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

Arun Kumar Ajjappa[1], Syeda Shaista Naz[2]

[1]Professor and HOD, Department of Anaesthesiology, S.S. Institute of Medical Sciences and Research Centre, Davangere.
[2]Postgraduate Student, Department of Anaesthesiology, S.S. Institute of Medical Sciences and Research Centre, Davangere.

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 H_2O 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 H_2O with a standard deviation of 32.049. Of the measured cuff pressures, only 2% had pressures within an optimal range (20-30cm of H_2O). 88% had cuff pressures more than 30cm of H_2O. The mean peak airway pressure found to be 20.50cm of H_2O 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.

HOW TO CITE THIS ARTICLE: Ajjappa AK, Naz SS. Measurement of endotracheal tube cuff pressure in mechanically-ventilated patients on arrival to intensive care unit -A cross-sectional study. J. Evid. Based Med. Healthc. 2017; 4(34), 2032-2035. DOI: 10.18410/jebmh/2017/396

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 ETT 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 H_2O.[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]

Financial or Other, Competing Interest: None.
Submission 30-03-2017, Peer Review 10-04-2017,
Acceptance 20-04-2017, Published 25-04-2017.
Corresponding Author:
Dr. Syeda Shaista Naz,
No. 118C, 1st Floor, 2nd Cross,
1st Main Road, Robertson Block,
Ramachandrapuram, Bengaluru-560021.
E-mail: shaiparadise@gmail.com
DOI: 10.18410/jebmh/2017/396

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 cmH_2O, whereas overinflation of endotracheal tube cuff is defined as cuff pressure more than 30 cm of H_2O. The size of the endotracheal tube, ventilator settings and peak airway pressure were recorded in every patient.

RESULTS

	Cuff Pressure (cm H_2O)
Number	50
Mean	64.10
Median	60.00
Standard deviation	32.049
Range	112
Minimum	8
Maximum	120

Table 1. Measured Cuff Pressure

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 64.10cm of H_2O with a standard deviation of 32.049. The lowest measured endotracheal tube cuff pressure was 8cm of H_2O and the highest was 120cm of H_2O.

Cuff Pressure (cm H_2O)	Number	Percentage
<20	5	10%
20-30	1	2%
>30	44	88%

Table 2. Measured Cuff Pressure Distribution

Of the measured endotracheal tube cuff pressures, only 2% of patients had cuff pressures within the recommended level of 20-30cm of H_2O, 88% had cuff pressures more than 30cm of H_2O, whereas 10% had cuff pressures less than 20cm of H_2O.

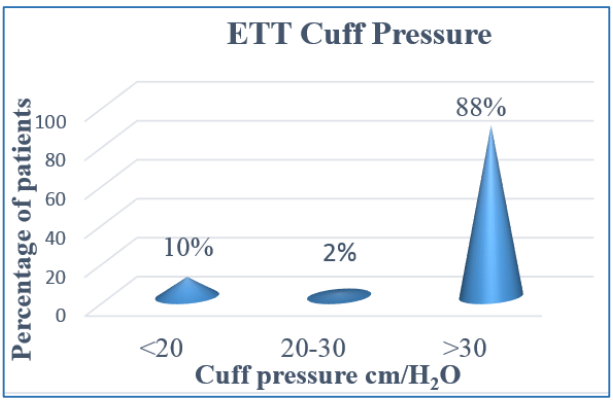

Figure 1. ETT Cuff Pressure

As the prevalence of endotracheal tube cuff inflated with high cuff pressure was found to be more, it was further studied to look for its range of distribution.

Cuff Pressure (cm H_2O)	Number of Patients	Percentage
30-45	15	30%
46-60	11	22%
61-75	8	16%
76-90	5	10%
91-105	3	6%
106-120	8	16%

Table 3. Measured High Cuff Pressure Distribution

It was noticed that out of 44 patients with measured high cuff pressures, 30%had cuff pressures in the range of 30-45cm of H_2O, 22% of patients had cuff pressures between 46-60cm of H_2O, 8 patients had cuff pressures between 61-75 cm of H_2O, 10% had cuff pressures between 76-90 cm of H_2O, 6% of patients (3 out of 44) had cuff pressures between 91-105 cm of H_2O and 16% of patients (8 out of 44) had cuff pressures of more than 105cm of H_2O, which is significantly high and extremely harmful for patients if not corrected within the optimal range.

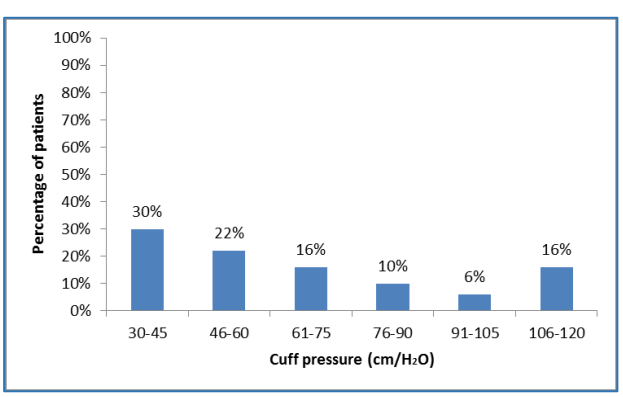

Figure 2. Cuff Pressure (Cm/H_2O)

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 H_2O.

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 thestudy group was 62 cm of H_2O and 20% cuff pressures were above 100 cm of H_2O.[13] The highest recorded in our study was 120cm of H_2O, 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 H_2O 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.

ACKNOWLEDGEMENT

I am very much grateful to the CCU staff of SSIMS and RC for all the help provided in collecting this data and for the support and advice given by the audit coordinator and ICU consultants.

REFERENCES

[1] Jordan P, Rooyen DV, Venter D. Endotracheal tube cuff pressure management in adult critical care units. S Afr J Crit Care 2012;28(1):13-16.
[2] Chapman J, Pallin D, Ferrara L, et al. Endotracheal tube cuff pressures in patients intubated before transport. Amer J Emerg Med 2009;27:980-982.
[3] Simmons KF, Scanlan CL. Airway management. In: Wilkins RL, Stoller JK, Scanlan CL, ed. Egan's fundamentals of respiratory care. 8th edn. St Louis, MO: Mosby 2003.

[4] Diaz E, Rodriguez AH, Rello J. Ventilator-associated pneumonia: issues related to the artificial airway. Respir Care 2005;50(7):900-906.
[5] Guidelines for preventing healthcare-associated pneumonia, 2003 recommendations of the cdc the healthcare infection control practices advisory committee. Respir Care 2004;49(8):926-939.
[6] Fan CM, Chow P, Tsai KC, et al. Tracheal rupture complicating emergent endotracheal intubation. American Journal of Emergency Medicine2004;22(4):289-293.
[7] Lu YH, Hsieh MW, Tong, YH. Unilateral vocal cord paralysis following endotracheal intubation-a case report. Acta Anaesthesiologica Sinica1999;37(4):221-224.
[8] Seegobin R, Hasselet G. Endotracheal cuff pressure and tracheal mucosal blood flow: endoscopic study effects of four large volume cuffs. British Medical Journal 1984;288(6422):965-968.
[9] Stauffer J. Complications of endotracheal intubation and tracheotomy. Respir Care1999;44(7):828-844.
[10] Safdar N, Crnich CJ, Maki DG. The pathogenesis of ventilator associated pneumonia: its relevance to developing effective strategies for prevention. Respir Care 2005;50(6):725-739.
[11] Safdar N, Dezfulian C, Collard HR, et al. Clinical and economic consequences of ventilator-associated pneumonia: a systematic review. Crit Care Med2005;33(10):2184-2193.
[12] Wujtewicz MA, Sawicka W, Sein Anand J, et al. Monitoring of tracheal tube cuff pressure in patients treated in intensive therapy unit and intensive care units. European Journal of Anaesthesiology 2004;21;177.
[13] Kumar SS, Young PJ. Overinflation of the tracheal tube cuff: a case for routine monitoring. Critical Care 2002;6 (Suppl 1):37.
[14] Sultan P, Carvalho B, Rose BO, et al. Endotracheal tube cuff pressure monitoring: a review of the evidence Journal of Perioperative Practice 2011;21:379-386.
[15] Duguet A, D'Amico L, Biondi G, et al. Control of tracheal cuff pressure: a pilot study using a pneumatic device. Intensive Care Med 2007;33(1):128-132.
[16] Sengupta P, Sessler DI, Maglinger P, et al. Endotracheal tube cuff pressure in three hospitals, and the volume required to produce an appropriate cuff pressure. BMC Anesthesiology 2004;4(1):8.
[17] Hoffman RJ, Lipovic D, Sturmann KM, et al. Linear correlation of endotracheal tube cuff pressure and volume. West J Emerg Med 2009;10(3):137-139.