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RESEARCH

Intraoperative management of ETT and LMA cuff pressures: a survey of anaesthetists' knowledge, attitude and current practice

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Background: Endotracheal tubes and laryngeal mask airway devices are routinely used during anaesthesia. Inappropriate inflation of cuffs has been shown to cause postoperative airway morbidity, and limiting the pressure decreases the incidence of pharyngo-laryngeal complications. Subjective measurements of cuff pressures correlate poorly to actual pressures, yet the use of objective cuff manometry is not routinely practised. The aim of this study was to determine current clinical practice of cuff inflation as well as the knowledge and attitude of anaesthetists in the University of KwaZulu-Natal (UKZN) Discipline of Anaesthesiology and Critical Care.
Methods: This was a descriptive, observational study and data were collected using an anonymous self-administered questionnaire from practising anaesthetists in the UKZN Discipline of Anaesthesiology and Critical Care.
Results: A total of 160 anaesthetists participated. The minimal occlusive volume test (38.8%) and the pilot balloon palpation technique (36.3%) were most commonly used. Most participants felt it was important to accurately measure ETT (84.8%) and LMA (56.1%) cuff pressures and that using a cuff manometer should be mandatory (76%). Reasons for not using it routinely included manometers not being readily available. Gaps in knowledge and education were also identified.
Conclusion: There is increasing importance placed on quality assurance. Clinical practice varies widely among practitioners with the only consistency being the omission of cuff manometers during routine intraoperative management, despite their proven benefit and efficacy. The authors propose recommendations to facilitate the routine intraoperative use of cuff manometers.

Keywords: anaesthesia, cuff manometer, endotracheal, intracuff pressure, intubation, laryngeal mask airway, sore throat, tracheo-laryngeal complications

Introduction

Endotracheal tubes (ETT) and laryngeal mask airway (LMA) devices are routinely used during general anaesthesia. They are essential in ensuring a proper seal during positive pressure ventilation without volume loss, while at the same time preventing aspiration of pharyngeal and gastric secretions.[1]

Postoperative airway morbidity caused by cuff over- and under-inflation is common and can be decreased by the use of cuff pressure manometers.[2–5] Cuff pressure maintenance is therefore an essential part of airway management.[6]

Subjective measurements of cuff pressures correlate poorly to actual pressures. Multiple studies have found a significantly increased percentage of overinflated ETT and LMA cuffs in various settings,[1,7–9] yet the use of intraoperative cuff manometry is not routinely practised.

The aim of this study was to determine the knowledge, attitude, current clinical practice and intraoperative management of ETT and LMA cuff pressures of anaesthetists in the University of KwaZulu-Natal (UKZN) Discipline of Anaesthesiology and Critical Care.

Methodology

Approval was obtained from the Biomedical Research Ethics Committee and Postgraduate Education Committee of the UKZN (ref nr: KZ_2015RP23_324).

A self-administered questionnaire was distributed to all anaesthetists affiliated with the UKZN Discipline of Anaesthesiology and Critical Care. At the time of the study, there were 196 practising anaesthetists. This included consultants (n = 61), registrars (n = 43) and medical officers (n = 92) working at 10 different hospitals in the Durban and Pietermaritzburg metropolitan areas. Community service and internship doctors were excluded.

Questionnaires were personally distributed during a two-week period after which an electronic version was distributed to the remaining anaesthetists. All potential participants were approached, either personally or electronically. Participation was voluntary and all data were treated as confidential. Data were entered into and analysed with SPSS® (version 22.0, IBM Corp, Armonk, NY, USA).

Results

A total of 160 completed questionnaires were collected. The response rates amongst consultants, registrars and medical officers were 83.6%, 95.3% and 73.9% respectively. Of the 160 participants, 32.5% were consultants (n = 52), 25.6% registrars (n = 41), 31.9% medical officers with a Diploma in Anaesthesia (DA) (n = 51) and 10.0% medical officers without a DA (n = 16). The median number of years of anaesthetic experience was five with an interquartile range of 3 to 10.

When asked about the importance of measuring cuff pressures intraoperatively, 84.8% (n = 134) of participants felt that it was important to measure ETT cuff pressures accurately and 56.1% (n = 87) felt so with regard to LMA cuff pressures. Some 76% (n = 117) of participants felt that the intraoperative use of cuff manometers should be mandatory. There was no significant difference between the opinions of consultants, registrars or medical officers (p = 0.11).

Participants were asked to report on the use of six intraoperative ETT and seven LMA cuff inflation techniques (Table 1). Techniques listed as other included using more than one technique concurrently or using LMAs with incorporated cuff pressure gauges.

Table 1: Most commonly used techniques to estimate cuff pressure intraoperatively

Technique used to determine cuff pressure	ETT	LMA
Pilot balloon palpation	36.3% (n = 58)	19.4% (n = 31)
Minimal leak test	11.9% (n = 19)	18.8% (n = 30)
Minimal occlusive volume test	38.8% (n = 62)	30.0% (n = 48)
Minimal occlusive pressure test	9.4% (n = 15)	5.6% (n = 9)
Injecting a set volume of air	0% (n = 0)	13.1% (n = 21)
Checking for outward movement of the LMA	N/A	6.9% (n = 11)
Cuff manometer	2.5% (n = 4)	1.3% (n = 2)
Other	1.3% (n = 2)	3.1% (n = 5)
Missing information – blank responses		1.9% (n = 3)

Table 2: Reasons for intraoperative reassessment of cuff pressures

Reason	ETT	LMA
Audible cuff leak	52.8% (n = 47)	64.8% (n = 46)
Change in ventilator parameters	28.1% (n = 25)	29.6% (n = 21)
Use of N_2O	23.6% (n = 21)	7.0% (n = 5)
Long procedures	20.2% (n = 18)	8.5% (n = 6)
Change in patient position	7.9% (n = 7)	4.2% (n = 3)
Routinely reassess	4.5% (n = 4)	2.8% (n = 2)
Aspiration risk	3.4% (n = 3)	n = 0
Paediatric patients	2.2% (n = 2)	n = 0
Other reasons	n = 9	n = 1
Missing	n = 0	n = 4

Among all participants, 30.2% thought their current clinical practice correlated poorly to actual measured cuff pressures, and 43.4% admitted to not knowing how it correlated. Pilot balloon palpation was the second commonest technique used for ETT cuff inflation, yet 56.9% of anaesthetists using this technique were aware that correlation to actual measured cuff pressures is poor. Most participants considered cuff manometers to be the gold standard for measuring ETT (85.2%) and LMA cuff pressures (59.3%).

Where a patient was intubated prior to theatre, 77.4% reported that they would reassess the ETT cuff pressure and pilot balloon palpation was the technique used most often for this (42.2%).

Safe cuff pressures were reported to be within 20–30cmH_2O by 45.0% of participants. A total of 36.3% accepted pressures below 20cmH_2O, 6.3% reported pressures above 30cmH_2O to be safe and 11.4% did not know. For LMA cuff pressures, 53.6% reported the safe range to be within 20–40cmH_2O, while 8.2% accepted pressures above 40cmH_2O as being safe.

More than half of the participants (59.4%) reported sometimes deviating from their usual technique and were most likely to deviate during long procedures (13%), with patients at risk for aspiration (9.8%), in an emergency situation (4.3%) and when there was an audible leak (7.6%), while 18.5% stated that they use a cuff manometer whenever it is available.

When caring for paediatric patients, 21.9% of participants reported that they would deviate from their usual technique and would use the minimal leak test (36.7%), a cuff manometer (30.0%) or the minimal occlusive volume test (23.3%).

ETT cuff pressures are reassessed intraoperatively by 55.6% of anaesthetists and LMA pressures by 45.5%. Reasons for reassessment are tabulated in Table 2. Reasons listed as 'other' include patients going to ICU, and at risk or shared airways.

Participants reported sore throats to be the commonest complication following use of an ETT. Participants were asked to report which postoperative complications are found commonly (defined as being present in more than 1 in 10 of their patients) and almost all participants reported sore throat (91.7%). Other complications reported to be common are given in Table 3.

Following use of ETT, 73.2% of participants felt that postoperative complications can be improved by using cuff manometers intraoperatively and 54.8% felt so for LMA use.

In all, 18% of participants did not know whether their current hospital had a cuff manometer. Of the 51.9% participants that reported their current hospital to have a cuff manometer, 41.3%

Table 3: Postoperative complications found to be common in clinical practice

Postoperative complication	Number of participants reporting complication to be common (> 1 in 10) following ETT use	Number of participants reporting complication to be common (> 1 in 10) following LMA use
Sore throat	91.7% (n = 143)	78.8% (n = 123)
Cough	39.7% (n = 62)	34.6% (n = 54)
Hoarseness	32.7% (n = 51)	10.9% (n = 17)
Dysphonia	12.2% (n = 19)	3.2% (n = 5)
Dysphagia	11.5% (n = 18)	12.8% (n = 20)
Stridor	2.6% (n = 4)	1.3% (n = 2)

Table 4: Common reasons reported for not using cuff manometers routinely

Reasons for not routinely using cuff manometers	Number (%)
Cuff manometer not readily available	*n* = 136 (87.2%)
Consider duration of surgeries too short	*n* = 24 (15.4%)
Do not know how to use a cuff manometer	*n* = 16 (10.3%)
Did not know that cuff manometers could be used with an LMA	*n* = 15 (9.6%)
Too time consuming	*n* = 14 (9.0%)
Trust own method	*n* = 12 (7.7%)
Do not feel postoperative complications are significant enough	*n* = 5 (3.2%)
Do not consider it best practice	*n* = 3 (1.9%)
Did not know about cuff manometers	*n* = 1 (0.6%)

did not know where it was kept and 49.4% of participants had not been trained to use a cuff manometer. Common reasons reported for not using cuff manometers routinely are tabulated in Table 4.

Discussion

Clinical practice varies widely among practitioners with the only consistency being the omission of cuff manometers during routine intraoperative management, despite their proven benefit and efficacy. To change current practice, it is essential to determine hindrances to the routine use of these devices such that appropriate guidelines may be established to overcome these hindrances.

There is wide variation in current practices among anaesthetists. In our department, the most commonly used techniques for ETT cuff inflation are the minimal occlusive volume test (38.8%) and the pilot balloon palpation technique (36.3%). This is in contrast to a study done in Johannesburg in 2015, which found that the minimal occlusive volume (37.5%), predetermined volume of air (31.25%) and the pilot balloon palpation (27.08%) techniques were used most often in their centres.[10] None of our participants reported using a predetermined volume of air. The pilot balloon palpation technique is a qualitative technique prone to subjective interpretation and was found to correspond poorly to actual measured cuff pressures in multiple studies.[11–14] The minimal occlusive volume technique uses the absence of an audible leak to ensure an adequate seal for ventilation and prevention of aspiration. It does not, however, prevent over-inflation with only 12% of cuffs being within safe ranges.[15] In the Johannesburg study, ETT cuff pressures were found to exceed 30 cmH_2O in 64.58% of patients and only 18.75% of patients had ETT cuff pressures within the safe recommended ranges.[10] We did not check cuff pressures in our study but we postulate that a similar trend would have been found. Pilot balloon palpation is the second most commonly used technique in our study, despite most participants being aware of its poor correlation to actual cuff pressures. Knowledge of its inadequacy thus does not change clinical practice. There are currently no studies looking at the frequency of techniques used for LMA cuff inflation but a recent survey in the UK found that anaesthetists are not routinely checking LMA cuff pressure. They were also unaware of correct inflation pressures and of any evidence of harm.[16] This is also evident in our study. The inflation of LMAs with a predetermined volume of air is a common teaching. It is also recommended in the instruction leaflet of many LMAs, but it has been shown that injecting this volume of air results in pressures > 60cmH_2O.[17]

Intubation does not always occur in theatre. Patients are often intubated during emergency situations either pre-hospital admission or in emergency departments. A study done by Stein *et al.* highlighted the inability of advanced life support paramedics and emergency department doctors in Johannesburg to accurately estimate safe ETT cuff pressures using the palpation technique alone.[11] Multiple studies have found serious complications following longer duration of intubation, with the incidence and severity increasing proportionally to the duration. Cuff pressure itself may also change over time.[18–20] In our health-care system, there are often long delays during inter- and intra-hospital transfer of patients. Only 77.4% of anaesthetists in our department reassess cuff pressures in patients who were intubated prior to theatre. These patients often require long and protracted surgery with a high probability of postoperative ICU placement. This significantly increases the duration of intubation with a probable over-inflated cuff. Cuff pressure management for these critically ill patients should be part of anaesthetic management. In our study, the pilot balloon palpation technique was used most often to reassess these cuff pressures, despite practitioners' knowledge of its inaccuracy, and only 11.7% of participants reported using cuff manometers in cases that were known to be for postoperative ventilation.

Paediatric patients are at increased risk of airway morbidity with cuffed ETTs not being used in paediatric patients until very recently. In our study, only 21.9% of practitioners deviate from their usual technique for paediatric patients and only 30% (*n* = 9) of these participants report using cuff manometers. This is a significant problem as hyperinflation of LMA and ETT cuffs can cause mucosal damage and subsequent oedema that may have a bigger impact on the smaller paediatric airway.[21]

There seems to be an obvious gap in knowledge or education among anaesthetic practitioners. The current accepted recommended range for ETT cuff pressure is 20–30cmH_2O[1] and the upper limit of safe LMA cuff pressures is considered to be 41cmH_2O.[22] Impairment of mucosal blood flow occurs at pressures above 30cmH_2O with complete obstruction at 50cmH_2O.[23] Oropharyngeal mucosal perfusion is reduced above LMA cuff pressures of 30cmH_2O.[24] In our study, 6.3% accepted pressures above 30cmH_2O to be safe for ETTs and for LMAs, 8.2% accepted pressures above 40cmH_2O. Half of our respondents (49.4%) had never been trained in using a cuff manometer and 10.3% did not know how to use it. This indicates a clear gap in anaesthetic training that needs to be addressed.

Postoperative airway complications following intraoperative ETT and LMA use are reported to be frequent with the incidence of sore throat and hoarseness ranging from 14.4% to 50% with ETT use and from 5.8% to 35% with LMA use.[25] Limiting cuff pressures has been shown to decrease incidence of sore throat, hoarseness and blood-streaked expectoration[2,3] and to decrease incidence of dysphagia with LMA use.[4,5] Even though the majority of respondents in our study observed postoperative complications frequently and felt that these could be decreased by using cuff manometers intraoperatively, the use of cuff manometers is still not being practised.

It would seem that there is a huge divide between practitioners' knowledge and clinical practice. Evidence-based medicine is continually evolving but there is a delay between research findings and routine clinical practice. Multiple factors influence the health care practitioner including intention, motivation,

beliefs and social influences, as well as economic and organisational factors.[26] Data collected during our study indicate that the majority of our anaesthetists are aware of the importance of cuff manometers. Yet this does not translate into current clinical practice.

The challenge of changing current practice is thus clear. The unavailability of cuff manometers seems to be a huge problem. All 10 hospitals included in our study had cuff manometers at the time of data collection, although at three of the hospitals the cuff manometer was kept in ICU. Only half of the participants knew that their hospital had a cuff manometer and most of them did not know its location. However, it should be noted that at most of the hospitals there was only one cuff manometer in the entire theatre complex with the number of theatres having to share this cuff manometer ranging from 5 to 16. This is a definite hindrance to changing current practice and we suggest cuff manometers be more readily available.

There are unfortunately still a small number of our practitioners who would not change their practice, as they do not see the need to do so. Among the participants, 15.4% consider the duration of surgery too short to necessitate the use of cuff manometers and postoperative complications are perceived as minor by 3.2% of participants. It has been shown that an uninflated ETT cuff can cause superficial damage to the epithelium overlying the cartilage in as little as 15 min in animal models, although human data are lacking. With an inflated cuff, increased mucosal damage was observed, the extent of which was directly related to the cuff pressure.[27] Postoperative complications have been shown to be of great concern to patients during the postoperative period[28] and can represent a significant anaesthetic burden.[29] The literature also contains reports of more serious morbidity following over-inflation of ETT and LMA cuffs.[4,8,19,21,30–32] Our data indicate a gap in anaesthetic training with the first step to changing clinical practice being a refocus on appropriate education.

We propose the following recommendations to facilitate the routine intraoperative use of cuff manometers:

- cuff manometers to be more readily available;
- a cuff manometer in every theatre/on every airway trolley;
- a dedicated space on the anaesthetic chart to record cuff pressures;
- training in the use of cuff manometers;
- cuff manometers to be included in standardised intubation protocols, e.g. SASA guidelines;
- use of cuff manometers by senior anaesthetists.

A dedicated space on the chart creates accountability for the anaesthetist and will make cuff pressure measurement more likely. We propose a refocus on training and education of junior staff in this regard, with reinforcement of appropriate behaviours by senior practitioner role models in theatre. We also propose that the routine use of cuff manometers be included in standard practice guidelines and minimum required equipment in theatre. This is currently not included in the South African Society of Anaesthesiologists (SASA) Practice Guidelines (2012).[33]

Limitations

This was a single department study and may not be a true representation of current practice at other academic departments or in private institutions where cuff manometers may be more readily available.

As this was a questionnaire-based study, responses may have been biased and answers concerning current practice may not represent actual clinical practice. Observational studies could be more useful in accurately determining current clinical practice.

Conclusion

There is increasing importance placed on quality assurance and many authors have called for cuff manometry to become routine practice.[2,5,7,8,30] Instead, there seems to be great variation in clinical practice. We feel the importance of cuff pressure care should be included in the teaching of anaesthesia, at both undergraduate and postgraduate level. This could have a wide impact on patient safety and experience. We hope to not only create awareness about the importance of appropriate intraoperative cuff pressure management but also to motivate for future inclusion of cuff manometry in South African standard anaesthesia practice guidelines, as well as increased availability of cuff manometers in operating theatres. Continuous monitoring and automatic adjustment of cuff pressures by electronic systems incorporated into breathing systems could be the future of accurate cuff management intraoperatively.[34]

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