Endotracheal intubation exposure obtained by Emergency Care students in Cape Town during work-integrated learning

By

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DECLARATION

I, **Daglin Donovan Thomas**, declare that the contents of this thesis/dissertation represent my own unaided work, and that the thesis/dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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ABSTRACT

BACKGROUND: Endotracheal intubation (ETI) is a critical, life-saving procedure in emergency medical care, requiring a combination of technical proficiency and the ability to manage cognitive load in stressful circumstances. Despite its importance, the training and clinical exposure necessary to achieve ETI competency vary between individual students, particularly in prehospital and emergency settings. In South Africa, Emergency Care Practitioner (ECP) students undergo Work Integrated Learning (WIL) placements to acquire the necessary knowledge, skills, and attributes for ETI. However, the variability in exposure to diverse clinical contexts and patients may impact the adequacy of graduate preparation for independent practice. This study examines ETI exposure among ECP students in Cape Town, Western Cape, South Africa, focusing on the frequency, diversity, and clinical characteristics of ECP student ETI exposures during WIL.

METHODOLOGY: A retrospective, quantitative, cross-sectional study design was used to analyse clinical data from the FISDAP™ database, capturing ETI experiences of ECP students during WIL placements from 2012 to 2016. Although the dataset reflects historical clinical practices, it remains valuable for understanding foundational airway management training trends during a period of curriculum stability. Key variables assessed included the number of ETI procedures performed or observed, success rates, patient characteristics, and exposure to advanced airway interventions, such as Rapid Sequence Intubation (RSI). Statistical analyses were performed using SPSS Version 29, with descriptive and inferential tests (Chi-Square, Fisher's Exact, Z-tests, and t-tests) used to explore relationships between variables.

FINDINGS: Analysis of 850 ETI events revealed variation in student exposure by setting, showing limited exposure to prehospital ETI. Intubations were most frequently performed in operating rooms (30.6%), followed by emergency centres (16.9%), prehospital settings (15.2%), and simulation laboratories (37.2%). In the prehospital clinical setting, students recorded a limited degree of individual exposure (range: 2 to 15). RSI exposure accounted for 21.4% of clinical ETI events. Students with greater overall exposure, including skills laboratory procedures (>60 intubations), achieved first-attempt success rates exceeding 88%.

CONCLUSION: The study highlights limited clinical exposure, particularly in the prehospital setting and in the diversity of patients. The study also highlights the role played by simulated ETI exposure to expand learning opportunities and focus on particular patient subgroups less frequently observed in the clinical setting. Strengthening preceptor support and structuring post-graduation internships are recommended to improve readiness for independent airway management. These findings contribute new, context-specific evidence to the body of knowledge on emergency medical education and suggest pathways for refining ECP airway management training strategies in South Africa.

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DEFINITION OF TERMS AND/OR ABBREVIATIONS

Acute Respiratory Distress Syndrome (ARDS): A severe lung condition characterised by widespread inflammation, fluid buildup in the lungs, and difficulty breathing, often caused by trauma, infections, or other severe health issues.

Airway Anatomy Classification:

- **Adolescent/Adult Airway Anatomy:**
  For the purpose of this study, *adolescent/adult airway* anatomy is defined as the airway anatomy of patients older who are 9 years and older, where developmental convergence of airway structures, such as laryngeal position and epiglottic morphology, permits the safe and effective application of adult airway management techniques, equipment, and procedural strategies (Santillanes & Gausche-Hill, 2008; Wilton & Hack, 2021).
- **Child/Paediatric Airway Anatomy:**
  For the purposes of this study, *child/paediatric airway anatomy* is defined as the airway anatomy of patients aged 8 years and younger, characterised by distinct features such as a proportionally larger tongue, more cephalad laryngeal position, and an omega-shaped epiglottis, which collectively require paediatric-specific airway management approaches (Santillanes & Gausche-Hill, 2008; Wilton & Hack, 2021).

This classification is adopted for the purposes of airway management within this study. It reflects the anatomical and procedural differences rather than legal, psychosocial, or broader healthcare-related definitions of childhood, adolescence, and adulthood. By anchoring the classification to structural airway development, this framework provides a clinically meaningful basis for analysing endotracheal intubation exposures amongst students and opportunities for learning as pertaining to the difference in approach and psychomotor skill development as related to differing techniques in these patients.

Amyotrophic lateral sclerosis (ALS): A progressive neurodegenerative disease that affects nerve cells in the brain and spinal cord, leading to muscle weakness, loss of motor control, and eventual paralysis.

Bag Valve Mask (BVM): A medical apparatus used to provide positive pressure ventilation to individuals who are not breathing or not breathing adequately. It consists of a self-expanding bag, a unidirectional valve, and a facial mask to deliver air or oxygen into the patient's lungs.

Confidence Interval (CI): A range of values, derived from sample data, that is likely to contain the true value of an unknown population parameter.

Chronic Obstructive Pulmonary Disease (COPD): is a progressive lung condition caused by damage to the airways or other parts of the lungs. This damage leads to inflammation and obstruction of airflow, making it difficult to breathe. COPD is typically caused by long-term exposure to harmful substances, such as smoking. Common symptoms include shortness of breath, coughing, and wheezing (abnormal breathing sounds) (National Heart, Lung, and Blood Institute (NHLBI), 2022. *Chronic Obstructive Pulmonary Disease (COPD)).*

Cerebrovascular Accident (CVA): A medical condition commonly known as a stroke, which occurs when blood flow to a part of the brain is interrupted, leading to brain cell damage. It can result in various neurological impairments depending on the area affected (National Institute of Neurological Disorders and Stroke, 2023).

Drug Facilitated Intubation (DFI) also Drug Assisted Intubation (DAI): intubation commonly involves the use of pharmacological agents in the prehospital setting, including sedatives like ketamine, midazolam, and etomidate, as well as neuromuscular blocking agents such as rocuronium and succinylcholine (Jarvis et al., 2022).

Difficult Airways: A difficult airway is a clinical situation in which a healthcare provider skilled in airway management encounters difficulty with one or more standard methods, such as facemask ventilation of the upper airway, tracheal intubation, or both (Kollmeier et al., 2023).

Delayed Sequence Intubation (DSI): A method of airway management in which induction agents are used to facilitate preoxygenation in agitated or uncooperative patients, prior to securing the airway through rapid sequence intubation (RSI) (Weingart et al., 2015).

Emergency Care (EC): The immediate medical response to acute illnesses or injuries requiring urgent intervention to prevent serious harm or death.

Emergency Care Practitioner (ECP): An individual with a Bachelor's degree in Emergency Medical Care who is registered on the Emergency Care Practitioner roll of the Health Professions Council of South Africa.

Emergency Care Practitioner Student (ECPS): A person enrolled in a 4-year Bachelor's degree in Emergency Medical Care and registered on the Emergency Care Practitioner Students (ECPS) roll of the Health Professions Council of South Africa.

Emergency Department (ED): A medical facility or unit within a hospital that provides immediate treatment to patients with urgent and life-threatening conditions. It operates 24/7 to handle emergencies, including trauma, heart attacks, strokes, and other critical health issues.

Emergency Medical Services (EMS): A network of medical professionals and systems designed to provide emergency care and transport to individuals experiencing medical emergencies.

Emergency Medical Technician (EMT): A healthcare professional trained to provide emergency medical care and transportation to individuals experiencing medical emergencies or trauma. They assess patients, administer basic treatments, and transport them to medical facilities.

Endotracheal Intubation (ETI) (also often referred to as simply Intubation): the procedure involves insertion of a flexible plastic tube, either cuffed or uncuffed, through the mouth and into the trachea (Fevang et al., 2017). This commonly performed invasive procedure is carried out by healthcare providers, including Emergency Care Providers (ECPs), Emergency Medicine physicians, or Anaesthesiologists, to establish a secure airway and provide ventilation for patients experiencing respiratory distress or arrest (Miller et al., 2020).

Field Internship Student Data Acquisition Project™ (FISDAP): is a program designed to collect, analyse, and manage data from students participating in field internships, particularly in healthcare and emergency medical services, to enhance learning and improve real-world experience.

Front of Neck Access (FONA): An emergency airway management technique used when conventional methods like intubation or ventilation fail. It involves creating a surgical or percutaneous airway through the front of the neck to secure oxygen delivery.

Glasgow Coma Scale (GCS): A clinical tool used to assess a patient's level of consciousness, particularly after a head injury or in cases of altered mental status. It evaluates three keys: Eye Opening, Verbal Response, and Motor Response.

Health Professions Council of South Africa (HPCSA): A regulatory body responsible for overseeing the registration, regulation, and professional conduct of healthcare practitioners in South Africa.

Health Professions Council of South Africa – Professional Board for Emergency Care (HPCSA PBEC): A governing body that oversees the regulation, professional conduct, and ethical standards of emergency care practitioners in South Africa. For Emergency Care Practitioners (ECPs) and students (ECPS), the HPCSA ensures they meet the required standards, adhere to ethical guidelines, and maintain professional competence to deliver safe and effective emergency care.

In high-income countries (HICs): nations with a high level of economic development are generally characterised by a high Gross National Income (GNI) per capita.

Intensive Care Unit (ICU): A specialised department in a hospital designed to provide comprehensive care and continuous monitoring for critically ill or medically unstable patients. Patients in the ICU typically require advanced medical support and close supervision due to life-threatening conditions, severe injuries, or complications from surgery or illness.

Inter-Group Quantifier (IGQ): A statistical measure used to evaluate and compare differences or relationships between two or more groups within a dataset. It is often applied in analyses involving group-level variables, such as mean differences, variance comparisons, or correlation assessments across distinct categories.

Laryngeal Mask Airway (LMA): A device for maintaining a patent airway, consisting of a tube connected to an oval inflatable mask that seals the larynx.

Low- and middle-income countries (LMICs): are countries that are not classified as high-income economies by the World Bank.

National Association of Emergency Medical Services Physicians (NAEMSP): It is a professional organization that supports and advocates for EMS physicians and the advancement of emergency medical services through education, research, and policy development.

Odds Ratio (OR): It is a measure of association between two events, used to compare the odds of an event occurring in one group relative to another group. It is commonly used in case-control studies.

Oxygen saturation or SpO_2: A measurement of the percentage of oxygen-carrying haemoglobin in the blood. It's a non-invasive measurement obtained by using a pulse oximeter.

PETI: The insertion of an airway tube most commonly through the mouth into the trachea outside the hospital setting.

Rapid Sequence Intubation (RSI): RSI is a combination of pre-oxygenation with the administration of a potent induction agent (sedative) followed by a neuromuscular blocking agent in rapid succession to induce unconsciousness and optimize conditions for efficient ETT placement in critically ill or injured patients while limiting the risk of patient harm (Walls & Murphy, 2012).

Research Ethics Committee (REC): A group of individuals responsible for reviewing and approving research studies to ensure they adhere to ethical standards, protecting the rights, safety, and well-being of participants.

Return of Spontaneous Circulation (ROSC): It refers to the restoration of a normal heart rhythm and blood circulation after a cardiac arrest, typically achieved through interventions like CPR or defibrillation.

Simulation-Based Training (SBT): A training method that uses simulated environments or scenarios to help individuals practice skills and decision-making without real-world risks or resources. It is commonly used in fields like aviation, healthcare, and military training.

SPSS Version 29: is a statistical analysis software designed for data management and advanced analytics. It provides tools for statistical analysis, data visualization, and predictive modeling, offering a user-friendly interface for both novice and advanced users in fields like research, social sciences, and business.

Standard Deviation (SD): It is a measure of the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates that the values are spread out over a wider range.

Sub-Saharan Africa (SSA): is the area and regions of the continent of Africa that lie south of the Sahara. These include Central Africa, East Africa, and Southern Africa.

Supraglottic Extra-glottic Airway Devices: These devices are designed to provide ventilation by sitting above the glottis, without the need for tracheal insertion. While they do not "secure" the airway in the same manner as endotracheal tubes, they effectively establish a seal around the glottic opening, facilitating oxygenation and ventilation. An example of such a device is the Laryngeal Mask Airway (LMA) (Miller et al., 2015). Example: Laryngeal Mask Airway (LMA) and Combitubes.

Systolic Blood Pressure (SBP): The pressure in the arteries when the heart beats and pumps blood. It is the higher number in a blood pressure reading.

Traumatic Brain Injury (TBI): An injury to the brain caused by an external force, such as a blow to the head, resulting in potential long-term physical, cognitive, and emotional effects.

Work-integrated Learning (WIL): An educational approach that combines academic learning with practical work experience, allowing students to apply their theoretical knowledge in real-world settings through internships, co-op programs, or industry projects.

CHAPTER I – INTRODUCTION TO THE STUDY

1.1. Introduction

Chapter one introduces the reader to the research topic by highlighting the importance of advanced airway management in prehospital emergency care (EC) as the background to the problem. It outlines the challenges of applying these into teaching and learning strategies and curriculum development to achieve the desired levels of airway management skill acquisition to enable graduate preparation for independent clinical practice. The research purpose, the main research question, and the objectives are presented.

1.2. Background of the Research Problem

Globally, effective airway management is a cornerstone of emergency medical care, with endotracheal intubation (ETI) recognised as a critical intervention in the resuscitation and stabilisation of critically ill or injured patients (Fevang et al., 2011; Weingart & Levitan, 2012). In high-income countries (HICs), the success of ETI in the prehospital environment is supported by mature emergency medical systems, well-established training programmes, and robust systems of supervision and clinical governance (Lockey et al., 2014; Warner et al., 2010). These factors make it possible for emergency care providers, including non-physician clinicians, to safely and competently perform advanced airway procedures.

In contrast, low- and middle-income countries (LMICs), particularly those in sub-Saharan Africa (SSA), frequently encounter systemic challenges such as inadequate infrastructure, inconsistent access to high-fidelity simulation training, and limited exposure to high-acuity cases (Wylie et al., 2019; Sobuwa et al., 2013). The differences between curriculum design, which is typically aligned with international standards, and the actual clinical preparedness of healthcare providers create a significant gap. Research has shown that the effectiveness and safety of endotracheal intubation (ETI) in low- and middle-income countries (LMICs) are closely linked to the quality, quantity, and consistency of clinical exposure during training (Wylie et al., 2019; Sobuwa et al., 2013).

South Africa, classified as an upper-middle-income country in Sub-Saharan Africa, presents a unique situation regarding its emergency care system. This system includes a registered group of Emergency Care Practitioners (ECPs) who are trained to perform advanced airway procedures, such as drug-facilitated endotracheal intubation techniques, including rapid sequence intubation (RSI) (Stein, 2017; Jarvis et al., 2022). According to the Health

Professions Council of South Africa (HPCSA), ECP students are required to perform a minimum of 30 ETIs, of which 20 must be RSIs, during their Work-Integrated Learning (WIL) placements in order to qualify for registration (HPCSA, 2016). However, emerging evidence indicates significant variability in the circumstances and settings in which these procedures are carried out, potentially hindering skill acquisition and affecting the clinical readiness of graduates (Wylie et al., 2022).

Despite these mandatory targets, there is insufficient evidence regarding whether Emergency Care Paramedic (ECP) students in South Africa receive adequate real-world exposure to diverse and high-risk airway management scenarios during their training. Research indicates that many endotracheal intubations (ETIs) are conducted in low-acuity settings, such as operating theatres or simulation labs. This limited exposure may not adequately prepare students for the dynamic challenges encountered in prehospital environments (Weinstein et al., 2019; Buis et al., 2016). In prehospital settings, ETI is performed in uncontrolled environments and often under significant time constraints. Additional complications may include difficult patient access, poor lighting, and limited resources (Bischof et al., 2016). In these situations, success is not solely based on technical skills; it also relies on rapid clinical decision-making and psychological resilience (Lockey et al., 2014; Wang et al., 2005).

The nature of drug-facilitated intubation significantly increases the associated risks. Rapid Sequence Intubation (RSI) and Delayed Sequence Intubation (DSI) demand detailed pharmacological knowledge, quick judgment, and precise execution (Jarvis et al., 2022; Botha et al., 2021). There are concerns that novice practitioners may struggle to perform these procedures safely and effectively once qualified, especially if they lack sufficient hands-on experience during their training. While simulation-based training is commonly used to bridge this gap, manikins cannot fully replicate the complexity or emotional intensity of real-life field conditions (Carlson & Wang, 2017).

There is a clear and pressing gap in the current evidence base regarding the real-world clinical exposure of South African Emergency Care Practitioner (ECP) students to endotracheal intubation (ETI), particularly within the prehospital environment, where conditions are unpredictable and the stakes are high. While regulatory frameworks may set minimum procedural requirements, these do not account for the variability in case complexity, patient characteristics, or clinical settings that students encounter during Work-Integrated Learning. This lack of detail limits educators, regulators, and clinical mentors in their ability to accurately assess students' readiness for independent practice. Additionally, the increasing complexity of drug-assisted airway management techniques requires a higher level of competence than ever before. This highlights the need for a deeper understanding of students' experiential learning during their training. To address this, we must closely examine endotracheal intubation, including its purpose, technical demands, and its role in emergency medical care.

1.2.1 Endotracheal intubation

Endotracheal intubation (ETI) is a critical procedure used in advanced airway management and is widely recognised as the definitive method for securing an airway in critically ill or injured patients (Bielski et al., 2019a; Gunning et al., 2013). This procedure involves the placement of a flexible endotracheal tube (ETT) into the trachea through the oral or nasal passage to facilitate ventilation and prevent aspiration. ETI is employed in both emergency and anaesthetic settings and serves as a foundational element of life support interventions (Miller et al., 2020; Fevang et al., 2017).

The clinical indications for ETI are categorized into three main areas: (1) inability to maintain a patent airway, which may occur in cases of upper airway obstruction due to trauma, foreign bodies, or epiglottitis; (2) inability to adequately oxygenate or ventilate, as seen in patients with acute respiratory failure due to chronic obstructive pulmonary disease (COPD), acute respiratory distress syndrome (ARDS), or severe asthma; and (3) anticipated clinical deterioration, such as in patients with reduced levels of consciousness, sepsis, or traumatic brain injury (Thomas & Moss, 2017; Scala & Pisani, 2018; Higgs et al., 2018). In these situations, ETI can be a life-saving intervention and is endorsed by various emergency and critical care societies as the gold standard for airway management (Gunning et al., 2013; Fevang et al., 2017).

ETI is a technically demanding skill that requires a thorough understanding of airway anatomy, familiarity with the needed equipment, and proficiency in patient assessment. Accurate assessment, timely decision-making, and precise execution are crucial to avoid complications such as aspiration, hypoxia, or cardiac arrest (Steuerwald et al., 2018; Burgess et al., 2018). Complications can arise from factors such as improper tube placement, prolonged intubation attempts, or inadequate preparation for difficult airways (Griesdale et al., 2008; Panchal & Raza, 2017).

The success of ETI relies not only on technical proficiency but also on clinical readiness. This includes assessing the airway, anticipating potential complications, and preparing backup strategies (Murphy & Laffey, 2007; Panchal & Raza, 2017). These considerations are particularly important in prehospital care, where providers often operate in poorly lit, physically constrained, and high-stress environments.

Consequently, regular practice, training, and competency assessments are essential for successful ETI performance in both hospital and prehospital settings (Murphy & Laffey, 2007; Benger et al., 2009). Therefore, ETI should be regarded not merely as a skill but as a comprehensive clinical intervention that demands system-level support, decision-making frameworks, and ongoing education.

1.2.2 Endotracheal intubation in the prehospital setting

The prehospital environment is characterised by uncontrolled and often chaotic conditions, making airway management inherently complex and high-risk (Kheterpal et al., 2016). Unlike procedures performed in hospitals, which take place in controlled settings, endotracheal intubation (ETI) in the field is often conducted by non-anaesthesiologists and under challenging circumstances such as limited lighting, space constraints, and minimal equipment (Caruana et al., 2015; Bischof et al., 2016). These environmental factors, along with the varying levels of practitioner experience, significantly contribute to the differences in outcomes.

Controversy remains surrounding the routine use of Endotracheal Intubation (ETI) in prehospital settings, particularly regarding its effectiveness when performed by non-anaesthesiologist providers. Early studies indicated that patients intubated outside of hospital settings had increased mortality rates (Wang et al., 2005), leading to debates about whether prehospital ETI improves or worsens patient outcomes.

Global literature from high-income countries (HICs) supports the use of advanced airway management techniques, including ETI and drug-facilitated intubation, which have been associated with improved patient outcomes when conducted by experienced providers (Lockey et al., 2014). However, research conducted in low- and middle-income countries (LMICs), particularly in sub-Saharan Africa, such as studies by Sobuwa et al. (2013) and Wylie et al., 2019), shows that the success and safety of prehospital ETI can vary widely. This variability is influenced by factors such as the quality of training, clinical exposure, and provider confidence. While some literature criticises the widespread prehospital use of ETI due to safety and efficacy concerns (Crewdson et al., 2018), others argue that with adequate training and system oversight, ETI remains a critical intervention for time-sensitive emergencies (Fevang et al., 2011; Lockey & Lossius, 2014). In South Africa, Emergency Care Practitioners (ECPs) are trained in advanced airway competencies, including ETI and pharmacologically assisted intubation techniques. However, their level of preparedness is directly linked to both the quality and quantity of ETI experiences during training. Research by Sobuwa et al. (2013) and Wylie et al. (2019) indicates that South African ECP students encounter highly variable opportunities for hands-on airway management during Work-Integrated Learning (WIL). Additionally, the low frequency of high-acuity cases can hinder the development of their clinical competence.

Operational and geographical disparities further limit students' ability to gain substantial exposure to patients requiring airway management.
Although South African ECPs are trained to perform ETI, disparities in WIL exposure suggest that not all students graduate with equivalent clinical competence. This highlights a pressing need to better understand and monitor the nature of ETI opportunities within the clinical training environment.

1.2.2.1 Drug-facilitated intubation or Drug-assisted intubation

Drug-facilitated intubation (DFI), also known as drug-assisted intubation (DAI), involves the use of pharmacological agents to optimize conditions for endotracheal intubation (ETI). DFI primarily includes two methods: Rapid Sequence Intubation (RSI) and Delayed Sequence Intubation (DSI) (Jarvis et al., 2022).
RSI is the most commonly taught method, consisting of the administration of an induction agent (such as ketamine or etomidate) followed immediately by a neuromuscular blocking agent (like succinylcholine or rocuronium). This approach quickly induces unconsciousness and paralysis, facilitating intubation while minimizing the risk of aspiration (Stollings et al., 2014; Burgess et al., 2018). RSI is particularly valuable in emergency situations because it reduces the time between the loss of airway protection and the placement of the endotracheal tube, thereby decreasing the risk of aspiration (Lockey et al., 2014).
However, it's important to note that the procedure temporarily causes apnoea. If intubation fails or is delayed, the risk of hypoxic brain injury significantly increases (Wang, 2017). This highlights the necessity of having well-trained practitioners and thorough clinical governance.
DSI serves as an alternative method for agitated or hypoxic patients who cannot tolerate preoxygenation. This technique involves sedating the patient in a controlled manner to facilitate effective oxygenation while preserving airway reflexes until proper induction and paralysis can be safely achieved (Weingart & Levitan, 2012; Weingart et al., 2015). Although DSI can be beneficial for agitated or hypoxic patients, it requires careful clinical judgment. Inappropriate use may worsen outcomes, making it advisable for more experienced providers with advanced training in pharmacology and airway management (Waack et al., 2018).

In the South African context, the inclusion of Drug-Facilitated Intubation (DFI) in Emergency Care Practitioner (ECP) training programs has significantly expanded the scope of prehospital airway management. While this advancement enhances the capabilities of ECPs, it also places greater responsibility on training institutions to ensure that graduates are clinically competent and confident in performing these high-risk interventions.
A persistent challenge is the variability in clinical exposure to key procedures, such as Rapid Sequence Intubation (RSI) and Delayed Sequence Intubation (DSI). This variability raises

legitimate concerns about the preparedness of newly qualified practitioners (Steyn et al., 2017; Botha et al., 2021). Jarvis et al. (2022) further emphasize that the safe and effective implementation of Drug-Assisted Airway Management (DAAM) within emergency medical services (EMS) relies on evidence-based protocols, structured clinical mentorship, and continuous quality assurance mechanisms. Without these foundational supports, there is a risk of compromising patient safety and undermining the effectiveness of prehospital airway interventions (Steyn et al., 2017; Botha et al., 2021).

1.2.2.2 Prehospital ETI and Alternative airway techniques

While endotracheal intubation (ETI) is seen as the definitive airway intervention, alternative airway devices such as supraglottic airway devices (SGADs) are increasingly used in prehospital care as less invasive options. This is particularly true for patients where ETI may pose too many risks or be impractical (Benoit et al., 2015; Wang et al., 2012). SGADs are often easier to insert and can provide rapid airway control during cardiac arrest or emergency situations. However, these devices do not offer definitive protection against aspiration and may not be suitable for complex airway conditions (Bielski et al., 2019b; Nguyen et al., 2015).

Blind ETI through SGADs or transitioning from SGADs to definitive intubation can sometimes be considered, but success is dependent on the device used, the provider's experience, and the patient's condition. Research indicates that SGADs may become dislodged during transport or may lead to inadequate ventilation in some critically ill patients, making them less suitable for long-distance or prolonged care (Blair et al., 2016; Kheterpal et al., 2016).

Bag-mask ventilation (BMV), while commonly used, carries a higher risk of gastric insufflation and regurgitation, and it may not ensure adequate oxygenation in cases of severe respiratory distress (Nguyen et al., 2015).

Despite their limitations, ETI remains the preferred intervention for specific patient groups where alternative techniques fall short. However, the skill and confidence required to successfully perform ETI, especially in uncontrolled prehospital settings, underline the need for targeted education and real-world experience among emergency care provider (ECP) students. The high-risk nature of rapid sequence intubation (RSI) emphasizes the importance of not only skill acquisition, but also appropriate case selection, provider support, and systems-level oversight to ensure patient safety (Warner et al., 2010; Almeida, 2016).

Given the high-risk nature and technical demands of advanced airway interventions, such as Endotracheal Intubation (ETI) and Rapid Sequence Intubation (RSI), it is essential for Emergency Care Practitioner (ECP) students to receive sufficient, high-quality clinical training and supervision during their education. The complexity of prehospital airway management requires not only proficiency in technical skills but also sound clinical judgment, which develops through meaningful, real-world exposure.

Therefore, it's important to focus on the educational frameworks that support the development of competency, particularly the adequacy of clinical learning opportunities during Work-Integrated Learning (WIL) placements. This study aims to examine the nature, frequency, and context of ECP students' exposure to advanced airway procedures to assess the sufficiency of their training and their readiness for independent practice.

1.3. Statement of the Research Problem

The background outlined above highlights significant challenges in preparing Emergency Care Practitioner (ECP) students for competent advanced airway management in the prehospital environment, particularly concerning endotracheal intubation (ETI) and drug-facilitated techniques such as rapid sequence intubation (RSI). These procedures are recognised as critical and life-saving interventions, however, there remains a persistent gap between what is required in the curriculum and the actual clinical exposure students receive. This research addresses the specific issue of whether current work-integrated learning (WIL) experiences adequately prepare students to perform ETI safely and effectively. Specifically, it investigates the adequacy, frequency, and diversity of ETI exposure among South African ECP students and whether these experiences translate into meaningful clinical competence under real-world prehospital conditions.

In South Africa, Emergency Care Practitioners (ECPs) are the only prehospital providers authorized by the Health Professions Council of South Africa (HPCSA) to perform advanced airway procedures, including endotracheal intubation (ETI) and rapid sequence intubation (RSI) (HPCSA, 2016). Other qualification levels, such as Basic Ambulance Assistants (BAAs), Advanced Emergency Assistants (AEAs), and Emergency Care Technicians (ECTs), are limited to basic or intermediate airway techniques like bag-valve-mask ventilation or supraglottic airway devices (SGADs). Given their exclusive scope of practice, ECPs bear the responsibility of independently managing critically ill patients, making their confidence and clinical experience essential for safe and effective airway management. Due to the complexity and high-risk nature of ETI in prehospital settings, assessing ECP student preparedness cannot be generalized to the broader Emergency Medical Services (EMS) workforce.
A systematic review by Buis et al. (2016) indicates that traditional learning curves for airway procedures vary significantly in prehospital settings due to the increased variability in airway challenges. These findings are supported by Burns et al. (2016) and Lockey et al. (2014), who

reported a high frequency of difficult airways and argued that prehospital anaesthesia is inherently more challenging than its hospital-based counterparts. This highlights the importance of providing students with exposure not only to the procedures themselves but also to the range of complexities involved in real-life EMS environments.

Learning airway management techniques and developing competence in providing these techniques in the prehospital setting provides a challenge to both ECP students and educators. Advanced airway interventions require the integration of multiple cognitive and motor skills, often under intense pressure (Weinstein et al., 2019). However, attaining this level of skill demands repeated, supervised exposure to actual patients, something that remains difficult to achieve (Warner et al., 2010). While manikin-based simulation training offers foundational skills, it does not replicate the unpredictability and physiological variability of real patients. Therefore, students must be exposed to a range of clinical presentations and practice in dynamic prehospital contexts to acquire the necessary competence. To perform ETI safely in the prehospital context, various factors must be taken into account, and importantly, it requires providing trainees with diverse learning opportunities and exposure to different types of airway problems to enhance cognitive and motor skills and improve performance in advanced airway interventions.

As part of the Emergency Care Professionals' (ECPs) training, work-integrated learning (WIL) placements are designed to connect theory with practice in real-world environments (Alrazeeni et al., 2021). These placements provide emergency care students with hands-on experience, as well as opportunities for reflection and professional development. However, questions remain regarding whether these placements offer sufficient opportunities for Emergency Training Intervention (ETI) practice and whether the quality and quantity of exposure truly prepare students for competent and autonomous practice.

Traditionally, ETI competence has been evaluated using tube-pass success rates, defined as the successful placement of the endotracheal tube into the trachea (Jaber et al., 2019). However, while this technical measure serves as a foundational indicator of procedural ability, it fails to capture the broader patient-centred outcomes such as first-pass success, avoidance of complications (e.g., hypoxia, aspiration, hypotension), and decision-making under pressure. There is growing consensus that competence in ETI must be measured not just by technical performance, but by the quality of clinical judgment and outcomes achieved (Sakles et al., 2013; Aziz, 2018; Reinert et al., 2022). This is especially relevant in prehospital settings where decisions must be made quickly and with limited resources.

Several studies have shown that increased exposure to real-life ETI cases improves success rates and enhances decision-making in high-pressure environments (Cook et al., 2011; Wass et al., 2001; American Heart Association, 2015). Yet, in many EMS systems, including South

Africa's, the frequency of ETI opportunities is low. In the United States, for example, the incidence of out-of-hospital endotracheal intubation (ETI) is relatively low, with reported rates of approximately 7 to 8 intubations per 1,000 emergency medical services (EMS) calls. As a result, many EMS providers perform less than one intubation per year (Carlson et al., 2016). The national minimum training standard requires paramedic students to complete at least five ETIs prior to graduation (National Highway Traffic Safety Administration, 2017). However, this benchmark falls short of the recommended threshold of 15 to 25 intubations, which is associated with a greater than 90% success rate (Wang et al., 2005). This discrepancy has led to concerns about whether current training volumes are sufficient to ensure competency, especially in high-stakes prehospital environments. Others suggest that at least 50 ETI experiences are necessary to obtain minimum competency. This challenge is compounded by a shift towards non-invasive methods (Mallory et al., 2018) and variable student placement scheduling, further limiting the chances of encountering ETI opportunities. Additionally, the potential for complications associated with advanced airway interventions has led to a more selective and cautious approach to their use (Mallory et al., 2018).

Other barriers include inconsistent supervision and instruction quality during clinical placements, which are often dependent on the experience and willingness of preceptors to allow students to perform high-risk procedures (Nguyen et al., 2019). The preceptor-student dynamic can affect trust, access to opportunities, and the quality of feedback. Some students, particularly those from underrepresented groups, may also face discrimination that hinders their access to critical learning experiences (Santiago et al., 2021).

While training only in real case scenarios would be ideal for the ECPS, training offers a partial solution to these challenges. The accessibility of simulation-based training and other educational resources may vary across clinical sites, which can affect the efficacy with which the students are able to learn and practice ETI in a safe and controlled environment (Barger & Kudenchuk, 2018). Simulation has, (as technology and simulators have improved), become an important tool for educators in EC, emergency medicine, and anaesthesia, particularly when teaching complicated and infrequent airway management procedures and emergencies (Kamat et al., 2018). Simulation-based training has been shown to improve prehospital providers' ETI skills and confidence (Wang et al., 2020). Studies have demonstrated that simulation-based training can lead to significant improvements in ETI success rates, as well as reductions in complications and adverse events associated with the procedure.

The extent to which simulation-based educational strategies can compare and substitute real-life intubation experiences has not been established. In principle, the manikin airway is always the same during training, but in real life, the patient's airway may differ significantly from one patient to another. The effect of this on the learning process is well described by Buis et al. (2016), showing that significantly more intubations are required to achieve desired performance levels in the prehospital setting. There is also consensus that the differences in

‘feel’ of human airway structures as compared to those of mannequins or airway management simulators are substantial. As such, it has been argued that airway management simulators are not equivalent to live ETI training (Carlson & Wang, 2017) for the development of the precise psychomotor skills required to perform laryngoscopy. Despite the limitations, the benefits of using manikins are acknowledged, and the use of simulation training appears to be growing since the same scenario can be created for different students, which attempts to ensure that students obtain exposure to skills, such as surgical airways, and improve confidence and better their success rates. De Lorenzo et al. (2019) suggested that competency in ETI among prehospital providers can be improved using simulation-based training. The study found that simulation-based training in combination with hands-on practice on human cadavers led to a significant increase in success rates of ETI among prehospital providers, and that the students reached a level of proficiency in a shorter time frame (De Lorenzo et al., 2019).
Moreover, Smith et al. (2018) found that incorporating regular, ongoing training and assessment of ETI skills can help maintain and improve the competency of prehospital providers in this critical skill. The gap between the skills taught in educational laboratories and those required in the professional field remains a major concern for medical educators. In this context, the term *industry* refers to the operational domain of the Emergency Medical Services (EMS) profession, including both prehospital and clinical care environments in which graduates are expected to function. This encompasses real-world EMS settings where providers are required to deliver time-sensitive, high-acuity interventions under dynamic and often unpredictable conditions. Bridging this gap is essential to ensure that students are not only theoretically prepared but also practically competent to meet the complex demands of frontline emergency care. Simulation-based training has been shown to be an effective way to bridge this gap (Dhakal et al., 2017). There is, however, limited research on the most effective approaches to simulation-based training for advanced airway skills (Crawford et al., 2018).

In summary, ECP student preparedness for advanced airway management is hindered by insufficient clinical exposure, inconsistent supervision, limited real-world ETI opportunities, and overreliance on simulation without adequate live case practice. These challenges are compounded by systemic and logistical barriers that affect students unevenly. While simulation-based education holds promise, it cannot fully substitute for the complexity, variability, and immediacy of real-life ETI encounters. The question remains whether current WIL structures, as they exist in South African ECP training programmes, are robust enough to produce clinicians who are not just technically proficient, but clinically competent and confident in managing advanced airways in the field.

1.4. Purpose of the Study

This study aims to address the gap in knowledge regarding the actual *clinical context, frequency, and complexity* of Emergency Care Practitioner (ECP) students' clinical exposure to advanced airway management, particularly endotracheal intubation, during work-integrated learning (WIL) placements in South Africa.

Although current South African regulatory guidelines require ECP students to complete a minimum number of ETI and rapid sequence intubation (RSI) procedures for professional registration, there is limited insight into the *nature* of these clinical encounters, such as patient characteristics, procedural context, supervision quality, and whether the experiences support true clinical competence. Consequently, students may meet procedural quotas without acquiring consistent or meaningful experience in managing complex airways.

Furthermore, reliance on simulation and inconsistent documentation of student activity during WIL placements obscures the full scope of their clinical readiness. The extent to which real-life patient encounters contribute to competence development, as compared to simulation, remains unclear and underexplored in the South African context.

This study, therefore, retrospectively investigates the characteristics and frequency of student exposure to advanced airway management during WIL, including both observed and performed interventions across simulation laboratories, hospital placements, and field settings. The findings will help determine whether current clinical education practices provide equitable, sufficient, and contextually relevant preparation for independent practice.

1.5. Research Objectives and Related Question(s)

The objectives are the basis for action and arise from the response to the gap in the knowledge:

I. To determine the frequency of ETI exposures either performed or observed by ECP students in various settings in the Western Cape.
II. To document the clinical patient characteristics related to ETI exposures encountered by prehospital EC students in the Western Cape.
III. To profile airway management interventions performed by students associated with the PBEC-based competence criteria for ETI.

1.6. Significance of the Study

The EC student's exposure to airway management in the South African prehospital context and the sufficiency of such exposure to promote competence in clinical practice remains undocumented. A description of such exposure, as a clinical and pedagogic imperative, is crucial for contextualising opportunities for improvements in teaching and clinical competency.

Conceptualising such improvements from an analysis of clinical practice airway encounters is prudent because airway compromise can rapidly lead to cerebral hypoxia or aspiration sequelae. Such morbidity and mortality risk adds to the existing burden of EC needs of vulnerable patient communities. That airway management at an advanced level is an EC capability renders it an expectation in the EC community. To advance the understanding of teaching and learning, it is essential to explore opportunities for education in airway management and how students acquire authentic clinical experiences in mastering this critical skill.

1.7. Assumptions

The external validity[1] of the FISDAP™ platform to inform EC students' clinical practice parameters is assumed as that was its intended purpose and design for EC training in the United States of America (USA).

1.8. Limitations/Delimitations Although there are currently four higher education institutions (HEIs) offering undergraduate EC programmes in South Africa, there is no reported homogeneity in how clinical practice is given expression (having regard to institutional autonomy). Potential variation in case presentations, geographic context, and resource availability may also impact students' clinical experiences and learning opportunities.

This study is limited to data obtained from students enrolled in the Department of Emergency Medical Sciences (DEMS) at the Cape Peninsula University of Technology (CPUT) in the Western Cape. This institution was selected due to its consistent use of the FISDAP™ platform since 2012, which offers a structured and longitudinal record of student clinical experiences. As such, the findings may not be generalisable to all ECP programmes in South Africa.

A key limitation relates to the external validity of the FISDAP™ platform, originally designed for Emergency Care training in the United States. While FISDAP™ provides a systematic method for tracking clinical exposure, it was not specifically validated for use in the South African context. Furthermore, the platform relies on self-reported data by students, which introduces the potential for inaccuracies, incomplete entries, or fictitious documentation. There is no built-in mechanism to guarantee that all recorded procedures were directly supervised or verified by a clinical preceptor at the time of entry. The absence of consistent real-time provider oversight may compromise data authenticity and should be considered when interpreting results.

[1] The internal validity of FISDAP™, however, cannot be assumed due to implementation nuances and the field being different. This study finding may inform on the aspect of internal validity.

Despite these limitations, FISDAP™ remains one of the few comprehensive, longitudinal tools available for capturing the scope of ECP student clinical activity, and its structured data format allows for a retrospective analysis of procedural exposure patterns.

1.9. Summary

Chapter one introduced the reader to the research topic by highlighting the importance of advanced airway management in prehospital EC as the background to the problem. It outlines the challenges of applying these into teaching and learning strategies and curriculum development to achieve the desired levels of airway management skill acquisition to enable graduate preparation for independent clinical practice - the problem statement. The research purpose, the main research question, and the objectives are presented. Brief notes on design, limitations/delimitations, assumptions, and key terms are also presented.

The structure of the thesis is as follows: Chapter One introduces the reader to the study problem and approach. Chapter Two provides the literature review, with Chapter Three mapping the Methodology for this study. Chapter Four presents the Results and is followed by the Discussion in Chapter Five. The final chapter, Chapter Six, closes with the Conclusions and recommendations. The reference list and annexures follow.

CHAPTER II – REVIEW OF THE LITERATURE

2.1 Introduction

Using a narrative analysis (Pare´ et al., 2015), this literature review intersects the major topics (Figure 1): ETI as a critical prehospital EC skill, the ECPS as a critical actor in skill acquisition and clinical practice as the modality through which clinical mentorship and patient encounters are experienced.

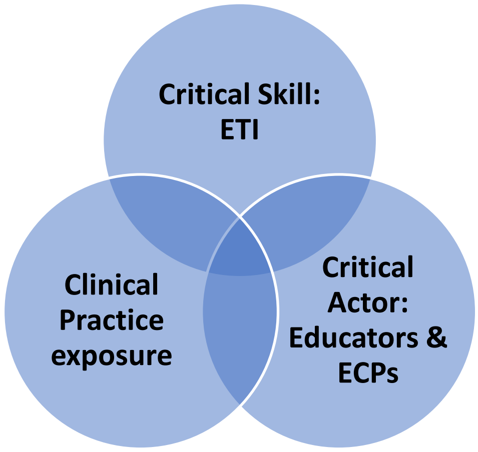

Figure 1 - Venn diagram of intersected major topics.

The review of literature was conducted through the Cape Peninsula University of Technology's Library database. An electronic database search was conducted using the PubMed search engine and included MEDLINE, Google Scholar, and Science Direct. Only full-text, peer-reviewed articles published in English were evaluated for inclusion. Search terms included: *"paramedic student endotracheal intubation," "student intubation," "paramedic work-integrated learning," and "paramedic students' clinical skills acquisition and retention."* Preference was given to contemporary and high-quality sources that directly informed the scope and focus of the study.

2.2 Endotracheal Intubation

Advanced airway management remains a cornerstone of emergency medicine, particularly in the prehospital and critical care environments, where timely and effective airway control can be lifesaving (Benger et al., 2019; Higgs et al., 2018). Endotracheal intubation (ETI) is widely regarded as the definitive method for airway management in critically ill or injured patients, especially when airway protection, oxygenation, and ventilation are compromised (Sakles et al., 2020). Recent evidence has resolved earlier debates by affirming that when performed by skilled providers under appropriate conditions, ETI, particularly when guided by structured protocols and pre-intubation assessment tools, leads to improved patient outcomes, including higher first-pass success rates and reduced complications (Russotto et al., 2021; Groombridge et al., 2017). This consensus has been reflected in updated airway management guidelines that emphasise the importance of training, supervision, and situational awareness, especially in emergency and prehospital contexts (Higgs et al., 2018). Therefore, ETI continues to be a critical intervention in emergency care, provided it is delivered within a framework of competence and system-level support.

ETI is an invasive clinical procedure in which a single-use cuffed tube is placed into the trachea of a patient, through the opening of the nose or oral cavity, for the maintenance of an imperilled airway to restore its patency and provide ventilatory support. Inflation of the cuff beneath the vocal cords successfully secures placement and allows early optimal oxygenation and ventilation. The tube also serves as protection to the trachea and lungs against aspiration of stomach contents and can be used as a port for drug administration during resuscitation (Thomas & Moss, 2014).

2.2.1. ETI in the prehospital setting background

The use of ETI in the prehospital setting dates back to the early 20th century. ETI was first described in 1913 by Dr. George Crile, who used it as a means of providing oxygen to patients during surgery (Crile, 1913).

The use of ETI in the prehospital setting began in the 1940s and 1950s, with the development of the first ambulance services and the establishment of the modern concept of emergency medical services (EMS) (Bledsoe et al., 2018). Initially, prehospital providers, such as ambulance drivers and first responders, were trained in basic life support techniques, including the use of ETI in cases of respiratory arrest (Bledsoe et al., 2018).

Over the last decade, the value of ETI has been reviewed with regard to its safety and efficacy when performed prehospitally. A large systematic review conducted between 1990 and 2020, including 99 studies and 630,397 patients, examined the comparative benefits and harms of three airway management approaches: bag-valve-mask (BVM), supraglottic airway (SGA), and ETI, in prehospital EC. The review found few differences in primary outcomes such as survival, neurological function, return of spontaneous circulation (ROSC), and successful airway insertion, with no clear advantage for ETI over BVM or SGA, particularly in trauma and cardiac arrest cases in the prehospital setting. It should be noted that the strength of evidence was judged to be low to moderate by the review authors, emphasising the need for more robust randomized controlled trials to inform practice and policy.

Crewdson et al. (2017) in their systematic review on the success of prehospital tracheal intubation by different prehospital providers, suggested that although the overall success rate of intubation performed in the prehospital setting has improved, there remains a significant difference in success rate between non-physician and physician providers. They emphasised that while different results can be expected between physicians and non-physicians, it is crucial to recognise that poorly performed intubation carries significant risks of morbidity and mortality. Therefore, careful consideration must be given to the training and experience necessary to perform this intervention safely.

2.2.2. Complications associated with ETI

Although ETI is commonly performed in emergency medicine, airway procedures such as intubation are not without complications or adverse events. This can range from minor to severe, life-threatening conditions in the airway. In order to provide an adequate strategy to prevent and be able to manage these complications as they arise (Divatia et al., 2011), it is important to consider the incidence and associated factors of ETI-related complications. These factors can be divided into the following categories: patient factors, the clinician, and procedural factors.

2.2.2.1 Patient factors

Complications in infants, children, and pregnant women

Airway management in infants, children, and adult women, particularly pregnant women, can be challenging due to their unique anatomy and physiology. Infants and children have relatively narrow airway structures, which can make intubation difficult and increase the risk of complications such as airway edema. Laryngeal injury is a common complication in infants during both direct and indirect laryngoscopy, due to the fragility of the infant's larynx and the difficulty of visualizing it during intubation. Other complications in infants include bronchospasm and airway obstruction due to mucus or secretions. Children also have larger heads in proportion to their body size, making visualization of the larynx more difficult (Kheterpal et al, 2009). Pregnant women have unique airway management challenges due to hormonal changes and the growing uterus, which can cause airway edema and can also make intubation more difficult. Additionally, the position of the fetus can also make it difficult to access the airway, particularly in emergency situations. To manage the airway in these patient groups, specialized equipment and techniques may be required. For example, using smaller endotracheal tubes and specialized laryngoscopes can make intubation easier in infants and children (Kheterpal et al, 2009). Awake intubation or the use of supraglottic airway devices may also be considered in pregnant women to minimise the risk of complications and ensure the safety of both the mother and the fetus. It is important to note that these patient groups are at higher risk of post-intubation complications such as laryngeal edema, stridor, and vocal cord damage (Kheterpal et al, 2009; Odor et al., 2021; Šklebar et al., 2023. Therefore, the airway management team should be prepared for these complications and have the necessary equipment and expertise. In summary, airway management in infants, children, and adult women, especially pregnant women, can be challenging due to their unique anatomy and physiology. Specialized equipment and techniques are often required, and these patient groups are at an increased risk of complications.

Patients with a variety of congenital, chronic acquired diseases, and anatomically difficult airways

Intubation may be challenging in patients with congenital and chronic acquired diseases due to the presence of abnormal anatomy and underlying medical conditions. Patients with congenital craniofacial anomalies such as cleft lip and palate may have a narrowed or distorted airway, making visualization of the vocal cords difficult. Similarly, patients with congenital conditions such as Pierre Robin syndrome, characterized by a small jaw and a posteriorly displaced tongue, can also pose a significant challenge during intubation. Obesity and sleep apnea may also make intubation challenging due to the presence of excess tissue in the upper airway, making visualization of the vocal cords difficult. Additionally, patients with chronic obstructive pulmonary disease (COPD) have an increased risk of complications during intubation due to bronchospasm and mucus plugs in the airway. Patients with neurologic conditions such as spinal cord injury, multiple sclerosis, and amyotrophic lateral sclerosis (ALS) may have difficulty with intubation due to muscle weakness, reduced cough reflex, and spasticity, making it harder to maintain the airway. Head and spinal injuries may cause decreased levels of consciousness and making induction of anaesthesia difficult, as well as making positioning for intubation risky due to an unstable cervical spine. Burns patients presenting with significant facial and upper airway edema may make visualization of the larynx difficult, and the use of certain medications, such as steroids, may also complicate the intubation process in burn patients.

Complications likely to occur during emergency situations.

Some of the complications that are more likely to occur during emergency intubation include: oxygen desaturation, aspiration, soft-tissue trauma, hypotension, dysrhythmia, and cardiac arrest

Intubation difficulty is one of the most encountered complications during emergency intubations. Emergency intubations are often performed on critically ill patients who may have altered airway anatomy, making intubation more challenging. This may lead to increased risk of hypoxia and brain injury. and may be due to factors such as obesity, cervical spine injury, or a patient's position during intubation. In such cases, it is crucial to have, for example, alternative airway management devices to manage these potential complications. Trauma to the airway is another potential complication that can occur during emergency intubation.

Emergency intubations may be performed in haste and with limited resources, increasing the risk of trauma to the airway, such as laryngeal or tracheal injury (Benumof, 2011). It is important to have appropriate equipment and personnel available to minimize the risk of airway trauma, such as using a video laryngoscope, which allows for better visualization of the airway.

During emergency intubations, there is a risk of accidentally placing the tube in the esophagus rather than the trachea, which can lead to hypoxia and other complications (Griesdale et al, 2008). To minimize the risk of esophageal intubation, it's important to confirm proper tube placement using capnography and/or a chest x-ray.

Cardiac arrest is another potential complication that may be encountered during emergency intubation. The procedure may lead to hypotension and cardiac arrest, particularly in patients with underlying cardiac disease. Ventilator-associated pneumonia is another potential complication that may occur as a result of the procedure. Emergency intubation may be associated with an increased risk of ventilator-associated pneumonia, particularly in critically ill patients. This risk can be minimised by implementing appropriate infection control measures, such as oral care and turning the patient to prevent prolonged pressure on one area of the body.

In conclusion, awareness of potential complications and having appropriate equipment, personnel, and skills to minimize them is important. Utilising appropriate techniques and tools, such as video laryngoscopy and supraglottic airway devices, and taking a multidisciplinary approach, the risk of complications may be minimised, and the chances of a successful outcome increased.

2.2.2.2 Anaesthesia-related factors

The knowledge, technical skills, and crisis management capabilities of the emergency care provider (ECP) play a vital role in the occurrence and outcome of complications during airway management.

Airway management is a critical aspect of EC and is often the first step taken by ECPs to ensure that patients receive adequate oxygenation and ventilation (O'Connor, 2005). However, the complexity of airway management, combined with the high-stress and fast-paced nature of EC, means that complications may occur (Wolf, 2016). The knowledge, technical skills, and crisis management capabilities of the ECP play a vital role in both the occurrence and outcome of these complications (Muratore, 2018).

The knowledge and technical skills of the ECP are essential for the successful management of the airway. ECPs must have a thorough understanding of the anatomy and physiology of the airway, as well as the various techniques and equipment available for airway management. This knowledge enables them to quickly identify and respond to potential complications, such as laryngeal trauma, foreign body obstruction, and airway obstruction (American College of Emergency Physicians, 2018).

Furthermore, technical skills are also critical in the management of complications. For example, ECPs must be able to perform advanced airway management techniques, such as ETI and more advanced alternative airways, to secure the airway and prevent hypoxia or asphyxia (American College of Emergency Physicians, 2018). These technical skills are acquired through training and practice and are essential for managing complications that arise during airway management (O'Connor, 2005).

In addition to knowledge and technical skills, crisis management capabilities are also vital for ECPs to have when managing airway complications. Personnel must be able to think critically, make quick decisions, and remain calm under pressure to effectively manage complications such as cardiac arrest, respiratory distress, and severe bleeding (Levitan, 2007; Marx, 2018). This requires both mental and physical preparation, as well as the ability to work effectively as part of a team.

A hurried intubation, without adequate evaluation of the airway or preparation of the patient or the equipment, increases the risk of damage.

ETI is a common procedure used in anaesthesia to secure a patient's airway and provide a means for mechanical ventilation. However, if the procedure is performed in a hurried or poorly prepared manner, it may lead to a number of complications.

One such complication is a difficult intubation, which may occur when the airway is not adequately evaluated prior to the procedure, or when the patient is not properly positioned or prepared. This may lead to prolonged intubation attempts, increased risk of trauma to the airway, and a higher likelihood of complications such as hypoxia or cardiac arrest (Kheterpal, et al., 2006). Another potential complication is equipment-related issues, such as using improperly sized or malfunctioning equipment, which can also increase the risk of difficult intubation and airway trauma (Griesdale, et al., 2008). Inadequate preparation of the patient also has the potential to lead to complications such as vomiting and aspiration, which may further complicate airway management. Overall, it is crucial that the airway is thoroughly evaluated, the patient is properly prepared, and the equipment is in good working condition prior to performing an ETI to minimize the risk of complications.

2.2.2.3 Procedural factors:

ETI is associated with several complications that may arise during the procedure, with the endotracheal tube (ETT) in situ, and post-intubation.

Complications that can arise during intubation include difficulty passing the ETT through the upper airway, which can lead to laryngospasm or trauma to the vocal cords (Bagshaw et al., 2018). Inadvertent placement of the ETT in the esophagus instead of the trachea can lead to hypoxia or hypercarbia (Kheterpal et al., 2016) and injury to the teeth or gums during the insertion of the ETT (Kheterpal et al., 2016).

Complications that can arise with the ETT in situ include displacement of the ETT, which can lead to partial or complete obstruction of the airway (Mort et al., 2016); ventilator-associated pneumonia (VAP), which can occur when bacteria are aspirated into the lungs through the ETT (Chastre et al., 2018); and tracheal stenosis, which is a narrowing of the airway due to the injury or inflammation caused by the ETT (Mort et al., 2016).

During the post-intubation period, patients may experience laryngeal edema, which is swelling of the larynx that can occur after ETT removal (Kheterpal et al., 2016); stridor, which is a high-pitched wheezing sound that can occur after ETT removal (Kheterpal et al., 2016); and hoarseness, which is a change in the voice that can occur after ETT removal (Kheterpal et al., 2016).

It is important for healthcare providers to be aware of these potential complications and to take steps to minimize them. This includes proper training in ETI techniques, close monitoring of patients during and after intubation, and prompt recognition and management of any complications that do occur.

ETI is a crucial procedure that is commonly used in critically ill patients, however, it is associated with a number of complications that can occur during the procedure, while the ETT is in situ, and post-intubation. The knowledge, technical skills, and crisis management capabilities of the ECP play a vital role in minimizing the occurrence and severity of complications during airway management in an emergency setting (Wolf, 2016; Muratore, 2018). Without these essential skills, ECPs may be unable to effectively manage airway complications, leading to poor patient outcomes. Therefore, it is crucial that ECPs regularly update their knowledge, skills, and capabilities to ensure they can provide the best possible care to their patients

2.2.3. Rapid Sequence Intubation

RSI is a combination of pre-oxygenation with the administration of a potent induction agent (sedative) followed by a neuromuscular blocking agent in rapid succession to induce unconsciousness and optimize conditions for efficient ETT placement in critically ill or injured patients while limiting the risk of patient harm (Walls & Murphy, 2012). The skill was introduced about three decades ago to select non-physicians, including EMS paramedics and nurses, with the aim of improving the outcomes of patients in the out-of-hospital setting (Dufour, Larose & Clement, 1995; Wang et al., 2001). RSI has since been reported as the safest and most reliable method of intubation in the trauma patient, associated with significantly fewer complications than other intubation techniques (Walls et al., 2000).

In many European countries, RSI is a core component of prehospital advanced life support and is only performed by specially trained physicians. In contrast, prehospital EMS systems in South Africa and many other developing countries base their advanced life support entirely on ECPs and/or nurses. Since RSI has been approved by the Health Professions Council of South Africa (HPCSA) in November 2009, it has become widespread as the procedure of choice for definitive airway management by pre- and in-hospital EC personnel. Compared with deep sedation intubation, the procedure takes less time for intubation and provides a safer combination dosage of drugs. Gunning et al. (2013) reason that despite the risks of using neuromuscular blocking agents, which potentially affect spontaneous respiratory effort and possibly the loss of airway patency under certain circumstances, the overall benefits of this technique outweigh the risks.

Gunning et al. (2013) also highlight that since the addition of RSI to the ECP scope of practice approximately seven years ago in South Africa, little data has emerged about the practice of RSI by ECPs in South Africa. More importantly, as part of the motivation for this study, there is no data currently available that describes the practice of RSI by South African ECP students (Stein, 2017).

2.2.3.1. Characteristics of Prehospital RSI

Literature does not explicitly indicate whether prehospital RSI is beneficial or harmful. However, prehospital RSI is reported as a difficult and complex procedure and contains significant pitfalls and may interact with other important aspects of patient care (Wang et al., 2006). Emergency airway management outside the hospital environment differs significantly from elective procedures in a controlled environment such as emergency departments (ED) or operating rooms. It is well recognised that the procedure is associated with significant risk and a variety of complications, including hypoxia, hypotension, tracheal tube misplacement, oesophageal intubation, vomiting and aspiration, cardiac arrhythmia, bleeding, and dental damage.

In contrast to the in-hospital practice, prehospital intubation often is accomplished in less controlled environments, such as the scene of an accident, the back of an ambulance, or in an aircraft. The lack of proper equipment and monitoring, adequate training, adequate lighting, medications, additional skilled personnel, no patient medical history and physical examination, impaired patient access, poor patient positioning, inability to assess the degree of difficulty of the airway, time pressure due to the urgent need to secure an airway, and inadequate access to airway equipment, are all factors that may increase the risk and complexity of unexpected difficult intubation in the prehospital setting.

Despite these factors, the same standards for successful intubation demanded in the hospital environment must be applied to the out-of-hospital setting to ensure positive outcomes. For this reason, Cook & Macdougall-Davis (2012) argued that ETI skills should be developed in such a way that is especially relevant to those who intubate in non-elective or emergency settings, where the incidence of a difficult or failed intubation is up to 20 times higher than in the elective setting. Swanson (2002) claimed that future investigation should focus on prospective evaluation of education programs designed to maximize intubation success and minimize complications in prehospital airway management.

2.2.4. Alternative Airways

Advanced airway management is a crucial component of EC, as it can ensure adequate oxygenation and ventilation in critically ill patients. However, there are several alternative advanced airway management techniques that may be used in lieu of or in addition to traditional RSI with an ETT. These alternative techniques may be useful in certain situations where RSI is not feasible or is associated with increased risk.

One alternative advanced airway technique is the use of SGA devices, such as laryngeal mask airways (LMA) or I-gel. These devices are inserted into the upper airway to provide an alternative route for ventilation and have been shown to be effective in providing adequate oxygenation and ventilation in critically ill patients (Jaber et al., 2018; Kheterpal et al., 2016).

Another alternative is video laryngoscopy, which uses a camera to visualize the larynx, and can be useful in difficult airway scenarios such as obesity, cervical spine injury or trauma, and when traditional laryngoscopy has failed

BMV is an alternative manual method of providing ventilation through a mask and a self-inflating bag. BMV can be used as an alternative to ETI in certain clinical situations, such as in patients with a limited jaw opening or a distorted airway, or in patients with a compromised airway or severe respiratory distress (Nguyen et al., 2015).

Cricothyroidotomy is a surgical procedure that involves making an incision in the patient's cricothyroid membrane and inserting the ETT through the incision (Walls R, Murphy, 2012). This method is used as a last resort when other forms of ETI are not possible due to the patient's anatomy or other factors.

Additionally, newer alternative airway techniques have been developed, like video laryngoscopy (VL) and the intubating laryngeal mask airway (ILMA), which have been reported to improve the success rates of intubation in difficult airway scenarios.

Non-invasive ventilation (NIV), such as continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP), may also be used to provide ventilation and oxygenation in patients with respiratory failure without the need for intubation. NIV has been shown to be effective in treating a variety of respiratory conditions, such as acute exacerbation of COPD and acute cardiogenic pulmonary edema, and it is associated with lower complication rates when compared to ETI.

Alternative advanced airway management techniques such as SGA devices, video laryngoscopy, and non-invasive ventilation can be useful in certain situations where RSI with ETI is not feasible or is associated with increased risk.

2.3. Clinical Education and Training

Poorly performed intubation carries a significant morbidity and mortality risk, and thus, there is a greater expectation from training institutions to improve the level of training strategies so that students may perform this prehospital intervention safely (Crewdson et al., 2017).

The education and training of EMS providers in ETI vary across countries and regions, with different curricula and methods of instruction being used. Over time, the education and training of prehospital providers in ETI has evolved beyond a narrow focus on didactic instruction and technical skill acquisition, towards more student-centred and competency-based approaches that reflect the broader professionalisation of Emergency Medical Services. This transition, from a primarily vocational model (e.g., CCA intubation based on GCS < 8) to a holistic framework of clinical decision-making and patient safety, mirrors international trends where ETI training is restricted to a smaller cadre of providers and is embedded within professional educational structures (Kerrey, 2002; Murphy & Laffey, 2007). In the 1980s, the National Highway Traffic Safety Administration (NHTSA) established national standards for the education and training of prehospital providers in the United States, including the use of ETI (Bledsoe et al., 2018). These standards outline the minimum competencies that must be met by prehospital providers in ETI, as well as the methods of instruction and evaluation that should be used (Bledsoe et al., 2018). With the advancement of technology, online and simulation-based training have become more prevalent in the education of prehospital ETI. Simulation-based training has been shown to be effective in the education of prehospital ETI, with several studies demonstrating improved performance and confidence in providers who have received simulation-based training. Online learning, while convenient and cost-effective, may not provide the same level of hands-on practice and immediate feedback as simulation-based training (Murphy and Laffey, 2007.

In South Africa, the education and training of prehospital providers in ETI has traditionally focused on didactic instruction and hands-on training with manikins and cadavers (Kerrey, 2002). However, in recent years, the use of simulation-based training has become more prevalent in the education of prehospital ETI. Alongside simulation-based and online training, in-person workshops and courses continue to be a popular method of educating prehospital providers in ETI. These courses usually involve a combination of didactic instruction and hands-on practice with manikins and cadavers (Kerrey, 2002).

Clinical practice exposure to ETI is considered a crucial component of training for healthcare professionals who are responsible for performing this procedure. It provides prehospital care provider students with the opportunity to gain hands-on experience in performing ETI under the supervision of licensed healthcare professionals. Clinical practice plays an important role in healthcare education and training, as it allows students to apply the knowledge and skills learned in the classroom to real-world situations. This type of hands-on experience is essential for preparing students for their future careers as healthcare professionals (Berman, Snyder, & Kozier, 2016). Since ETI is a critical procedure in prehospital care and requires a high level of skill and knowledge, it is vital that prehospital care provider students receive adequate education and training in ETI in order to perform this procedure safely and effectively in a prehospital setting (Maguire et al., 2019).

This type of experience is essential for developing the skills and confidence necessary to perform ETI in a real-world setting (Maguire et al., 2019). Additionally, clinical practice also allows students to develop their critical thinking and problem-solving skills, which are essential for providing safe and effective prehospital care (Berman, Snyder, & Kozier, 2016).

Overall, clinical practice is an essential component of healthcare education and training and is particularly important for prehospital care provider students who need to develop the knowledge and skills necessary to perform endotracheal intubation safely and effectively in South Africa.

2.3.1. Work-integrated Learning

Work-integrated learning (WIL) is defined as "a form of education in which students engage in real-world, work-related experiences, such as internships, co-op programs, and apprenticeships, in order to apply and further develop the knowledge and skills acquired through their formal education" (Boud & Cohen, 2013). This type of learning is designed to bridge the gap between academic learning and practical, on-the-job experience, and is often seen as an important step in preparing students for careers in their chosen fields.

WIL has been reported to be an effective method for the clinical training of prehospital care providers in the critical skill of ETI. In the field of EC education, WIL placements offer students the opportunity to gain hands-on experience and apply their knowledge in real-world settings. WIL placements can expose students to a wide range of clinical scenarios and procedures, including ETI. The proficiency and expertise required to perform ETI make it crucial for providers to regularly update their skills in this area

WIL placements provide students with a wealth of learning opportunities, as they enable the integration of theory and practice, the development of professional skills and attitudes, and the chance to reflect on their own learning (Boud & Cohen, 2013). The hands-on experience and real-world scenarios provided by WIL enable students to practice and refine their skills under the guidance and supervision of experienced healthcare professionals, leading to improved intubation success rates and greater confidence in the ability to perform intubation in real-world situations.

Chen et al. (2018) found that prehospital care provider students who participated in WIL-based ETI training had better intubation success rates compared to students who received traditional classroom-based instruction. This study also showed that students who participated in WIL-based training had a higher level of confidence in their ability to perform intubation and were more likely to perform intubation in real-world situations. Wang et al. (2016) also highlighted the importance of providing prehospital care provider students with hands-on training opportunities to improve their ETI skills. It is proposed that WIL provides an ideal platform for clinical practice education and training for prehospital care provider students. The hands-on experience and real-world scenarios provided by WIL allow students to practice and refine their skills under the guidance and supervision of experienced healthcare professionals, which can lead to improved intubation success rates and greater confidence in the ability to perform intubation in real-world situations.

2.3.2. Experiential Learning

Experiential learning (EL) is a method of learning that involves hands-on experience, rather than just reading about or being told about something. It is a process of learning through doing, reflecting on the experience, and making connections to theoretical concepts (Kolb, 1984).

During clinical practice, EL becomes the process of acquiring knowledge, skills, and attitudes through direct experience. It is based on the idea that learning is most effective when it is actively engaged in, rather than simply passively received (Lewin, 1951). EL can take place in a variety of contexts, including classrooms, workplaces, and everyday life (Schön, 1983).

There are several different models of experiential learning, including Kolb's model, which proposes that learning occurs through a cycle of experiencing, reflecting, thinking, and acting (Kolb, 1984). According to Kolb (1984), learners should engage in hands-on activities or practical experiences to acquire new skills and then reflect on those experiences to develop new insights and understanding.

Other models of experiential learning include Lewin's model, which suggests that learning occurs through a three-stage process of unfreezing, moving, and refreezing (Lewin, 1951), as well as Schön's model, which emphasizes the importance of reflection in action in the learning process (Schön, 1983).

Experiential learning has been found to be effective in a variety of settings, including education, training, and professional development. It can be particularly useful in helping learners to develop problem-solving skills, critical thinking skills, and the ability to apply knowledge and skills in real-world situations (Kolb, 1984; Lewin, 1951; Schön, 1983).

2.3.3. Educational models during Experiential Learning

2.3.3.1. Kolb's model

Kolb's model of experiential learning suggests that learning is an active process that involves four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation.

According to Kolb (1984), concrete experience is the first stage of the learning cycle and involves actively participating in a new experience or situation. Reflective observation is the second stage and involves thinking about and reflecting on the experience. Abstract conceptualization is the third stage and involves forming abstract theories or concepts based on experience. Finally, active experimentation is the fourth stage and involves applying the new concepts and theories to new situations or problems.

Kolb's model proposes that individuals learn best when they are able to progress through all four stages of the learning cycle. It also suggests that individuals have a preferred learning style, which is influenced by their experiences and preferences.

Kolb's model of experiential learning can be applied to the acquisition of skills and competence in endotracheal intubation, a medical procedure in which a tube is inserted into a patient's trachea through the mouth or nose to establish an airway and assist with ventilation.

According to Kolb's model, the acquisition of competence in endotracheal intubation involves progressing through all four stages of the learning cycle:

1. **Concrete experience:** This stage involves actively participating in the process of intubating patients, including practicing the procedure on manikins and observing experienced practitioners. It is important for learners to have hands-on experience in order to develop their tactile skills and understanding of the procedure.
2. **Reflective observation:** This stage involves thinking about and reflecting on one's experiences with intubation, including any challenges or successes. This allows learners to identify areas for improvement and begin to develop their own approach to the procedure.
3. **Abstract conceptualization:** In this stage, learners learn about the theory and principles behind endotracheal intubation, including anatomy, physiology, and pharmacology. This knowledge helps learners understand the rationale behind the procedure and how to anticipate and manage potential complications.
4. **Active experimentation:** In the final stage, learners apply their new knowledge and skills to real-life situations, such as intubating patients under the supervision of an experienced practitioner. This stage allows learners to consolidate their learning and develop their confidence and competence in the procedure.

It is important to note that the acquisition of competence in endotracheal intubation also involves ongoing practice and feedback to maintain and improve skills over time.

2.3.3.2 Millers model

Millers model of skill acquisition, also known as the Millers model of competence (Miller, 1982), is a framework that describes the development of skills and competence in learners. It suggests that learners progress through four stages of skill acquisition: cognitive, associative, autonomous, and expert. At each stage, learners exhibit different characteristics and face different challenges as they acquire new skills (Miller, 1982).

Miller's model of skill acquisition and competence, also known as the "Miller Triangle," proposes that there are three key factors that influence the development of skills and competence: motivation, ability, and opportunity. According to Miller (1997), motivation is the driving force that drives individuals to seek out new skills and experiences. It can come from both internal and external sources, such as a desire to improve one's own performance or meet the expectations of others. Ability refers to an individual's natural aptitude or talent for a particular skill. It is important to note that ability is not fixed and can be developed and improved through practice and training. Opportunity refers to the availability of resources and experiences that allow individuals to develop their skills and competence. This can include access to training, exposure to new experiences, and the availability of role models or mentors. Miller's model suggests that individuals are more likely to develop new skills and competence when they have a high level of motivation, sufficient ability, and access to opportunities. The Millers model has been applied to the study of ETI to understand how medical professionals progress through different stages of skill acquisition as they learn to perform the procedure (Lang et al., 2014). For example, at the cognitive stage, learners may rely heavily on step-by-step instructions and may not yet have developed the ability to anticipate problems or recognize patterns (Miller, 1982). As practitioners progress through the stages of skill acquisition, they develop a greater understanding of the underlying principles of ETI and are able to rely more on intuition and judgment (Miller, 1982).

Studies that applied the Millers model to ETI found that learners at the cognitive stage had lower success rates and made more errors compared to learners at the autonomous stage (Lang et al., 2014). This finding is consistent with the idea that the level of competence a learner demonstrates is determined by the complexity of the tasks they are able to perform and the level of judgment and intuition they have developed (Miller, 1982).

The Millers model can be useful for identifying the types of training and support that are most appropriate at different stages of learning and for designing assessment tools that can measure competence in ETI (Lang et al., 2014). It can also inform the development of curricula and training programs that are tailored to the needs of learners at different stages of skill acquisition (Miller, 1982). Overall, the Millers model provides a useful framework for understanding the development of competence in ETI and can inform the design of effective training programs and assessment tools.

2.3.3.3 The Dreyfus model

The Dreyfus model of skill acquisition, also known as the Dreyfus model of competence (Dreyfus & Dreyfus, 1980), is a framework that describes the development of skills and competence in learners. It suggests that learners progress through five stages of skill acquisition: novice, advanced beginner, competent, proficient, and expert. At each stage, learners exhibit different characteristics and face different challenges as they acquire new skills (Dreyfus & Dreyfus, 1980).

One of the key ideas of the Dreyfus model is that the level of competence a learner demonstrates is not simply a matter of the amount of time they have spent practicing a skill, but rather is determined by the complexity of the tasks they are able to perform and the level of judgment and intuition they have developed in relation to those tasks (Dreyfus & Dreyfus, 1980).

The Dreyfus model has been widely applied in a variety of fields, including education, psychology, and engineering (Dreyfus & Dreyfus, 1980; Chen et al., 2016; Lee et al., 2018), and has been used to inform the design of training programs and curricula (Chen et al., 2016). It has also been used to understand the development of expertise (Dreyfus & Dreyfus, 1980; Chen et al., 2016) and to identify the factors that contribute to the acquisition of advanced skills (Lee et al., 2018).

One area where the Dreyfus model has been particularly influential is in the field of medical education (Santiago et al., 2012; Chen et al., 2016). In this context, the model has been used to understand how medical students and residents progress through different stages of skill acquisition as they learn to diagnose and treat patients (Santiago et al., 2012). It has also been used to identify the types of training and support that are most effective at different stages of learning (Chen et al., 2016) and to inform the development of assessment tools that can measure competence (Santiago et al., 2012).

Overall, the Dreyfus model provides a useful framework for understanding the development of competence and expertise in learners (Dreyfus & Dreyfus, 1980; Santiago et al., 2012; Chen et al., 2016; Lee et al., 2018). It has been widely applied and has contributed to understanding the factors that may influence skill acquisition (Dreyfus & Dreyfus, 1980; Santiago et al., 2012; Lee et al., 2018) and the design of effective training programs (Chen et al., 2016).

The Dreyfus model has been applied to the study of ETI to understand how medical professionals progress through different stages of skill acquisition as they learn to perform the procedure (Goyal et al., 2017). For example, Novice practitioners may rely heavily on step-by-step instructions and may not yet have developed the ability to anticipate problems or recognize patterns (Dreyfus & Dreyfus, 1980). Goyal et al., (2017) found that novice practitioners were more likely to make errors and have lower success rates compared to more experienced practitioners. This finding is consistent with the idea that the level of competence a learner demonstrates is determined by the complexity of the tasks they are able to perform and the level of judgment and intuition they have developed (Dreyfus & Dreyfus, 1980).

The Dreyfus model can be useful for identifying the types of training and support that are most appropriate at different stages of learning and for designing assessment tools that can measure competence in ETI (Goyal et al., 2017). It can also inform the development of curricula and training programs that are tailored to the needs of learners at different stages of skill acquisition (Dreyfus, 2004).

Overall, the Dreyfus model provides a useful framework for understanding the development of competence in ETI and can inform the design of effective training programs and assessment tools.

2.3.4. Clinical Competence and the Learning Curve

Prehospital ETI is a critical skill for prehospital ECPs as it allows for the establishment of a secure airway and the provision of ventilatory support to patients in respiratory distress. However, the performance of ETI by ECP students can be challenging, as it requires a high level of clinical competence.

Several studies have investigated the clinical competence of ECP students in prehospital ETI. Wang et al. (2019) found that the overall success rate of prehospital ETI among ECP students was no more than 66.7%, with a higher success rate for students who had more clinical experience. This suggests that clinical experience is an important factor in the development of clinical competence in prehospital ETI among ECP students.

Buis et al. (2016) reported on the learning curve for ETI using direct laryngoscopy during emergency intubation. The review showed that in mostly elective circumstances, at least fifty ETIs with no more than two intubation attempts needed to be performed by providers to reach a success rate of at least 90% which had remained consistent over ten intubations. However, Buis et al. (2016) reasoned that the actual number or range of ETIs a health care provider in training needs to perform to achieve proficiency within two attempts is unknown and cannot be derived from the literature at present.

Adhikari et al. (2018) found that the use of simulation-based training may improve the clinical competence of ECP students in prehospital ETI. The study found that students who received simulation-based training had a significantly higher success rate in prehospital ETI (86.6%) compared to those who did not receive such training (66.7%). This suggested that simulation-based training is an effective tool for improving the clinical competence of ECP students in prehospital ETI.

Addi Rupp et al. (2016) found that the use of VL may improve the clinical competence of ECP students in prehospital ETI. The study found that students who used VL had a higher first-attempt success rate (88.9%) compared to those who did not use VL (77.8%). This suggested that VL could be an effective tool for improving the clinical competence of ECP students in prehospital ETI.

Prehospital ETI is a critical skill for ECPs, and the clinical competence of ECP students in this skill can be challenging. Factors such as clinical experience, simulation-based training, and the introduction to alternative advanced equipment, such as VL, have the potential to improve the clinical competence of ECP students in prehospital ETI.

Currently, in South Africa, no data on the learning curves for ETI exists, with no data available describing the practice of RSI (which includes ETI) by ECP students (Stein, 2017). At present, the HPCSA PBEC requires learners studying the four-year degree programme to perform a total of 30 ETIs during their clinical workplace learning. However, the success rate required has not been specified or required for reporting.

2.4. Emergency Care Practitioner Student as critical actors

Emergency Care Practitioner (ECP) students play a pivotal role in advancing the field of prehospital emergency care. These individuals, enrolled in a rigorous 4-year Bachelor's degree in Emergency Medical Care, are registered under the Emergency Care Practitioner Students (ECPS) roll of the Health Professions Council of South Africa (HPCSA). Their training is designed to equip them with the advanced knowledge and clinical competencies needed to manage critically ill or injured patients in dynamic and often unpredictable prehospital environments.

A cornerstone of their education is the acquisition of advanced airway management skills, including endotracheal intubation (ETI). These skills are essential for providing life-saving interventions such as establishing a secure airway and delivering ventilatory support to patients in respiratory distress (Griesdale et al., 2015). Despite their critical importance, mastering these skills poses significant challenges for ECP students. The transition from theoretical knowledge and simulation-based training in controlled laboratory settings to applying these skills effectively in real-world, high-pressure scenarios often exposes a gap in readiness (Barger et al., 2018).

To address these challenges, the HPCSA Professional Board for Emergency Care (PBEC) provides oversight of the ECP training curriculum. This oversight ensures that students acquire the requisite clinical experience and adhere to standardised competencies, fostering the delivery of safe and effective patient care. As part of their training, ECP students are required to perform a minimum of 30 ETIs during clinical workplace learning. However, the success rate for these procedures is neither specified nor mandated for reporting (Stein, 2017).

The absence of nationally defined metrics for success underscores the variability in the preparedness of ECP students, with proficiency often influenced by factors such as the availability of opportunities to practice ETI, mentorship quality, and the integration of modern tools such as video laryngoscopy (VL). Simulation-based training has shown promise in bridging the gap between classroom learning and field application, offering a controlled environment to build confidence and competence (Adhikari et al., 2018).

ECP students are critical actors in emergency medical systems, not only as learners but also as contributors to the evolving standards of care. Their performance and experiences during training directly impact the quality of prehospital care and inform the future of emergency medical education in South Africa and beyond.

2.5. Summary

Chapter 2 provides a comprehensive review of literature exploring critical dimensions of emergency care practice with a focus on endotracheal intubation (ETI). It explored the clinical significance of ETI as an advanced airway management intervention, as well as the educational approaches adopted to train Emergency Care Practitioner (ECP) students in this skill. While ETI remains a key clinical competency, the review highlighted the challenges of skill acquisition, maintenance, and safe application in high-stakes prehospital contexts.

The literature emphasised the importance of combining theoretical instruction, simulation-based training, and supervised clinical exposure to optimise student learning. Educational frameworks such as Kolb's experiential learning cycle, the Dreyfus model of skill acquisition, and Miller's pyramid of clinical competence were considered to contextualise the progression from novice to competent practitioner. These models provide a basis for aligning educational strategies with competency outcomes, reinforcing the value of structured, staged learning. This evolution in ETI education reflects the broader shift in EMS training towards professionalisation, where student-centred, competency-based approaches integrate theoretical knowledge, simulation, and supervised clinical exposure to support safer and more holistic clinical practice.

Work-integrated learning (WIL) and experiential learning models emerge as vital tools, bridging the gap between academic learning and practical application. These approaches are proposed to address the challenges of mastering ETI and rapid sequence intubation (RSI) in prehospital settings, particularly in low-resource environments. The literature demonstrates that ETI training cannot be reduced to a procedural focus but must be understood as a complex educational process embedded within broader professional and contextual frameworks. This underscores the need for tailored educational strategies that prepare ECP students for competent and safe practice, while addressing both global debates and local challenges in prehospital airway management.

CHAPTER III – METHODOLOGY

3.1. Introduction

This chapter discusses and unpacks the suitability of the research design in relation to the research approach, and issues related to the design, as well as provides a description of the data source and instruments implemented. The data collection procedure and analysis are described, as well as the related ethical considerations. The measures taken to protect the participants and the institution under study are discussed, and there is an exploration of internal and external validity.

3.2. Research Design

This study employed a quantitative retrospective descriptive cross-sectional survey design situated within the quantitative research paradigm. The research focused on retrospective patient and simulation data, documenting instances where Emergency Care Practitioner (ECP) students either performed or observed endotracheal intubation (ETI) procedures across various clinical and simulated settings. The aim was to determine the frequency, diversity, and characteristics of ETI exposures, including patient type (trauma or medical), clinical status (vital signs, medications administered, triage scores), and the environmental context (hospital or prehospital setting). Furthermore, the role of the student (performed or observed) in each ETI event was documented, along with success rates, number of intubation attempts, and the use of advanced airway techniques such as Rapid Sequence Intubation (RSI) (see Annexure B for the complete variable list).

A purposive sampling strategy was used to select 22 exemplar ECP students enrolled during the 2012 and 2013 academic years. This sampling strategy was employed to ensure data integrity, as the included students demonstrated consistent and accurate use of the FISDAP™ platform, with adequate validation measures applied to their clinical entries. Purposive sampling also enabled the researcher to longitudinally trace each student's ETI exposures across the full span of their four-year training programs (graduating in 2015 and 2016, respectively), providing a comprehensive overview of skill development and clinical exposure trends aligned with curriculum progression.

The dataset used for this study was derived from clinical experiences recorded between 2012 and 2016. Although this represents historical data, it provides a valuable opportunity to explore foundational trends in Emergency Care Practitioner (ECP) training during a period of curricular stability. Longitudinal student data spanning a complete clinical cycle (2nd to 4th year) offers rich insights into airway management exposure patterns, skill development trajectories, and gaps in training. Given the limited availability of comparable national datasets, the use of this historical cohort remains highly relevant to informing current and future educational strategies.

3.3. Data Source and Sampling

Data was collected from the CPUT Field Internship Student Data Acquisition Project™ (FISDAP) database. FISDAP™ is a fit-for-purpose skills exposure and learner management system used in many countries in EMS contexts. FISDAP™ is an electronic database and is contractually responsible (as a legal person) for the protection of all information of its users. Due to the nature of internet sources, control and security measures are provided on the systems as all applicants have a personal login and password, which are required each time students need to log in and make an entry. FISDAP™ also uses industry-standard processes, such as cookies, IP addresses, and other industry-standard processes, designed to monitor all activity and performance, whether it is an original submission or a change, it can be traced to a specific time and person.

The FISDAP™ ePRF system was initially implemented for use by ECP students at CPUT in 2012. Data were collected for all intubation-related cases for the sampled students (n = 22) between 01 January 2013 and 31 December 2016. As the data sample included all records for the selected students over the study period, no *a priori* sample size calculation was performed. The data collection began in 2013, as the first cohort (2012 group) would have performed their first intubations in 2013 during their second year of study and completed their programs in 2015. All clinical case information was retrieved for each patient record, which was de-identified, and the dataset was anonymized to maintain both patient and student confidentiality. The frequency and characteristics of ETI exposures, as well as patient clinical characteristics, were recorded.

During their WIL, students were required to document each clinical case after patient contact on the FISDAP™ platform. and hence students documented all skills and their clinical experiences (performed or observed) on the FISDAP™, which is routinely audited for data verification purposes. This data is also used as part of their portfolio submission for professional registration upon graduation. As described above, intubation events are therefore routinely recorded by students during their workplace learning on the FISDAP™ database as part of their program requirements. The same policy applies when practicing skills and simulations in the laboratory with manikins. With each skill entry made by the students, instructors, assigned preceptors, and year coordinators are notified via an automated email system which forwards the students’ patient care narratives for review and auditing. After the completion of a shift, students have 10 working days to finalise and submit their clinical data, after which the shift is electronically locked. Once the shifts are locked, they are unable to add clinical data for that respective shift without special arrangements and additional auditing and verification requirements.

By the end of academic terms, for periodical audits and accreditation, comprehensive reports are generated by clinical facilitators, which form part of the students’ clinical portfolios of evidence. Additionally, reports can be generated that allow for the comparison of students' achievements to their customized program goals that are aligned to the curriculum expectations.

3.4. Data Collection Procedure

Upon receiving ethics approval from the Faculty of Health and Wellness Sciences Research Ethics Committee (REC), the site permission was obtained from the Head of Department, Emergency Medical Sciences at CPUT. Subsequent to receipt of site permission, the departmental FISDAP™ administrator provided access to the FISDAP™ electronic database to sample the dataset as described above (Annexure B).

On sampling the data, all cases were de-identified and anonymised to exclude all patient and student identifiers. All ETI cases for the sampled students for the indicated time period were extracted from the FISDAP™database by the DEMS FISDAP™ administrator and were presented to the researcher in a Microsoft Office Excel™ format. The researcher then screened cases for inclusion.

The data was stored on a secure laptop and password-protected, with the laptop secured in a locked cupboard in an office at the Emergency Medical Sciences Department, at the CPUT, Bellville campus. A data quality audit of all data entries in the dataset was performed by the researcher. In this process, it was noted that from some skills entry categories, students had not completed all FISDAP™ record fields. On further enquiry, it was noted that at the time of data entry, some fields had not existed, while others were not mandatory entry fields. This was particularly true when students added an intubation event as a ‘quick skill’. When this option was selected, the completion of all clinical data parameters for the patient record was no longer required by the platform. This reflects both the developmental process of the FISDAP platform and the evolution of its use in the DEMS over the study period. Thus, for some variables, not all records have completed data, which was reflected as such in the results as missing data.

3.5. Data Processing and Analysis

Statistical analysis was performed using SPSS Version 29. Descriptive analysis included measures of frequency, central tendency and variation as appropriate to individual variable distributions. The statistical methods used in the analysis of associations depended on the variable distributions and included parametric or non-parametric measures as appropriate. ETI success rates were represented as percentages.

An exploratory *post hoc* analysis was performed to explore and measure possible relationships between variables observed during the descriptive analysis. The decision on statistical analysis approach was guided by data type and distribution as assessed on descriptive analysis. Odds ratios, 95% confidence intervals, Chi-Square, Fisher's Exact, and Z-tests were used for the analysis of dichotomous variables as appropriate to data type and distribution as appropriate. T-tests, Kruskal-Wallis and Mann-Whitney U tests were used for the analysis of continuous variables as appropriate, based on data distribution. All hypothesis tests were 2 sided and the significance level was set at p = 0.05. The decision on which possible relationship to include as part of the exploratory *post hoc* inferential analysis was carefully weighed against the risk for false positive of negative conclusions. The robustness of this analysis approach and its limitations will further be discussed in the limitation section in Chapter 5.

3.6. Ethical Approval

3.6.1. Institutional Ethics Clearance/Approval

The study proposal was submitted to the CPUT Faculty of Health Sciences Research Ethics Committee[2] for their approval to conduct this study (Ethics Clearance number: CPUT/HW-REC 2017/H28).

3.6.2 Risk of Group Harm

The researcher committed himself to the optimisation of the benefits and minimisation of the risk of harm to any persons or organizations taking part in this study. The researcher ensured that all raw data were managed with the strictest confidence and that all personal information obtained during the data collection process was only accessible to the researcher and supervisors (Gillon, 1994). The data collection for this study was retrospective in nature; therefore, no patients or participants were harmed during the study (Gillon, 1994). The researcher committed himself to ensuring that no identifying data with reference to patients, supervising practitioners, and hospitals were recorded at any stage during the data collection

[2] The REC is duly registered with the National Research Ethics Council.

process. All of the raw data remains confidential and will be stored in a password-protected file at all times. Only the researcher has access to this file (Ashcroft et al., 2007).

The researcher is employed by CPUT as a former Clinical Instructor and now Lecturer in the Department of Emergency Medical Sciences. As such, the researcher is also accountable by the employee code of conduct and the HPCSA ethics guidelines. This insider status will not create a bias, as the data being assessed is retrospective in nature. Considering an older sample also reduces the risk of harm that would accrue to new graduates. Such risk includes inferences on clinical exposure adequacy, skills competence/proficiency, work-readiness/employability, etc. Care is taken to consider such risk in the analysis. The data collection period is undisclosed here (in the interest of deidentification) but is approved by the Ethics Committee.

3.7. Summary

This chapter outlines the research design, data sources, data collection, and analysis procedures for the study, emphasising ethical considerations and data validity. The study employed a quantitative retrospective descriptive cross-sectional survey design, focusing on 22 exemplar ECP students from the 2012–2013 cohorts. Data was collected through the FISDAP™ platform, a robust learner management system used in EMS contexts, documenting intubation events (performed or observed) between 2013 and 2016.

The dataset, anonymised for confidentiality, included clinical and contextual details of ETI procedures, such as patient characteristics, settings, and student roles. Sampling was purposive to ensure data validity. Data were analysed using SPSS, employing descriptive and inferential statistical methods, including parametric and non-parametric tests, to explore associations and outcomes like ETI success rates.

Ethical clearance was obtained, and strict measures were implemented to safeguard participant confidentiality and minimize risks. The researcher’s insider status was addressed to mitigate bias, with retrospective data reducing potential harm to participants. Limitations related to incomplete data fields in FISDAP™ were acknowledged, reflecting system evolution during the study period.

CHAPTER IV – RESULTS

4.1. Introduction

The data for this analysis were retrieved from the FISDAP™ system for the period of January 2012 to December 2016. The datasets included approximately 800 intubation events, contributed by a total of 22 individual ECP students. The scope of the data encompassed both clinical and simulated intubation procedures, allowing for the analysis of key aspects of intubation success rates, patient demographics, and clinical settings.

For full disclosure, it should be noted that the dataset presented challenges. For example, primary impression data were missing for 70.1% of cases, and other critical parameters, like systolic blood pressure and oxygen saturation, were also absent in over 80% of events. Regardless of these limitations, the available data still could provide meaningful insights into student performance and clinical experiences across various settings.

4.2 Frequency by Clinical Placement Site

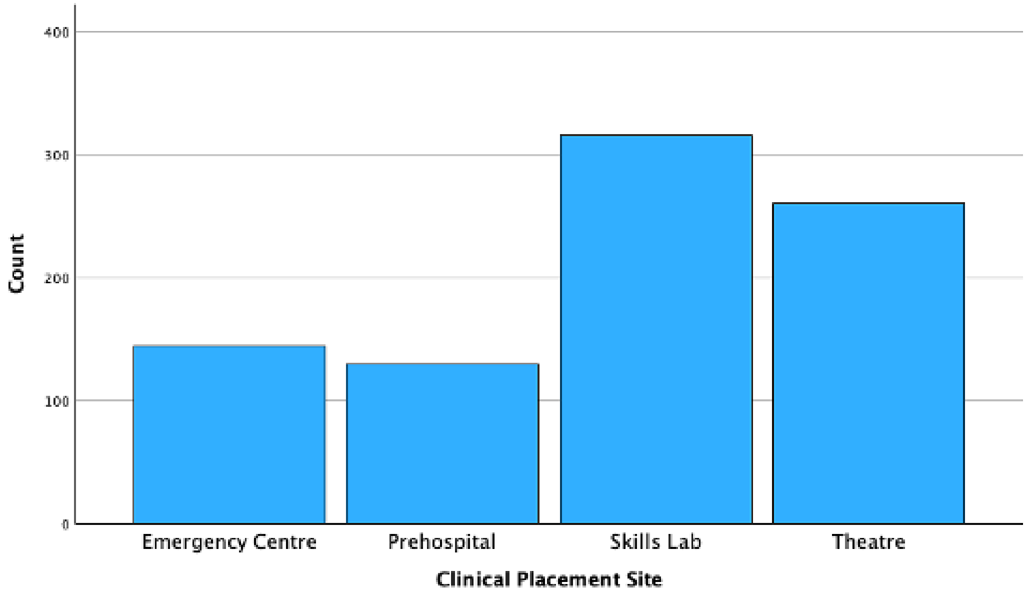

Figure 2: Frequency distribution of intubation events by clinical placement site for the period of January 2012 to December 2016

Table 1: Frequency Distribution of Intubation events by Clinical Placement Site category

		Frequency	%
Clinical Placement Site	Missing Data	1	0.1%
	Emergency Centre	144	16.9%
	Prehospital	129	15.2%
	Skills Lab	316	37.2%
	Operating Room	260	30.6%
	Total	850	100.0%

Figure 2 and Table 1 illustrate the distribution of all (n=850) intubation events performed or observed by ECP students across different clinical placement sites by category. As illustrated in Table 1 and Figure 3 (below), the majority of procedures took place in the clinical setting (62.8%, n=533) with 37.2% (n=316) of events occurring in the skills lab of a simulated setting. Of all intubations in the clinical setting, a total of 260 events (i.e., 30.6% of all events or 48.8% of all clinical intubations) occurred in the operating room setting. In contrast, a total of 273 intubation events (51.2% of all clinical intubations) occurred in the emergency context (prehospital or emergency centres), with 144 intubation events (16.9% of all events) occurring in the emergency centre setting and 129 (15.2% of all events) occurring in the prehospital setting.

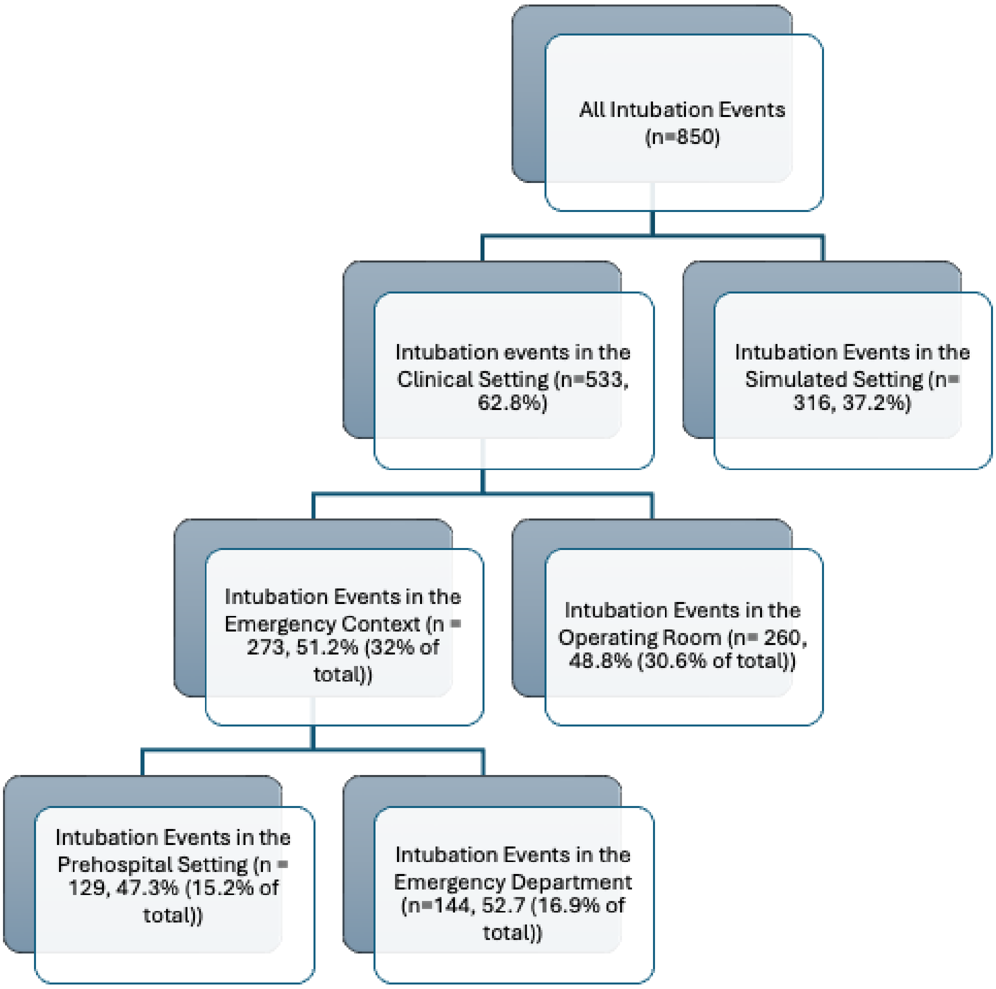

Figure 3: Breakdown of intubation event frequency by clinical site category

4.3 Frequency by Patient Type

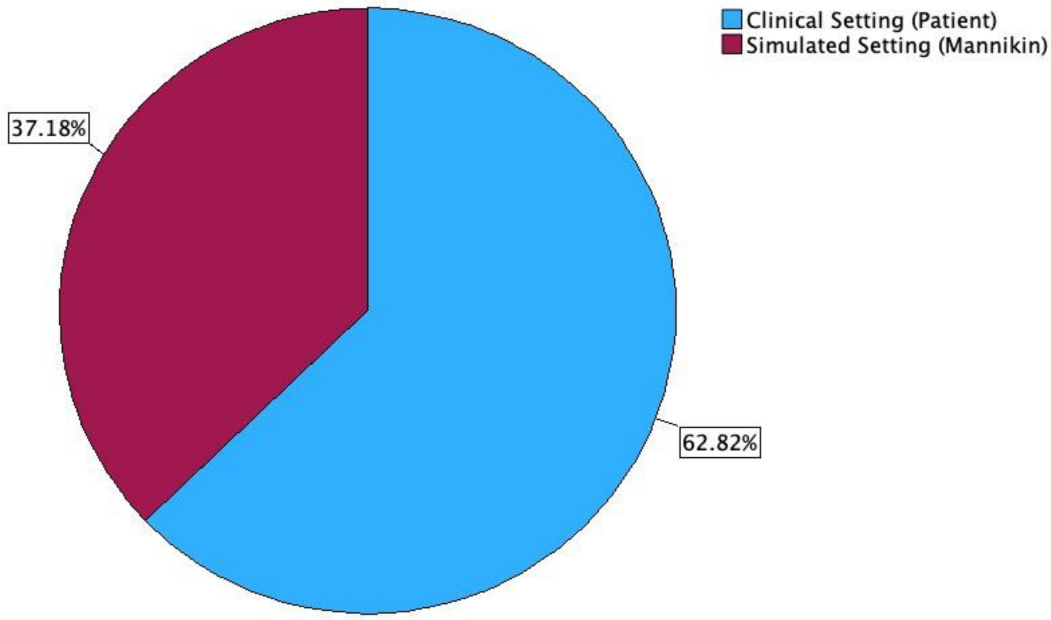

Figure 4: Frequency distribution of intubation events by patient category

Table 2: Distribution of Intubation Events by Patient Category

		Frequency	%
Patient Type Category	Clinical Setting (Live Patient)	534	62.8%
	Simulated Setting (Mannikin)	316	37.2%
	Total	850	100.0%

The pie chart in Figure 4 and Table 2 illustrates the distribution of intubation events performed by ECP students on live patients versus simulation manikins. Most events (62%, n = 534) were performed on live patients in a clinical setting, while 37.2% (n = 316) procedures were performed on manikins in the simulated setting.

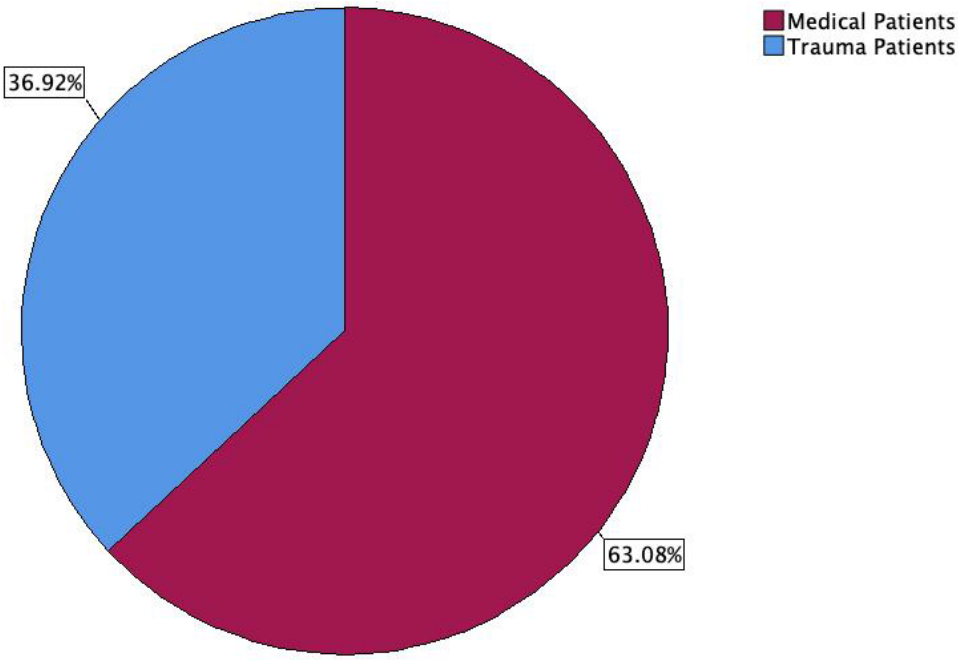

Figure 5: Frequency distribution of intubation events by Medical/Trauma category

Table 3: Frequency distribution of intubation events by Medical/Trauma category

		Frequency	Percentage (%)
Medical / Trauma Category	Missing Data	590	69.4
	Medical	164	19.3
	Trauma	96	11.3
	Total	850	100.0

Figure 5 and Table 3 categorise all intubation events into a dichotomous impression category, as either being related to a Medical or Trauma patient. A total of 63% (n = 164) of cases with valid impression data were linked to patients with medical conditions, while 37% were linked to trauma patients. On further exploratory analysis, there was no direct relationship between the primary (dichotomous) impression category and the odds of students being allowed to perform the intubation procedure (OR = 0.760 (95% CI: 0.432 to 1.335), $x^2 = 0.914$, p = 0.339).

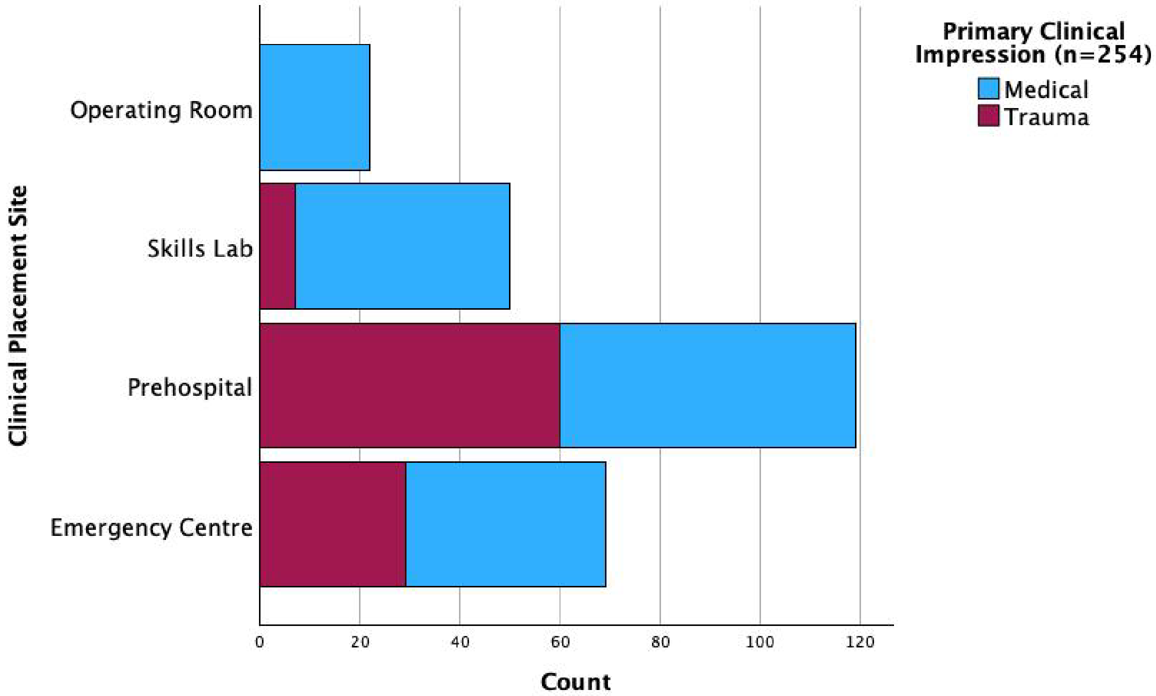

Figure 6: Frequency distribution of medical/ trauma intubation events by clinical site category

The graph in Figure 6 illustrates the frequency distribution of intubation events across clinical placement site categories and primary clinical impression for cases with valid clinical impression data (n = 254). Most intubations occurred in the prehospital environment with close to equivalent exposure to both medical (22.7%) and trauma (23%) cases. In the emergency centre, a close distribution between trauma and medical cases is observed (11.2% vs 15.4%). Interestingly, in the operating room, no trauma cases were observed, while in the Skills Lab (simulated setting), most cases related to medical patient impressions (16.5% vs 2.7% for trauma).

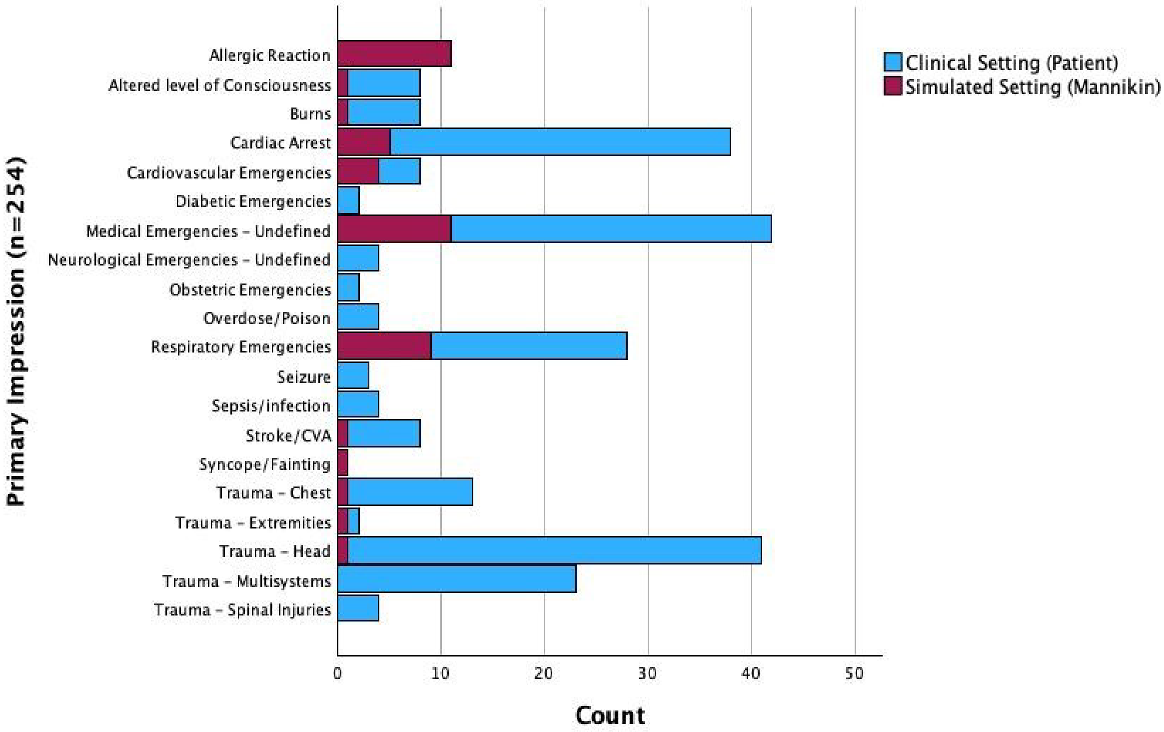

Figure 7: Frequency distribution of intubation events by primary patient impression by patient type category

The distribution of intubation events by primary impression and patient category involving either a live patient in the clinical setting or a simulation manikin is illustrated in Figure 7. Primary impression data is only available for 29.9% (n = 254) of cases in the dataset. The category for Medical Emergencies – Undefined, was the most common specific incident, representing, 16.5% (n = 42), (4.9% of the total cases) followed by "Trauma - Head" 16.1% (n = 41), (4.8% of the total cases) and "Cardiac Arrest" 14.9% (n = 38), (4.5% of the total cases). Other categories, such as "Respiratory Emergencies" 11% (n = 28) (3.3% of total cases) and "Allergic Reactions" 4% (n = 11) (1.3% of total cases), were less frequent. This distribution indicates a wide range of emergency scenarios, with a noticeable focus on trauma and critical conditions, while the large amount of missing data (i.e., data not recorded by the ECP students) highlights potential limitations in the study. It is worth noting that high proportions of intubation exposures for some primary impressions occur in the simulated setting. This trend appears to be most prominent for the primary impressions of allergic reactions, medical emergencies (undefined), cardiovascular emergencies, respiratory emergencies, and syncope/fainting.

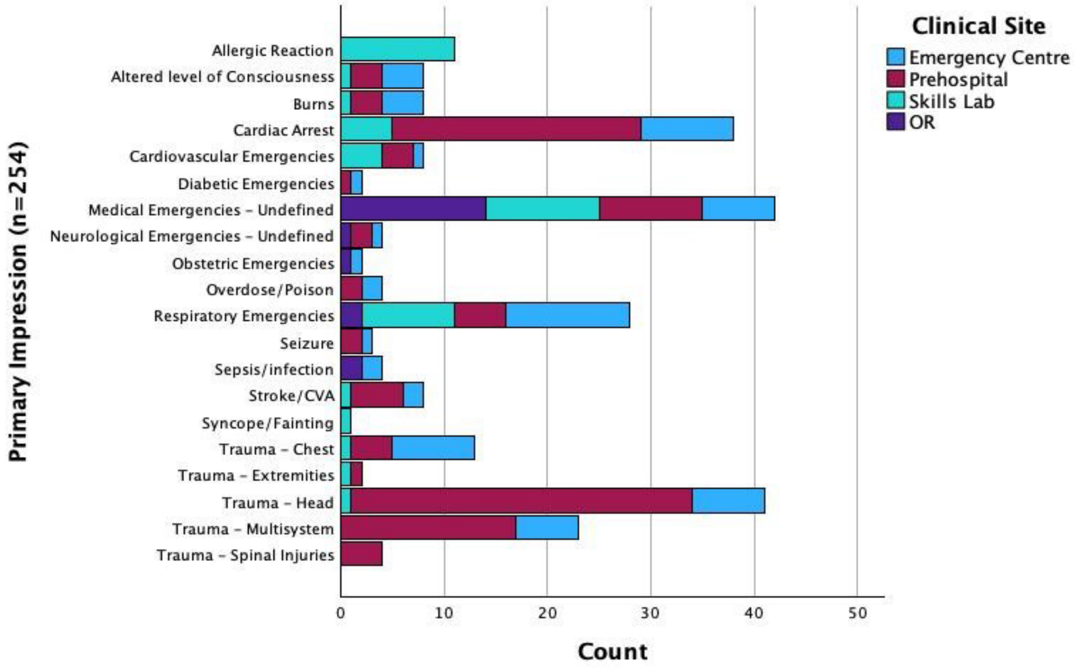

Figure 8: Frequency distribution of intubation events for primary patient impression by clinical site category

Figure 8 illustrates the distribution of primary impressions for 254 cases out of 850 intubation events across various clinical settings. Of the 850 total cases, a total of 596 (70.1%) did not include primary impression data. This implies that there is a substantial amount of data not captured by the ECP students with respect to primary impressions. Intubation events related to trauma, particularly multisystem and extremity-related trauma and cardiac arrest, appear to be most commonly encountered in prehospital and emergency centre settings. In contrast, intubation events associated with medical patients (such as respiratory emergencies), obstetric patients, and septic patients are more often encountered in the hospital setting (EC or OR). It is also worth noting that for some primary impressions, such as allergic reactions, cardiovascular emergencies, and medical emergencies, a larger proportion of recorded intubation events are performed in the skills lab.

4.4 Frequency of intubation events by Airway Anatomy Category

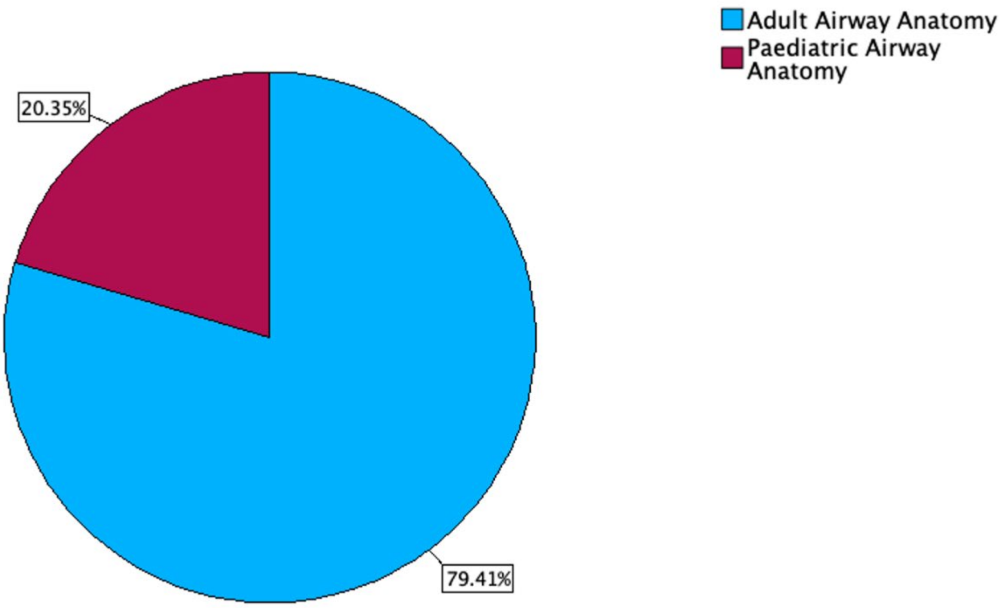

Figure 9: Frequency distribution of intubation events by airway anatomy category

Table 4: Frequency distribution of intubation events by airway anatomy category

		Frequency	%
Age Categories	Missing Data	2	0.2%
	Adult Airway Anatomy	675	79.4%
	Paediatric Airway Anatomy	173	20.4%
	Total	850	100.0%

Figure 9 and Table 4 illustrate the distribution of intubation events by airway anatomy category. The majority of intubation events (79.4%, n = 675) occurred in patients with adult airway anatomy, of which 78.7% (n = 531) of the events occurred in patients in the clinical setting and 21.3% (n = 144) on manikins in the simulated setting. When considering intubation performed in the clinical setting (n=531), students were significantly more likely to perform the intubation procedure on patients with adult airway anatomy as compared to patients with paediatric airway anatomy (Odds Ratio = 3.09 (CI 0.95%: 1.88 - 5.09), $x^2 = 20.99$, $p < 0.001$). A total of

173 (20.4% of all events) intubation events occurred in patients with paediatric airway anatomy. Of all intubation events for patients with paediatric airway anatomy, 75 (43.4%) occurred in patients in the clinical setting. In addition, of all intubation events for paediatric airway anatomy, 30 events occurred in the emergency setting (representing 17% of all paediatric intubation events), with 6 events occurring in the prehospital setting (representing 3% of all paediatric airway anatomy intubation exposures), and 24 in the emergency centre setting (13.8% of all paediatric airway anatomy exposures events). Only 0.7% of all intubation events in the dataset represent paediatric airway anatomy exposures in real patients in the prehospital setting.

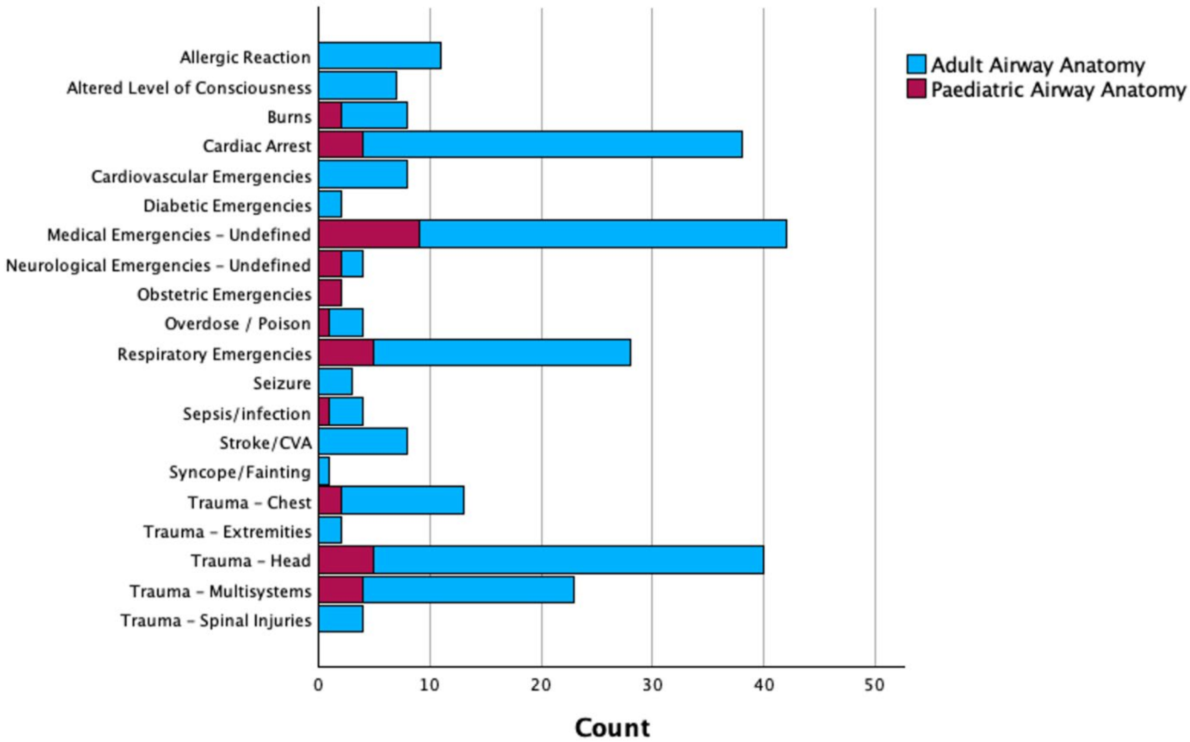

Figure 10: Frequency distribution of intubation events by primary patient impression category by patient airway anatomy category

Figure 10 illustrates the distribution of the patient primary impressions (n=254) for intubation events, classified by airway anatomy category. The data show that for most impression categories, the exposure frequencies are similar to those illustrated in Figure 7 (in which the frequency distribution of intubation events by patient type category is shown). However, in some categories, such as seizures, respiratory emergencies, trauma, and sepsis (common paediatric presentations), exposure appears comparatively lower than that of patients with adult airway anatomy.

4.5 Frequency by Patient Characteristics

Table 5: Initial Patient Vital Signs by Airway Anatomy Category and Clinical Site (Live patients only, n = 75)

		Adult Airway Anatomy		Paediatric Airway Anatomy	
Site		**Mean (95% CI), SD**	**Median (IQR)**	**Mean (95% CI), SD**	**Median (IQR)**
Emergency Centre	**SBP**	126 (100 – 142), 48		90 (56 – 123), 32	
	SpO_2		92 (80 – 98)		97 (95 – 100)
	GCS		4 (3 – 8)		7 (3 – 8)
Prehospital	**SBP**	126 (114 – 137), 39		124 (110 – 137), 17	
	SpO_2		91 (80 – 98)		88 (75 – 95)
	GCS		3 (3 – 8)		3 (3 – 6)
Operating Room	**SBP**	107 (85 – 129), 18		146 (-), -*	
	SpO_2		99		99 (99 – 99)
	GCS		3		15 (15 – 15)

*The low number of eligible data points do not allow for the calculation of 95% CI or SD.

Table 5 presents selected vital sign characteristics of patients encountered in the clinical setting by airway anatomy category and clinical site. Only 88 (10.4%) of the patients in the dataset had complete clinical data by airway anatomy category and placement site.

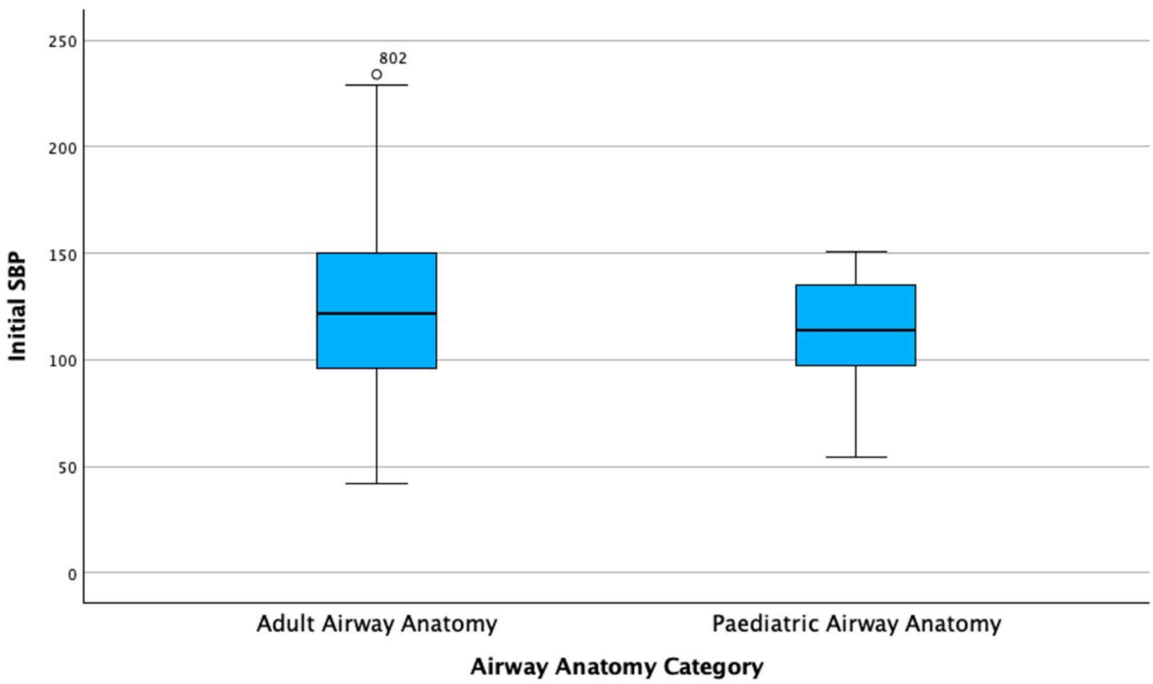

Figure 11: Frequency distribution of Initial Systolic Blood Pressure (SBP) measurements by airway anatomy category

Figure 11 illustrates the distribution of initial Systolic Blood Pressure (SBP) measurements of patients encountered in the clinical setting by airway anatomy category. The data indicate that for most intubation events, the patient's initial SBP fell within normal ranges for both patients with adult and paediatric airway anatomy. As shown in Table 5, the mean SBP of patients with adult anatomy was 126mmHg (CI 0.95; 100 to 142) in the emergency centre setting, 126mmHg (CI 0.95; 114 to 137) in the prehospital setting, and somewhat lower in the Operating Room setting at 107mmHg (CI 0.95; 85 to 129). The mean SBP of patients with paediatric airway anatomy, as shown in Table 5, in the emergency centre setting was recorded at 90mmHg (CI 0.95; 56 to 123) and was at 124mmHg (CI 0.95; 110 to 137) in the prehospital setting.

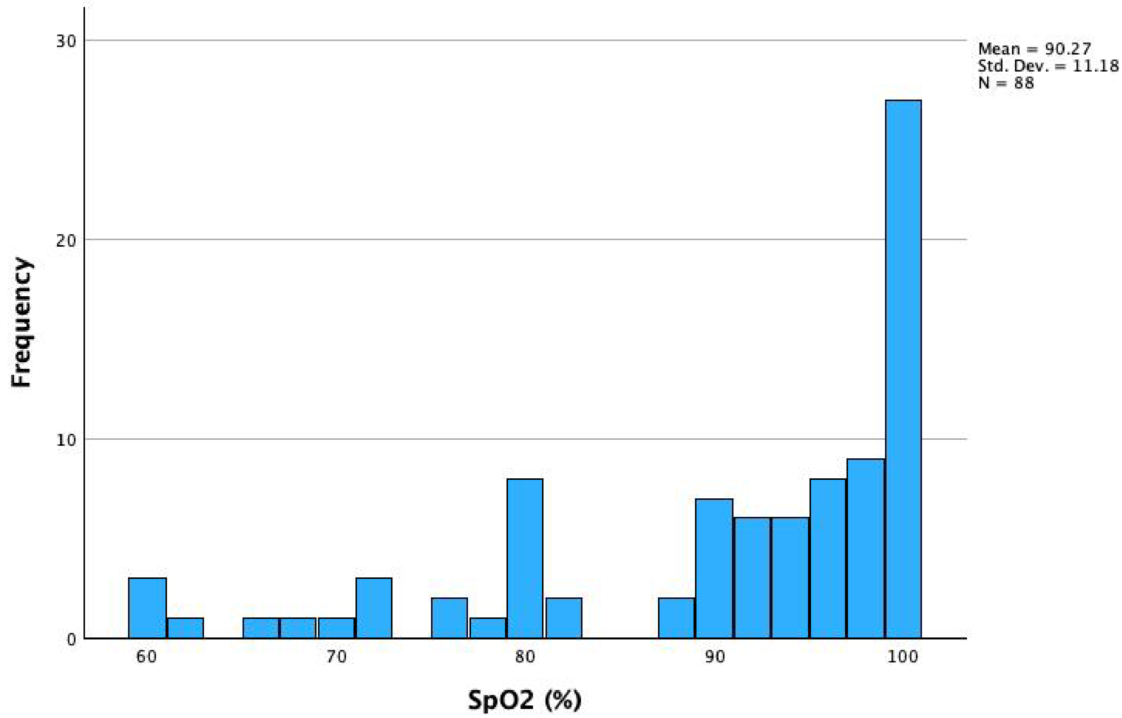

Figure 12: Histogram showing the frequency distribution of initial oxygen saturation (SpO2 (%) values

Figure 12 illustrates the distribution of initial oxygen saturation values. The median oxygen saturation is 94.5% (IQR: 80 to 98) across all patients, with the majority of cases having had an SpO_2 > 90%. However, there are several instances with lower SpO_2 values, within a small but notable proportion of cases between 60% and 80% (usually indicative of significant hypoxemia in patients).

When considering SpO_2 data in relation to setting and patient age category (Table 5), it can be noted that for patients with adult airway anatomy, median SpO_2 was recorded at 92% (IQR: 80 to 98) and 91% (IQR: 80 to 98) in the emergency centre and prehospital settings, respectively. For patients with paediatric airway anatomy, median SpO2 values were recorded at 97% (IQR: 95 – 100) and 88% (75 to 95) for the emergency centre and prehospital setting, respectively.

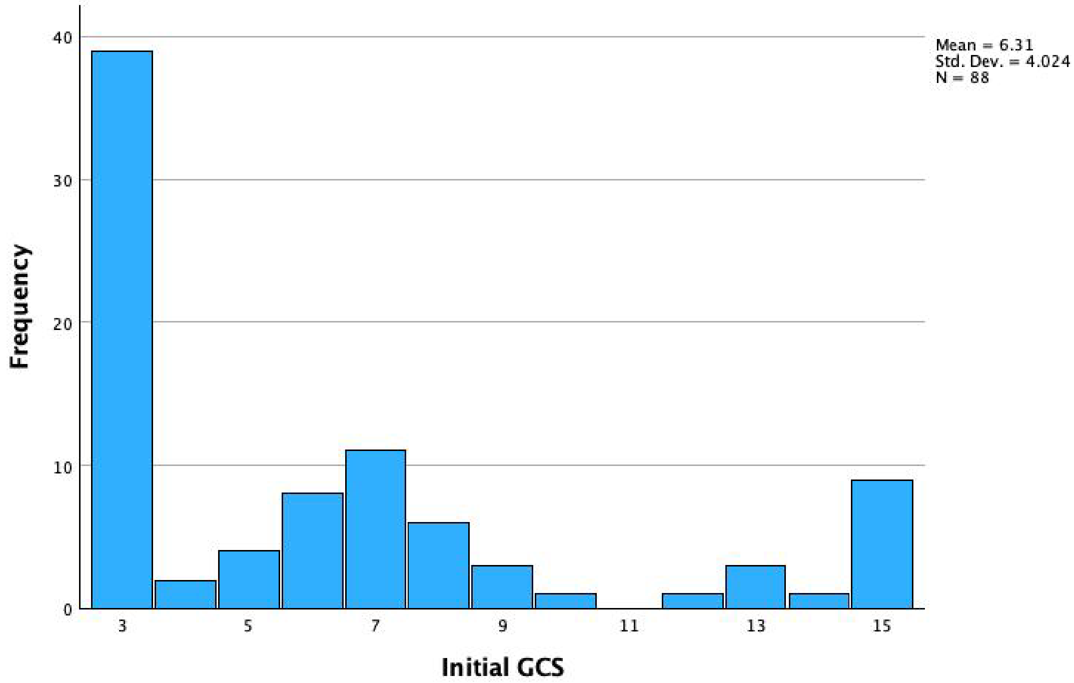

Figure 13: Histogram showing the frequency distribution of Initial GCS (Glasgow Coma Scale) scores

Figure 13 illustrates the distribution for initial Glasgow Coma Scale (GCS) scores for all patients. The median GCS score across all patients was recorded at 5 (IQR; 3 to 8). The most frequent score was noted at a GCS of 3. As shown in Table 5, for patients with adult airway anatomy, the median GCS score was recorded at 4 (IQR: 3 to 8) and 3 (IQR: 3 to 8) for the emergency centre and prehospital settings, respectively. For patients with paediatric airway anatomy, the median initial GCS was recorded at 7 (IQR 3 to 8) and 3 (IQR 3 to 6) for the emergency centre and prehospital settings, respectively. This trend appears to indicate that the initial GCS scores for patients with paediatric airway anatomy being intubated in the prehospital setting tended to be lower than those intubated in the emergency department setting. To test this possible relationship, a Kruskal-Wallis Test was performed. There was no statistically significant difference between the initial GCS score and clinical sites when considering all cases (x^2 = 1.581, p = 0.454). When considering only cases with paediatric airway anatomy and a pairwise comparison between prehospital and emergency centre intubations, there was also no statistical difference in initial GCS scores observed (x^2 = 3.683, p = 0.374).

4.6 Frequency by Perform or Observed Intubation Events

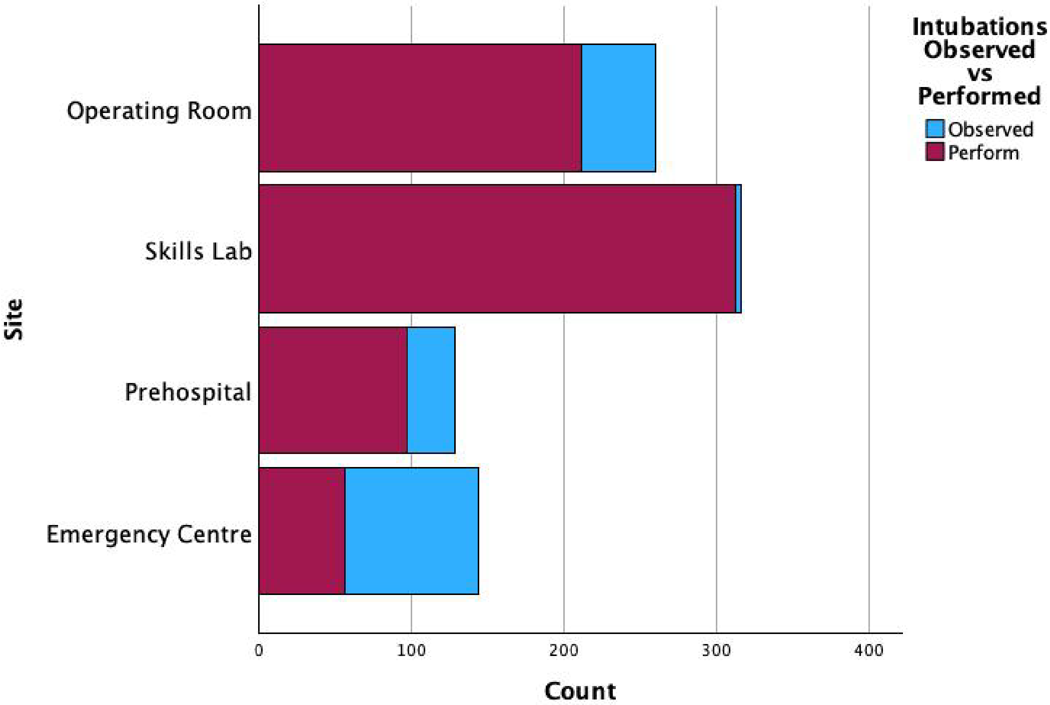

Figure 14: Frequency distribution intubation events perform or observed by clinical placement site category

Table 6: Frequency of intubations events performed and observed by clinical placement site.

		Performed	Observed	Total
Clinical Placement Site	**Missing Data**	0	1	1
	Emergency Centre	56	88	144
	Prehospital	97	31	128
	Skills Lab	312	4	316
	Operating Room	211	49	260
Total		676	173	849

Table 6 shows that most intubation events (79.6%) were performed by students. This appears to be the case for most placement sites except for the emergency centre setting, where more intubations were observed (Figure 14). When considering the relationship between clinical placement site category and whether students were likely to perform intubations at these sites, a significant relationship is noted (x^2 = 223.85, p <0.001).

Data analysed from clinical placement sites excluding the skills lab setting (therefore only live patients) showed a significantly higher odds of a student performing an intubation in the operating room when compared to the emergency setting (prehospital or emergency centre), OR = 3.35 (CI 0.95; 2.26 to 4.96), x^2 = 38.16, $p < 0.001$. When considering the same comparison between the prehospital setting alone and the operating room, the relationship was not significant, OR = 0.727 (CI 0.95; 0.44 to 1.21), x^2 = 1.51, p = 0.219. Comparison of the same relationship between performed intubations in the emergency department and in the operating room showed that the odds were significantly lower for a student to perform the intubation in the emergency department, OR = 0.148 (CI 0.95; 0.09 to 0.23), x^2 = 73.87, $p < 0.001$.

Table 7: Frequency distribution of intubation events performed or observed by category on patients in the clinical setting (excluding simulated patients)

	Performed		Observed	
	n	**%**	**n**	**%**
Airway Anatomy Category				
Missing Data	2	0.5%	0	0.0%
Adult Airway Anatomy	328	90.1%	128	75.7%
Paediatric Airway Anatomy	34	9.3%	41	24.3%
Medical or Trauma				
Missing Data	238	65.4%	86	50.9%
Medical	69	19.0%	51	18.9%
Trauma	57	15.7%	32	18.9%
First Attempt Success				
Yes	309	84.9%	86	50.9%
No	55	15.1%	57	33%
Primary Clinical Impression				
Missing Data	238	65.4%	89	52.7%

Altered level of Consciousness	4	1.1%	3	1.8%
Burns	2	0.5%	5	3.0%
Cardiac Arrest	24	6.6%	9	5.3%
Cardiovascular Emergencies	2	0.5%	2	1.2%
Diabetic Emergencies	1	0.3%	1	0.6%
Medical Emergencies - Undefined	20	5.5%	11	6.5%
Neurological Emergencies - Undefined	3	0.8%	1	0.6%
Obstetric Emergencies	0	0.0%	2	1.2%
Overdose / Poison	0	0.0%	4	2.4%
Respiratory Emergencies	11	3.0%	8	4.7%
Seizure	1	0.3%	1	0.6%
Sepsis/infection	1	0.3%	3	1.8%
Stroke/CVA	4	1.1%	3	1.8%
Trauma - Chest	5	1.4%	7	4.1%
Trauma - Extremities	1	0.3%	0	0.0%
Trauma - Head	30	8.2%	10	5.9%
Trauma – multi-system	17	4.7%	6	3.6%
Trauma - Spinal Injuries	0	0.0%	4	2.4%
Vital Signs	**Mean (95% CI)**	**SD**	**Mean (95% CI)**	**SD**
Initial SBP	127 (117 – 137)	39	118 (106 – 130)	42
	Median	**IQR**	**Median**	**IQR**
Initial SpO_2	91	80 - 98	95	80 – 99
Initial GCS	3	3 – 8	3	3 - 8

Table 7 illustrates a comparison between performed and observed intubation events across various categories.

Comparison of Performed and Observed Intubations by Airway Anatomy Category

For intubations performed by students, the majority (90.1%) were performed on patients with adult airway anatomy compared to only 9.3% on patients with paediatric airway anatomy. For observed intubation events, a slightly higher proportion of events is noted for patients with paediatric airway anatomy (24.3%) as compared to those performed. The odds of a student performing an intubation on a patient with adult airway anatomy were significantly higher compared to a patient with paediatric airway anatomy (OR = 3.09 (95% CI: 1.877 to 5.087), x^2 = 20.99, p <0.001). This is noteworthy, as only 75 intubation exposures involving patients with paediatric airway anatomy occurred in the clinical setting (excluding simulated cases), of which only 34 (45%) were intubated by students. When compared to patients with adult airway anatomy in the clinical setting (n 456), students performed the intubation in 71.9% (n = 328) of cases. With exposure to paediatric airway anatomy being less frequent compared to adult airway anatomy, the lower relative rate of intubation performance opportunities is noteworthy.

Comparison of Performed and Observed Intubations by First Attempt Success Category

Data obtained from student-performed intubation events showed an 84.9% first attempt success rate. When compared to intubation events observed by students, a 66.3% first attempt success rate is observed for these events. Odds ratio for first attempt success when students perform the intubation is 2.859 (95% CI: 1.862 to 4.391, x^2 = 24.1, p <0.001) when compared to observed intubations.

Comparison of Performed and Observed Intubations by Medical or Trauma Category

In the Medical or Trauma category, performed intubations comprised 19% of medical cases and 15.7% of trauma cases. For observed events, a higher proportion of medical intubations were recorded at 30.2%, while trauma events represented 18.9% of the events. This observed difference was, however, not statistically significant, OR = 0.760 (95% CI: 0.432 to 1.335), x^2 = 0.914, p = 0.34. Analysis indicates that within this sample of students, they were equally likely to be allowed to intubate a medical or trauma patient.

Comparison of Performed and Observed Intubations by Primary Impression Clinical Category

The most frequently performed procedures are in cases involving trauma to the head (8.2%), cardiac arrest (6.6%), and undefined medical emergencies (5.5%). With observed intubations, the most common primary impressions are also head trauma (5.9%), undefined medical emergencies (6.5%), and cardiac arrest (5.3%). Certain categories, such as obstetric emergencies and burns cases, show small but notable accounts in observed cases but none in performed cases, again indicating student exposure to these cases in practice, with what appears to be very limited opportunity to perform intubations.

Comparison of Performed and Observed Intubations by Patient Vital Signs

Analysis conducted between performed and observed intubation categories for Mean SBP ($p = 0.14$), SpO_2 ($p = 0.37$), and Initial GCS ($p = 0.79$) values showed no statistical differences despite a trend towards slightly higher mean SBP values in the performed group and higher median SpO_2 values in the observed group. The significance of the observed differences above was tested using the Mann-Whitney U Test.

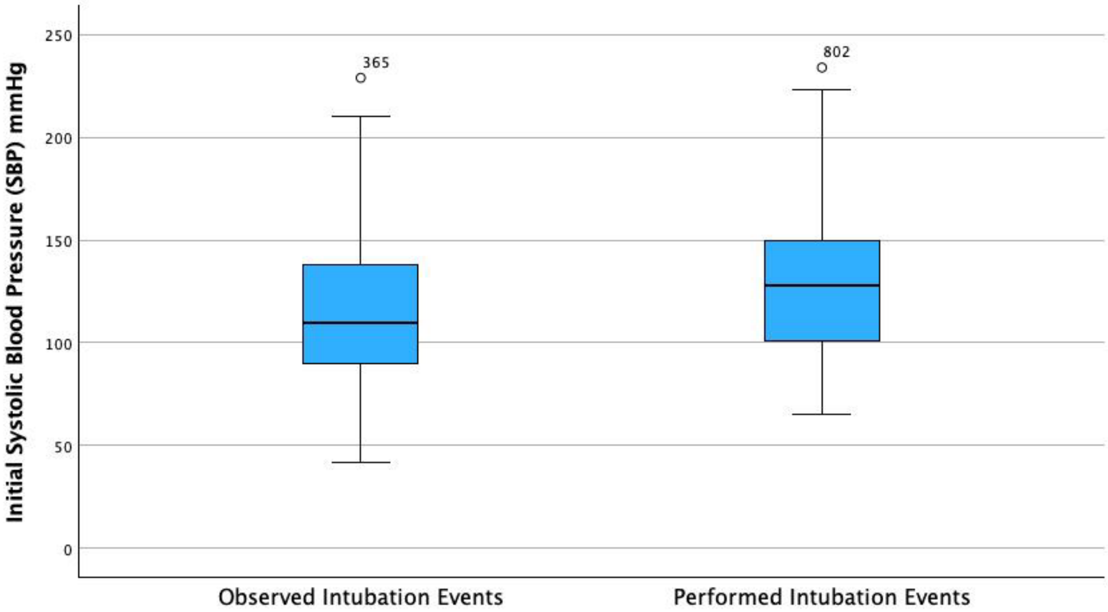

Figure 15: Frequency distribution of systolic blood pressure (SBP) values by performed or observed intubation category

The boxplot (Figure 15) illustrates the distribution of SBP values for observed and performed intubation events. Both groups have similar mean SBP values, but the Observed group has greater variability and more outliers, indicating a wider range of patient conditions with at least one event (event 365) showing an SBP above 200 mmHg, a notable deviation from the overall trend. The Performed group shows a more compact distribution, though it also contains a few outliers, such as (event 802) in this group with an SBP above 200 mmHg. As noted, there is no statistically significant difference between mean SBP values between observed and performed intubations (Mann-Whitney U Test statistic = 1820.5, $p = 0.14$)

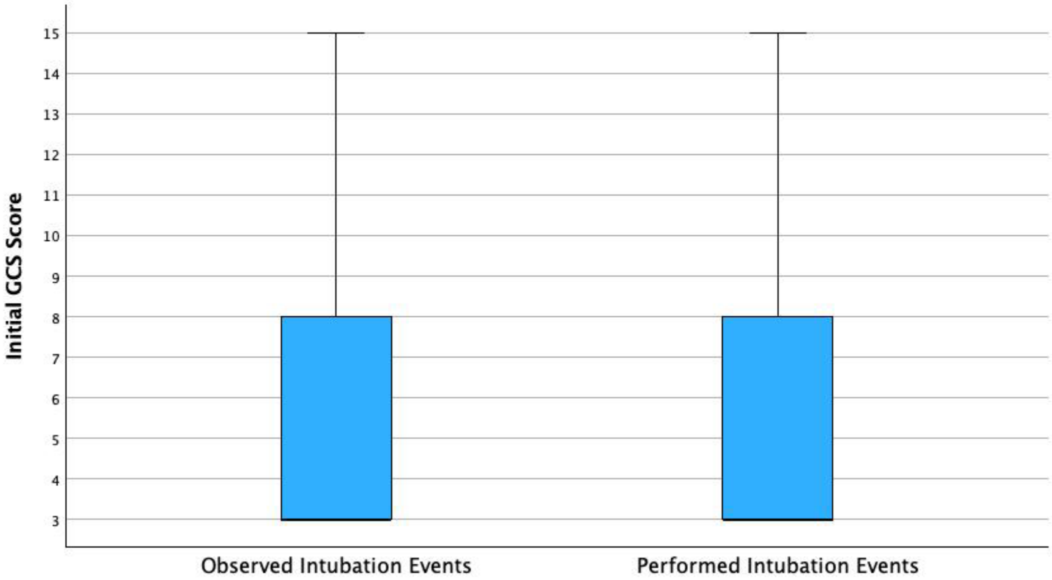

Figure 16: Frequency distribution of Initial Glasgow Coma Scale (GCS) by performed or observed intubation category

Figure 16 illustrates the distribution of Initial GCS scores for Observed and Performed intubation events. Both groups display similar distributions, with the median GCS at 3 for both. The ranges are comparable, with no significant variation (Mann-Whitney U Test statistic = 2085.0, p = 0.79).

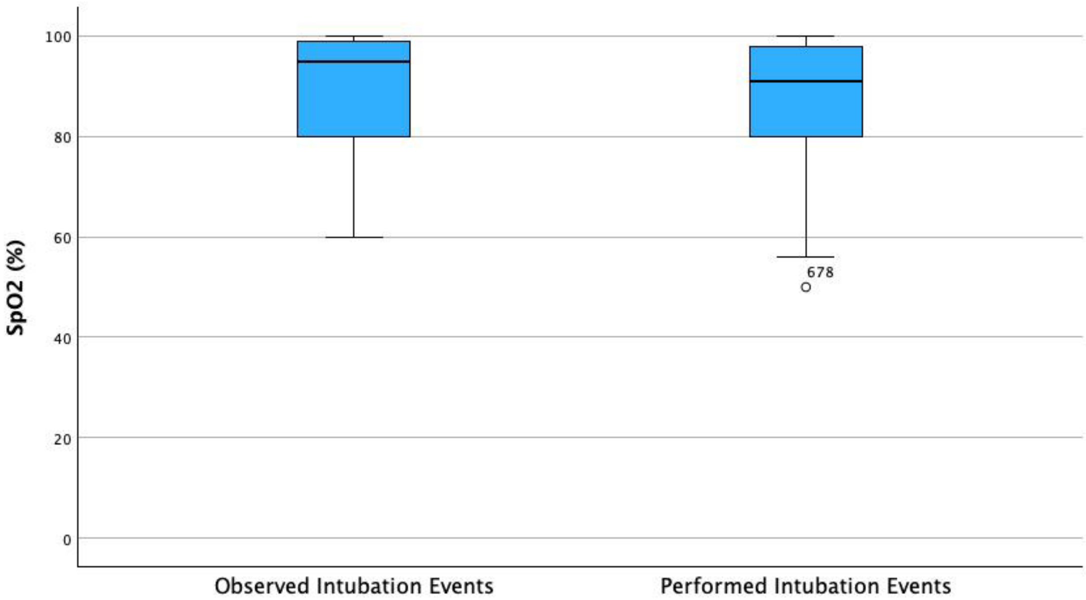

Figure 17: Frequency distribution of SpO2 (oxygen saturation) values by performed or observed intubation category

Distribution of SpO_2 values for Observed and Performed intubations events are illustrated in Figure 17. Both groups have similar ranges, with SpO_2 medians of 95% and 91%, respectively. The observed group shows a slightly wider range of SpO_2 values. These observed differences are not statistically significant (Mann-Whitney U Test statistic = 2075.5, p = 0.37).

4.7 Rapid Sequence Intubation and Exposure to Induction and Paralytic Agents

A total of 114 Rapid Sequence Induction intubation (RSI) procedures were recorded in the clinical setting, with 72 (65%) being performed by ECP students.

Table 8: Frequency Distribution RSI events by Perform or Observed Intubation Category

	Live Patient (Clinical Setting)					Simulated Patients (Mannikin)				
	Performed		Observed			Performed		Observed		
	n	%	n	%	Total	n	%	n	%	Total
RSI	72	63.2	42	36.8	114	1	100	0	0	1
Induction Agent (Ketamine/Midazolam/Etomidate)	76	58.9	53	41.1	129	3	100	0	0	3
Suxamethonium Chloride	44	63.8	25	36.2	69	1	100	0	0	1
Rocuronium Bromide	9	56.3	7	43.8	16	0	0	0	0	0

Table 8 shows that the majority of RSI data recorded in the dataset occurred in the clinical setting on live patients. It may appear that simulated RSI procedures may not have been routinely recorded by students. When considering RSI procedures recorded in the clinical setting, a total of 114 are recorded, with a total of 72 (63.2%) being performed by students. This demonstrates that only 13.4% (114 of a total of 850) of all intubation events in this dataset involved RSI, which also accounts for only 21.4% (114 of a total of 532) of all intubation events that occurred in the clinical setting on live patients. It should also be noted that only 48 of a total of 532, or 9% RSIs, occurred in live patients in the prehospital setting, while only 16% (85 of a total of 532) occurred in live patients in an emergency context. This data shows that contextually relevant RSI exposures are exceedingly rare events for students. Students also reported 129 intubation procedures associated with administration of induction agents (included in the ECP scope or practice) where administered of which 58.9% were administered by students. Analysis related to neuromuscular blocking agents (NMBA) shows 69 cases of Suxamethonium Chloride administration, of which 63.8% were administered by students, while 16 cases of rocuronium administration were recorded, of which 56% were administered by students.

Analysis of the relationship between the use of RSI and whether events were performed or observed by students, an OR of 0.734 (95% CI: 0.475 to 1.134, x^2 = 1.95, p = 0.163) showed no statistically significant relationship between RSI being performed and a student being allowed to perform the procedure.

Data in Table 9, below, shows that only 69% of RSI procedures achieved first attempt intubation success. As previously mentioned, the majority of RSI procedures occurred in the emergency context (75%), with 48 (42%) occurring in the prehospital setting and 37 (33%) in the emergency department. RSI in patients with paediatric airway anatomy appears to be very rare (n = 16 or 15%), with RSI procedures primarily involving patients with adult airway anatomy (n = 97 or 85%). The majority of RSI procedures involved trauma patients (n = 45 or 39%) with head trauma or multi-system trauma, representing the largest primary clinical impression categories.

Table 9: Characteristics of RSI-related intubation procedures performed or observed by students in the clinical setting (n=114)

		Performed (n = 72)	Observed (n = 42)	
		n (Row %)	n (Row %)	Total (Column %)
First Attempt Success	Yes	56 (71)	23 (29)	79 (69)
	No	16 (46)	19 (54)	35 (31)
Primary Context	Operating Room	20 (69)	9 (31)	29 (25)
	Emergency Setting	52 (61)	33 (39)	85 (75)
Clinical Placement Site	Emergency Centre	14 (38)	23 (62)	37 (33)
	Prehospital	38 (79)	10 (21)	48 (42)
	Operating Room	20 (69)	9 (31)	29 (25)
	Adult Airway Anatomy	64 (66)	33 (34)	97 (85)

Airway Anatomy Category	Paediatric Airway Anatomy	7 (44)	9 (56)	16 (15)
Primary Clinical Impression	Missing Data	19 (59)	13 (41)	32 (28)
	Altered level of Consciousness	4 (80)	1 (20)	5 (4)
	Burns	1 (25)	3 (75)	4 (4)
	Cardiac Arrest	1 (50)	1 (50)	2 (2)
	Cardiovascular Emergencies	0 (0)	0 (0)	0 (0)
	Diabetic Emergencies	0 (0)	1 (100)	1 (1)
	Medical Emergencies - Undefined	6 (60)	4 (40)	10 (9)
	Neurological Emergencies - Undefined	1 (100)	0 (0)	1 (1)
	Obstetric Emergencies	0 (0)	0 (0)	0 (0)
	Overdose / Poison	0 (0)	2 (100)	2 (2)
	Respiratory Emergencies	5 (100)	0 (0)	5 (4)
	Seizure	0 (0)	1 (100)	1 (1)
	Sepsis/infection	1 (50)	1 (50)	2 (2)
	Stroke/CVA	3 (75)	1 (25)	4 (4)
	Trauma - Chest	1 (20)	5 (80)	6 (5)
	Trauma - Extremities	1 (100)	0 (0)	1 (1)
	Trauma - Head	18 (82)	4 (18)	22 (19)
	Trauma – Multi-systems	11 (79)	3 (21)	14 (12)

Trauma - Spinal Injuries	0 (0)	2 (100)	2 (2)

4.8 Frequency by Intubation Procedures with students acting in the Lead or Assistant role.

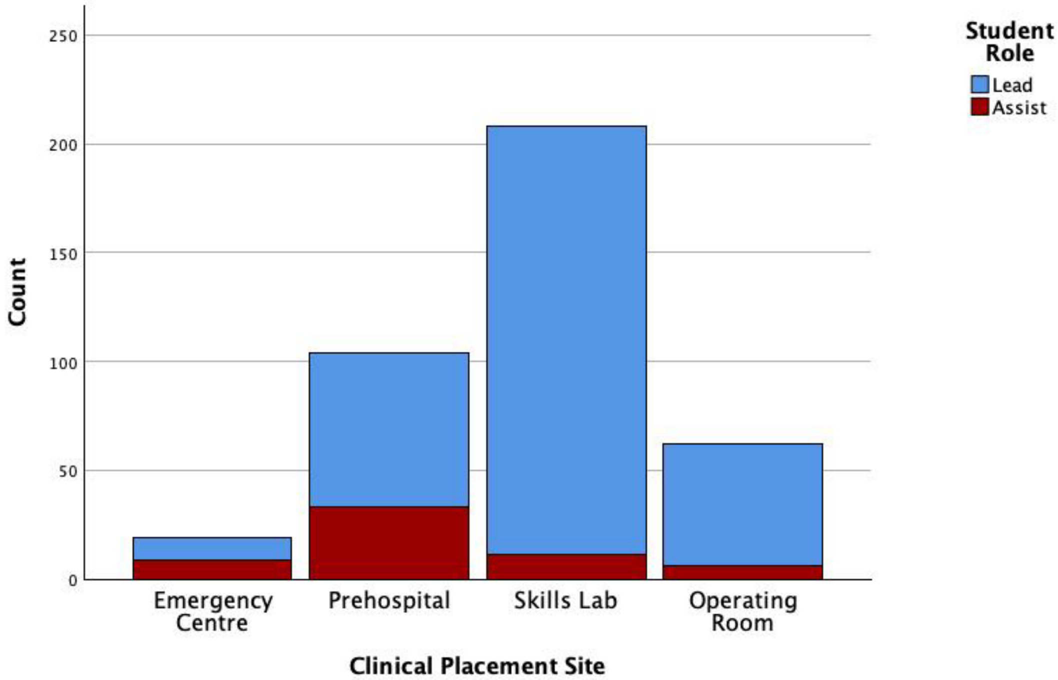

Figure 18: Frequency Distribution of intubation events lead or assist by clinical placement site category

Figure 18 presents the distribution of the student role (Lead vs. Assist) in the intubation event across different placement sites. The lead role implies that the student is acting as the lead clinician role managing the patient (under supervision). It should be noted that in this role the student is responsible for managing all aspects of the case, including decision making regarding techniques and medications. This can include the performance of clinical skills such as intubation, but may also involve the delegation of these tasks to other providers by the student. It can be noted that for most of the recorded intubation events, students acted in the lead role (while under supervision), particularly in the Skills Lab, where the majority of cases are led by students. This trend is also prevalent in the Prehospital setting, though there is a larger proportion of assist roles compared to other environments. Data from Theatre sites also shows a predominance of lead roles. In the Emergency Centre, the counts for lead and assist roles are nearly equal, though the overall number of cases in this setting is lower than in the other settings.

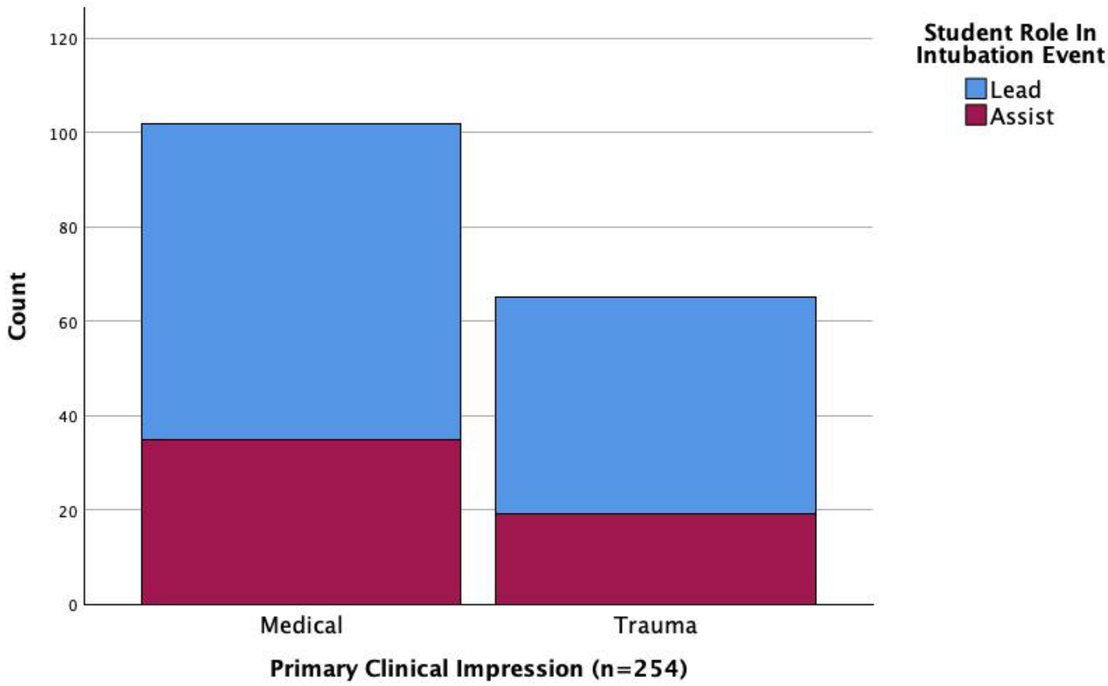

Figure 19: Frequency distribution of student role in intubation event by primary clinical impression category

Table 10: Frequency Distribution of Medical/ Trauma intubation events by Student Role (Lead or Assist) category

		Frequency	Percentage (%)
Student Role in the Procedure	Missing Data	456	53.6%
	Assist	59	6.9%
	Lead	335	39.4%
	Total	850	100.0%

The distribution of student roles by primary clinical impression category is illustrated in Figure 19 and Table 10. For intubation event cases, which include valid student role data (46.4%), the majority of intubation events were led by students (39.4%, n = 335). This suggests that for a significant portion of intubation events with valid data, students are involved in the role of incident lead. Students were also more likely to perform the intubation procedure if they were acting in the lead role for the case (OR = 9.56; CI 0.95: 4.5 to 20.3, x^2 = 40.475, $p < 0.001$).

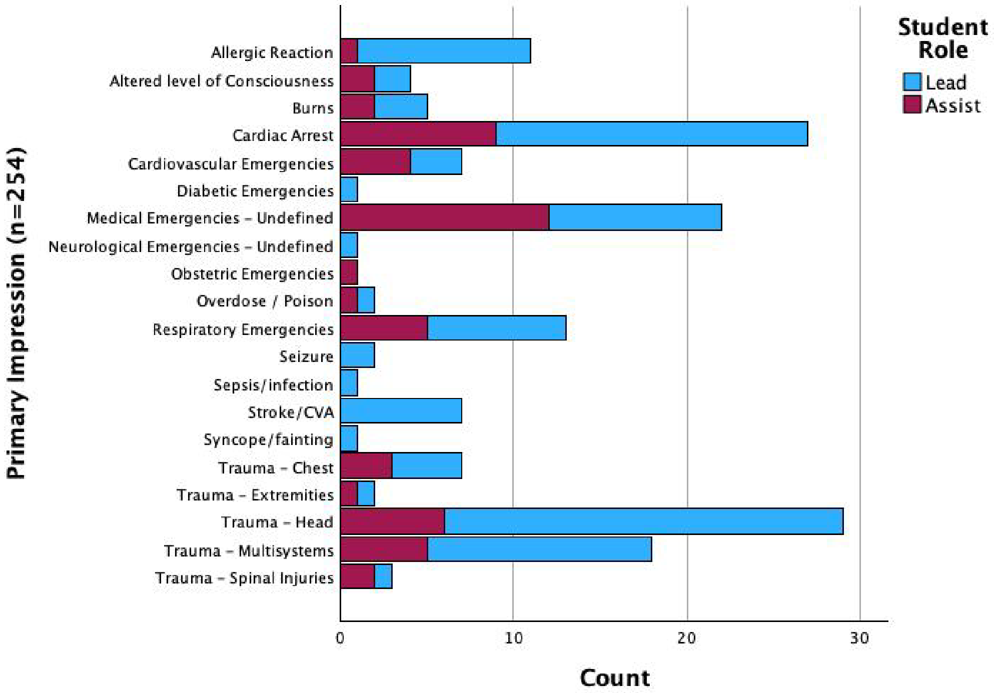

Figure 20: Frequency distribution of intubation events lead or assist by primary patient impression category

Figure 20 presents the distribution of primary impressions for patients by student role. For the majority of intubation events, students acted in the lead role for most primary impression categories. The exceptions to this trend include the Cardiovascular Emergencies, Undefined medical emergencies, and primary impression categories, where students appear more likely to act in the assistant role. Students were significantly more likely, almost 10-fold more likely, to perform the intubation procedure when they were also acting in the lead role (OR = 9.560 (95% CI: 4.496 to 20.327), x^2 = 40.48, $p < 0.001$) as compared to acting in the assistant role.

4.9 Frequency by Intubation Procedure Success Rate (All Attempts)

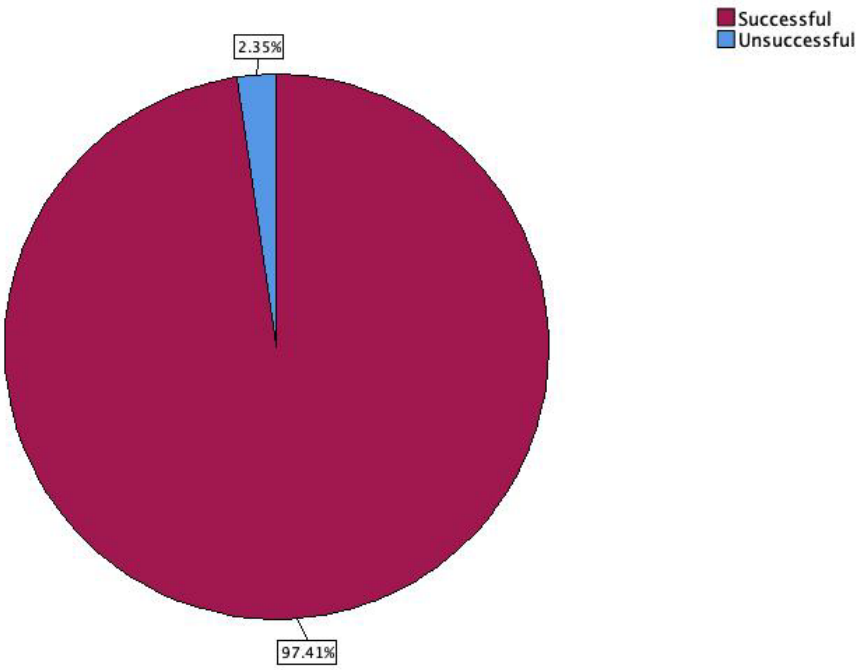

Figure 21: Frequency Distribution intubation events by successful or unsuccessful category

Table 11: Frequency Distribution intubation events by successful or unsuccessful category

		Frequency	Percent	Valid Percent	Cumulative Percent
ETI Success (all attempts)	Missing Data	2	.2	.2	.2
	Successful	828	97.4	97.4	97.6
	Unsuccessful	20	2.4	2.4	100.0
	Total	850	100.0	100.0	

The data presented in Figure 21 and Table 11 illustrated the rate of overall intubation procedure success for all intubation attempts. As shown, a total of 97.4% of intubation events were categorised as "Successful," indicating a high success rate. Only n=20 (2.4%) of the events were marked as "Unsuccessful" where the patient could not be intubated.

Table 12: Frequency Distribution intubation events by unsuccessful outcomes by various category

		Unsuccessful ETI		Total	
		Frequency	%	Frequency	%
Airway Anatomy Category	Adult Airway Anatomy	20	100.0%	20	100.0%
	Paediatric Airway Anatomy	0	0%	0%	0%
Primary Clinical Impression	**Missing Data**	2	10.0%	2	10.0%
	Allergic Reaction	1	5.0%	1	5.0%
	Altered level of Consciousness	1	5.0%	1	5.0%
	Cardiovascular Emergencies	2	10.0%	2	10.0%
	Respiratory Emergencies	1	5.0%	1	5.0%
	Seizure	2	10.0%	2	10.0%
	Sepsis/infection	1	5.0%	1	5.0%
	Trauma - Chest	1	5.0%	1	5.0%
	Trauma - Head	4	20.0%	4	20.0%
	Trauma - Multisystems	5	25.0%	5	25.0%
Medical or Trauma	**Missing data**	2	10.0%	2	10.0%
	Medical	9	45.0%	9	45.0%
	Trauma	9	45.0%	9	45.0%
Clinical Placement Site	Emergency Centre	6	30.0%	6	30.0%
	Prehospital	11	55.0%	11	55.0%
	Skills Lab	2	10.0%	2	10.0%
	Theatre	1	5.0%	1	5.0%
Perform or observed	**Missing Data**	1	5.0%	1	5.0%
	Observed	2	10.0%	2	10.0%
	Perform	17	85.0%	17	85.0%

Mannikin or Live Patient	Live Patient	18	90.0%	18	90.0%
	Mannikin	2	10.0%	2	10.0%

The detailed breakdown of unsuccessful intubation attempts by various categories is shown in Table 12. In terms of airway anatomy, all unsuccessful events were associated with patients with adult airway anatomy, with no unsuccessful events recorded for patients with paediatric airway anatomy. Analysing the primary impressions associated with unsuccessful outcomes, "Trauma - Head" and "Trauma – Multi-systems" had the highest incidence, accounting for 20.0% (n=4) and 25.0% (n=5) of the unsuccessful cases, respectively. Other categories, such as "Cardiovascular Emergencies" and "Seizure," each represented 10.0% (n=2) of the unsuccessful cases, indicating varied but specific issues across different types of incidents. Regarding the medical vs. trauma categorization, unsuccessful outcomes were evenly split between medical 45.0% and trauma 45.0% (n=9 events).

Clinical placement site analysis reveals that the majority of unsuccessful cases occurred in the prehospital setting, 55.0% (n=11), with a smaller proportion in emergency centres, 30.0% (n=6), and other settings. Procedure type intubations performed by students had the highest percentage of unsuccessful outcomes, 85.0% (n=17), compared to "Observed," 10.0% (n=2) intubation attempts. The unsuccessful cases predominantly involved live patients, 90.0% (n=18), with a smaller proportion of 10.0% involving manikins in the simulation lab (n=2).

4.10 Number of Intubation Attempts

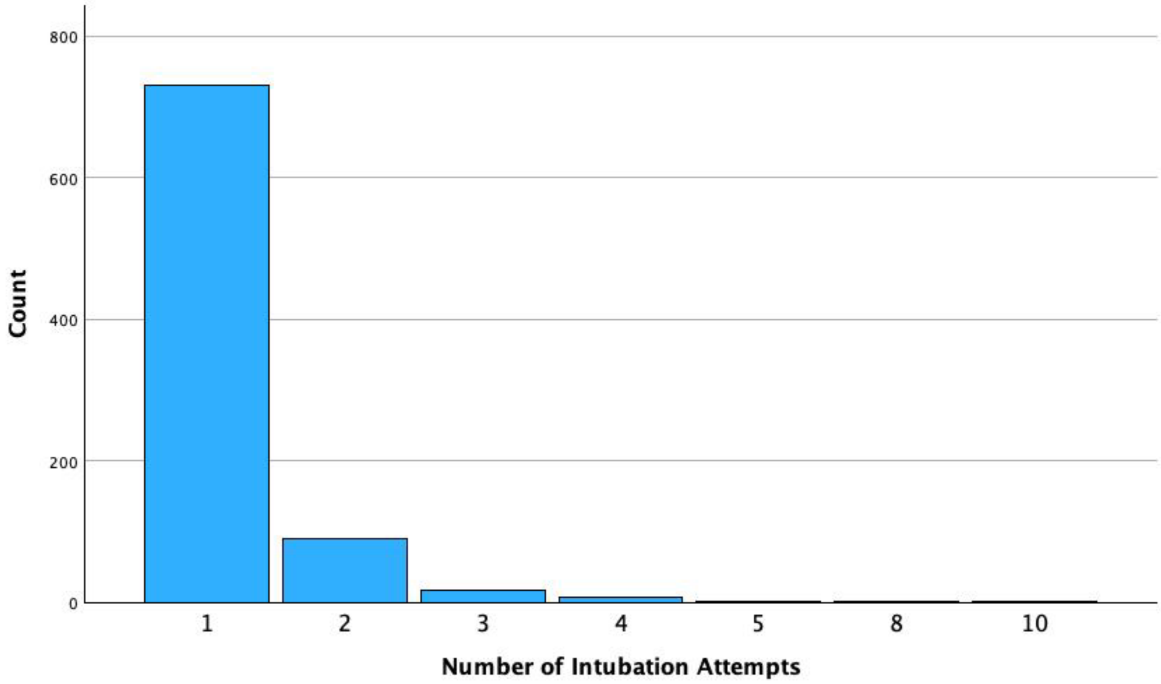

Figure 22: Frequency distribution intubation events success rate by attempts category

Table 13: Frequency Distribution intubation events attempt by successful category

		Successful ETI		Unsuccessful ETI	
		Frequency	**%**	**Frequency**	**%**
Number of Intubation Attempts	1	724	87.4%	5	25.0%
	2	78	9.4%	12	60.0%
	3	15	1.8%	2	10.0%
	4	7	0.8%	1	5.0%
	5	1	0.1%	0	0.0%
	8	2	0.2%	0	0.0%
	10	1	0.1%	0	0.0%
	Total	828	100.0%	20	100.0%

Figure 22 and Table 13 show the distribution of the number of intubation attempts in relation to the intubation attempt outcome. Of the n=828 successful intubation events, 87.4% (n=724) intubations were achieved on the first attempt, indicating a high rate of first-pass success. In contrast, in 25.0% (n=5) of unsuccessful intubation events, intubation was only attempted once.

For unsuccessful intubation events, the majority include only 1 or 2 attempts (85% of unsuccessful intubation) at intubation. For successful intubation events, a significant number required a second or third attempt (9.4% (n = 78) and 1.8% (n = 15)), with a few cases (a total of n=11) requiring between 4 and 10 attempts at intubation.

Table 14: Frequency Distribution of the number of intubation event attempts by performed or observed category

		Observed		Perform	
		Frequency	%	Frequency	%
Number of Intubation Attempts	1	116	67.1%	615	91.0%
	2	35	20.2%	54	8.0%
	3	11	6.4%	6	0.9%
	4	8	4.6%	0	0.0%
	5	1	0.6%	0	0.0%
	8	1	0.6%	1	0.1%
	10	1	0.6%	0	0.0%
	Total	173	100.0%	676	100.0%

Table 14 illustrates the distribution of the number of intubation attempts by the type of engagement, whether the intubation attempt was "Observed" or "Performed" by the student. The data demonstrates notable differences in first attempt success rates. Of the n=173 observed intubation events, n=116 (67.1%) were successful on the first attempt, compared to a higher number of 91.0% (n=615) first attempt success rate for performed intubation events. The noted relationship is statistically significant, with students being almost three times as likely to be allowed to perform an intubation that was successful at the first attempt as compared to one that was not (OR = 2.86 (CI 0.95: 1.86 to 4.39), $x^2 = 24.10$, $p < 0.001$). This observation may imply that students are more likely to be allowed to intubate patients with a higher likelihood of first pass success, as opposed to difficult airway situations (indicated by more than one required attempt at intubation), which students appear to be more likely to observe, as noted in Table 12.

4.11 First Attempt (First Pass) Intubations Success Rate

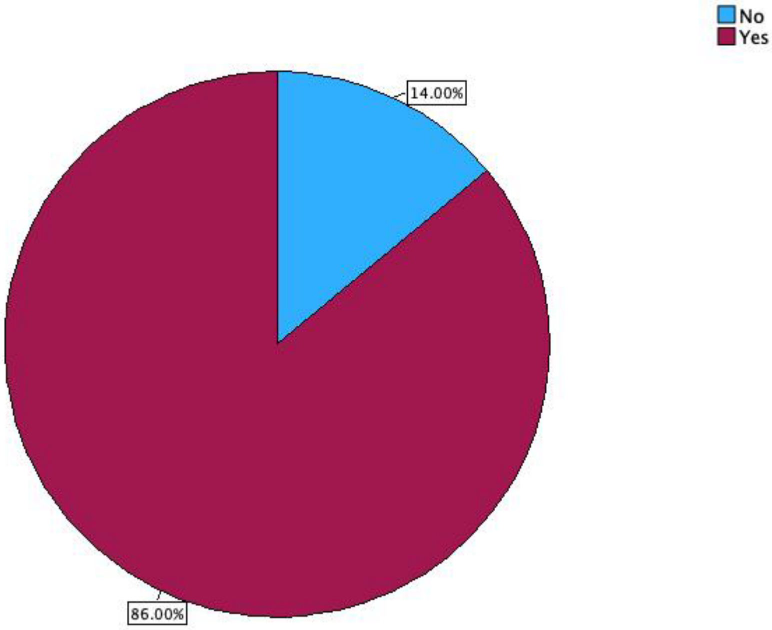

Figure 23: Frequency Distribution of intubation events success by First Attempt category

Table 15: Frequency Distribution of intubation events success by First attempt success category

		Frequency	%
First Attempt Success	No	119	14.0%
	Yes	731	86.0%
	Total	850	100.0%

Figure 23 and Table 15 illustrate the first attempt success rate (first-pass success) of 86.0% (n=731/850 events). Conversely, 14.0% (n=119 intubation events) were unsuccessful on the first attempt.

Table 16: Frequency Distribution intubation events First attempt success rate by various categories

	First Attempt Success					
	No		**Yes**		**Total**	
	n	%	n	%	n	%
Missing Data	1	0.8%	0	0.0%	1	0.1%

Clinical Placement Site	Emergency Centre	50	42.0%	94	12.9%	144	16.9%
	Prehospital	43	36.1%	86	11.8%	129	15.2%
	Skills Lab	6	5.0%	310	42.4%	316	37.2%
	Operating room	19	16.0%	241	33.0%	260	30.6%
Primary Clinical Impression	Missing Data	47	39.5%	549	75.1%	596	70.1%
	Allergic Reaction	0	0.0%	11	1.5%	11	1.3%
	Altered level of Consciousness	3	2.5%	5	0.7%	8	0.9%
	Burns	2	1.7%	6	0.8%	8	0.9%
	Cardiac Arrest	12	10.1%	26	3.6%	38	4.5%
	Cardiovascular Emergencies	3	2.5%	5	0.7%	8	0.9%
	Diabetic Emergencies	0	0.0%	2	0.3%	2	0.2%
	Medical Emergencies - Undefined	8	6.7%	34	4.7%	42	4.9%
	Neurological Emergencies - Undefined	1	0.8%	3	0.4%	4	0.5%
	Obstetric Emergencies	1	0.8%	1	0.1%	2	0.2%
	Overdose / Poison	2	1.7%	2	0.3%	4	0.5%
	Respiratory Emergencies	7	5.9%	21	2.9%	28	3.3%
	Seizure	2	1.7%	1	0.1%	3	0.4%
	Sepsis/infection	2	1.7%	2	0.3%	4	0.5%
	Stroke/CVA	0	0.0%	8	1.1%	8	0.9%
	Syncope/fainting	0	0.0%	1	0.1%	1	0.1%
	Trauma - Chest	5	4.2%	8	1.1%	13	1.5%
	Trauma - Extremities	0	0.0%	2	0.3%	2	0.2%
	Trauma - Head	14	11.8%	27	3.7%	41	4.8%
	Trauma – Multi-systems	8	6.7%	15	2.1%	23	2.7%
	Trauma - Spinal Injuries	2	1.7%	2	0.3%	4	0.5%
Medical or Trauma	Missing Data	45	37.8%	545	74.6%	590	69.4%
	Medical	40	33.6%	124	17.0%	164	19.3%

	Trauma	34	28.6%	62	8.5%	96	11.3%
Lead or Assist Role	Missing Data	73	61.3%	383	52.4%	456	53.6%
	Assist	12	10.1%	47	6.4%	59	6.9%
	Lead	34	28.6%	301	41.2%	335	39.4%

The highest first attempt success rates occurred in the Skills Lab (42.4%), followed by the Operating Room (33.0%), while Prehospital settings (11.8%) and the Emergency Centre (12.9%) had lower comparative rates of first attempt success. Clinical placement site was significantly associated with first attempt success rate (x^2 = 145.7, p <0.001).

For primary clinical impression categories such as those associated with trauma, first attempt success appears to be less common; these include the Trauma – Head (11.8% failed, 3.7% succeeded, p < 0.001) and Trauma Multi-systems (6.7% failed, 2.7% succeeded, p = 0.004) with comparatively higher failure rates. Trauma overall had more first attempt failures (28.6%) than medical cases (33.6%), while medical cases had higher success rates (17.0%) (x^2 = 71.18, p < 0.001). The cardiac arrest category also showed a relatively higher first attempt success rate (10.1% vs 4.5%, p = 0.001)[3]. First attempt success rates were higher when students were acting in the "Lead" role (41.2%) than "Assist" (6.4%) (x^2 = 7.62, p = 0.022), but missing data limits further potential correlations and conclusions for this category despite the statistically significant relationship.

[3] P-values in this paragraph were calculated with a z-test comparison for proportions

4.12 Intubation Events by Individual Students

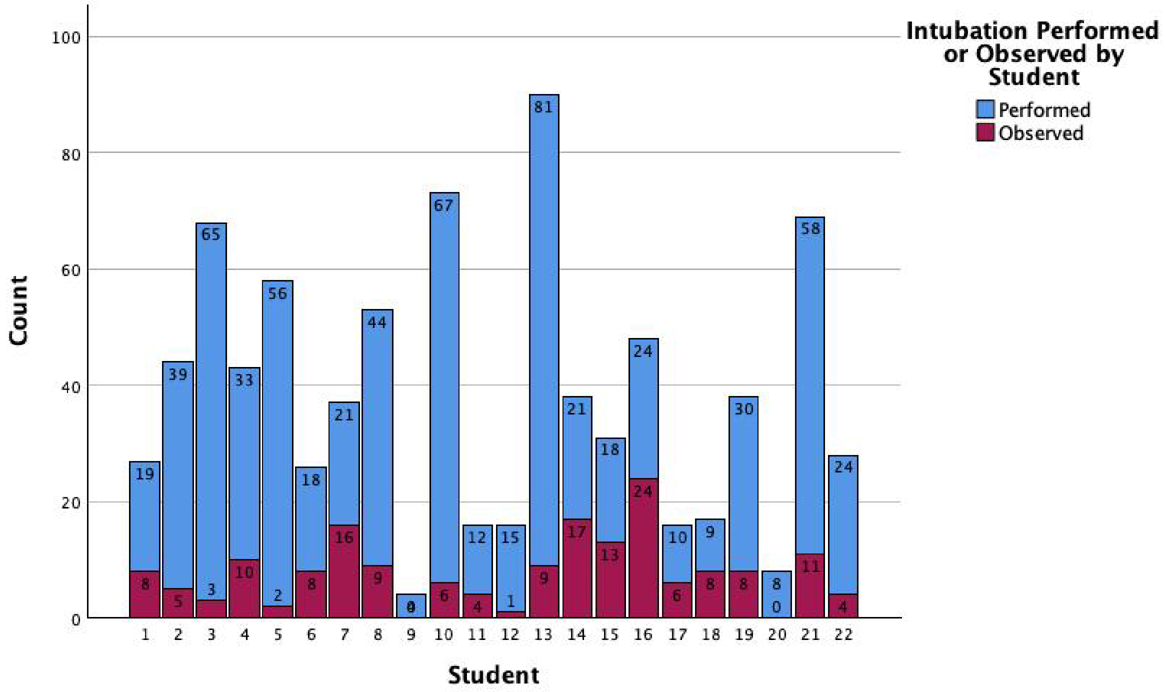

Figure 24: Number of Intubations Performed and Observed per Student

Table 17: Number of Intubations Performed and Observed per Student

		Intubation Event		
		Performed	**Observed**	**% Performed**
Student	**1**	19	8	70.0
	2	39	5	88.6
	3	65	3	95.6
	4	33	10	76.7
	5	56	2	96.6
	6	18	8	69.2
	7	21	16	56.8
	8	44	9	83.0
	9	4	0	100.0
	10	67	6	91.8
	11	12	4	75.0

12	15	1	93.8
13	81	9	90.0
14	21	17	55.3
15	18	13	58.1
16	24	24	50.0
17	10	6	62.5
18	9	8	52.9
19	30	8	78.9
20	8	0	100.0
21	58	11	84.1
22	24	4	85.7

As shown in Figure 24 and Table 17, there is a substantial range in the overall number of intubation events by the individual student (range = 4 to 90), with two students reporting fewer than 10 intubation events, while six students reported over 50 events. A single individual student reported 90 events, of which 81 were performed by the student. The mean number of intubations per student was 30.7. It is also notable that some students observed relatively more intubations in comparison to others, while students with more overall intubation exposure (>50) tended to perform relatively more intubations.

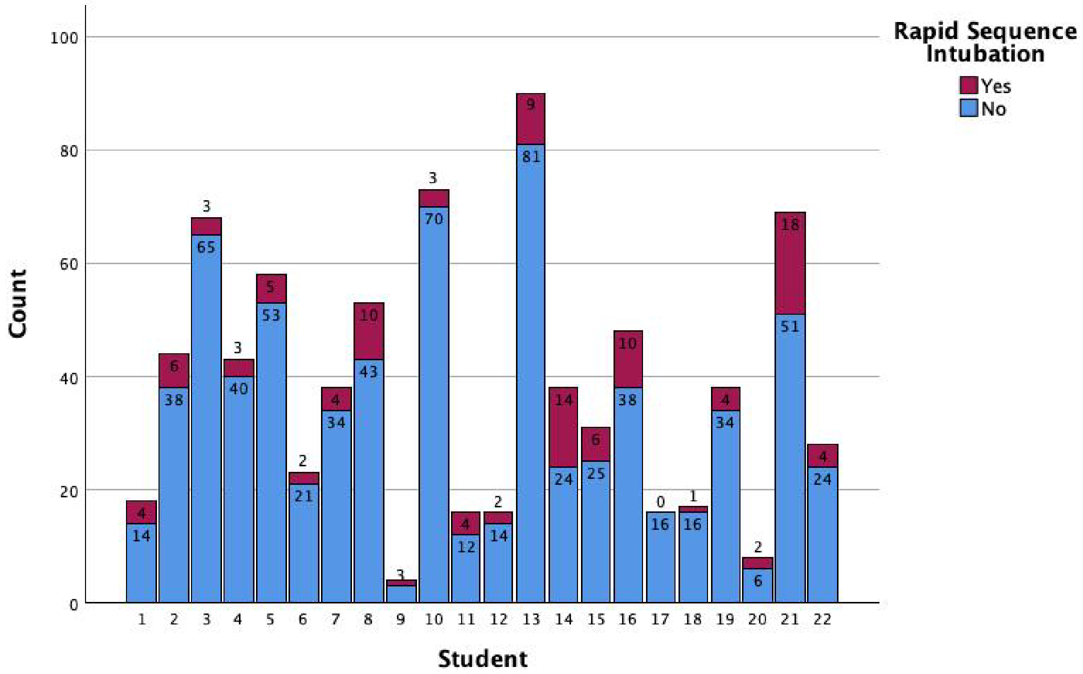

Figure 25: Number of RSI procedures per Student over the course of their program (all settings, observed or performed)

Table 18: Proportions of RSI Intubations vs non-RSI intubations Procedures per Student

		RSI		
		Yes	**No**	**RSI %**
Student	**1**	4	23	14.8
	2	6	38	13.6
	3	3	65	4.4
	4	3	40	7.0
	5	5	53	8.6
	6	2	24	7.7
	7	4	34	10.5
	8	10	43	18.9
	9	1	3	25.0
	10	3	70	4.1
	11	4	12	25.0

12	2	14	12.5
13	9	81	10.0
14	14	24	36.8
15	6	25	19.4
16	10	38	20.8
17	0	16	0.0
18	1	16	5.9
19	4	34	10.5
20	2	6	25.0
21	18	51	26.1
22	4	24	14.3

Figure 25 and Table 18 illustrate the distribution of intubation events performed by each student, categorised into Non-RSI (Non-Rapid Sequence Intubation) and RSI categories, with the RSI percentage indicating the proportion of intubations involving RSI events for each student. Notably, RSI procedures appeared to be a relatively infrequent event, with the range between students being 0 to 18. Student 13, who had the most intubations at 81, only recorded 9 RSI procedures (10%), while student 21, who had a total of 51 intubations, recorded 18 RSI procedures (26.1%). Across all students, the mean number of RSI procedures was 5.22, with only 4 students recording more than 10 RSI procedures throughout the course of their programme. Exposure to non-RSI intubations (drug facilitated without paralysis, general induction in the operating room or non-drug facilitated) was more common (86.5%). This data suggests varied clinical exposure among students, potentially indicating differences in assigned cases or patient needs across training experiences.

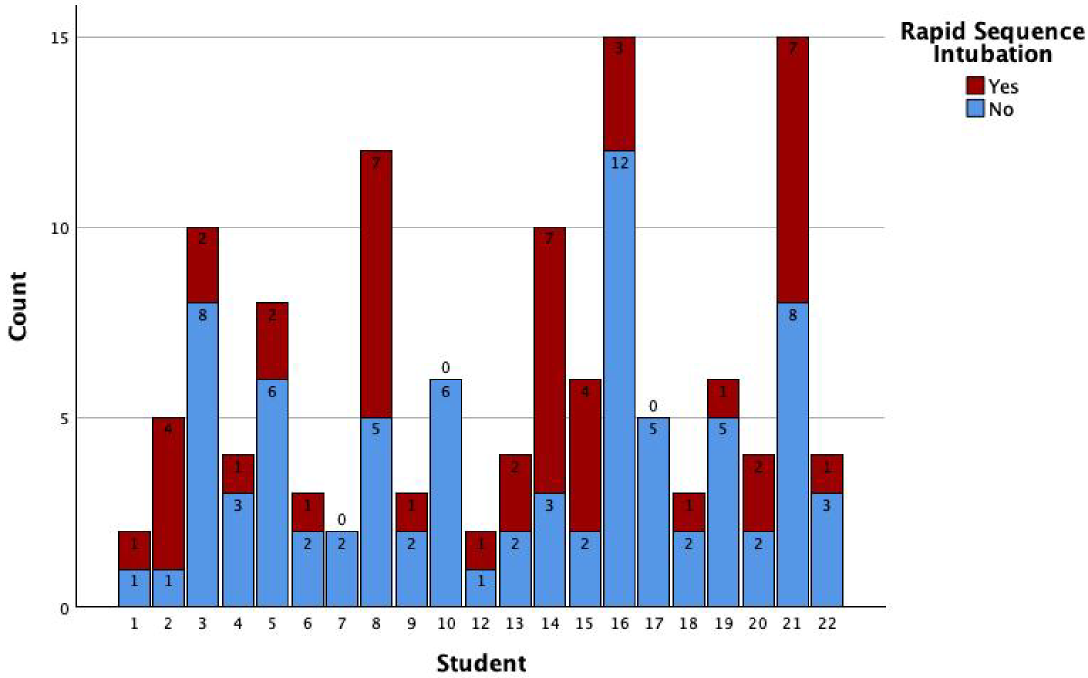

Figure 26: Number of RSI procedure per student performed or observed in the prehospital setting on live patients

Figure 26 illustrates the number of live patient intubations (divided by RSI and Non-RSI related procedures) performed or observed by ECP students in the prehospital setting. Compared to the data shown in Figure 25, it is worth noting that when only live patients in the prehospital setting are considered, the number of intubations and RSI procedures is substantially lower. This may be of particular importance as these intubations are linked directly to what students will be expected to perform with a high level of competence upon graduation. It can also be noted that the mean number of prehospital intubation exposures on live patients per student was equal to 5.81 (CI 0.95: 4.06 to 7.56) with a range of 0 to 15. Student number 11 (as noted by the absence of data in Figure 26) did not record exposure to any prehospital intubations. For RSI, it can be noted that students 7, 10, 11, and 17 did not document a single exposure to prehospital RSI. The mean RSI exposure on live patients in the prehospital setting was equal to 2.18 (CI 0.95: 1.23 to 3.12) with a range of 0 to 7.

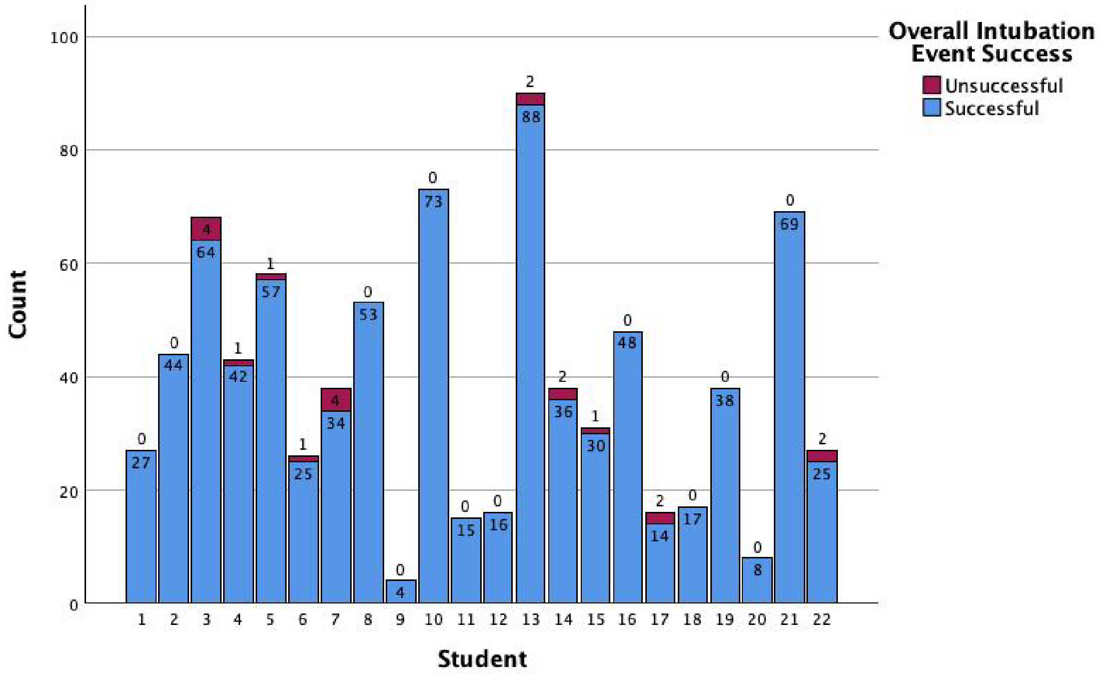

Figure 27: The number of overall successful intubation attempts by student

Table 19: Students' Overall Intubation Procedure Success Rate (after all attempts)

		Successful	Unsuccessful	% Successful
Student	**1**	27	0	100.0
	2	44	0	100.0
	3	64	4	94.1
	4	42	1	97.7
	5	57	1	98.3
	6	25	1	96.2
	7	34	4	89.5
	8	53	0	100.0
	9	4	0	100.0
	10	73	0	100.0
	11	15	0	93.8
	12	16	0	100.0
	13	88	2	97.8

14	36	2	94.7
15	30	1	96.8
16	48	0	100.0
17	14	2	87.5
18	17	0	100.0
19	38	0	100.0
20	8	0	100.0
21	69	0	100.0
22	25	2	89.3

Figure 27 and Table 19 illustrate each student's overall intubation exposure, showing counts of successful and unsuccessful events alongside the overall success rate after all attempts at intubation. The data, as displayed in Table 19, shows both performed and observed intubation exposure, and as such can be an indication of both student intubation proficiency (considering the majority of intubations are performed by students (Figure 14) and student exposure to failed intubation situations. Students 2, 10, 13, 19, and 21 demonstrate high proficiency, achieving success rates above 89% (albeit with some having less overall exposure), with Students 12 and 20 attaining a perfect 100% success rate, but having relatively few intubations (16 and 8, respectively). Most students, such as Students 1, 3, 4, 5, and 16, have success rates between 75% and 88%. However, a few students, including 14, 15, and 17, have lower success rates (ranging from 53.8% to 65.5%). The majority of students reported low exposure to situations where a patient could not be intubated.

4.13 First Attempt Success Rate by student

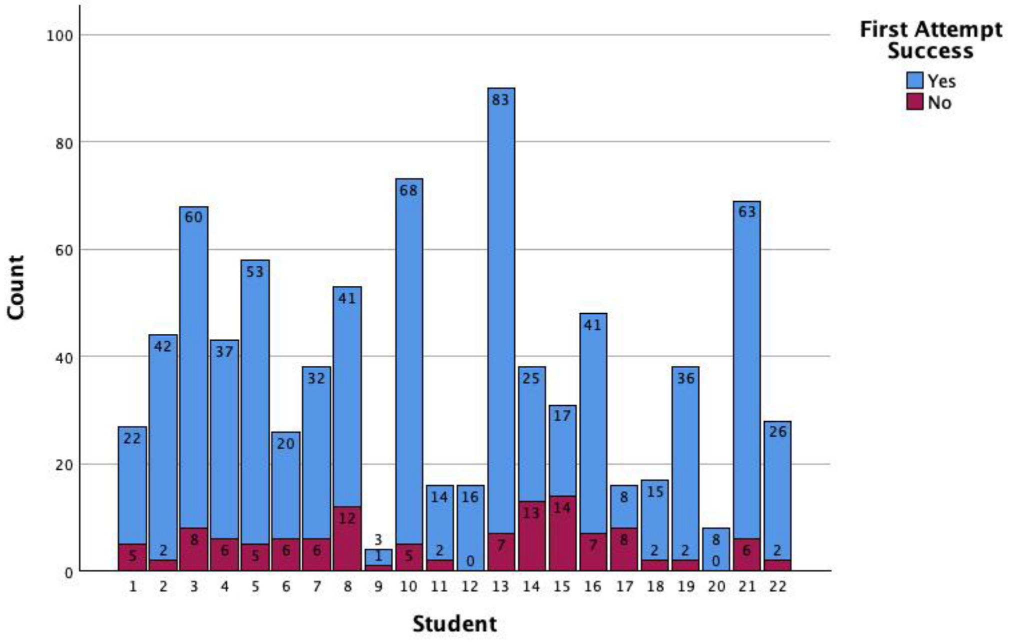

Figure 28: Number of First Attempt Successful Intubations Procedures by student

Table 20: First Attempt Success Rate by Student

		First Attempt Success		
		Yes	No	First Attempt Success %
Student Name	**1**	22	5	81.5
	2	42	2	95.5
	3	60	8	88.2
	4	37	6	86.0
	5	53	5	91.4
	6	20	6	76.9
	7	32	6	82.4
	8	41	12	77.4
	9	3	1	75.0
	10	68	5	93.2
	11	14	2	87.5
	12	16	0	100.0

13	83	7	92.2
14	25	13	65.8
15	17	14	54.8
16	41	7	85.4
17	8	8	50.0
18	15	2	88.2
19	36	2	94.7
20	8	0	100.0
21	63	6	91.3
22	26	2	92.9

As illustrated in Figure 28 and Table 20, the majority of intubations for most students were successful at the first attempt. All students, with the exception of one student, had at least one exposure to an initial failed intubation attempt. The first attempt success rate varied between students, with a range of 50 to 100%. Of all students, 9 of 22 (41%) reported first attempt success rates above 90%, while 6 of 22 (27%) reported success rates below 80%. Again, these results should be taken in context in relation to the overall intubation exposure of students, with the top four students in relation to overall intubation exposure (> 60 intubation events) reporting first attempt success rates above 88%.

4.14 Summary

In this chapter, intubation events involving ECP students were analysed, as recorded in the FISDAP™ data platform. The data provided insights into the distribution of intubation events across different clinical settings, patients' clinical status, and event outcomes.

The data captured showed that the majority of intubations were performed in clinical settings, particularly in operating rooms, emergency centers, and the prehospital setting, with a smaller portion occurring in simulated environments. Patients with adult airway anatomy accounted for the majority of intubation events, while cases with paediatric airway anatomy were relatively few. Notably, first-attempt success rates were high, particularly in controlled environments like the operating room, while prehospital settings showed more variability in outcomes. Student exposure appears to be highly variable, with some students reporting substantially higher exposure when compared to others. The rates of high-risk intubation procedure exposures, such as RSI and failed intubation events, were low.

A key limitation identified in the dataset was the substantial amount of missing data (FISDAP™ data not captured by ECP students), particularly in areas involving clinical information such as patient primary impressions, systolic blood pressure, and oxygen saturation values. This missing data presents challenges in fully understanding the scope of the students' experiences and clinical outcomes. Despite these gaps, the available data highlights the importance of clinical exposure for ECP students, especially in high-acuity settings, and underscores the need for improved data collection practices to ensure more comprehensive future analyses.

CHAPTER V – DISCUSSION AND RECOMMENDATIONS

5.1 Introduction

This chapter contextualises the findings of this study from the analysis of intubation experiences by ECP students in the Western Cape, as presented in Chapter IV. The discussion evaluates these results in alignment with the study's objectives and relevant literature, focusing on students' exposure and success rates in different clinical settings, as well as the broader implications for clinical competency in airway management.

5.2. Student Intubation Exposure in by Clinical Setting

This study revealed a balanced distribution of exposure between simulated and real-life settings (Figure 2 and Figure 3), echoing trends in airway management education in other fields. According to Murphy and Laffey (2007), a mix of theoretical knowledge, simulation, and hands-on experience is essential to prepare students for complex procedures like endotracheal intubation (ETI). This approach is important for the development of fundamental knowledge and psychomotor skills. However, context and feedback on performance with deliberate practice are critical to the development of clinical judgement and the appropriate focus on patient outcomes rather than obtaining only experience (Dorsett et al., 2022). This implies that performing intubation procedures in the right context, in particular the emergency context, with high acuity patients and with a preceptor who can provide quality feedback, is critical to students' development of competencies in the cognitive and affective domains of airway management (Dorsett et al., 2022).

The distribution of intubation events among Emergency Care Practitioner (ECP) students showed that most intubation exposure occurred in the non-emergency setting (37.2% in the Skills Lab and 30.6% in the Operating Room) (Figure 3). This finding aligned with the broadly understood importance of performance-based learning in low-stakes environments for mastering high-stakes skills like ETI (Aziz et al., 2015). Conversely, 16.9% of events occurred in the Emergency Centre (n = 144) and 15.2% in the Prehospital setting (n = 129). Dorsett et al. (2022), in their position statement on airway management competence for prehospital providers, emphasized the importance of learning in the authentic clinical setting. They argued that airway skills (psychomotor domain) learnt through an experiential process are not sufficient for the development of competence. Clinical judgement, higher order decision making (cognitive domain), and how patient outcomes are valued (affective domain) are equally important in developing airway management competence (Dorsett et al., 2022). These results to some extent reflected the curriculum design for undergraduate ECP programs, where students start learning laryngoscopy skills and the ETI procedure in their second year of study. Following the skills lab phase, students start intubations on live patients in the operating room setting, after which, during their third and fourth year of study, they will progress to the emergency setting (emergency centre and prehospital), including the use of RSI.

The combination of the 37.2% of intubation exposures in the skills lab and 30,6% of clinical intubation exposures in the operating Room (OR) bodes well for students' early development. The OR provides a more controlled environment where students can focus on mastering the technical aspects of laryngoscopy and intubation without the added challenges of high-stakes situations or critically ill patients, but still in an authentic setting. This controlled setting is beneficial for foundational skill acquisition, as students can focus on mastering procedural skills without the added stress of critical patient outcomes (Maguire et al., 2016). It should, however, be considered that intubation in the OR is substantially different from intubation in the prehospital setting and is not sufficient on its own for developing competence as defined by Dorsett et al. (2022).

The concern that arises from the findings of this study was the relatively low numbers of emergency contexts intubation exposures, particularly prehospital intubation in the clinical setting (Figure 3). The findings in this study, however, align with previous research, which highlights that exposures to airway management in high-intensity contexts, such as emergency centres and prehospital settings, are infrequent despite their critical role in developing competency for emergency care professionals (Crewdson et al., 2018; Kheterpal et al., 2018). The distribution of intubation frequency by individual student and prehospital intubations on live patients (Figure 26) has been shown to occur both rarely and inconsistently, constituting only a small portion of most students' overall intubation exposure, with more complex scenarios such as RSI (Table 8 & Figure 26) being even less common.

When considering the process by which emergency care providers develop competence as outlined by Dorsett et al. (2022), the low exposure to prehospital intubations is of concern, as this is the context ECP students are training for and where they will need to act as competent providers upon qualification. Although this study did not measure the quality of these learning experiences or their impact on learning, the low frequency of prehospital exposure and other (Figure 3 & Figure 26, Tables 8 & 9) high acuity situations, such as RSI-related intubations, may not be adequate for the development of the desired levels of competence for all students before graduation.

5.2.1 Simulation and Clinical Exposure in Airway Management Training

Advanced airway management, ETI, requires a nuanced training approach that balances foundational skill development in structured settings with clinical exposure to high-risk, real-world scenarios. This balance is critical to prepare students to meet both professional board requirements and global standards. The integration of simulation-based training (SBT) into airway management education is particularly relevant in contexts where clinical exposure is limited.

5.2.1.1 The Role of Simulation-Based Training vs the Clinical Environment as Blended Training Approaches towards Competency Development.

The Skills Lab and SBT play a crucial role in developing students' ETI competencies by enabling repetitive practice in a low-risk environment. Simulated ETI accounted for 37.2% (n = 316, Figure 3) of all intubation events in this study. It has been well documented that simulation-based ETI training is particularly valuable for building confidence and technical accuracy without the pressures of real-life patient care

Conversely, 62% (n = 533) of ETI exposures occurred in patients in the clinical setting (Figure 3). Emergency contexts, such as prehospital and EC settings, accounted for 51.2% of all intubation exposures in the clinical setting (n=272). This included a total of 85 RSIs, which accounted for 16% of all intubations in the clinical setting (Table 9). However, as discussed above (and shown in Figure 26), when considering this exposure at the level of the individual student, prehospital-specific exposure is relatively low.

The systematic review by Bienstock et al. (2022) underscores the role of simulation in paramedic and Emergency Medical Technicians (EMT) training, highlighting that 21 of 25 reviewed studies used high-fidelity simulation, which mirrors real-world complexities. Bienstock et al. (2022) note that simulation was particularly effective in improving procedural success, students' ability in identifying errors, and enhancing perceived knowledge and skills. This aligned with the findings of this study, which showed that simulation exposure played a pivotal role in preparing students to manage infrequently encountered but critical emergencies. Significant intubation exposure to some clinical presentations, such as medical, respiratory, and cardiovascular emergencies, occurred in the skills lab setting (Figures 7 and 8). For rare clinical presentations such as allergic reactions, exposure occurred exclusively in the simulated setting.

Bienstock et al. (2022) also identified gaps in the sustained impact of SBT, particularly concerning skill retention. While SBT improves short-term performance and confidence, its ability to replace real-world experience is limited, highlighting the importance of combining simulation with clinical exposure. This aligns with the blended learning models advocated by

Kolb's experiential learning theory, which emphasises integrating theoretical knowledge with practical application for clinical exposure to ensure competence in dynamic, high-pressure environments Weingart & Levitan, 2012

As shown in the results, the reliance on SBT, especially in the early phases of learning the psychomotor skills associated with ETI, is consistent with global trends. Paramedics and EMTs often depend on SBT more than other allied health professions due to shorter educational pathways and fewer opportunities for clinical exposure. However, SBT alone cannot replace the variability and unpredictability of real-world clinical encounters. Global standards, such as those outlined by the NAEMSP and the PBEC, advocate for hybrid training models that combine simulation with supervised clinical practice to bridge the gap between foundational learning and practical application

The PBEC benchmarks recommend a minimum of 30 ETI procedures, including 20 RSI cases, to achieve competence. However, studies suggest that 50 or more intubations may be necessary to reach a first-pass success rate exceeding 90%, a critical determinant of patient outcomes. In this study, limited exposure to high-risk scenarios like RSI highlights a gap in meeting these thresholds, reinforcing the importance of simulation in addressing training deficiencies while ensuring alignment with professional and global standards (Panchal et al., 2020).

The findings reaffirm the critical role of both simulation and clinical exposure in advanced airway management training. Simulation provides a structured and risk-free environment for building foundational skills, particularly for rare and high-stakes scenarios. However, real-world clinical experiences are indispensable for developing the adaptability and decision-making competencies required in prehospital care. Aligning training programs with global standards and integrating blended learning models are essential steps toward ensuring that students are adequately prepared to perform high-stakes procedures like RSI effectively and safely (Weingart & Levitan, 2012).

5.2.2 The relationship between Student Roles during intubation exposures and Skill Acquisition.

5.2.2.1 Observed vs Performed

Results in this study showed that students acted in the role of provider performing the procedure in the majority (79.6%, n = 676/849) of intubations documented (Table 6). In the simulated setting, students performed 98.7% (n = 312/316) of all intubations, while in the clinical setting, students performed 68.4% (n=364/532) of all intubations, observing a total of 31.6%. When considering intubations in the emergency setting, students only performed

56.2% (n=153/272) of intubations overall, with 38.9% (n=56/144) and 75.8% (n=97/128) being performed by students in the emergency department and prehospital settings, respectively. The likelihood of students performing intubations varied significantly across clinical placement contexts ($x^2 = 223.85$, $p < 0.001$). In operating rooms, students were 3.35 times more likely to perform intubations compared to emergency settings (95% CI: 2.26–4.96, $p < 0.001$). However, there was no significant difference between operating rooms and prehospital environments (OR = 0.727, 95% CI: 0.44–1.21, $p = 0.219$). These findings suggest that students are equally likely to have the opportunity to perform intubations in the prehospital setting compared to the OR; however, as argued above, the low frequency of prehospital intubation exposures should be considered in the context of this finding. When comparing the prehospital setting to the emergency department, students were significantly less likely to intubate in the emergency department (OR = 0.148, 95% CI: 0.09–0.23, $p < 0.001$).

These findings highlight the importance of the low-risk, well-controlled environment for obtaining hands-on practice, especially the OR setting, which would be, in most cases, the students' first exposure to performing intubation in live patients. These findings are not unexpected as it again appears to align with the broad principles of curriculum delivery in ECP programs and highlight the structured emphasis on repetitive, performance-based learning. This approach aligns with evidence emphasizing the importance of hands-on practice in developing technical competence and procedural proficiency (Aziz et al., 2015).

The low proportion of intubation procedures in the emergency context, performed by students, is, however, more concerning, yet not unexpected. Clinical preceptors remain the final decision makers regarding whether a student will be allowed to perform any clinical procedure on a given patient. Although not the subject of this study, there are a number of possible factors which may influence preceptors when making this decision, including confidence in the student, the particular context, predicted airway difficult and patient acuity to name a few . Another important factor may be related to clinical preceptors understanding of the skills and capabilities of ECP students. This may aid in the explanation of the low proportion of performed intubation procedures in the Emergency Department when compared to the prehospital setting. It is plausible, that emergency physicians acting as preceptors in these setting may not be sufficiently familiar with ECP student curricula and therefore less likely to allow students to perform intubations.

Despite these possible barriers, it remains noteworthy that although over half of intubation exposures in the clinical setting occur in the emergency context (51.2%) students only performed 56.2% of those procedures. When viewed more holistically, it would imply that of the 849 intubation events recorded by the 22 students included in this study, only 272 intubations occurred in the emergency context, and only 153 were performed by students. To state this another way, only 18% of total intubation exposure translated to intubations performed by students on actual critically ill patients. Moreover, only 11.4% (n=97) of total intubations performed by students on critically ill patients occurred in the prehospital setting.

Despite the aforementioned low rate of performed intubations in the emergency setting, observation, particularly observation of expert practice, does play an important role in experiential learning. Experiential learning is known to enhance psychomotor skills and competencies, as demonstrated by Alrazeeni et al. (2021), who reported a significant improvement in EMS students' performance during internships, with success rates rising to between 85.49% and 99.4% over time. In contrast, observational learning, especially in high-risk settings, provides students with valuable insights into complex cases and the clinical decision-making processes, vital for equipping them for independent practice (Carlson & Wang, 2017; Barker et al., 2017). This combination of practical and observational learning is considered essential for comprehensive skill and competence development. As such the observation of intubations in the clinical setting, particularly those in the emergency context still hold great value for student learning, particularly as part of their development of clinical decision making and reasoning. The dual exposure of observation and performance mirrors educational recommendations advocating for combining structured practice with observational experiences to ensure comprehensive skill acquisition (Murphy & Laffey, 2007; Weinstein et al., 2019).

The observed distribution of intubation exposure aligns with scaffolded learning pathways, as described by the Dreyfus model, where students progress from low-risk environments to increasingly complex and demanding settings as they progress from novices to advanced beginners and transition towards competence (Dreyfus, 2004). This stepwise approach fosters confidence, minimises anxiety, and optimises learning outcomes as students prepare for high-stakes clinical scenarios (Panchal & Raza, 2017). The experience of prehospital rapid sequence intubation (RSI) in South Africa highlights the value of diverse placement contexts. Despite the high-risk nature of prehospital RSI, students demonstrated a strong overall success rate of 92.4%, with a first-pass success rate of 85.2%. These results emphasise the importance of combining real-world exposure with structured training to enhance critical decision-making skills under pressure. However, the 5% incidence of cardiac arrest and low rates of post-intubation sedation underscore the urgent need for stricter protocols and robust clinical governance to improve patient safety and outcomes (Stein, 2017).

5.2.2.2 The role of students in clinical decision-making

Students are required to document their role in the intubation procedure, being observation or performance of the psychomotor ETI skill. An important component, particularly for more senior students, is their role in the clinical decision-making process in relation to managing the case more holistically. On FISDAP™, this is indicated by students through the Lead or Assist category designation. When the lead category is indicated, the student is considered to have been acting in the role of lead clinical, whilst under supervision by the preceptor. In this role, the student is directly involved in or leading the clinical decision-making related to patient management, including the decision to perform intubation and the associated clinical management. Data for the lead or assistant category were available in 394 of 850 intubations (Table 10). Students were more likely to adopt the lead role during intubation events, with 85% (n = 335/394) of documented cases designating the student in the lead clinician role. This was especially evident in the Skills Lab (Figure 18), where most simulated intubation events were led by students. The prevalence of the lead role in the simulated setting is unsurprising, as this is the setting in which students practiced in the role of the lead clinician in a simulated setting. The simulation setting plays a critical role in fostering hands-on learning for contextual clinical decision-making. As emphasised in the NAEMSP guidelines, structured training environments like the Skills Lab provide an opportunity for students to develop not only psychomotor skills but also higher-order clinical judgment through focused, deliberate practice. These settings encourage students to navigate complex decisions with direct feedback, aiding in the transition from theoretical knowledge to practical competence

Similarly, students predominantly acted in the lead role in prehospital and operating room settings. This finding is encouraging as it indicates that students are gaining exposure to playing an active part in the clinical decision-making process in an authentic setting and in the context of the management of a critically ill patient. Students acting in the lead role were less common in the emergency centre setting, with an almost equal number of lead and assist cases (Figure 18). This observation is similar to that made in relation to performed ETI procedures in the Emergency centre setting. The same explanation may be plausible here as well, in that preceptors in this setting may tend to assume greater control over clinical decision-making as they perceive patient acuity to be too high or are not fully aware of the capabilities or learning objectives of ECP students.

Students were significantly more likely to perform intubation procedures when acting in the lead role, with an almost tenfold higher likelihood compared to when in the assist role (OR = 9.56, CI 95%: 4.5–20.3, $p < 0.001$) (Figure 18 and Table 10). This correlation underscores the interdependence of clinical leadership and skill execution. The NAEMSP position statement highlights that clinical judgment is critical to this process, where decision-making involves selecting appropriate techniques, managing complications, and ensuring patient outcomes are prioritised over procedural success. This is an encouraging trend, as such exposure will act as a seminal learning event, allowing skill development, critical reflection, and building a student's confidence in their ability to act in the ECP role, post-graduation.

Notably, primary clinical impression categories also influenced role distribution (Figure 19). Students acted as leads in most categories, with exceptions noted in cardiovascular emergencies and undefined medical emergencies, where they were more likely to assist. This trend may reflect the perceived complexity or critical nature of certain cases, prompting preceptors to retain greater decision-making authority.

The findings align with educational principles emphasising the scaffolded progression of students from novice observers to competent decision-makers (Dreyfus, 2004). The predominance of lead roles in simulated and structured environments supports the development of confidence and decision-making skills in the early phase of learning, particularly as students begin to interlink procedural knowledge and application in the cognitive process domain (Heer, N.d.). Simultaneously, the opportunity to assist in high-risk settings like emergency centres allows students to observe expert decision-making processes, which is crucial for developing clinical reasoning and judgment (Dreyfus, 2004). Experiential learning models, such as the Dreyfus model, provide a framework for understanding this progression. Students transition from controlled, low-risk environments to increasingly complex scenarios, fostering confidence and competence in clinical decision-making (Dreyfus, 2004). This stepwise approach minimizes anxiety and optimizes learning outcomes, preparing students for the demands of independent practice.

The NAEMSP framework emphasises that development of clinical judgment must extend beyond fundamental knowledge, incorporating reflective practice and exposure to decision-dense environments. The blended training approaches identified in this study are critical in fostering this growth. Despite structured learning environments' benefits, the lower prevalence of student-led decision-making in emergency centres highlights barriers such as preceptor confidence, patient acuity, and case complexity. As the NAEMSP document recommends, addressing these challenges requires enhancing preceptor training to balance supervision with opportunities for student autonomy in decision-making

5.2.2.3 Student Exposure to Rapid Sequence Intubation (RSI)

The RSI procedure was used in 13.4% (n = 114/850) of all recorded intubations and 21.4% (114/533) of all intubations in the clinical setting, with students performing the intubation in 63.2% of RSI events recorded in the clinical setting Figures 8 and 9). When context is considered, 75% of RSIs were performed in the emergency context, 33% in the Emergency Department, and 42% in the prehospital setting, with 25% being performed in the OR. First-pass success was only achieved in 69% of all cases included, where RSI was used, highlighting the complexity and challenges of the procedure. When RSI was used, the student performed intubation; first pass success was recorded at 77.8%. Despite its importance, RSI was performed infrequently, emphasising the need for enhanced training strategies (Table 9 and Figure 26). This is particularly problematic when considering the data shown in Figure 26. Apart from the overall low frequency of RSI exposure, RSI exposure specifically in the prehospital setting is significantly less, with only 48 event reports. Of these 48 events, 38 (79%) were performed by students. The degree of variation between students is also noteworthy, with some students having as many as 15 exposures, while others have less than 5 (Figures 25 and 26). The mean number of RSI exposures (observed or performed) per student was 5.22 for all clinical settings, but only 2.18 exposures were recorded in the prehospital setting. The observed first pass success rate for students performing RSI-related intubations falls below the 80–90% first pass success rate benchmark recommended by global standards for airway management (Lockey et al., 2015; Dorsett et al., 2022). It also falls below the recommended number of intubations performed to be considered competent (Buis et al., 2016; Dorsett et al., 2022).

International evidence highlights the need for more deliberate practice and frequent exposure related to airway management procedures. While not all systems allow paramedics to perform RSI, findings from related contexts still offer relevant insights. For example, Western Australian paramedics, who do not routinely undertake RSI, report diminished confidence in advanced airway management due to infrequent exposure and a lack of emphasis on human factors in training (Wilson, 2017). Introducing competency-based programs and simulation-based learning has the potential to address these gaps. However, simulations alone cannot replicate the cognitive demands of real-world scenarios, necessitating hybrid training models that blend simulation with supervised clinical practice (Aziz et al., 2015; Panchal et al., 2020).

5.2.2.4 Possible barriers to exposure, meeting standards, and possible solutions.

International guidelines recommend at least 30 intubations, including 20 RSI cases, to achieve competency, with higher thresholds (50+ cases) linked to a 90% success rate (Buis et al., 2016; Dorsett et al., 2022). The findings of the study highlight that not all of the included students met these benchmarks (Figure 24), due to the low prevalence of prehospital intubations and RSI during clinical placements. Simulation, therefore, emerges as a viable solution, offering controlled environments for practicing high-stakes procedures and the potential for practicing less common clinical presentations. However, as discussed, simulation alone is insufficient, with hybrid models integrating simulation with supervised clinical practice, especially in the early phase of post-qualification, being essential for bridging gaps in clinical exposure (Aziz et al., 2015; Panchal et al., 2020).

A major challenge to mastering and maintaining advanced airway management skills, recently cited in the literature, is the general decline in clinical opportunities (Dorsett et al., 2022). These changes are related to multiple factors, including changes to clinical guidelines, increased saturation of the clinical setting with providers, and improved early detection and responsiveness to patient deterioration. Although these advances bode well for patients, the consequences for providers include clinical skills decay and highlight the critical need for ongoing practice and continuing education (Dorsett et al., 2022). In Western Australia, the increased use of supraglottic airways and competition among clinicians to perform ETI have significantly reduced paramedics' opportunities to perform ETI (Wilson, 2017). The infrequent occurrence of RSI further limits practice opportunities, aligning with global findings that emphasise the complexity and risks of the procedure (Armstrong et al., 2020; Dorsett et al., 2022). For ECP students, a further barrier, as discussed above, is the role of the preceptor in allowing the student to perform the ETI skill. Preceptors are also faced with the dilemma of teaching or supervising a student while simultaneously caring for a critically ill patient. The relationship between the student and preceptor, as well as the trust the preceptor has in the student's abilities, is likely a determinant for the nature of student intubation exposure.

Although not measured in this study, it would appear plausible that inconsistent field placements may undermine the development of student-preceptor relationships, which may act as a determinant of standardised skill acquisition. From the results in this study, this may to some extent explain the differences in intubation performance rate noted between the OR, EC, and Prehospital settings. In the OR, where multiple intubations are performed during a single shift, cases are often elective, uncomplicated, and clinically stable; it may be easier for anaesthesiologists to gauge student readiness and guide the student during the performance of the intubation procedure. This may make it more likely for a student to have the opportunity to perform the procedure in the OR setting. Similarly, in the prehospital setting, especially for students at an advanced level of study, preceptors are likely to be more familiar with ECP student capability, and preceptors may be better able to gauge a student's readiness to perform ETI, resulting in more opportunities for students to perform the ETI procedure.

Historical airway education models also fall short in addressing the human factors and contextual challenges inherent in prehospital and emergency care settings. For example, while novice physicians demonstrated improved intubation techniques after a year of training by applying less force to oral structures, such incremental progress must be reinforced through robust pre-placement assessments and ongoing competency evaluations (Takeuchi et al., 2017). The prehospital application of RSI presents additional challenges, such as resource limitations and high-pressure decision-making, which further complicate the procedure and demand targeted educational strategies (Burns et al., 2016).

The findings of this study illustrate how diverse clinical placements form part of the development of ECP students with respect to airway management skills and competencies, fostering comprehensive skill development. However, reliance on clinical experiential learning alone may not be sufficient for all clinical presentations or in relation to prehospital context clinical exposure. Another possible option to explore in future research would be the feasibility of clinical internships for ECPs post-graduation, which could allow for periods of surprised practice, allowing further ETI skills development for commencing independent practice. Such practices are commonplace in other fields and in the prehospital setting globally.

5.3 Intubation Exposure by Patient Type and Clinical Characteristics

This study reveals the diverse clinical exposure of emergency care practitioner students with respect to patient types and clinical acuity. The findings underline that the variety of exposure to differing case types and patient populations in each setting influences which may have a bearing on student skills developed during training. In this section, both commonly encountered scenarios and possible gaps in exposure for less frequent, high-stakes situations are highlighted.

5.3.1 Patient Type: Trauma and Medical Emergencies

Data obtained showed that only 260 of the 850 cases had valid data for primary clinical impressions (Table 3). The majority (63%, n = 164/260) of ETI events were associated with medical patients (Figure 5), and trauma cases are notably more prevalent in prehospital and emergency settings (Figure 6). This is not an unexpected finding and reflects the general clinical case mix of the clinical platform where these students practice (Abdullah et al., 2021). Trauma scenarios demand rapid decision-making and adaptive management strategies, as highlighted by Murphy et al. (2007). The distribution of intubation events in the prehospital setting shows a nearly equivalent exposure between trauma (23%) and medical cases (22.7%) (Figure 6). This finding is encouraging, as it suggests that despite the high burden of trauma seen by prehospital providers (Abdullah et al, 2021), students were obtaining substantial exposure to ETI in the context of medical emergencies in the prehospital setting. To support the findings, further statistical analyses revealed no significant relationship between primary case type (medical or trauma) and whether students performed or observed intubation (OR = 0.760, CI 95%: 0.43 to 1.34, $x^2 = 0.914$, $p = 0.339$).

Similarly, exposure in the emergency department setting also demonstrated almost similar rates of trauma and medical cases, with medical cases being slightly more common (11.2% and 15.4% respectively). When considered in conjunction with the pattern of prehospital exposure, it can be argued that students are being exposed to a balanced and diverse mix of aetiologies during their authentic intubation exposures, particularly in the emergency context.

In contrast, controlled environments like operating rooms (ORs) and the skills lab setting primarily involve medical cases, with less exposure to trauma-related scenarios. In the OR, intubation procedures are more often performed on elective cases, enabling students to refine technical skills in a stable environment. It is plausible that the pattern observed in the skills labs reflects the perceptions of clinical educators, focusing on less common medical emergencies as opposed to trauma scenarios to augment competence in these cases. These environments complement prehospital and emergency experiences by providing a systematic framework for learning airway management, from preparation and oxygenation to verification of tube placement and complication management (Blair et al., 2016).

5.3.2 Airway Anatomy Type: Adult and Paediatric airway anatomy exposure Intubation

Findings in this study show that the majority of intubations (79.4%, n = 675) were related to patients with adult airway anatomy, with 78.7% (n 531) of these performed in clinical settings and 21.3% (n = 144) on manikins in simulated environments (Figure 9). This distribution underlines a curriculum reflecting the clinical realities of emergency care, where adult cases are more prevalent due to higher incidences of trauma and respiratory emergencies (Van der Hoven, 2018). However, the limited exposure paediatric airway anatomy comprises only 20.4% of all events (n = 173), indicating a potential training gap that warrants attention. This data highlights a clear need to focus on both simulated intubation training and obtaining more access to exposure to paediatric airway management for ECP students.

Analysis of clinical intubations (n = 531) reveals that students were significantly more likely to perform ETI procedures on patients with adult airway anatomy as compared to patients with paediatric airway anatomy (Odds Ratio = 3.09, 95% CI: 1.88–5.09, $x^2 = 20.99$, $p < .001$). The distribution of intubation events of patients with paediatric airway anatomy further illustrates this disparity. Of the 173 paediatric airway anatomy-related intubation events, only 43.4% (n = 75) occurred in live patients, with a mere 17% (n = 30) taking place in emergency settings and 6 in prehospital environments (3% of all paediatric airway anatomy exposures), and 24 in emergency centres (13.8% of paediatric airway anatomy exposures). Critically, paediatric airway anatomy exposures in live prehospital settings represented just 0.7% of all intubation events in this dataset. This highlights the rarity of such cases and the consequent low levels of authentic clinical exposure, especially in the emergency context.

These findings align with the odds ratio patterns observed for both performed and observed intubations. As shown in Table 7, adult airway anatomy exposures were overwhelmingly performed (90.1%), while paediatric airway anatomy exposure cases were more likely observed (24.3% as opposed to 9.3% performed). When considered in relative terms, the odds of a student performing an intubation as opposed to observing the procedure on a patient with adult airway anatomy were 1.587 (95% CI: 1.229–2.048). In contrast, students were far more likely to observe intubations in patients with paediatric airway anatomy (OR = 0.513 (95% CI: 0.399–0.661). This suggests that while students gain practical experience primarily through exposure to cases with adult airway anatomy, their exposure to paediatric airway anatomy remains very limited and predominantly observational.

5.3.2.1 Implications for Training Curricula

The current training approach prioritises adult intubation procedures, likely a reflection of their higher frequency in the clinical setting. However, paediatric intubations, though less common, present unique challenges due to significant anatomical and physiological differences between children and adults. The smaller airway size, distinct physiological characteristics, and heightened risk of complications make paediatric intubation a high-stakes procedure (Kheterpal et al., 2018).

In this study, most paediatric airway anatomy intubation experiences occurred in simulated settings, providing students with a risk-free environment to develop proficiency in critical skills. This aligns with Fleischman et al. (2016), who advocate for simulation-based training as an essential component in preparing students for rare but critical procedures like paediatric intubation. However, the data show a notable gap in exposure to common paediatric presentations such as seizures, respiratory emergencies, trauma, and sepsis, which are underrepresented compared to patients with adult airway anatomy (Figure 10).

To address these disparities, ECP training programs should incorporate more structured paediatric training modules, combining real-life and simulation-based experiences. Simulation remains vital for ensuring proficiency in rare, high-risk scenarios, but increasing exposure to live paediatric cases, particularly in controlled clinical environments, would better prepare students for real-world practice. Bielski et al. (2019) support this approach, emphasizing the need for balanced, context-specific training that equips future practitioners with a comprehensive skill set.

By prioritising a more balanced curriculum that integrates high-frequency adult cases with structured paediatric simulations and controlled clinical exposures, ECP programs can ensure students are well-prepared for the demands of emergency care across all age groups.

5.3.3 Patient Clinical Characteristics and Acuity

The characteristics of patients included in the study offer valuable insights into the clinical context of intubation events across different settings and age groups. However, it is important to acknowledge the limited availability of complete clinical data, as only 10.4% (88 patients) had comprehensive clinical data records, severely limiting the generalisability of the findings.

5.3.3.1 Vital Signs and Age Group

The distribution of initial systolic blood pressure (SBP) measurements (Table 5 and Figure 11) revealed that most patients had values within normal ranges for their airway anatomy categories. Patients with adult airway anatomy had mean SBP values of 126 mmHg in both the emergency centre and prehospital settings, with slightly lower values in the operating room (107 mmHg). Patients with paediatric airway anatomy displayed distinct trends, with a mean SBP of 90 mmHg in the emergency centre and a higher mean of 124 mmHg in prehospital settings. In both adult and paediatric airway anatomy subgroups, some of the patients presented with significant hypotension, but the frequency was very low. While these differences provide context for age (as airway anatomy category can be seen as a proxy in the context, as related to the definition used in this study) and setting specific physiological responses, no significant differences between airway anatomy subgroups were noted.

Initial SpO2 values were distributed widely, with a median of 94.5% across all patients (Figure 12). Most cases had SpO2 values above 90%, but a substantial proportion fell between 60% and 80%, suggesting the presence of significant initial hypoxemia in some patients. Median SpO2 for patients with adult airway anatomy was comparable across settings (92% and 91% for emergency centre and prehospital settings, respectively). Patients with paediatric airway anatomy demonstrated more variability, with median SpO2 values of 97% in emergency settings and 88% in prehospital environments, indicating greater vulnerability to desaturation and clinical acuity in the prehospital setting.

The distribution of initial GCS scores showed a median of 5 across all patients, with a frequent score of 3, indicating critical neurological compromise in many cases (Figure 13). Patients with adult airway anatomy demonstrated median GCS scores of 4 (emergency centre) and 3 (prehospital setting). Patients with paediatric airway anatomy had a median GCS of 7 in emergency centres, dropping to 3 in prehospital settings. Despite these differences, statistical tests (e.g., Kruskal-Wallis Test) revealed no significant relationships between GCS and clinical settings for the airway anatomy, both paediatric and adult patient subgroups.

The results indicate that most of the patients that students are likely to be exposed to are critically ill as indicated by high number of patients with initial GCS scores less than 9 (Figure 13). Exposure to patients with significant initial hypotension is relatively low, while some exposure to patients with initial hypoxemia was observed. This implies that exposure to ETI procedures being performed on clinical unstable patient is relatively low. These results likely reflect the common clinical presentation of patients as related to dominant clinical pathologies (Trauma with TBI or isolated TBI, Figure 10).

5.3.3.2 Relationships between patient acuity and students performing the ETI procedure

A comparative analysis of observed and performed intubation subgroups indicated that clinical patient acuity had no statistically significant differences for the variables systolic blood pressure (SBP) ($p = 0.14$), oxygen saturation (SpO2) ($p = 0.37$), or Glasgow Coma Scale (GCS) scores ($p = 0.79$). From these results, it would appear that students are equally able to perform the ETI procedure irrespective of the level of patient acuity. It is, however, possible that this result may be impacted by the low numbers of clinically unstable, critically ill patients. In the data, in relation to SBP, the observed group demonstrated a larger subgroup of patients who has initial SBP values lower than 80mmHg. This suggests that although not statistically significant in the study (likely due to low frequency), students may be more likely to observe rather than perform ETI in patients presenting with cardiovascular instability (Figure 15).

Conversely, in relation to SpO2, the opposite trend is noted. For patients in the performed intubation group, more initial SpO2 readings below 85% are noted for patients where students performed the ETI (Median = 95% for observed ETI as compared to 91% in the performed ETI group, Figure 17). Again, this may have likely been due to the low number of patients with these low SpO_2 levels (this relationship is not statistically significant).

The distribution of GCS scores was similar between the two groups, with both having a median score of 3 and comparable ranges. This suggests a similar degree of neurological compromise in patients across both groups (Figure 16).

These findings highlight slight differences in patient characteristics that, while not statistically significant, may still have implications for the decision made by preceptors in relation to allowing students to perform the ETI procedure. Although in this dataset, these clinical characteristics were uncommon, a larger sample size including more patients with higher acuity may be more powered to verify these results or detect a difference if the results represented here are, in fact, a false negative.

5.3.3.3 Implications of patient characteristics and acuity of ETI exposure

These findings underscore how patient-specific characteristics and context determine the nature of exposure and the student's likely role during intubation events. Variability in SBP, SpO2, and GCS values may reflect underlying differences in patient severity, clinical environment, or procedural circumstances. However, the absence of statistically significant differences limits the ability to draw definitive conclusions regarding the impact of these characteristics on intubation outcomes. The small proportion of patients with complete data further highlights the need for more comprehensive data collection in future studies to improve the robustness of these analyses. These results provide foundational insights into patient characteristics during intubation but emphasise the necessity for larger datasets to refine understanding and inform clinical practice.

5.4 ETI Success Rates and ETI First-Attempt Success

5.4.1 Success Rate for Intubation Events & Exposure to Failed Intubation

The overall success rate for intubation procedures (all settings) in this study was 97.4%, implying that only 2.6% of patients could not be intubated. Results shown in Figure 22 and Table 13 demonstrate that most patients were successfully intubated at the first attempt. A total of 91% of all students performed ETI procedures successfully at the first attempt (Table 14). The abovementioned values include both intubations in the simulated and clinical settings. This information is valuable, not only as a measure of success rate, but also as a proxy measure for failed intubation exposure. The ability to safely and effectively manage a failed intubation situation is considered a critical skill for all providers who perform advanced airway management, particularly if RSI is involved (Blair et al., 2016); Difficult airways have been reported to occur in up to 30% of ED patients, contribute to first-attempt intubation failure rates of approximately 12.7%, often leading to complications like desaturation, aspiration, and hemodynamic instability (Blair et al., 2016; . A breakdown of the characterises of patients who could not be intubated is provided in Table 12. It is noteworthy that most of these patients were encountered in the emergency context, most often in the prehospital setting.

Of the 848 ETI events with valid intubation attempt data, only 124 (14%) of patients were not successfully intubated after the first attempt, which is similar to findings of previous studies (Blair et al., 2016). This implies that among the 22 students whose data were collected, the cumulative total of patients in whom the first attempt at ETI failed was 124 events. When this exposure is considered by an individual student (Figure 28), it should be noted that some students have as few as 2 or no exposures to failed intubations recorded. It can also be noted that only 6 of these events were documented in the skills lab setting (Table 16). This may illustrate either that those students had not routinely captured data on failed intubation event exposure in the skills lab setting at the time, or that the exposure to simulated training of the procedure may also be low. Considering the importance of competency in failed intubation management, future research may be helpful in determining whether student ECPs are sufficiently prepared to manage failed intubation scenarios upon graduation.

Another finding which may be noteworthy is that of all RSI-related ETI events for which first pass success was not achieved, 54% (n=19/35) were observed rather than performed by students (Table 9). A similar trend is observed when considering all intubation attempts, where

50.8% (n=57/112) of ETI events that did not achieve first pass success were observed by students (Table 7). Although again not directly measured in this study, this may indicate that students are less likely to be allowed to attempt intubation on anticipated difficult airways and are more likely to be acting in the observation role. Students were almost three times as likely to be allowed to perform an intubation that was successful at the first attempt as compared to one that was not (OR = 2.86 (CI 0.95: 1.86 to 4.39), $x^2 = 24.10$, $p < 0.001$). This finding may be explained by preceptors anticipating possible peri- and post-intubation complications related to difficult airways and repeated intubation attempts, including oxygen desaturation (43%) and bradycardia (13%), which can occur during or after the first attempt at ETI (Blair et al., 2016).

5.4.2 Success in Clinical and Simulated Settings

A key aspect of the findings of this study is the comparison between simulated and clinical settings. Simulation-based training demonstrated a high first-attempt success rate of 98.1%, which reflects its role as a powerful tool for skill acquisition and psychological readiness (Table 16) (Crawford et al., 2018). Simulations allow students to practice safely, rehearsing responses to clinical scenarios that range from routine to complex, while avoiding patient risk (De Lorenzo et al., 2019). The controlled environment of high-fidelity simulations mimics the physical and emotional challenges of real-life intubations, helping to bridge the gap to clinical practice (Dhakal et al., 2017). However, first-attempt success in clinical settings was comparatively lower, particularly in the prehospital setting (66.7%, n = 86/129) and the emergency centre setting (65%, n = 94/144) (Table 16). These findings highlight the complexity of real-world environments, where stressors such as time pressures and patient acuity can impact performance (Sell et al., 2020). This reinforces the need for a blended approach to training, using simulations as a foundation and clinical practice as a final competency-building phase.

The setting of intubations also played a role in first pass success exposure. Higher first attempt success rates were observed in controlled environments, such as the Skills Lab (98%, n=310/316) and Operating Room (92%, n = 241/260), as compared to the emergency context (65.9% n=180/273), where most unsuccessful outcomes occurred (Table 16). This supports findings that controlled settings are conducive to skill acquisition, which can then be transferred to less predictable environments (Carlson et al., 2016). Benger et al. (2009) emphasise that procedural success often correlates with the frequency of direct practice, underscoring the value of a hands-on approach. Similarly, Muratore (2018) notes that practice enhances both technical efficiency and student confidence, contributing to better patient outcomes in complex cases. Active performance not only builds technical skills but also fosters confidence, both essential for successful intubation (Crawford et al., 2018).

Only 3.1% of successful events required three attempts; however, unsuccessful ETI outcomes rose significantly after the first attempt, with 60.0% of unsuccessful ETI outcomes stopping on the second attempt (Table 13). In a total of 15% of successful intubation events, providers attempted 3 to 4 attempts. Although this only accounts for 15 individual events, it highlights the need for comprehensive simulation-based training in troubleshooting and managing difficult intubations when the initial attempt is unsuccessful.

The data also show a substantial discrepancy in first-attempt success rates based on the clinical setting, with trauma cases and cardiac arrest scenarios being particularly challenging (Table 16). The unsuccessful ETI events in this study, although small in frequency, offer insight into potential areas for targeted improvement. A closer examination reveals that all unsuccessful events involved patients with adult airway anatomy and were associated with TBI and multisystem trauma, which had failure rates of 20.0% and 25.0%, respectively. This is consistent with literature noting the complexity of trauma patients in airway management, where complications are more likely due to severe and varied injury patterns (Crewdson et al., 2017). These findings highlight an opportunity to strengthen training specifically around trauma-related intubations, particularly through simulated high-stakes scenarios, which could help address these complex cases.

5.4.3 First Attempt (Pass) Success

First-attempt success emerged as a key performance indicator in airway management, as repeated intubation attempts significantly increase patient risk and complication rates, including hypoxia and airway trauma (Jaber et al., 2008; Aziz et al., 2015). The generally accepted global benchmark for first pass success for ETI in most settings is 80–90% (Panchal et al., 2020; Lockey et al., 2015). In this study, first-attempt success was observed in 86.0% of all ETI events (Figure 23). This rate aligns with established benchmarks in the literature for first-attempt success rates, aligning with the expectations for novice practitioners (Aziz et al., 2015), considering that this proportion reflects success rates on both clinical and simulated ETI events combined. Success on the first attempt is critical in clinical contexts, as it not only reflects skill proficiency but also contributes positively to patient outcomes and builds provider confidence (Bielski et al., 2019). Jaber et al. (2008) noted that first-attempt success rates are a reliable indicator of skill proficiency.

In this study, the first-pass success rate for students performing intubations in the clinical setting (non-simulated patients) was 78.8% (n = 421/534) and 77.8% (n=56/72) for students performing ETI procedures involving RSI (Table 16 and Table 9, respectively). This may be a reflection of the complexity of learning the ETI procedure and the challenges faced by students in their clinical learning, as related to, particularly, intubation in an emergency setting. This same trend is reflected in the data representing first pass success data for both performed and

observed ETI events combined (Table 16). First pass success was lowest in the prehospital setting (66.7%, n = 86/129) and the emergency centre setting (65%, n = 94/144), as compared to 92% (n = 241/260) in the operating room. As this data reflects both student-performed and observed ETI events, it may illustrate the complexity of ETI procedures, particularly in the emergency setting, even when preceptors are performing the ETI procedure.
A possible key finding that may aid in explaining the observed first pass success rate was the inconsistency in hands-on opportunities across clinical settings. Students were three times more likely to perform intubations in operating rooms compared to the Emergency centre (OR = 3.35, $p < 0.001$), where students observed 61.1% (Figure 14 and Table 6) of the intubation procedures. This represents a potential missed opportunity for students to gain hands-on ETI experience with high acuity patients in an emergency context, but one that is a more controlled environment as opposed to the prehospital setting. Although observational learning is valuable for understanding decision-making processes and advanced techniques (especially when observing experienced emergency physicians), it must be supplemented with hands-on practice to build comprehensive skills (Murphy & Laffey, 2007). Furthermore, RSI accounted for only 21.4% of all intubations in the clinical setting, emphasizing the need for targeted interventions to increase exposure to this critical procedure

5.4.4 Individual Student Performance

When considering the data presented on first pass success rated by individual students, some substantial variation is noted. Student first attempt success rates varied substantially, with some achieving over 100% success and others as low as 50% (Figure 28 and Table 20). Factors contributing to this variability may have included differences in case complexity and exposure. Students with higher overall exposure (>50 intubations) reported higher success rates, particularly in first-attempt scenarios. For instance, students who led intubation attempts had a higher success rate (41.2%) compared to those assisting (6.4%) ($x^2 = 7.62$, $p = 0.022$), despite missing data limiting a more comprehensive analysis.

The distribution of intubation attempts by students showed that some students had limited exposure to complex scenarios, such as RSI, with an average of 5.22 RSI cases per student (Figure 25 and Table 18). Exposure to non-RSI cases was significantly more common (86.5%). Among students, only four recorded more than 10 RSI procedures, with substantial variability in overall intubation exposure (range: 4–90 events). This variation underscores the need for individualized training to ensure equitable clinical experiences and competency development.

Students with high intubation exposure (>60 events) consistently achieved first-attempt success rates above 88%, while those with limited exposure (<10 events) reported greater variability in success. These findings emphasize the importance of balancing the quantity and quality of exposure to optimize outcomes.

5.5 Limitations

5.5.1 Limitations in study design, sampling, and statistical analysis

A key limitation of this study relates to the study design. As this study employed a cross-sectional descriptive survey design, the study was primarily designed to estimate and describe the characteristics of ECP student intubation exposure during their WIL placements. Although some cross-sectional descriptive surveys can be designed to have an analytical component with the *a-priori* intention to estimate relationships between variables, this was not the case in this study. The primary reason for the design choice used in this study related to the researcher's existing knowledge of the nature of the available data and the sampling methodology that was planned. It is therefore important to interpret these results with caution, particularly the results around associations or relationships between variables (Kim, 2024). As indicated above, the study design did not include any *a-priori* analytical objectives or hypotheses. However, considering the nature of the data and the limited published data on the description of intubation exposure among ECP students, the researcher elected to perform a *post hoc* exploratory analysis. This analysis was intended to be hypothesis-generating, with an intention to guide possible future research questions, a common intention in cross-sectional studies (Kim, 2024; Wang & Cheng, 2020), and should not be interpreted as confirmatory of any hypothesis. Considering the sampling design and limited sample size within some subgroup comparisons, there is a high risk for false positive results with respect to any statistically significant relationships. Similarly, the limited sample size would likely result in most of the subgroups' analyses being underpowered and, therefore, the risk of false negative conclusions in the event of non-statistically significant findings (Kim, 2024). These limitations should be considered carefully when interpreting the results of this study.

As one of the objectives of the study was to develop a description of students' exposure over the four-year period of their program, it was deemed impractical to perform a random sample of individual intubation events from the dataset. Similarly, at the time of sampling, the number of individual students who had complete four-year datasets was limited. Another challenge to sampling was the perceived quality of data. As the study site had only initiated the use of FISDAP™ in 2012, there were several data validation concerns. Firstly, the system underwent some additional development during the study period, adding data collection variables and verification rules. To overcome these challenges, the research site used an additional process of manual data auditing by clinical facilitators. Verification of data accuracy was performed using correlation with preceptor-signed and dated skills logbooks, and as such, staff at the research site were able to indicate which students they believed had the most accurate data. Considering these challenges, it was decided that a purposive sampling methodology using exemplar samples of specific students would be the best approach to ensure reliable data was included in the study. The trade-off in using this sampling technique is that the data from the study lacks external validity, is likely to be influenced by selection bias, and should therefore only be considered a reflection of the intubation exposure of the included students. Despite this significant limitation, it can still be argued that the results provide valuable insight into student exposure and are valuable with regard to hypothesis generation for future research and contribute to our understanding of ECP student exposure to ETI prior to qualification (Kim, 2024; Wang & Cheng, 2020).

5.5.2 Missing Data and Data Reliability

A significant limitation in this study was the high proportion of missing data, particularly regarding primary impressions (70.1% or 596/850 analysed cases), and other key parameters like medication documentation and vital signs. This incomplete data limits the reliability of the analysis, posing challenges to drawing comprehensive conclusions about student clinical experiences. For example, only 10.4% of the dataset contained complete clinical data by age category and placement site. Such gaps align with challenges noted by Cook et al. (2011), who emphasized that missing data compromises the interpretability and generalizability of clinical research outcomes.

Missing data were especially notable in procedures involving RSI, where pharmacological details were often omitted. This is concerning, given the critical importance of accurate and comprehensive documentation for assessing student competencies. Griesdale et al. (2009) emphasize that reliable data collection is essential for tracking clinical exposures and outcomes, particularly in emergency medical education, where procedures like ETI play a central role. Missing data in this study hindered the ability to fully evaluate students' exposure to pharmacological aspects of intubation, an area crucial for preparing them for independent clinical practice.

The high prevalence of missing data highlights the need for improved data management practices with regard to student clinical data collection practices. Implementing standardized and rigorous data capture protocols, as suggested by Nguyen et al. (2019), could help reduce missing data occurrences, providing a more accurate picture of clinical training and student competency.

5.5.2.1 Impact of Retrospective Data Collection on Data Completeness

Using retrospective data introduced additional challenges related to data completeness. Retrospective clinical datasets, often collected for operational rather than research purposes, are prone to inconsistencies in documentation quality and scope. Hegde et al. (2019) noted that this often results in incomplete datasets, limiting the ability to draw comprehensive conclusions.

For instance, the study found significant variation in the completeness of data entries across clinical sites and students. This inconsistency underscores the need for improved documentation training and systems. Maguire et al. (2016) and Buis et al. (2016) suggest that regular training on documentation practices and the use of electronic systems with mandatory entry fields could reduce data gaps, ensuring more consistent and reliable datasets for future longitudinal training evaluations.

5.5.2.2 Documenting during Performed and Observed of Procedures

The study also revealed that missing data were more prevalent in performed events than in observed ones, particularly in recording medication use. This discrepancy likely stems from the inherent pressures and focus required during performed events, where students may prioritise immediate clinical actions over detailed documentation. Barker et al. (2017) argue that, especially in high-stakes environments, students may prioritise clinical actions over thorough documentation. This is crucial, as gaps in clinical data records can limit the understanding of students' exposure to essential clinical interventions, such as various airway events and medications, which are fundamental to airway management competence.

Sell et al. (2020) highlight that accurate documentation is essential for understanding the clinical context in which intubations are performed, as these interventions can significantly influence patient outcomes and procedural complexity. Without complete records, assessments of students' exposure to these critical elements of ETI are potentially underestimated. Additionally, Fleischman et al. (2016) emphasise that procedural skill development relies not only on technical execution but also on an understanding of associated requirements, further underscoring the need for complete data.

5.5.3 Study Delimitations and Recommendations for Future Research

The study's reliance on data from the FISDAP™ system, which contains five years of clinical records, reflects trends among students from the Western Cape but limits the generalisability of findings to other regions or institutions. The absence of comparable datasets from other higher education institutions (HEIs) in South Africa further restricts broader applicability. This limitation underscores the need for national-level standardised data collection practices to enable comparative research and inform evidence-based curriculum development.

Future studies should explore strategies for reducing missing data, such as integrating electronic documentation systems with mandatory fields and offering targeted training on clinical record-keeping. Additionally, longitudinal research is recommended to examine how clinical training experiences, including exposure to paediatric and complex trauma cases, influence skill retention and competency development post-graduation. Comparative studies between training models, such as integrated simulation-clinical exposure versus traditional approaches, could provide further insights into best practices for emergency medical education.

CHAPTER VI – CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This chapter draws together the key findings of the study, situating them within the broader landscape of emergency medical education in South Africa. The study was conducted with Emergency Care Practitioner (ECP) students from the Cape Peninsula University of Technology (CPUT) in the Western Cape, and as such, the findings reflect experiences within this institutional and provincial context. While these results cannot be assumed to represent all ECP students nationally, they nonetheless provide important insights into advanced airway management training, particularly with regard to endotracheal intubation (ETI) exposure during Work Integrated Learning (WIL) placements. The results offer valuable insights into the frequency, diversity, and characteristics of these exposures, highlighting gaps in training and underscoring the importance of curriculum adjustments to address these shortcomings.

6.2. Conclusions:

6.2.1 Contribution to Knowledge

This research contributes significantly to the understanding of ETI competency development processes for ECP students within the context of the Western Cape. The results underscore the role of blended learning approaches, combining simulation-based training and real-world clinical exposure, in equipping ECP students with the requisite skills. However, the findings also highlight potential disparities in exposure to critical contexts, such as prehospital and emergency settings, where proficiency in procedures like Rapid Sequence Intubation (RSI) is essential. While the findings offer useful insights that may inform curriculum design in comparable settings, caution must be exercised in extending these conclusions to all ECP training programmes nationally. Broader, multi-institutional studies are needed to confirm the generalisability of these results and to support the development of nationally relevant strategies for enhancing ETI training.

The findings in this study align with international literature that underscores the necessity for comprehensive training to ensure competency in advanced airway management. For instance, studies by Dorsett et al. (2022) and Aziz et al. (2015) emphasize the importance of exposure to real-life scenarios to develop clinical judgment, decision-making, and psychomotor skills. However, this study identifies a reliance on simulation-based training, particularly in the early stages of learning, with limited opportunities for hands-on practice in high-pressure environments. While simulation provides a risk-free environment for skill acquisition, it cannot fully replicate the variability and complexity of live patient encounters (Carlson & Wang, 2017).

The findings reveal that a considerable portion of ETI training exposure occurs in the operating room (30.6%) and skills lab (37.2%), with limited opportunities in emergency centres (16.9%) and prehospital settings (15.2%). This imbalance highlights a significant gap in exposure to high-stakes scenarios, which are critical for preparing students for independent practice in emergency care. Prehospital intubation, a key component of ECP practice, was performed infrequently, with significant variability among students. For example, while operating rooms accounted for a significant portion of intubation exposure, these environments, although controlled, do not mirror the dynamic challenges of ETI in the prehospital and emergency settings. The disparity in training environments suggests the need for greater emphasis on emergency context exposures, particularly in procedures like Rapid Sequence Intubation (RSI). On average, students had only 2.18 prehospital RSI exposures, far below the recommended 20 cases for competency (Panchal et al., 2020; Dorsett et al., 2022). Although these findings cannot be generalised, it does raise concerns about whether students are adequately prepared for independent practice in high-stakes, unpredictable environments (Dorsett et al., 2022).

Barriers to hands-on learning, including preceptor confidence, patient acuity, and contextual factors, further exacerbate the challenges in ETI training. In clinical settings like emergency centres, the findings of this study may suggest that preceptors may limit students' opportunities to perform procedures in high-stakes situations due to concerns about patient safety or uncertainty about students' capabilities. These findings are consistent with prior research that underscores the importance of preceptor training to enhance trust in students' abilities and facilitate meaningful clinical experiences (Carver & Lazarsfeld-Jensen, 2018).

Simulation-based training (SBT) emerged as a cornerstone of ETI education, accounting for 37.2% of intubation exposures in this study. High-fidelity simulations, as supported by Bienstocke et al. (2022), provide an effective platform for building foundational skills and confidence. However, it also reiterates the limitations of simulation, as it cannot replicate the variability and unpredictability of real-life clinical experiences. The reliance on manikins for rare clinical scenarios, such as paediatric airway management, highlights the necessity for integrating more live patient exposures into training programs.

While SBT is essential for addressing gaps in clinical exposure, it must be complemented by hands-on experiences in authentic settings to develop well-rounded competence. The integration of hybrid training models that blend simulation with clinical practice aligns with Kolb's experiential learning theory, which advocates for the application of theoretical knowledge through practical engagement to achieve competency in complex skills (Kolb, 1984; Weingart & Levitan, 2012). By balancing simulated and clinical learning, ECP programs can ensure students develop both technical skills and critical clinical judgment.

6.2.2 Significance of the Study

The findings of this study have important implications for future research and advancing emergency medical education, particularly in the training of Emergency Care Practitioner (ECP) students. They highlight several key areas for enhancing training and competency development, which are crucial for preparing students to manage high-stakes situations effectively.

6.2.2.1 Curriculum Development:

A critical insight from the study is the need for curriculum adjustments to ensure a more balanced and comprehensive training approach. While simulation-based training (SBT) plays a significant role in building foundational skills, there is a clear need to align training programs with global standards, such as those outlined by the NAEMSP. This alignment can better prepare ECP students to handle high-acuity patients in dynamic and unpredictable environments (Panchal et al., 2020). Curriculum development should prioritise exposure to both controlled settings, such as operating rooms and skills labs, and real-world emergency environments like prehospital settings and emergency centres, where students can hone their clinical judgment and decision-making skills.

6.2.2.2 Preceptor Training:

Another key recommendation emerging from this study is the enhancement of preceptor training. Preceptors play a pivotal role in shaping the clinical experiences of ECP students, as their confidence in a student's abilities often determines the extent of the student's participation in procedures. By strengthening preceptor training, educators can ensure that preceptors are well-versed in the students' curriculum and learning objectives. This understanding can foster greater trust in students' capabilities, reduce barriers to their involvement in high-stakes procedures, and provide more consistent opportunities for hands-on practice.

6.2.2.3 Post-Graduation Internships:

Additionally, the study identifies the introduction of structured post-graduation internships as a valuable strategy for bridging gaps in real-world exposure. Such internships would offer newly qualified ECPs a supervised environment to further refine their skills and gain experience in performing complex procedures, such as RSI. These internships can help build the confidence and competence of ECP graduates before they transition to independent practice. Drawing from the success of similar programs in other healthcare fields, this approach has the potential to significantly enhance the readiness and capabilities of ECP professionals.

6.2.2.4 Simulation as a Supplementary Tool:

Lastly, while the study reaffirms the value of SBT in developing technical skills, it also highlights its limitations in replicating the cognitive and contextual challenges of real-world emergency scenarios. Enhancing simulation programs to include high-fidelity, context-specific scenarios could help bridge the gap between theoretical training and practical application. For rare or intricate procedures like RSI, simulation serves as a critical supplementary tool, offering students the opportunity to practice in a controlled yet realistic environment that mirrors the pressures of actual patient care.

This study emphasises the need for a multifaceted approach to training ECP students. By addressing curriculum gaps, enhancing preceptor roles, introducing post-graduation internships, and refining simulation-based programs, emergency medical education can be significantly strengthened to ensure that future practitioners are well-equipped to provide safe and effective care in emergency settings.

6.3. Recommendations: for Future Research and Education

The findings of this study highlight critical areas for improvement in the training of Emergency Care Practitioner (ECP) students and underscore the need for targeted interventions and reforms to optimize ECP training. These insights pave the way for further research and practical interventions aimed at optimising training methodologies and ensuring that ECPs are well-prepared for the complexities of their roles.

One of the key recommendations is the need for comparative studies across institutions and regions to identify best practices in ECP training. Such research would provide a broader understanding of the diverse approaches currently in use and help establish national benchmarks for training. Standardising key performance indicators, such as the number of ETI exposures required for competence or the optimal mix of simulation and clinical practice, would enable institutions to align their curricula with global best practices while addressing local healthcare needs.

Another vital area for exploration is longitudinal research to track skill retention and competency development post-graduation. While the current study provides insights into the training phase, there is limited understanding of how skills developed during training are retained and applied in professional practice. Longitudinal studies would offer valuable data on the long-term effectiveness of training programs, including how often ECPs perform advanced airway management procedures and the impact of these experiences on patient outcomes. Such research could inform the design of continuing education programs and highlight areas where additional support may be needed for practitioners in the field.

The efficacy of hybrid training models also warrants further investigation. The study findings suggest that a blend of simulation-based training (SBT) and real-world clinical exposure is essential for building competency in advanced airway management. However, the optimal structure of such hybrid models remains unclear. Future studies could examine the effectiveness of different training combinations, such as high-fidelity simulations, cadaveric workshops, and clinical placements, to determine which approaches best prepare students for high-stakes, dynamic scenarios in emergency care. This research would be instrumental in refining training strategies and ensuring that they meet the demands of both urban and rural healthcare settings.

In conclusion, this study makes a significant contribution to understanding the complexities of advanced airway management training within the Western Cape's ECP curriculum. While the findings are context-specific, they highlight critical aspects of ETI competency development and may inform similar educational environments across South Africa, with the understanding that broader generalizations require further research.

By identifying key training gaps and proposing actionable recommendations, it provides a foundation for enhancing the education and preparedness of ECP students. Addressing these gaps through targeted interventions and evidence-based reforms can improve the overall quality of emergency care, ultimately enhancing patient safety and outcomes in high-pressure medical environments. Continued research and collaboration among educators, policymakers, and healthcare institutions will be crucial to achieving these goals.

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APPENDICES

Annexure A

DESCRIPTION OF SKILL/CAPABILITY (PERFORMED IN AN AUTHENTIC ENVIRONMENT IN CLINICAL PRACTICE ON ACTUAL PATIENTS, UNDER SUPERVISION)	MINIMUM NUMBER PER REGISTRATION CATEGORY - THESE ARE NUMBERS THAT MUST BE ACHIEVED BY THE TIME OF COMPLETION OF THE QUALIFICATION		
	Student Emergency Care Practitioner	Student Paramedic	Student Emergency Care Assistant
Temperature Measurement: Rectal/Oesophageal	2	0	0
Airway Assessment (with all characteristics described)	60	0	0
Out-of-Hospital Rapid Sequence Intubation (RSI): Medication Administration	2	0	0
Out-of-Hospital RSI : Clinical Decision Making	3	0	0
Out-of-Hospital RSI: Management & Control	2	0	0
RSI: Medication Administration	10	0	0
RSI: Clinical Decision Making	10	0	0
RSI: Management & Control	10	0	0
Oral Endotracheal Intubation - Routine	30	0	0
Nasal Intubation - Routine	0	0	0
Video-Assisted Laryngoscopy	0	0	0
Bag-valve-mask Ventilation (or equivalent)	35	20	10
Bag-valve-tube Ventilation (or equivalent)	35	20	10
Use of a Bougie or equivalent	0	0	0
Use of Supraglottic/Extraglottic Device	10	10	0
Use of an Oropharyngeal/Nasopharyngeal Tube (OPT/NPT)	12	5	0
Suctioning: Oropharynx/Nasopharynx	15	10	5
Suctioning: Endotracheal Tube/Tracheostomy	15	5	0

Annexure B

Student No.	Date	patient	Case No	Case info: Site (Field/ Clinical/ lab)	Location	Patient Info: Age	Gender	Complaints	Primary Impression	Medical/ trauma	Mechanism of Injury: --	Cause of Injury	Criticality:	Treatment: Airway Skill: Perform/ Observe	Lead/ Assist	Successful / Unsuccessful	No of attempts	Medication Given (RSI Agent): Suxamethonium (Y/N)	Rocuronium (Y/N)	Rapid sequence induction (Ketamine/ Etomidate/	Vitals BP	GCS	Pulse	Respiratory rate	SpO2
Student 1	11/05/2013	1	1	Clinical	Kraaifontein Community	child	0	0	0	0	0	0	red	Observed	0	Successful	4	0	0	0	0	0	0	0	0
Student 1	20/07/2013	1	1	Field	Medical Emergency Transport and Rescue:	child	Female	Change in responsiven	Overdose/ Poison		0		red	Observed	Assist	Successful	2	No	No	No	0	0	0	0	0
Student 1	12/04/2014	1	1	Clinical	Groote Schuur Hospital: ER (Medical)	adult	Female	General body	Other Medical	Medical			yellow	Observed	Assist	Successful	1	No	No	No	136/87,158 /97,145/88	12,10,10	117,109,121, Regular	24,36, Normal	99,99,99
Student 1	16/05/2014	1	1	Clinical	Eerste River Hospital: Casualty	adult	Male		Other Medical		0	0	red	Perform		Successful	1	Yes	No	Yes	223/78	6	64, Regular Strong	18, Normal	95
Student 1	22/06/2014	1	1	Field	Medical Emergency Transport and Rescue	child	0	Death	Trauma - Multisystems				red	Observed	Assist	Successful	1	No	Yes	Yes					
Student 1	10/07/2014	1	1	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0		0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	10/07/2014	2	2	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0			0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	10/07/2014	3	3	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	10/07/2014	4	4	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0			0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	1	1	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	2	2	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0			0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	3	3	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	4	4	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0			0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	5	5	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	6	6	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0			0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	11/07/2014	7	7	Clinical	Groote Schuur Hospital: Theatre	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	08/05/2015	1	1	Clinical	Tygerberg Hospital: ER (Trauma)	adult	0	0	0			0	0	Perform	0	Successful	2	0	0	yes	0	0	0	0	0
Student 1	15/05/2015	1	1	Clinical	Tygerberg Hospital: ER (Medical)	adult	0	0	0		0	0	0	Perform	0	Successful	1	0	0	0	0	0	0	0	0
Student 1	15/05/2015	2	2	Clinical	Tygerberg Hospital: ER (Medical)	adult	0	0	0			0	0	Perform	0	Successful	2	0	0	0	0	0	0	0	0
Student 1	22/05/2015	1	1	Clinical	Tygerberg Hospital: ER (Trauma)	adult	0	0	0			0	0	Perform	0	Successful	2	0	0	0	0	0	0	0	0
Student 1	05/06/2015	1	1	Clinical	Karl Bremer Hospital: Theatre									Perform		Successful	1								

Annexure C

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09 October 2017

Mr DD Thomas
11 Plaza Sirrocco Village
Bellville
7530

REQUEST TO CONDUCT RESEARCH: ENDOTRACHEAL INTUBATION EXPOSURE OBTAINED BY EMERGENCY CARE STUDENTS IN CAPE TOWN DURING WORK INTEGRATED LEARNING

This serves to confirm that I, Lloyd Christopher, the HOD: Emergency Medical Sciences hereby give permission for Daglin Thomas (Student No.206063857) to conduct a research with the title: "Endotracheal intubation exposure obtained by Emergency Care students in Cape Town during work integrated learning" in the department for the purposes of his Master's Degree in Emergency Medical Care.

Yours Sincerely

Mr. Lloyd Christopher
HOD: Emergency Medical Sciences,
Faculty of Health & Wellness Sciences

Annexure D

Cape Peninsula University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HWS-REC)
Registration Number NHREC: REC- 230408-014

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25 November 2022
REC Approval Reference No:
CPUT/HW-REC 2017/H28(renewal)

Dear Mr. Daglin Thomas

Re: APPLICATION TO THE HWS-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC on 14 September 2017 to Mr Thomas for ethical clearance. This approval is for research activities related to student research in the Department of Emergency Medical Care at this Institution.

TITLE: **A descriptive survey of the profile of endotracheal intubation exposure obtained by Emergency Care Practitioner students in the City of Cape Town during work integrated learning.**

Supervisor: Mr. de Waal and Prof. K Gamieldien

Comment:

Approval will not extend beyond 26 November 2023. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the HWS-REC in December of that particular year, for the HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Ms. Carolynn Lackay
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences