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Anaesthetic nurses' knowledge and skills in perioperative airway management at Chris Hani Baragwanath Academic Hospital

Matthew Dold

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

Johannesburg, 2024

Declaration

I, Matthew Dold, herewith declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

The authors declare no conflict of interest. No funding source is to be declared.

The author/s declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

Prior to commencement of the study ethical approval was obtained from the following ethical review board: Wits Human Research Ethics Committee (M220863). Participants were supplied with a study information sheet and informed consent was implied by completion of the questionnaire.

The authors confirm that all authors have made substantial contributions to all of the following:

- The conception and design of the study, or acquisition of data, or analysis and interpretation of data.
- Drafting the article or revising it critically for important intellectual content.
- Final approval of the version to be submitted.
- Sound scientific research practice

The authors further confirm that:

- The manuscript, including related data, figures and tables has not been previously published and is not under consideration elsewhere.
- No data have been fabricated or manipulated (including images) to support your conclusions.
- This submission does not represent a part of single study that has been split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time (e.g. “salami-publishing”).
- The authors confirm that the work submitted is original and does not transgress the plagiarism policy of the journal.
- No data, text, or theories by others are presented as if they were the author’s own.
- Proper acknowledgements of other’s work has been given (this includes material that is closely copied, summarized and/or paraphrased), quotation marks are used for verbatim copying of material.
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Signed_____ On the _____ day of _____ 2024

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List of Abbreviations

aOR: Adjusted odds ratio

CHBAH: Chris Hani Baragwanath Academic Hospital

CICV: Cannot intubate, cannot ventilate

CO2: Carbon dioxide

CRNA: Certified Registered Nurse Anaesthetist

ESI: Elective sequence induction

ICU: Intensive care unit

IQR: Inter-quartile range

LMA: Laryngeal mask airway

MD: Mean Difference

OR: Odds ratio

OSCE: Objective standardized clinical examination

P: p value

R-sq: R-Squared

RSI: Rapid sequence induction

SASA: South African Society of Anaesthetists

SBE: Simulation based education

SD: Standard deviation

1st Gen, 2nd Gen:

Draft Article

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Abstract

Background: Airway management in the peri-operative period carries specific inherent risks, and the benefit of assistance by a skilled anaesthetic nurse cannot be over-stated. The aim of this study was to assess the theoretical and clinical knowledge regarding perioperative airway management in anaesthetic nurses at Chris Hani Baragwanath Academic Hospital (CHBAH).

Method: A quantitative, contextual, cross-sectional and descriptive survey was performed by means of a self-administered anonymous questionnaire using convenience sampling. The questionnaire assessed identification of airway equipment, knowledge of the cleaning, maintenance and use of equipment and clinically applicable insight into perioperative airway procedures and emergencies. It's adequacy and validity were ensured by means of the Angoff standard setting method. Data was analysed in consultation with a biostatistician.

Results: A total of 68 nurses took part in the study. By distribution of rank, 78% (n=53) enrolled nurses, 19% (n=13) professional nurses and 3% (n=2) nursing assistants. The incidence of prior airway training was 41% (n=28). The overall mean questionnaire score was 69,8% (SD: 9.6%) with a range of 45% - 97%. Only 19% (n=13) of nurses achieved adequate overall scores. Years of experience was positively associated with overall mean scores (p=0.0009) and adequacy of knowledge (OR 1.28, p=0.004). Airway training showed a small increase mean scores (mean difference=4.63%, p=0.049). There were no statistically significant associations between adequate knowledge and age, prior airway training and nurse qualification.

Conclusion: This study found that the theoretical and clinical knowledge of perioperative airway management of many anaesthetic nurses at CHBAH is inadequate. Knowledge adequacy improved with increasing experience but not with current forms of formal training. This may be attributed to the low frequency of training as well as the type of training methods currently employed; both of which should be addressed to improve anaesthetic nurse competence and ultimately patient perioperative safety.

Introduction

The provision of an anaesthetic in the era of modern medicine is a precise, intricate, and inherently risky task, best performed by a skilled anaesthetic team [1, 2]. Anaesthetic nurses are regarded as crucial members of the anaesthetic team required to deliver a safe anaesthetic [3]. Whilst the presence of a skilled and competent anaesthetic nurse has been found to minimise the impact of adverse anaesthetic incidents, inadequate assistance was found to be a contributing factor in poor peri-operative outcomes [4,5].

Airway management in the peri-operative period carries specific risks, and the benefit of assistance by a skilled anaesthetic nurse cannot be over-stated. Anaesthetic nurses not only provide technical skills to assist with airway procedures but also contribute by means of knowledge and practical task completion such as airway equipment assembly, care and maintenance. The combination of these technical, and non-technical skills such as situational awareness and communication, decrease adverse incidents in the theatre environment [6].

In South Africa, the entity of an anaesthetic nurse as well as their roles, functions and core competencies are outlined within the South African Society of Anaesthesiologists (SASA) Guidelines [7]. These core competencies are based on the applied knowledge of airway and respiratory anatomy and physiology, ventilation and acute emergency care. In keeping with international guidelines [8], competence also includes knowledge of anaesthetic equipment as well as the function, care, cleaning and maintenance thereof. SASA also outlines the scope of clinical practice in which anaesthetic nurses are expected to operate [7]. However, the responsibility of their training falls to their respective hospitals, theatre managers and anaesthetic departments [7, 9].

The competence of anaesthetic nurses in South Africa varies; undergraduate training in anaesthesia is either absent or severely lacking and the quality of work-based training varies by institution and is often inconsistent [10]. However, through personal diligent application to the task as well as appropriate and targeted work-based training, anaesthetic nurses can become an invaluable member of the anaesthetic team [11].

The clinical and practical nature of the tasks performed by an anaesthetic nurse suggest that the work-based training provided at health care institutions may benefit from a transition from a didactic theoretical teaching programme to a simulation-based education (SBE) model which has shown a positive relationship with learning outcomes [12].

The aim of this study, focussing on the anaesthetic nurses at Chris Hani Baragwanath Academic Hospital (CHBAH), was to assess their theoretical knowledge relating to airway equipment identification, preparation, and use, as well as to assess their perioperative practical airway skills and situational awareness of perioperative airway emergencies. The identification of gaps in knowledge and skills deficits can then be targeted by means of targeted work-based training to better empower anaesthetic nurses to perform their function and ultimately improve perioperative patient safety.

Method

This quantitative study was a contextual, cross-sectional and descriptive survey. The study population comprised anaesthetic nurses working at CHBAH, sampled by convenience sampling. A minimum sample size of 67 was selected as calculated by 80 percent of the total population size. Ethical approval was obtained from the Wits Human Research Ethics Committee (M220863) and permission was granted by CHBAH Medical Advisory Committee.

Data was collected by means of a self-administered anonymous questionnaire. This was developed on the background of a thorough literature review and its adequacy and validity was ensured by means of the Angoff method of standard setting in consultation with a panel of experts. The panel was comprised of three anaesthetic nurses identified by the theatre matron as sufficiently experienced and of exemplary performance, and two anaesthetic consultants with a special interest in airway management and healthcare worker training. The anaesthetic nurses on the development panel were excluded from participation in the final study. The questionnaire was divided into four sections, namely participant demographic information, identification of airway equipment, knowledge of care, maintenance and use of airway equipment, and clinical scenarios to assess practical knowledge and insight into airway emergencies and procedures,

Participants were provided with a study information sheet and informed consent was implied by completion of the questionnaire. Completed questionnaires were placed in a sealed receptacle. Data was captured onto Microsoft Excel® and analysed using descriptive statistics on Stata® in consultation with biostatisticians. Categorical variables were reported as percentages and frequencies. Continuous variables that were normally distributed were summarised using means, standard deviations and percentages. Abnormally distributed variables were described using median and interquartile range (IQR). Correlation was

calculated using Pearson correlation coefficient. T-tests, chi square and Fisher exact as well as a logistic regression and ANOVA were performed to describe the relationship between mean scores, adequacy of knowledge and participant experience, age, qualification and prior training.

The overall score required to indicate adequacy of knowledge and skill was determined by an average of adequacy marks of all individual questions as determined by the panel of experts. For the entire questionnaire, this was calculated as a adequacy threshold of 77.5%. This was subdivided into categories: equipment identification (78.5%), maintenance care and uses (81.8%) and clinical skills and practical scenarios (72.5%).

Results

Demographics.

A total of 68 participants were enrolled in the study between January and May 2023 comprised of 53 enrolled nurses, 13 professional nurses and 2 nursing assistants. The mean age of anaesthetic nurses in the study was 41 years (SD: 7.23) and the median experience working as an anaesthetic nurse was 6 years (IQR: 3 - 10). The percentage of anaesthetic nurses who had undergone airway training was 41.2%, specifically, in-service training (32%), refreshers (12%), airway courses (4%) and workshops (1%).

Participant overall mean scores and knowledge adequacy.

The distribution of mean overall scores appeared normally distributed. The overall mean scores and knowledge adequacy are summarised in table I.

Table 1: Mean scores and adequacy by category of knowledge.

Knowledge category	**Mean score % (SD)**	**Adequate Knowledge % (n)**	**Inadequate Knowledge % (n)**
Combined Equipment knowledge score	79.6 (±9.5)	51 (35)	49 (33)
Equipment Identification	84.4 (±11.6)	74 (50)	26 (18)
Equipment Care, Maintenance and Uses	73.4 (±12.9)	22 (15)	78 (53)
Clinical Scenarios	50.1 (±17.3)	13 (9)	87 (59)
Total	69.8 (±9.6)	19 (13)	81 (55)

Overall mean scores by core areas of knowledge.

Figure 1 displays overall scores and adequacy for individual questions.

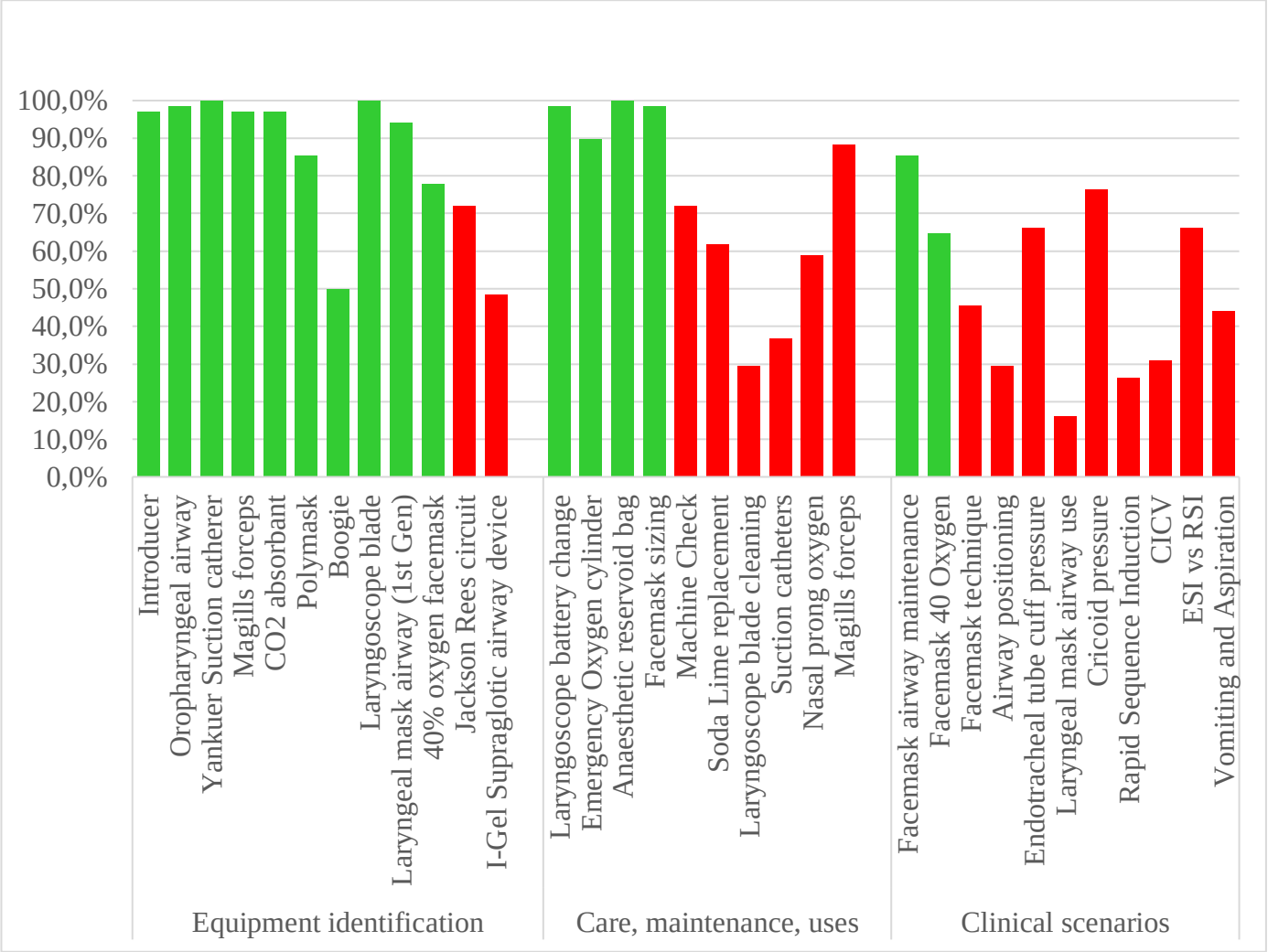


Figure 1: Individual questions mean scores and knowledge adequacy (Adequate = Green, Inadequate = Red).

Correlations and associations.

A moderate positive correlation was noted between years of experience and overall individual mean scores (Pearson coefficient: 0.53) as shown in Figure 2.

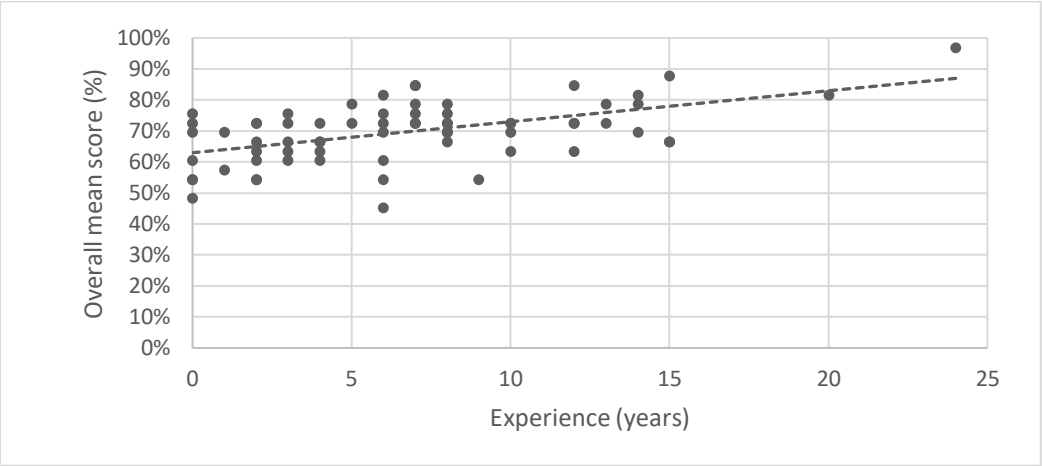


Figure 2: Scatter Plot of Correlation of Overall mean score (%) to Experience (years)

One-way ANOVA of experience and overall mean scores demonstrated a statistically significant association between mean scores and increasing years of experience (F=5.32, p=0.0009). Prior airway training showed a small statistically significant increase in overall mean scores (Mean Difference (MD) = 4.63, t=2, p=0.049). Nursing qualification showed no significant impact on overall mean score (MD=0.93, t=0.31, p=0.76).

Adequacy of Knowledge

No statistical association was found between either adequacy of knowledge and prior airway training (chi^2=1.0652, p=0.302), or nursing qualification (Fisher's Exact, p=0.732).

Table II: Univariate and multivariate analysis demographic variables and adequacy of knowledge.

	Univariate		**Multivariate**	
Demographic variables	**OR (95% CI)**	**P Value**	**aOR (95% CI)**	**P Value**
Age	1.07 (0.98 - 1.17)	0.112	0.99 (0.83 - 1.18)	0.889
Years of experience	1.29 (1.10 - 1.50)	0.001	1.28 (1.09 - 1.51)	0.003
Airway Training	1.89 (0.56 - 6.39)	0.306	0.99 (0.24 - 4.09)	0.99
Nursing Qualification				
Professional Nurse	1.29 (0.30 - 5.57)	0.733	0.59 (0.94 - 3.66)	0.569
Enrolled Nurse	1		1	

In the multivariate analysis, as shown in Table II, a statistically significant relationship between years of experience and adequate knowledge was found (aOR=1.28, 95% CI 1.09 - 1.51, p=0.003). No statistically significant relationship was found between adequacy of knowledge and airway training, nursing qualification and age.

Discussion

The goal of health care training is to improve health outcomes and patient safety. A critical step in the process of improving training is the review of current practice, identification of shortcomings and the proposal and implementation of novel or modified training techniques [13]. The results of this study have highlighted several shortcomings in anaesthetic nurse airway knowledge as well as insights and opportunities to improve patient care.

The demographic distribution of anaesthetic nurses revealed that the majority (78%) are enrolled nurses with a median experience of 6 years. This suggests that despite 10% of anaesthetic nurses having less than 1 year of experience, the majority have been employed for an adequate duration to receive comprehensive training in airway equipment and management. However, the total incidence of reported airway training was only 41%, with in-service training, refreshers and airway management courses (32%, 12% and 4% respectively) identified as forms of training. This indicates that the frequency and urgency of anaesthetic nurse training may need revision. The nature of an anaesthetic airway emergency is sudden and unpredictable and every effort should be made to equip the entire anaesthetic team with the appropriate skills as early into their career as possible.

While an overall mean questionnaire score of 69,8% suggests anaesthetic nurses have received some degree of airway training, there are areas in need of improvement. The ability to correctly identify airway equipment (mean score: 84,8%) and knowledge of airway equipment use and maintenance (mean score: 73,4%) scored relatively well; in contrast, the mean score for clinical scenarios, practical skills and situational awareness was only 50,1%. This is of concern as many of these scenarios draw on knowledge required in an anaesthetic emergency where the aid of an anaesthetic nurses is paramount. These findings may suggest that knowledge regarding airway equipment is used and reinforced on a more regular basis resulting in familiarity with most of these concepts. Repetition of tasks is a key tool in improving knowledge retention [14].

Acknowledging the inherent risks involved in providing an anaesthetic, a high degree of knowledge and skill is expected of the entire anaesthetic team, including the anaesthetic nurse. It is therefore appropriate that the benchmark of adequacy of knowledge and skill must also be set high to ensure the safety of patients under anaesthesia. With this in mind, the participant questionnaire scores were measured against the pre-determined level of adequacy. As shown in Table I, varying levels of inadequate knowledge were demonstrated in all knowledge categories assessed. Specific deficits in knowledge, where mean scores fell below predetermined levels of adequacy, included identification of Jackson Rees circuit (72.1%), second-generation supraglottic airway devices (48.5%) and laryngoscope blade cleaning procedures (29.4%). The identification of second generation supraglottic airway devices was likely poor due to decreased exposure to such devices in the study setting however their role in anaesthetic airway emergency management is clear, matching or out-performing first generation supraglottic devices [13]. Phillips and Monaghan studied the incidence of visible and occult blood on laryngoscope blades and handles and found that 20% of blades and 40% of handles tested positive for occult blood [16]. Inadequate training on laryngoscope cleaning, as found in this study, or poor adherence to the protocols thereof, form part of a worldwide concern for inadequate airway equipment sterility. The use of breathing systems other than the circle system are important core knowledge particularly in paediatric anaesthesia. In keeping with inadequate knowledge scores of the Jackson Rees system in this study, Von Ungern-Sternberg et al. demonstrated that nursing students provided the least effective ventilation using a Jackson Rees system compared to other anaesthetic providers, indicating that specific training is required to operate this device effectively [17].

Regarding clinical scenarios and situational awareness, only 13 (19%) anaesthetic nurses obtained an adequate score. More specifically, the practical core concepts of facemask technique, airway positioning, laryngeal mask airway (LMA) use, rapid sequence induction (RSI), cannot intubate cannot ventilate (CICV) and vomiting and aspiration scenarios showed mean scores well below the adequacy threshold. This highlights the need for improved training not only of airway equipment but also in the management of various airway-related emergencies and procedures. The mean knowledge score for CICV scenarios of 30.9% (adequacy threshold: 50.0%) contrasts with an international study by Scott-Herring et al. where 54% of the Certified Registered Nurse Anaesthetists (CNRA) were able to successfully perform a surgical cricothyroidotomy on a training manikin in under the required 120 seconds on first attempt, and given multiple attempts, all but one CRNA were able to

successfully perform the procedure in under 120 seconds [18]. The knowledge of acute management of peri-operative vomiting and aspiration (mean knowledge score 44.1%, adequacy threshold: 83.0%) was in keeping with findings of a local study by Scribante et al. where anaesthetic nurses knowledge of perioperative aspiration was answered inadequately in the following categories; anatomy and physiology (54.7%), clinical signs (5.2%), treatment (21.4%) and general knowledge (62.8%) [19].

There is no directly comparable literature available at present using this questionnaire however these findings are in keeping with local studies of post-anaesthesia recovery room nurses' knowledge of airway emergencies. In 2004, Van Huyssteen and Botha studied recovery room nurses' knowledge of post-anaesthetic airway emergencies in the private sector in Northern Gauteng [20]. Key areas of knowledge assessed in this study were the anatomical and physiological characteristics, clinical findings and treatment of soft tissue obstruction, laryngeal oedema, laryngospasm, bronchospasm, noncardiogenic pulmonary oedema and aspiration. They found that mean knowledge scores were 43%, 27% below the predetermined level of adequacy. These findings were similar to those of McCallum et al. in 2015 for recovery room nurses in Gauteng public sector (mean score: 46.2%) [21]. In a follow-up study in 2021 using the questionnaire adapted from Van Huyssteen and Botha, Scribante et al. found that recovery room nurses in Johannesburg and Cape Town had inadequate mean knowledge scores (40.4%) [19]. In all studies, the total average scores were well below the predetermined level of adequate knowledge (70%) and showed no substantial improvement in scores over the years between studies. Noting that this study used a different data collection tool to the aforementioned, direct comparisons between scores cannot be made however the findings of inadequate knowledge scores are consistent throughout.

Of all the variables described, only duration of experience as an anaesthetic nurse was found to have a moderately positive correlation to adequacy of knowledge. This was complemented by the multivariate analysis demonstrating an OR=1.28 for years of experience and overall adequacy of knowledge. So, for each additional year of experience, the odds of achieving a score of adequate knowledge increased by 28%. This is in keeping with an international study finding that ICU nurses with greater years of experience had higher scores on knowledge tests [22]. In contrast, Perrie et al. found that years of experience in ICU did not improve knowledge scores of ICU nurses in Johannesburg [23].

Interestingly, there was no association demonstrated between prior airway training and overall adequacy of knowledge, and only a 4.6% improvement in overall mean knowledge scores with those with prior airway training. This further emphasizes the need to revise the methods of training within the hospital environment. The majority of reported training received was in the form of refreshers or in-service training. These forms of training are most common due to the logistical and financial constraints within which they must be implemented. However, didactic passive teaching has been proven to have inferior knowledge retention compared to interactive and practical teaching sessions [(24)]. Practical training or interactive sessions may be of greater benefit than the current format. For example, SBE training of nurses for surgical airway procedures significantly improved post-test confidence in their ability to successfully perform the procedure [(18)]. In patient-based simulation training of newly graduated nurses in the management of anaphylaxis, all participants showed significant improvement of clinical competencies including identification of the emergency, management of the airway and application of oxygen and appropriate positioning of patient [(25)]. A SBE model would allow for improvement of situational awareness and the emergency algorithm-based format that management of many airway emergencies follow. The incidence of true airway emergencies is relatively low therefore frequent repetition of simulation training for airway procedures assists greatly in the knowledge and skill retention [(26)].

Recommendations

The results of this study indicate that changes in the training of anaesthetic nurses are needed to improve levels of knowledge and skills to a level deemed adequate. The authors recommend that the current training formats of in-service training and refreshers are to be complemented by, or revised into, practical in-theatre training sessions and simulation-based training sessions for the management of airway emergencies. These skills and knowledge should be reenforced in theatre by anaesthetists who should acknowledge their pivotal role in the upskilling of anaesthetic nurses. Following the implementation of the above, it is recommended to repeat a study assessing anaesthetic nurses airway competence to assess for improvement.

Limitations

This study was performed at a single hospital and the results may not necessarily be transferrable to other health care facilities. The lack of a previously validated questionnaire specifically assessing perioperative airway knowledge required that a new questionnaire be constructed. The decision to perform data collection by means of a questionnaire was based on feasibility. All efforts were made to assess clinically applied knowledge as well as theoretical knowledge in the way clinical scenarios were constructed. However, a practical objective structured clinical exam (OSCE) based assessment would more accurately measure practical skills.

Conclusion

Anaesthetic nurses in South Africa rely on institution-based training which is often inconsistent and insufficient [10]. This study has found that the clinical and theoretical knowledge of perioperative airway management of anaesthetic nurses at CHBAH is inadequate. Knowledge scores improved with increasing years of experience as an anaesthetic nurse but adequacy of knowledge did not improve with formal training. This may be attributed to the low incidence of training as well as the type of training methods currently employed; both of which should be addressed to improve anaesthetic nurse competence, job satisfaction and ultimately patient perioperative safety.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

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Appendices

Appendix 1: Proposal

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Appendix 1: Proposal

Anaesthetic nurses' knowledge and skills in perioperative airway management at Chris Hani Baragwanath Academic Hospital

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Introduction

The provision of an anaesthetic in the era of modern medicine is a precise, intricate and inherently risky task, best performed by a skilled anaesthetic team. Anaesthetic nurses are regarded as crucial members of the anaesthetic team required to deliver a safe anaesthetic to a patient. Whilst the presence of a skilled and competent anaesthetic nurse has been found to minimise the impact of adverse anaesthetic incidents, inadequate assistance was found to be a contributing factor (1).

Anaesthetic nurses play an important role in the provision of anaesthesia globally and whilst many countries today are adopting healthcare models that incorporate anaesthetic nurses for reasons including improved patient outcomes, healthcare access and economic benefits, the concept of anaesthetic nurses is by no means novel. The first recorded case of anaesthesia provided by a nurse was that of Catherine S. Lawrence, giving ether to wounded soldiers during the American Civil War in 1862, far preceding the birth of anaesthesiology as a profession (2). Sister Mary Bernard Sheridan was the earliest recorded nurse to specialise in anaesthesia and subsequently many Catholic nuns were trained by surgeons to administer chloroform and ether. Over the course of World War I, and later World War II, the demand for surgical procedures and therefore anaesthesia grew rapidly thereby prompting the formation of numerous nurse anaesthesia training programmes within the United States and globally. In modern times, the specific training and career paths of anaesthetic nurses vary between countries; registered nurses in the United States may obtain a master's degree and practice as Certified Registered Nurse Anaesthetists (CRNA) whilst other nurses may undergo standardised undergraduate nursing education and obtain anaesthetic skills through exposure and institution-based training[3,4,5].

Anaesthetic nurses are utilised across the globe in various capacities. In the United States, CRNAs perform various forms of anaesthetic care, mostly under the supervision of anaesthesiologists; however, they may perform independently in 16 states. This model of anaesthetic care provision is driven largely by the need to reduce healthcare costs; average salaries for CRNAs are less than half that of anaesthesiologists and the cost and duration of training is significantly less [6]. Silber and associates [7] reviewed CRNA quality of care outcomes when not directed by an anaesthesiologist to those of anaesthesiologists alone and found that CRNAs had 2.5 excess deaths per 1,000 patients and 6.9 excess failures-to-rescue (deaths in the first 30 days after surgery) per 1,000 patients, whereas complications were not increased (complication odds ratio = 1.00, $P < 0.79$) [7]. However, subsequent articles published non-inferior outcomes between CRNAs, supervised or unsupervised, and anaesthesiologists alone [8].

Economics has and will continue to be one of the primary drivers in the incorporation of anaesthetic nurses within healthcare systems. Much of the current data regarding the financial impact of anaesthetic nurses pertains specifically to CRNAs practising independently versus anaesthesiologists. The cost of employing CRNAs is substantially less than that of employing anaesthetists thereby reducing monthly hospital expenditure. However, unfortunately these cost reductions do not always directly translate into more affordable healthcare for the patient. Some healthcare insurance providers maintain that various additional healthcare professionals may also be required where CRNAs are practising independently, thereby offsetting the proposed cost benefit. The counterarguments put forward by the American Society of Anaesthesiologists (ASA) demonstrate that when an anaesthesiologist supervises anaesthesiology services, a reduction of 75% in additional medical consultations, 88% in cancellations, and 59% in laboratory tests, however the accuracy and validity of these statements has been called into question [9].

Rather than independently practising anaesthesiologists and anaesthetic nurses, many propose a model that combines their services into a single functional unit. The model of an anaesthetic care team consisting of an anaesthesiologist and anaesthetic nurse has been recognised as crucially important for improved patient perioperative outcomes [10] looked at outcomes of solo anaesthesiologists versus anaesthetic care teams and found that anaesthetic care teams had a significantly lower 30-day mortality rate compared with solo anaesthesiologists (0.76 vs. 1.56%, P = 0.0014). In addition, when an anaesthesia care team was present, length of hospital stay was also significantly reduced (4.9 ± 10.1 vs. 5.6 ± 11.5 days, P = 0.0011) [10].

Within the context of Africa, data on the role and function of anaesthetic nurses is scarce. This is in part due to the relative shortage of anaesthetists and secondary or tertiary health facilities compared to the first world as well as shortage of equipment, drug shortages and biomedical support [11]. In Rwanda, an anaesthetic training program has been established that focuses on academic and practical skills within the operating theatre for resident physicians. In addition, anaesthetic nurses are also trained and equipped. [11]. The training is provided by American and Canadian volunteers to fill a void in state training programs. In South Africa, whilst the entity of an anaesthetic nurse as well as their role and functions are outlined within the South African Society of Anaesthesiologists (SASA) Guidelines, the responsibility of their training falls to their respective hospital, theatre managers and anaesthetic departments [5,12].

The task of perioperative airway management carries specific inherent risks, with adverse incidents potentially arising from incomplete theatre preparation or during the phases of induction, maintenance, emergence, extubation and post-operative recovery. Improper or incomplete preparation of anaesthetic airway equipment can lead to delay or inability to secure the airway with potentially disastrous consequences. In the UK, of all anaesthetic equipment failures reported, 17.9% were ventilator related whilst 9.6% involved circuit leaks.

This highlights the paramount importance of theatre airway equipment preparation and maintenance, a responsibility shared between anaesthesiologists and anaesthetic nurses. The ability to maintain a patent airway on induction prior to intubation may require the trained hands of the anaesthetic nurse; the inability to do so may hinder the anaesthesiologist from performing other critical tasks during the induction process. The incidence of failed tracheal intubations ranges from 1 in 1000-2000 elective cases to 1 in 250 obstetric rapid sequence inductions [13]. The occurrence of this anaesthetic emergency requires skilled hands to assist in maintaining oxygenation by whichever means necessary. Similarly, anaesthetic assistants are indispensable in the event of perioperative airway complications such as laryngospasm or aspiration.

Anaesthetic nurses not only provide skilled hands to assist with airway procedures but also contribute by means of knowledge and theoretical assistance. Particularly in the setting of airway emergencies, a sound understanding of human airway anatomy and respiratory physiology is critical. In addition, anaesthetic nurses may assist in the co-execution of tasks such as preoperative airway assessment. However, these are not performed to the exclusion of the anaesthetist; it has been demonstrated that neither a patient's self-assessment nor anaesthetic nurse's airway assessments are adequate substitutes for the anaesthesiologists' airway assessment [14].

Within the context of COVID-19, anaesthetic nurses have been required to broaden their skill set further to cope with the evolving pandemic and the strain that it places on healthcare systems globally. During the Covid-19 pandemic, anaesthetic nurses in China are frequently required to use ventilators during the post-anaesthesia care of patients undergoing general anaesthesia. These tasks include setting ventilation parameters, adjusting respiratory modes and respiratory parameters based on patient recovery, and assisting the anaesthesiologist during the extubation procedure [15]. Severe COVID-19 respiratory disease requires expert

respiratory support and flawless airway management as aerosol-generating procedures place the entire healthcare team at risk for infection. Whilst perioperative airway management in COVID-19 is led by an anaesthetist, the assistance of an anaesthetic nurse is vital in rapidly and safely securing an airway. A comprehensive knowledge of emergency airway management including both the procedure, equipment and backup plans is therefore essential [16].

The clinical scope of practice of anaesthetic nurses varies globally. In certain countries, anaesthetic nurses form part of pre-hospital emergency response teams and may be required to intubate and ventilate patients at the scene and prepare for transfer to hospital. In a study by Gellerfors et al. [17], nurse anaesthetists in critical care teams in Denmark, Finland, Sweden and Norway had a 97.6% (p=0.03) success rate for endotracheal intubation pre-hospital transfer. It should be noted that at least 67% of these intubations were performed by experienced practitioners who had performed more than 2500 endotracheal intubations. This clearly demonstrates that airway management, including airway instrumentation and invasive ventilation does not always fall exclusively within the province of the anaesthetist; anaesthetic nurses with appropriate training and experience are more than capable of performing this task to the highest standards. Over the past several decades, anaesthetic airway equipment has become increasingly complex but also user-friendly and intuitive. For example, whilst the video-assisted and fibreoptic technologies have become commonplace in the anaesthetic airway trolley, simple and user-friendly devices such as laryngeal mask airways (LMAs) have become everyday airway tools. These user-friendly devices have been proven effective tools in the hands of nurses with only basic airway training and experience. In a district health care facility in Poland, Cierniak et al. [18] found that after a short training lecture, actively practising professional nurses were able to use an LMA in a resuscitation

scenario and achieve better ventilation outcomes as compared to a standard bag mask ventilator.

The likelihood of performing a safe airway procedure perioperatively correlates directly with the competence of the anaesthetist as well as the anaesthetic nurse. An excellent example of competence is the ability to assist the anaesthetist during a rapid sequence induction by applying Sellick's manoeuvre. This task requires both a theoretical knowledge of airway anatomy, practical skill of correct pressure application as well as situational awareness to guide when the manoeuvre is appropriate or not. While the practical applicability has come into question in recent years, its application is still widely practised but can be unhelpful or even harmful if incorrectly applied. Andruszkiewicz et al. (19) found that in a simulated scenario, cricoid pressure was applied in the wrong place by half of participants while the majority of participants applied an inappropriate amount of force. Similar findings are reported in various other studies globally [20, 21].

When looking at anaesthetists working within an accident and emergency department in the United Kingdom, 68% felt that the assistance they received during emergency airway management was inadequate. Most of these anaesthetists were assisted by emergency department nurses whose training in rapid sequence inductions and airway management were inadequate. They concluded it is unreasonable to expect people to perform tasks for which they are not specifically trained and then criticise them for the way in which the tasks are carried out. Findings such as this prompted the development of specific core competencies by their respective regulatory bodies. These core competencies provide a framework on which to structure skills training and assessment [22].

The competence of anaesthetic nurses in South Africa varies; undergraduate training in anaesthesia is either absent or severely lacking and the quality of work-based training varies

by institution and is often inconsistent [23]. However, through personal diligent application to the task as well as appropriate and targeted work-based training, anaesthetic nurses can become an invaluable member of the anaesthetic team. Within the context of South Africa and the setting of the operating theatre, SASA outlines the core competencies required by the practising anaesthetic nurse. These core competencies are based on the applied knowledge of airway and respiratory anatomy and physiology, respiratory and other acute emergency care. Competence also includes knowledge of anaesthetic equipment as well as the function, care, cleaning and maintenance thereof. SASA also outlines the scope of clinical practice in which anaesthetic nurses are expected to operate [12].

The task of anaesthetic airway management training, particularly in the case of airway emergencies, is inherently challenging as these situations are generally high-risk but low frequency events. The potential morbidity and mortality associated with airway emergencies managed by under-trained staff is far greater, however the opportunities to develop such specific skills in a high-pressure environment are scarce. Didactic teaching in the form of lectures have proven inferior to practical scenario-based simulation sessions and there is evidence that simulation-based training in emergency airway management improved nurses' knowledge, confidence, and team skills [24]. Simulation-based training was also found to provide a statistically significant increase in nurses' knowledge and skills regardless of their level of prior experience. In fact, nurses with little experience that undergo simulation training are likely to achieve levels of knowledge and skill similar to those of more experienced colleagues undergoing simulation training [25].

Anaesthetic nurses play a pivotal role in minimising adverse anaesthetic airway incidents by assisting with appropriate theatre preparation as well as providing skilled assistance during perioperative airway events to prevent or reduce associated morbidity or mortality. With very little formalised undergraduate nursing training focussed specifically on anaesthesia,

anaesthetic nurses are expected to acquire relevant knowledge and learn skilled tasks, often in high pressure situations, simply from the healthcare facilities where they practice. The aim of this study, focussing on the anaesthetic nurses at Chris Hani Baragwanath Academic Hospital (CHBAH), is to assess their theoretical knowledge relating to airway equipment identification, preparation, and use.

It will also assess their perioperative practical airway skills, their situational awareness of perioperative airway emergencies and their understanding of and ability to perform their role within the anaesthetic team. This information will allow for the identification of gaps in knowledge and skills which can then be targeted by means of focussed work-based training to better empower anaesthetic nurses to perform their function and ultimately improve perioperative patient safety.

2. Problem statement

Anaesthetic nurses function as part of the anaesthetic team and therefore require a working knowledge of airway anatomy and physiology as well as an adequate level of competence regarding elective and emergency perioperative airway skills. Undergraduate nursing training on perioperative airway management may not be comprehensive and therefore anaesthetic airway management, both knowledge and skills, may depend on institution based training or experiential learning at work. At present, the theoretical knowledge and practical skills of anaesthetic airway management amongst anaesthetic nurses at CHBAH is not known. It is therefore essential that this be measured in order to implement problem-focussed airway training to improve patient outcomes and healthcare worker satisfaction.

3. Aim

The aim of this study is to describe the theoretical and practical knowledge of anaesthetic nurses in routine and emergent perioperative airway management.

4. Objectives

The Primary objectives of this study are to:

- Describe the anaesthetic nurse's theoretical knowledge of anaesthetic airway equipment and its appropriate use as well as appropriate preparation and maintenance.
- Describe perioperative airway skills and situational awareness of routine and emergency scenarios by means of a scenario-based questionnaire.
  (Appendix A)

The Secondary objectives of this study are to:

- Describe the correlation between the perioperative airway skills and years of experience, age and prior airway training.

5. Research assumptions

The following definitions will be used in the study**:**

Anaesthetic nurse: a nurse, of various levels of qualification or experience, tasked to assist the anaesthetist in performing an anaesthetic. The level of independence and autonomy of anaesthetic nurses varies globally.

Airway: the human anatomical passage of respiration, from mouth to alveoli, required to be patent for respiration.

Scenario-based questionnaire: a questionnaire with questions based on clinical vignettes that aims to assess practical knowledge and situational awareness.

General anaesthetic: An anaesthetic that involves the whole body and involves loss of consciousness.

JD Allen Theatre complex: The main theatre complex at CHBAH.

Induction: the process or transition between an awake state to an anaesthetised state.

Emergence: the transition from an anaesthetised state to an awake state.

6. Demarcation of study field

The study field will be delineated by the following parameters.

Geographic

The study will be conducted at CHBAH within the various theatres where anaesthetic nurses function, namely, JD Allen theatre complex (elective and emergency theatres), burns theatre, hands theatre, maternity complex (obstetrics and gynaecology theatres) and St John's Eye Hospital general anaesthetic theatre.

Function

Only anaesthetic nurses performing their function within theatre will be included; anaesthetic nurses working in recovery rooms or reception will not participate in the study.

Time

Only anaesthetic nurses functioning in the role of 'Anaesthetic nurse' during the period of data collection will be included.

7. Ethical considerations

Prior to the undertaking of this study, formal permission will be obtained from the Postgraduate research committee, Human Research Ethics Committee (HREC), Medical Advisory Committee (MAC), relevant heads of departments and theatre matrons.

The overarching goal of this study is to provide information on how to better train, equip and empower anaesthetic nurses and thereby improve patient and hospital outcomes. This goal should in no way compromise the rights of anaesthetic nurses or patients. It should also bring no harm to anyone involved. No monetary or material incentive will be offered for participation however prospective participants will be fully educated on the role and aim of the study. The data collection phase will be streamlined to ensure that it requires a minimum time to complete the form. This will minimise the impact on the working day of the anaesthetic nurse and have no impact on patient care.

This study involves a doctor investigating anaesthetic nurses' knowledge. Within the context of South Africa undergraduate nursing curricula cover little to no practical training pertaining to the functioning of anaesthetic nurses. As described in the South African Society of Anaesthesiologists Practice Guidelines 2018 Revision (12), there is no specific accredited anaesthesia nurse training in South Africa and the quality of anaesthetic training varies between institutions. The recommendation is therefore that anaesthetic doctors, within the context of their anaesthetic departments, must have a training programme which includes the teaching and assessment of anaesthetic nurses. Furthermore, the anaesthetic doctors should assess for the technical and non-technical skills of the anaesthetic nurse and then guide and teach anaesthetic nurses where necessary.

There have also been several similar studies performed and published in South Africa within the last 20 years involving a doctor investigating nurses' knowledge and skills. Van Huyssteen et.al. investigated the knowledge of recovery room nurses regarding post-operative airway emergencies in Northern Gauteng (27). A similar study was replicated by Scribante et.al. sampling anaesthetic nurses from Cape Town and Johannesburg (26). With anaesthetic departments taking on a primary role in anaesthetic nurse training, it is essential that

anaesthetic departments are able to adequately assess anaesthetic nurses' knowledge and skills to improve in-hospital training programmes.

7.1 Data Collection Tool

The questionnaire has been reviewed and approved prior to use. The construction of the questionnaire is described in detail in section 8.4 (Data Collection). Standard setting of each question was done by the Angoff method.

7.2 Participant confidentiality and anonymity

The identity of all participants will be kept strictly confidential. Apart from essential demographic information (Age, level of experience, qualification, prior airway training), no individual identifying information is contained on the questionnaire. Participants will be presented with a study information sheet that outlines the study details and assures them of their confidentiality. Each questionnaire will be assigned a study number for data collection purposes. In this way, participant anonymity will be maintained.

7.3 Informed consent

Participants will be presented with a study information sheet (Appendix D) that outlines in detail the background and aims of the study. It will also explain the study design and process. Consent will be implied by completion of the questionnaire.

7.4 Data security and storage

Questionnaires will be deposited by participants into a closed box that can only be opened once all questionnaires are collected. Data entry will be performed only by the primary investigator. Digital data entry will be performed on a computer that contains up-to-date firewall and antivirus software. Data will be password protected and backed up by physical and secure online means.

7.5 Discarding of Data

Once all relevant data has been captured, physical data (questionnaires) and digital data will be stored securely for a period of six years after completion of the study. After which, physical data will be shredded, and all raw digital data will be deleted.

8. Research Methodology

8.1 Research design

The study design will take the form of a contextual, cross-sectional and descriptive survey.

8.2 Study population

The study population is the anaesthetic nurses working within the CHBAH theatres in JD Allen and Maternity complexes. Both day and night nursing shifts, not including recovery room or theatre reception staff. An anaesthetic nurse, within the context of this study, is defined as any nurse, of any prior background, qualification, or experience level, who's function in theatre is to assist the anaesthetist in the administration of anaesthesia to patients on a daily basis. This excludes clinical associates and nursing students.

8.3 Study sample

Sample size

The sample size will be a target of a minimum of 67 participants (n=67) and ideally all anaesthetic nurses meeting criteria will be included. This is calculated as 80% of the total number (N=84) of anaesthetic nurses employed within the demarcated study field, excluding those who participated in the validation of the questionnaire.

Sampling method

The participants in the study will be sampled by means of convenience sampling. Permission will be obtained from the theatre matron in advance for the period of data collection. Anaesthetic nurses working on the current shift will be identified and will be approached at a time where their presence is not immediately required in their theatre, as and when available. Due to the nature of the working environment of theatre, participants will be approached in a

manner that does not interfere with the efficiency of delivery of patient care. The questionnaire has been designed as to not be laborious or time consuming.

Inclusion criteria

All nurses, of any experience level or qualification, functioning within the role of Anaesthetic Nurse within the study field are eligible for inclusion. Both day and night shifts, midweek and weekend teams are included.

Exclusion criteria

Anaesthetic nurses who are on leave or not present at work during the period of data collection will be excluded. Participants who partake in the data collection tool validity review will not be included in the main study. Nurses who, on the day of data collection, are assisting with anaesthesia due to staff shortages but who do not usually function in this role will be excluded. Anaesthetic nurses who decline to participate in the study will also be excluded.

8.4 Data collection

Data will be collected by means of a four-part anonymous questionnaire (Appendix A). This questionnaire is divided into the following sections.

1. Demographic information
2. Identification of airway equipment
3. Theoretical knowledge of airway equipment
4. Scenario-based practical knowledge and skills

The questionnaire has been constructed by a thorough literature review. The structure and format of the questionnaire has been based on two papers published in the South African Journal of Anaesthesia and Analgesia [26,27]. Both these articles describe anaesthetic nurses within the context of South Africa, in particular, their knowledge of anaesthetic airway

emergencies in the post-operative period. In these published articles, basic demographics as well as multiple choice format questions on specific areas of knowledge are present. The scope of questions ranges from theoretical anatomy and physiology knowledge to clinical based emergency scenarios.

The questionnaire has also been assessed by various experts in the field to assess its adequacy and validity by means of the Angoff method.

These panel members included.

- Anaesthetic nurses of varied experience levels with recognised competence in their discipline.
- Anaesthetist with a special interest in airway management.
- Anaesthetist with an interest in healthcare worker training.

The questionnaire has been reviewed and refined by the panel. Each individual question was scrutinised to ensure it is appropriate for the scope of practice of the study population and is focussed on the objectives of the study. The panel also decided on an appropriate pass mark for each question, based on the level of difficulty and necessity of knowledge. These pass marks for each individual question have been indicated on the questionnaire template.

Study participants will be identified as per sampling method described above. Eligible persons will be approached, and the study explained to them. If agreeable, the participant will be handed the questionnaire. The researcher will be physically present and available to clarify any queries regarding the instrument however will not assist with the content of the questionnaire. Participants will be requested not to share their answers nor discuss the questionnaire amongst one another. Completed questionnaires will be placed into a sealed box made available.

Participants will only be permitted to complete the questionnaire once. Questionnaires will be linked to participants by study numbers allocated.

8.5 Data analysis

The questionnaire is structured to measure three broad categories of knowledge and skill: identification of airway equipment, use, care and maintenance of airway equipment, and airway management clinical scenarios.

These questions will have binary correct or incorrect responses which will be tallied within their groups. Total scores will be calculated for each area of knowledge or skill. Participant scores for each question will also be evaluated against the predetermined pass mark as set by Angoff method.

Data capture will be performed using Microsoft Excel 2022. The data will be analysed using Stata version 17 (StataCorp, USA) in consultation with a biostatistician. Descriptive statistics will be used to analyse the data. Categorical variables will be summarised using percentages and frequencies. Continuous variables that are normally distributed will be summarised using means and standard deviations. Those that are not normally distributed will be summarised using medians and interquartile ranges. Comparisons between groups will be done using t-tests or Mann-Whitney tests as appropriate. Comparison between groups of categorical variables will be done using the chi-squared test or the Fisher's exact test. Correlation will be described using Pearson or Spearman's correlation coefficient where appropriate. A p value of ≤ 0.05 will be considered statistically significant.

Subcategories within the questionnaire will measure for specific skills within the context of perioperative airway management.

Airway equipment functionality check and theatre preparation.	**Airway equipment care and maintenance.**	**Airway equipment uses.**	**Clinical scenarios (assessing for correct responses and situational awareness)**
• Circuit leak test • Direct laryngoscope light • Oxygen cylinder • CO2 absorber	• Leaking reservoir bag • Laryngoscope blade cleaning	• Suction catheters • Nasal prong oxygen • Nasal intubation and Magill's forceps • Facemask sizing	• Maintenance of patent airway in spontaneously breathing patient • Clinical signs of successful or unsuccessful holding of facemask • Optimising airway position for intubation • Endotracheal tube cuff pressure • Laryngeal mask airway application • Facemask oxygen • Cricoid pressure application • Rapid sequence induction • Cannot intubate, cannot ventilate emergency scenario • Elective sequence induction

Correlations will be described between sample demographics (age, qualification, years of experience and previous airway training) and airway equipment knowledge as well as clinical airway scenarios (specific skill areas listed above).

8.6 Significance of the study

This study assessing the knowledge and clinical skills of the anaesthetic nurses in perioperative airway management will be beneficial both to the anaesthetic nurses, the

anaesthetist working in a team, and ultimately the patient receiving the anaesthetic. The ability of this study to identify gaps in knowledge and practical skills deficits as well as shortcomings in the current training environment will allow for targeted training to equip and empower anaesthetic nurses to improve airway competence levels and thereby improving sense of job satisfaction and fulfilment. The anaesthetist will benefit from the improved assistance rendered whilst ultimately decreasing the incidence of, or impact of, anaesthetic perioperative airway complications for the patient. If areas of poor performance are identified in this study, targeted training can be implemented. Having identified potential gaps in knowledge relating to equipment care and maintenance, the institution will also benefit from improved care and condition of costly airway equipment.

9. Validity and reliability of the study

Study validity is the degree to which a study accurately measures quantitative outcomes. The validity and reliability of the study will be ensured by minimising recall bias, selection bias and observation bias (see 10. Potential limitations of the study). The questionnaire has also been reviewed and refined by a panel of experts, independent of the study, from the various fields of which airway management concerns.

This process of refining the questionnaire will ensure that it accurately and fairly measures the knowledge and skills of anaesthetic nurses. (See 8.4 Data Collection)

To further avoid bias, data collection will be performed anonymously. Appropriate statistical testing will be used in consultation with a biostatistician.

10. Potential limitations of the study

This study will be performed within the context of CHBAH and therefore the outcomes measured will reflect the knowledge and skills of anaesthetic nurses within this setting only.

While it may provide some insight into other settings with similar model health services, the findings will be contextual and not generalizable.

The data will be collected by convenience sampling and whilst efforts will be made to keep the contents of the questionnaire private, however as per the Hawthorne effect, some information may emerge from those who have already participated.

Participation in this study will be purely voluntary and therefore this study may not encompass the full complement of anaesthetic nurses within the defined setting.

The development of this questionnaire (see 8.4 Data Collection) has provided the questionnaire with context validity however a separate pilot study has not been performed to validate the questionnaire further. This decision has been made to preserve the study sample size. As such, there is the potential for follow-up studies with this study serving as the pilot study.

The study may be affected by the following bias.

Recall bias: participants' responses to the questionnaire may be informed by the way they recall past events, for example, airway emergencies resulting in poor outcomes may be recalled more vividly than routine airway practices. The questionnaire is constructed in a way that provides a general clinical vignette for each question that is relatable and conceivable to any anaesthetic nurse.

Selection bias: as the study is voluntary, anaesthetic nurses who are eager to improve their anaesthetic airway skills may be more likely to participate in the study compared to those who are less interested. All anaesthetic nurses will be encouraged to participate, and the length of time required to complete the questionnaire will be kept to an absolute minimum.

Observation bias: as it is not feasible to perform physical airway skills and techniques assessments, the form of a paper-based questionnaire has been adopted. This may lead to participants completing the form in a manner which they believe to be correct for the study, whilst actually not possessing the airway skills required. The questionnaire, however, is designed to cover basic knowledge or airway equipment and care and then situation or clinical based scenario questions that will assess decision-making and situational awareness.

11. Project outline

11.1 Time frame

Year	2022										2023	
Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Proposal	■	■	■									
Ethics approval				■								
Postgraduate approval					■	■	■					
Data collection								■				
Data analysis									■	■		
Submission											■	■

11.2 Financial plan

Description	Price per item	Amount of items	Total
Printing proposal	R34.50	x4	R138.00
Printing research report	R45.00	x4	R 180.00

Binding final research report	R18.00	x4	R 72.00
Total			R 390.00

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Appendix 2: Data Collection Sheet





Anaesthetic Nurses' Theoretical Knowledge and Practical Skills in perioperative Airway Management at Chris Hani Baragwanath Academic Hospital

Principal Investigator: Dr Matthew Dold
Supervisors: Dr Lizil Gilliland, Dr Tristan Leonard

Questionnaire

Thank you for agreeing to participate in this study. All personal identifying information will be kept strictly confidential. The purpose of this study is purely academic and no findings nor information will be sold.

This questionnaire is divided into 4 sections;

1. Basic Demographic Information:
2. Airway equipment identification: Single word/phrase answers
3. Equipment care and maintenance: Indicate whether each statement is **True or False**
4. Practical Clinical Scenarios; For each scenario, choose the **Single Best Answer**\

[Standard setting as determined by Angoff method]

1. Demographic information

Age	
Highest Nursing qualification	
Number of years experience as an Anaesthetic nurse	
Training in airway management e.g. Airway course, refresher, in-service training etc.	YES / NO
If yes, please specify	

2. Equipment identification

Name the following anaesthetic airway equipment (pictured);

	Picture	Answer		Picture	Answer
1		{87.5%}	7		{90%}
2		{88.75%}	8		{56%}
3		{90%}	9		{84%}
4		{88%}	10		{10%}
5		{79%}	11		{89%}
6		{90%}	12		{90%}

3. Equipment Use, Care & Maintenance (True or False)

Below are three areas of knowledge within day-to-day anaesthetic nursing care.
For each statement (bullet point), indicate whether the statement is **True** or **False**

Equipment checking (true or false)

3.1 Anaesthetic machine circuit leak test should be performed after any part of the circuit (tubing, soda lime, reservoir bag etc…) is changed. (True) {88%}

3.2 Laryngoscope batteries should be changed if the light is flickering or dim (true) {83%}

3.3 There is no need for an emergency oxygen cylinder as long as the hospital oxygen pipeline pressure is adequate (false) {79%}

3.4 Soda Lime should be replaced only when it is completely purple in colour (false) {81%}

Equipment maintenance and care (true or false)

3.5 An anaesthetic reservoir bag with a leak should be discarded and replaced (true) {85%}

3.6 The direct laryngoscope blade should be washed with alcohol and rinsed with water after use (false) {73%}

Different Equipment uses

3.7 Flexible suction catheters are adequate if a patient is vomiting (false) {75%}

3.8 Nasal prong oxygen should be connected to wall oxygen at a rate of **8l/min** (false) {74%}

3.9 The Magill's forceps is often used during a nasal intubation (true) {90%}

3.10 The correct size facemask should cover the patient's nose and mouth but not cover the eyes (true). {90%}

4. Practical Skills

4.1 Facemask holding; technique {78%}

During an inhalation induction of a 5-year-old child, the anaesthetic doctor asks you to help by maintaining the airway while she or he inserts an IV line in the hand. After 30 seconds you notice that the sats are dropping to 90% and there are snoring noises from the airway. Choose the **incorrect** response.

- Perform a jaw thrust manoeuvre
- Push the face mask harder into the patients face
- Insert an oral airway
- Increase the Oxygen concentration

4.2 Facemask holding; Clinical signs {78%}

In the scenario above, you make the appropriate change/s and the oxygen saturation starts to improve. Another sign of successful ventilation includes (Choose the **correct statement)**

- The lips start to turn blue
- The reservoir bag is moving
- The trachea starts to "tug" downwards with each breath
- There are high-pitched noises coming from the patient's airway

4.3 Airway positioning/Ramping {73%}

An adult patient requires a general anaesthetic. The anaesthetic doctor says that you should optimise or improve the patient's position for intubation. The most useful step would be to… Choose the **correct answer**.

- Adjust the level of the bed to the anaesthetist's waist
- Pillow/s should be placed under the shoulders/head so the ear is level with the sternum.
- The neck should be in the flexed position.
- Airway positioning should **only** be performed when preparing to intubate obese patients.

4.4 Endotracheal tube (ETT) cuff pressure {73%}

The anaesthetic doctor successfully intubates the patient and asks you to please inflate the endotracheal tube cuff. You should do the following (choose the **correct answer**)

- Inject 5ml of air with a clean syringe
- Inject air into the cuff until the pilot balloon is hard to the touch.
- Inject air just until there is no leak past the endotracheal tube
- Inject air into the cuff and leave the syringe attached

4.5 Laryngeal mask airway (LMA) {75%}

The anaesthetic plan for a patient includes insertion of an LMA. Choose the **correct statement.**

- KY jelly or lubricant should be applied to all surfaces of the LMA before insertion
- The cuff of the LMA should be completely deflated before insertion.
- The cuff of an adult size LMA should never be inflated with more that 10ml air
- LMAs may be removed at the end of the anaesthetic without completely deflating the cuff

4.6 Facemask oxygen {50%}

A patient with chronic lung disease needs an operation to their ankle and a spinal anaesthetic is performed which is successful without complications. A 40% oxygen facemask (pink facemask O2) is applied to maintain Sats above 92%. Choose the **correct statement**.

- The mask can be modified to deliver more oxygen by blocking the holes of the pink venturi with sleek tape
- The oxygen flow rate should be started at 8l/min
- Facemask oxygen provides the same concentrations of oxygen as Nasal prong
- The venturi face mask requires a tight seal to the face to work

4.7 Cricoid pressure {81%}

A patient with a stab abdomen is brought to theatre for an exploratory laparotomy. The anaesthetic team plans to perform a Rapid sequence induction. The anaesthetic doctor asks for cricoid pressure. Choose the **correct statement**.

- Cricoid pressure should be applied after the patient is asleep
- Cricoid pressure should be applied on the trachea below the Adam's apple
- Cricoid pressure should only be released once the correct placement of the ETT is confirmed or the anaesthetic doctor requests that it be released.
- The cricoid should be pushed with as much force as you can.

4.8 Rapid Sequence Induction (RSI) {73%}

In the above scenario, you are applying cricoid pressure while the anaesthetic doctor is attempting to intubate. The patient now starts to vomit forcefully. The **correct** action is to;

- Release the cricoid pressure
- Increase your cricoid pressure downward force
- Change the position where you are applying pressure
- Hold the cricoid pressure and pass the anaesthetic doctor the suction catheter

4.9 "Cannot Intubate, Cannot Ventilate" (CICV) {50%}

During an induction for a general anaesthetic, the doctor is unable to intubate the patient on multiple attempts, they are also unable to insert an LMA and when they try to bag the patient with the facemask/ambubag there is no chest rise. They declare an "can't intubate can't ventilate" situation. Choose the **correct statement**.

- Chest compressions should be started immediately.
- The doctor will be required to perform a cricothyroidotomy.
- This is not an emergency and you may walk to the next theatre to restock the anaesthetic trolley.
- Patients should receive 1 amp of adrenaline IVI immediately.

4.10 Elective Sequence Induction (ESI) vs Rapid Sequence Induction (RSI) {83%}

An adult patient requires a GA for an elective inguinal hernia repair. The anaesthetic doctor says it will be an "Elective Sequence Induction" (ESI). This means that… (choose **the correct statement**)

- The patient will only be "bagged" once the ETT is inserted as bagging before could increase risk of Aspiration.
- An ESI can be performed safely because the patient is NPO and has a low risk of Aspiration.
- Cricoid pressure must always be performed during an ESI
- It is an emergency if the doctor fails to intubate the patient on the first attempt in an ESI

4.11 Aspiration/vomiting {83%}

During a rapid sequence induction, the patient starts to vomit large volumes of gastric fluids with chunks of food before the endotracheal tube has been placed in the trachea. **choose the incorrect statement**)

- Turn the patient on their side
- Tilt the bed in the “head-up” position
- Suction the mouth with a yankauer catheter
- Suction gently down the endotracheal tube once it is inserted

Appendix 3: Approval Letter, Department of Anaesthesia

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

WITS
UNIVERSITY

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
DIRECTORATE - ANAESTHESIA
Tel. number: (011) 933-9335/0349
Fax number: 086 553 2529
Email: Palesa.Mogane@wits.ac.za
Email: moganep@gmail.com

2nd August 2022

To whom it may concern

RE: PERMISSION TO PERFORM MMED (ANAESTHESIA) RESEARCH

I would like to confirm that I have granted permission to Dr Matthew Dold (student number 448112) to interview anaesthetic staff at Chris Hani Baragwanath Academic Hospital. This is in order to perform a research project for the purposes of his MMed (Anaesthesia) titled:

"ANAESTHETIC NURSES' KNOWLEDGE AND SKILLS IN PERIOPERATIVE AIRWAY MANAGEMENT AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL".

I wish him well on this endeavor.

Kind regards

Dr Palesa Mogane
HOD Chris Hani Baragwanath Academic Hospital
Department of Anaesthesia
University of the Witwatersrand
palesa.mogane@wits.ac.za
0731731440

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Appendix 4: Approval Letter, Hospital Medical Advisory Committee

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 23nd August 2022

TITLE OF PROJECT:

Anaesthetic nurses' knowledge and skills in perioperative airway management at Chris Hani Baragwanath Academic Hospital.

UNIVERSITY: Witwatersrand

Principal Investigator: Dr M J Dold

Department: Anaesthesia

Supervisor : Dr T Leonard

NHRD Number: GP_202208_001

Permission Head Department (where research conducted): Yes

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Academic Hospital. The CEO / management of Chris Hani Baragwanath Academic Hospital is accordingly informed and the study is subject to:-

- **Permission having been granted by the Committee for Research on Human Subjects of the University of Witwatersrand.**
- The Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- The MAC will be informed of any serious adverse events as soon as they occur
- Permission is granted for the duration of the Ethics Committee Approval.

Recommended
(On behalf of the MAC)
Date: 23/08/2022

Approved/~~Not Approved~~
Hospital Management
Date: 24/08/2022

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Appendix 5: Approval Letter, Post-graduate office

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

03 August 2022
Person No: 448112
PAG

Mr MJ Dold
84a 5th avenue, Melville
Melville
Melville
2109
South Africa

Dear Mr Matthew Dold

Master of Medicine in Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled *Anaesthetic nurses' knowledge and skills in perioperative airway management at Chris Hani Baragwanath Academic 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

Appendix 6: Approval Letter, Wits Human Research Ethics Committee

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R49 Dr M Dold

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M220863

NAME: (Principal Investigator)	Dr M Dold
DEPARTMENT:	School of Clinical Medicine Department of Anaesthesiology Medical School University
PROJECT TITLE:	*Anaesthetic nurses' knowledge and skills in perioperative airway management at Chris Hani Baragwanath Academic Hospital*
DATE CONSIDERED:	2022/08/26
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Drs T Leonard and L Gilliland
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2022/10/10

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **August** and therefore reports and re-certification will be due in the month of **August** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

2022/10/12
Date

Appendix 7: Author Guidelines

Submitted manuscripts that are not in the correct format and without the required supporting documentation specified in these guidelines will be returned to the author(s) for correction and will delay publication.

AUTHORSHIP

All named authors must consent to publication **by signing a covering letter** which should be submitted as a supplementary file. Authorship should be based on substantial contribution to:

1. conception, design, analysis and interpretation of data;
2. drafting or critical revision for important intellectual content; and
3. approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to **icmje.org**); and
4. exact contribution of each author must be stated.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - **www.icmje.org**. Manuscripts must be provided in **UK English**. The manuscript and supporting documentation should be submitted as follows:

Manuscript

The manuscript must contain the title, abstract, keywords (5), body text and references as specified below:

Categories of submissions

Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Original articles

Original articles on research relevant to anaesthesia and analgesia should not exceed 3 200 words, no more than 30 references, with up to 6 tables or figures. A structured abstract under the following headings, Background, Methods, Results, and Conclusion is a requirement and should not exceed 300 words.

Clinical Review articles

Review articles relevant to anaesthesia and analgesia should not exceed 2 400 words, with a maximum of 20 references and no more than 6 tables or figures. A summary of 300 words or less is required.

Case reports

Case reports should not exceed 1 800 words with no more than 10 references. Figures are limited to 2 figures and may include images or photographs. The case report should have

three headings: Summary (not exceeding 100 words), Case report (with no introduction) and Discussion.

Scientific Letters

Scientific Letters should not exceed 2 400 words with a maximum of 10 references. Only one table or illustration is permissible. A structured abstract under the following headings, Background, Methods, Results, and Conclusions, is a requirement and should not exceed 250 words.

Letters to the editor

Letters to the editor should be 800 words or less with only one image or table.

Title Page:

The title page should include:

1. Article Title
2. Authors Details: Qualification and affiliation (department and place of work), email addresses of all authors, ORCID number of **ALL** authors must be provided – if authors do not have ORCID, please register at https://orcid.org/
3. Corresponding author's information.
4. The following declarations must be included on the title page:

Declaration of conflict of interest

Authors must declare all sources of support for the research and any association with a product or subject that may constitute a conflict of interest. If there is no conflict of interest to declare please include the following statement: The authors declare no conflict of interest.

A conflicting interest exists when professional judgement concerning a primary interest (such as patient's welfare or the validity of research) may be influenced by a secondary interest (such as financial gain or personal rivalry). It represents a situation in which financial or other personal considerations from authors, reviewers or editors have the potential to compromise or bias professional judgment and objectivity. It may arise for the authors when they have financial interest that may influence their interpretation of their results or those of others. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. All potential conflicts of interest need to be declared. The conflict of interest statement should list each author separately by name, i.e.

"John Smith declares that he has no conflict of interest. Paula Taylor has received research grants from Drug Company A. Mike Schultz has received a speaker honorarium from Drug Company B and owns stock in Drug Company C."

Funding source

All sources of funding should be declared. Also define the involvement of study sponsors in the study design, collection, analysis and interpretation of data; the writing of the manuscript;

the decision to submit the manuscript for publication. If the study sponsors had no such involvement, this should be stated as follows: No funding source to be declared.

Research Ethics Committee Approval

The submitting author must provide written confirmation of Research Ethics Committee approval for all studies including case reports. The ethics committee as well as the approval number should be included.

Compliance with ethical guidelines

For all publications:

"The author/s declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010."

Available from: http://publicationethics.org/resources/international-standards-for-editors-and-authors

Institutional Review Board (IRB) ethical approval must have been given if the study involves human subjects or animals. Please provide the approval number as well as the approval letter.

"Prior to commencement of the study ethical approval was obtained from the following ethical review board: *Provide name and reference number"*

For studies with human subjects include the following:

"All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008."

"Informed written consent was or was not obtained from all patients for being included in the study."

For studies with animals include the following sentence:

"All institutional and national guidelines for the care and use of laboratory animals were followed."

For articles that do not contain studies with human or animal subjects:

"This article does not contain any studies with human or animal subjects."

If doubt exists whether the research was conducted in accordance with the Helsinki Declaration, the authors must explain the rationale for their approach, and demonstrate that the institutional review body explicitly approved the doubtful aspects of the study. If any identifying information about patients is included in the article, the following sentence should also be included: Additional informed consent was obtained from all patients for which identifying information is included in this article. The Helsinki Declaration 2008 can be found at http://www.wma.net/en/30publications/10policies/b3/

The submitting author must provide written confirmation of Research Ethics Committee approval for all studies including case reports. The ethics committee as well as the approval number should be included.

Authorship

The authors confirm that all authors have made substantial contributions to all of the following:

- The conception and design of the study, or acquisition of data, or analysis and interpretation of data.
- Drafting the article or revising it critically for important intellectual content.
- Final approval of the version to be submitted.
- Sound scientific research practice

The authors further confirm that:

- The manuscript, including related data, figures and tables has not been previously published and is not under consideration elsewhere
- No data have been fabricated or manipulated (including images) to support your conclusions
- This submission does not represent a part of single study that has been split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time (e.g. “salami-publishing”).

Plagiarism:

- The authors confirm that the work submitted is original and does not transgress the plagiarism policy of the journal.
- No data, text, or theories by others are presented as if they were the author’s own.
- Proper acknowledgements of other’s work has been given (this includes material that is closely copied, summarized and/or paraphrased), quotation marks are used for verbatim copying of material.
- Permissions have been secured for material that is copyrighted.

Acknowledgements

General Information

Abbreviations

All abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

Scientific measurements

Scientific measurements must be expressed in SI units except blood pressure (mmHg) and haemoglobin (g/dl). Litres is denoted with a lowercase 'l' e.g. 'ml' for millilitres). Units should be preceded by a space (except for %), e.g. '40 kg' and '20 cm' but '50%'. Greater/smaller than signs (> and 40 years of age) should also be preceded by a space e.g. > 20 years. No spaces should precede ± and °, i.e. '35±6' and '19°C'.

Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
Round **brackets** (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

Formatting

The manuscript must be in Microsoft Word document format. Text must be 1,5-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes, except for Tables). *The manuscript must be free of track changes.*

ILLUSTRATIONS AND TABLES

If tables or illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.

Tables may be embedded in the manuscript file **and** must be provided as **'supplementary files'**. They must be numbered in Roman numerals (I, II, III, etc.) and referred to consecutively in the text (e.g. 'Table I'). Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged. Tables must be cell-based (i.e. not constructed with text boxes, tabs or enters, and NOT supplied as an image) and accompanied by a concise title and column headings. Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Figure 1)'. Figure legends: Figure 1: 'Title...'. All illustrations/figures/graphs must be of **high resolution/quality**: 300 dpi or more is preferable, but images must not be resized to increase resolution. Unformatted and uncompressed images must be attached as '**supplementary files**' upon submission (**not** embedded in the accompanying manuscript). TIFF and PNG formats are preferable; JPEG and PDF formats are accepted, but authors must be wary of image compression. Illustrations and graphs prepared in Microsoft PowerPoint or Excel must be accompanied by the original workbook.

Graphs may be embedded in the manuscript but the original (open) file must be provided as a supplementary file.

REFERENCES

Authors must verify references from the original sources. *Only complete, correctly formatted reference lists will be accepted.* Reference lists may be generated with the use of reference manager software, but the final document must be delinked from the reference database or otherwise generated manually. Citations should be inserted in the text as superscript, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6] The

superscript reference number should come after the punctuation mark and should not be in brackets.

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Journal references:

1. Jun BC, Song SW, Park CS, Lee DH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.
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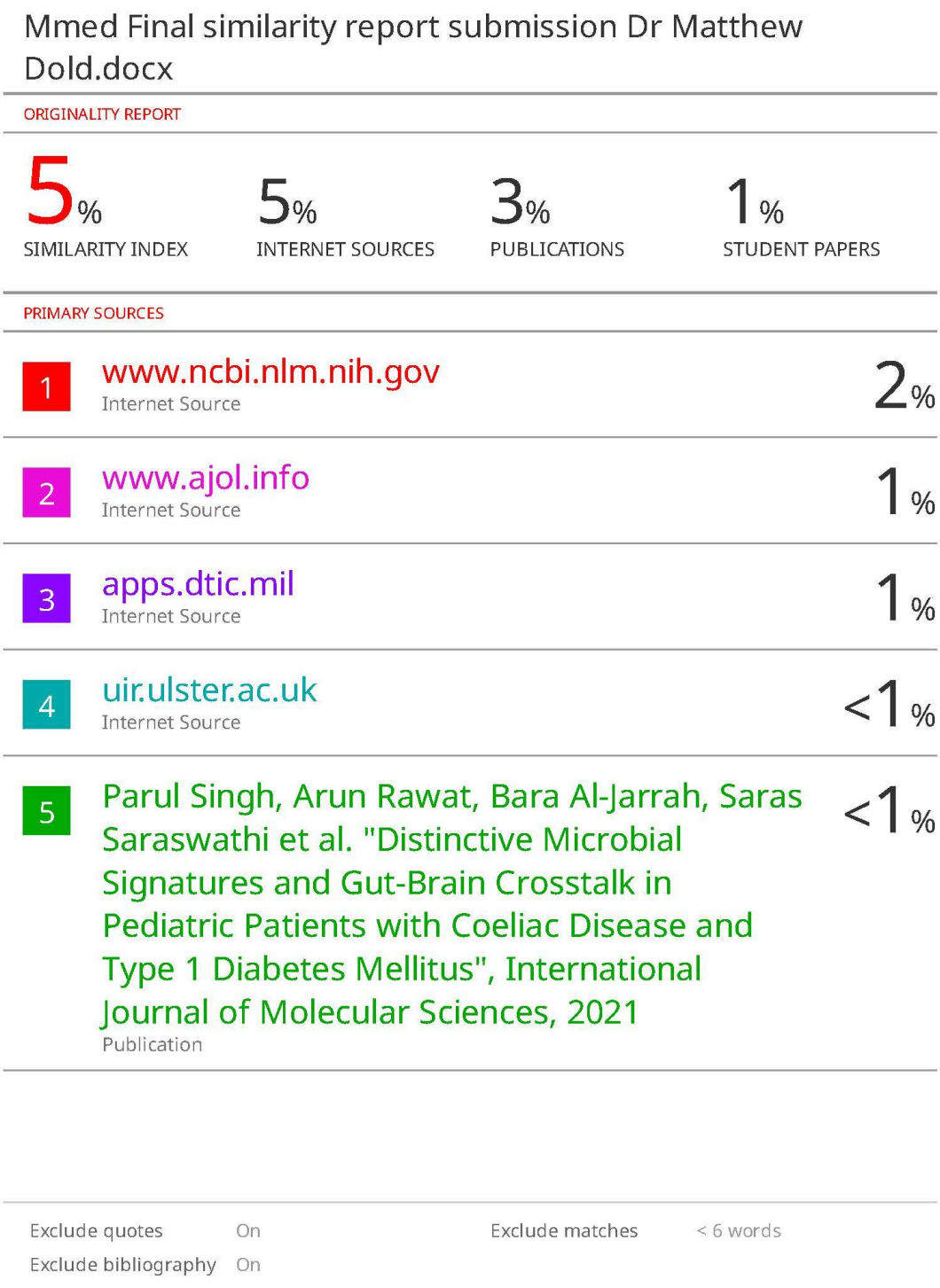
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