MEASUREMENT OF ENDOTRACHEAL TUBE CUFF PRESSURE IN MECHANICALLY-VENTILATED PATIENTS ON ARRIVAL TO INTENSIVE CARE UNIT - A CROSS-SECTIONAL STUDY

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ABSTRACT

BACKGROUND
The monitoring of Endotracheal Tube (ETT) cuff pressure in intubated patients on arrival to intensive care unit is very essential. The cuff pressure must be within an optimal range of 20-30cm H2O ensuring ventilation with no complications related to cuff overinflation and underinflation. This can be measured with a cuff pressure manometer.

The aim of the study is to measure the endotracheal tube cuff pressure in patients on arrival to intensive care unit and to identify prevalence of endotracheal cuff underinflation and overinflation.

MATERIALS AND METHODS
A cross-sectional study was done on mechanically-ventilated patients who were intubated in casualty (emergency department) on arrival to intensive care unit in S.S. Institute of Medical Sciences and Research Centre, Davangere. About 50 critically-ill patients intubated with a high volume, low pressure endotracheal tube were included in the study. An analogue manometer was used to measure the endotracheal tube cuff pressure. It was compared with the recommended level. The settings of mechanical ventilation, endotracheal tube size and peak airway pressure were recorded.

RESULTS
It was found that the mean cuff pressure was 64.10 cm of H2O with a standard deviation of 32.049. Of the measured cuff pressures, only 2% had pressures within an optimal range (20-30cm of H2O). 88% had cuff pressures more than 30cm of H2O. The mean peak airway pressure found to be 20.50cm of H2O with a Standard Deviation (SD) of 5.064.

CONCLUSION
This study is done to emphasise the importance of cuff pressure measurement in all mechanically-ventilated patients as cuff pressure is found to be high in most of the patients admitted to intensive care unit. Complications of overinflation and underinflation can only be prevented if the acceptable cuff pressures are achieved.

KEYWORDS
Cuff Pressure, Endotracheal Tube.

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BACKGROUND
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.1 Emergency patients are especially prone to cuff pressures that remain unmeasured for hours.2 Therefore, monitoring of ET cuff pressure in intubated patients on arrival to intensive care unit becomes an important monitoring component. The cuff pressure must be within an optimal range ensuring ventilation with no complications related to cuff overinflation and underinflation. This can be measured with the help of cuff pressure manometer.2 The ideal range for cuff pressure is usually between 20 to 30cm of H2O.3-5 Adverse complications are related to both overinflation as well as underinflation of cuff.6-7 Complications such as hoarseness of voice, sore throat, tracheal stenosis and necrosis due to mucosal ischaemia are associated with patients intubated with high cuff pressures.8 Whereas, patients intubated with low cuff pressures are at the risk for aspiration of gastric contents and consequently leading to aspiration pneumonitis and ventilator-associated pneumonia.4

OBJECTIVES
1. To measure the endotracheal tube cuff pressure in mechanically-ventilated patients on arrival to intensive care unit.
2. To identify prevalence of underinflation and overinflation of endotracheal cuff.

MATERIALS AND METHODS
A cross-sectional study was done on mechanically-ventilated patients who were intubated in casualty (emergency department) on arrival to intensive care unit in S.S. Institute of Medical Sciences, Davangere, Karnataka, over a period of 2 months between July 2016 and August 2016. About 50 critically-ill adult patients aged 18 years or older intubated with a high-volume, low-pressure endotracheal tube were included in the study. The sources of admission were into the Respiratory ICU (critical care unit), Medical ICU, Surgical ICU and Neurosurgical ICU. Patients with airway deformities and/or tracheostomies were exclusion criteria. The endotracheal tube cuff pressure was measured using an analogue manometer and the measured value was compared with the recommended level.

Underinflation of endotracheal tube cuff is defined as cuff pressure less than 20 cm H₂O, whereas overinflation of endotracheal tube cuff is defined as cuff pressure more than 30 cm of H₂O. The size of the endotracheal tube, ventilator settings and peak airway pressure were recorded in every patient.

RESULTS

<table>
<thead>
<tr>
<th>Cuff Pressure (cm H₂O)</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>20-30</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>&gt;30</td>
<td>44</td>
<td>88%</td>
</tr>
</tbody>
</table>

Table 2. Measured Cuff Pressure Distribution

The endotracheal tube cuff pressures were measured in 50 mechanically-ventilated patients on arrival to intensive care unit. The mean cuff pressure was found to be 64.10 cm of H₂O with a standard deviation of 32.049. The lowest measured endotracheal tube cuff pressure was 8 cm of H₂O and the highest was 120 cm of H₂O.

DISCUSSION
Endotracheal tubes have become indispensable for securing the airway during surgical procedures and in critically-ill patients treated with mechanical ventilation. The cuff of the tube seals the extra luminal airway.
facilitating positive-pressure ventilation and reducing aspiration of subglottic secretions. The measurement of endotracheal tube cuff pressure is very essential in all mechanically-ventilated patients as it is found to be high in most of the patients admitted to intensive care unit. The endotracheal tube cuff pressure manometer deflates and inflates high volume, low pressure endotracheal or tracheal cuffs. It is an easier alternative to other methods that are required to check cuff pressure. It consists of an air vent button and inflator bulb, which aids to adjust cuff pressure quickly and easily. Manometer gauge shows recommended pressure range in cm of H₂O.

**Figure 3. Cuff Pressure Manometer**

In patients with prolonged intubation, more discrete levels of overinflation may lead to long-term complications such as tracheal stenosis or formation of a fistula.⁹ Underinflation of the cuff puts patients at risk for microaspiration of subglottic secretions. This microaspiration is considered the major pathogenic mechanism for ventilator-associated pneumonia.¹⁰ A complication associated with marked morbidity and mortality.¹¹ The tendency to overinflate tube cuffs in some studies was still dominating and even more disturbing. This problem was more common in the group of highly-experienced anaesthesiologists.¹² An audit done in Department of Anaesthesia, The Queen Elizabeth Hospital, King’s Lynn, UK, showed that the mean cuff pressure in the study group was 62 cm of H₂O and 20% cuff pressures were above 100 cm of H₂O.¹³ The highest recorded in our study was 120 cm of H₂O, which is extremely harmful for mechanically-ventilated patients.

An audit done by Pervez Sultan et al.¹⁴ revealed that the pressure of the endotracheal tube cuff against the tracheal wall depends on the compliance of the trachea and cuff. Pressure measured at the pilot balloon of an ET tube cuff can be considered a good estimate of the pressure exerted onto the tracheal mucosa by the cuff. Duguet A et al.¹⁵ found that the use of pneumatic device for control of cuff pressure was effective in maintaining the ET tube cuff pressure within a range of 20 to 30 cm of H₂O nearly twice as often as during the control condition (88.9% vs. 48.3%). Sengupta et al.¹⁶ and Hoffman et al.¹⁷ described a linear relationship between the measured cuff pressure and the volume of air inserted into the cuff. Hoffman et al. described this relationship with a 97% linear correlation.

An audit was conducted at S.S. Institute of Medical Sciences and Research Centre, Davangere, to find out as to what would be the cause for overinflation and underinflation of the ET tube cuff. It was found that securing the airway was of a priority in the emergency situation in which patients had landed to the emergency room. It was also found that the cuff inflation was done by house surgeons and nursing staff randomly without any proper ET tube cuff pressure measuring devices. On certain occasions, few patients intubated by prehospital Emergency Medical Services (EMS) personnel were also found to have randomly inflated ET tube cuffs.

Overall, it was found that the lack of knowledge among the nursing staff, house surgeons and EMS personnel and lack of cuff pressure measuring protocols were the major causes for the improper inflation of the ET tube cuff. This audit was done to improvise the patient care, which highlights the need for training, education and increased awareness of more frequent manometric measurement of cuff pressure throughout the day.

**CONCLUSION**

It can be concluded that cuff pressure management in mechanically-ventilated patients is very important for the better outcome of the patients to prevent complications. Complications of overinflation and underinflation can only be prevented if the acceptable cuff pressures are achieved. Thus, this study is done to emphasise the importance of cuff pressure measurement, which can be achieved with the help of cuff pressure manometer.

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**REFERENCES**