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Research paper

Effect of patient position on endotracheal cuff pressure in mechanically ventilated critically ill patients

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ABSTRACT

Background: Endotracheal tube cuff pressure must be maintained within 20–30 mH_2O to prevent complications. There is limited literature reporting the impact of nursing care on endotracheal cuff pressure. However, few studies have reported the effect of nursing care on endotracheal cuff pressure.
Objectives: This study was performed to investigate the effects of body position on endotracheal cuff pressure.
Methods: Twenty-five patients receiving mechanical ventilatory therapy were placed in a baseline position (semirecumbent position with the head of the bed elevated at 30° and head in a neutral position) with endotracheal tube cuff was adjusted to 25 cmH_2O. The patients were moved into 16 different positions: anteflexion of the head; hyperextension of the head; left lateral flexion of the head; right lateral flexion of the head; rotation of the head to the left; rotation of the head to the right; semirecumbent position with 45° elevation of the head of the bed; recumbent position with 10° elevation of the head of the bed; supine position; trendelenburg position 10°; left lateral position at 30°, 45°, and 90°; and right lateral position at 30°, 45°, and 90°. The endotracheal tube cuff pressure was measured and recorded after each position change.
Results: Among the 400 endotracheal tube cuff pressure measurements (25 patients × 16 positions) 10 (2.5%) were lower than 20 cmH_2O; 201 (50.3%) were between 20–30 cmH_2O and 189 (47.3%) were higher than 30 cmH_2O. Mean endotracheal tube cuff pressure increased from 25 to 32.59 ± 4.08 cmH_2O after changing the patients' position. Friedman test indicated a statistically significant deviation in the ETCP across the 16 positions (X2: 122.019, p: 0.0001).
Conclusions: Body positioning during daily nursing care effected the endotracheal tube cuff pressure, suggesting that endotracheal tube cuff pressure should be measured after changing a patient's position and adjusted within the recommended range.

1. Background

Although mechanical ventilation is a supportive therapy for diseases leading to respiratory failure, it can cause serious complications.[1–3] The management of endotracheal cuff pressure (ETCP) is one of the most crucial factors associated with complications of mechanical ventilation.[1–3] The management of ETCP involves cuff pressure management, with the purpose of maintaining the airway and tracheal perfusion, ensuring ventilation and preventing aspiration.[3–5]

In the literature it has been recommended that ETCP should be maintained within the range of 20–30 cmH_2O, which is sufficiently

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high for preventing aspiration but sufficiently low for ensuring tracheal capillary perfusion.[5,6] There are various techniques for maintaining ETCP include minimal occlusive volume, minimal leak technique, cuff pressure measurement and palpation. In critical care areas, the ETCP measurement method is commonly used and standard of care for cuff pressure management.[7,8] However, maintaining ETCP within the recommended range is challenging because patient-related, environmental and therapeutic factors may contribute to deviations in ETCP.[4,5,9]

1.1. Over-inflation of the ETCP

Over-inflation of the endotracheal cuff occurs when the endotracheal cuff pressure exceeds the capillary perfusion pressure of tracheal mucosa.[6] Many factors, including positive pressure ventilation, nitrous oxide, high altitude, laryngeal spasm, bronchoconstriction and edema are associated with the over-inflation of an endotracheal cuff.[4,9,10] Excess ETCP is transmitted onto the trachea, leading to hypoperfusion, which is associated with tracheal ischemia, stenosis, necrosis, inflammation, ulceration, nerve damage or fistula.[6] Excessive ETCP can also lead to respiratory complications, such as cough, sore throat, hoarseness and blood-streaked expectoration.[6,10] Even in a short period an endotracheal cuff pressure higher than 30 cmH_2O can cause tracheal lesions leading to complications.[6]

1.2. Sub-inflation of the ETCP is also associated with complications

If ETCP is too low, secretions can be microaspirated, leading to ventilator-associated pneumonia.[4,5,9] Accidental extubation and inadequate ventilation are the other concerns associated with low ETCP. Sedative and neuromuscular blocking medications, low core temperature, and time can lead to a sub-inflated endotracheal cuff.[4,9,10]

Of the many factors associated with deviations in ETCP, body positioning is another factor that should be considered.[8] Some studies have shown that a patient's position during surgery, particularly the supine and prone positions, results in deviations in ETCP.[11–13] Alterations in the head and neck position can also cause a significant rise in ETCP.[13–15] Lizy et al. determined that simple and frequent body positioning of patients receiving mechanical ventilatory therapy has a significant effect on the ETCP.[10] Almost all of these studies were performed in operating rooms which involved prolonged positioning.[11–13] As different from surgical patients, periodically changing critically ill patients' positions is one of the most important nursing practices for preventing complications of immobility.[16] Many different positions are used while caring for critically ill patients receiving mechanical ventilator therapy.[16] The potential advantages of the positioning of critically ill patients are promoting comfort and relaxation, preventing deformities or injuries, stimulating circulation, improving gastrointestinal functions, promoting respiratory function. Besides changing positions allows for visibility and accessibility during treatments or diagnostic tests.[17] Nevertheless, information on the effects of various and frequent body positioning on ETCP is lacking. Thus, the present study was performed to determine the effects of patient positioning on ETCP.

2. Method

2.1. Study aim

This prospective, observational study was performed to investigate the effects of body positioning on ETCP.

2.2. Study design and settings

Data were collected between February 19 and June 6, 2016 at the Ege University Hospital Anesthesiology intensive care unit (ICU), which is a 27-bed tertiary adult ICU that cares for approximately 450 patients annually. The ETCP is monitored and adjusted every 4 h by ICU nurses. All patients were intubated with the same high volume low pressure cuffed oral endotracheal tube (Chilecom Cuffed Endotracheal Tubes; Chilecom Medical Devices Co., Ltd., Huizhou, China) of appropriate size.

Data were collected using a form designed for this study. The form included 26 questions regarding patient's age, sex, body height and weight, diagnosis, comorbidities, endotracheal tube size, endotracheal tube fixation area, positive end-expiratory pressure, Ramsay Sedation Scale score, and ETCP measured after each position change. Demographic data were collected from the patient's medical record and via direct observation.

The Ramsay Sedation Scale is a scale used to assess the rousability with respect to patient's ability to respond. It defines the conscious state at six levels from level 1 (patient is anxious) to level 6 (the patient is completely unresponsive).[18]

All patients were placed in the baseline position: which was a semirecumbent position with the head of the bed elevated at 30° and the head in a neutral position. The endotracheal tube was then connected to a cuff pressure manometer (VBM Medizintechnik GmbH, Sulz am Neckar, Germany) using a connecting tube, and ETCP was adjusted to 25 cmH_2O. The lines were equipped with male and female luer-lock adapters were used to prevent disconnections and leaks. All patients were moved into one of 16 selected positions in the same sequence from the baseline position. Sixteen body positions often used during daily nursing care were selected. The 16 positions were; anteflexion of the head, hyperextension of the head, left lateral flexion of the head, right lateral flexion of the head, rotation of the head to the left, rotation of the head to the right, semirecumbent position with a 45° elevation of the head of the bed, recumbent position with a 10° elevation of the head of the bed, supine position, 10° trendelenburg position, left lateral position at 30°, 45°, and 90°; and right lateral position at 30°, 45°, and 90°. All patients were placed in Hill-Rom AvantGuard® patient beds (Hill-Rom, Chicago, IL, USA). All beds had angle indicators located on the head side rails, indicating the exact angle of the head when the head of the bed was elevated. The head of bed elevation angle was measured using these angle indicators.

The ETCP was measured and recorded after each position change. To avoid any potential effect on ETCP; the researchers did not interfere with the process by inflating/deflating of the cuffs. A registered nurse from the research team and a trained auxiliary staff moved the patients into the predetermined positions. Another registered nurse from the research team was responsible for ETCP measurements and recordings. Total intervention time for each patient was 40–45 min.

2.3. Sample selection

The sample size was determined statistically using a power analysis. The Type II error was set to 0.20, Type I error was set to 0.05, and the anticipated difference in ETCP was ≥ 6 cmH_2O (because a deviation of 5 cmH_2O was required to exceed the recommended ETCP limits); thus, 13 patients were required for the study. All patients older than 18 years of age, who were orotracheally intubated and were receiving invasive mechanical ventilatory therapy were included in the study (Fig. 1).

Patients who had received a tracheostomy, were not intubated, had a contraindication of head of bed elevation, had a disability in neck mobility, were hemodynamically unstable, were not able