.
_____ Pre-oxygenate the patient.
_____ Connect End-tidal CO₂ detector and observe for a waveform on monitor.
_____ Using either linen or adhesive tape secure the ETT in position.
_____ Ensure airway is clear.
_____ Hold the laryngoscope with the left hand.
_____ Stabilise the head and neck.
_____ Place a bite block in situ.
_____ Remove the stylet.
_____ Place patient’s head in a neutral position.
_____ Remove the laryngoscope.
_____ Identify the arytenoid cartilage and vocal cords.
_____ Insert the ETT from the right of the patient’s mouth.
Appendix 8: Concept map
Appendix 9: Curriculum framework

The aim of the curriculum is to provide guidance on the learning, teaching and assessment requirements for paramedics to achieve the required knowledge, skills and competency standards to be safe and effective when performing adult airway management.

While this curriculum follows a contemporary health curriculum design, in that it focuses primarily competency achievement, the education system has to be able to deliver paramedics who are competent in the basic, core skills before a dynamic, multi-dimensional and integrated curriculum which connects the curriculum to the broader political, social and economic issues associated with the paramedic profession and its complexities. While the curriculum describes the cognitive, psychomotor and behavioural areas that should be taught, it will need to be developed further by the educators to describe how it is to be delivered, assessed, maintained and evaluated (220, 234).
### 1.0 Cognitive

**Subject**

*By the end of the training, the student will be able to:*

<table>
<thead>
<tr>
<th>Learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description of knowledge</strong></td>
</tr>
<tr>
<td>1.1</td>
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### 2.0 Psychomotor

**Subject**

*By the end of the training, the trainee will be able to:*

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### 3.0 Affective

**Subject**

*By the end of the training, the trainee will be able to:*

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Appendix 10: Adult airway management clinical decision making algorithm


Appendix 11: Adult intubation checklist

While it can be difficult to correctly recall a list of procedure steps within the classroom environment the likelihood is reduced in stressful situations, especially if the practitioner is under pressure and fatigued. To minimise the risk of memory reliance, some organisations have turned to checklists to ensure that nothing is missed. Strategies to improve intubation quality assurance have used various education strategies, including simulation-based training with computerised patient simulation and basic crew resource management with a combined team approach and a comprehensive checklist (232).

A checklist has been developed for the pre-hospital environment which details the planning stages to be considered when considering intubation, including crew resource management and contingency planning.
## INTUBATION CHECKLIST

### PREPARE PATIENT
- Pre-oxygenation optimal?
  - add nasal prongs or NIV
- Patient assessment
  - allergies/ sensitivities
  - medications
  - previous medical Hx
  - last meal/ drink
- Patient position optimal?
  - ear canal in horizontal line with sternal angle
- Patient haemodynamics optimal?
  - can patient’s condition be improved before intubation?
- Airway assessment
  - facial/ head trauma
  - neck size/ mobility
collar
  - mouth opening
dentition
  - jaw protrusion
  - tongue size
  - oedema/ masses
  - kyphosis
- Is intubation still the most appropriate management technique with the available resources?

### PREPARE EQUIPMENT
- Suction working?
  - back-up suction available
- Airway adjuncts
  - OP and NP airways
- BVM/ ventilator connected to sufficient oxygen
- Working laryngoscope with appropriate blade length?
- Appropriate means of securing tube?
- Endotracheal tube selected (2 sizes) and cuff tested?
- Catheter mount, syringe, stethoscope, stylet or bougie?
- LMA staked and available?
- Surgical airway equipment
- Patient monitoring applied
  - ECG
  - blood pressure
  - SpO2 probe
  - capnography
- Drugs selected, doses calculated, drawn up, checked & labelled

### PREPARE TEAM
- Identified?
  - team leader
  - first intubator
  - second intubator
  - external laryngos/ cricoid manipulator
  - drug administrator
- Personnel
  - introduced by name and role
  - briefed in turn by team leader
- Difficult intubation plan described
- Anticipated problems discussed
  - anyone on the team have any questions or concerns?
- How to contact further help if required?
  - Senior clinician
  - No xxxxx
  - Medical oversight
  - No xxxxx

### PREPARE FOR DIFFICULTY
- Is intubation still the most appropriate management technique with the available resources?
- Are there any specific complications anticipated?
- If the intubation is difficult, how will oxygenation be maintained?
  - Plan A:
  - Plan B:
  - Plan C:
  - Plan D:
- Failed intubation equipment (LMA & surgical airway) prepared

### PREPARE FOR TRANSPORT
- Placement confirmation?
  - visualisation of tube passing through cords
  - fogging of tube
  - auscultation
  - chest rise
capnography
- Tube length at teeth/ gums
  - ______ cm
- Airway/ tube secure
  - suction required?
  - NG tube insertion?
- Breathing
  - adult: 5-7 ml/ Kg
  - rate appropriate
  - ETCO2: ______ mm Hg
  - SpO2: ______ %
  - ventilator available?
- Circulation
  - Heart rate: ______
  - BP: ______/______
  - fluid & drugs required?
  - 12-lead ECG?
  - additional venous access?
- Disability
  - Adequate sedation
  - Patient positioning
- Exposure/ evaluate
  - thermoregulation
  - temperature ______°C