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Original article

Medición del neumotaponamiento con manómetro para prevenir la neumonía asociada a ventilación mecánica en el CEMENAV

Measurement of cuff pressure using a manometer to prevent ventilator-associated pneumonia at CEMENAV

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Resumen

Introducción: Las Infecciones Asociadas a la Atención a la Salud (IAAS) son un problema relevante de salud pública. La Neumonía Asociada a la Ventilación Mecánica (NAVM) es una de las infecciones que se adquiere de forma frecuente. El neumotaponamiento asegura el funcionamiento adecuado de la vía aérea, evitando fugas, broncoaspiraciones o extubación del paciente.

Objetivo: Analizar el impacto del control del neumotaponamiento con el uso del manómetro en la disminución de la neumonía asociada a la ventilación mecánica en los pacientes hospitalizados en la Unidad de Cuidados Intensivos Adultos (UCIA) del Centro Médico Naval.

Metodología: Se realizó un estudio descriptivo, transversal, prospectivo y cuantitativo, con 157 controles de presión de neumotaponamiento en 32 pacientes adultos con ventilación mecánica en la UCIA del Centro Médico Naval. La recolección de datos incluyó análisis estadístico descriptivo de los resultados obtenidos en la medición al inicio de turno y antes de la aspiración de secreciones, confirmación de neumonía mediante cultivos bronquiales y aprobación ética para riesgo mínimo.

Resultados: Se registraron 157 mediciones de neumotaponamiento. Las presiones bajas (< 19 mmHg) predominaron (59 %) y se asociaron con un 13 % de infecciones, mientras que las presiones normales (20-30 mmHg) presentaron una menor incidencia de infecciones (8 %). La mayoría de los pacientes fueron mujeres, con mayor prevalencia en el rango de edad de 65 a 75 años. Las bacterias más frecuentes identificadas fueron Acinetobacter baumannii (16 %), Pseudomonas aeruginosa (10 %), Klebsiella pneumoniae (7 %) y Aspergillus niger (5 %).

Discusión: El estudio resalta que el control adecuado del neumotaponamiento con manómetro reduce la incidencia de NAVM. Hallazgos microbiológicos y demográficos refuerzan diferencias institucionales, mientras el rango crítico de ventilación mecánica (6-12 días) subraya la importancia de estrategias preventivas para pacientes intubados.

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Conclusión: En la UCI es importante disminuir los riesgos de neumonía asociada a ventilación mecánica debido al incremento en la resistencia a los antibióticos. Así mismo, es necesario implementar medidas preventivas que disminuyan dicha incidencia. Se identificó que el personal de salud realiza sus mediciones de manera táctil.

Palabras clave: Control, presión, neumotaponamiento, neumonía, ventilación mecánica.

Abstract

Introduction: Healthcare-associated infections (HAIs) represent a significant public health issue. Ventilator-associated pneumonia (VAP) is one of the most common infections acquired in this context. Cuff pressure management ensures proper airway function, preventing leaks, aspiration, or patient extubation.

Objective: To analyze the impact of cuff pressure control using a manometer on reducing Ventilator-Associated Pneumonia in mechanically ventilated patients hospitalized in the Adult Intensive Care Unit at the Naval Medical Center.

Material and Methods: A descriptive, cross-sectional, prospective, and quantitative study was conducted with 157 cuff pressure controls in 32 adult patients under mechanical ventilation in the Intensive Care Unit of the Naval Medical Center. Data collection included a descriptive statistical analysis of measurements taken at the beginning of shifts and before secretion aspiration, pneumonia confirmation through bronchial cultures, and ethical approval for minimal-risk research.

Results: The study analyzed 32 mechanically ventilated patients, recording 157 cuff pressure measurements. Low pressures (<19 mmHg) were predominant (59%) and associated with 13% of infections, while normal pressures (20-30 mmHg) showed a lower infection rate (8%). Most patients were women, with the highest prevalence in the 65-75 age range. The most frequently identified pathogens were Acinetobacter baumannii (16%), Pseudomonas aeruginosa (10%), Klebsiella pneumoniae (7%), and Aspergillus niger (5%).

Discussion: The study highlights that proper cuff pressure management using a manometer reduces VAP incidence, with lower infection rates in normal pressures (8%) compared to low pressures (13%). Microbiological and demographic findings underscore institutional differences, while the critical mechanical ventilation range (6-12 days) emphasizes the need for preventive strategies for intubated patients.

Conclusion: In the ICU, reducing the risks of VAP is crucial due to increasing antibiotic resistance. Preventive measures must be implemented to decrease this incidence. It was observed that healthcare personnel often rely on tactile methods for cuff pressure measurement.

Keywords: control, pressure, endotracheal tube intracuff inflation, pneumonia, mechanical ventilation.

Introduction

Health Care Associated Infections (HAI) are a relevant public health problem of great economic and social importance, which constitutes a challenge for institutions and health personnel responsible for their care[1]. Therefore, hospital-acquired infections are the cause of the highest morbimortality rates, since they affect the life and health of people, resulting in disability or death, in addition to generating high economic costs in hospitals[2].

Nosocomial pneumonia is one of many infections that hospitalized patients frequently acquire. Specifically, VAP is identified at the clinical level as an infectious complication of pneumonia[3]; most critically ill patients require orotracheal intubation to isolate the airway and ensure effective mechanical ventilation. Airway care is a very important part of the critical care nurse's role[4].

During endotracheal tube placement in mechanical ventilation therapy, knowing how to control the appropriate pressure levels in the endotracheal balloon is an essential aspect to maintain airway care and favor the survival of this type of critically ill patient[11,12]. Inadequate control in pressure management leads to various complications, either due to excess or lack of pressure, according to the standards suggested in the various guidelines.

Many of the complications of mechanical ventilation are related to inappropriate endotracheal tube cuff pressure. In this context, it is a priority for the nursing staff to know and apply the appropriate methods to regulate and control cuff pressure during orotracheal intubation, with the aim of preventing the incidence of VAP in patients hospitalized in the ICU. Airway surveillance constitutes an important part of the nursing staff's duties in the intensive care area. Therefore, a crucial aspect of airway management is the control and maintenance of adequate pneumotach pressure of the orotracheal tube[5]. The control of cuff pressure involves all care to ensure the proper functioning of the tracheal cuff, which seals the trachea creating two distinct compartments between the upper and lower airway[6].

Providing safety for critically ill patients is vital, and nurses play a very important role, as they are the ones who provide daily patient care. There are preventive packages that include a wide range of activities and procedures suitable for preventing and protecting patients from healthcare-related adverse events.

Among such care is the control of cuff pressure, which acts as an obstacle between the walls of the trachea, exerting pressure provided by the air inside the balloon of the endotracheal tube[17]. The Clinical Practice Guideline for the prevention, diagnosis and treatment of VAP and the Zero Pneumonia protocol, within its recommendations, refer that maintaining a pressure of 20 to 30 cm H_2O or 18 to 25 mmHg is considered normal inflation; in addition to monitoring every 6 hours to quickly identify pressure deviations, which allows for their rapid correction[18,19].

Despite advances in medical equipment, palpation estimation is the fastest technique and is the one currently used in intensive care units[13]. The tactile estimation method of inflation may not be the most appropriate method to achieve the correct pressure.

To accurately regulate the cuff pressure, the use of digital or hand-held devices that provide reliable figures is recommended. Measurement with a manometer is most recommended in critical care units[20]. In this context, it is a priority for the nursing staff to know and apply the appropriate methods to regulate and control cuff pressure during orotracheal intubation.

Therefore, the aim of the present study was to analyze the impact of cuff pressure control with the use of a manometer in the reduction of VAP in patients hospitalized in the adult intensive care unit of the Naval Medical Center.

Methodology

A descriptive, cross-sectional, prospective and quantitative study was carried out, in which 125 cuff pressure controls were performed in 32 adult patients with mechanical ventilation admitted to the ICU of the Naval Medical Center.

The sample was calculated by convenience. Patients admitted to the ICU during the three months prior to data collection were considered. Following the inclusion, exclusion, and elimination criteria, 32 patients were eligible. Inclusion criteria included patients over 18 years of age, of either sex, hospitalized in the adult intensive care unit, with invasive mechanical ventilatory support by orotracheal intubation or tracheostomy and without previous diagnosis of pneumonia associated with mechanical ventilation. On the other hand, exclusion criteria considered those patients with underlying respiratory pathologies (COPD, SARS-CoV-2, influenza), with noninvasive ventilatory support, hospitalization in other areas and positive bronchial culture results during monitoring. Likewise, elimination criteria were established, such as withdrawal of invasive ventilatory support due to clinical improvement or death during the study. The variables studied were defined and classified to facilitate their analysis. The presence of pneumonia associated with mechanical ventilation was conceptualized as a pulmonary complication developed after 48 to 72 hours of endotracheal intubation and was clinically diagnosed based on microbiological criteria and classified as a dichotomous variable (1: Yes, 2: No). The method for measuring cuff pressure was defined as the procedure used for this measurement, categorized as palpation or mechanical; for the present study, the latter was considered and its values determined by the established parameters.

Cuff pressure measurements were taken at the beginning of the working day and before secretion aspiration and oral lavage. A conventional manometer (consisting of an aneroid manometer, latex tubing, a three-way stopcock and a 5-10 ml syringe) designed specifically by the investigator for the study was used. The results were classified into three categories: low (< 19 mmHg), normal (20-30 mmHg) and high (> 30 mmHg). In cases where the pressure was not within the appropriate range, adjustments were made to allow air to be insufflated until a safe pressure was reached. In the case that it was not adequate, an adjustment was made in the measurement with the sphygmomanometer until a safe range was reached. These adjustments were

made by the investigator at the beginning and end of each shift.

Figure 1. Device for cuff pressure measurement.

Parts that make up a three-way stopcock

Aneroid manometer

Connection of the manometer to the latex tube

Connect the external balloon of the endotracheal tube to the outlet cap of a three-way stopcock.

Integration of manometer, latex tube and three-way stopcock

A 5 or 10 ml syringe is attached to one of the lines of the valve and is used to blow air into the balloon.

Connecting the device to the endotracheal tube balloon

The external balloon of the endotracheal tube is connected to the outlet plug, while a 5- or 10-ml syringe is attached to line 1 to insufflate 4 to 5 ml of air, reaching a pressure of 20 to 30 mmHg. This adjustment ensures optimal balloon functionality and prevents complications associated with inadequate pressures.

Source: Prepared by the researcher

Data collection was carried out using a questionnaire of our own design that collected general patient data, service of origin, admission diagnosis, history of pneumonia, days hospitalized and with Mechanical Ventilation (MV), tube diameter, cuff pressure and bronchial culture results; this information was recorded in Microsoft Forms. Descriptive statistical analyses were performed in Microsoft Excel for Windows 2010, from which frequencies, percentages and graphs were obtained for the variables studied.

To confirm the presence of ventilator-associated pneumonia, bronchial secretion cultures were taken in the laboratory, which allowed validation of the clinical diagnoses.

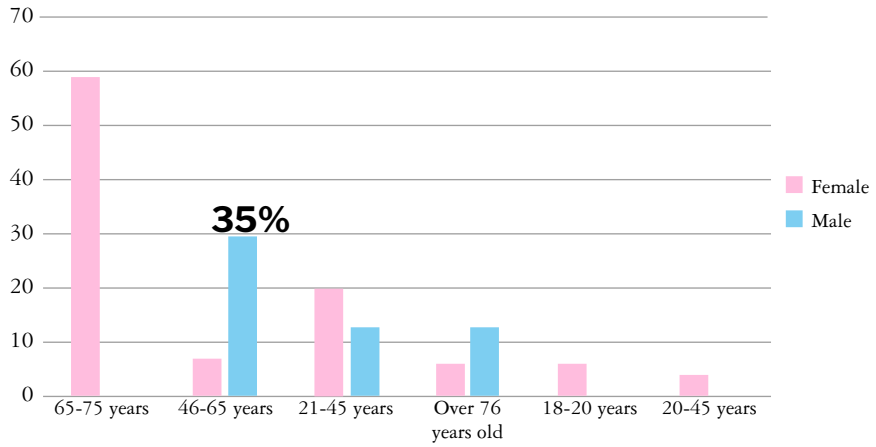
The study was approved by the Bioethics and Research Committee of the Naval Medical Center, as it complied with Mexican

legislation; in addition, data confidentiality and respect for ethical principles were guaranteed. It was considered minimal risk research, since it only included the measurement of cuff pressure, a routine procedure. Due to the physical impossibility of the patients to sign the informed consent, a waiver letter was used, supported by the prior consent signed by the family member or legal representative at admission, which covers invasive procedures, including cuff pressure measurement

Results

During the study period there were a total of 32 patients admitted to the ICU with mechanical ventilation, of which the age range of 65-75 years, as well as female sex had a higher prevalence (Figure 2).

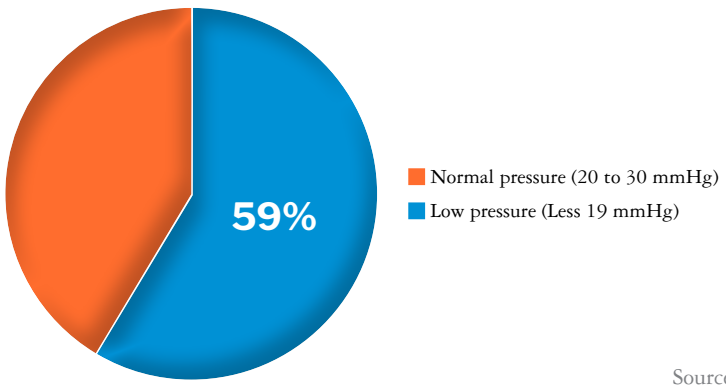
Figure 2. Socio-demographic characteristics



Source: Author›s own elaboration.

A total of 157 cuff pressure measurements were recorded with an average of 5 measurements per patient, 59 % of which corresponded to low pressures (< 19 mmHg), while the rest were distributed between normal (20-30 mmHg) and high pressures (> 30 mmHg) (graph 1).

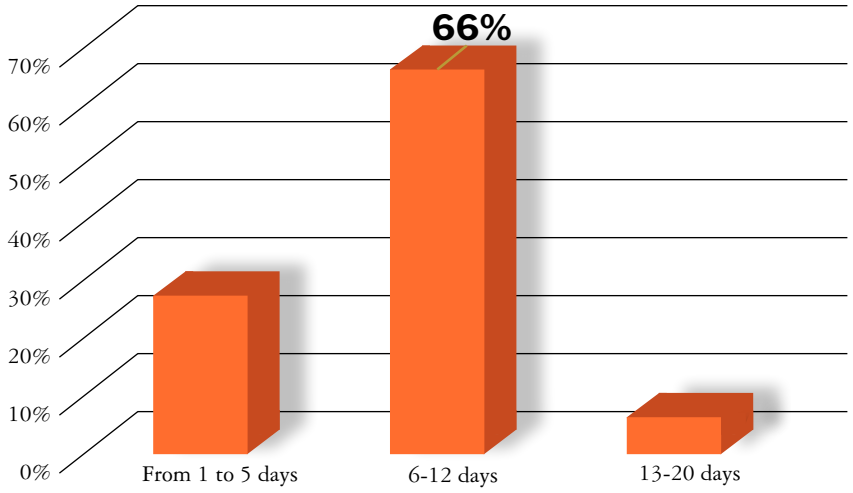
Graph 1. Cuff pressure measurement results



Source: measurement results.

The majority of patients (66%) were under MV for 6 to 12 days, while 27% were under MVA for 1 to 5 days, and only 6% remained for 13 to 20 days.

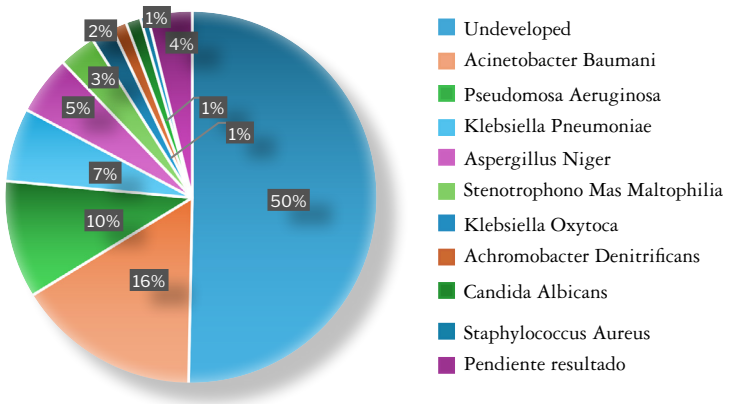
Graph 2. Duration of mechanical ventilatory (MV)



Source: measurement results.

A bronchial secretion culture sample was taken from all patients in the study 48 hours after admission to the ICU. Fifty percent showed no growth of any pathogen. However, of the remaining 50 %, 16 % developed *Acinetobacter baumannii*, 10 % *Pseudomonas aeruginosa* and 7 % *Klebsiella pneumoniae*.

Graph 3. Bronchial secretion sample result



A correlation of patients with low cuff pressure with the occurrence of VAP was performed, which shows that 63% of patients 20 presented low cuff pressure (< 19 mmHg), with 59% of the measurements in this category, and 13% of these associated with infections. On the

other hand, 37 % of the patients12 had normal pressure (20-30 mmHg), representing 41 % of the measurements, with a lower percentage of infections (8 %). In total, 157 measurements were performed in 32 patients, with an overall infection rate of 21%.

Table 1. Relationship between cuff pressure and bronchial secretion sample result

Pressure	*Patients*	*%*	*Number of measurements*	*%*	*Infections*	*%*
Low pressure (under 19 mmHg)	20	63%	92	59%	12	13%
Normal pressure (20 to 30 mmHg)	12	37%	65	41%	5	8%
Grand total	32	100%	157	100%	17%	21%

Discussion

The data suggest that adequate control of cuff pressure by use of the manometer could contribute to decrease the incidence of VAP. Measurements in the normal range (20-30 mmHg) presented a lower association with infections (8 %) compared to low pressures (< 19 mmHg), where an incidence of 13 % was observed. This shows the importance of maintaining adequate pressure to reduce the risk of infectious complications in hospitalized patients under mechanical ventilation.

Ruiz and López[18] evaluated the accuracy of cuff pressure measurement using a manometer (King Systems Corporation, Germany) with pressure units in centimeters of water and a range from 0 to 120. They concluded that endotracheal balloon insufflation is often performed using subjective techniques, which makes it difficult to know the exact pressure exerted on the tracheal mucosa, a practice that could generate complications.

In the present study, the female gender was predominant, and the age range was between 65 and 75 years. These findings coincide with those reported by Miranda Pedrozo[26], who observed that patients over 70 years of age constituted the predominant age group and that the female gender had a higher incidence in his study population.

Regarding the microbiological results, Montelo Rodríguez *et al*.[6] found that Acinetobacter was the predominant microorganism, followed by *Klebsiella pneumoniae* and *Staphylococcus aureus*. However, in the present study, 50 % of the population did not present any pathogen in bronchial secretion culture. Among the remaining 50 %, *Acinetobacter baumannii* was identified in 16 % of the cases, *Pseudomonas aeruginosa* in 10 % and *Klebsiella pneumoniae* in 7 %. This highlights differences in the order of frequency and type of prevalent microorganisms according to the institution, which underlines the importance of the local context in microbiological studies.

Regarding the number of days on mechanical ventilation, 69 % of the patients studied were intubated for 6 to 12 days. These data agree with the conclusions of Arias *et al*.[16], who, in their update of the Zero Pneumonia project, reported that between 62% and 73% of cases of VAPV occur after the fourth day of intubation, with a higher risk between days 6

and 8. This reinforces the recommendations to reduce intubation time to reduce the incidence of this complication.

Conclusion

The study showed that health personnel in the critical areas of this institution mostly use the digito-palpation technique to control cuff pressure, partly due to the lack of adequate devices for objective monitoring. This practice, based on subjective estimates, does not guarantee accurate pressure values, which may increase the risk of complications.

On the other hand, it was confirmed that the use of a manometer allows maintaining a balloon pressure between 20 and 25 mmHg, considered safe to prevent complications such as tracheal ischemia or tissue degeneration. This method, besides being reliable and economical, should be routinely implemented in cuff pressure monitoring to improve the quality of care and patient safety.

Ventilator-associated pneumonia can be prevented by implementing guidelines and protocols based on national and international standards. These recommendations include adequate monitoring of cuff pressure, hand hygiene, reduction of ventilation time and continuous training of critical care staff.

Finally, the routine use of devices to measure cuff pressure could optimize the control of tracheal pressures, allowing real-time detection of variations and reducing the risk of associated complications, thus improving patient safety in intensive care units.

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