RBCMS
Revista Brasileira de
Ciências Médicas e da Saúde
Brazilian Journal of Medical Science and Health

ORIGINAL ARTICLE

PEEP *versus* Conventional Aspiration in Removing Secretions in Patients Under Mechanical Ventilation

PEEP versus Aspiração Convencional na Remoção de Secreções em Pacientes Sob Ventilação Mecânica Invasiva

Bruno Rabite Dornelas

Specialist in in-Hospital Physical Therapy, Coordinator of the ICU Physical Therapy Services of the Therezinha de Jesus Hospital and Maternity Center - HMTJ/JF

ABSTRACT

Objective: To verify the effect of the PEEP in the secretion removal, the saturation of O_2, the arterial pressure and the cardiac frequency of patients under ventilation invasive mechanics when compared with the conventional aspiration. **Methods:** It was collected the variable homodynamic FC, SpO_2, SHOVELS and PAD before and after the endotraqueal aspiration and maneuver of PEEP/aspirations as well as the weighting of the removed secretion of patients of both the sorts that if found in the Unit of Intensive Therapy of the Hospital and Maternity Therezinha de Jesus/JF that auscultates after it pulmonary presented snores. **Results:** The average value of the FC before the accomplishment of the technique of isolated aspiration was of 89.8 ± 0.02 (average ± error standard), after aspiration 99.5 ± 0.02, after the accomplishment of the maneuver of PEEP/aspirations 89.2 ± 0.02. Initial SpO_2 average was of 0.95 ± 0.02, after 0.02 aspiration 0.98 ± and after maneuver of 0.987 PEEP/aspirations ± 0.02. The average weight after PEEP/aspiration was 23.4 ± 0.02 and after 21.5 aspiration ± 0.02. The value in SHOVELS e (122 PAD) initial ± 0.02 (79.5 ± 0.02), after aspiration 131 ± (82.0 ± 0.02) and after 125 0.02 PEEP/aspiration ± 0.02 (80.8 ± 0.02). **Conclusion:** The results indicate that the use of the PEEP associated with the aspiration for the secretion removal infering more effective, beyond having separately possibly collaborated for better homodynamic standards when compared the aspiration maneuver.

Keywords: Positive-Pressure Respiration, Intrinsic; Respiratory Aspiration; Physical Therapy Modalities

RESUMO

Objetivo: Verificar o efeito da PEEP na remoção de secreções, na saturação de O_2, na pressão arterial e na frequência cardíaca de pacientes sob ventilação mecânica invasiva quando comparada à aspiração convencional. **Métodos:** Foi coletado as variáveis hemodinâmicas FC, SpO_2, PAS e PAD antes e após a aspiração endotraqueal e manobra de PEEP/aspiração assim como a pesagem da secreção removida de pacientes de ambos os sexos que se encontravam na Unidade de Terapia Intensiva do Hospital e Maternidade Therezinha de Jesus/JF que após a ausculta pulmonar apresentavam roncos. **Resultados:** O valor médio da FC antes da realização da técnica de aspiração isolada foi de 89,8 ± 0,02 (média ± erro padrão), após aspiração 99,5 ± 0,02, após a realização da manobra de PEEP/aspiração 89,2 ± 0,02. A média SpO_2 inicial foi de 0,95 ± 0,02, após aspiração 0,98 ± 0,02 e após manobra de PEEP/aspiração 0,987 ± 0,02. O peso médio após PEEP/aspiração foi 23,4 ± 0,02 e pós aspiração 21,5 ± 0,02. O valor na PAS e (PAD) inicial 122 ± 0,02 (79,5 ± 0,02), pós aspiração 131 ± 0,02 (82,0 ± 0,02) e pós PEEP/aspiração 125 ± 0,02 (80,8 ± 0,02). **Conclusão:** Os resultados indicam que a utilização da PEEP associada à aspiração para a remoção de secreções mostou-se mais efetiva, além de ter possivelmente colaborado para melhores padrões hemodinâmicos quando comparada a manobra de aspiração isoladamente.

Palavras-chave: Fisioterapia; Respiração Artificial; Respiração com Pressão Positiva

INTRODUCTION

Physical therapy is increasingly active in intensive care units (ICUs) and at various stages of the patient's recovery[1,2]. Respiratory physical therapy plays an important role in the ICU, by assisting in the preparation and settings of mechanical ventilators, participating in the use and discontinuation of mechanical ventilation (MV), and in kinesiotherapeutic rehabilitation[1,2].

Mechanical ventilation is administered in patients unable to maintain adequate alveolar ventilation, in order to help clear the airways, optimize gas exchanges and prevent respiratory muscle fatigue[1-3,4]. However, the use of MV may cause injuries to patients, such as the accumulation of secretions due to ineffective coughing, which occurs as a result of impaired mucociliary clearance and no-closure of the glottis[5-7,8]. Due to the retention of secretions, hypoxemia, atelectasis and pneumonia are commonly associated with MV, which contributes to a longer hospitalization of patients[5,7-9].

Some techniques are routinely used for bronchial hygiene, such as aspiration and airway clearance maneuvers, and the combination of techniques is widely used in physical therapy[1,2,6,8].

Improvements in respiratory mechanics and gas exchanges have been reported after displacement of secretions achieved with the use of various bronchial hygiene techniques. Airway clearance techniques are one of the basic tools used by respiratory physical therapists, and is defined as the external application of a combination of forces to increase mucus transport in the airways[10].

According to the American Association for Respiratory Care (AARC)[11], endotracheal aspiration is one of the most performed procedures in patients with artificial airways. It is a component of bronchial obstruction therapy and MV, which involves the aspiration of pulmonary secretions to prevent airway obstruction caused by mucus. The AARC recommends that the aspiration of secretions should be initiated in response to clinical signs and symptoms, such as respiratory distress, secretion within the cannula, agitation and fall of saturation (measured by pulse oximetry).

According to Presto B (2009)[12], another resource used for the treatment of intubated critically ill patients is Positive End-Expiratory Pressure (PEEP), which can be basically defined as the maintenance of positive pressure within the airway (AW). Theoretically, one of its main effects is that, when PEEP is increased for at least 30 seconds, gas is redistributed through collateral ventilation, reaching adjacent alveoli previously collapsed by mucus. This redistribution induces the reopening of small airways, detaching the mucus from their walls. This technique is considered one of the best treatment modalities for acute lung injury, inducing greater alveolar recruitment and reopening of previously collapsed airways, and improving gas exchange when applied appropriately[13].

However, little is known about the use of PEEP for removing secretions. Thus, this study aimed to investigate the effects of PEEP on secretions removal, O_2 saturation, arterial blood pressure and heart rate of patients under invasive mechanical ventilation, when compared with conventional aspiration.

METHODS

This study was conducted with patients of both sexes for a period of four months at the Intensive Care Unit (ICU) of a teaching hospital. Inclusion criteria were: patients who required more than 48 hours of mechanical ventilation, were hemodynamically stable, had rhonchi on auscultation of the lungs and were ventilated with a maximum PEEP of 8 cmH_2O.

These patients were auscultated and evaluated by a single physical therapist, who used a Rappaport stethoscope (Wenzhou Instruments, China, 2006). 15 patients were evaluated during the study, but only 10 remained within the inclusion criteria. Three patients died and two were not allowed to participate in this study.

All selected patients underwent the procedure at least four times (two days of data collection), depending on their to the length of hospitalization. A total of 59 procedures were performed.

Two clearance techniques were used 30 minutes apart: conventional aspiration and PEEP/aspiration. The order of performance of the techniques (first aspiration and then PEEP/aspiration or vice versa) varied according to the day of the visit. Endotracheal bronchial aspiration was performed through an open system, by connecting a disposable Mark Med silicone probe Nº 14 (Mark Med, Brazil, 2010) to the vacuum gauge, increasing the inspired oxygen fraction (FiO_2) of the ventilator to 100%, and waiting 1 minute before opening the vacuum system. The patient was disconnected from the ventilatory support at the time when the probe was introduced into the endotracheal tube with the aspiration cannula clamped. The aspirated secretions were drained into a 70-ml sample collection bottle (Broncozamm TR, Brazil, 2008), which was connected to the vacuum gauge cannula. The secretion was subsequently weighed on an electronic precision balance (DiamondModel 500, China, 2010). The bottle weight was discounted from the value obtained. To prevent loss of secretion, the aspiration circuit was constantly washed with saline (0.9% NaCl solution). The amount used was discounted from the total material collected. This technique was performed for a maximum of 15 seconds, during which the patient was disconnected from the ventilator. The physical therapist wore cap, protection glasses, gown, mask, procedure gloves and sterile gloves. In order to perform PEEP/aspiration, the physical therapist begins with PEEP at 8cmH_2O, and then increases 2cmH_2O, so that a PEEP of 10 cmH_20 is applied. This PEEP value is maintained for 5 minutes. Then endotracheal aspiration, as well as the aforementioned procedures are performed. The following hemodynamic variables were collected before and after each procedure: HR, SpO_2, SBP and DBP.

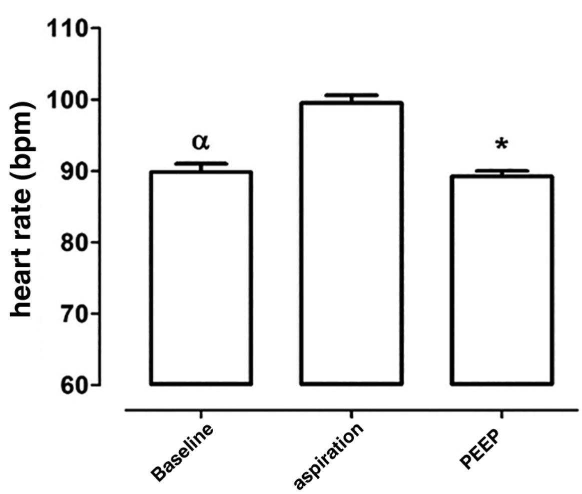
This study was approved by the Research Ethics Committee, protocol 018/08, in accordance with the provisions of Resolution 196/96 of the regional Board of Education. Those persons legally responsible for the patients authorized their participation in the study by signing an informed consent form. The data collected were analyzed using Student's *t* test and evaluated by mean ± standard deviation, at a significance level of $p<0.05$.

RESULTS

After sample selection and data collection and analysis were completed, we found that the mean age of the patients was 62.2 ± 10.7 years. Six patients were male. Regarding the reason for admission to the ICU, 60% (six patients) had Pulmonary Acute Respiratory Failure (ARF) as underlying lung disease, 30% (three patients) had cerebral vascular accident (CVA) and 10% (one patient) had pneumonia. The mean hospital stay was 36.3 ± 23.2 days.

With regard to the techniques used (aspiration and PEEP/aspiration), we obtained the following hemodynamic parameters before and after their performance: Heart rate (HR), systolic blood pressure (SBP) and Peripheral Oxygen saturation in the blood (SpO_2).

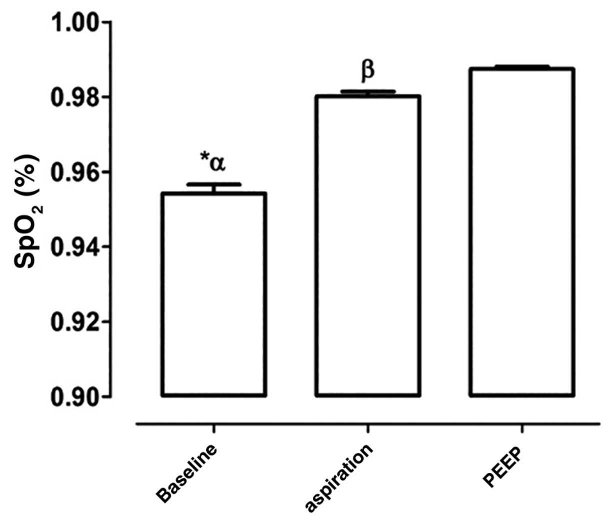
The mean HR value was 89.8 ± 0.02 (mean ± standard error) before aspiration, 99.5 ± 0.02 after aspiration alone and 89.2 ± 0.02 after PEEP/aspiration ($p<0.05$), as shown in Graph 1.



α p<0.001 vs aspiration
* p<0.001 vs aspiration

Graph 1

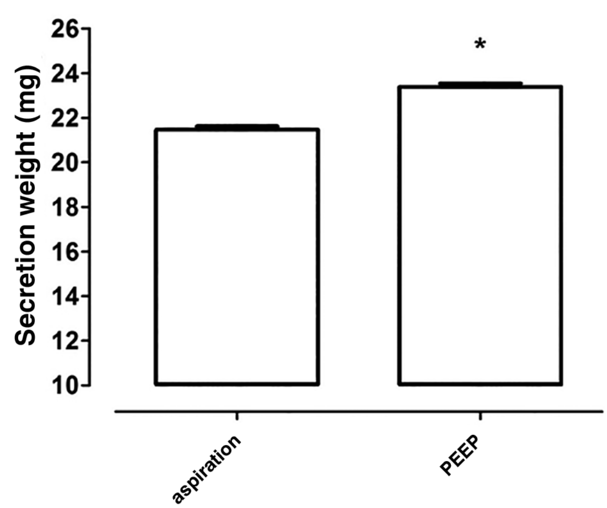
The mean SpO_2 was 0.95 ± 0.02 before aspiration,0.98 ± 0.02 after aspiration and 0.987 ± 0.02 after PEEP (Graph 2).



* p<0.001 vs aspiration
α p<0.001 vs PEEP
β p<0.001 vs PEEP

Graph 2

The mean weight of secretion was 23.4 ± 0.02 after PEEP/aspiration and 21.5 ± 0.02 after aspiration, as shown in Graph 3.

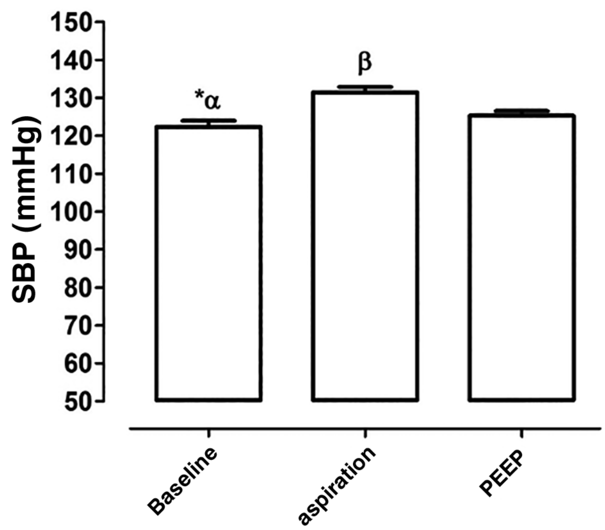


* p<0.001 vs PEEP

Graph 3

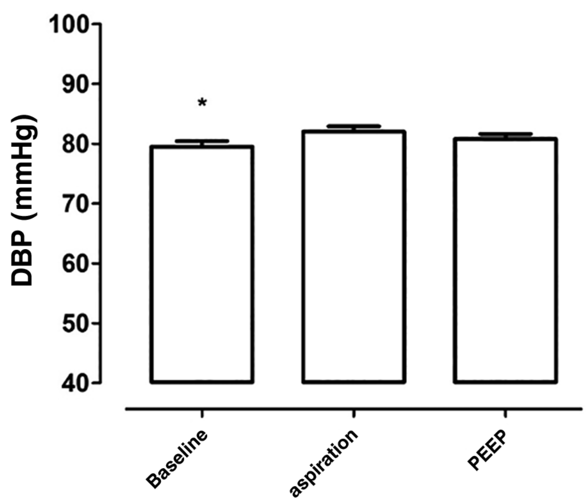
The mean SBP value after aspiration was higher (131 ± 0.02) than the mean SBP values obtained after PEEP/aspiration (125 ± 0.02) and before aspiration (122 ± 0.02), with $p<0.05$ (Graph 4).

The mean DBP) was 79.5 ± 0.02 before aspiration, 82.0 ± 0.02 after aspiration and 80.8 ± 0.02 after PEEP/aspiration, with $p<0.05$ (Graph 5).



* p<0.001 vs aspiration
α p<0.001 vs PEEP
β p<0.001 vs PEEP

Graph 4



* p<0.001 vs aspiration

Graph 5

DISCUSSION

Positive End-Expiratory Pressure (PEEP) is the maintenance of positive pressure within the airway (AW). It is responsible for an increase in functional residual capacity (FRC). FRC increases because PEEP delays expiration, causing a greater volume of gas to be trapped in the lungs at the end of expiration. In addition to increased FRC, its beneficial effects also include: Increase in lung compliance, increase in PaO_2, redistribution of alveolar and interstitial fluid into the vascular space, alveolar recruitment, displacement from the point of equal pressure to more central AWs. Among its side effects are barotrauma, reduced venous return (caused by reduced cardiac output and reduced systemic blood pressure due to the reduction in preload caused by an increased mediastinum).

The heart is located in the mediastinum, which is situated between the lung. So, when lung compliance is increased, a compression of the vena cava may occur, leading to reduced venous return. Another effect of PEEP that may lead to reduced cardiac output is related to the excessive increase of the alveolar-capillary area. In this case, the overstretched alveoli - which have greater pressure than the capillaries - prevent blood flow, increasing thereby the post-load of the right ventricle. Therefore, the hemodynamic function of patients receiving PEEP over 10 cmH_20 should be properly monitored. In addition, it can lead to changes in the biomechanics of respiratory muscles and increased alveolar dead space. However, it is important to remember that most deleterious effects come from the use of large amounts of PEEP[12,14]. In our study, the greater amount of secretion removed (23.4 ± 0.02 mg), the decrease in HR (89.2 ± 0.02 bpm), the lower mean values of SBP (80.8 ± 0.02 mmHg) and DBP (80.8 ± 0.02 mmHg) measured after performance of PEEP/aspiration, when compared to aspiration alone, are probably a result of the use of PEEP.

Lobo et al., (2010)[15] compared the applicability of the Bag-squeezing or Squeezing maneuver with the applicability of the ZEEP maneuver in patients undergoing mechanical ventilation. The authors compared the hemodynamic variables of SBP, DBP, SpO_2 and HR, and the amount of secretion removed at three different moments: before, during and after performing each technique. The hemodynamic variable of SpO_2 was significantly reduced before and during the Squeezing maneuver, but no statistically significant differences were found when compared to ZEEP maneuver. HR was statistically different at two moments when the Squeezing technique was used (before and during). With regard to SBP and DBP, the authors found no significant changes when comparing both techniques. There was also no statistically significant differences between the two techniques in relation to the amount of secretion removed. However, a greater effectiveness of the squeezing technique was expected, since this maneuver enhances the elastic recoil force of the lungs, favoring an increased expiratory flow and thus increasing mucus transport in the airways[2].

According to Lemes et al., (2007)[15,16], who conducted a systematic review, manual hyperinflation and hyperinflation by mechanical ventilation are effective in removing secretions and improving the levels of PaO_2 and consequently increasing SpO_2. However, hyperinflation by mechanical ventilation allows greater control of hemodynamic parameters, because there is no disconnection of the endotracheal tube, which ensures greater comfort to patients. Nevertheless, the studies reviewed used various PEEP levels, which makes it impossible to set an optimal level for the performance of such a maneuver. In our study, PEEP was increased to 10 cmH_2O and followed by aspiration, which resulted in a greater removal of secretion and better hemodynamic levels, when compared to the aspiration alone. This is possibly due to the redistribution of alveolar gas and maintenance of the alveolar opening for a longer period of time, which is made possible by PEEP[12].

The use of endotracheal suctioning is common in the ICU to preserve patency of the airways, oxygenation and good ventilation. It is used either in association with open aspiration systems or closed aspiration systems[17-19].

During aspiration, vagal reflex stimulation may be produced by the insertion of the probe beyond the necessary length. This may cause some hemodynamic changes, such as increased heart rate, loss of alveolar recruitment caused by excessive vacuum, bronchial constriction, fall of lung-volume and decreased SpO_2[12,18,19]. Analyzing the results obtained in our study, we found improvements in SpO_2 after aspiration. However, there was also an increase in HR and SBP and DBP after aspiration, when compared to PEEP/aspiration.

Studies show that using open aspiration systems may cause some injuries to patients, such as: small areas of hypoxia during MV disconnection; increased risk of bacterial colonization, predisposing patients to pneumonias associated with mechanical ventilation; and negative hemodynamic effects. Thus, the use of a closed aspiration system is preferred[2,17-19]. Nevertheless, open aspiration systems have been widely used in clinical practice, which may have influenced the statistically significant changes found in our study for the hemodynamic variables of HR, SpO_2, SBP, DBP before and after aspiration, as the open aspiration system was used.

Analysis the results, we found that the hemodynamic variable SBP was significantly altered after aspiration, when compared to the SBP values measured before the procedure and after PEEP/aspiration. This corroborates the results of Rosa et al. (2007)[7], who showed that SBP increased significantly after aspiration, probably due to the disconnection of the MV.

Also according to the III Brazilian Consensus on Mechanical Ventilation (2007)[2], sudden chest compression, also known as manual chest compression, is a clearance technique. A study conducted by Santos et al., (2009)[21] compared chest manual compression (CMC) and PEEP-ZEEP, and showed an improvement in SpO_2. However, it is not possible to assert that the routine use of this technique can optimize the removal of secretions, as it is only described in the literature in association with other clearance techniques[2,21]. Naueet al., (2014)[22] associated chest compression with higher levels of ventilatory support pressure and found no significant differences in HR when assessing the hemodynamic effects of the procedure. However, they found an increased amount of secretion removal, when compared to the control group. This procedure is in line with the findings of this study regarding the combination of different techniques aimed at removing lung secretions.

However, we found that the use of PEEP and mechanical ventilation (for a short period of time) associated with aspiration results in better hemodynamic responses and removes a larger volume of secretion, malking the use of other clearance techniques unnecessary.

CONCLUSION

The results indicate that the combined use of PEEP and aspiration for the removal of secretions was more effective than aspiration alone, and might have contributed to better hemodynamic features. Although PEEP is widely used in alveolar recruitment, there is little evidence on the use of this technique alone for removal of secretions. Thus, we suggest that further studies are warranted on this topic.

REFERENCES

1. Stiller K. Chest physiotherapy in Intensive Care* Towards an Evidence-Based Practice. Chest 2000;118;1801-1813.

2. Jerre G, Beraldo MA, Thelso de Jesus Silva, et al. III Consenso de Fisioterapia: Fisioterapia no Paciente sob Ventilação Mecânica. Rev Bras de Ter Intensiva 2007:19:3:399-407.

3. Lopes FM, Brito ES. Humanização da assistência de fisioterapia: estudo com pacientes no período pós-internação em unidade de terapia intensiva. RevBras Ter Intensiva. 2009; 21(3):283-291.

4. Faustino EA. Mecânica Pulmonar de Pacientes em Suporte Ventilatório na Unidade de Terapia Intensiva. Conceitos e Monitorização. Revista Brasileira de Terapia Intensiva 2007; 19:2:161-169.

5. Konrad F, Schreiber T; Brecht-Kraus D et al. Mucociliary Transport in ICU Patients. Chest 1994;105;237-241.

6. Trindade SHK, de Mello Júnior JF, Mion OG. Métodos de estudo do transporte mucociliar. RevBras de Otorrinolaringol 2007; 73: 704-12.

7. Rosa FK, Roese CA, Savi A, et al. Comportamento da Mecânica Pulmonar após a Aplicação de Protocolo de Fisioterapia Respiratória e Aspiração Traqueal em Pacientes com Ventilação Mecânica Invasiva. RevBras de Terapia Intensiva 2007; 19:2:170-175.

8. Carvalho CRR· Pneumonia associada à ventilação mecânica. J BrasPneumol 2006;32: 20-22.

9. Zeitoun SS, Barros ALBL, Diccini S et al. Incidência de Pneumonia Associada à Ventilação Mecânica em Pacientes Submetidos à Aspiração Endotraqueal pelos Sistemas Aberto e Fechado: Estudo Prospectivo- Dados Preliminares. Rev. latino-am. Enfermagem 2001 (9): 1: 46-52.

10. Diaz E, Rodríguez AH, Rello J. Principais Manobras Cinesioterapêuticas Manuais Utilizadas na Fisioterapia Respiratória: descrição das técnicas. Rev de Ciências Médicas 2009; 18: 35-45.

11. AARC clinical practice guideline: endotracheal suctioning. respiratory care 2010 (55):6.

12. Presto BLV, Presto LDN. Fisioterapia Respiratória - uma nova visão. 3nd ed. Rio de Janeiro: BP, 2007.

13. Mazzonetto et al. Análise da Oxigenação e Ventilação na Aplicação de Métodos de Cálculo de Pressão Positiva no Final da Expiração (PEEP) Ideal em Pacientes com Síndrome da Angústia Respiratória Aguda. Revista Brasileira Terapia Intensiva 2004:(16):2.

14. M. Vargas, Y. Sutherasan, C. Gregoretti, et al. PEEP Role in ICU and Operating Room: From Pathophysiology to Clinical Practice. ScientificWorld Journal. (2014).

15. Lobo DML, Cavalcante LA, Mont'Alverne DGB. Aplicabilidade da Manobra de Bag Squeezing com a Manobra de ZEEP em Pacientes Submetidos à Ventilação Mecânica. RevBras Ter Intensiva 2010; 22(2):186-191.

16. Lemes DA, Guimarães SF. O Uso da Hiperinsuflação como Recurso Fisioterapeutico em Unidade de Terapia Intensiva. Revista Brasileira de TerapiaIntensiva 2007:19:2:222-225.

17. Pagotto IM, Oliveira LRC, Araújo FCLC et al. Comparação entre os Sistemas Aberto e Fechado de Aspiração. Revisão sistemática. Rev. Bras. Ter Intensiva. 2008; 20(4): 331-338.

18. Lasocki S, Lu Q, Sartorius A, et al. Open and Closed-circuit Endotracheal Suctioning in acute lung injury: effi-ciency and effects on gas exchange. Anesthesiol 2006;104(1):39-47.

19. De Carvalho WB, Johnston C. Panorama Internacional: Análise comparativa dos sistemas de aspiração traqueal aberto e fechado. RevAssocMedBras 2007; 53(2): 95-107.

20. Lopes FM, López MF. Impacto do sistema de aspiração traqueal aberto e fechado na incidência de pneumonia associada à ventilação mecânica: revisão de literatura. RevBras Ter Intensiva. 2009; 21(1):80-88.

21. Santos FRA, Schneider Júnior LC, Forgiarini Junior LA, et al. Efeitos da compressão torácica manual versus a manobra de PEEP-ZEEP na complacência do sistema respiratório e na oxigenação de pacientes submetidos à ventilação mecânica invasiva. RerBras Ter Intensiva. 2009; 21(2):155-161.

22. Naue WS, Forgiarini Junior, LA, et al. Compressão torácica com incremento da pressão em ventilação com pressão de suporte: efeitos na remoção de secreções, hemodinâmica e mecânica pulmonar em pacientes em ventilação mecânica*. J Bras Pneumol. 2014; 40(1):55-60.