Endotracheal tube cuff pressure management in adult critical care units

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Background. The monitoring of endotracheal tube (ETT) cuff pressure in intubated patients is important in preventing complications related to cuff over- and under-inflation.

Objectives. To explore and describe the existing practice related to ETT cuff pressure management by professional nurses in adult critical care units (CCUs) in the public and private healthcare sectors.

Method. A quantitative survey was used. Data were collected from professional nurses from adult CCUs in the public and private healthcare sectors in the Nelson Mandela Metropole, Eastern Cape, South Africa, using a structured self-administered questionnaire based on a literature review.

Results. The survey response was 75% (100/134). Practice variances included the frequency of cuff pressure monitoring: only 52% of respondents performed cuff pressure measurements every 6 - 12 hours; 32% reported performing measurements at 2 - 4-hourly intervals; 15% only assessed cuff pressure when a leak occurred; and 1% never monitored cuff pressure. Of the 100 respondents, 37% used the cuff pressure measurement (CPM) method, 24% used the palpation method or listened to air leaks, and 22% used minimal occlusive volume (MOV). None of the respondents used the minimal leak technique (MLT). Only 20% of the respondents maintained cuff pressures at 18 - 22 mmHg. Thirty-one per cent indicated that they still performed the practice of cuff deflation and re-inflation before and after suctioning. There were incongruities related to the management of air leaks and the amount of air instilled.

Conclusion. Practice variances were noted among the professional nurses, especially in the private healthcare sector. The lack of evidence-based clinical decision-making related to cuff pressure management in mechanically ventilated patients was evident. Best practice recommendations need to be used effectively when performing ETT cuff pressure management, to reduce practice variance, standardise safe patient care, and minimise complications.

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Endotracheal tube (ETT) cuff pressure management is an essential part of airway management in intubated and mechanically ventilated patients. The ETT cuff should be inflated in order to seal the airway without volume loss or pharyngeal content aspiration. However, the pressure exerted on the trachea must be maintained within a therapeutic range (25 - 30 cmH_2O or 18 - 22 mmHg) that is high enough to ensure delivery of mechanical ventilation and prevention of marked aspiration, but low enough to ensure perfusion to the tracheal capillaries without causing injury.[1,2]

Potential injuries from cuff over-inflation include tracheal rupture, necrosis and stenosis, trachea-oesophageal fistula, and recurrent laryngeal nerve palsy. More commonly, over-inflation can result in stridor and a sore throat after extubation.[1] Under-inflation can lead to bronchial aspiration of secretions, particularly during inspiration. Importantly, aspiration of pharyngeal secretions has been associated with ventilator-associated pneumonia.[3] Tracheal stenosis often develops weeks to months after the patient has undergone mechanical ventilation and may produce no symptoms until the lumen has been reduced by 50 - 75%.[4] The condition has been confirmed in mechanically ventilated patients as a complication related to over-inflated cuffs.[5,6] Apart from maintaining correct cuff pressure, it is important to perform cuff pressure measurements at 6 - 12-hourly intervals and to use the correct method.

Evidence-based guidelines can be used to reduce inappropriate variations in clinical practice and discourage practices lacking convincing or sufficient evidence of effectiveness.[7] The Nesibopho Best Practice Guideline[8] provides recommendations for tracheal tube cuff pressure monitoring in nursing care practice.

We aimed to assess whether existing practices related to cuff pressure management in the mechanically ventilated patient by professional nurses in the adult critical care units (CCUs) in the public and private

healthcare sectors in a specified geographical area were performed according to best practice recommendations.

Methods

This survey was conducted among professional nurses in 6 adult CCUs in the public and private healthcare sectors in the Nelson Mandela Metropole, Eastern Cape, South Africa. The size of the CCUs varied between 8 and 16 beds for medical-surgical patients. Approximately 75% of the patients admitted to the units were connected to mechanical ventilators.

Data were collected from respondents using a structured, self-administered questionnaire, developed and based on a literature search. Data collected included the demographics of professional nurses, the frequency of cuff pressure monitoring, methods used to monitor cuff pressure, normal ranges for maintaining cuff pressure, the practice of cuff deflation and inflation before and after suctioning, management of air leaks, and tools used for clinical decision-making. To enhance reliability and face and content validity, the questionnaire was evaluated by a statistician, respiratory therapist, intensivist and nurse experts in the field. A 14-respondent pilot study was conducted to test the questionnaire's appropriateness.

At the time of the study, 134 professional nurses were available to participate; 101 agreed to participate voluntarily. Sixty-four questionnaires were distributed to professional nurses working in 3 public-sector CCUs; 40 (63%) responded. Seventy questionnaires were distributed to professional nurses working in 3 private-sector CCUs; 61 (87%) responded and 1 (2%) questionnaire was spoilt. A total of 100/134 questionnaires were analysed, representing an overall response rate of 75%. To maintain confidentiality and anonymity, respondents placed their completed questionnaires in sealed boxes.

Demographic data were categorised using dichotomous, discrete and continuous variables. Respondents were categorised according to gender, years of CCU experience (<5, 6 - 10, and >10 years), qualification structure, and position (non-leadership positions: professional nurses and agency workers, and leadership positions: unit managers, shift leaders and clinical facilitators/mentors). We utilised *t*-tests and chi-square tests of independence to assess possible differences in the nursing care practices of the public v. private sector professional nurses. Cohen's *d* statistics were calculated for statistically significant *t*-test results, to determine whether mean score differences were practically significant. Cramer's *V* was similarly used for significant chi-square results. Microsoft Excel was used for data processing and Statistica (version 9.0) was used for data analysis.

Study permission and ethical clearance were granted by the Department and Faculty Research Committees at the Nelson Mandela Metropolitan University. Permission was also granted by the respective hospital and CCU managers. The study purpose and method was explained to the professional nurses and written consent was obtained. The principles of anonymity, confidentiality and voluntary participation were maintained throughout the study.

Results

Respondent demographics

Most respondents were female (95%), which was expected in a predominantly female profession; almost half (49%) were aged between 41 and 50 years; the highest proportion (45%) had worked in CCUs for longer than 10 years; the majority (57%) were permanently employed professional nurses; and only 36% had an additional qualification in critical care nursing.

For each demographic variable a chi-square test of independence was conducted to test whether the distribution differed between the public and private sectors. The only significant difference (chi^2=23.57 (degrees of freedom (df)=4); p=0.005; V=0.39) was observed in CCU positions held: permanent nurses comprised 73% in the public sector sample, compared with 48% in the private sector. This may be attributable to the lack of agency workers in the public sector compared with more than one-third (38%) in the private sector.

Frequency of monitoring cuff pressure

More than half of the respondents (52%) performed cuff pressure measurements every 6 - 12 hours, while more frequent monitoring (every 2 - 4 hours) was performed by 32%. Fifteen per cent only assessed cuff pressure when a leak occurred, while 1% never performed monitoring.

A significant difference was observed between the public and private sectors (chi^2=29.75 (df=4); p<0.001; V=0.55), ascribed to the more frequent monitoring of cuff pressure in the private sector (predominantly every 4 - 6 hours). In the public sector, monitoring was more typically performed at 6 - 12-hour intervals or when a leak occurred.

ETT cuff pressure monitoring methods

Thirty-four per cent of respondents used the cuff pressure measurement (CPM), 24% used the palpation method and 22% indicated that they listened for air leaks. Only 20% indicated the use of the minimal occlusive volume (MOV) technique. None of the respondents used the minimal leak technique (MLT). No statistically significant difference was observed between responses from the nurses in the public v. private healthcare sectors (chi^2=4.90 (df=3); p=0.179).

Normal range for cuff pressure measurement

Twenty-two per cent of respondents indicated the correct range (18 - 22 mmHg) for maintaining adequate cuff pressure. Other responses including the maintenance of cuff pressure at 23 - 25 mmHg (33%), 26 - 30 mmHg (43%) and >31 mmHg (1%). Only 1% of respondents did not know the correct cuff pressure to be maintained. No statistically significant difference was noted in the responses of public v. private sector CCU nurses (chi^2=2.71 (df=4); p=0.607).

ETT cuff deflation and re-inflation before and after suctioning

Although 69% of respondents indicated that they did not perform deflation and re-inflation of the ETT cuff before and after suctioning, a significant proportion (31%) indicated that they did still perform this out-dated practice. Differences between public v. private sector CCU nurses were not statistically significant (chi^2=4.12 (df=2); p=0.420).

Management of an audible leak

In exploring the management of cuff leaks, 51% of respondents indicated that they only assessed cuff pressure; 29% indicated that they continued cuff inflation and notified the physician; 15% indicated that they continued cuff inflation irrespective of the volume of air inserted; 3% indicated that they monitored for an ongoing cuff

leak; and the remaining 2% indicated that they manipulated the patient's ETT and position. No statistically significant difference was noted in the responses of public v. private sector nurses (chi^2=7.054 (df=4); p=0.132).

Amount of air to inflate for a leak

Responses to the volume of air used for cuff inflation when an audible leak was noted, included: 2 ml (36% of respondents); continued ETT cuff inflation until the audible leak disappeared, irrespective of the amount of air used (34%); 5 ml (23%); 10 ml (6%); and 20 ml (1%). No statistically significant difference was noted in the responses from professional nurses in the public v. private sectors (chi^2=7.150 (df=4); p=0.128).

Discussion

Only 52% of respondents monitored cuff pressures once per shift (every 6 - 12 hours), which is congruent with other surveys where cuff pressures were monitored 8 - 12 hourly or once per shift.[3,9,10] However, nurses in the private sector were less inclined to check cuff pressures at the recommended intervals (47% v. 60% in the public sector). Furthermore, private sector nurses (43%) were inclined to perform more frequent monitoring (every 4 hours), which is not necessarily more beneficial to patient safety and outcomes. Best practice guidelines recommend cuff pressure monitoring once per shift, as soon as possible after intubation, following transfer from another unit or hospital, and on receipt of the patient from the operating theatre.[8]

Considering the lack of significant differences in the respondents' demographic data, the differences in the practices of nurses from the public v. private sectors could be ascribed to the significant number of agency nurses employed in the private sector. The study did not explore differences in care rendered by agency v. permanent nurses; therefore, no assumptions could be derived. However, Scribante and Bhagwanjee[11] and Rispel[12] have suggested that variances may arise from agency nurses' unfamiliarity or non-adherence with unit practices and policies. Furthermore, agency nurses are assigned according to unit demands rather than their qualifications and experience, which may contribute to a lower quality of patient care.

The techniques described to maintain cuff pressure include MLT, MOV, CPM and the palpation method.[3] No advantage of CPM over MOV or MLT has yet been proven.[9,13] Best practice recommendations include initial cuff inflation using MLT followed by direct CPM using an aneroid manometer.[8] While MLT was the preferred method for cuff inflation in a North American survey,[9] it was not practised by any of the respondents in our survey.

CPM with an aneroid manometer, recommended as best practice by several studies,[1,13-15,18] provides an objective measurement of cuff pressure that does not involve cuff deflation, potentially decreasing the risk of aspiration. Only 34% of the respondents used CPM, with the nurses in the private healthcare sector being more inclined to do so (37% v. 30% in the public sector). Aneroid manometers were available in the majority of the CCUs surveyed; reasons for the lack of their use were not explored. Our results indicating infrequent CPM use are consistent with the findings of other practice surveys,[14] but inconsistent with a CCU survey in Spain which reported 57% CPM use.[13]

The palpation method is inadequate and may contribute to cuff over- and under-inflation. Listening for air leaks is also not recommended practice.[15,18] In this survey, 24% of the nurses used the palpation method, while 22% of the total cohort listened for air leaks. These practices may compromise patient safety and increase the risk of adverse advents in the critically ill.

Cuff pressure must be maintained at 18 - 22 mmHg (25 - 30 cmH_2O) as it greatly reduces the risk of cuff site ischaemia, injury and the risk of aspiration.[18] Cuff pressures >30 cmH_2O compress mucosal capillaries, impair blood flow, cause mucosal damage and tracheal rupture, with total occlusion occurring at 50 cmH_2O.[19] A study of a 10-bed CCU in Australia with 101 patients confirmed that cuff pressures <20 cmH_2O were associated with an increased risk of aspiration, and the incidence of tracheal stenosis was common with cuff pressures >30 cmH_2O.[19] The results of our survey indicated that only 22% of the nurses maintained the range for cuff pressure measurements. It was of concern that 2% of nurses in the private sector maintained cuff pressure at >31 mmHg and 2% did not know the normal cuff pressure to maintain. This can compromise patient safety and lead to complications related to cuff over-inflation. These results are similar to those of a study conducted in the Western Cape, South Africa, in which excessively high cuff pressures were reported in 30% of 135 critically ill patients.[20,21]

Routine cuff deflation and re-inflation is no longer recommended.[22] However, 31% of the respondents still performed this out-dated practice; this can compromise patient safety and increase the length of time on the ventilator.

Loss of cuff volume increases the risk of aspiration of pharyngeal content and ventilator-associated pneumonia. Management of the leak includes cuff inflation until cessation of an audible leak, and continuation of ventilation as long as adequate tidal volumes and appropriate ventilation are maintained. Air volumes of 2 and 4 ml can be injected to produce cuff pressures of 20 - 30 cmH_2O. If there is a need to inflate the cuff to more than 10 ml, the practitioner should raise concern about tracheal injury and investigate the cause of the leak.[17] Various practice variances found among the respondents indicate the lack of standardised care provided by professional nurses in both the public and private healthcare sectors.

The majority of the respondents based their clinical decision-making with regard to cuff pressure management on their own expertise or traditions, rather than best available evidence. Only 36% of the respondents held an additional qualification in critical care nursing. In the private sector, 36% of the respondents were employed by nursing agencies. Further research is required to establish the relationship between ETT cuff pressure management and practitioner qualification/employment position (agency v. permanent worker).

Limitations

Study limitations include the possible effect of the self-reported practice of professional nurses rather than the actual practice performed in the clinical setting. Furthermore, the response rate of 75% did not indicate the practice of non-participating nurses. The relationship between the demographic data and the variables was not comprehensively explored.

Conclusion

It can be concluded that cuff pressure management in mechanically ventilated patients is often not performed according to best recommended practice. Private sector nurses were more inclined not to practise according to such recommendations, and a wide variation of practice existed among the respondents in both healthcare sectors. Possible reasons for this may be the use of a high percentage of agency nurses in the private sector, lack of additional qualifications in critical care nursing, and dependency on the use of own expertise and traditions in clinical decision-making. Greater awareness should be created regarding implementing best recommended practices related to ETT cuff pressure management among professional nurses, in order to standardise nursing practice, improve the safety and quality of patient care, and minimise practice variances.

Conflict of interest. The authors have no conflicts of interest to declare.

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