Efficacity of Ventilator Strategy in A.R.D.S (Acute Respiratory Distress Syndrome).

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Abstract

Background: ARDS is defined as pulmonary inflammatory process characterized by increased capillary permeability associated with acute severe hypoxemia and bilateral infiltrates on the chest radiograph. Chlinical manifestations of ARDS is associated with a reduction of functional residual capacity and static compliance of the respiratory system.Recently,after experimental models and physiological studies have just established the principles to understand the potential beneficial effects of PEEP and reduction in mortality to 22%. The benefit of PEEP has been demonstrated in terms of preventing cyclic opening and collapsing alveoli in acute respiratory distress syndrome patients (ARDS).

Aim of study: To determine the appropriate PEEP level in-patients with ARDS.

Objective: By using optimal PEEP:to realize the maximal alveolar recruitment.To avoid the decrease of oxygen delivery (DO2) as result of an unfavourable reduction in cardiac output.

Material and methods: Retrospectiv study of 120 patients which only 63 of them are included in study with age 18-70 years old.(2012-2014) The entry criteria were clinically (severe dyspnoea, tachypnea, cyanosis); PaO2/FiO2 <200mmHG, the presence of bilateral chest infiltrates. The exclusion criteria were: aged < 18 yrs, COPD in history of diseases, heart attack; PEEP was set the level that provided the greatest improvement in oxygenation. The optimal PEEP came as a result of gradual increase of PEEP from 2-5 cmH2O every 6 hours, depended on gas analyses. The right PEEP level is the PEEP allowing the highest PaO2 value without causing hemodynamic compromise.

Results: During this study we conclude that the gradual increase of PEEP improves significantly arterial oxygen tension (PaO2). Per value of PEEP 9.6-15.8, CI 95% is 145.9-191.8. The Pearson test with a significant correlation coefficient of level 0.995 and significance level 0.000 shows also a very important result. It was considered significant statistically the value of $P \leq 0.05$. Also, the value of Chi ^{2} of PaO_2 and of PEEP, has resulted significant in 0.950 with $P < 0.001$.

Conclusion: Mechanical ventilation using optimal PEEP increases the value of PaO2. As a matter of fact, 88% of cases with PaO2 > 220 mmHg survive. The role of PEEP in clinical practice is still debated but, in selected categories of patients with a careful monitoring, it may play an important role in improving outcome.

Key words: PEEP, PaO2, mechanical ventilation, ARDS

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Full Text

Introduction

Modern artificial ventilation (AV) started 60 years ago. First time it has been used by Danish doctors, when the country was hit by the polio epidemic of 1952 to 1953 years. The problem of lung congestion, "stiff-lung" was resolved. In Europe this method spread very quickly. AV few months allowed to be treated successfully in cases of alveolar hypoventilation in patients with neuromuscular coma and barbiturates. [1,2,3,4]

A new era began in the late fifties, when AV was applied on patients with decompensate chronic obstructive pulmonary disease, which lead to respiratory encephalopathy almost always lethal. Changes in the early sixties took place. There are many studies and surveys published cases of acute respiratory distress syndrome with different etiologies. [5,6]

1967 ASHBAUGH and his colleagues regrouped under the term "Adult Respiratory Distress Syndrome " (ARDS); they proposed a single interpretation that allows integration of all clinical, radiological, evolutionary and anatomical different state such as acute respiratory failure, acute viral pneumonia, the embolism from fats, acute pancreatitis, the toxic coma etc.[8]

This new treatment of ARDS proposed maintaining a positive pressure. In Albania patients with ARDS were diagnosed in early 1982-1983.

It was necessary to formulate a clear definition of the syndrome. Such a definition was developed in 1994 by the American-European Consensus Conference (AECC) on Acute Respiratory Distress Syndrome (ARDS). The term “acute respiratory distress syndrome” was used instead of “adult respiratory distress syndrome” because the syndrome occurs in both adults and children. [7]

ARDS is a syndrome that commonly begins after exposure to a known risk factor. Why some people develop ARDS and others do not is still unknown. The risk factors for ARDS include primary pulmonary etiologies (, aspiration, pneumonia, toxic inhalation, pulmonary contusion) and extra pulmonary etiologies (sepsis, pancreatitis, multiple blood transfusions, trauma, use of drugs such as heroin). Sometimes, ARDS is not only a reaction to another event but also the result of a known cause, such as an acute interstitial pneumonia (AIP) or a severe, extensive, infectious pneumonia.[9,10,11,12]

In 2012, the ARDS Definition Task Force met in Berlin and decided on a new and improved definition of ARDS using 3 mutually exclusive categories of ARDS based on the degree of hypoxemia:

- Mild: $PaO_2/FIO_2 \leq 300$ mm Hg but > 200 mm Hg
- Moderate: $PaO_2/FIO_2 \leq 200$ mm Hg but > 100 mm Hg
- Severe: $PaO_2/FIO_2 \leq 100$ mm Hg

The Berlin Definition outlines stages of mild, moderate, and severe ARDS as associated with increased mortality and increased duration of mechanical ventilation in survivors and was found to be more predictive than the prior AECC definition.[13,14,15,16]

Mild, moderate, and severe ARDS were associated with increased mortality rates (27%, 32%, and 45%, respectively; $P < .001$) and increased median duration of mechanical ventilation in survivors (5, 7, and 9 days; $P < .001$).

Four ancillary variables for severe ARDS, to include radiographic severity, respiratory system compliance (≤40 ml/cm water), positive end-expiratory pressure (≥10 cm water), and corrected expired volume per minute (≥10 L/min), were not predictive, and it was decided to drop them from the definition.[17,18]

The purpose and objectives of the study

To determine the optimal level of PEEP in order to achieve a maximal alveolar recruitment through the appropriate levels of oxygenation.

Material and methods

Of the 120 patients in the study they were included 63 of them aged 18-70 years admitted to the Intensive Care Service of Pulmonary and Critical Care of the polyvalent University Hospital Centre, Tirana during 2012-2014. Inclusion criteria of patients with ARDS defined by clinical data (severe dyspnea, tachypnea, cyanosis). Arterial blood gas shows refractory hypoxemia progressively. PaO2 / FiO2 <200 mmHg; X-ray examination with bilateral diffuse alveolar infiltration; Exclusion criteria ;Patients with chronic obstructive pulmonary disease (COPD), previous myocardial infarction, neuromuscular disease that may impair breathing, patients with hemodynamic instability, patients operated by pneumonectomy , lobectomy, pulmonary biopsy, patients with pneumothorax (PNX), patients with pulmonary hypertension ,patients aged under 18 years.

Variables	**Protocol**
Regimes in ventilator	Volume assist - controll
Tidal volume	≤ 10 ml /kg weight
Pressure plateau	≤ 30cmH2O
Respiratory frequency	6 – 35 / min ; goal to achieve Ph ≥ 7 . 30
I : E	1:1 - 1:3
The goal of achieving oxygen	55 ≤ PaO2 ≤ 80mmHg or 88 ≤ SpO2 ≤ 95%
Fi/O2 / PEEP (mmHg)	0.3/5, 0.4/5, 0.5/8, 0.5/10, 0.6/10, 0.7/10, 0.7/12 , 0.7/14 , 0.8/14, 0.9/ 14, 0.9 / 16, 0.9/16 , 0.9/18
Weaning from ventilator	FiO2/PEEP ≤ 40/8

Table 1: *Protocol regimes imposed on ventilator variables*

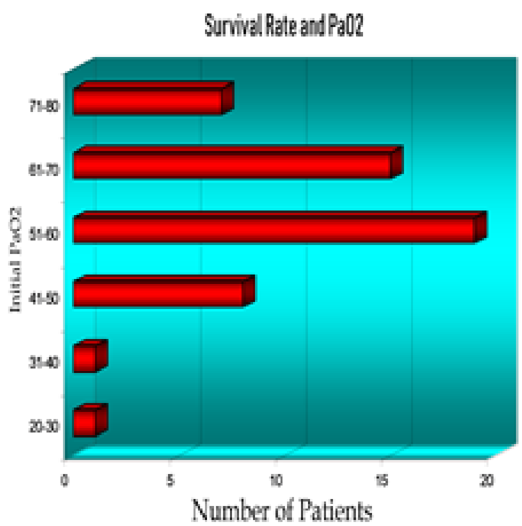
Statistical analysis

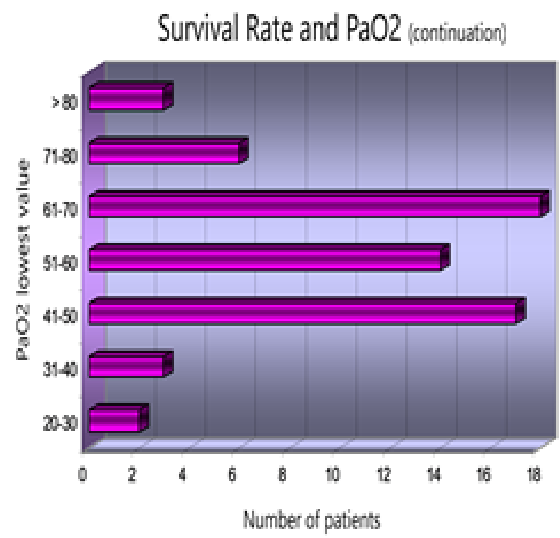
Processing of the obtained results is made by the method of analysis of variance (ANOVA) using SPSS14, statistical program (Statistical Program for Social Sciences). In statistical processing are determined by Pearson correlation initial PaO2 values, lower PaO2, best PaO2 and highest PEEP giving the average, standard deviation, and the average standard error. Also, by standard deviation is done with Pearson correlation to determine the initial values of shunt, shunt with minimal PEEP, shunt with maximum PEEP. Also, this correlation determines values of DO2 (delivery of oxygen) and PEEP, CF (cardiac frequency) and PEEP, MAP (mean arterial pressure) and PEEP. To evaluate the relationship between the values of PaO2 and PEEP are performed statistical analysis: average, the error standard and error average of deviation standard. (One Sample Statistics) and (One Sample Test which sets t statistic, is significant, the average error and confidence interval (95% CI) values of probability (P value). It is evaluated as statistically significant $P \leq 0.05$. Also, to evaluate the link between the values of PaO2 and PEEP correlation of Pearson and CHI2 test (Chi Square) were performed. For the initial values of PaO2, lower PaO2, best of PaO2 and highest

PEEP value were performed by Pearson correlation too. Correlation of 0995 shows that it is significant at the level of values 0.01. Whereas higher chi square test shows that this value is reliable. Also, these values are presented in Box plot (distribution of variance around the average).

Results

Presentation of the PaO2 values and the number of patients in the table presented by Survival and PaO2 shows the PaO2 initial values, PaO2 lower values and higher PaO2. Processing of these statistical study therefore PaO2 values and PEEP is presented in the following table which sets out the average, standard deviation and average deviation error standard. (One Sample Statistic). Presentation of statistical values, is significant and 95% confidence interval is given in the following table (One Sample Test).





Figures 1, 2: *Presentation of the PaO2 values and the number of patients*

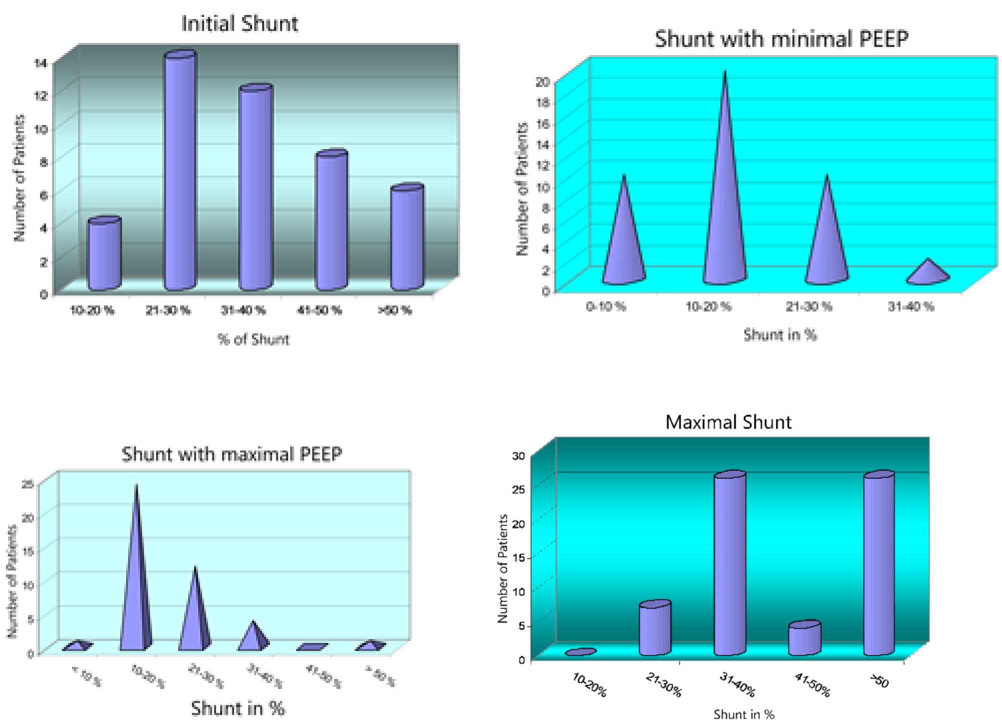
One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
PAO2FIL	29.908	42	.000	57.0233	53.1756	60.8709
PAO2KEQ	20.277	42	.000	57.4419	51.7251	63.1587
PAO2MIRE	14.840	42	.000	168.8605	145.8973	191.8236
PEEPLART	8.418	22	.000	12.6957	9.5680	15.8233

Table 2: *The PaO2 values and PEEP*

Table 2 sets out the average, standard deviation and average deviation error standard regarding PaO2 values and PEEP. (One Sample Statistic).

Presentation of shunt values and PEEP



***Figures 3,4,5,6:** Presentation of shunt values and PEEP. The values of the maximum PEEP and shunt.*

To evaluate the relationship between shunt values and PEEP values are presented as a percentage of initial of shunt and PEEP, shunt with minimum and maximum PEEP. Relation of shunt and PEEP is given in the following tables (initial values of shunt, shunt with minimal PEEP, maximum shunt and shunt with maximum PEEP.

Presentation of values of PEEP and DO2 (delivery of oxygen and PEEP). Evaluation of the relationship between values of PEEP and DO2 (delivery of oxygen and PEEP) is performed by using Pearson correlation. This correlation is valid at 0433 value, a relatively good value.

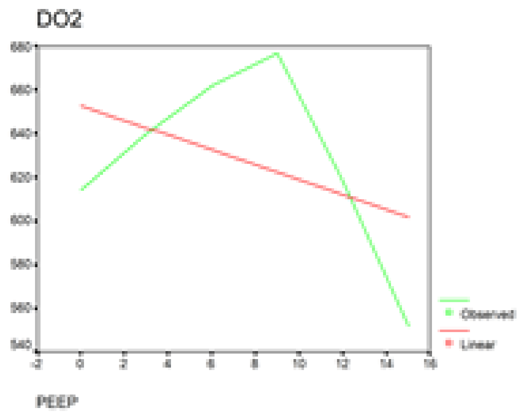


Figure 7: *Presentation of values of PEEP and DO2*

Correlations

		DO2	PEEP
Pearson Correlation	DO2	1.000	-.433
	PEEP	-.433	1.000
Sig. (2-tailed)	DO2	.	.391
	PEEP	.391	.
N	DO2	6	6
	PEEP	6	6

Table 3: *PEEP and DO2 presented by Pearson correlation.*

Correlations

		PACO2	PEEP
Pearson Correlation	PACO2	1.000	.967**
	PEEP	.967**	1.000
Sig. (2-tailed)	PACO2	.	.002
	PEEP	.002	.
N	PACO2	6	6
	PEEP	6	6

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4: *Presentation of PaCO2 values and PEEP.*

Evaluation of the relationship between the values of PaCO2 and PEEP is performed by using Pearson correlation; the value 0.967 shows that the correlation is significant at the 0.01 level. Further presentation of these values is shown graphically.

Correlations

		FC	PEEP
Pearson Correlation	FC	1.000	.995**
	PEEP	.995**	1.000
Sig. (2-tailed)	FC	.	.000
	PEEP	.000	.
N	FC	6	6
	PEEP	6	6

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5: *Presentation of values of CF and PEEP.*

Evaluation of the relationship between values of CF (cardiac frequency) and PEEP is carried out using Pearson correlation. This value is 0995. (close theorist). This correlation is significant at the 0.01 level.

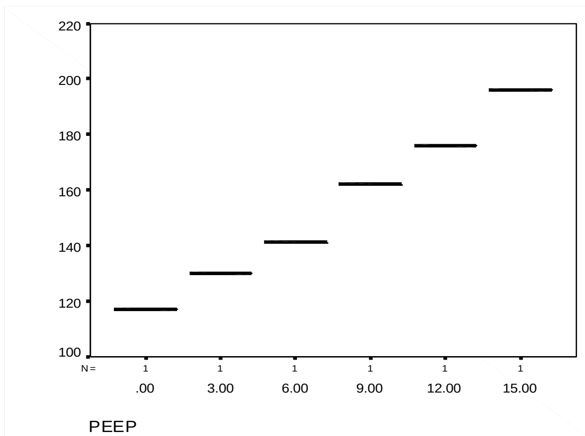


Figure 8: *Presentation of the PaO2 values and PEEP presented in Box plot (distribution of variance around the average).*

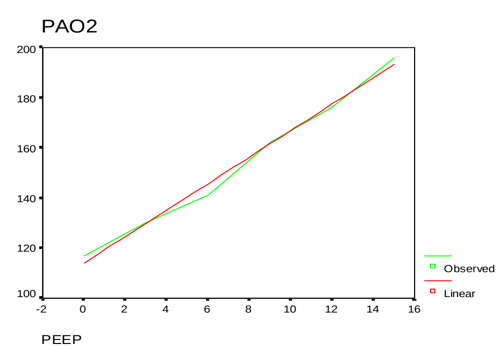


Figure 9: *Graphic presentation of PaO2 and PEEP*

Proportion growth recorded in the fair values of PaO2 with gradual increase of PEEP.

Correlations

		PAO2	PEEP
Pearson Correlation	PAO2	1.000	.995**
	PEEP	.995**	1.000
Sig. (2-tailed)	PAO2	.	.000
	PEEP	.000	.
N	PAO2	6	6
	PEEP	6	6

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6: *Correlation is worth at 0.995 level ,presented by Pearson correlation is significant at the 0.01 level*

Discussion

Respiratory distress syndrome is a pulmonary inflammatory disease characterized by pulmonary edema, bilateral pulmonary infiltration and refractory hypoxemia. ARDS clinical manifestations are associated with reduced functional residual capacity and static compliance.

Epidemiological data are linked with etiology; mortality, including cause of death, the presence of any other vital organ failure and improving of pulmonary function and quality of life.

The lack of a specific therapy in ARDS is associated with high morbidity and mortality and pose a significant financial burden for human health care. Therefore, from different studies on patients with ARDS, recognition of physiopathology mechanisms with inflammatory process in the early stages of the disease and fibro-proliferative stage in advanced stages of the disease, require the determination of strategies and supportive therapy, having as main objective the reduction of morbidity, mortality and improving the quality of life.

Although care for the treatment of ARDS has improved in recent decades, few studies have shown that a particular treatment may reduce mortality of this deadly syndrome. In recent editions of the New England Medical Journal was demonstrated strategies of pulmonary ventilation to minimize lung damage and reduce mortality by 22%.

An important issue in publications made for ARDS is: "What is important in recruitment manoeuvre and how to determine an optimal setting (of appropriate PEEP in patients with ARDS).

The pressure / volume (p / v) curve in the respiratory system plays a central role in developing the concept of pulmonary protection and offers a unique opportunity to assess alveolar recruitment/de recruitment. This information can be useful to characterize the stage of the disease and the identification optimal PEEP regime in ventilator, making the pressure / volume curve a valuable tool for the treatment of respiratory acute pulmonary impairment in ARDS.

Conclusions

The use of recruitment maneuvers and high PEEP is a fairly good way of ventilation in patients with ARDS

It is important to note that gaseous exchange parameters were evaluated prognostic factors in response of using PEEP

It is observed that the improvement of the PaO2 values in 24 hours after application of PEEP it is quite significant in patients who survive.

In fact, 88% of patients with PaO2 value > 220 mmHg survive.

MV with PEEP can not be considered as a solution to all hypoxemia severe cases, however, it allows number of patients with ARDS to survive ,because without it they would not survive.

The role of PEEP in clinical practice is still debatable, but in selected categories of patients with a careful monitoring, it may play an important role in improving outcome.

References

1. Lim CM, Jung H, Koh Y, Lee JS, Shim TS, Lee SD, Kim WS, Kim DS, Kim WD. Effect of alveolar recruitment maneuver in early acute respiratory distress syndrome according to anti de recruitment strategy, etiological category of diffuse lung injury, and body position of the patient. Crit Care Med.2003;31:411–418. doi: 10.1097/01.CCM.0000048631.88155.39.
2. Gattinoni L, Pelosi P, Suter PM, Pedoto A, Vercesi P, Lissoni A. Acute respiratory distress syndrome caused by pulmonary and extrapulmonary disease. Different syndromes? Am J Respir Crit Care Med.1998;158:3–11.
3. Steimback PW, Oliveira GP, Rzezinski AF, Silva PL, Garcia CSNB, Rangel G, Morales MM, Silva JRL, Capelozzi VL, Pelosi

PP, Rocco PRM. Effects of frequency and inspiratory plateau pressure during recruitment manoeuvres on lung and distal organs in acute lung injury. Intensive Care Med.2009;35:1120–1128. doi: 10.1007/s00134-009-1439-y.

4. Riva DR, Contador RS, Baez-Garcia CSN, Xisto DG, Cagido VR, Martini SV, Morales MM, Rocco PRM, Faffe DS, Zin WA. Recruitment maneuver: RAMP versus CPAP pressure profile in a model of acute lung injury. Respir Physiol Neurobiol. 2009; 169:62–68. doi: 10.1016/j.resp.2009.08.010
5. Iannuzzi M, De Sio A, De Robertis E, Piazza O, Servillo G, Tufano MA. Different patterns of lung recruitment manoeuvers in primary acute respiratory distress syndrome: effects on oxygenation and central hemodynamics. Minerva Anestesiol. 2010;76:692–698.
6. Chiumello D, Carlesso E, Cadringher P, Caironi P, Valenza F, Polli F, Tallarini F, Cozzi P, Cressoni M, Colombo A, Marini JJ, Gattinoni L. Lung stress and strain during mechanical ventilation for acute respiratory distress syndrome. Am J Respir Crit Care Med. 2008;178:346–355. doi: 10.1164/rccm.200710-1589OC.
7. Ashbaugh DG, Bigelow DB, Petty TL, et al. Acute respiratory distress in adults. Lancet 1967;2:319-23
8. ARDS Definition Task Force , Ranieri VM, Rubenfeld GD, et al. Acute respiratory distress syndrome: The Berlin Definition. JAMA 2012;307:2526-33
9. Bernard GR, Artigas A, Brigham KL, et al. Report of the American-European consensus conference on ARDS: definitions, mechanisms, relevant outcomes and clinical trial coordination. The Consensus Committee. Intensive Care Med 1994;20:225-32
10. National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network, Wiedemann HP, Wheeler AP, et al. Comparison of two fluid-management strategies in acute lung injury. N Engl J Med 2006;354:2564-75.
11. Bernard GR, Artigas A, Brigham KL, et al. The American-European Consensus Conference on ARDS. Definitions, mechanisms, relevant outcomes, and clinical trial coordination. Am J Respir Crit Care Med1994;149:818-24

12. Ferguson ND, Frutos-Vivar F, Esteban A, et al. Acute respiratory distress syndrome: underrecognition by clinicians and diagnostic accuracy of three clinical definitions. Crit Care Med 2005;33:2228-34
13. Villar J, Pérez-Méndez L, López J, et al. An early PEEP/FIO2 trial identifies different degrees of lung injury in patients with acute respiratory distress syndrome. Am J Respir Crit Care Med 2007;176:795-804
14. ARDS Definition Task Force , Ranieri VM, Rubenfeld GD, et al. Acute respiratory distress syndrome: The Berlin Definition. JAMA 2012;307:2526-33
15. D. Meininger, C. Byhahn, S. Mierdl, K. Westphal, and B. Zwissler, "Positive end-expiratory pressure improves arterial oxygenation during prolonged pneumoperitoneum," Acta Anaesthesiologica Scandinavica, vol. 49, no. 6, pp. 778–783, 2005.
16. G. Imberger, D. McIlroy, N. L. Pace, J. Wetterslev, J. Brok, and A. M. Møller,
17. "Positive End-Expiratory Pressure (PEEP) during anaesthesia for the prevention of mortality and postoperative pulmonary complications," Cochrane Database of Systematic Reviews, vol. 9, Article ID CD007922, 2010.
18. M. B. P. Amato, C. S. V. Barbas, D. M. Medeiros et al., "Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome," The New England Journal of Medicine, vol. 338, no. 6, pp. 347-354, 1998.
19. J. Villar, R. M. Kacmarek, L. Pérez-Méndez, and A. Aguirre-Jaime, "A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: a randomized, controlled trial," Critical Care Medicine, vol. 34, no. 5, pp. 1311–1318, 2006