Intubations in an emergency department and intensive care unit at a central hospital

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

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Declaration

I, Sheena Diedre Smith declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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Abstract

Background

The development of the emergency medicine speciality in the emergency department (ED) and the multi-speciality environment of the intensive care unit (ICU) have necessitated airway management skill in specialities other than anaesthesiology. The aim of this study was to describe the intubation process in adult patients within the ED and the general medical and surgical ICU at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A prospective, contextual, descriptive research design was followed, using a consecutive convenience sampling method. The study population consisted of adult patients requiring intubation within the ED and ICU at CMJAH.

Results

The study period was from 2 January to 20 May 2019, and 140 patient intubations were described. The most frequent indication for intubation was a reduced Glasgow coma scale in 56 (40.0%) patients. First attempts at intubation were completed by doctors from: emergency medicine (47.9%), general surgery (17.1%), anaesthesiology (19.3%), internal medicine (9.3%), and obstetrics and gynaecology (6.5%). Junior doctors intubated 133 (95.0%) patients. First-pass attempts occurred in 85.7% of intubations, with no difference in the number of first-pass attempts between ED and ICU ($p = 0.340$). Ketamine was the favoured induction agent, used in 68 (48.6%) intubations, and rocuronium was the preferred neuromuscular blocker, used in 91 (65%) intubations. Appropriate pharmacological therapy was evidenced in 67 (47.9%) of cases. Adverse events were observed in 22 (15.7%) intubations with haemodynamic instability occurring most frequently, in 16 (11.4%) intubations. Airway-related deaths occurred in 2 (1.4%) intubations. Non-airway related deaths occurred in 5 (3.5%) of intubations.

Conclusion

Anaesthetists are no longer involved in the majority of emergency intubations outside of theatre. Junior doctors perform most of the emergency intubations, with similar success rates, peri-intubation adverse events and direct outcomes to that in the literature, despite a high rate of inappropriate drug choice.

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Abbreviations

CMJAH	Charlotte Maxeke Johanessburg Academic Hospital
CP	Cricoid pressure
ED	Emergency department
GCS	Glasgow coma scale
ICU	Intensive care unit
MO	Medical officer
NAP4	4th National Audit Project of the Royal College of Anaesthetists
NEAR	National Emergency Airway Registry
NMBA	Neuromuscular blocking agent
REG	Registrar
RSI	Rapid sequence induction
SS	Sheena Smith

Statement

The Research Report consists of a literature review, draft article, study proposal and appendices. The study proposal is included for background reference and is not for examination.

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the rest of the Research Report in order to comply with the author guidelines of the Southern African Journal of Anaesthesia and Analgesia (SAJAA), the journal to which it is intended to be submitted.

Section 1: Review of the literature

1.1 Introduction

Anaesthetists are thought to have superior expertise when it comes to airway management (1). Development of the emergency medicine specialty and the condition of patients that attend the emergency department (ED) has necessitated airway management skill in this field (2, 3). In the critically ill patient in the intensive care unit (ICU), airway management often involves intubation of the trachea (4). Practitioners who do not routinely intubate often perform this procedure, as well as physicians-in-training under strained circumstances (4).

The most common method of endotracheal intubation involves the use of a direct laryngoscope and the Macintosh® laryngoscope blade. In some cases, airway management can be challenging, requiring the employment of video-laryngoscopes, such as the CMAC® or Glidescope®, as well as the McCoy® direct laryngoscope with a flexible blade (5).

The location of airway management does impact on patient outcome. In the ED, failure and complication rates are higher than in a controlled theatre environment. This is regardless of the speciality of the doctor involved in the intubation, and rates of difficult intubation have reached 9% in the United Kingdom (2). In the ICU, potential intubation failure and complication rates become important, as a large proportion of the critically ill require intubation (2). Intubation is urgent, and is required to be rapid (6). The general organisation of ICU and the poor physiological reserve of the patients in ICU translate to a high-risk and unpredictable intubation process within this setting (2).

This literature review describes the emergency intubation process, and the factors around it. Intubations in the ED and intensive ICU are then explored. The literature reviewed is limited to the adult population.

1.2 The intubation process

This section will describe the intubation process, including intubation strategies, difficult airway management, and the various pharmacological strategies that can be employed in order to facilitate intubation.

1.2.1 Intubation strategies

Induction is the achievement of a state of hypnosis, analgesia and amnesia by administration of one or more drugs (7). Two main variants of induction are used: elective sequence, and rapid sequence. Cricoid pressure (CP) and difficult airway management will also be explored in this section.

Elective sequence induction

Following a period of pre-oxygenation (administration of 100% oxygen to a spontaneously breathing patient) the elective intubation process usually involves administration of an induction agent with a short onset-of-action. The ability to manually bag-mask-ventilate the patient would then be checked, after which administration of a rapid acting neuromuscular blocking agent (NMBA) would occur. Bag-mask ventilation would then continue until the NMBA has taken full effect, at which time ideal conditions for intubation would be achieved (8).

Rapid sequence induction

Rapid sequence induction (RSI) is carried out when the patient is anticipated to be at risk of aspiration. It differs to an elective induction as the neuromuscular blocking agent is administered immediately after the induction agent. Bag-mask ventilation is not carried out unless intubation is prolonged, or desaturation occurs. Additionally, cricoid pressure (CP), otherwise known as the Sellick Manoeuvre, is applied until the positioning of the endotracheal tube is confirmed (8). RSI and modified RSI provide rapid airway control and a decreased incidence of aspiration. It also has a high success rate in the emergency setting, and is thus the recommended method of intubation (2, 9).

Cricoid pressure

Monro first described CP in 1774 according to its uses in preventing gastric distension in drowning victims. It was then introduced into the anaesthetic society in the way that we use it now by Sellick, in 1961 (10). Sellick postulated that backward pressure on the cricoid cartilage would occlude the upper oesophagus and thus prevent the regurgitation of gastric contents during induction of anaesthesia. Despite failings in Sellick's 1961 report, CP is still used widely as a component of RSI (11). CP remains controversial, as its efficacy has only been ascertained in cadavers; however, it can be assumed that CP is not effective until adequate trials have been carried out (11-13).

The Emergency Medicine Society of South Africa (14) have released guidelines for airway management during an RSI. These guidelines state that CP is not mandatory. Conversely, the United Kingdom-based Difficult Airway Society Guidelines for RSI support the use of CP, and only suggest its release if repeat attempts at laryngoscopy are required, as CP itself is thought to be a contributing factor (15). The Australian and New Zealand College of Anaesthesia also advocates for CP during an RSI (16).

Difficult airway management

The Difficult Airway Society (15) has formulated an approach to management of the unanticipated difficult airway. The approach consists of a series of algorithms depending on the patient's airway and is based on evidence as well as expert opinion. The society highlights the need for early recognition and planning in a can't-intubate-can't oxygenate situation. Emphasis is placed on airway assessment and planning for a difficult airway, as well as limited airway manoeuvres where possible. The society further recommends a list of necessary equipment to use when faced with a difficult airway, which should be readily available on a difficult airway trolley to minimise poor outcomes (15).

Bougies and video-laryngoscopes are theoretical aids to an otherwise blind-intubation. The actual benefit of these devices is not yet known, and requires more in-depth research (2). A multi-centre emergency airway registry showed that videolarygoscopy use increased over a ten-year period, up to 39% in the final year

of data collection. This had a paralleled increase in first-pass attempts at intubation (17).

1.2.2 Drugs used to facilitate intubation

Induction agents

There are four main induction agents that are used: sodium thiopentone, etomidate, propofol and ketamine. Midazolam and ketofol have also been described for induction. Drug choice for induction should be based on the clinical state of the patient, with the aim of maintaining homeostasis of organ systems and avoiding adverse outcomes.

Sodium thiopentone is a barbiturate. It was previously the most popular induction agent, despite its known side effects, which include sporadic extreme falls in blood pressure, laryngospasm and bronchospasm (18). In the absence of a neuromuscular blocker, it does not provide ideal intubating conditions to the extent of other induction agents. It is also unstable in aqueous solution (19, 20).

Ketamine is structurally related to phencyclidine and is a water-soluble agent. It acts as an N-Methyl-D-aspartate receptor-antagonist, making it responsible for inducing general anaesthesia (20). At smaller doses it can also be used for sedation and analgesia. Ketamine is well known for producing a dissociative state. It is a potent bronchodilator but has almost no effect on control of ventilation. In patients suffering from shock, ketamine is also known to affect arterial blood pressure and heart rate favourably and has thus been used in such cases. However, these positive effects are due to the presence of noradrenalin. Precautions must be taken in patients who are in hypovolaemic shock where noradrenalin levels are low, as it may exhibit its direct negative inotropic effects, dropping heart rate and blood pressure (19, 20).

Etomidate is an imidazole derivative induction agent and is not structurally related to any of the other induction agents (18, 20). Etomidate is the agent of choice for health care providers dealing with critically ill, hypotensive patients as a result of its haemodynamic stability (21). Its use is unfortunately associated with significant nausea and vomiting. Another negative characteristic of etomidate is that it may

act as a steroid synthesis inhibitor by inhibiting the function of the enzymes involved in cortisol and aldosterone synthesis. Even a single dose of etomidate in an otherwise-well patient coming for an elective procedure can have this effect and it lasts for 5 – 8 hours after dosing. It is thus recommended to give a dose of steroid with etomidate (18, 20, 22). Etomidate infusion use in ICU patients has been shown to increase mortality. Single bolus doses of etomidate, however, are controversial in ICU patients, and studies done previously on patient outcomes following it use have shown differing results (20, 23).

Propofol (2,6 di-isopropyl phenol) is an emulsion preparation and is a widely used induction agent. It is a potent respiratory depressant and causes prolonged apnoea when administered in doses of 2.0 – 2.5 mg/kg. Propofol is also known to have potent antiemetic effects. The main problem that has been found with propofol is its dose-related hypotension, which can be problematic in unstable patients who are already hypotensive (18, 20). In a randomised controlled trial comparing intubation conditions of propofol and etomidate in stable patients, 94% of the patients induced with propofol were reported to give acceptable intubating conditions (good or excellent), versus 75% of the patients induced with etomidate. Propofol has been found to offer a superior suppression of cough and laryngospasm. Additionally, the systolic blood pressures obtained in the etomidate group were significantly higher than that of the propofol group (24). In a study comparing propofol and etomidate for induction in the acutely injured patient, however, the only statistically significant haemodynamic change was evident in the etomidate group, where a post-induction increase in systolic blood pressure was found (25).

Midazolam, a benzodiazepine, has historically been used as an induction agent. It is regarded as a good induction agent as it provides amnesia and a swift loss of consciousness. Relevant to this ED and ICU patients, it also causes haemodynamic instability if it is used as the only induction agent. Unfortunately, benzodiazepines display significant “interindividual variability”, making it an unreliable agent for induction (20).

Ketofol, a mixture of ketamine and propofol has also been used as an induction agent. Their sedative effects have been found to be synergistic and their negative

haemodynamic side effects have been found to cancel each other out (26, 27). A randomised controlled trial in theatre comparing ketofol with propofol at induction of anaesthesia showed that when ketofol was used, it was associated with better haemodynamics and a reduction in risk for side effects when compared with propofol alone (21).

Neuromuscular blocking agents

“Conventionally, it is understood that the term ‘neuromuscular block’ specifically refers to the block of transmission by those drugs that interact with acetylcholine receptors located on the post-junctional face of the motor endplates of striated muscles” (28).

Suxamethonium, a rapid-onset, short-acting depolarising NMBA has traditionally been used to facilitate the RSI process. Its side effects can have negative effects on critically ill patients, including increasing the level of extracellular potassium. Rocuronium, an intermediate-onset, non-depolarising NMBA with a longer duration of action and fewer side effects has been suggested as an alternative to suxamethonium for intubation. Although some studies have found rocuronium 1.2 mg/kg to give similar conditions to suxamethonium (15), a 2011 Cochrane review (29) found suxamethonium to be superior to rocuronium for achieving ideal intubating conditions, and this has resulted in a longer intubation process when using rocuronium (30). It is suggested that rocuronium be preserved for situations where suxamethonium is contraindicated or a more prolonged period of intubation is anticipated (29).

Adequate intubating conditions when using a muscle relaxant can be determined using a peripheral nerve stimulator. Helbo-Hansen et al. (31) demonstrated that the manual assessment of the response to double-burst stimulation is more reliable than the 0.1Hz single twitch stimulation in determining ideal intubating conditions.

Sugammadex

Sugammadex is a newer agent in anaesthesia, undergoing Phase 3 testing in 2006. It is a synthetic cyclodextran that acts as an antagonist to steroidal

neuromuscular drugs. It binds rocuronium in a 1:1 ratio and results in its rapid reversal without affecting plasma cholinesterase levels. Faster establishment of spontaneous ventilation following RSI has been found when using a rocuronium-sugammadex combination when compared to suxamethonium in the traditional RSI method (32, 33).

Adjuncts

No single induction agent available at this time can provide a well-titrated level of anaesthesia. Co-induction agents, or adjuncts, may be used which can reduce the amount of primary induction agent needed. This reduces the potential side effects caused by the primary induction agent. Opioids, benzodiazepines and alpha-2-agonists may be used as adjuncts (34). Lignocaine and atropine may also be given to prevent the increases in blood pressure and heart rate associated with intubation (14).

1.3 Intubations in the ED and ICU

This section will report on intubations within the ED and ICU. Indications for intubation, intubation practitioners and intubation practices will be discussed. Peri-intubation adverse events and patient outcomes will also be described.

1.3.1 Indications for intubation

Indications for intubation can be placed into broad categories, including the following: airway protection, maintenance of a patient airway, pulmonary hygiene, positive-pressure ventilation, and maintenance of adequate oxygenation (8). Specific indications for intubation in the ED and ICU will be discussed**.**

Indications for intubation in the ED

In the United States of America, in a national multi-centre report of ED patient intubations, 67% of patients had medical indications, and 26% had trauma indications. The most common medical conditions requiring intubation included cardiac arrest (7.9%), overdose (7.0%) and congestive heart failure (7.0%). The most frequent trauma conditions included head injuries (10%), airway trauma (4.5%) and general trauma (3.8%) (3). Conversely, during a 12-month

observational study conducted at the Brooke Army Medical Centre, the majority of patients requiring intubation were those suffering from trauma (71%). Medical indications for intubation most commonly included non-overdose mental status change (28.0%), cardiac arrest (18.7%), and overdose (8.0%) (35). In a 2016 prospective case series study on trauma emergency intubations conducted in KwaZulu-Natal (36), the main indications for intubation in the ED were reduced level of consciousness (86.4%), inadequate ventilation (27.3%) and existing or pending airway obstruction (13.6%). A prospective observational study in the Western Cape found major trauma-related indications for intubation included traumatic brain injury (54.4%), lung contusion with hypoxia (12.3%) and chest injury with poor ventilatory mechanism (10.5%) (37).

Indications for intubation in ICU

In a prospective investigation of 297 tracheal intubations in critically ill adults in San Francisco (4), the most frequent indications for intubation included respiratory failure (50%), airway protection (17%), endotracheal tube exchange (13%) and cardiac and/or respiratory arrest (10%). In a multi-centre observational study carried out across seven ICUs in France, the main indications for intubation were acute respiratory failure (53%), shock (13%) and neurological disorders (13%) (6). In a multi-centre report on emergency airway management carried out in Scotland in various EDs and ICUs, the most common indications for intubation were reported as new admission to ICU (54%), failed trial of extubation (12%), problems with existing airway (11%), and deterioration (10%). Intubations for cardiac arrest were excluded from this study (38). No South African ICU studies could be identified.

From the differences in specific indications for intubation reported above, it could be deduced that indications for intubations vary between patient cohorts, medical specialties and medical centres.

1.3.2 Practitioners involved in intubation

Two multi-centre studies showed that by 2002, and confirmed in 2012, most of the emergency intubations carried out in the ED were done by emergency medicine practitioners. Emergency medicine practitioners performed up to 95% of

intubations, and anaesthesiologists as little as 2.9%. The remaining 2.1% was made up by several other specialties. Importantly, residents performed 94% of first-attempt intubations (3, 17). Resident practitioners are equivalent to registrars in South Africa. This evidence proves that critically ill patients requiring airway management are evaluated and stabilised primarily by emergency physicians and once again highlights the need for competence within the department (17).

The second phase of the 4th National Audit Project of the Royal College of Anaesthetists (NAP4) (2), in the United Kingdom reviewed all major airway events occurring in theatre, the ED and ICU, with a total of 184 cases meeting inclusion criteria. Of the 15 (8.2%) reported ED airway events, anaesthetists performed 73%, and consultants managed 53%. In ICU, 36 (19.6%) major airway events were reported, but the authors of NAP4 did not comment on these intubator characteristics.

In a 2016 KwaZulu-Natal study (36), junior doctors performed 54.5% of intubations, and senior doctors 36.4%. Uncategorised doctors completed 9.1% of intubations. In this study, junior doctors were defined as interns and grade 1 medical officers. Senior doctors were grade 2 and 3 medical officers, specialists and trainees in emergency medicine, anaesthetics, or intensive care (36).

Schwartz et al. (4) highlighted that the workforce within the ICU is made up of practitioners from different specialties. Of the 297 intubations reported by the authors, 31% were completed by anaesthesia residents, 32% by non-anaesthesia residents not otherwise specified, 30% by critical care fellows, and 7% by attending physicians. According to Divatia et al. (39) in India, junior medical staff members perform the majority of ICU intubations. The junior staff may be unsupervised, and may have limited experience with airway management. In addition to this, intubations within the ICU are performed on critically ill patients who differ physiologically to a patient in theatre undergoing an elective procedure. This combination lends itself to potential adverse events (39, 40). In a French multicentre study of intubations in an ICU setting, Jaber et al. (6) described 58% of intubations as being performed by junior doctors (registrars) and 42% by senior doctors (consultants). Conversely, in a multi-centre study in EDs and ICUs, Simpson et al. (38) reported anaesthetists as the chief intubators, with more than

80% having more than 12 months anaesthetics experience, and nearly 75% of intubators having more than 24 months anaesthetics experience.

1.3.3 Intubation practice

There are various influences on clinicians' drug choice, including familiarity with certain drugs, literature available favouring certain drugs, drug availability within institutions, and relationships with the pharmaceutical companies that manufacture drugs. This is demonstrated in the differences between the results of a multi-centre study on emergency intubations in adults in the ED, where Brown et al. (17), reported only 1% of cases receiving ketamine for induction, and 91% receiving etomidate, versus an observational study carried out at the Brooke Army Medical Centre where 59.8% of patients received ketamine for induction (35). April et al. (35) concluded that the ketamine preference described could be due to national trends as a result of recent literature promoting its favourable outcomes. The authors also considered familiarity with ketamine as contributory, as intubators at their facility had been trained to use it in intubation practice, as well as for analgesia during fieldwork (35). Brown et al. (17) demonstrated that drug selection changed over the course of the study from 2002 to 2012. Etomidate was found to remain the standard induction agent used for emergency intubations, used in 90% of cases. This began to decline in 2012 with a parallel increase in use of both propofol and etomidate (17). Propofol was used in 1.4% of cases, ketamine in 1.9% of cases, and sodium thiopentone in 2.6% of cases. The authors concluded that this decline in etomidate use could have been a result of a national shortage of etomidate in 2012 (17). In KwaZulu-Natal, inappropriate drugless intubations were seen in 1% of cases in the ED. The authors did not report which drugs were used for intubations (36). In a Western Cape trauma ED, etomidate and suxamethonium were favoured, with other drugs seldom being used. The authors did not comment on this drug choice (37).

In a prospective investigation on intubations in critically ill adults in San Francisco in 1994 (4), 59.6% of intubations were facilitated with sodium thiopentone, 5.4% with benzodiazepines, 4.4% with opioids and 1.7% with ketamine. Owing to haemodynamic instability, 29.0% of intubations were not facilitated with any form of hypnotic or opioid (4). In a multi-centre study in seven ICUs in France in 2007,

Jaber et al. (6) reported etomidate as the most popular induction agent, being used in 50% of cases. Propofol and sodium thiopentone were used in 14% and 9% of intubations respectively. Simpson et al. (38) reported propofol use in 61% of intubations, sodium thiopentone in 20%, etomidate in 9%, ketamine in 3%, and midazolam in 4%. No hypnotic was given in 4% of cases.

In a multi-centre study on emergency intubations in the ED, Brown et al. (17) demonstrated that suxamethonium (75%) was the most common NMBA to be used in emergency airway management. Rocuronium was used in 23% of intubations. Physicians at the Brooke Army Medical Centre, however, favoured rocuronium, using it in 62.9% of patients, and suxamethonium in only 18.9% of patients (35).

Schwartz et al. (4) reported suxamethonium (57.2%) to be the NBMA of choice to facilitate intubation, followed by vecuronium (22.9%). In 19.8% of intubations, no NMBA was used. In a French multi-centre ICU observational study (6), suxamethonium was the preferred NMBA, used in 69% of intubations. Similarly, in EDs and ICUs in Scotland in 2015, Simpson et al. (38) also reported a preference towards suxamethonium for intubations (58%), followed by rocuronium (25%) and lastly atracurium (9%). In 8% of intubations, no NMBA was used.

1.3.4 Peri-intubation adverse events

Intubations performed outside of theatre have a high rate of major complications, and may occur in up to 40% of critically ill patients (38). One in four major airway events reported in NAP4 (2) resulted from intubations carried out in the ED or ICU. Moreover, these patients are often critically ill, which predisposes them to decompensation on administration of intubating drugs (2, 41). The adverse events that will be discussed include: oesophageal intubation, regurgitation and aspiration, airway trauma, difficult or failed intubation, can’t-intubate-can’t ventilate, hypoxia and hypoxaemia, and haemodynamic complications.

Oesophageal intubation

Oesophageal intubation can be avoided by use of capnometry or capnography. Both of these are methods of carbon dioxide detection, which is the most reliable

indicator of endotracheal tube placement (42). Capnometry includes colorimetric carbon dioxide detectors. The detectors contain pH-sensitive chemicals which change colour according to the composition of sampled gases. This can give rise to false-positive and false-negative intubations. False positives can be caused by contamination with acidic or carbon dioxide-filled gastric content, as well as recent administration of bicarbonate. False-negatives can be caused by low cardiac-output, severe airway obstruction or oedema, as well as intubation during low-quality cardio-pulmonary resuscitation (43). NAP4 suggests that capnography should be available at all intubations carried out in the ED, as well as all intubations in critically ill patients, regardless of where they are (2).

Regurgitation and aspiration

Aspiration of gastric contents was found to be a prominent problem in NAP4. It was the most frequent cause of death (50% of cases) and brain damage (53%). The majority of cases occurred when a patient had not been assessed for aspiration risk. It also occurred in patients who were aspiration risks, but had been inadequately assessed as not being at risk for aspiration. Protection from aspiration of gastric contents occurs once the endotracheal tube is correctly placed, and the tube cuff is inflated. Patients must be carefully assessed – it is particularly important in patients for emergency intubation (1).

Airway trauma

Airway trauma can vary from simple, local trauma to severe morbidity and may even result in death. Simple trauma can include local mucosal damage and dental damage and is usually caused by the common airway devices used during an intubation such as the laryngoscope or oropharyngeal airway. Severe trauma has been noted to include tracheal and oesophageal perforation and resultant mediastinitis which carries a high risk of mortality. The risk of airway trauma increases proportionately with the number of attempts at intubation and the more severe airway trauma tends to be related to airway adjuncts such as bougies, endotracheal tube exchange catheters (1, 2).

Difficult or failed Intubation

A standardised definition of a difficult airway could not be found in the relevant literature (15). In the ED, ICU and the pre-hospital setting, difficult or failed intubation can happen in as many as 1 in every 50 − 100 cases. As a comparison, in theatre it happens in 1 in 1 − 2000 cases and 1 in 300 cases of RSI (1). Difficult or failed intubation is often associated with cardiac arrhythmias, bronchospasm, hypoxia and the consequences of this hypoxia, which include cardiac arrest, brain damage and death. NAP4 (2) identified several cases where difficult intubation was managed in an unstructured manner with seemingly multiple attempts at intubation. Guidelines on difficult airway management should be adopted and adhered to by a department (2). One example would be the Difficult Airway Society Guidelines (15) developed in the United Kingdom. Clinicians are urged to have difficult airway equipment available, help and back up plans with regards to airway management in patients with anticipated difficult airways. This becomes particularly important in the ED where patients may present with potential facial trauma and distortion of airway anatomy (1, 2).

Can’t intubate can’t ventilate

Can’t intubate can’t ventilate accounts for up to 25% of anaesthesia-related deaths. It means that the patient cannot be adequately oxygenated, as there is also a failure of ability to mask-ventilate a patient. The incidence of can’t intubate can’t ventilate is 1 in 5 000 elective surgical cases and requires an emergency surgical airway in roughly 1 in 50 000 cases (1). Emergency surgical airways may be required in as many as 1 in 600 intubations in the ED (1).

Hypoxia and hypoxaemia

Hypoxaemia refers to an arterial oxygen saturation level of less than 90% (44). Hypoxia is “an oxygen deficiency at the level of the tissue” (45). In NAP4 (2), hypoxia was the most frequent cause of death. Critically ill patients have a higher oxygen demand than other patients, making them more susceptible to hypoxia (45).

Haemodynamic Complications

Induction agents may have an effect on the cardiovascular system. Propofol, a commonly used induction agent, is associated with cardiovascular depression, whereas ketamine can result in increases in arterial blood pressure (20). These changes may be unfavourable to specific patient management, depending on their baseline state (21). The National Emergency Airway Registry (3) reported hypotension in 1.8% of cases and dysrhythmias in 0.2% of cases. Cardiac arrest has been reported in approximately 2% of ICU intubations (9).

In a 12-month descriptive analysis on emergency intubations at the Brooke Army Medical Centre (35), peri-intubation adverse events occurred in 23.5% of cases. The most common adverse events were hypoxia (59.0%), hypotension (21.3%) and cardiac arrest (16.4%). In the multi-centre registry on ED intubations in adults, Brown et al. (17) reported a peri-intubation adverse event rate of 12.4%. The most common of these were oesophageal intubation with immediate recognition (26.5%), hypotension (12.8%) and cardiac arrest (11.8%). Aspiration was reported in 4.8% of adverse events. In the National Emergency Airway Registry (3), peri-intubation adverse events were reported in 12% of cases, the most common being recognised oesophageal intubation (23.5%). Other adverse airway events included mainstem bronchus intubation (15.6%), hypotension (12.1%) and the patient never being successfully intubated (10.3% of adverse events, 1.4% of all cases). It was also found that the probability of an associated adverse event was 1.7 times higher if no NMBA was used (3). In a prospective consecutive case series in KwaZulu-Natal on emergency trauma airway management (36), only one peri-intubation adverse event in the ED was reported (4.5%). The adverse event identified was an endo-bronchial intubation.

In a San Francisco prospective investigation on emergency intubation in critically ill patients (4), 3% of patients were reported to have haemodynamic instability and intubation-related mortality. Other adverse events included oesophageal intubation (11.8%), aspiration (4%) and pneumothoraces (0.7%). In a multi-centre observational study across seven ICUs in France (6), at least one major peri-intubation adverse event occurred in 28% of intubations. Of these, severe haemodynamic collapse (95.1%), severe hypoxaemia (93.0%) and cardiac

arrhythmias (10%) were the most common. Cardiac arrest was reported in 1.6% of adverse events. In a multi-centre study in Scottish EDs and ICUs, Simpson et al. (38) recorded desaturation (74%), haemodynamic instability (63%), oesophageal aspiration (2%), regurgitation (2%) and cardiac arrest (1%).

1.3.5 Immediate patient outcomes

Pharmacological choice and dose, as well as competence in airway management are key factors in facilitating a successful intubation, especially in the critically ill patient (38). In a prospective, multi-centre registry of ED intubations (17), the first-pass success rate was achieved in 83% of intubations. Additionally, 99% of patients were intubated in three or fewer attempts. Surgical airways were required in 0.45% of cases. Emergency medicine trainees had a first-pass success rate of 87% compared to attending physicians who had a 72% first-pass success rate. In a National Emergency Airway Registry in the United States of America (3), first-pass success was achieved in 95% of cases, and intubation was ultimately successful in 98.8% of cases. The outcome remaining 1.2% of cases was not recorded. In a descriptive analysis on emergency intubations at the Brooke Army Medical Centre (35), a first-pass success of 83% was reported, with a higher first-pass success rate where video-laryngoscopy was employed versus direct laryngoscopy (90.9% and 73%). In KwaZulu-Natal, 82% of intubations in the ED had first-pass success (36).

Schwartz et al. (4) described a 73.4% first-pass success rate. 89% of patients were successfully intubated within two attempts. In a multi-centre study completed in various ICUs in France, 75% of intubations had first-pass success, 13% required two attempts and 9% required three attempts (6). Jaber et al. (6) reported death within 30 minutes in 0.8% of instances but it is not documented as to whether these were airway-related or non airway-related deaths. In Scottish EDs and ICUs, Simpson et al. (38) documented a first-pass success rate of more 90%. Only 1% of patients required three attempts at intubation.

1.4 Summary

In summary, airway management outside of theatre has been evolving, becoming the responsibility of emergency medicine and intensive care practitioners (3).

Airway management in these critically ill patients has a high risk for adverse events, and regardless of patient pathology, factors such as airway expertise, pharmacological choice, and pre-intubation management can impact intubation outcomes (38). The authors of NAP4 (2) report that intubation outside of theatre requires the same equipment as that available inside theatre in order to mitigate potential adverse events. This includes capnography or capnometry, a difficult airway trolley containing equipment in a layout similar to that of theatre, as well as a videolaryngoscopy and a fibrescope. The authors also suggest training of staff members that will be involved in difficult airway management, with particular attention to performing emergency airways (2).

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The following are sample references:

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9. All photographs must be at 300dpi and clearly marked according to the figure numbers in the text. (Figure 1, Table II, etc.)
10. All numbers below ten, without percentages or units, must be written in words.
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Section 3: Draft article

Intubations in an emergency department and intensive care unit at a central hospital

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Key words: emergency department, intubation, intensive care

Abstract

Background: The development of the emergency medicine speciality in the emergency department (ED) and the multi-speciality environment of the intensive care unit (ICU) have necessitated airway management skill in specialities other than anaesthesiology. The aim of this study was to describe the intubation process in adult patients within the ED and the general medical and surgical ICU at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods: A prospective, contextual, descriptive research design was followed, using a consecutive convenience sampling method. The study population consisted of adult patients requiring intubation within the ED and ICU at CMJAH.

Results: The study period was from 2 January to 20 May 2019, and 140 patient intubations were described. The most frequent indication for intubation was a reduced Glasgow coma scale in 56 (40.0%) patients. First attempts at intubation were completed by doctors from: emergency medicine (47.9%), general surgery (17.1%), anaesthesiology (19.3%), internal medicine (9.3%), and obstetrics and gynaecology (6.5%). Junior doctors intubated 133 (95.0%) patients. First-pass attempts occurred in 85.7% of intubations, with no difference in the number of attempts between ED and ICU ($p = 0.340$). Ketamine was the favoured induction agent, used in 68 (48.6%) intubations, and rocuronium was the preferred neuromuscular blocker, used in 91 (65%) intubations. Appropriate pharmacological therapy was evidenced in 67 (47.9%) of cases. Adverse events were observed in 22 (15.7%) intubations with haemodynamic instability occurring most frequently, in 16 (11.4%) intubations. Airway-related deaths occurred in 2 (1.4%) intubations. Non-airway related deaths occurred in 5 (3.5%) of intubations.

Conclusion: Anaesthetists are no longer involved in the majority of emergency intubations outside of theatre. Junior doctors perform most of the emergency intubations, with similar success rates, peri-intubation adverse events and direct outcomes to that in the literature, despite a high rate of inappropriate drug choice.

Introduction

Endotracheal intubation is a routine procedure in theatre, and is often life saving in the critically ill.[1] These critically ill patients may present to the Emergency Department (ED) or the Intensive Care Unit (ICU), where their airway management and intubation poses unique challenges, resulting in higher complication rates compared with that in a controlled theatre setting.[1]

In anaesthesia, induction occurs prior to intubation of patients. Induction is the achievement of a state of hypnosis, analgesia and amnesia by administration of one or more drugs.[2] Drug choice for facilitating induction and subsequent intubation should be based on the clinical state of the patient, with the aim of maintaining homeostasis of organ systems and avoiding adverse outcomes. Drug choice is based on required clinical end points and which drugs would achieve these.[3] This once again becomes problematic in the ED or ICU setting, as standard induction agents normally used in elective theatre cases may have profound negative effects in unstable patients' deranged physiology.[1] This combination lends itself to potential adverse events.[4,5]

Anaesthesiologists are more familiar with intubations than other doctors, and have traditionally taken ownership of airway management as they are thought to have superior expertise.[6] Now, however, emergency physicians are increasingly responsible for performing this intervention.[7, 8] Development of emergency medicine as a specialty and the condition of the patients that attend ED has necessitated a skill in airway management.[8, 9]

A multi-centre study on adult intubations in EDs conducted between 1997 and 2002 in the United States of America showed that emergency physicians were the primary intubators in 95% of cases. Anaesthesiologists were found to perform as little as 2.9% of emergency intubations, and the remaining 2.1% was made up by several other specialities.[8]

Similarly, in the ICU, there is also a need for airway management and intubation skills due to the high rate of intubation and re-intubation of critically ill patients.[1] According Higgs et al,[1] a direct challenge of intubation in the ICU is that doctors may not have the necessary drug knowledge and airway skills. Additionally, the ICU is a multi-speciality environment with inconsistent team membership.[1]

Focused airway training in the ED and ICU is infrequent, which can contribute to the higher complication rate when compared with anaesthetic practice.[1] The Fourth National Audit Project (NAP 4) reported one in four major airway events resulting from intubations carried out in the ED or the ICU.[9] These complications can be reduced with the provision of the same airway equipment available in theatres. This includes capnography or capnometry, and difficult airway equipment such as videolaryngoscopy.[9] In a multi-centre study conducted in seven ICUs in France, supervision by a senior doctor was also found to be a protective factor for intubation.[12] The aim of this study was to describe the intubation process in adult patients within the ED and the general medical and surgical ICU for a period of three months at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A prospective, contextual, descriptive research design was followed in this study. Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical), and other relevant authorities.

The study population consisted of adult patients requiring intubation within the ED and ICU at CMJAH. A consecutive convenience sampling method was used. In consultation with a biostatistician it was determined that for a 80% power and significance level of 5%, a minumum sample size of 140 participants was calculated for a percentage of 15% adverse effects in the ED. This was based on a 25% occurrence found in the Fourth National Audit Project. Patients were excluded if they refused consent or if they were unable to give consent, and if they were intubated by one of the authors (SS).

A draft data collection sheet was formulated following an extensive literature review, and was reviewed by three senior anaesthesiologists. The reviewers' suggestions were incorporated into the final data collection sheet, which enabled data collection encompassing the primary objectives shown in Table I.

Table I: Objectives of the study

Objectives	Including
Primary objectives	
To describe:	
Patient characteristics	
Indications for intubation	
Professional designation of the intubator	
The intubation process	
Immediate direct adverse effects of intubation	Oesophageal intubation
	Regurgitation and aspiration
	Airway trauma
	Failed intubation
	Hypoxia/hypoxaemia
Immediate patient outcome	Haemodynamic effect
	Intubation success or failure
	Need for a surgical airway
	Airway related death
	Non-airway related death
Secondary objectives	
To compare:	
the number of intubation attempts between ED and ICU intubators	
the number of intubations done by junior versus senior intubators	Junior: medical students, interns, medical officers and registrars
	Senior: consultants
To determine:	
the appropriateness of drug choice and dosing	

Data was collected on a daily basis by one author (SS) from 2 January 2019 to 20 May 2019. Newly-intubated patients in the ED and ICU were identified, and the required data was obtained from the patients' folders once consent had been attained. Although eligible for the study, some intubated patients could not be invited to take part in the study. In this case, the family was approached and the study was explained. If they agreed that their family member could be included in the study, they received an information letter, and written consent was obtained at the discretion of the family member. Once the patient was fit to give consent, the patient was informed that their family member gave permission to be enrolled in the study on their behalf. The study was explained to the patient, and the patient was invited to take part. If the patient agreed, they were given an information letter, and consent was obtained. If they refused consent, their data was excluded from the study. If a patient was unable to be invited to take part in the study, and they did not have any

family members present, they were enrolled in the study and they were approached once they were fit to give consent. At this point, the study was explained, an information letter was provided, and consent was obtained. If a patient was unable to, or did not give consent to participate in the study, their data was excluded.

If any information was not noted, the intubator of the patient was contacted directly by one of the researchers (SS) to obtain the missing information. Appropriateness of drug choice and dose given was determined by two consultant anaesthesiologists with subspecialties in critical care.

Data were captured on a Microsoft Excel spreadsheet and analysed in consultation with a biostatistician using Stata version 15 (StataCorp, USA). Descriptive and inferential statistics were used. Categorical variables were described using frequencies and percentages. Continuous variables were descibed using means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparisons between groups was done using Chi-squared or Fisher's exact tests. A p-value of <0.05 was considered statistically significant.

Results

A total of 167 patients were screened for inclusion in the study. Missing information and inability to obtain consent lead to 27 exclusions, resulting in a total sample size of 140.

The patient characteristics are presented in Table II and the patients' pre-intubation vital signs are presented in Table III. There were 11 (7.9%) patients who were intubated for cardiac arrest, and they have been excluded from Table III.

Table II: Patient characteristics

Characteristic	n	%
Location		
ED	64	45.7
ICU	76	54.3
Sex		
Male	76	54.3
Female	64	45.7
Age (years)		
≤18	6	4.3
19 − 29	17	12.1
30 − 39	41	29.3
40 − 49	20	14.3
50 − 59	21	15.0
60 − 69	23	16.4
≥70	12	8.6
Weight (kg)		
30 − 39	4	2.9
40 − 49	3	2.1
50 − 59	14	10.0
60 − 69	20	14.3
70 − 79	60	42.9
80 − 89	19	13.6
90 − 99	10	7.1
≥100	10	7.1

Table III: Patient pre-intubation vital signs

Vital	n (%)	Min	Max	Mean	SD
Heart rate (beats/minute)	129 (92.1)	45	180	117	24
Mean arterial pressure (mmHg)	129 (92.1)	43	175	95	24
Oxygen saturation (%) on:					
Not recorded	8 (5.7)				
Room Air	68 (48.6)	0	99	75.6	21.1
NPO_2* – 28%	3 (2.1)	80	98	86.6	9.9
FMO_2 † – 40%	26 (18.6)	60	100	89.7	9.6
FMO_2 † – non-rebreather (+/-100%)	9 (6.4)	64	100	89.3	11.6
NIV ‡ – 60%	7 (5.0)	78	99	91.1	7.3
NIV ‡ – 100%	1 (0.7)	100	100	100	0
Intubated – FiO_2 40%	6 (4.3)	95	98	97	1.1
Intubated – FiO_2 60%	1 (0.7)	95	95	95	0
Glasgow coma scale					
Intubated (2 – 10)	9 (6.4)	2	10	7.6	2.4
Not intubated (3 – 15)	131 (93.6)	3	15	9.6	4.5

* NPO_2: nasal prong oxygen
† FMO_2 : face mask oxygen
‡ NIV: non-invasive ventilation

The indications for intubation are presented in Table IV. In some cases, there was more than one indication for intubation. There were 31 (22.1%) patients with one indication, 77 (55.0%) patients with two indications and 25 (17.8%) patients with three indications. Only 7 (5%) patients had four indications.

Table IV: Indications for intubation

Indication	Total		ED		ICU	
	n	%	n	%	n	%
Reduced Glasgow coma scale	56	40.0	34	53.1	22	28.9
Hypoxaemic respiratory failure	33	23.6	12	18.8	21	27.6
Respiratory distress	22	15.7	5	7.8	17	22.4
Hypercapnic respiratory failure	18	12.9	9	14.1	9	11.8
Lower respiratory tract infection	16	11.4	7	10.9	9	11.8
Re-intubation	12	8.6	0	0.0	12	15.8
Tube exchange	11	7.9	1	1.6	10	13.2
Septic shock	11	7.9	5	7.8	6	7.9
Cardiac arrest	11	7.9	7	10.9	4	5.3
Other	98	70.0	41	64.1	57	75.0

The professional designation of the intubator, either student, medical officer (MO), registrar (reg) or consultant, is represented in Figure 1. It is important to note that each intubation attempt is on a specific patient. The failures in each discipline at each attempt may not be represented in the following attempt, as the intubators for subsequent attempts may have been from other disciplines, and the figure is presented per discipline.

As indicated in the Figure 1, 4 (2.9%) patients required three attempts at intubation. Successful intubation followed in 1 (0.7%) of these patients. Another patient (0.7%) went on to require five attempts at intubation. An anaesthesiology registrar completed the fifth attempt. The remaining 2 (1.4%) patients were not successfully intubated, and this resulted in airway related deaths.

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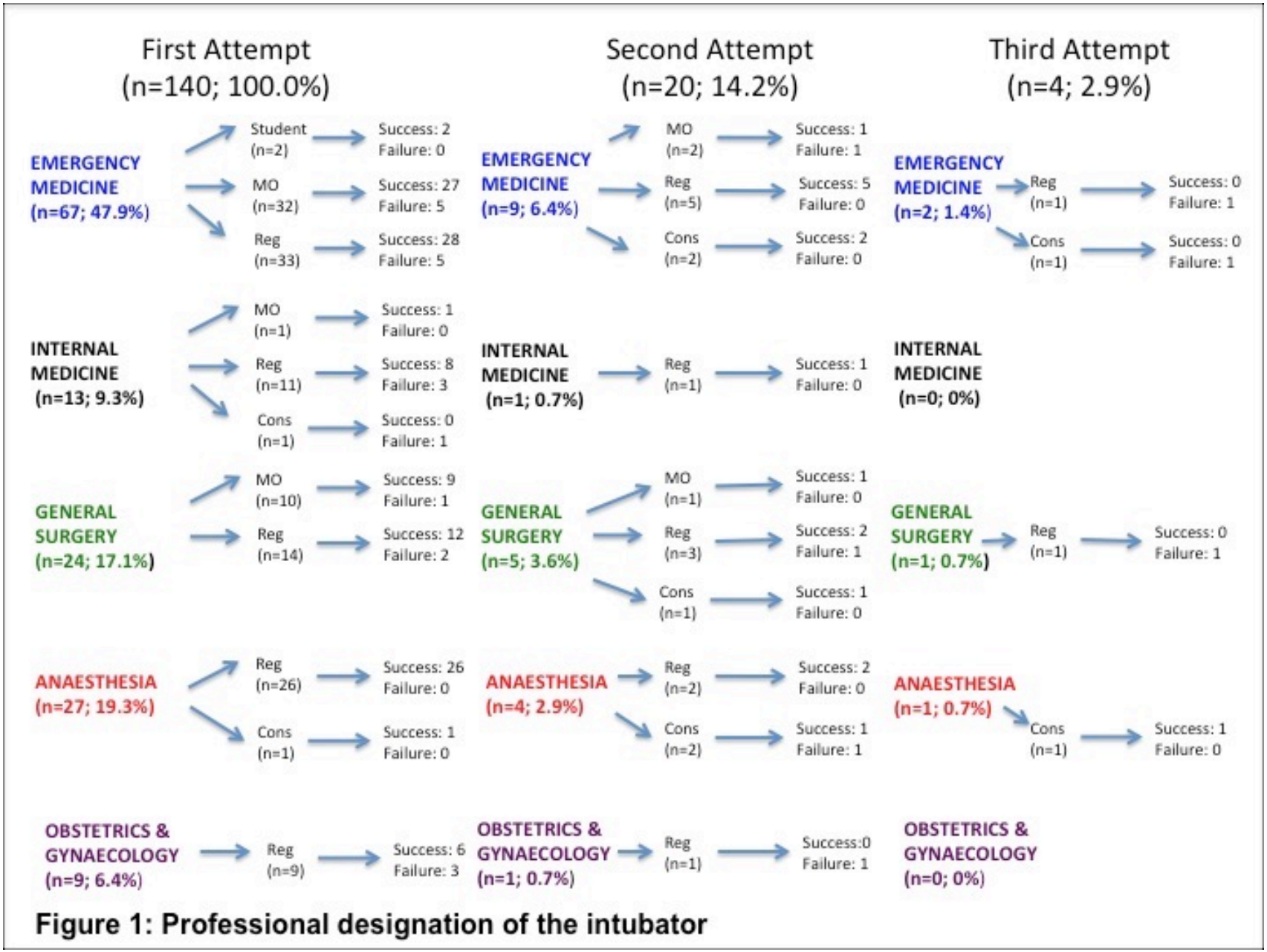

Figure 1: Professional designation of the intubator

The intubation processes in the ED and ICU are summarised in Table V. In 83 (59.3%) intubations, at least one airway adjunct was used. Of these, the favoured airway adjunct was an introducer, used in 76 (54.3%) intubations. The bougie, or tube exchanger, was the least commonly used airway adjunct, in 3 (3.6%) intubations.

Ketamine was used most commonly as an induction agent in 68 (48.6%) intubations, followed by propofol in 38 (27.1%), and etomidate in 18 (12.9%) intubations. Administration of more than two induction agents was seen in 7 (5.0%) intubations, and in 17 (12.1%) intubations, no induction agent was used.

Neuromuscular blockade ranged from absent in 8 (5.7%) intubations, to two agents (rocuronium and suxamethonium) in 1 (0.7%) intubation. Rocuronium was the NMBA of choice, used in 90 (64.8%) intubations. Suxamethonium was used in 40 (28.6%) cases, and cisatracurium was used in 2 (1.4%) intubations.

Appropriate drug therapy was used in 67 (47.9%) intubations. The most frequent reason for inappropriate drug therapy was low dosing of neuromuscular blocking agents, occurring in 35 (52.2%) of these intubations. Other reasons included high dosing of induction agent in 22 (32.8%) intubations, and high dosing of neuromuscular blocking agent in 12 (17.9%) intubations.

Table V: The intubation process

Process	Total		ED		ICU	
	n	%	n	%	n	%
Time of intubation						
Day	81	57.9	37	57.8	44	57.9
Night	59	42.1	27	42.2	32	42.1
Week	102	72.9	49	76.6	53	69.7
Weekend	38	27.1	15	23.4	23	30.3
Intubator						
Junior	133	95.0	62.0	96.9	71.0	93.4
Senior	7	5.0	2.0	3.1	5.0	6.6
Number of attempts						
1 attempt	120	85.7	57	89.1	63	82.9
2 or more attempts	20	14.3	7	10.9	13	17.1
Airway adjuncts						
None	57	40.7	10	15.6	47	61.8
1	70	50.0	49	76.6	20	26.3
2	11	7.9	5	7.8	6	7.9
3	2	1.4	0	0.0	3	3.9
Introducer	76	54.3	52	81.3	24	31.6
Oropharyngeal airway	9	6.4	3	4.7	6	7.9
Bougie/tube exchanger	3	2.1	2	3.1	1	1.3
Videolaryngoscope	10	7.1	2	3.1	8	10.5
Induction agent used						
None	17	12.1	8	12.5	9	11.8
1	116	82.9	55	85.9	61	80.3
2	7	5.0	1	1.6	6	7.9
Etomidate	18	12.9	14	21.9	4	5.3
Ketamine	68	48.6	35	54.7	33	43.4
Propofol	38	27.1	4	6.3	34	44.7
Ketofol	3	2.1	1	1.6	2	2.6
Other (midazolam)	3	2.1	3	4.7	0	0.0
Neuromuscular blocking agent used						
None	8	5.7	4	6.3	4	5.3
1	131	93.6	60	93.8	71	93.4
2	1	0.7	0	0.0	1	1.3
Cisatracurium	2	1.4	0	0.0	2	2.6
Rocuronium	91	65.0	36	56.3	55	72.4
Suxamethonium	40	28.6	24	37.5	16	21.1
Drug appropriateness						
Appropriate	67	47.9	34.0	53.1	33.0	43.4
Inappropriate	73	52.1	30.0	46.9	43.0	56.6

Immediate adverse events following intubation were evident in 22 (15.7%) intubations, ranging from 1 adverse event in 12 (8.6%) patients to 3 adverse events in 4 (2.9%) patients. The most common adverse event was haemodynamic instability in 16 (11.4%) patients. Desaturation in 9 (6.4%) patients and cardiac arrest in 6 (4.3%) patients also occurred. The immediate adverse events are represented in Table VI. There were 2 (1.4%) episodes of equipment failure reported, both of which were laryngoscope failure, and took place in the ICU. Because equipment failure was not an originally defined adverse event, it is not included in the overall adverse events statistics, but it is included in Table VI.

Table VI: Immediate adverse events

Adverse Event	Total		ED		ICU	
	n	%	n	%	n	%
None	118	84.3	57	89.1	61	80.3
1	12	8.6	6	9.4	6	7.9
2	6	4.3	1	1.6	5	6.6
3	4	2.9	0	0.0	4	5.3
Haemodynamic instability	16	11.4	7	10.9	9	11.8
Desaturration	9	6.4	0	0.0	9	11.8
Cardiac arrest	6	4.3	0	0.0	6	7.9
Oesophageal intubation	1	0.7	1	1.6	0	0.0
Aspiration	2	1.4	0	0.0	2	2.6
Can't intubate can't ventilate	2	1.4	0	0.0	2	2.6
Equipment failure	2	1.4	0	0.0	2	2.6

Successful intubation, regardless of the number of attempts required, was reported in 138 (98.6%) intubations. Surgical airways were required in 2 (1.4%) intubations. In these 2 patients, the intubators failed intubation, and were unable to bag-valve-mask ventilate the patients. These intubations resulted in airway-related deaths. Non-airway related deaths were seen following 5 (3.6%) other intubations. The immediate patient outcomes are represented in Table VII.

Table VII: Immediate patient outcomes

Ouctome	Total		ED		ICU	
	n	%	n	%	n	%
Intubation successful	138	98.6	64	100.0	74	97.4
Surgical airway	2	1.4	0	0.0	2	2.6
Supraglottic airway used	1	0.7	0	0.0	2	2.6
Death − airway related	2	1.4	0	0.0	2	2.6
Death − not airway related	5	3.6	2	3.1	3	3.9

In the ED, 57 (89.1%) intubations were successul at first attempt. In ICU, 63 (82.9%) intubations were successful at first attempt. With a p-value of 0.340 following a Fisher's exact test, there was no statistically significant difference in the number of intubation attempts between intubators in the ED and ICU.

In the ED, 62 (96.9%) intubations were carried out by junior intubators, and 2 (3.1%) intubations were carried out by senior intubators. Similar results were seen in ICU, where junior intubators completed 71 (93.4%) intubations, and senior intubators completed 7 (9.2%) intubations. With a p-value of 0.454 following a Fisher's exact test, the difference in junior versus senior intubations between the ED and ICU was not statistically significant.

In the ED, 34 (53.1%) intubations and 33 (43.4%) intubations in ICU were facilitated using appropriate drug therapy. This difference was not statistically significant, with a p-value of 0.252 following a chi-squared test.

Discussion

The emergency intubation process outside of theatre is complex and dynamic, with a high rate of major complications, and many variables influence patient outcomes.[10]

Patients with differing disease profiles will present with diverse indications for intubation. In our study, the most common indication for intubation was a reduced Glasgow coma scale (GCS) in both the ED (53.1%), and ICU (28.9%). Similarly, April et al.[7] at an army medical centre reported non-overdose mental status change (28.0%) as the most frequent indication for intubation, and in South Africa, Lewis et al.[11] in a trauma ED reported a reduced level of consciousness (86.4%) as the most common indication for intubation. Conversely, in a multi-centre report of ED intubations, Walls et al.[8] described the most common indication as cardiac arrest (7.9%). In a multi-centre study in seven French ICUs, Jaber et al.[12] identified the main indication for intubation as acute respiratory failure (53%), whereas in our study, hypoxic respiratory failure was an indication for intubation in only 27.6% of patients. Of note, our study did not subdivide a reduced GCS into overdose and non-overdose.

Traditionally, anaesthetists were thought to have superior airway management expertise.[6] In recent times, however, practitioners who do not routinely intubate often have to do so under strained circumstances in the ED and ICU as part of airway management in critically ill patients.[13] The development of the emergency medicine speciality and the condition of patients that attend the ED has necessitated airway management skill in this field.[8, 9] Being a multi-speciality environment, another challenge of emergency intubation within ICU is inconsistent team membership.[1] In our study, first attempts at intubation were completed by doctors from the following departments: 47.9% by emergency medicine, 9.3% by internal medicine, 17.1% by general surgeons, 19.3% by anaesthetists and 6.5% by obstetrics and gynaecology. The speciality diversity in emergency intubation was also shown by Schwartz et al.,[13] where 31% were carried out by anaesthetic residents, 32% by non-anaesthetic residents, 30% by critical care fellows and 7% by attending physicians.

In our study, junior doctors in the ED and ICU did 96.9% and 93.4% of intubations respectively. This is higher than the 80% reported by Brown et al. 14, and 54% by Lewis et al.[11] in EDs, as well as the 58% reported by Jaber et al.,[12] and 63% by Schwartz et al.[13] in ICUs. However, it must be noted that the definition of a junior doctor is not universal. First pass attempts in our study were successful in 89.1% of intubations in the ED and 82.9% in ICU. This is similar to other studies done in EDs. Brown et al.[14] reported an 83% first pass success rate and Lewis et al.[11] reported an 82% first pass success rate. First-pass success rates in ICU

were found to be 75% by Jaber et al.[12] and 73.4% by Schwartz et al.[13]

Pharmacological choice and correct dosing for intubation facilitation in our study was found to be appropriate in 53.1% of intubations in the ED, and 43.3% in ICU. Although our study was done in a resource-poor environment, the appropriate induction agents and neuromuscular blockers were available during the study period. The inappropriate choice or incorrect dose or both could be attributed to the fact that junior doctors performed the majority of intubations. It is acknowledged that the choice of pharmacological agents is also influenced by other factors, for example practitioners from different disciplines staff the ICU, and would use drugs that they are more familiar with. This is supported by Simpson et al.,[15] where anaesthetists had a large presence in ICU. Propofol, commonly used in an elective theatre setting, was the prominent induction agent used in their study. Drug choice could also be influenced by what is regarded as "best practice" at the time of the respective studies. Ketamine (54.7%) was found to be the induction agent of choice in ED in our study, and rocuronium (56.3%) was the neuromuscular blocking agent (NMBA) of choice. Brown et al.[14] reported that intubations were facilitated with etomidate (91%), and suxamethonium (75%). April et al.,[7] in a military centre, reported that the majority of intubations were facilitated with ketamine (59.8%). In a Western Cape trauma ED, etomidate and suxamethonium were favoured.[16] In ICU in our study, propofol (44.7%) and ketamine (43.3%) were the preferred induction agents, which could be a reflection of the anaesthetic and surgical influences respectively. NMBA use in the ICU at CMJAH favoured rocuronium (72.4%). Schwartz et al.[13] reported that 59.6% of intubations were facilitated with sodium thiopentone and 57.2% with suxamethonium. Jaber et al.[12] reported etomidate (50%) as the most popular induction agent, and suxamethonium (69%) was the most popular NMBA. Simpson et al.[15] reported propofol (51%) use in most intubations, with a preference for suxamethonium (68%).

Although junior doctors completed the majority of first attempts at intubation in our study, peri-intubation adverse events and deaths were similar or lower than in other studies. In our study, at least one peri-intubation adverse event was found in 11% in the ED, and 19.7% in ICU. Furthermore, deaths were 3.1% and 6.6% respectively in the ED and ICU. These findings were similar to, or lower than, other studies. In the ED, peri-intubation adverse events of 23.5% by April et al.,[7] 12.4% by Brown et al.,[14] 12% by Walls et al.,[8] and 4.5% by Lewis et al.[11] were reported. In ICU studies, Jaber et al.[12] reported at least one major peri-intubation adverse event in 28% of intubations, and Schwartz et al.[13] reported adverse events in 19% of intubations.

One of the direct outcomes reported in our study was airway related death in 2.6% of ICU patients. Non-airway related deaths occurred in 3.1% of ED patients, and 3.9% of ICU patients. Death as a direct outcome is not reported widely in the literature. Neither Brown et al.[14] or Walls et al.[8] reported peri-intubation mortalities, and Jaber et al.[12] reported 0.8%.

Our study had some limitations. The trauma ED declined participation, and therefore our study does not include data on trauma emergency related airway management. Due to the scope of our study, no long-term follow-up was done after intubation completion. Only immediate adverse events and direct outcomes were reported, and therefore valuable information on intubations in less controlled environments could have been missed.

Conclusion

Anaesthetists are no longer involved in the majority of emergency intubations outside of theatre. Junior doctors carry out most of the emergency intubations, with similar success rates, peri-intubation adverse events and direct outcomes to that in the literature, despite a high rate of inappropriate drug choice.

Conflict of interest

The authors declare that we have no financial or personal relationships which may have inappropriately influenced us in writing this paper.

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Section 4: Proposal

Intubations in an emergency department and intensive care unit at a central hospital

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4.1 Introduction and problem statement

Endotracheal intubation involves the insertion of a polyvinyl chloride tube through the opening of the vocal cords and into the trachea (1). It is a routine procedure in theatre, and is often life saving in the critically ill (2). These critically ill patients may present to the Emergency Department (ED) or the Intensive Care Unit (ICU), where their airway management and intubation poses unique challenges, resulting in higher complication rates compared with that in a controlled theatre setting (2).

Indications for intubation can be placed into broad categories: airway protection, maintenance of a patent airway, pulmonary hygiene, positive-pressure ventilation, and maintenance of adequate oxygenation (1). Complications of intubation include oesophageal intubation, regurgitation and aspiration, airway trauma and failed intubation (3).

In anaesthesia, induction occurs prior to intubation of patients. Induction is the achievement of a state of hypnosis, analgesia and amnesia by administration of one or more drugs (4). Drug choice for facilitating induction and subsequent intubation should be based on the clinical state of the patient, with the aim of maintaining homeostasis of organ systems and avoiding adverse outcomes. Drug choice is based on required clinical end points and which drugs would achieve these (5). This once again becomes problematic in the ED or ICU setting, as standard induction agents normally used in elective theatre cases may have profound negative effects in unstable patients' deranged physiology (2). This combination lends itself to potential adverse events (6, 7).

Anaesthesiologists are more familiar with intubations than other doctors, and have traditionally taken ownership of airway management as they are thought to have superior expertise (8). Now, however, emergency physicians are increasingly responsible for performing this intervention (9, 10). Development of emergency medicine as a specialty and the condition of the patients that attend ED has necessitated a skill in airway management (3, 10).

A multi-centre study on adult intubations in EDs conducted between 1997 and 2002 in the United States of America showed that emergency physicians were the

primary intubators in 95% of cases. Anaesthesiologists were found to perform as little as 2.9% of emergency intubations, and the remaining 2.1% was made up by several other specialities (10).

Similarly, in the ICU, there is also a need for airway management and intubation skills due to the high rate of intubation and re-intubation of critically ill patients (2). According Higgs et al (2), a direct challenge of intubation in the ICU is that doctors may not have the necessary drug knowledge and airway skills. Additionally, the ICU is a multi-specialty environment with inconsistent team membership (2).

Focused airway training in the ED and ICU is infrequent, which can contribute to the higher complication rate when compared with anaesthetic practice (2). The Fourth National Audit Project (NAP 4) reported one in four major airway events resulting from intubations carried out in the ED or the ICU (3). These complications can be reduced with the provision of the same airway equipment available in theatres. This includes capnography or capnometry, and difficult airway equipment such as videolaryngoscopy (3). In a study conducted in seven ICUs in France, supervision by a senior doctor was also found to be a protective factor for intubation (6).

The Difficult Airway Society (11) based in the United Kingdom, has formulated an approach to the management of the unanticipated difficult airway. The approach consists of a series of algorithms and suggested equipment needed, depending on the patients' airway and is based on evidence as well as expert opinion. This algorithm has been developed to assist all doctors involved with airway management in order to minimise poor outcomes, and can thus be used to guide those practitioners in the ED and ICU.

Research on intubations outside theatre could not be identified in a South African setting. According to NAP 4, "…the majority of the major complications reported to NAP 4 from the emergency department would have been preventable through improved systems, better preparation and good communication" (3). NAP 4 also identified that a lack of advanced airway equipment and a lack of advanced airway skills played a part in some of the ICU adverse outcome reports (3). This led to avoidable patient harm.

4.2 Aim and objectives

4.2.1 Aim

The aim of this study is to describe the intubation process in adult patients within the ED and the general medical and surgical ICU for a period of three months at Charlotte Maxeke Johannesburg Academic Hospital.

4.2.2 Objectives

The primary objectives of this study are to**:**

- demographic profile of patients
- the indications for intubation
- the professional designation of the intubator
- the intubation process
- immediate direct adverse effects of intubation
- immediate patient outcome.

The secondary objectives of this study are to**:**

- compare the number of intubation attempts between ED and ICU intubators
- compare the number of intubations done by junior versus senior intubators
- determine appropriateness of drug given and dosing.

4.3 Research assumptions

The following definitions will be used in this study.

Intubator: is any qualified doctor or medical student working in the ED or ICU including medical officers, registrars and consultants**.** Junior intubators will be medical students, interns, medical officers and registrars. Senior intubators will be consultants.

Medical officer (MO): is a qualified doctor practising under specialist supervision**.** Any medical officer with ten or more years of experience within that specific specialty will be considered as a consultant.

Registrar (Reg): is a qualified doctor who is registered with the Health Professions Council of South Africa as a trainee.

Consultant: is a doctor who has completed all criteria and passed the required South African College of Medicine examinations, or equivalent. They are regarded as specialists in the field

Adult: is a person 18-years and older**.**

Immediate direct complication of airway management: includes oesophageal intubation, regurgitation and aspiration, airway trauma and failed intubation (3).

Immediate outcome: consists of haemodynamic effect, intubation success or failure, surgical airway.

Day: includes any week day from 08h00 to 16h00

Night: includes any week day from 16h00 to 08h00 the following day

Week: starts on Monday mornings at 08h00 and continues until Friday afternoon at 16h00

Weekend: starts on Friday afternoon at 16h00 and continues until Monday morning at 08h00

4.4 Demarcation of study field

The study will be conducted at CMJAH, 1200-bed central hospital, affiliated to the University of the Witwatersrand. CMJAH has an adult and a paediatric ED. The adult ED treats on average 40 000 patients per annum. CMJAH has seven ICUs. The general medical and surgical ICU has ten beds and eight high care beds. On average ICU admits approximately 900 patients per annum.

4.5 Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of the University of the Witwatersrand. Permission to conduct the study will be obtained from the CEO of

CMJAH (Appendix 1). Additional permission has been obtained from the relevant Heads of Department as follows: Department of Anaesthesiology (Appendix 2), Department of Emergency Medicine (Appendix 3), Intensive Care (Appendix 4).

Although eligible for the study, intubated patients may not be able to be invited to take part in the study. If this is the case, the family will be approached and the study will be explained. If they agree that their family member can be included in the study, they will receive an information letter (Appendix 5), and written consent will be obtained (Appendix 6). Once the patient is fit to give consent, the patient will be informed that their family member gave permission to be enrolled in this study on their behalf. The study will be explained to the patient, the patient will be invited to take part, and if they agree, they will be given an information letter (Appendix 7), and consent will be obtained (Appendix 9). If they refuse consent, their data will be excluded from the study. If a patient is unable to be invited to take part in the study, and they do not have any family members present, they will be enrolled in the study and they will be approached once they are fit to give consent. At this point, the study will be explained, an information letter will be provided (Appendix 8), and consent will be obtained (Appendix 9). If a patient is unable to, or does not give consent to participate in the study, their data will be excluded.

Anonymity and confidentiality

Anonymity and confidentiality will be ensured – patient's data will be assigned a study number and no identifying information will be collected. A list containing patient names, file numbers and study numbers will be kept separately. Only the researcher and supervisors will have access to the raw data to ensure confidentiality. The raw data will be stored securely in a locked cupboard for six years after completion of the study.

If the results show that the intubation practice is suboptimal, the relevant Heads of Department will be informed for potential intervention.

The study will be conducted according to the principles of the Declaration of Helsinki (12) and the South African Guidelines for Good Clinical Practice (13).

4.6 Research methodology

4.6.1 Research design

A prospective, contextual, descriptive research design will be followed in this study.

A prospective study is one where a population is followed over a period of time and an outcome or effect is observed or measured (14). This is a prospective study, as data will be collected at the time the intubation takes place.

According to De Vos et al. (15), a contextual study is a focus on a “small-scale world” which can be related to a larger population or context. An example of this would be a hospital ward. This study is contextual as it will be carried out within the ED and ICU at CMJAH.

A descriptive study is intended to describe a situation, without manipulation of any variables (14). Burns and Grove (16) state that its aim is to “paint a picture” of a situation as it naturally happens, and can be used to “develop theories and identify potential problems of practice”. This study is descriptive as the intubation process will be described without influencing any of the variables.

4.6.2 Study population

The study population consists of adult patients requiring intubation within the ED and ICU at CMJAH.

4.6.3 Study sample

Sample size

For an 80% power and significance level of 5%, a minumum sample size of 140 participants was calculated for a percentage of 15% adverse effects in the ED. This was based on a 25% occurrence found in the Fourth National Audit Project.

Sampling method

In this study, a consecutive convenience sampling method will be used. Convenience sampling is known as “accidental” or “availability sampling”, as the study-participants chosen tend to be accessible to the researcher but may not be representative of the entire population (14). According to Endacott and Botti (17), consecutive convenience sampling is “a version of convenience sampling where every available individual or event within an accessible population is chosen”, and is seen as the best form of non-random sampling

Inclusion and exclusion criteria

The inclusion criterion for this study is adult patients who are intubated in the ED and ICU.

The exclusion criteria in this study are:

- patients, or family members of patients, who refuse to take part in the study
- inability to obtain consent:
    - if a patient is unable to give consent, and they have no family to obtain consent from
    - unknown patients
- patients who are intubated by the researcher herself.

4.6.4 Data collection

Data collection sheet

A draft data collection sheet was formulated following an extensive literature review. This data collection sheet was then reviewed by three senior anaesthesiologists. The reviewers’ suggestions were incorporated into the final data collection sheet. The final data collection sheet (Appendix 10) will collect the following data:

- patient demographics
    - age

    - sex
    - height
- time of intubation
- indication for intubation
- intubator's professional designation and discipline
- intubation process
    - drugs used
    - number of attempts
    - airway adjuncts and equipment
- immediate direct complications of intubation
- immediate outcome.

Data collection

Data will be collected on a daily basis for a three-month period by the researcher during her ICU rotation. The researcher will identify newly-intubated patients in the ED and ICU and will obtain the required data from the patients' folders once consent has been obtained. Any required information that is not in the folder will be obtained from the intubator in person by the researcher. Data collection may continue beyond three months in order to obtain the required minimum sample size of 140 cases. Patient records will be examined but not removed from CMJAH. If any information is not noted, the intubator of the patient will be contacted directly to obtain the missing information.

The number of cases for which the researcher is unable to obtain consent will be documented.

Appropriateness of drug choice and dose given will be determined by two consultant anaesthesiologists with subspecialties in critical care.

4.6.5 Data analysis

Data will be captured on a Microsoft Excel spreadsheet and analysed in consultation with a biostatistician using Stata version 15 (StataCorp, USA). Descriptive and inferential statistics will be used. Categorical variables will be described using frequencies and percentages. Continuous variables will be

descibed using means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparisons between groups will be done using Chi-squared or Fisher's exact tests. A p-value of <0.05 will be considered statistically significant.

4.7 Significance of the study

Endotracheal intubation is a routine procedure in critically ill patients and is often life saving (2). Anaesthetists, largely known as the airway specialists, routinely intubate patients in a controlled theatre environment. They are unaccustomed to intubation processes in more demanding surroundings outside theatre, and whether they comply with best practice. In situations where anaesthetists are called to the ED and ICU to assist with difficult intubations, they may be unprepared to manage these patients. This can become problematic and negatively impact these patients.

Research around intubations outside of theatre could not be identified in South Africa. Exploring this may identify shortcomings in the intubation process in the ED and ICU, leading to a revision of the intubation process. This could potentially reduce the incidence of adverse outcomes and improve the patient safety at CMJAH.

4.8 Validity and reliability of the study

According to Botma et al (18), "validity refers to the degree to which a measurement represents a true value". Reliability pertains to the ability of a measuring instrument to produce the same results when applied to different study populations. It is a measure of consistency (18).

The validity and reliability of this study will be ensured by:

- using an appropriate study design
- a draft data collection sheet being developed following a thorough literature review to ensure collection of relevant data
- three senior anaesthesiologists reviewing the data collection sheet for face and content validity

- using a single data collector to guarantee consistent collection
- data analysis will be done in consultation with a biostatitican.

4.9 Potential limitations

As this is a contextual study, the results may not be generalisable to other hospitals.

4.10 Project outline

4.10.1 Time frame

Activity	Aug 2018	Oct 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019
Proposal preparation										
Literature review										
Proposal submission										
Ethics approval										
Postgraduate approval										
Data collection										
Data analysis										
Draft article										
Submission										

4.10.2 Budget

Item	Price per page	Number of pages	Copies	Total
Proposal	1	25	10	R 250
Ethics	1	20	25	R 500
Post graduate form	1	2	6	R 12
Complete report	1	100	4	R 400
Grand total				**R 1162**

The Wits Department of Anaesthesiology will incur the costs of paper and printing.

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4.12 Appendices

Appendix 1: Letter to the CEO

19 Gregory Avenue

Melrose North

Johannesburg

2193

8th October 2018

TO: The Chief Executive Officer, Charlotte Maxeke Johannesburg Academic Hospital

Dear Sir/Madam,

RE: Permission for MMed, Dr Sheena Smith, Student No: 1914326

My name is Sheena Smith and I am currently a registrar in the department of Anaesthesiology at the University of the Witwatersrand. I would like to do a study with the title **Intubations in an emergency department and intensive care unit at a central hospital.**

The aim of the study is to explore the emergency airway management and intubation process within the Emergency Department and Intensive Care Unit (576) for a period of three months at Charlotte Maxeke Johannesburg Academic Hospital. I have obtained written permission to review hospital records from the Heads of the abovementioned departments.

Ethical clearance (ethical clearance number M180836) and Graduate Studies approval have been provisionally obtained, one condition of which includes your written permission. Hospital records will not be removed.

I would like to request permission to investigate the objectives of the research proposal attached. There will be no cost to the hospital as a result of this study. Should you wish to see the results, they will be made available.

Yours Sincerely,

Sheena Smith

083 458 9424

sheenzsmith1@hotmail.com

Appendix 2: Letter to the Anaesthesiology HOD

Appendix 2: Letter to the Anaesthesiology HOD

19 Gregory Avenue

Melrose North

Johannesburg

2193

1st August 2018

TO: The Acting Head of Department of Anaesthesiology, University of the Witwatersrand

Dear Dr Lines,

RE: Permission for MMed, Dr Sheena Smith, Student No: 1914326

My name is Sheena Smith and I am currently a registrar in the Department of Anaesthesiology at the University of the Witwatersrand. I would like to do a study with the title **Intubations in an emergency department and intensive care unit at a central hospital.**

The aim of the study is to explore the intubation process in adult patients within the Emergency Department and general adult Intensive Care Unit (576) for a period of three months at Charlotte Maxeke Johannesburg Academic Hospital. I have obtained written permission to review hospital records from the Heads of the abovementioned departments, and I will be procurring writen permission from the Chief Executive Officer.

Ethical clearance (ethical clearance number XXXX) and Graduate Studies approval have been obtained. Hospital records will not be removed.

I would like to request permission to investigate the objectives of the research proposal attached. There will be no cost to the department or the hospital as a result of this study. Should you wish to see the results, they will be made available.

Yours sincerely,

Sheena Smith

083 458 9424

sheenzsmith1@hotmail.com

Approval Granted:

Dr D Lines
7 August 2018

Appendix 3: Letter to the Emergency department HOD

19 Gregory Avenue

Melrose North

Johannesburg

2193

1st August 2018

TO: The Head of Emergency Medicine, Charlotte Maxeke Johannesburg Academic Hospital

Dear Professor Motara,

RE: Permission for MMed, Dr Sheena Smith, Student No: 1914326

My name is Sheena Smith and I am currently a registrar in the Department of Anaesthesiology at the University of the Witwatersrand. I would like to do a study with the title **Intubations in an emergency department and intensive care unit at a central hospital.**

The aim of the study is to explore the intubation process in adult patients within the Emergency Department and the gerenal adult Intensive Care Unit (576) for a period of 3 months at Charlotte Maxeke Johannesburg Academic Hospital. I have obtained written permission from the Head of Intensive Care to review hospital records, and I will be procurring written permission from the Chief Executive Officer.

Ethical clearance (ethical clearance number XXXX) and Graduate Studies approval have been obtained. Hospital records will not be removed, and the study results will be stored in a locked cupboard for a period of 6 years following completion of the study

I would like to request permission to investigate the objectives of the research proposal. There will be no cost to the hospital as a result of this study.

Yours sincerely,

Sheena Smith

083 458 9424

sheenzsmith1@hotmail.com

FACULTY OF HEALTH SCIENCES WITS

FEROZA MOTARA
ACADEMIC HEAD
DIVISION OF EMERGENCY MEDICINE
DEPARTMENT OF FAMILY MEDICINE AND
PRIMARY CARE
UNIVERSITY OF WITWATERSRAND

SIGNATURE:

Approved + Supported 7/8/18
PROF F MOTARA

Appendix 4: Letter to the Intensive care unit HOD

19 Gregory Avenue

Melrose North

Johannesburg

2193

1st August 2018

TO: The Head of Intensive Care, Charlotte Maxeke Johanesburg Academic Hospital

Dear Professor Richards,

RE: Permission for MMed, Dr Sheena Smith, Student No: 1914326

My name is Sheena Smith and I am currently a registrar in the Department of Anaesthesiology at the University of the Witwatersrand. I would like to do a study with the title **Intubations in an emergency department and intensive care unit at a central hospital.**

The aim of the study is to explore the intubation process in adult patients within the Emergency Department and general adult Intensive Care Unit (576) for a period of 3 months at Charlotte Maxeke Johannesburg Academic Hospital. I have obtained written permission from the Head of Emergency Medicine to review hospital records, and I will be procurring written permission from the Chief Executive Officer.

Ethical clearance (ethical clearance number XXXX) and Graduate Studies approval have been obtained. Hospital records will not be removed, and the study results will be stored in a locked cupboard for a period of 6 years following completion of the study

I would like to request permission to investigate the objectives of the research proposal. There will be no cost to the hospital as a result of this study.

Yours sincerely,

Sheena Smith

083 458 9424

sheenzsmith1@hotmail.com

Appendix 5: Family member's information letter

Hello,

My name is Sheena Smith and I am a doctor who is training to become an anaesthesiologist (a doctor who makes someone sleep for an operation). I am studying at the University of the Witwatersrand. I would like to invite your family member to participate in my research.

I am doing research to understant the process of intubation. This is the name for putting a tube into the windpipe to help someone to breathe. This is an important skill for doctors as it can save a patient's life. I would like to know more about how the doctors placed the tube in your family member's windpipe and why they had to put the tube there. I will be able to get this information from the file of medical notes that is kept with your family member. I will not be making any changes to the medical care of your family member.

Your participation in this research is entirely voluntary. It is your choice whether to let me use the information or not. Whether you choose to grant me permission or not, all the services that your family member receives at this hospital will continue and nothing will change. You may choose not to participate at any time – you are allowed to change your mind. I will also ask the permission of your family member when they wake up.

There will not be any direct benefit for your family member as a result of this study but your participation is likely to help us understand this process. This will, in turn, help us determine if we need to change our intubation practice in any way.

The information that I collect from this research project will be kept confidential. This means that any information about your family member will be put away and no one but the researchers will be able to see it. Any information about your family member will not have their name on it; it will have a number instead. Only the researchers will know what their number is and we will lock that information up with a lock and key.

This study has been reviewed and approved by the Human Research Ethics Committee (ethical clearance number M180836) which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to contact them, the details are as follows: Professor Penny (Chairperson): 011 717 2301. If you would like to contact me at any stage, my telephone number is 011 488 4392.

Thank you for taking the time to read this letter.

Sheena Smith

Appendix 6: Family member's consent form

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily for my family member to participate in this research.

Print name of family member_____

Signature of family member _____

Date _____

Day/month/year

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____

Signature of witness _____

Date _____

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the family member of the potential participant, and to the best of my ability made sure that he/she understands that I will be using information from the file about the intubation process.

I confirm that the family member of the participant was given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

Appendix 7: Patient information letter for patients with prior family consent

Hello,

My name is Sheena Smith and I am a doctor who is training to become an anaesthesiologist (a doctor who makes people sleep for an operation). I am studying at the University of the Witwatersrand. I would like to invite you to participate in my research.

I am doing research to understant the process of intubation. This is the name for putting a tube into the windpipe to help someone to breathe. This is an important skill in the medical profession as it can save a patient's life. I would like to know more about how the doctors placed the tube into your windpipe and why they had to put the tube there. I will be able to get this information from the file of medical notes that is kept with you. I will not be making any changes to your medical care.

Your family member gave permission for me to use the notes from your file. I now want to ask your permission to use the information that I had taken from your file. Your participation in this research is entirely voluntary. It is your choice whether to let me use the information or not. Whether you choose to grant me permission or not, all the services you receive at this hospital will continue and nothing will change. You may choose not to participate at any time – you are allowed to change your mind.

There will not be any direct benefit for you as a result of this study but your participation is likely to help us understand this process. This will, in turn, help us determine if we need to change our intubation practice in any way.

The information that I collect from this research project will be kept confidential. Information about you that was collected during the research will be put away and no one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key.

This study has been reviewed and approved by the Ethics Review committee (ethical clearance number M180836) which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to contact them, the details are as follows: Professor Penny (Chairperson): 011 717 2301. If you would like to contact me at any stage, my telephone number is 011 488 4392.

Thank you for taking the time to read this letter.

Sheena Smith

Appendix 8: Patient information letter for patients with no prior family consent

Hello,

My name is Sheena Smith and I am a doctor who is training to become an anaesthesiologist (a doctor who makes people sleep for an operation). I am studying at the University of the Witwatersrand. I would like to invite you to participate in my research.

I am doing research to understand the process of intubation. This is the name for putting a tube into the windpipe to help someone to breathe. This is an important skill in the medical profession as it can save a patient's life. I would like to know more about how the doctors placed the tube into your windpipe and why they had to put the tube there. I will be able to get this information from the file of medical notes that is kept with you. I will not be making any changes to your medical care.

I now want to ask your permission to use the information from your file. Your participation in this research is entirely voluntary. It is your choice whether to let me use the information or not. Whether you choose to grant me permission or not, all the services you receive at this hospital will continue and nothing will change. You may choose not to participate at any time – you are allowed to change your mind.

There will not be any direct benefit for you as a result of this study, but your participation is likely to help us understand this process. This will in turn help us determine if we need to change our intubation practice in any way.

The information that I collect from this research project will be kept confidential. Information about you that was collected during the research will be put away and no one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key.

This study has been reviewed and approved by the Ethics Review committee (ethical clearance number M180836) which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to contact them, the details are as follows: Professor Penny (Chairperson): 011 717 2301. If you would like to contact me at any stage, my telephone number is 011 488 4392.

Thank you for taking the time to read this letter.

Sheena Smith

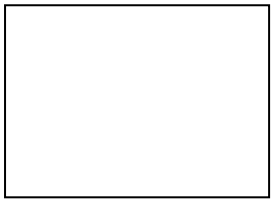
Appendix 9: Patient consent

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate in this research.

Print Name of Participant_____

Signature of Participant _____

Thumb print of participant if unable to write



Date _____Day/month/year

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____

Signature of witness _____

Date _____Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the family member of the potential participant, and to the best of my ability made sure that he/she understands that I will be using information from the folder about the intubation process.

I confirm that the family member of the participant was given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____ Day/month/year

Appendix 10: Data Collection Sheet

Study Number:	

Intubations in an emergency department and intensive care unit at a central hospital

1. Patient Profile

Age		years	Sex	Male	Female	Estimated Weight		kg
Ward	ED	ICU						

2. Intubator professional designation

Medical Officer	Registrar	Consultant	Other

3. Intubator's discipline

4. Intubation process

Time of intubation	……h…….		
Day	Night	Week	Weekend
Indication			
Clinical status pre intubation	HR	BP	R/A Sats	GCS

Number of attempts

Airway Adjuncts	None	Stylet	OPA	Bougie	Video-laryngoscope	Other

5. Drugs used

Induction Agent/ hypnotic and dose	Propofol	Ketamine	Etomidate	Ketofol
	Other			
NMB and dose	Suxamethonium	Rocuronium	Cisatracurium	Other
Adjuncts and dose	Opioid	Lignocaine	Midazolam	Other

6. Adverse events

Adverse events	None	Oesophageal intubation	Airway trauma	Failed intubation	CICV	Haemodynamic instability
	Other					

7. Outcome

Immediate outcome	Intubation successful	Supraglottic airway	CICV	Surgical airway	Death	
					Airway related	Not airway related

Section 5: Annexures

5.1 Ethics approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Sheena Smith

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180836

NAME: (Principal Investigator)	Dr Sheena Smith
DEPARTMENT:	Anaesthesiology Charlotte Maxeke Johannesburg Academic Hospital
PROJECT TITLE:	Intubations in an emergency department and intensive care unit at a central hospital
DATE CONSIDERED:	31/08/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Helen Perrie, Juan Scribante and Megan Sanders
APPROVED BY:	Dr C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/11/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed August and will therefore be due in the month of August each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

5.2 Ethics letter of acknowledgement for change in proposal

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

16/06/2019

Dr SD Smith
School of Clinical Medicine
Department of Anaesthesiology
Charlotte Maxeke Johannesburg Academic Hospital

Sent by e-mail to: sheenzsmith1@hotmail.com

Dear Dr Smith

Re: **Protocol Ref No: M180836**
Protocol Title: *Intubation in an emergency department and intensive care unit at a central hospital*
Principal Investigator: Dr SD Smith

Thank you for your letter of 05/06/2019.

I confirm that the additional reference in your protocol to drug choice has been noted and approved.

Thank you for keeping us informed.

Yours Sincerely

J. Burns

.....

Mr I Burns
For the Human Research Ethics Committee (Medical)

Works2000/Iain0007/Acknowledge.docx

5.3 Graduate studies approval

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

06 November 2018
Person No: 1914326
PAG

Dr SD Smith
No. 8 Gregory Wose
19 Gregory Avenue
Melrose North
2196
South Africa

Dear Dr Sheena Smith

Master of Medicine in Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled *Intubations in an emergency department and intensive care unit at a central hospital* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.4 Clinical Executive Officer approval, CMJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. N. Mzila
Office of the Clinical Director
Tell: (011): 488-4812
Email: Nolwazi.Mzila@gautemg.gov.za
26th November 2018

GP_2018010_008

Dear Dr. S. Smith

STUDY TITLE: Intubations in an Emergency Department and Intensive Care Unit at a Central Hospital

Permission is granted for you to conduct the above recruitment activities as described in your request provided:

1. Charlotte Maxeke Johannesburg Academic Hospital will not anyway incur or inherit costs as result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the HOD and Unit Manager or sister in charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

Supported / ~~**not supported**~~

Dr. M.I. Mofokeng
Clinical Director
DATE: 26/11/2018

~~**Approved**~~/~~**not approved**~~

Ms. G. Bogoshi
Chief Executive Officer
Date: 23.11.2018

5.5 Turnitin report

1914326:Turn_it_in.docx

ORIGINALITY REPORT

12%	6%	9%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	1%
2	academic.oup.com Internet Source	1%
3	Brown, Calvin A., Aaron E. Bair, Daniel J. Pallin, and Ron M. Walls. "Techniques, Success, and Adverse Events of Emergency Department Adult Intubations", Annals of Emergency Medicine, 2015. Publication	<1%
4	www.science.gov Internet Source	<1%
5	David E. Schwartz. "Death and Other Complications of Emergency Airway Management in Critically Ill Adults", Anesthesiology, 02/1995 Publication	<1%
6	link.springer.com Internet Source	<1%

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | FACULTY OF HEALTH SCIENCES

18th September, 2019

The Chairperson
Graduate Studies Committee
Faculty of Health Sciences
University of the Witwatersrand

Dear Madam,

Re: M Med: **Intubations in an emergency department and intensive care unit at a central hospital**

Dr Sheena Smith, student number: 1914326, has submitted her research report to Turnitin which revealed a similarity index of 12%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of the research.

Yours sincerely,

H C Perrie

Helen Perrie
Supervisor