Comparison of endotracheal cuff pressure measurements before and after nursing care in emergency patients: pilot balloon palpation

Background: Manual inflation of tracheal tube cuff after intubation is necessary to provide a safe airway in intubated patients. An increase or decrease in the pressure of cuff balloon leads to serious complications such as mucosal necrosis and micro aspiration.

The aim of the study was to compare the endotracheal tube cuff pressure measurements before and after selected nursing care in emergency patients underwent pilot balloon palpation during cuff inflation.

Methods: A prospective cross-sectional design was utilized in the emergency department at Al Manial University Hospital upon a convenient sample of 100 mechanically ventilated patients from April 2016 to June 2017. Demographic and medical data were collected. Later, the endotracheal cuff pressure was checked with manometer before and 15 minutes after each nursing intervention and data were analyzed using SPSS software version 20.

Results: The majority of the studied sample was male with mean age 47.09 ± 15. Significant differences were detected regarding Endotracheal suctioning (t=16.99, p=0.000), Changing body position (t=2.76, p=0.026) and sedating patients (t=3.951, P ≤ 0.0001). As changing patients' body position to lateral sides, performing endotracheal and applying sedation caused a significant decrease in cuff pressure 15 minutes after.

Conclusion: ETT cuff pressure was affected significantly with medical and nursing procedures and the pilot balloon palpation volume method was not suitable to estimate cuff pressure during intubation and the cuff pressure must be monitored and controlled by the manometers.

Keywords: comparison, end tracheal, cuff pressure, pilot, balloon palpation

Introduction

Invasive endotracheal intubation maintains the airway among emergency patients [1]. After securing endotracheal position, endotracheal tube cuff is usually inflated with air to provide an adequate seal of the airway around the ETT and preventing the pharyngeal contents to pass into patient's lungs [2] and prevent gas leakage [3]. When this seal is compromised, aspirations of pharyngeal contents and poor ventilation may occur; causing respiratory complications [4]. Therefore, the appropriate cuff pressure to prevent respiratory complications has been validated to be 20-30 cm of water [5].

Endotracheal cuff pressure is influenced by several factors such as airway anatomy, cuff location, cuff material and structure, size and volume, and peak inspiratory pressure [6]. In addition, suctioning and patient position also affects ETT cuff pressure [7]. As well; the cuff pressure may be influenced by patient-related factors, environmental circumstances, and therapeutic interventions [8]. Hence There is challenging to maintain the cuff pressure within an optimal range because there are many factors affect the ETT cuff pressure.

Pilot balloon palpation has been introduced by Medical ICU staff as an alternative way to control cuff pressure that could prevent the complications of increased cuff pressure [9]. As the technique of balloon palpation, depend on the relative pressure of pilot balloon between two fingers and palpated as the firmness by a relaxed hypothenar region of palm [10]. However, In the emergency situation, when the endotracheal cuff is filled with over increased air, it causes serious complications such as tracheal stenosis, mucosal ischemia, paralysis of vocal cords and tracheal perforation [5,11]. On the other hand, under-inflation of Cuff balloon causes bronchial

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aspiration of secretions and leads to ventilator-associated pneumonia [12].

Critical care nurses and respiratory care practitioners assume responsibility for airway management and related care for patients who require mechanical ventilation. These patients have an artificial airway, either ETT or a tracheostomy. Airway management for such patients is multifaceted and includes oral care, oral suctioning, ETT suctioning, and management of ETT cuff pressure .As the endotracheal tube cuff pressure tube differs according to patient-related factors, environmental conditions, and medical interventions. Factors that may lead to a decrease in cuff pressure include sedation and neuromuscular blockade. Moreover, Loss of cuff volume with time has also been described [13]. As well, 22 showed that changing the position of the head resulted in a displacement of the tube and reported that no information was reported about the influence of these displacements on the cuff pressure. Knowledge of these aspects and factors can assist in designing interventions to optimize management of endotracheal tube cuffs and prevent complications associated with over inflation and under inflation of the cuff. Therefore, the researchers aimed to investigate and validate the variation of endotracheal cuff pressures before and after selected medical and nursing procedures among all eligible patients who underwent pilot balloon palpation technique after endotracheal intubation in the emergency department.

The aim of the study

The aim of this study is to compare the endotracheal tube cuff pressure measurements before and after selected nursing care in emergency patients underwent pilot balloon palpation during cuff inflation

Material and methods

The prospective cross-sectional design was carried out one in the emergency department at Al Manial University hospital. A convenient sample of 100 patients who required endotracheal intubation was recruited to participate in the study. The inclusion criteria included all the consecutive patients who needed mechanical ventilation from April 2016 to February 2017. The exclusion criteria were patients less than 20 years, laryngeal stenosis, tracheal bleeding and tracheal fistula.

Later, all patients were contacted by the researchers to get Patients' consent form as well as an official permission from the local research ethical committee and directors of Intensive Care Units at a Cairo university hospital to collect the patient's baseline and medical data. In the presence of researcher participants, the routine endotracheal cuff inflation was carried out for all patients in the emergency department by ICU physicians utilizing pilot Balloon palpation. Later, all patients' participants cuff pressure were rechecked by the researchers utilizing Mallinckrodt manometer (Hand Pressure Gauge, version 2011, Germany) and were documented in researcher's checklist after each selected nursing intervention such as changing position, endotracheal suctioning and sedation.

Protocol of intervention

■ Change body position

Right lateral, left lateral and semi setting positions (30:45 degree) were selected; these positions were chosen because they are part of daily ICU routine. The endotracheal tube cuff pressure was measured before and after each changing position by 15 minutes and record these measurements.

■ Performing of endotracheal tube suctioning

The endotracheal cuff pressure was initially measured utilizing Mallinckrodt manometer. Patients were suctioned utilizing open method utilizing vacuum pressure 120 mmHg and distilling 5 cm saline into the endotracheal tube and suctioning. Later, after 15 minutes, the endotracheal cuff pressure was re-checked again and documented.

■ Performing Administering and monitoring sedation

Endotracheal tube cuff pressure was measured before applying sedation. Later, after 15 minutes after administering sedation, endotracheal cuff pressure was re-checked again and documented.

Data analysis

The collected data were analyzed by SPSS software version 20. Descriptive statistic was utilized to describe the patients' demographic and medical data such as frequency, percentage,

mean and standard deviation. As well, inferential statistics was used to compare the patients' endotracheal cuff pressure before and after each medical and nursing intervention such as paired t-test considering P value< 0.05 to be significant.

Results

As can be seen from the **(TABLE 1)**, most of the patients were males, their age ranged between 50-60 years with a mean age of 47.09 ± 15.6years. More than one third (34%) of the studied sample admitted with trauma (road traffic accident and Disturbed conscious level) and also nearly one quarter (21%) had respiratory emergencies distributed as exacerbated COPD and respiratory failure).

It is clear from the **(TABLE 2)** that significant differences of endotracheal cuff pressure before and after selected medical and nursing interventions were detected regarding endotracheal suctioning (t=16.99, p=0.000), Changing body position (t=2.76, p=0.026) and sedating patients(t=3.951, P ≤ 0.0001). As changing patients' body position to lateral sides, performing endotracheal and applying sedation caused a significant decrease in cuff pressure 15 minutes after. However, the baseline data were very high before and after procedures.

Table 1. Baseline characteristics of the studied patients (n=100).

Item	Findings
Age (Mean ± SD)	47.09 ± 15.6
Gender N (%)	
Male	70 (70)
female	30 (30)
Comorbid conditions N (%)	
DM	13 (13)
HTN	12 (12)
Others	10(10)
Medical diagnosis N (%)	
Cardiovascular emergencies	12 (12)
Respiratory emergencies	21 (21)
Neurological emergencies	10 (10)
Gastrointestinal emergencies	11 (11)
Trauma (RTA /DCL)	34 (34)
shock	12 (12)
Endotracheal tube N (%)	
Site of insertion (oral)	100 (100)

Table (2) Comparison of the endotracheal tube cuff pressure before and after selected medical and nursing procedures.

Procedure	Mean pressure	SD	T	p
Endotracheal suction				
Pre	61.9	24.005	16.99	0.000*
Post	44.57	20.90		
Changing body position				
pre	53.5	22.89	2.76	0.026*
post	51.58	22.53		
Sedation				
pre	15.98	28.50	2.158	0.033*
post	18.70	34.60		
*Significant at the p < 0.05 probability level				

Discussion

Previous studies have shown that maintaining endotracheal cuff pressure between 20 and 30 mm Hg can prevent complications in mechanically ventilated patients [14,15]. In the present study, concerning the change of body position (decubitus), there was a significant change in the cuff pressure. However, the mean cuff pressure before and after changing the position was still high. This reading may have relevance to many factors; one of them is the routine use of pilot balloon palpation estimates, another factor was concerning to patients' head flexion as most of them were assuming flexion position before changing position from supine to lateral position keeping head neutral and non-compliance of endotracheal cuff pressure monitoring after performing procedures throughout the day. The researchers' point of view is partially supported by 15 who assessed the compliance of regular and routine measuring of endotracheal pressure during elective surgery and mentioned that endotracheal tube cuff pressure is elevated by factors including, head position, position of endotracheal cuff, patient position, temperature of inspired air and inhaled nitrous oxide anesthesia and volume of inflated cuff.

Regarding reduction of endotracheal cuff pressure after changing position to lateral position from 53 to 51 mmHg, the current findings finding is not agreed with [16] who detected significant increase of the cuff pressure of endotracheal tube in 40% of cases and emphasized that frequent changes in a patient's body position may cause harmful cuff elevation and recommended for a strict monitoring of this pressure. Therefore, our cuff pressure finding before and after changing position was very dangerous and was prone to develop complications. That finding was supported by [8] who stated that inflation of the endotracheal cuff more than 30 cm H_2O destroys the tracheal

mucosa by interfering with the capillary perfusion and when pressures are more than 50 cm H_2O, total occlusion of tracheal blood flow takes place.

Concerning with endotracheal tube cuff pressure and sedation, it revealed that there was the difference in endotracheal cuff pressure reading before and after patients' sedation. As there was an increase in ETT tube cuff pressure before applying sedation infusion. This finding was congruent with a similar study done by [17,18] that studied variations in endotracheal tube cuff pressure and found that endotracheal tube cuff pressure increased with the withdrawal of sedation. On the other hand, our study finding was inconsistent with [19] who conducted a study on Variations in endotracheal cuff pressure in intubated critically ill patients and risk factors and found the duration of prior intubation and absence of sedation are independently associated with increased risk for cuff under inflation. From the researcher's point of view, cessation of sedation can lead to increase muscle tone resulting in changing in ETT cuff pressure leading to an increase in ETT cuff pressure.

Concerning with end tracheal tube cuff pressure and suctioning, our findings revealed a decrease in ETT cuff pressure 15 minutes after suctioning. This finding may be interpreted in light of [20] who stated that ETT cuff pressures change over time by measuring cuff pressures at 4-hour intervals over a 12-hour shift and all patients in their study showed statistically significant decreases in cuff pressure at each measurement interval (4, 8, and 12 hours). Moreover, added that these periods of low pressure make the patient prone to micro aspiration, because secretions pooled on top of the ETT cuff and simple mobilization of the ETT may influence cuff pressure enough to provide this avenue into the lungs [21,22]. Another factor may have relevance to inducing low cuff pressure is the way of measuring ETT cuff pressure may affect reading as in continuous way of measuring pressure, there was no disconnection of transducer from the connected valve with pilot balloon whereas intermittent way like in our study, there was disconnection between valve of pilot Balloon and manual manometer that may lead to escape of pressure resulting in reduction of endotracheal cuff pressure.

Limitations

The study was not based on random allocation and findings, which were based on a single clinical setting which compromises data extrapolation.

Conclusion

The present study revealed that ETT cuff pressure was influenced by different factors as performing suctioning procedure, changing patient position, and patients' withdrawal from sedation. Such changes in ETT cuff pressure may make the patients' liable to develop harmful complications.

Recommendation

Rechecking the endotracheal cuff pressure after each intervening medical and nursing procedure.

Provide additional cuff pressure devices facilitate measuring of cuff pressure.

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